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Health Impact Assessment (2014-2016) of Proposed Code Changes Regarding Individual Sewerage Systems in Suffolk County, New York

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Office of Research and Development
U.S. Environmental Protection Agency
Cincinnati, OH 45268

Notice

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This HIA Report and supporting materials are located at www.epa.gov/healthresearch/health-impact-assessments.

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Executive Summary

Background

This report documents the process and findings of a health impact assessment (HIA) conducted on the proposed changes to the Suffolk County Sanitary Code for single family residential individual sewerage systems. Suffolk County, New York is the eastern region of Long Island, the second largest county in total area in New York (including land and water), and with a population of nearly 1.5 million people, has more people than 11 U.S. states. In a town hall meeting held January 23, 2014, County Executive Steven Bellone announced “nitrogen pollution is public enemy number one for our bays, waterways, drinking supply and the critical wetlands and marshes that protect us from natural disasters like Super Storm Sandy…. Nitrogen pollution adversely affects our coastal resiliency, our environment, our economy, our land value, our tourism industry, and our recreational use of our waters.”[1]

Much of the nitrogen pollution in Suffolk County has been linked to unsewered, single-family residences that rely on individual sewerage systems – onsite sewage disposal systems (OSDS; i.e., cesspools) or septic tank-leaching pool systems (“conventional” onsite wastewater treatment systems or C-OWTS) – to manage their wastewater. These individual sewerage systems provide no treatment of nutrients (e.g., nitrogen) and limited treatment of pathogens (i.e., viruses, bacteria, and protozoa that can cause disease) before discharging the wastewater into the ground.

Revisions to the Suffolk County Sanitary Code went into effect on January 1, 1973, requiring the use of C-OWTS for single-family residences. However, individual sewerage systems constructed prior to 1973 were grandfathered in, and since that time, residents have been allowed to replace the systems in-kind (i.e., cesspools have not been required to be upgraded to “conventional” OWTS to meet the County standards). Suffolk County Department of Health Services (SCDHS) is proposing changes to the Suffolk County Sanitary Code that would require upgrading existing individual sewerage systems to meet current County standards (in place as of September 2016), as one of many strategies for addressing nitrogen pollution in Suffolk County’s waterways. The overarching goal of updating the Suffolk County Sanitary Code is to improve water quality and help protect public health. Suffolk County anticipates the code changes will help decelerate 1) the impairment of regional waters; 2) the frequency of harmful algal blooms; and 3) the loss of native eelgrass and wetland area, which are important for coastal resiliency.

This report documents the HIA as it was conducted, including the conditions, sanitary code in effect, and proposed code changes under consideration by Suffolk County at the time of analysis (December 2014 – September 2016). It should be noted that since completion of the HIA analysis and reporting of preliminary findings and recommendations to the decision-makers and stakeholders in the fall of 2016,

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[1] Suffolk County Government. (2014a, January 23). Tele-Town Hall Meeting on the Water Quality Crisis in Suffolk County. Hauppauge, New York, United States of America. Retrieved September 10, 2015, from http://www.suffolkcountyny.gov/Departments/CountyExecutive/WaterResourcesManagementPlan.aspx

Suffolk County entered into a period of robust activity working to change the local nutrient pollution paradigm. This included, among other things, consideration of different sanitary code changes than those assessed in this HIA. The activities and code changes undertaken after completion of the HIA analysis are noted throughout the report for informational purposes, but were not considered in the HIA analysis. A summary of actions and proposed wastewater upgrade recommendations that have occurred since the time of the HIA analysis can be found in the County's Subwatersheds Wastewater Plan (https://reclaimourwater.info/TheSubwatershedsWastewaterPlan.aspx).

Why was an HIA performed?

The U.S. Environmental Protection Agency (EPA) has identified HIA as one of many decision-support tools that can be used to provide science-based resources and information for community-driven initiatives and to promote sustainable and healthy communities. An important factor in deciding to conduct the HIA was the potential human health and environmental consequences of high-density, substandard (e.g., inadequately designed, sited, or maintained), and/or malfunctioning individual sewerage systems in Suffolk County – namely cumulative loading of nutrients and pathogens to groundwater. In Suffolk County, groundwater is the sole source of public drinking water and has a major influence on recreational waters and waters of economic importance. An HIA would broaden the health discussion and could be used to not only show how the proposed changes could impact health directly, but also indirectly through various health determinants like those identified by Suffolk County Executive Steve Bellone – the environment, coastal resiliency, economy, property value, tourism, and recreational water use. Suffolk County agreed to host an HIA, supported by EPA, to help inform the decision about the proposed code changes.

Who performed this HIA?

Staff in EPA guided the HIA process. They established the HIA Project Team, which consisted of EPA staff, contractors, research fellows, and professional stakeholders (e.g., individuals from academia; community organizations; local, county, and state government agencies; and environmental organizations) who served on the HIA Leadership Team and/or HIA Research Team. The HIA Project Team conducted the HIA with input and guidance from an HIA Technical Advisory Committee (TAC), made up of technical experts and representatives from several stakeholder groups. A TAC and Community Stakeholder Steering Committee (CSSC) were both initially established for the HIA, but the CSSC was later consolidated into the TAC due to low participation.

What methods were used in this HIA?

HIA is "a systematic process that uses an array of data sources and analytical methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program or project on health of a population and the distribution of those impacts within the population. HIA provides recommendations on monitoring and managing those effects."[2] The systematic HIA process

[2] National Research Council. (2011). Improving Health in the United States: *The Role of Health Impact Assessment.* Washington, D.C.: The National Academies Press.

includes six steps – *Screening, Scoping, Assessment, Recommendations, Reporting,* and *Monitoring and Evaluation*.

This HIA utilized a variety of methods to inform the assessment of health impacts, including the methods listed below. Beyond community and stakeholder engagement activities, this HIA did not involve primary data collection efforts, such as water sampling, water quality testing, or administration of human health surveys.

- ✓ Pre-existing and publicly-available data
- ✓ Geographic information systems (GIS) modeling, mapping, and spatial analyses
- ✓ Statistical and graphical analysis
- ✓ Systematic literature review
- ✓ Community engagement and expertise from local public health professionals, researchers, and other stakeholders
- ✓ Measurable (quantitative) and relative (qualitative) characterization of impacts

NOTE: Although scientific literature is useful and informative, it may sometimes be limited in its generalizability and broad applicability.

What was the scope of this HIA?

This HIA assessed the potential health impacts of four decision scenarios under consideration at the time of the HIA (Table ES-1) – the baseline (i.e., the existing conditions, should none of the alternatives be implemented) and the three alternatives outlined by SCDHS in the proposed code changes.

Based on input from stakeholders, including community members, scientific experts and decision-makers, the HIA Project Team identified pathways through which the proposed code changes could potentially impact health. The five pathways that were prioritized for assessment included:

- Individual Sewerage System Performance and Failure;
- Water Quality;
- Resiliency to Natural Disaster;
- Vector Control; and
- Community and Household Economics.

The HIA assessed each of these pathways by answering the following questions: What are the current conditions? – How will each decision alternative impact the current conditions? – What is the connection to health? – and – How might health be impacted by each decision alternative?

Table ES-1. Decision Scenarios Assessed

Decision Scenarios	Details
Baseline[*]	The existing conditions at the time of the HIA analysis.
Alternative I	All existing individual (onsite) sewage disposal systems[†] serving single-family residences must conform to current County Sanitary Code and standards (in place as of September 2016). All existing cesspools must be upgraded to the County-defined C-OWTS[‡] – a septic tank and leaching pool.
Alternative II	All existing individual (onsite) sewage disposal systems serving single-family residences in high priority areas[§] must conform to current County Sanitary Code and standards (in place as of September 2016). All existing cesspools on lots located in high priority areas must be upgraded to the County-defined C-OWTS – a septic tank and leaching pool.
Alternative III	All existing individual sewerage systems (either cesspool-only systems or C-OWTS)[‖] serving single-family residences in high priority areas must be upgraded to SCDHS-approved innovative/alternative OWTS[¶,**].

[*] The baseline is used as a point of comparison. The baseline does not represent the future state if no upgrades to individual sewerage systems are made.

[†] Onsite sewage disposal system (OSDS) describes the pre-1973 type of individual sewerage system that includes a disposal unit alone (i.e., a cesspool) serving single-family residences in Suffolk County.

[‡] "Conventional" onsite wastewater treatment system (C-OWTS) describes the post-1973 type of individual sewerage system that includes a septic tank and disposal unit (leaching pool) serving single-family residences in Suffolk County.

[§] At the time of the HIA analysis, SCDHS designated "high priority areas" as areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in SLOSH (Sea, Lake, and Overland Surges from Hurricanes) zones, and areas located where groundwater is less than 10 feet below grade. Priority area designations have since been revised and can be found in the Subwatersheds Wastewater Plan released by the County (https://reclaimourwater.info/TheSubwatershedsWastewaterPlan.aspx).

[‖] Individual sewerage system describes the overall category of individual (onsite) systems used to treat and/or dispose of wastewater from single-family residences in Suffolk County.

[¶] Innovative/alternative onsite wastewater treatment system (I/A OWTS) describes the innovative (pending approval) type of individual sewerage system designed for nitrogen reduction/control used as an alternative to the C-OWTS serving single-family residences in Suffolk County.

**Effluent nitrogen concentrations of 19 mg/L or less are a requirement for I/A OWTS approval.

Main Findings of the HIA and Recommendations for Decision-makers

Wastewater and Water Quality in Suffolk County

Nitrogen loading to waterbodies can come from a number of present-day sources, including wastewater, atmospheric deposition, fertilizer use, as well as legacy sources (i.e., past land use practices). Wastewater effluent from individual sewerage systems (and sewage treatment plants) has been shown to be a major source of nitrogen loading to Suffolk County waters. The type of individual sewerage system, its design, siting, operation, and maintenance all determine the ability of the system to control the wastewater constituents discharged to the environment, including nitrogen and pathogens. These systems discharge wastewater effluent into the soil, where it can make its way into the groundwater – the sole source of drinking water for the County. Due to hydrogeology and soil composition, constituents in wastewater effluent discharged into the soil can also have a major influence on surface, recreational, and, ultimately, coastal waters.

Although modeling shows that not all sewerage-derived nitrogen loading to the environment reaches receiving waters (i.e., waterbodies downgradient in the watershed), some modeling efforts indicate 60-70% of the nitrogen in individual sewerage system effluent may make its way through the groundwater to the estuaries of Long Island. This nitrogen loading can impact not only the water quality of Suffolk County estuaries but, through subsurface flow and overland transport of groundwater during heavy precipitation and overflow events (e.g., shallow groundwater flooding), can also affect freshwater resources and wetlands. In addition to nitrogen, wastewater can contain pathogens and other constituents that make their way through the aquifer and can impact the quality of groundwater and surface waters, cause human illness, and affect the local shellfish economy.

Nutrient and pathogen loading to Suffolk County waters can come from a number of sources. Regardless of source, potential problems associated with nitrogen and pathogen loading to Suffolk County waters include human illness; harmful algal blooms; beach closures; contamination and/or loss of fish and shellfish; promotion of mosquito habitat; coastal wetland loss; declines of stabilizing vegetation and eelgrass; declines in residential property values; and loss of revenue and employment from tourism, aquaculture, and recreation industries. Declines in coastal wetlands, stabilizing vegetation, and eelgrass can ultimately have an impact on shoreline resiliency to coastal flooding and lower-intensity storms.

Predicted Impacts of the Proposed Sanitary Code Changes

Soil characteristics, load rate to the system, age of the system, and operation and maintenance all play roles in the treatment performance of individual sewerage systems. The "conventional" OWTS (i.e., septic tank-leaching pool systems) called for in Decision Alternatives I and II can potentially provide a 1-$\log_{10}$ (10-fold)[3] reduction in pathogens in the effluent coming from the system, but are essentially ineffective at reducing nutrients (e.g., nitrogen). As a result, there would be no change in nitrogen loading and a limited reduction in pathogen loading to the environment expected with Alternatives I or II as compared to the baseline (current conditions). The innovative/alternative OWTS (I/A OWTS) in Alternative III, however, can provide a considerable reduction in nitrogen as compared to the baseline (particularly if the 19 mg/L or less total nitrogen effluent concentration required for SCDHS approval of these systems is achieved) and potentially a 1-$\log_{10}$ or greater reduction in pathogens in individual sewerage system effluent, when treatment/disinfection options are included.

[3] "Log reduction" is a mathematical term used to show the relative number of pathogens eliminated by treatment or disinfection. A 1-$\log_{10}$ reduction means lowering the number of pathogens by 10-fold. That is, if the raw wastewater going into the individual sewerage system had 100,000 pathogens in it, a 1-$\log_{10}$ reduction would reduce the number of pathogens in the liquid effluent—what comes directly out of the individual sewerage system, taking into account settling/treatment within the system and pumping from the system (if any)—to 10,000. This level of reduction may not be protective of human health.

The HIA demonstrated that the proposed decision alternatives could have both positive and negative effects on health through a number of health determinants (i.e., factors known to directly or indirectly impact human health), but only Alternative III would result in a net positive public health impact (Figure ES-1).

Community and Household Economics. There are considerable costs associated with all three Decision Alternatives, which could reduce the amount of expendable household income available for nutrition and essential health-related goods and services if funding assistance is not provided. However, upgrades could also result in new employment opportunities, and the improvements in water quality from Alternative III could result in increased property values and bolster revenue and employment from water-related industries.

Water Quality. Alternatives I and II ("conventional" OWTS or C-OWTS) would provide no nitrogen reduction and limited reduction in pathogens. The innovative/alternative OWTS (I/A OWTS) in Alternative III would provide a considerable reduction in nitrogen and may also reduce pathogens, especially when treatment/disinfection options are included. Water quality improvements in groundwater could influence the quality of surface, recreational, and coastal waters, all of which are essential to public health, the economy, and the desirability of living in Suffolk County.

The proposed decision has the potential to affect the risk of water-related illness, vector-borne disease, injury, and premature death; stress; and overall health and well-being.

Individual Sewerage System Performance and Failure. All three alternatives would reduce the risk of system failures and likely improve system performance through upgrades to existing systems, many of which are at the end of their useful lives (i.e., 25+ years old). Upgrades would also likely lead to reduced risk of injury due to structural failure (as long as original system components are no longer present or, if present, are filled with soil or gravel) and reduced risk of illness from exposure to untreated wastewater in cases of hydraulic failure (i.e., backup into the home or surfacing above ground), provided the systems are properly designed, sited, and maintained.

Resiliency to Natural Disasters. Nitrogen loading can contribute to the loss of native eelgrass and the wetlands that protect the shoreline from storm and tidal surges, flooding, and erosion, especially during lower intensity storms and coastal flooding. While the reduction in nitrogen loading from implementing Alternative III should help increase wetlands and eelgrass, the degree of improvement in shoreline protection is unknown, as there are other factors contributing to the loss of eelgrass and wetlands (e.g., legacy nitrogen loading, accelerated sea level rise, etc.). Storm and tidal surges and coastal flooding can lead to property and infrastructure damage, evacuations, and human injury and death.

Vector Control. Upgrades to individual sewerage systems would reduce the number of old, failing systems and reduce potential mosquito breeding habitats and mosquito populations near residential areas, if systems are maintained. Alternative III would lead to a further reduction in mosquito populations by reducing nitrogen-enriched waters. Reductions in mosquito habitat would reduce the spread of mosquito-borne diseases and the need for pesticide application for mosquito control.

Figure ES-1. Predicted impacts of the proposed sanitary code changes on health and health determinants through five pathways examined in the HIA.

The HIA determined that there might be unequal sharing of the burdens and/or benefits of the proposed code changes within the population. Some subgroups within the population may be more sensitive to or more affected by the changes in the physical and natural environment, social environment, and/or economic environment as a result of the decision, including:

- low-income households,
- minority households,
- young children (under 5 years of age),
- pregnant and/or nursing women,
- older adults (over 65 years of age) and physically disabled,
- populations residing in unsewered residences constructed over 25 years ago or in flood-prone or high groundwater areas,
- residents with individual sewerage systems and private drinking water wells, and
- coastal populations and those living and working in areas experiencing Sea, Lake, and Overland Surges from Hurricanes (i.e., SLOSH zones).

Recommendations for Managing These Impacts

The HIA Project Team identified recommendations for maximizing the potential positive health impacts, minimizing or avoiding the potential negative health impacts, and offering decision alternatives and health supportive measures. Adoption of any of these recommendations is at the discretion of the decision-maker, Suffolk County. Recommendations were developed related to:

- General Recommendations;
- Planning and Implementation of the Proposed Code Changes;
- Outreach and Communication;
- I/A OWTS Evaluation;
- System Siting, Design, and Installation;
- System Maintenance;
- Cost Control and Funding Measures;
- Employment and Hiring; and
- Protection of Water Resources.

In addition to these recommendations related to the proposed sanitary code changes themselves, additional recommendations beyond the code changes were developed to address some of the issues identified by the County (e.g., nitrogen loading and resiliency). These health-supportive measures relate to Wetland Protection/Restoration, Wetland/Green Infrastructure Creation, and Resiliency Planning.

Conclusion

The proposed code changes will have health impacts, both positive and negative; although only Alternative III could result in a net positive public health impact. Recommendations for promoting the positive health impacts and reducing the negative health impacts of all three decision alternatives are provided in this report. It should be noted that since completion of the HIA analysis and reporting of preliminary findings and recommendations to the decision-makers and stakeholders in the fall of 2016, Suffolk County entered a period of robust activity working to change the local nutrient pollution paradigm.

The County revised the Suffolk County Sanitary Code and the residential and commercial construction standards to define requirements for the design and construction of innovative/alternative onsite wastewater treatment systems (I/A OWTS) and developed standards for management and approval of I/A OWTS. The County has provisionally approved six I/A OWTS for use in Suffolk County and completed reports summarizing the 2016, 2017, 2018, and 2019 performance of the I/A OWTS installed in Suffolk County and neighboring jurisdictions. The County has implemented a Septic Improvement Program to provide grants and low-interest financing to make system upgrades more affordable for homeowners, and several individual town-septic upgrade assistance programs are now in place in Suffolk County, as well. County-specific nitrogen loading models have been completed for several areas and a countywide modeling effort has recently been completed to delineate subwatersheds, establish travel times, and establish nitrogen load reduction goals for all surface waterbodies and public supply wells in Suffolk County. To learn more about these and other efforts undertaken by the County since the completion of the HIA, visit: https://reclaimourwater.info/.

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Abbreviations/Acronyms

C Context Clue **L** Limitation Recommendations

ACS	American Community Survey
ADD	attention deficit disorder
APHA	American Public Health Association
BAT	best available technology
BNR	biological nutrient removal
BOD	biological oxygen demand
BRFSS	Behavioral Risk Factor Surveillance System
B.t.i.	*Bacillus thuringiensis israelensis*
CDC	U.S. Centers for Disease Control and Prevention
CDESS	Communicable Disease Electronic Surveillance System
CEHA	Coastal Erosion Hazard Areas
CEQ	Council for Environmental Quality
CERT	Community Emergency Response Team
CFU	colony forming units
CHNA	community health needs assessments
cm	centimeters
C-OWTS	conventional onsite wastewater treatment system
CPF	Community Preservation Fund
CRRA	Community Risk and Resiliency Act
CSO	combined sewer overflow
CSSC	Community Stakeholder Steering Committee
CSSLP	Community Septic Service Loan Program
CWSRF	Clean Water State Revolving Fund
DDT	Dichlorodiphenyltrichloroethane
DEQ	Department of Environmental Quality
DHS	U.S. Department of Homeland Security
DIN	dissolved inorganic nitrogen
DO	dissolved oxygen
DON	dissolved organic nitrogen
DOT	Department of Transportation
DSP	diarrhetic shellfish poisoning
DWRLF	Drinking Water Revolving Loan Program
ECHO	Enforcement and Compliance History Online
EEEV	eastern equine encephalitis virus
EFC	Environmental Facilities Corporation
EFDC	Environmental Fluids Dynamic Code
EHEC	enterohaemorrhagic *E. coli*
EJ	environmental justice

EJSCREEN	Environmental Justice Screening and Mapping Tool
EMS	emergency medical services
ENR	enhanced nutrient removal
EPA	U.S. Environmental Protection Agency
FEMA	U.S. Federal Emergency Management Agency
FIB	fecal indicator bacteria
FIRM	flood insurance rate maps
g	grams
GEBCO	General Bathymetric Chart of the Oceans
GEIS	General Environmental Impact Statement
GIS	geographic information systems
GNIS	Geographic Names Information System
HAB	harmful algal bloom
HAZUS-MH	Hazards U.S.-Multihazard
HIA	Health Impact Assessment
HPA	high priority area
HUD	U.S. Department of Housing and Urban Development
IA	individual assistance (FEMA)
I/A OWTS	innovative/alternative onsite wastewater treatment system
ICU	intensive care unit
IMM	integrated marsh management
IPM	integrated pest management
ISPF	individual sewerage system performance and failure
kg	kilograms
L	liters
LICAP	Long Island Commission for Aquifer Protection
LILWA	Long Island Liquid Waste Association
LiMWA	Limit of Moderate Wave Action
LINAP	Long Island Nitrogen Action Plan
LIRPC	Long Island Regional Planning Council
LIS	Long Island Sound
LIVOAD	Long Island Voluntary Organization Active in Disaster
m	meters
MDE	Maryland Department of the Environment
mg	milligrams
MIT	Massachusetts Institute of Technology
mL	milliliters
mm	millimeters
MPN	most probable number
MS4	Municipal Separate Storm Sewer System
N_2	nitrogen
NAICS	North American Industry Classification System
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NGDC	National Geophysical Data Center

NHD	National Hydrography Dataset
NH_3	ammonia
NLM	Nitrogen Loading Model
NO_3-	nitrate
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NSFC	National Small Flows Clearinghouse
NWI	National Wetlands Inventory
NYCRR	New York Codes, Rules, and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York Department of Health
NYSDOS	New York State Department of State
O&M	operations and maintenance
OEM	Office of Emergency Management
ORD	Office of Research and Development
OSDS	onsite sewage disposal system
OWTS	onsite wastewater treatment system
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEP	Peconic Estuary Program
PPD	Presidential Policy Directive
PSP	paralytic shellfish poison
PTSD	posttraumatic stress disorder
RIWPCRF	Rhode Island Water Pollution Control Revolving Fund
RME	responsible management entity
ROE	Rules of Engagement
RPA	Regional Plan Association
SAV	submerged aquatic vegetation
SCDEDP	Suffolk County Department of Economic Development and Planning
SCDEQ	Suffolk County Department of Environmental Quality
SCDHS	Suffolk County Department of Health Services
SCDPW	Suffolk County Department of Public Works
SC SWP	Suffolk County Subwatersheds Wastewater Plan
SCUPE	Septic/Cesspool Upgrade Program Enterprise
SCWA	Suffolk County Water Authority
SEQRA	State Environmental Quality Review Act
SFHA	Special Flood Hazard Area
SHC	Sustainable and Health Communities
SIP	Septic Improvement Plan
SLOSH	sea, lake, and overland surges from hurricanes
SNAP	Supplemental Nutrition Assistance Program
SOPHIA	Society of Practitioners of HIA

SSO	sanitary sewer overflow
STEC	Shiga toxin-producing *E. coli*
STILF	Sewer Tie-in Load Fund
STP	Sewage treatment plant
SUNY	The State University of New York
SWAP	Source Drinking Water Assessment Program
SWSD	Southwest Sewer District
TAC	Technical Advisory Committee
TCA	1,1,1 trichloroethane
TKN	total kjeldahl nitrogen
TMDL	Total Maximum Daily Load
TN	total nitrogen
TNC	The Nature Conservancy
TP	total phosphorous
TSS	total suspended solids
µg	microgram
ULV	ultra-low volume
USFWS	U.S Fish and Wildlife Service
USGS	U.S. Geological Survey
WHO	World Health Organization
WIC	Women, Infants, and Children
WNV	West Nile Virus
WQFA	Water Quality Financing Administration
WSC	Wetlands Stewardship Committee
WWTP	wastewater treatment plant
yr	Year

1. Introduction

Many communities across the United States are facing issues related to aging infrastructure, limited financial resources, and impaired surface and ground waters. Additionally, population growth can mean a growing need for development and businesses and an additional stress on aging infrastructure. The accelerated development of land can put a strain on the local ecosystem and surrounding natural resources. Decisions are often a result of trade-offs between the needs of people and the needs of the environment in which they live. Such trade-offs may yield short-term benefits, but also long-term adverse consequences.

The U.S. Environmental Protection Agency (EPA) is working to test models, tools, and best practices that enable the shift from trade-off to mutual benefit so that communities can move towards more sustainable and healthy states. This is achieved by "creating and maintaining the conditions under which humans and nature can exist in productive harmony, that permit the fulfilling of social, economic and other requirements of present and future generations" (EPA, 2016a). EPA's Sustainable and Healthy Communities (SHC) Research Program, in the Office of Research and Development (ORD), has identified health impact assessment (HIA) as one of many decision-support tools for providing science-based resources and information to decision-makers and for promoting sustainable and healthy communities.

1.1. HIA: A Tool for Sustainable and Healthy Communities

The pursuit of more sustainable solutions has steered public health professionals to promote the use of more comprehensive and integrated approaches to addressing public health challenges. HIA is one of the many tools used to consider health in traditionally non-health related decision-making processes. HIA has been used to manage potential impacts of proposed decisions to promote and protect the health of individuals and the community.

What is HIA?

The National Research Council (NRC) defines HIA as "a systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of those effects within the population. HIA provides recommendations on monitoring and managing those effects" (National Research Council, 2011). HIA was developed based on the awareness that health, which is defined by the World Health Organization (WHO, 1948) as "a state of complete physical, mental, and social well-being; not merely the absence of disease and infirmity," is influenced by a spectrum of determinants (Figure 1-1). These health determinants are factors known to directly or indirectly impact an individual's health.

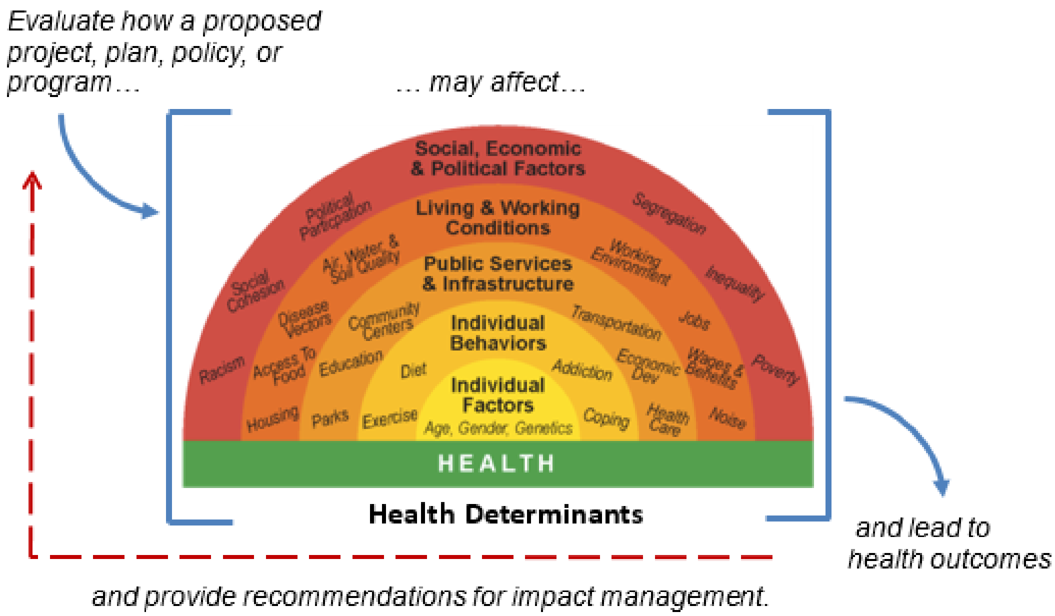

Figure 1-1. Overview of HIA and the role of health determinants in overall health.

Five essential "core values" guide the design and implementation of HIA (Quigley, et al., 2006):

- ***Comprehensive approach*** to individual and community health issues (i.e., the analysis of potential health impacts is guided by the wider determinants of health, including physical, social, and economic factors that impact health);
- ***Equity*** in the opportunity for healthy living (i.e., includes authentic participation of the community and vulnerable populations, consideration of the distribution of health impacts across the population (paying specific attention to vulnerable groups), and recommendations to improve the proposed decision for affected groups and ensure equitable distribution of health benefits;
- ***Democracy*** in the decision-making process (i.e., community members and other stakeholders are engaged throughout the process to help inform and influence decisions that affect their lives);
- ***Sustainable development*** (i.e., both short-term and long-term goals and impacts of the decision are examined to ensure that the decision is sustainable both in the present and for future generations); and
- ***Ethical use of evidence*** that includes transparent and rigorous methods (i.e., use of the best-available qualitative and quantitative evidence to determine potential impacts and inform recommendations, remaining neutral to the decision result and advocating only for health and wellness, and communicating the evidence, findings, and recommendations of the HIA to decision-makers and stakeholders).

There are six major steps in the HIA process – *Screening, Scoping, Assessment, Recommendations, Reporting, and Monitoring and Evaluation* – each of which have several tasks involved (Bhatia R. , 2011;

Human Impact Partners, 2011; National Research Council, 2011; Bhatia, et al., 2014; Human Impact Partners, 2014)

Table 1-1 lists the six steps of the HIA process and provides a brief description of each step.

Table 1-1. Steps of the HIA Process

HIA Step	Description
Screening	Determines whether HIA is an appropriate approach to evaluate the pending decision and whether the HIA will provide information useful to the stakeholders and decision-makers. The proposal, any decision alternatives, and the anticipated added value of the HIA are explicitly identified.
Scoping	Establishes the purpose, goals, and team that will perform the HIA. Boundaries of the assessment are defined, including the geographic area, timeframe in which the HIA will be completed, health impacts that will be appraised, and the population and vulnerable sub-groups that will be impacted by the proposal.
Assessment	Involves a two-part process that a) describes the existing (baseline) status of health and related factors, and b) forecasts potential impacts that may result from the decision. A variety of data sources and analytical methods are used.
Recommendations	Identifies actions or strategies to manage the health impacts of the decision, if any are predicted. Recommendations are developed to maximize potential benefits and minimize or avoid potential adverse impacts.
Reporting	Documents the HIA activities, materials developed, and communicates the findings and recommendations of the HIA to stakeholders and the public.
Monitoring and Evaluation	Involves (or provides a plan for) follow-up activities that track how the HIA was implemented, the result of the decision, and impacts of the decision. Evaluations should be included that assess the HIA's impact on the decision and/or decision-making process (i.e., impact evaluation), whether the HIA met its intended goals/objectives and practice standards (i.e., process evaluation), and whether the decision affected health (i.e., outcome evaluation).

The steps of HIA provide a structured, yet flexible framework for conducting an HIA, and are not necessarily performed in a linear sequence. For instance, although the decision as to which impacts will be examined in the HIA is made in the *Scoping* step, this decision may be revised as a result of evidence collected in the *Assessment* step of the process. In addition, impact and process evaluation (part of the *Monitoring and Evaluation* step) and *Reporting* can be performed throughout the process.

1.2 HIA in Suffolk County

Suffolk County, New York is the eastern region of Long Island, the fourth most populated county in New York and larger in population than 11 states (Figure 1-2). Suffolk County was home to over 1.4 million people as of the 2010 Census (and as of publication of this report, the population of the County was nearing 1.5 million).

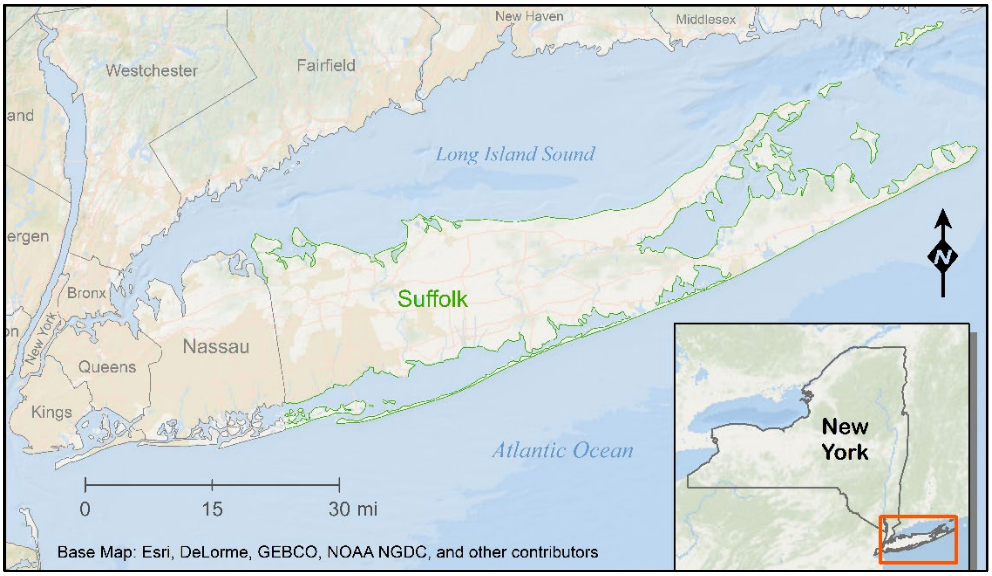

Figure 1-2. Suffolk County, New York, eastern Long Island.

In October 2012, Hurricane Sandy, one of the costliest hurricanes in the history of the United States, struck Long Island. Shortly thereafter, EPA, the Federal Emergency Management Agency (FEMA), New York State Department of State (NYSDOS), New York State Department of Environmental Conservation (NYSDEC), Long Island counties (Nassau and Suffolk), and the Metropolitan Transportation Authority (i.e., the Partnership) began collaborating on several efforts on Long Island to promote more resilient and sustainable recovery. This partnership was, in part, an outgrowth of a broad collaboration through the National Disaster Recovery Framework, Presidential Policy Directive (PPD-8), in addition to the U.S. Department of Housing and Urban Development (HUD, 2013) Hurricane Sandy Federal Recovery Support Strategy.

EPA, in collaboration with FEMA Region 2, delivered a two-day HIA training as part of Hurricane Sandy recovery efforts in January 2014. In attendance were individuals from EPA, FEMA, American Red Cross, and Suffolk County government. In May 2014, the Partnership organized a conference, “Accepting the Tide: A Roundtable on Integrating Resilience and Smart Growth on a Post-Sandy Long Island,” which brought together a wide variety of stakeholders from across the island. EPA gave a presentation at the roundtable about HIA and how HIA is used to support decision-making processes. As a result of the Roundtable, the Partnership decided to focus efforts on ecosystem services valuation and health impact assessment to guide Hurricane Sandy recovery and redevelopment efforts on Long Island. Suffolk

County agreed to host a pilot HIA that would help the County's recovery efforts and achieve resiliency and sustainability goals.

1.3 What is this HIA about?

> ***Individual Sewerage Systems***
>
> Because there are many different types of systems that receive and dispose of wastewater coming from a residence, decentralized, individual (onsite) systems will collectively be referred to as individual sewerage systems in this report. Appendix A defines the various individual sewerage system terms used in this HIA.

Because of a growing concern about increased nitrogen loadings to Long Island waterways and the need to rebuild more resiliently after Hurricane Sandy, Suffolk County proposed changes to their sanitary code (Suffolk County Code Chapter 760) that would require upgrading existing onsite sewage disposal systems (OSDS) – the pre-1973 type of individual sewerage system serving single family residences in Suffolk County that includes only a disposal unit – to meet current County code and standards (in place as of September 2016; https://www.reclaimourwater.info/regulatory.aspx), as one of many strategies for reducing nutrient loading to regional waterways from residential sewage systems.[4] The overarching goal of these code changes is to reduce nutrient and pathogen loading to surface and ground waters from residential sewerage systems in order to improve water quality and help protect public health. Suffolk County anticipates the code changes will help decelerate 1) the impairment of surface waters, 2) the frequency of harmful algal blooms, and 3) the loss of native eelgrass and wetland area, which are important for coastal resiliency. Suffolk County hosted an HIA, guided by the EPA, to help inform the decision about the code changes. Suffolk County Department of Health Services (SCDHS), its administrative Board of Health, and the Suffolk County Legislature ultimately make the decision on which code changes get adopted.

EPA Office of Research and Development (ORD), the scientific research arm of EPA, supported this HIA. ORD conducts research for EPA that informs Agency decisions, provides the foundation for credible decision-making to safeguard human health and ecosystems from environmental pollutants, and supports the emerging needs of EPA stakeholders, including the Agency's state, tribal, and community partners. Although this HIA was conducted to help inform a county-level policy decision around sanitary code changes, it is important to note that policy-making is outside the purview of EPA ORD. Any action by Suffolk County to implement any "Recommendations" shared in this report is entirely voluntary and at the discretion of Suffolk County, as the decision-maker. As indicated in the Notice (on page ii), the

[4] At the time the HIA started, the Suffolk County Sanitary Code (Suffolk County Code Chapter 760, revised November 2011) and its implementing standards were in effect. The standards and articles of code applicable to the decision, and considered in the HIA, included Article 6 (6/28/1995), General Guidance Memorandum #12 (6/8/2000), and Standards for Approval of Plans and Construction for Sewage Disposal Systems for Single Family Residences (1/9/2004). During the course of the HIA analysis, Article 19 was added to the Sanitary Code (7/2016) and interim revisions were adopted to the Standards for Approval of Plans and Construction for Sewage Disposal Systems for Single Family Residences (9/21/2016).

views expressed in this report are those of the authors and do not necessarily represent the views or the policies of the EPA.

1.4 HIA Reader's Guide

This report documents the process and findings of this HIA, including potential health impacts of the proposed code changes and whether the code changes have the potential to achieve the outcomes anticipated by Suffolk County.

Key findings of the HIA are shown in bold. Throughout the report you will also find context clues, limitations of analysis, and recommendations for the decision-maker indicated as follows:

C Context Clue – indicates information unique to Suffolk County and/or extenuating circumstances (e.g., effect of sea level rise, climate change, and soil erosion)

L Limitation – indicates assumptions made and/or limits of analysis

Recommendation – indicates the initial recommendations developed during the HIA *Assessment* step that could be used to help manage the impacts of the decision; these are presented in the context of the *Assessment* discussion to help tie the recommendation to the HIA findings. The process that was undertaken for development and vetting of the recommendations, along with the final recommendations developed as part of this HIA, are presented in Section 5.

The HIA Report is organized into the following sections:

- **Section 1: Introduction.** Provides background and an introduction to HIA in general and more specifically to this HIA conducted in Suffolk County, NY.
- **Section 2: Screening for an HIA.** Documents the sanitary code changes considered in Suffolk County and how the decision to conduct an HIA was made.
- **Section 3: Scoping the HIA.** Explains the process that was used to identify HIA participants, engage stakeholders, determine the scope of the HIA, and develop an overall methodology for conducting the HIA.
- **Section 4: Assessment of Existing Conditions and Potential Health Impacts.** Documents the qualitative and quantitative evidence used to assess five pathways through which the proposed sanitary code changes could potentially impact health and discuss the findings of that assessment.
- **Section 5: Recommendations: Considerations for Managing Impacts of the Decision.** Identifies evidence-based recommendations for managing the predicted health impacts of the sanitary code changes, so that potential benefits are maximized, and potential harms are avoided and/or minimized.
- **Section 6: Reporting.** Documents how communication and reporting of HIA findings and recommendations were accomplished.

- **Section 7: Monitoring and Evaluation.** Provides an evaluation of the HIA process, including successes, challenges, and lessons learned, and outlines actions that can be taken to determine the impact of the HIA on the decision-making process and monitor the impact of the code changes on health.
- **Section 8: References.** Documents the evidence used in the HIA.
- **Appendices.** Contain supporting data and information.

Note: The HIA Project Team recognizes that this HIA Report is an extensive document and due to the level of detail provided in the report may not be easy to manage or use for advocacy and/or raising awareness within the community. Therefore, a summary of the full HIA Report and a fact sheet on the findings of the HIA have also been produced. All of these documents are located on EPA's HIA website (https://www.epa.gov/healthresearch/health-impact-assessments).

2. Screening for an HIA

Screening is the first step in the HIA process in which the proposed decision is clearly defined, including any alternative scenarios, and stakeholders consider whether an HIA is needed, feasible, and would add value to the decision-making process (National Research Council, 2011). Not all screenings result in an HIA, because an HIA is not always warranted and may not be the best approach for bringing human health into a decision. HIAs should be initiated when health is not already being considered in the decision, the decision has the potential to significantly impact health, or disproportionate health consequences are likely. In addition, there should be enough time for the completed HIA to inform the decision, and sufficient stakeholder interest and capacity for conducting the HIA. The outputs of the *Screening* step in an HIA include:

- A description of the proposed policy, program, plan, or project that will be the focus of the HIA, including the timeline for the decision and intervention points at which HIA information will be used (see Section 2.1).
- A statement of why the proposed decision was selected for screening and which factors were considered in making the decision to conduct an HIA (see Section 2.2).
- A description of the potential for the proposed decision to impact health (see Section 2.2).
- The expected resource requirements of the HIA and the capacity that exists to meet them (see Section 2.2).
- A description of the political and policy context of the decision and consideration for the opportunities to influence decision-making or otherwise make health-oriented changes (see Section 2.2). (National Research Council, 2011)

The following individuals participated in the HIA *Screening* discussions in Suffolk County: Florence Fulk, EPA Office of Research and Development (ORD); Anhthu Hoang, and Rabi Kieber EPA, Region 2; John Halfon, FEMA Region II; and Sarah Lansdale, Suffolk County Department of Economic Development and Planning (SCDEDP). *Screening* participants agreed that the proposed decision to change the Suffolk County Sanitary Code regarding individual sewerage systems would benefit from an HIA and decided to move forward with conducting the HIA.

2.1 The Proposed Decision: Changes to the Suffolk County Sanitary Code

Article 6 of the Suffolk County Sanitary Code (SCDHS, 1995) lays out the wastewater treatment requirements in Suffolk County for new construction, but does not give Suffolk County the authority to enforce upgrades of existing OSDS when there is no new construction proposed. SCDHS (2014a) proposed the following changes to the Suffolk County Sanitary Code (original document provided in Appendix B) to allow enforcement of OSDS upgrades (Table 2-1):

Table 2-1. Proposed Sanitary Code Changes at the Time of HIA Analysis

Alternatives	Details
Alternative I	All existing individual (onsite) sewage disposal systems serving single-family residences must conform to current County Sanitary Code and standards (in place as of September 2016). All existing cesspools must be upgraded to the County-defined "conventional" OWTS (septic tank and leaching pool).
Alternative II	All existing individual (onsite) sewage disposal systems serving single-family residences in high priority areas* must conform to current County Sanitary Code and standards (in place as of September 2016). All existing cesspools on lots located in high priority areas must be upgraded to the County-defined "conventional" OWTS (septic tank and leaching pool).
Alternative III	All existing individual sewerage systems (either cesspool-only systems or "conventional" OWTS) serving single-family residences in high priority areas* must be upgraded to SCDHS-approved innovative/alternative (I/A) OWTS.

* At the time of the HIA analysis, SCDHS designated "high priority areas" as areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in SLOSH (Sea, Lake, and Overland Surges from Hurricanes) zones, and areas located where groundwater is less than 10 feet below grade. Priority area designations have since been revised and can be found in the Subwatersheds Wastewater Plan released by the County (https://reclaimourwater.info/TheSubwatershedsWastewaterPlan.aspx).

This report documents the HIA as it was conducted, including the conditions and proposed code changes under consideration by the County at the time of analysis. It should be noted that since completion of the HIA analysis and reporting of preliminary findings and recommendations to the decision-makers and stakeholders in the fall of 2016, Suffolk County entered into a period of robust activity working to address nutrient pollution. This included further demonstration testing, sampling, and provisional approval of I/A OWTS for use in the County; convening of an Article 6 Working Group; consideration of different sanitary code changes than those assessed in the HIA; development of standards for approval and management of I/A OWTS; development of a Subwatersheds Wastewater Plan to guide future policy and implementation procedures; as well as other actions taken in accordance with Suffolk County's Reclaim Our Waters initiative (http://www.reclaimourwater.info/) and the Long Island Nitrogen Action Plan (LI NAP). For more on the activities conducted in the County since completion of the HIA analysis, please see the last Appendix of this report (Appendix K).

2.1.1 Details of the Proposed Code Changes at the Time of HIA Analysis

In the SCDHS (2014a) proposal, three potential strategies for implementing the proposed code changes were outlined, although final implementation methods had not yet been determined:

1) Upon Failure of existing OSDS – As part of their licensing obligations, cesspool contractors would be required to report to SCDHS when a system has been pumped multiple times in a given period or is in need of replacement, as part of their licensing obligations. SCDHS would then send a legal notice to the property owner requiring them to apply for a permit to upgrade their OSDS.

2) Upon property transfer – In order to initiate the sale of a property, the current property owner would be required to obtain a certificate from SCDHS indicating their existing sewerage system complies with current code requirements or submit an application to obtain a permit to upgrade their OSDS, if not in compliance.
3) Fixed schedule by region – SCDHS would prioritize areas of the County with parcels that rely on individual sewerage systems and assign a fixed schedule (by region) for property owners to provide proof to SCDHS that their existing sewerage system meets current code requirements or upgrade the system.

When the code changes were proposed, no I/A OWTS was permitted for general use in Suffolk County for single family residences. In December 2014, Suffolk County launched a Septic Demonstration Pilot Project to evaluate I/A OWTS technologies that, at a minimum, are designed to reduce total nitrogen (TN) in treated effluent to 19 mg/L (Suffolk County Government, 2015a; SCDHS, 2016a). Three firms were demonstrating their systems on private residential properties (selected via lottery) – BUSSE Green Technologies (which utilizes the ***membrane bioreactor treatment process***), Hydro-Action Industries, and Norweco (both of which utilize ***extended aeration and activated sludge processes***) – and a fourth firm was demonstrating its system on County municipal property (SCDHS, 2014b).

In July 2016, the Suffolk County Legislature approved an amendment to the Sanitary Code, adding Article 19, which gave SCDHS the authority to develop procedures, protocols, and standards for approving the use of I/A OWTS throughout the County and establishing effluent TN concentrations of 19 mg/L or less as a requirement for I/A OWTS approval (SCDHS, 2016b). The 19 mg/L TN performance requirement mimics the requirements established in Rhode Island and Massachusetts I/A OWTS programs. Six weeks later, it was announced that for the first time in Suffolk County history, an I/A OWTS had been provisionally approved for residential use. The approved system was manufactured by Hydro-Action Industries (one of the three firms that participated in the pilot program).

See Appendix C for more details on Article 19, these I/A OWTS technologies, the demonstration process at the time of the HIA, and the provisional approval of the Hydro-Action system for residential use in the Suffolk County[5].

2.1.2 Motivation for the Proposed Code Changes

In a tele-town hall meeting on January 23, 2014, County Executive Steven Bellone announced “nitrogen pollution is public enemy number one for our bays, waterways, drinking supply and the critical wetlands and marshes that protect us from natural disasters like Super Storm Sandy…. Nitrogen pollution adversely affects our coastal resiliency, our environment, our economy, our land value, our tourism industry, and our recreational use of our waters” (Suffolk County Government, 2014a). Suffolk County asserts, “much of the nitrogen pollution in Suffolk County waters has been linked to unsewered, dense

[5] See Appendix K for information on demonstration testing, sampling, and provisional approval of additional I/A OWTS that occurred after completion of the HIA analysis.

suburban sprawl" (Suffolk County Government, 2015a) and therefore, the County needs to address the problems associated with unsewered residences.

In 1958, the first countywide standards for construction of OSDSs went into effect, requiring concrete block cesspools for single-family homes. On January 1, 1973, updates to the Suffolk County Sanitary Code went into effect, requiring all new construction and/or renovations of single-family residences to utilize a conventional OWTS consisting of a 900-gallon septic tank upstream of a reinforced precast concrete leaching pool (cesspool), when a community sewage disposal system was not available (SCDHS, 2014a). At the time that the proposed code changes were being considered, the Suffolk County Sanitary Code (Suffolk County Code Chapter 760, revised November 2011) and implementing standards allowed property owners of failed cesspools and conventional OWTS to replace the systems in-kind (i.e., it did not require cesspools to be upgraded to meet the current standards).

By 1990, an estimated 70.7% of total Suffolk County housing units (estimated at 340,519) were served by individual sewerage systems (National Environmental Services Center, n.d.) and today, Suffolk County Department of Economic Development and Planning (SCDEDP) estimates that approximately 74% or 360,000 residences utilize individual sewerage systems (Suffolk County Government, 2015a). Of those approximately 360,000 residences, about 252,000 were built prior to 1973 and are assumed to be served by cesspools alone (i.e., no septic tank). According to SCDEDP, approximately 209,000 of the unsewered residences are located in environmentally sensitive areas, referred to as the "high priority areas" (Suffolk County Government, 2015a).

Unsewered Areas in Suffolk County

Unsewered areas in Suffolk County are served by decentralized sewage treatment plants (STPs) – smaller-scale sewage treatment plants – or individual sewerage systems.

Decentralized STPs are typically used for apartment buildings, condos, hotels, or commercial buildings built on single lots. The majority of these decentralized STPs are designed to control nitrogen. SCDHS has undertaken efforts to require those STPs that lack nitrogen removal capabilities and those with under-performing treatment performance to be renovated or replaced (Dale, 2017). The sanitary code requirements for these types of buildings are detailed separately from requirements for single-family residences.

The vast majority of Suffolk County residences (360,000 or more) and most commercial buildings (over 39,000) use individual sewerage systems – cesspools or septic tank-leaching pool systems – that provide little to no treatment of the wastewater before discharging it into the ground (Dale, 2017).

Suffolk County is looking to curtail nitrogen discharge to groundwater from residential sewerage systems as one means to help reduce nitrogen loading to County waters (SCDHS, 2014c).

2.2 The Decision to Conduct the HIA

Screening participants agreed that the proposed decision to change the Suffolk Sanitary Code regarding individual sewerage systems would benefit from an HIA. It was determined that the HIA was needed, feasible, and would add value to the decision-making process. HIA would broaden the health discussion and could be used to not only show how the proposed code changes could directly impact human health, but also impact human health indirectly through various health determinants, like those identified by Suffolk County Executive Steve Bellone – the environment, coastal resiliency, economy, property values, tourism, and recreational water use.

The potential human health and environmental consequences of copious, substandard (e.g., inadequately designed, sited, or maintained), and/or malfunctioning individual sewerage systems, namely cumulative loading of nutrients and pathogens to groundwater, was a major factor in deciding to conduct the HIA. In Suffolk County, individual sewerage systems are the primary mode of wastewater management for residences. Also, groundwater is the sole source of public drinking water in Suffolk County and has a major influence on recreational waters and waters of economic importance; the quality of groundwater is essential to ensuring public health protection. Households that rely on private drinking water wells may be more at risk of health impacts from water quality issues, if drinking water is not properly treated before consumption. Another factor was that the information provided by the HIA would be timely and relevant to the decision-making process. SCDHS proposed the sanitary code changes as part of a larger initiative to address growing issues from nutrient loading of Suffolk County soil, groundwater, and surface waters. The HIA process could help inform the decision to change the County Sanitary Code, assuming that the County's priorities remain the same. The HIA provides information to the County and to the public about the potential beneficial and adverse impacts to health that may result from the decision.

Based on the information provided and resources available to conduct the HIA within the Agency, EPA agreed to oversee an HIA to evaluate the proposed code changes in Suffolk County from a health-focused perspective. As an EPA HIA Case Study, the HIA would be conducted from a neutral position (i.e., not advocating for or against any code change alternative) and help make the relationships between nature (ecosystem goods and services) and health more explicit, broadening the "health conversation."

This HIA would be conducted primarily using existing resources (funding and personnel) from EPA's Sustainable and Healthy Communities Research Program, Region 2, and contracts within ORD. These staff would be augmented, as needed, by EPA researchers and supported by advisory committees made up local stakeholders and community members. FEMA provided funding for EPA travel through a cooperative agreement with EPA.

Ecosystem Goods and Services

Ecosystem goods and services are the tangible and intangible benefits people receive from an ecosystem or nature. For example, water resources, such as groundwater and surface waters, provide invaluable ecosystem services, such as drinking water, habitat for food sources, recreational opportunities, protection from storms and/or tidal surges, and social/cultural benefits. Each of those ecosystem services, in turn, have impacts on human health and well-being. For more on the linkages between human health and ecosystem services, see EPA's Eco-Health Relationship Browser.

3. Scoping the HIA

In the *Scoping* step, the HIA Project Team establishes the goals of the HIA; HIA participants and participant roles; timeline for the HIA; plans for stakeholder engagement; communication and reporting strategies; the scope of the HIA (e.g., study area, potential health impacts of the proposed decision and pathways of impact that will be assessed in the HIA, and the populations potentially affected); and the data sources and methods to be used (National Research Council, 2011). The choice of what to include in the HIA scope reflects the specific social, political, and policy context of the decision; the needs, interests, and questions of stakeholders and decision-makers; and the health status of the affected population. *Scoping* results in a framework for the HIA and a written project plan that includes the following:

- A brief summary of the pathways through which health could be affected and the health effects to be addressed, including a rationale for how the effects were chosen and an account of any potential health effects that were considered but were not selected and why. Any logic models or scoping tables that were completed should also be included (see Section 3.5.2).
- Identification of the population and vulnerable groups—such as children, the elderly, racial or ethnic minorities, low-income people, and communities—that are likely to be affected (see Section 3.5.3).
- A description of the research questions, data sources, methods to be used, and any alternatives to be assessed (see Section 3.5.4).
- Identification of apparent data gaps and data collection efforts that could be undertaken to address the gaps (or a rationale for not undertaking data collection; see Section 3.5.4).
- A summary of how stakeholders were engaged, the main issues that the stakeholders raised, and how they will be addressed or why they will not be addressed (see Sections 3.2, 3.4.2 and 3.5.2). (National Research Council, 2011)

3.1. Goals of the HIA

The purpose of this HIA was to provide information about the potential health impacts that may result from proposed changes to the Suffolk County Sanitary Code, from a neutral position (i.e., not advocating for or against any alternative), and provide recommendations aimed at optimizing health benefits and/or mitigating potential adverse impacts to the people of Suffolk County. The health effects examined and the extent to which the effects were assessed was based on stakeholder input and available resources and timing.

As a decision-support HIA, the individuals who participated in the *Screening* of the HIA (from EPA, FEMA, and Suffolk County) established the following goals for the HIA to achieve:

- Develop a comprehensive HIA that addresses stakeholder concerns for sustainability, resiliency, environmental justice, and health equity.

- Bring evidence-based information to help inform Suffolk County's decision on proposed code changes regarding OSDS.
- Provide a neutral and inclusive platform for stakeholders to discuss the needs and issues in Suffolk County related to the proposal, founded on a common objective to advocate for health and wellness, and enhance stakeholder consensus and ownership of the decisions made.
- Raise awareness of HIA as a decision-support tool that considers direct and indirect consequences, both benefits and harms, before the decision is made.

In the *Monitoring and Evaluation* step (discussed in Section 7), the HIA was evaluated as to whether these goals were achieved.

3.2. HIA Kickoff Meeting and Initial Public Meetings

3.2.1 HIA Kickoff Meeting

EPA and Suffolk County Government co-hosted a kickoff meeting to launch the HIA on December 19, 2014 at the Suffolk County Office in Yaphank, NY; attendance was by invitation only. The launch event started with a half-day HIA 101 training (short course) that introduced participants to the concept of HIA, the importance of HIA in decision-making, and the principles and methods used in HIA practice. The training also introduced a few examples of completed HIAs and opportunities for HIA in the New York/New Jersey area. Following the training, a workshop was held that included an introduction to the HIA in Suffolk County and a series of exercises to kick off the *Scoping* step of the HIA. Participants included representatives from county government, local environmental advocacy groups, federal government agencies and contractors, and a local university.

During the workshop, HIA Leadership introduced the decisions leading up to the HIA (i.e., conclusions from the *Screening* step); Walt Dawydiak, from Suffolk County Division of Environmental Quality (SCDEQ), provided background on the issues and current policies behind the proposed code changes, as well as the anticipated outcomes of the proposed changes; and attendees participated in group activities that informed tasks associated with the *Scoping* step. Participants were asked to identify key stakeholder groups and potential mechanisms in which the "no change" decision could affect conditions in Suffolk County and lead to health outcomes. The group consensus was that <u>if no changes are made</u> to the Suffolk County Sanitary Code regarding OSDS, individual and community health could be affected through:

- A change in **risk of illness** from toxics and/or pathogens in the water and soil;
- A change in **physical activity** (a health-related behavior) as a result of beach closures, fish advisories, and the avoidance of recreational spaces due to the spread of harmful algal blooms (HABs);

Algal Blooms

Throughout this report, you will find discussion of algal blooms; however, not all algal blooms are the same. Algal blooms can be harmless, harmful, or toxic. Appendix A defines the various algal bloom terms used in this HIA.

- A change in **outdoor air quality** as a result of increased vehicle emissions, because residents have to travel farther to reach safe beaches and other recreational areas;
- A change in **employment/unemployment** as a result of decreased demand on fishing, shellfish, and recreation industries due to beach closures, fish advisories, and loss of patronage;
- A change in **diet/nutrition**, specifically the consumption of fish and shellfish, as a result of the increased spread of HABs and die-off of native species;
- A change in **housing security/insecurity** as a result of the increased risk of flooding and storm damage from reduced shoreline resiliency;
- A change in **costs of living** as a result of increased property insurance costs, increased municipal costs to remove pollutants and pathogens from drinking water, and reduced real estate tax from loss in property values;
- A change in **funding available for public services** (e.g., sanitation, public works, recreation management) as a result of reduced tax revenue; and
- A change in **blight and/or crime** resulting from increased transience and decreased stewardship of the community due to loss of perceived quality of the environment and community.

EPA documented and summarized the discussions from the HIA Kickoff Meeting to present to the broader, Suffolk County public in March 2015. Refer to Appendix D for the HIA Kickoff Meeting agenda, notes, and list of attendees.

3.2.2 March 2015 Public Meetings

EPA held a set of public meetings to provide information to residents and other stakeholders about the proposed code changes and HIA and to solicit their input. Three meetings were scheduled for March 4 and 5, 2015 in Cold Spring Harbor, Riverhead, and Brentwood, New York. Unfortunately, EPA had to cancel the last community meeting in Brentwood due to inclement weather. The agenda for the public meetings followed the same outline as the HIA Kickoff Meeting, but in a shorter, expedited format. For the *Scoping* workgroup activity, attendees were asked to identify how the proposed code changes would affect "daily life" in Suffolk County, NY.

The group consensus was that if the Suffolk County Sanitary Code was not changed, "daily life" could be affected through:

- A change in **social cohesion/disruption** in the valuation of ecosystem-based assets;
- A change in **household financial benefit/cost** for the property owner, as an immediate benefit would exist from avoiding the costs and inconveniences of upgrading the sewerage system, but there would be long-term costs associated with the monetary depreciation of the home due to degradation of the surrounding environment;
- A change in **employment/unemployment** in the aquaculture industry and potential expansion to the tourism and/or recreation industries; and
- A change in **human illness** from exposure to polluted waters during aquatic recreation and/or eating contaminated fish/shellfish.

If the Suffolk County Sanitary Code is changed to require existing OSDS to be upgraded to meet current standards (countywide or in high priority areas), the group identified that "daily life" could be affected through:

- A change in **political support/opposition** due to increases in regulations of individual sewerage systems, taxes/fees, and code enforcement;
- A change in **household financial benefit/cost** for the property owner – and potentially renters – related to the cost of upgrading the sewerage system;
- A change in **community financial benefit/cost** for residents in an area that may be displaced from increasing housing costs; and
- A change in **perceived advantages/disadvantages** for upgrading the system against realized advantages/disadvantages (e.g., market value of the home, ability of system to control nutrients and pathogens).

If the Suffolk County Sanitary Code is changed to require existing individual sewerage systems to be upgraded to I/A OWTS in high priority areas, the group identified that "daily life" could be affected through:

- A change in **social cohesion/disruption** on attitudes and behaviors related to management of individual sewerage systems;
- A change in **household financial benefit/cost** for the property owner – and potentially renters – related to the cost of upgrading the sewerage system and convenience of operating and maintaining that system, considering innovative/alternative systems are more expensive and require more management;
- A change in **community financial benefit/cost** from the increase in demand for manufacturing, installing, inspecting, and servicing individual sewerage systems, which may lead to the creation of a new industry/market;
- A change in **employment/unemployment** in the wastewater management industry from demand increases; and
- A change in **quality of water resources** from a reduction in nutrient (e.g., nitrogen) and pathogen loading, assuming innovative/alternative systems perform as expected.

EPA documented and summarized the discussions from the public meetings. Refer to Appendix D for the March 2015 Public Meeting agendas, notes, and lists of attendees.

3.3. Establishing the HIA Project Team and Advisory Committees

At the kickoff meeting in December 2014 and the public meetings in March 2015, EPA asked attendees to inform others about the plan to perform the HIA in Suffolk County and to invite fellow stakeholders to participate in the HIA process. In addition, EPA reached out to community organizations and other agencies involved in Suffolk County to solicit participation. In July 2015, EPA sent invitations to individual stakeholders requesting them to participate in the HIA. Formal roles, in which stakeholders could participate, included the HIA Project Team, HIA Technical Advisory Committee (TAC), and HIA Community Stakeholder Steering Committee (CSSC).

3.3.1 HIA Project Team

The HIA Project Team included a small group of EPA staff, contractors, research fellows, and local professional stakeholders that served either on the HIA Leadership Team and/or on the HIA Research Team.

Members of the HIA Leadership Team were responsible for:

- Designing the HIA processes, managing HIA progress, and making final decisions regarding the HIA;
- Planning logistics for upcoming HIA meetings and activities;
- Scheduling, attending, and facilitating HIA meetings and managing HIA tasks;
- Participating in scheduled quality assurance (QA) audits;
- Contributing to the development of HIA materials and approving HIA materials for distribution;
- Securing funding vehicles and personnel to perform HIA activities; and
- Communicating with stakeholders and distributing final HIA products.

By September 2015, the HIA Research Team was established. Members of the HIA Research Team were responsible for:

- Assisting in the development and completion of the assessment plan and apprising the HIA Leadership Team of task progress and any challenges with completing specific tasks;
- Performing other specific tasks related to collecting, synthesizing, and analyzing data;
- Participating in scheduled QA audits;
- Contributing to the development of HIA materials;
- Attending HIA Research Team meetings; and
- Identifying and developing HIA recommendations.

3.3.2 HIA Advisory Committees

The HIA Leadership Team established two advisory committees to help guide the HIA – the TAC and the CSSC – with equal responsibilities and “voice” for guiding the HIA process. The TAC and CSSC held their first meetings in August 2015.

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In November 2015, the CSSC was consolidated into the TAC due to low participation. This was unfortunate because the community voice is often the voice that is unheard in decision-making; HIA strives to bring community members to the table and give them a role in decisions that impact their lives. It should be noted that many of the TAC members, although representing particular organizations, were also residents of the County and could be impacted by the proposed code changes. For more on the challenges of public participation and possible reasons for the limited engagement, see Section 7.1.3.

Members of the TAC were responsible for:

- Advising the HIA Project Team on technical and non-technical aspects of the proposed changes (e.g., implementation, enforcement, funding, local knowledge, history, and interests and/or concerns of other community stakeholders);
- Attending TAC meetings (or providing a representative); and
- Providing input and feedback on the HIA goals, assessment plan, recommendations, follow-up activities, HIA materials, and implementation of the HIA process.

The formal participants in this HIA were identified in the opening pages of the report in the HIA Participants section. Appendix E provides the HIA Rules of Engagement Agreement to which each of these individuals consented in order to participate in the HIA.

3.4. HIA Timeline and Plans for Stakeholder Engagement, Communications, and Reporting

3.4.1 HIA Timeline

The HIA timeline was first drafted in the *Screening* step; further refined in the *Scoping* step; and then updated as the process progressed through the last steps of the HIA. Figure 3-1 provides the final HIA timeline.

The HIA analysis was complete in 2016 and preliminary HIA findings and recommendations were presented to stakeholders and decision-makers in August of that year. The HIA was slated to be complete and published in 2016; however, due to changes in EPA priorities at the end of 2016, the completion of the HIA *Recommendations*, *Monitoring and Evaluation*, and *Reporting* steps was postponed until 2017. In July 2017, the Draft HIA Report was presented to Suffolk County and distributed to the TAC and external peer reviewers for review. Competing priorities within EPA, including support of hurricane recovery efforts in Texas, Florida, Puerto Rico, and the U.S. Virgin Islands, caused resolution of review comments and finalization of the HIA Report to be postponed until 2020. Following the presentation of preliminary findings and recommendations in August 2016, the County continued to move forward with a number of efforts to address nitrogen loading to Suffolk County waters, including changes to the sanitary code; those efforts are described in Appendix K.

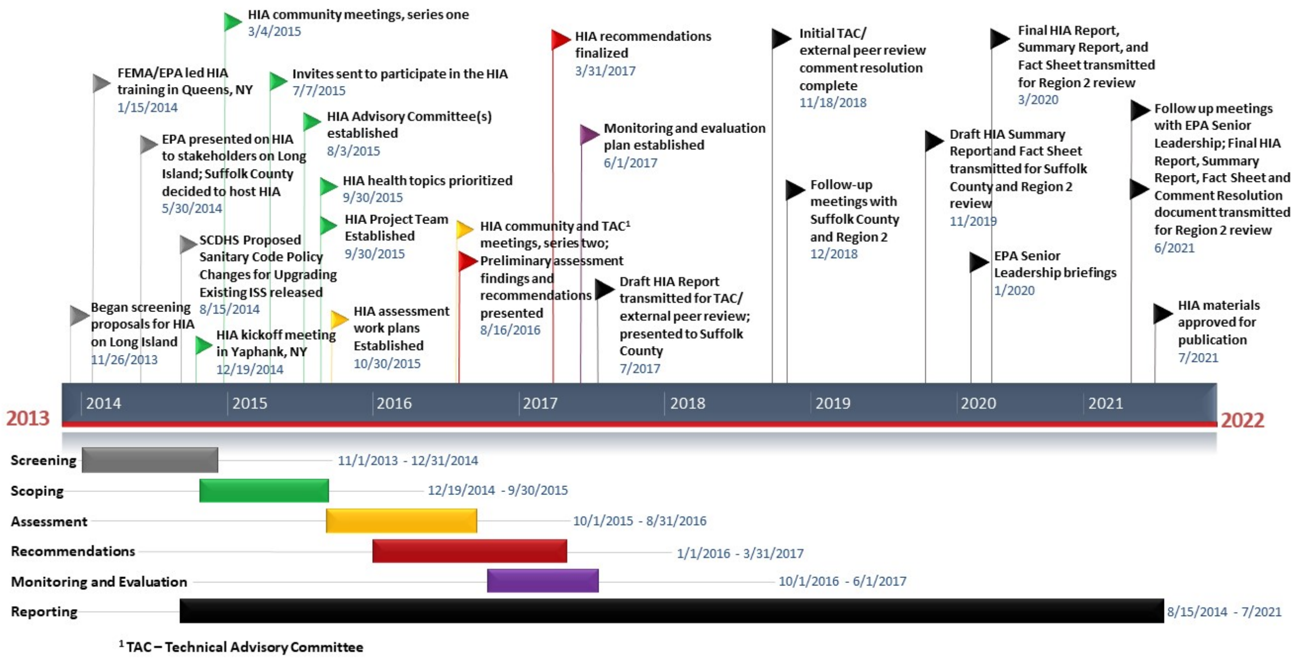


Figure 3-1. Final HIA timeline.

Note: This HIA required significant time and resources and involved collecting and analyzing data from multiple sources to provide a comprehensive assessment of potential health impacts. Not all HIAs are this intensive, nor do they need to be in order to be effective.

3.4.2 Stakeholder Engagement Plans

At the start of the HIA, EPA was aware of complaints from Suffolk County stakeholders about the overburden of engagement from the various federal, state, and locally-led projects and interventions occurring in the County. Taking this into consideration, the HIA Leadership Team planned to execute public meetings to engage residents and other stakeholders in Suffolk County at two critical points in the HIA process – *Scoping* and *Recommendations*.

3.4.3 Communications and Reporting Plans

Reporting is the communication of the findings and recommendations of an HIA to decision-makers, the public, and other stakeholders (National Research Council, 2011). It includes the production and dissemination of written materials that document the HIA process, methods, findings, recommendations, and limitations of the analysis; and it includes the public dissemination of results through other channels, such as meetings with the public, decision-makers, and other stakeholders. The Rules of Engagement Agreement (Appendix E), which outlined roles and responsibilities for participants, also included plans for communication and the review process for HIA materials.

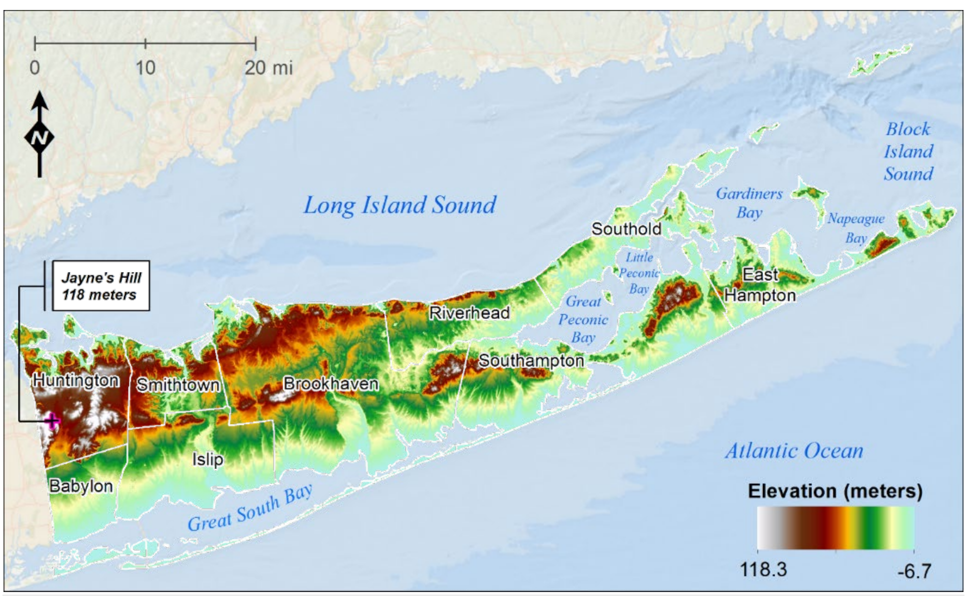
An HIA Report, summary report, fact sheets, and presentations to the public, decision-makers, and other stakeholders were all planned to help communicate the process, progress, and findings of the HIA (see Section 6).

3.5. Setting the Scope of the HIA

3.5.1 Defining the HIA Study Area

The proposed code changes (SCDHS, 2014a) targeted single-family residences served by individual sewerage systems across the County and in designated high priority areas. Suffolk County-designated high priority areas were defined as "areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in a SLOSH zone (Sea, Lake, and Overland Surges from Hurricanes), and areas located where groundwater is less than 10 feet below grade" (SCDHS, 2014a)[6].

Suffolk County is in the eastern region of Long Island and is the second largest county in total area in New York State (total land plus water area of 1,517,523 acres or 2373.13 square miles; 2010 Census Summary File 1). Most of Suffolk County is low-lying area; the highest peak is in the Town of Huntington, called Jayne's Hill, estimated at 387.1 feet (118.0 m) above sea level. Three estuarine systems border the County, including the Great South Bay to the south, and two estuaries of national significance – the Peconic Estuary to the east and Long Island Sound to the north. The Fire Island National Seashore, comprising barrier islands along the south coast, separates most of the Great South Bay from the Atlantic Ocean. Figure 3-2 illustrates the geography and towns of Suffolk County, and Figure 3-3 highlights the County-designated high priority areas, which consist of approximately 72% (671 square miles) of the total land area in Suffolk County.



Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors

Figure 3-2. Suffolk County elevation and towns.

[6] See Appendix K for more information on actions taken since the HIA analysis to develop a Suffolk County Subwatersheds Wastewater Plan and refine the priority areas.

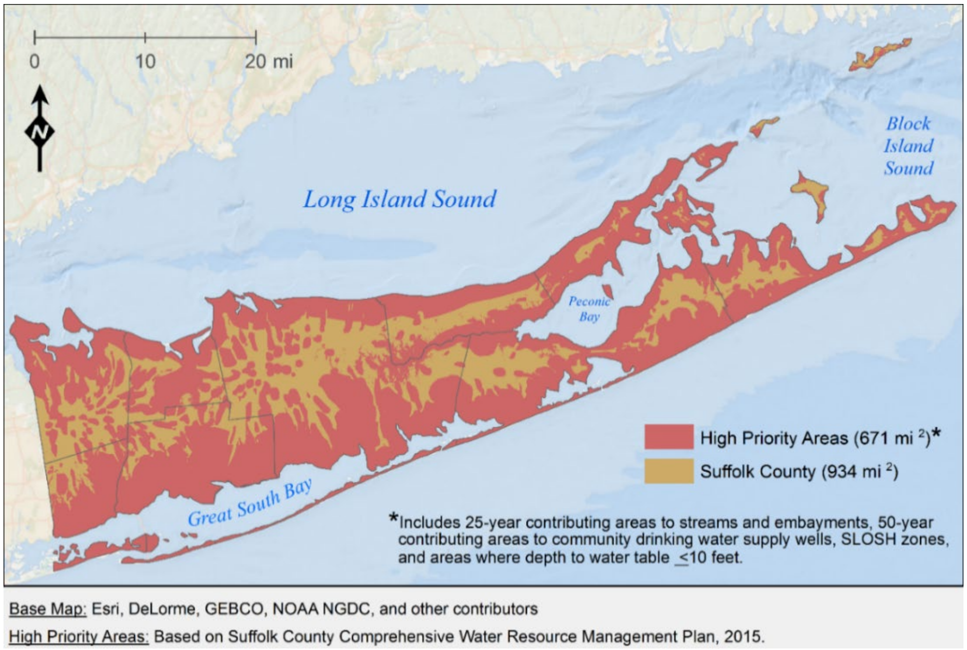


Figure 3-3. Designated high priority areas for reduction of wastewater-derived nitrogen.

3.5.2 Establishing the Pathways of Impact

Part of the *Scoping* process involves determining the rigor or level of HIA that will be conducted, including the number of potential impacts that will be assessed, the depth of assessment (e.g., extent of data collection, stakeholder involvement, sources of evidence, etc.), and the length of time that is available to complete the HIA. There are four levels of HIA as defined by Harris, Harris-Roxas, Harris, and Kemp (2007), listed from least to most rigorous (and least to most resource-intensive): Desk-based, Rapid, Intermediate, and Comprehensive.

The HIA Leadership Team took the information gleaned from stakeholder discussions at the kickoff meeting and initial public meetings and drew from widely-accepted impact pathways (i.e., identified by the World Health Organization, U.S. Centers for Disease Control and Prevention, Society of Practitioners of Health Impact Assessment) to help organize the potential health impacts identified into categories. The scope of the issues and the potential pathways through which impacts could occur reflects input from the public and a variety of stakeholders; it is not the viewpoint of any one organization. Due to the large number of potential impacts, the HIA Project Team agreed that the HIA could not evaluate all of the pathway categories identified within the project timeframe (i.e., a Comprehensive HIA could not be conducted). Thus, the HIA Leadership Team asked the Advisory Committee members to rank the pathway categories on a scale from most important (1) to least important (10) and ordered the average rank for each pathway category to help prioritize which pathways to include in the HIA *Assessment*.

Note: Although all were asked to participate, only seven stakeholder committee members submitted their rankings.

The results of the prioritization activity were as follows:

- ***High Priority***: water quality (average rank of 1.71), resiliency to natural disaster (average rank of 2.57), and household economics (average rank of 4.28)
- ***Moderate Priority***: community economics (average rank of 5.14), social norms and/or beliefs (average rank of 5.5), food safety (average rank of 5.67)
- ***Low Priority***: physical activity (average rank of 6.16), household quality (average rank of 6.71), air quality (average rank of 7.67), and crime and perceived safety/security (average rank of 8.5)

The HIA included a detailed appraisal of the high priority pathways but did not address those pathways ranked moderate or low priority. As the high priority pathways were detailed and refined, some changes were made, including combining the Community Economics and Household Economics into a single (high priority) pathway, and breaking out variables originally in the Water Quality and Resiliency Pathways – Individual Sewerage System Performance and Failure and Vector Control, respectively – into their own pathways.

At the completion of *Scoping*, five pathways were prioritized for detailed assessment in this Intermediate HIA:

- Individual Sewerage System Performance and Failure;
- Water Quality;
- Resiliency to Natural Disaster;
- Vector Control; and
- Community and Household Economics.

Table 3-1 outlines the pathways included in the final scope of the HIA and the means by which they may influence and/or impact health, as identified during the kickoff meeting and initial public meetings. Figure 3-4 illustrates how those five pathways are interconnected. The pathway diagram for each individual pathway is presented in its respective segment of Section 4.

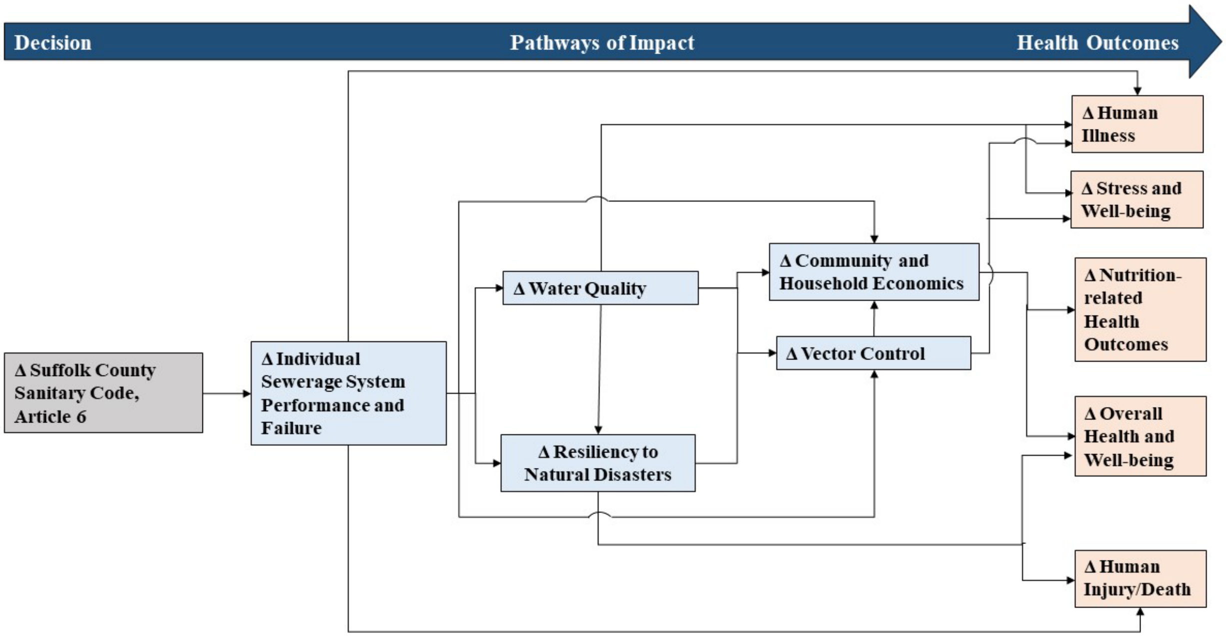


Figure 3-4. Pathway diagram showing the interconnections of the five pathways assessed in the HIA and their connection to health.

Table 3-1. HIA Scope and Pathways

Pathway	Means of Influence/Impact	Potential Health Outcome(s)
Individual Sewerage System Performance and Failure (originally included in Water Quality pathway)	• The Suffolk County Sanitary Code ultimately determines the type and siting of individual sewerage systems in Suffolk County. • The technology type, age, and characteristics of the site (location) are key factors in predicting the system's risk of a structural failure (i.e., collapse, deterioration, and/or a cover malfunction) and/or hydraulic failure (i.e., backflow into the home and/or surcharge above ground), and the capacity of the system to control nutrients and pathogens in effluent discharged to the surrounding environment (i.e., treatment performance). • Site characteristics, such as depth to groundwater, potential for persistent flooding and rising groundwater due to storms and/or tidal surges, pose a risk for structural and hydraulic failure for onsite systems. • Structural failure (i.e., the collapse, deterioration, and/or cover malfunction/removal) of a system is a falling hazard that may lead to human injury and/or death. • Exposure to wastewater due to hydraulic failure (i.e., backflow into the home and/or surcharge above ground) includes gastrointestinal illness, upper respiratory illness, rashes, and more.	**Injury and/or death** from *structural failure* **Illness** from exposure to untreated wastewater due to *hydraulic failure*

Pathway	Means of Influence/Impact	Potential Health Outcome(s)
Water Quality (Quality of water resources)	• The collective loading of nutrients (e.g., nitrogen) and pathogens from individual sewerage systems to the surrounding environment is a critical determinant in the quality of groundwater and surface waters (both saline and fresh waters), downgradient of those systems. • Groundwater is the only source for drinking water in Suffolk County. Thus, the quality of groundwater has direct human health consequences. • Long-term nutrient and pathogen loading to surface waters affects the presence of pathogens, algal blooms, and/or the loss or contamination of aquatic animal-life (e.g., shellfish, finfish, reptiles, waterfowl, etc.) in those ecosystems. • Persons who swim, fish, or participate in other forms of aquatic recreation where waters are sewage-contaminated and/or experiencing toxic algal blooms may be at risk for illness. • Waters temporarily affected by flooding and sewage contamination because of a storm and/or tidal surges also pose a human health risk for those crossing floodwaters and/or exposed to contaminated waters after the event.	**Illness** from sewerage-derived pollutants in source water (groundwater) **Illness** from aquatic recreation **Stress and well-being**
Resiliency to Natural Disasters	• Water quality plays an important role in the protectiveness of coastal/tidal wetlands by influencing wetland structure, function and overall acreage (e.g., loss of submerged vegetation and loss due to erosion). • The protective capacity of coastal/tidal wetlands helps to determine the resiliency of the shoreline against storms and/or tidal surges and coastal and inland flooding. Persons occupying areas prone to flooding are at risk for injury and/or death. • Shoreline resiliency affects the risk of human injury and property/infrastructure damage from storms and/or tidal surges, flooding, and inundation, as well as the need for households and businesses to evacuate and/or relocate from risk-prone areas. • The ability of coastal communities to evacuate and the condition of roads and disaster infrastructure directly determines the capacity for emergency responders to respond in the event of a natural disaster. • Property/infrastructure damage and the need for evacuation and/or relocation have implications for individual health and well-being.	**Injury and/or death** from storms and/or tidal surges **Overall health and well-being** (mental health, physical activity, respiratory health)

Pathway	Means of Influence/Impact	Potential Health Outcome(s)
Vector Control (originally included in Resiliency pathway)	• Standing and sewage-contaminated waters, either from individual sewerage systems in structural and/or hydraulic failure or from flooding and damage to system due to a storm event, provide excellent habitat for mosquito breeding and productivity. • Mosquitoes carry pathogens, such as West Nile Virus (WNV) and Eastern equine encephalitis virus (EEEV) that can be transmitted to humans and lead to disease. • Mosquitoes are also a common nuisance around residences and areas used for recreation. (Not all mosquitoes carry disease; for some, their bites just present a nuisance.) • In order to control mosquito populations (and inherently the spread of disease), insecticides are sprayed over large areas where the habitat is suited for mosquitoes, in addition to individual spraying on self and/or around residences. • Mosquito nuisance and perceptions of insecticide toxicity can lead to stress and impacts to well-being.	**Illness from vector-borne pathogens** (mosquitoes) **Stress and well-being**
Household and Community Economics	• The cost to upgrade, certify, and maintain the individual sewerage system or fees associated with non-compliance of a system will result in a direct household economic impact, which may be passed on to renters in the case of rental properties. • The type of individual sewerage system may change the perceived or actual market value of the residence and the ability to sell (transfer) the property between owners. • Changes in actual and perceived quality of surface waters may affect the market value of nearby residences. • Existing and future risk of property damage from a storm and/or tidal surge will affect recovery costs and future home insurance costs. In addition, the perceived risk of damage and/or actual damage to residences from storms and/or tidal surges may have consequences to the market value of the residence • In Suffolk County, property values are a considerable source of county and local municipal tax revenue. • Changes in areas that need spraying for mosquito control will affect municipal costs for vector control. • The increase in demand related to sewerage application, inspection, and certification of compliance will result in changes, both costs and revenues, for SCDHS. • The increase in demand related to sewerage system manufacturing, construction, maintenance, and (3rd party) inspection would lead to additional employment opportunities in the individual sewerage system industry.	**Overall health and well-being** related to changes in household and community economics **Nutrition-related health outcomes**

Pathway	Means of Influence/Impact	Potential Health Outcome(s)
Household and Community Economics (Continued)	• The potential aquatic animal-life lost from long-term changes in water quality may result in changes in costs and/or revenues and employment opportunities in the aquaculture and recreational fishing industries. • The sum of changes to household costs and income available directly affects household economics, such as expendable income for health services and health care, food, utilities, etc. • The collective changes in municipal costs and revenues and community property values affects the municipality's ability to provide public services and maintain public assets. • Both household and community economics are strong drivers of overall health in a community.	**Overall health and well-being** related to changes in household and community economics **Nutrition-related health outcomes**

L

Appendix F shows the pathways excluded from assessment in the HIA due to time and resource constraints.

3.5.3 Identifying Populations Potentially Affected

The proposed code changes distinguish between two potentially affected groups – 1) single-family households across the County and 2) single-family households in designated high priority areas.

L

The HIA Project Team acknowledges that visitors to Suffolk County could also be indirectly affected by the decision; however, assessing the health implications for all visitors to Suffolk County would be impractical.

Populations Likely to Experience Disproportionate Impacts

HIAs assess the distribution of potential impacts within the population affected. This practice helps to determine if there may be unequal sharing of burdens and/or benefits resulting from the proposed decision. Some subgroups within the population may be more sensitive to or more affected by changes in the physical and natural environment, social environment, and/or economic environment as a result of the decision. The HIA Project Team determined that individuals in low-income households, young children, the elderly and/or physically disabled, pregnant and/or nursing women, the immunocompromised and those with preexisting conditions, minority households, linguistically-isolated households, and coastal populations and those living and working in SLOSH zones may be more likely to experience disproportionate health impacts. A description of each population and the rationale for inclusion follow.

L

Note: Because the geographic locations of the individual sewerage systems targeted by the proposed sanitary code changes were unknown at the time of the HIA analysis, the socioeconomic status and demographics of the populations affected by the three decision alternatives were unable to be determined. Populations of certain socioeconomic status and demographics are included here because of the potential for disproportionate health impacts; it is assumed that these populations would be among the population affected.

- ***Low-income households***

  Individuals and households that are economically disadvantaged have less adaptive capacity to changes in economic conditions than those with means. For example, if housing costs (e.g., rent, property taxes) increase, those in the lower end of the income spectrum would be less likely to accommodate those increased costs and therefore have less expendable income for nutritious food and health services. Health practitioners have concluded that as income increases, regardless of racial and ethnic group, health outcomes improve (Braveman, Egerter, An, & Williams, 2011; Heller, Malekafzali, Todman, & Wier, 2013). Low-income was quantified using the number or percent of a Census block group's population in households where the total household income is less than or equal to twice the federal "poverty level."

- ***Minority households***

  Minority populations often experience health inequities that may make them more vulnerable to the potential health impacts of a project. Minority populations are represented by the number or percent of individuals in a block group who list their racial status on the decennial Census as a race other than "White alone" and/or list their ethnicity as "Hispanic or Latino" on national surveys. In Suffolk County, minorities include the federally-recognized Shinnecock tribal nation and the state-recognized Unkechaug tribal nation.

- ***Young children (under 5 years of age)***

  Young children are highly sensitive to changes in physical, social, and economic conditions in the household and community, because of their low adaptive capacity and high dependency on others. Infants and young children are more likely to acquire infections due to naïve (less-developed) immune, gastrointestinal, respiratory or other systems and, once infected, are more likely to develop severe outcomes (Fewtrell, Butler, Ali Memon, Ashley, & Saul, 2008).

- ***Pregnant and/or nursing women***

  Certain infections are more severe in pregnancy, either increasing the risk of fatality for the woman or damage to the fetus (Fewtrell, Butler, Ali Memon, Ashley, & Saul, 2008). Likewise, pregnant and/or nursing women can be affected more by nutrition-related impacts.

- ***Older (over 65 years of age) and physically disabled adults***

  Older adults (elderly) are more likely to acquire infections due to waning immunity and, once infected, are more likely to develop severe outcomes (Fewtrell, Butler, Ali Memon, Ashley, & Saul, 2008). Elderly and/or physically disabled individuals are more dependent on the accessibility of the built environment, compared to those without physical restrictions. Elderly living alone and the physically disabled are more at risk for injury or death in the event of storm and/or tidal surges, due in part to limited mobility and/or access to evacuation.

- ***Populations residing in unsewered residences constructed over 25 years ago or in flood-prone or high groundwater areas***

  Residences with OSDS and residences in high-priority areas with "conventional" OWTS are targeted by the various alternatives to the proposed code changes, making the populations living in these residences disproportionately impacted, both negatively and positively, by the code change. These individuals would directly experience the potential health impacts identified for the project.

- ***Residents with individual sewerage systems and private wells***

  Co-location of private wells and individual sewerage systems increase the likelihood of contaminated groundwater intrusion and because private wells may lack the levels of treatment, management, and testing of public water supplies, individuals relying on these wells for drinking water may be at greater risk for contracting water-related illnesses.

- ***Coastal populations and those living and working in SLOSH zones***

  Individuals living and working along the coast and in SLOSH zones are more likely to experience the direct impacts of storms/and or tidal surges, sea level rise, and coastal flooding, including impacts to daily life, health, property, and infrastructure.

Equity and Environmental Justice Considerations

Sometimes differences in health outcomes are unavoidable; at other times, differences in health outcomes may arise between subgroups in a population because of differences in levels of power and access to opportunity (SOPHIA Equity Working Group, 2014). These differences often exist along lines of race, ethnicity, income, education levels, and other characteristics. Avoidable differences in health outcomes that result from "unjust and unfair differences in social, economic, environmental, and political conditions" are known as health inequities (Heller, Malekafzali, Todman, & Wier, 2013; Healthy People 2020, n.d.).

Health Equity

"The aim of… equity and health is not to eliminate all health differences so that everyone has the same level of health, but rather to reduce or eliminate those which result from factors which are considered to be both avoidable and unfair. ***Equity is therefore concerned with creating opportunities for health and with bringing health differentials down to the lowest levels possible***" (Whitehead, 1990)

Similar to equity, environmental justice (EJ) is concerned with "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" and ascertains that "no group of people should bear a disproportionate burden of environmental harms and risks, including those resulting from the negative environmental consequences of industrial, governmental, and commercial operations or programs and policies" (EPA, 2011).

The HIA Project Team paid particular attention to the distribution of potential health impacts across the population and whether any populations would be disproportionally affected by the proposed code changes in the *Assessment* step of the HIA. Recommendations were provided, where possible, to address impacts to communities facing inequities.

3.5.4 Developing the Assessment Workplan and Data Acquisition

The HIA Research Team developed an Assessment Workplan that identified the following for each variable in the five pathways:

- Baseline research question – to identify the current conditions in Suffolk County related to the variable
- Impact research question – to determine how the proposed decision alternatives would potentially impact the variable
- Indicators and data sources – to be used to answer the research questions
- Approach or methods – to be used to answer the research questions
- Data gaps and/or data acquisition needs
- Task Lead – individual(s) responsible for leading and carrying out the assessment of that variable.

The Assessment Workplan was presented to the TAC to gather their input and help identify potential data sources that could be used in *Assessment*.

4. Assessment of Existing Conditions and Potential Health Impacts

The third step of the HIA process – *Assessment* – involves two major tasks: 1) creating a profile of the population potentially affected by the decision, including a baseline health status and information on the conditions important to health; and 2) analyzing and characterizing the potential health impacts of the proposed decision and any decision alternatives under consideration (National Research Council, 2011). The *Assessment* step results in reporting that:

- Describes data sources and analytic methods used in the assessment (see Section 4).
- Describes the baseline conditions that could be impacted by the proposed alternatives, including health status, affected population, health vulnerabilities or disparities, and health determinants that affect health (see Sections 4.1-4.6).
- Integrates stakeholder input into the analysis of the impacts[7].
- Describes methods used to engage stakeholders[7].
- Identifies limitations and uncertainties of the impact characterization (see Section 4.1-4.6).
- Characterizes beneficial and adverse health effects of the decision in terms of direction, magnitude, likelihood, severity, and distribution in the population (see Sections 4.2-4.6).

This HIA assessed the potential health impacts of four alternatives – the baseline and the three code change alternatives identified previously in Section 2.1. The baseline is simply the existing conditions at the time of the HIA analysis and is used as a point of comparison; the baseline does not represent the future state if no upgrades to individual sewerage systems are made.

L Note: This HIA analyzed impacts to existing single family residences with individual sewerage systems and did not project impacts of new construction.

The HIA Research Team utilized a variety of methods for the assessment, including qualitative (narrative and nominal) data and quantitative (numeric or measured) data to inform the analysis. Specifically, geographic information system (GIS) methods, epidemiologic methods, statistical and graphical analysis, systematic literature review, and stakeholder engagement were used.

L Note: Beyond community and stakeholder engagement activities, this HIA did not involve field data collection efforts, such as water sampling, water quality testing, or administration of human health surveys. When possible, data specific to Suffolk County were utilized; however, in some

[7] EPA was aware of complaints from Suffolk County stakeholders about the overburden of engagement from the various federal, state, and locally-led projects and interventions occurring in the County. Taking this into consideration, the HIA Leadership Team planned to execute public meetings to engage residents and other stakeholders in Suffolk County at two critical points in the HIA process – *Scoping* and *Recommendations*. TAC members provided input on the analysis of impacts, but community members and other stakeholders did not participate in the *Assessment* step of the process.

cases the best available data were from publicly-available data sets or the scientific literature. Although scientific literature is useful and informative, it may sometimes be limited in its generalizability and broad applicability and therefore may not relate specifically to Suffolk County.

The following criteria were used to characterize the health impacts of the decision alternatives:

- **Direction** – indicates whether the effect is harmful, beneficial, or in some cases – unclear (values = "benefit to health," "detract from health," "no change," or "uncertain/both benefit(s) and harm(s)")
- **Likelihood** – the chance or probability that the effect will occur (values = "highly likely," "possible," or "not likely")
- **Magnitude** – indicates the expected size of the effect; can be described by the number of people affected or by expected changes in the frequency or prevalence of symptoms, illness, or injury (values = "high" if thousands of people affected, "moderate" if hundreds of people affected, "low" if few to none are affected)
- **Distribution** – delineates the spatial and/or socioeconomic boundaries of various groups that are likely to bear differential effects (values = "all groups affected relatively equally" or "disproportionate effects," with the groups likely to be affected disproportionately identified)
- **Severity (intensity)** – indicates the severity of the effect (values = "severe" for fatal or disabling, "moderate" if needs medical treatment or intervention to resolve, or "minor" if does not need medical treatment or intervention to resolve)
- **Permanence (timing and duration)** – indicates at what point of the proposed activity the effect will occur, how long it will last, and how rapidly the changes will occur (values = "immediate" if effect occurs within 1 year or "long-time" if effect takes 1 to several years; "short-term" if duration of impact is limited or "long-lasting" if impact is expected to persist for an extended period of time or be permanent)
- **Strength of evidence** –the scientific evidence used to verify (or refute) the connections hypothesized in the *Scoping* step and characterize the potential health impacts of the decision in the *Assessment* step was graded based on levels of strength modified from the U.S. Agency for Healthcare Research and Quality's grading of evidence (values = "strong," "limited," "lacking," and "insufficient"); see Figure 4-1 for further details. Note that the evidence can be from the general literature and/or Suffolk County-specific evidence.

Strength of Evidence Determinations
(modified from the U.S. Agency for Healthcare Research and Quality)

- ***Strong*** – There is high confidence that the evidence reflects the hypothesized relationship between variables. Further research is very unlikely to change the confidence or the estimate of effect.
- ***Limited*** – The evidence reflects the hypothesized relationship between variables, but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship. Further research may change the confidence or the estimate of effect.
- ***Lacking*** – There is low confidence that the hypothesized relationship between variables exist, such that the evidence results in inconsistent conclusions or the evidence available concludes that no association between the variables of interest exists beyond coincidence.
- ***Insufficient*** – There is not enough evidence available to draw a conclusion one way or another, such that further research is needed to verify the hypothesized relationship and/or make an estimate of effect.

Figure 4-1. Strength of evidence grade descriptions.

Section 4.1 provides a snapshot of the demographics, socioeconomic status, and overall health of the population living in Suffolk County at the time the HIA analysis was conducted. Sections 4.2–4.6 of the report document the *Assessment* of the five pathways of impact considered in this HIA. Information is presented regarding elements of the pathway, existing conditions in Suffolk County related to those elements, and potential impacts of the decision alternatives on the pathway. A table is presented at the end of each assessed pathway, characterizing the potential impacts of each decision alternative.

4.1. Profile of the Suffolk County Population at the Time of the HIA Analysis

The HIA Research Team used a combination of national survey data and historic records from the U.S. Census Bureau, such as *QuickFacts and American Fact Finder*, to collect demographic and socioeconomic information (http://www.census.gov/data.html) and referenced the 2016 County Health Rankings (www.countyhealthrankings.org) for general health information. As noted previously, the geographic locations of the individual sewerage systems targeted by the proposed code changes was unknown at the time of the analysis; therefore, demographics, socioeconomic status, and health status of the specific populations affected by the three decision alternatives were unable to be determined. Following is a profile of the population living in Suffolk County, NY at the time of the HIA analysis.

4.1.1 Population Size and Density

According to decennial Census data, from 1940 to 1970 the total population in Suffolk County grew by 471% (from 197,355 to 1,127,030 people) and total housing units increased by 343% (from 75,586 to 335,041 units). In comparison, over the next forty years (1970 to 2010), the total population grew only 32.5% and the number of housing units grew only 70.1% (See Figure 4-2). The drastic increase in population between 1940 and 1970 is referred to as the “population boom.” The most recent national survey (2010 Census) reported 1,493,350 residents living in Suffolk County or about 1,637 persons per square mile.

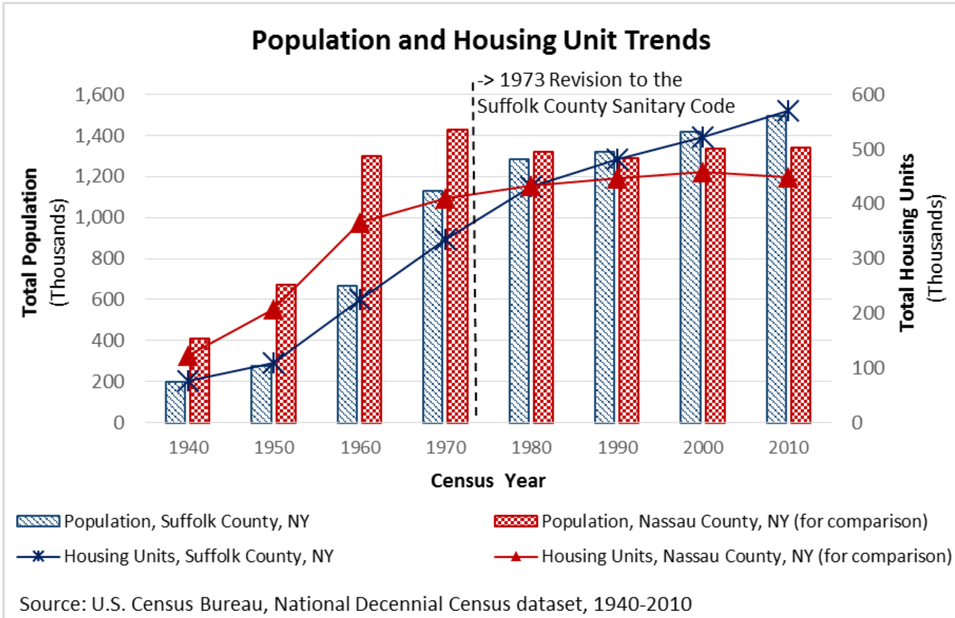


Figure 4-2. Total population and housing unit trends over time in Suffolk County, NY. Nassau County statistics provided for comparison; Nassau County borders Suffolk County to the west.

The increase in Suffolk County's population did not occur evenly across the County, but instead is largely concentrated in the western portion of the County. The eastern portion remains relatively less populated, with more agricultural farms and non-primary housing (i.e., vacation homes). Figure 4-3 maps population density across Suffolk County.

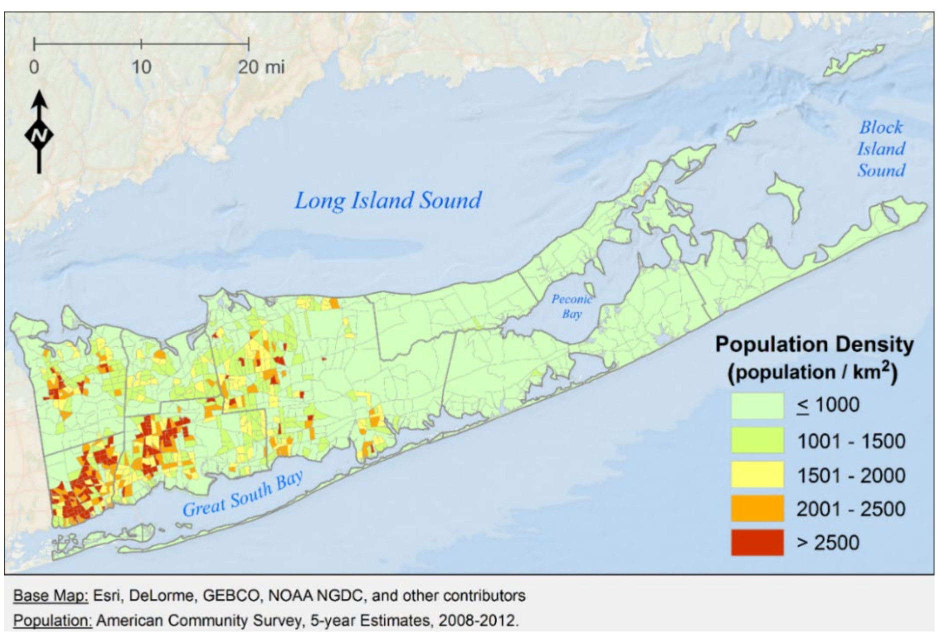


Figure 4-3. Population density across Census block groups in Suffolk County, NY

4.1.2 Population Demographics

According to the 2010 Census, 74.2% of households in Suffolk County were family households and the average household size was about three people (2.93). Residents in Suffolk County were almost exclusively of "one race" (97.6%), and Anglo-Americans represented the predominant demographic group (80.8%), with very little representation of African-American and Asian-American (7.5% and 3.4%, respectively). One in six residents reported origins of Hispanic or Latino ethnicity. Over half of the population (54.3%) was age 20 to 59. Table 4-1 provides the demographic information reported in the decennial Census for residents of Suffolk County, with a comparison to New York State.

According to the 2013 State and County People Quick Facts (U.S. Census Bureau), Suffolk County has an estimated 20.6% of residents that speak English as a second language at home. An estimated 89.8% of residents are high school graduates. Persons under 5 years old represented 5.4% of the population; whereas persons 65 years and older represented 14.9% of the population.

Table 4-1. Demographics among residents of Suffolk County, NY as compared to New York State

Indicator	Suffolk County		New York State
	Count*	Percent of Total	
Total population	1,493,350	100.0%	19,378,102
0 to 9 years	183,803	12.3%	12.0%
10 to 19 years	213,359	14.3%	13.4%
20 to 59 years	811,117	54.3%	55.7%
60 to 69 years	145,930	9.8%	9.5%
70 years and over	139,141	9.3%	9.5%
Male population	734,668	49.2%	48.4%
Female population	758,682	50.8%	51.6%
One Race	1,457,319	97.6%	97.0%
Two or More Races	36,031	2.4%	3.0%
Hispanic or Latino Ethnicity (of any race)†	246,239	16.5%	17.6%
Total households	499,922	100.0%	7,317,755
Family households	370,897	74.2%	63.5%
Average family size	3.36	-	3.2
Non-family households	129,025	25.8%	36.5%
Average household size	2.93	-	2.57

* Source: U.S. Census Bureau, 2010 Census summary file

† For the 2010 Census, Hispanic or Latino Ethnicity represents people whose origins are from the Dominican Republic, Spain, and Spanish-speaking Central or South American countries.

The HIA Research Team utilized the data and GIS tools in the Environmental Justice Screening and Mapping Tool (EJSCREEN; http://www.epa.gov/ejscreen) to develop a demographic index for the County. EJScreen's Demographic Index is based on the average of two demographic indicators – percent low income and percent minority – for each Census block group. Low income and minority populations appear in isolated clusters across Suffolk County (Figure 4-4). It should be noted that the reservation of the federally-recognized Shinnecock tribal nation is one area with a high proportion of minority and low-income residents.

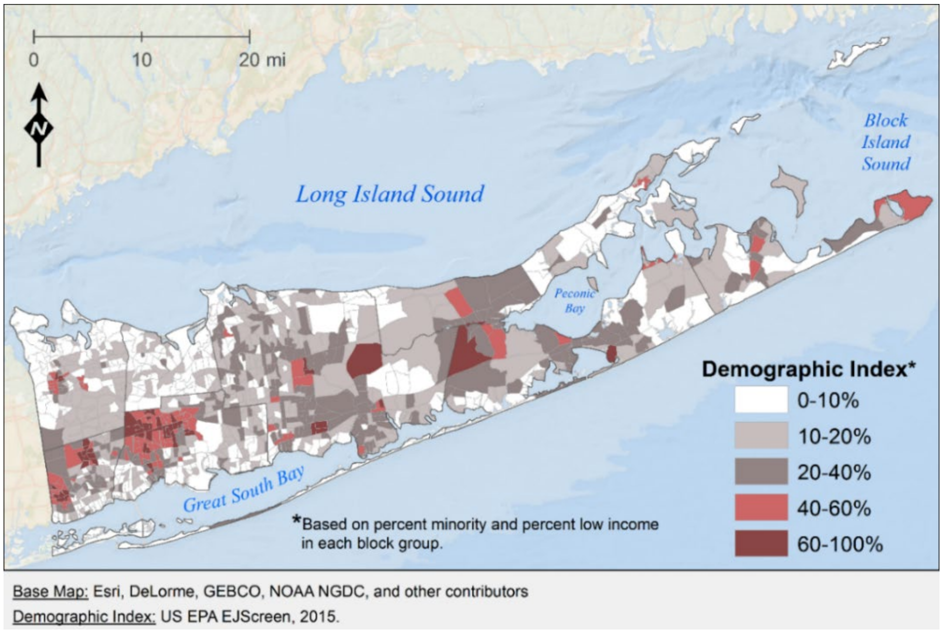


Figure 4-4. Demographic Index reflecting the average of % minority and % low income in each Suffolk County block group.

4.1.3 General Health in Suffolk County, NY

According to 2016 County Health Rankings comparisons (www.countyhealthrankings.org), Suffolk County ranked 9th best out of New York's 62 counties for overall health, based on several health-related indicators, such as premature death and self-reported quality of life (University of Wisconsin Population Health Institute, 2016). The County was ranked 10th best in the State for length of life, indicated by premature deaths (i.e., avoidable deaths measured as the number of years of life lost before age 75 per 100,000 people). The estimated number of premature deaths (for 2011 to 2013) in Suffolk County was 5,300 per 100,000 people, which was not significantly different from the state rate (5,400 per 100,000 people). Furthermore, the rate of premature death in Suffolk County has been on the decline since 1997, a sign of improving overall health (University of Wisconsin Population Health Institute, 2016).

Because health is a measure of the complete state of physical, emotional, and mental well-being (WHO, 1948), public health practitioners also monitor self-reported quality of life including days healthy versus unhealthy (Andresen, Catlin, Wyrwich, & Jackson-Thompson, 2003). According to the 2016 County Health Rankings comparisons (University of Wisconsin Population Health Institute, 2016), Suffolk County ranked 20th best in New York for self-reported quality of life among residents. Specifically, an estimated 12% of adults in Suffolk County reported that, in general, they had poor or fair health and adults reported poor physical health or poor mental health an average of 3.1 days and 3.2 days, respectively, in the previous 30 days. For comparison, neighboring Nassau County (which is demographically similar to Suffolk County) ranked 2nd best out of New York's 62 counties in 2016 for overall health, 4th best for length of life (premature death rate of 4,400 per 100,000 people), and 8th best for self-reported quality of life among residents.

4.1.4 Baseline Rates of Illness Associated with Pathogens That Can Be Found in Human Waste

The risk of exposure to pathogens is applicable to multiple pathways examined in the HIA, therefore, rates of illness associated with pathogens that can be found in human waste are presented here in the overall profile of the Suffolk County population for simplicity. The baseline profile of health endpoints associated with only one pathway are presented in their respective pathway discussions in Section 5.

There have been cases of disease in Suffolk County related to pathogens that can be found in human waste (SCDHS, 2015a). It is important to note that exposure to these pathogens could have occurred through a number of pathways (e.g., foodborne or waterborne routes, person-to-person transmission, contact with contaminated fomites, etc.). Some of the potential water-related routes can include direct contact with sewage (e.g., individual sewerage system or sewage treatment plant failure; addressed in Section 4.2.5), drinking contaminated well water (addressed in Section 4.3.4), incidental ingestion (e.g., during bathing or recreating in contaminated surface waters; addressed in Section 4.3.6), or aspiration/inhalation (EPA, 2002a).

Adapted from a Suffolk County Community Health Assessment (SCDHS, 2015a), Table 4-2 shows the 2012 baseline rates of illness in Suffolk County for some diseases associated with pathogens found in human waste [per EPA (2002a)]. Based on existing data, most cases of these illnesses were caused by bacteria, such as *Shigella* and *Salmonella*. While many of these diseases are primarily foodborne pathogens, it is important to consider that pathogens present on food that we consume are eventually excreted in our waste and end up in the wastewater stream. Suffolk County 2012 incidence rates of diseases associated with pathogens that can be found in human waste were either not different from New York State averages (*Salmonella*, hepatitis A) or significantly lower (*E. coli* O157:H7, *Shigella*) (NYSDOH, 2013).

Table 4-2. Baseline Rates of Illness Associated with Select Pathogens That Can Be Found in Human Waste in Suffolk County and New York State, 2012

Disease	Cause	Pathogen Type	Health Effects*	Suffolk County†		New York State, Exclusive of New York City‡	
				Cases	Rate (per 100,000)	Cases	Rate (per 100,000)
Amebiasis	*Entamoeba histolytica*	Protozoa	Prolonged diarrhea, abscesses of the liver and small intestine	25	1.68	131	1.2
Cryptosporidiosis	*Cryptosporidium hominis and C. parvum*	Protozoa	Diarrhea	14	0.94	229	2.0
Enterohemorrhagic *E. coli* (EHEC)	Shiga toxin-producing *Escherichia coli* (STEC)	Bacteria	Abdominal cramps, diarrhea, nausea	9	0.60	141	1.2
E. coli O157:H7	*Escherichia coli* O157:H7	Bacteria	Abdominal cramps, bloody diarrhea	6	0.40	110	1.0
Giardiasis	*Giardia duodenalis*	Protozoa	Mild to severe diarrhea, indigestion, nausea	84	5.64	975	8.7
Hepatitis A	Hepatitis A virus (HAV)	Virus	Fatigue, low appetite, stomach pain, nausea, jaundice	8	0.54	63	0.6
Salmonellosis	*Salmonella*	Bacteria	Diarrhea, dehydration	217	14.56	1395	12.4
Shigellosis	*Shigella spp.*	Bacteria	Diarrhea, fever, and stomach cramps	43	2.89	828	7.4
Typhoid Fever	*Salmonella enterica* serovar Typhi	Bacteria	High fever, diarrhea, ulcers in the small intestine	6	0.40	22	0.2
Non-O1 *V. cholerae*	*Vibrio cholerae*, non-O1 serogroups	Bacteria	Extreme diarrhea, dehydration	17	1.14	N/A	N/A

*Source: EPA Onsite Wastewater Treatment Systems Manual (EPA, 2002a), WHO Guidelines for Drinking Water Quality (WHO, 2017)

†Source: Suffolk County Community Health Assessment, 2014-2017 (SCDHS, 2015a)

‡Source: New York State Department of Health 2012 Communicable Disease Reports (NYSDOH, 2013)

4.2. Individual Sewerage System Performance and Failure: Existing Conditions and Potential Impacts

4.2.1 Individual Sewerage System Performance and Failure Pathways of Impact

Figure 4-5 shows the pathways by which the proposed code changes are expected to impact individual sewerage system treatment performance and failure and ultimately, health.

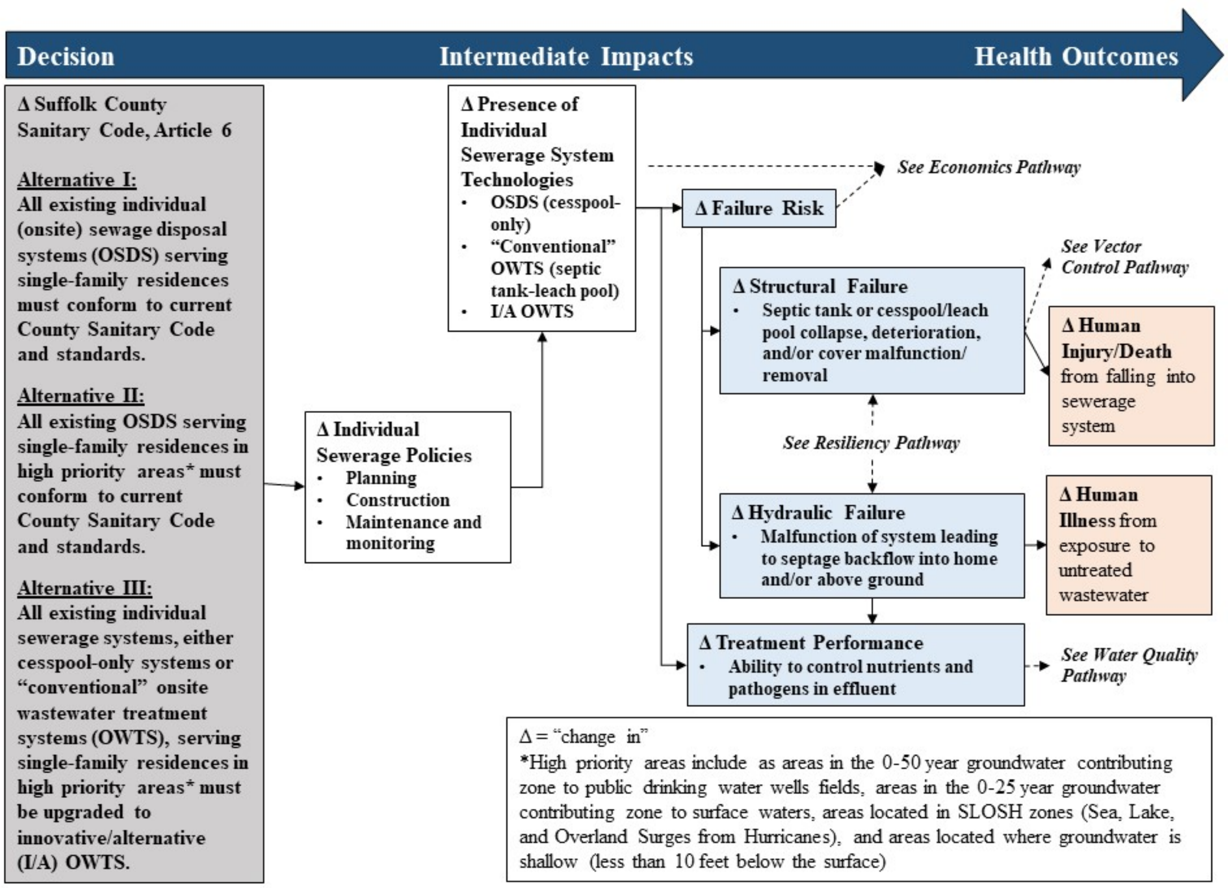


Figure 4-5. Individual Sewerage System Performance and Failure Pathway Diagram.

A change in the Sanitary Code will require changes to existing policies on the planning, construction, maintenance, and monitoring of individual sewerage systems. Individual sewerage system failure and performance may impact health directly and indirectly through other pathways.

4.2.2 Impact of Code Changes on *Individual Sewerage System Policies*

In order to identify the potential impact of the proposed code changes, it is important to understand the basics of the existing policies affecting individual sewerage systems. The New York State Department of Health (NYSDOH) and Department of Environmental Conservation (NYSDEC) develop and enforce decentralized wastewater rules, regulations, and standards within the State and issue guidelines for implementation (NYSDOH, 2012; NYSDEC, 2014a). The NYSDOH regulates individual sewerage systems through Title 10 of the Compilation of Codes, Rules and Regulations (10NYCRR). Appendix 75-A of Title 10, the Wastewater Treatment Standards for Residential Onsite Systems, specifically establishes the minimum statewide requirements for all new residential OWTS (effective February 3, 2010).

A local health department may adopt more stringent standards and/or requirements but may not adopt standards less stringent than the State standard unless the State Commissioner of Health has issued a General Waiver (10NYCRR, Chapter II, Appendix 75-A). It is important to note that Suffolk County holds several General Waivers for deviations from state design standards (NYSDOH, 2012).

Existing Individual Sewerage System Policies in Suffolk County at the Time of the HIA Analysis

When the HIA started, the Suffolk County Sanitary Code (Suffolk County Code Chapter 760, revised November 2011) and its implementing standards were in effect. The standards and articles of code applicable to the decision, and considered in the HIA, included Article 6 (6/28/1995), General Guidance Memorandum #12 (6/8/2000), and Standards for Approval of Plans and Construction for Sewage Disposal Systems for Single Family Residences (1/9/2004). During the course of the HIA analysis, Article 19 was added to the Sanitary Code (7/2016) and interim revisions were adopted to the Standards for Approval of Plans and Construction for Sewage Disposal Systems for Single Family Residences (9/21/2016).

Article 6 of the Suffolk County Sanitary Code (Realty Subdivisions, Developments and Other Construction Projects and §760-605) regulates individual sewerage systems in Suffolk County. In 1995, SCDHS issued its *Standards for Approval of Plans and Construction of Sewage Disposal Systems for Single-family Residences*. In September 2016, SCDHS prepared interim revisions to these standards to allow I/A OWTS without the need for a variance from the Board of Review; additional revisions to the standards will be forthcoming to address I/A OWTS specifications (SCDHS, 2016a).

Owners or developers of any *new* residential development, construction, or renovation of a property are required to obtain approval for individual sewerage systems from SCDHS (Suffolk County Sanitary Code §760-602). For *existing* sewerage systems, SCDHS operates under General Guidance Memorandum #12 (Memo #12), *Guidelines for Issuing Approval of Sewage Disposal Systems and Water Supplies for Existing Residences* (issued June 8, 2000), which states that residences that have a sewage disposal system constructed prior to 1973 are exempt from conforming to current code requirements and construction standards, since they conformed to the standards at the time they were built.

Historically, individual sewerage systems have been constructed on sites, such as those with a high groundwater table, impervious soils, and shallow bedrock or limestone formations, all of which are potentially unsuitable for this type of wastewater management system (EPA, 1997; Seabloom, 1982). Now, to ensure this construction practice does not continue, a site analysis is required and must include "an analysis of the flood plain, slope, soil type, percolation rate, depth to limiting layer or groundwater, and adequate area" (Kneen & Lemley, 1994; NYSDOH, 2012). In Suffolk County, a state-certified design professional is responsible for taking into consideration these elements, as well as locations of existing and proposed water supply wells, surface waters and wetlands, planned improvements such as foundations and driveways, and construction on adjacent properties (SCDHS, 1995; SCDHS, 2016a).

Soils and Siting

Inadequate or impermeable soil is the predominant limiting factor for siting individual sewerage systems because improper soil will prevent wastewater from percolating through the system and impede sufficient treatment (Kneen & Lemley, 1994). Four feet (depth) of "acceptable" soil is needed to install most conventional soil absorption (drain) fields (Kneen & Lemley, 1994). In Suffolk County, the soils are generally permeable, but there are some areas, particularly in northern parts of the County, where the soils tend to be less permeable. Depth of soil is an issue in Suffolk County, as there are areas where the depth to groundwater is less than 10 feet.

A site chosen for an individual sewerage system must be located in an area where subsoil and groundwater conditions are conducive to the proper functioning of the system (SCDHS, 1995; SCDHS, 2016a). According to NYSDOH (2012), native/original soil must extend at least two feet beneath the proposed trench bottom to sufficiently treat the wastewater, before it reaches either the seasonal high water table or an impermeable soil layer.

Moreover, the Suffolk County Standards (SCDHS, 1995; SCDHS, 2016a) provide alternate design, construction, and installation requirements for individual sewerage systems in high groundwater conditions, and now with the 2016 revisions, also outline criteria if septic tanks or I/A OWTS treatment components have to be placed within the groundwater (albeit, the standards indicate "whenever practical," individual sewerage systems should not be located within groundwater). Although tanks and treatment components are permitted to be placed in groundwater or tidally-influenced areas in some instances, the bottom of any leaching structures in the individual sewerage system must be at least two or three feet above the highest expected/recorded groundwater elevation. For further site conditions/requirements, refer to *Suffolk County Interim Standards for Approval of Plans and Construction – Sewage Disposal Systems for Single-family Residences* (SCDHS, 2016a).

There are additional restrictions, other than site conditions, for siting individual sewerage systems. For example, the installation of an individual sewerage system is prohibited when the site to be developed is within a sewer district or has an approved sewer system and treatment works available and accessible (pursuant to Suffolk County Administrative Code §740-44-A and §760-502-4(a) and Suffolk County Sanitary Code §760-502-4(c)). If at some point a County central sewage service becomes available and accessible in an area, the residence is required to connect within one year to the County sewage works (pursuant to Suffolk County Administration Code §740-14). However, the number of eligible systems present in sewer districts was unknown at the time of the HIA analysis.

Pursuant to Suffolk County Administrative Code §740-44-A and §760-502-4(a) and Suffolk County Sanitary Code §760-502-4(c), ensure sites with individual sewerage systems that are required to be upgraded as part of the changes to the Suffolk County Sanitary Code are given the option to tie into sewer, if an approved sewer system is accessible and has capacity.

After soil testing and site evaluation, a determination is made as to which system design can be installed. Individual sewerage systems are typically designed based on the anticipated wastewater flow.

SCDHS (2016a) also provides prescriptive construction criteria and installation standards for septic tanks, leaching pools, and I/A OWTS, including the types of materials, piping configurations, and access openings and cover (see *Suffolk County Interim Standards for Approval of Plans and Construction – Sewage Disposal Systems for Single-family Residences* for more information).

With regard to maintenance of systems, New York State allows localities the authority to adopt and/or require maintenance and/or management programs for individual sewerage systems. For example, Chapter 374 of the Suffolk County Code addresses the use of additives, which can help break down sludge and/or scum to decrease the need of evacuating an individual sewerage system. Guidelines for individual sewerage system maintenance (e.g., inspections and pumping) are communicated to homeowners, but adoption of those best management practices are at the discretion of the homeowner. With the issuance of the *Interim Standards* (SCDHS, 2016a), the Suffolk County Sanitary Code requires an initial 3-year warranty and an executed operation and maintenance contract between the maintenance provider and property owner prior to approval of an I/A OWTS. And Article 19 of the Suffolk County Sanitary Code (SCDHS, 2016b), adopted in July 2016, outlines the role of SCDHS for overseeing that I/A OWTS are properly managed, maintained and provide the intended levels of treatment. **This may necessitate a culture shift that calls for greater involvement by the County and puts more requirements on Suffolk County homeowners, limiting the autonomy of the homeowner with regard to sewerage system maintenance. It should be noted that there could be some challenges and barriers to making a culture shift like this.**

Suffolk County could consider potential barriers to implementing and enforcing policies related to individual sewerage systems and develop strategies to overcome such barriers.

Anticipated Change(s) to Individual Sewerage System Policies

Table 4-3 identifies the potential impacts of the proposed code changes on individual sewerage system policies for each decision alternative.

Table 4-3. Impact of Decision on Policies Regarding Individual Sewerage Systems

Alternatives	Potential Change(s) in Policies
Baseline	SCDHS operates under existing policies and procedures (i.e., “business as usual”). Homeowners have autonomy with the management of their individual sewerage systems.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	All General Waivers under Memorandum #12* will be rendered defunct. Cesspool/septic system service professionals will be required to report systems needing upgrades to SCDHS. SCDHS will assign a fixed schedule for each region in which property owners must upgrade the sewerage system. In the event of a property sale, the seller will be required to obtain a certificate from SCDHS verifying the existing OSDS conforms to current codes and standards.

Alternatives	Potential Change(s) in Policies
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	General Waivers under Memorandum #12 will be rendered defunct for residences in high priority areas. Cesspool/septic system service professionals will be required to report systems needing upgrades to SCDHS. SCDHS will assign a fixed schedule in which property owners must upgrade the sewerage system. In the event of a property sale, the seller will be required to obtain a certificate from SCDHS verifying the existing OSDS conforms to current codes and standards. (Homeowners outside the high priority areas will maintain autonomy with the management of their individual sewerage systems.)
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	Suffolk County Interim Standards for Approval of Plans and Construction of Sewage Disposal Systems for Single-family Residences (SCDHS, 2016a) must be amended to permit alternative system designs approved by SCDHS for sites that meet 2016 Interim Standards (Sept. 21, 2016). General Waivers under Memorandum #12 will be rendered defunct for residences in high priority areas. Cesspool/septic system service professionals will be required to report systems needing upgrades to SCDHS. SCDHS will assign a fixed schedule in which property owners must upgrade the sewerage system. In the event of a property sale, the seller will be required to obtain a certificate from SCDHS verifying the existing OSDS conforms to current codes and standards. (Homeowners outside the high priority areas will maintain autonomy with the management of their individual sewerage systems.)

*Memorandum #12, *Guidelines for Issuing Approval of Sewage Disposal Systems and Water Supplies for Existing Residences* states that residences that have a sewage disposal system constructed prior to 1973 are exempt from conforming to current code requirements and construction standards, since they conformed to the standards at the time they were built.

Implementation of an alternative that only addresses parcels in high priority areas (Alternatives II and III), may come with fairness and conformity concerns[8]. For example, builders, installers, service providers, and realtors will not likely want to have to look at a detailed map and wonder what side of the "priority line" a property is on and whether it requires upgrade. These options would also likely come with concerns over fairness amongst who has to versus does not have to upgrade and how those costs are distributed (for more on costs, see Section 4.6).

Develop tools that cesspool/septic service contractors can easily and consistently deploy to determine whether a system is in need of maintenance, repair, or upgrade and document the issue(s), such as a checklist or logic framework for use in the field and/or an open-access, web-based platform for documenting issues and reporting properties that need to upgrade their individual sewerage systems.

[8] Note that the Subwatersheds Wastewater Plan developed by Suffolk County, after completion of this HIA, involved countywide nitrogen loading modeling that was used to establish travel times and nitrogen loading estimates for each subwatershed, establish nitrogen load reduction goals based upon specific human health and environmental endpoints, refine priority areas in which to focus those efforts, and establish recommended wastewater treatment alternatives through science-based criteria. For more on this effort, see Appendix K.

4.2.3 Impact of Individual Sewerage System Policy Changes on *Presence of Individual Sewerage System Technologies*

Each alternative associated with the proposed changes to the Suffolk County Sanitary Code will affect the type of individual sewerage systems in use in Suffolk County.

Existing Individual Sewerage Systems Designs in Use in Suffolk County at the Time of the HIA Analysis

There are currently two predominant designs of individual sewerage systems in use by single-family residences in Suffolk County – the septic tank-leaching pool system (C-OWTS) and the cesspool (only) system (referred to as OSDS in Suffolk County). There are also a very small number of septic tank-soil absorption field systems.

Septic Tank-Leaching Pool System

The septic tank-leaching pool system that serves single-family residences in Suffolk County is known as the “conventional” OWTS (C-OWTS) (SCDHS, 1995; SCDHS, 2016a). It utilizes the septic tank as basic or primary treatment (Figure 4-6). Wastewater enters the underground septic tank, where natural processes physically separate the liquid component from heavier solids and lighter oils (EPA, 2001a; EPA, 2005a). Oil and grease float to the top forming “scum” and the larger solids and organic matter settle at the bottom forming “sludge.” Although highly dependent on other variables (usage, volume, etc.), after approximately 24 to 48 hours, the liquid portion leaves the tank as “effluent” and drains to the leaching pool, where it is stored until it is distributed and absorbed into the surrounding soil (Figure 4-6). Some anaerobic digestion of organic matter may take place in the septic tank (Beal, Gardner, & Menzies, 2005a), along with a limited (1-$\log_{10}$)[9] reduction in pathogens (Lowe, et al., 2009).

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[9] “Log reduction” is a mathematical term used to show the relative number of pathogens eliminated by treatment or disinfection. A 1-$\log_{10}$ reduction means lowering the number of pathogens by 10-fold. That is, if the raw wastewater going into the individual sewerage system had 100,000 pathogens in it, a 1-$\log_{10}$ reduction would reduce the number of pathogens in the liquid effluent—what comes directly out of the individual sewerage system, taking into account settling/treatment within the system and pumping from the system (if any)—to 10,000. This level of reduction may not be protective of human health.

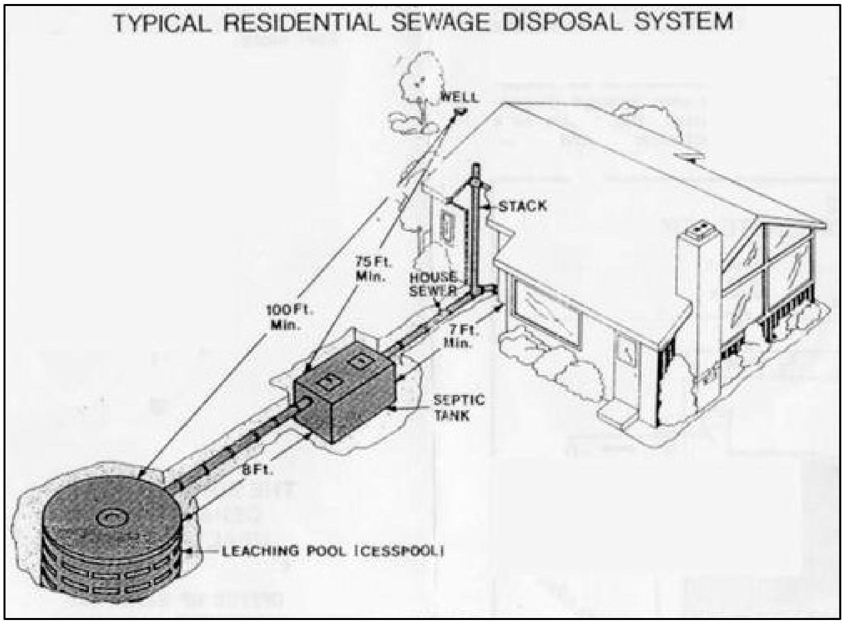


Figure 4-6. "Conventional" OWTS in Suffolk County consisting of a septic tank and leaching pool. Source: (Suffolk County Government, 2015a)

A leaching pool is a pit with precast perforated walls, an open bottom, and a removable metal or concrete slab covering just below the ground surface for monitoring and maintenance. The leaching pool, although the same in design, is by name different from a cesspool because a leaching pool accepts septic tank effluent rather than untreated (raw) wastewater (SCDHS, 1995; SCDHS, 2016a).

Cesspool (referred to as OSDS in Suffolk County)

A cesspool is a pit with perforated walls, an open bottom, and a metal or concrete slab cover. Although the same design as a leaching pool, a cesspool accepts untreated (raw) wastewater instead of septic tank effluent. Historically, cesspools were constructed with brick and mortar or concrete blocks that break down over time making them increasingly susceptible to collapse. Newer cesspools can be constructed with reinforced, precast concrete, which make them less susceptible to collapse. However, many cesspools in Suffolk County were installed before 1973 and are assumed not to be reinforced.

Septic Tank-Soil Absorption System

In the septic tank-soil absorption system, septic tank effluent discharges into soil through shallowly-buried perforated pipes, known as the soil absorption field, where it undergoes secondary treatment. Within the soil absorption field, effluent drains through the biomat zone (i.e., a heterogenic mixture of organic matter, soil, and microbials), where natural biological processes further separate out smaller organic matter from wastewater and microorganisms convert ammonia into nitrate (i.e., a process called *nitrification*). When the soil is saturated (wet and depleted of oxygen), bacteria in the soil use the nitrate as an oxygen source – converting the nitrate-nitrogen (NO_3-) to gaseous forms of nitrogen (N_2) – in a process called *denitrification* (Johnson, Albrecht, Ketterings, Beckman, & Stockin, 2005).The septic tank-soil absorption system relies on the soil for treatment and thus, "is limited to locations with moderately permeable soils and relatively high soil depths to the water table or impermeable strata" (Kreissl, 1982). Due to parcel size, soil conditions, and hydrogeology, the number of septic tank-soil absorption systems in Suffolk County is limited (NYSDOH, 2012; Suffolk County Government, 2013a). According to a survey of homeowners, only about 76 of these systems exist throughout the east end of the County (Berry, 2015).

C

In Suffolk County, the “conventional” OWTS is the septic tank-leaching pool (vertical) system. However, elsewhere in the professional and scientific literature, the septic tank-soil absorption (horizontal) system (originally patented by Mouras in 1881) is referred to as a conventional OWTS (Bennett & Linstedt, 1978). Although they are similar in terminology, the septic tank-soil absorption system is technologically different from the septic tank-leaching pool system. Because of the highly permeable soils present on Long Island, conventional septic systems there have not included a horizontal leaching field commonplace in most other parts of the U.S. The vertical pools employed on Long Island can be effective in dealing with the hydraulics and pathogens in domestic wastewater, as long as they are properly maintained and there is an appropriate separation distance between the bottom of the system and the water table as well as any private drinking water well. However, neither conventional vertical nor horizontal systems are especially effective in removing nitrogen, hence the need for denitrifying systems where excessive nitrogen load is an issue. Although well maintained conventional septic systems can provide acceptable wastewater treatment at low densities and where soil conditions and separation from groundwater and surface waters are adequate, these conditions are not generally met in Suffolk County.

L

The NYSDOH (2012) Residential Onsite Wastewater Treatment Systems Design Handbook acknowledges the reduced treatment capability of leaching pools and states if soil and site conditions are adequate for absorption trenches or beds, leaching pools shall not be used. However, NYSDOH has issued general waivers to allow the use of leaching pools in Suffolk County due to the “nature of construction, soil conditions and known hydrogeology”. It is important to keep this difference in terminology in mind when examining the existing literature on design, siting, and performance of conventional OWTS, as the data may not be relevant to Suffolk County’s “conventional” systems.

<u>Innovative/Alternative OWTS</u>

The I/A OWTS are innovative types of individual sewerage system designed specifically for nitrogen control and reduction and were included in the proposed code changes as an alternative to C-OWTS. Recall that at the time the code changes were proposed, no I/A OWTS was approved for general use in Suffolk County. However, in December 2014, Suffolk County launched a Septic Demonstration Pilot Project to evaluate I/A OWTS technologies, and in July 2016, the Suffolk County Legislature gave SCDHS the authority to develop procedures, protocols, and standards for approving the use of I/A OWTS throughout the County. Six weeks later, the first I/A OWTS technology was provisionally approved for residential use. Since that time, additional I/A OWTS technologies have been provisionally approved for residential use in Suffolk County (see Appendix K).

Existing Presence of Individual Sewerage System Technologies in Suffolk County at the Time of the HIA Analysis

At the time of this HIA analysis, Suffolk County did not have an inventory of individual sewerage system locations or types. Some towns and hamlets tracked this information, but not consistently. Suffolk County developed estimates of the number of OSDS (pre-1973 systems) and C-OWTS (post-1973 systems) countywide, but the methodology used to develop those estimates was unknown. Therefore, HIA estimates were developed by the HIA Project Team to allow for geographic analysis of the number and type of individual sewerage systems impacted by each decision alternative and to provide transparent, defensible documentation of the estimated number of households that could potentially be impacted by the code changes.

More specifically, the HIA Research Team used parcel (property) shapefiles from the Suffolk County Real Property Tax Agency Service and overlaid them with the best available data from the U.S. Census Bureau, U.S. Geological Survey (USGS), National Oceanic and Atmospheric Association (NOAA), Suffolk County Government, and others using GIS-based methods. Residential parcel boundaries that were not contained within or did not intersect sewered areas were examined for their geographic proximity to high priority areas, and other factors. This approach is consistent with the approach used in other studies performed in Suffolk County, including Kinney and Valiela (2011) and Lloyd (2014). Refer to Appendix G of this report for a more detailed discussion of the methods used and the rationale for any discrepancies with Suffolk County estimates.

L

Note: The HIA estimates developed by the HIA Research Team assume parcels not intersecting or contained within sewered areas are unsewered and do not further distinguish “unsewered parcels” into individual or cluster wastewater systems; unsewered parcels are assumed to be served by individual sewerage systems for purposes of this analysis.

L

Note: Because the proposed sanitary code changes pertain only to individual sewerage systems at single-family residences, only these residences were included in the HIA analyses (i.e., multifamily and commercial parcels served by individual sewerage systems were excluded). However, there were inconsistencies in the reported parcel classification codes, which limited the ability to identify, with certainty, all single-family residential parcels in Suffolk County. The figures presented herein do not reflect the total number of individual sewerage systems present in Suffolk County, but rather just for single-family residential parcels.

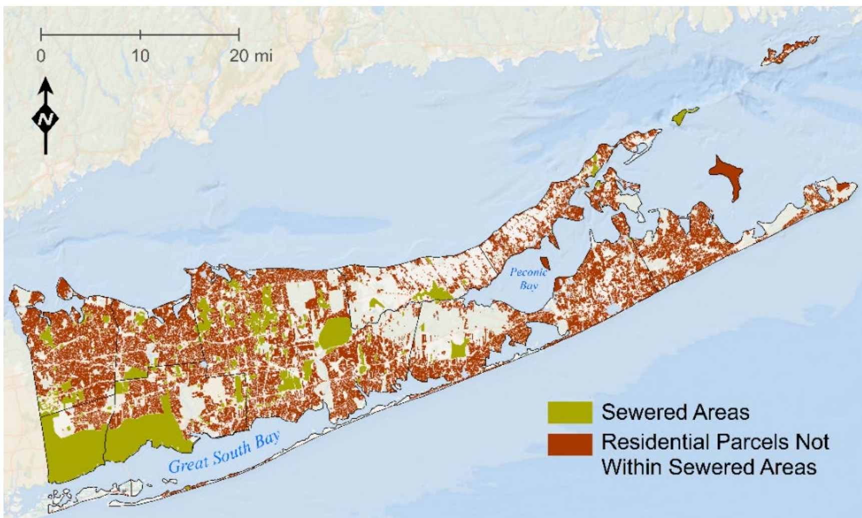
L

Note: In determining which unsewered, single-family residential parcels are located in high priority areas, parcels were identified that either intersected or were within high priority areas and the numbers were tallied. In an effort to be more consistent with Suffolk County estimates, the HIA Research Team utilized counts of parcels within the high priority areas in the HIA analyses. It should be noted that this may underestimate the number of residential parcels affected by the proposed code changes (see Appendix G).

Using this methodology, the HIA Research Team calculated that there are 488,375 single-family residential properties (parcels) in Suffolk County. Of these properties, 385,117 are unsewered and assumed to be served by an individual sewerage system (Figure 4-7). Of those 385,117 parcels, 251,502 (65.3%) are located in SCDHS-designated high priority areas (i.e., areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in a SLOSH zone, and areas located where groundwater is less than 10 feet below grade).

L

Note: As discussed above, data are limited regarding the types of individual sewerage systems present in Suffolk County and their locations, such that identifying where older OSDS systems are located within the County was not possible for this HIA. Some local municipalities maintain information about residences and sewerage systems; however, that information is not consistently recorded across municipalities, nor is it collected at the County level, according to SCDHS.



Base Map: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
Sewered Areas: Suffolk County Department of Economic Development and Planning, 2012.
Parcels: Suffolk County Real Property Tax Service.

Figure 4-7. Unsewered single-family residences.These residences (n=385,117) are assumed to be served by individual sewerage systems.

The HIA Research Team used existing data from national and local surveys/studies to estimate what percent of the existing unsewered, single family residential parcels are likely to be served by OSDS (cesspool). As indicated previously, prior to 1973, individual sewerage systems for single-family homes in Suffolk County consisted of an OSDS. In 1973, that requirement changed to a C-OWTS. Considering that the sanitary code policies at the time of the HIA allowed for structures to be replaced in-kind, housing structure age was used as a proxy for individual sewerage system age. Therefore, housing structures built prior to 1970 were assumed to be served by OSDS for this analysis.

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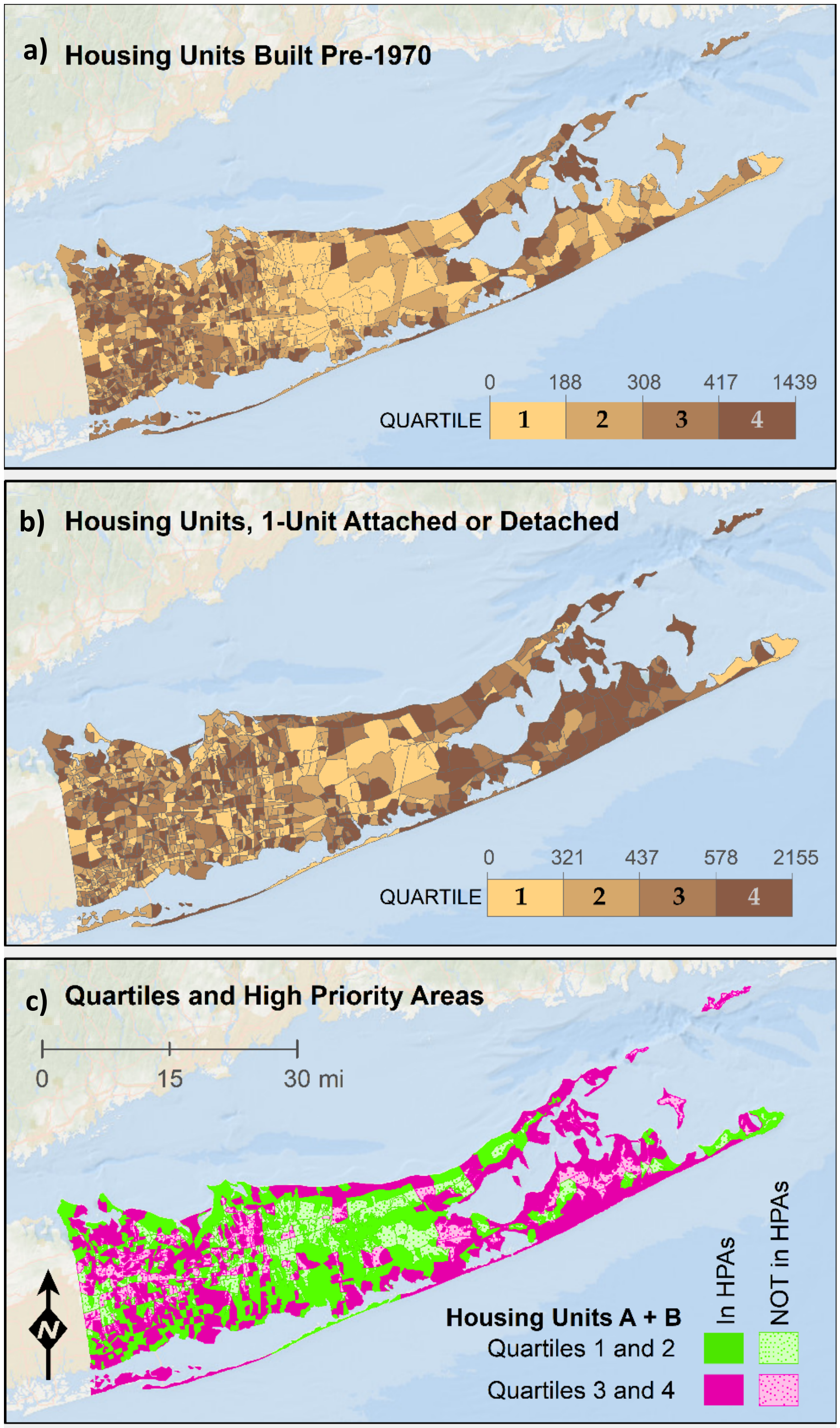
Note: The parcel data obtained from the Suffolk County Real Property Tax Service Agency did not include age of housing. Best available data on the age of housing units in Suffolk County came from housing survey data from the U.S. Census Bureau American Community Survey 5-Year Estimates (2008-2012), but these data are only available at the Census block group level.

Figure 4-8 maps the Census block groups ranked by a) the number of housing units built before 1970, b) the number of housing units that are single-family, and c) those two indicators grouped by quartiles and shown relative to the location of high priority areas in Suffolk County. The areas highlighted in pink in the figure are those most likely to have a high proportion of residences served by OSDS. As shown, the majority of Census block groups that are more likely to have a high proportion of single-family residences served by OSDS are also located in high priority areas.

Suffolk County Department of Economic Development and Planning (SCDEDP) estimates that 252,530 of the unsewered parcels pre-date the requirement for a septic tank (Suffolk County Government, 2015a), and the 2008-2012 American Community Survey 5-year estimates show that approximately 315,602 housing units (i.e., 55.5% of the 568,570 total [single and multi-family] housing units in Suffolk County at that time) were built before 1970.



Base Map: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Housing Estimates: U.S. Census Bureau, 2008-2012 American Community Survey 5-Year Estimates

Figure 4-8. Census block groups ranked by a) number of all (single and multi-family) housing units built before 1970, b) number of housing units that are single-family, and c) a compilation of those two indicators relative to the location of high priority areas (HPAs) in Suffolk County.

Based on the data available, the HIA Research Team determined that a *reasonable estimate* for the number of existing, individual sewerage systems that precede the 1973 standards, would be at least 50% of unsewered, single-family residential parcels. This estimate is consistent with those used in other studies performed in Suffolk County, including Stinnette (2014), Lloyd (2014), and Gobler (2016). It is important to note that this value may actually underestimate the public health impacts associated with the proposed sanitary code changes.

Regardless of the decision alternative chosen, Suffolk County could create an inventory of existing individual sewerage systems, including their geolocation, design type, and (if possible) maintenance schedule (last inspection/evacuation) to aid in identifying residences affected by the decision and enforcing the code change. This inventory can be accomplished through sewage industry reporting of cesspool, septic tank and I/A OWTS pump outs, retrofits, and replacements.

Table 4-4 summarizes the estimated presence of individual sewerage systems in Suffolk County. The number of persons served by those systems is based on the U.S. Census Bureau 2010 Decennial Census summary file, which indicated that the total population in Suffolk County in 2010 was 1,493,350 and the average household size was 2.93 persons. To calculate the number of persons served by each type of system, it was assumed that each of the calculated single-family parcels contained one household.

Table 4-4. Number of Single-family Residential Parcels and Persons Served by Individual Sewerage Systems in Suffolk County

Parcel Description	Total Count	Total Persons Served*
Unsewered, Single-family Residential Parcels, assumed to be served by individual sewerage systems	385,117 (Baseline)	1,128,3931
Unsewered, Single-family Residential Parcels, assumed to be served by individual sewerage systems, in High Priority Areas	**251,502** (Alternative III)	736,901
Unsewered, Single-family Residential Parcels, assumed to be served by OSDS {50% of the total 385,117}	**192,558** (Alternative I)	564,195
Unsewered, Single-family Residential Parcels, assumed to be served by OSDS, in High Priority Areas {50% of the total high priority 251,502}	**125,751** (Alternative II)	368,451

* Assuming 2.93 persons per household per the 2010 Census.

Anticipated Change(s) to the Presence of Individual Sewerage System Technologies

Table 4-5 identifies the potential impacts of the proposed code changes on the presence of individual sewerage system technologies for each decision alternative.

Table 4-5. Impact of Decision on Presence of Individual Sewerage System Technologies

Alternatives	Potential Change(s) in Technologies
Baseline	There are **385,117 unsewered, single-family residences**, which are assumed to represent residences served by individual sewerage systems.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If about 50% of unsewered, single-family homes are served by OSDS, **an estimated 192,558 residences will be required to upgrade their individual sewerage system to a C-OWTS.**
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Based on GIS mapping of unsewered parcels (see Appendix G), the total number of unsewered, single-family parcels in the high priority areas is 251,502. If about 50% of these parcels are served by OSDS, **an estimated 125,751 residences will be required to upgrade their individual sewerage system to a C-OWTS.**
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	Based on GIS mapping of unsewered parcels (see Appendix G), **an estimated 251,502 residences will be required to upgrade their individual sewerage system to an I/A OWTS.**

Perform homeowner outreach early and often and provide information on each system design, including the average life span, operation and maintenance needs, average treatment performance, signs of system failure, and the benefits of routine inspections and maintenance (e.g., increase in system longevity, reduced costs over the life of the system). Outreach may help resolve disagreements as to the necessary maintenance of an individual sewerage system and may help manage expectations for system performance and needs.

There are many resources available for educational outreach materials, such as those developed by the National Small Flows Clearinghouse and EPA.

Over the past 30 years, the National Small Flows Clearinghouse (NSFC) has provided technical assistance, training, and educational outreach publications, such as *Pipeline*, *Tap*, and *Small Flows Quarterly*, for consumers and communities on OWTS performance, design, inspections, issues, etc. The NSFC is located at West Virginia University, managed through the National Center for Coal and Industry. For more information, visit: http://www.nesc.wvu.edu/index.cfm.

The EPA provides resources to support homeowner awareness, education, and management of septic systems (https://www.epa.gov/septic) and *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems* to help communities establish comprehensive management programs so their decentralized systems function properly. These resources focus on outreach, education, planning, operation and maintenance, and financial assistance.

4.2.4 Impact of Changes in Individual Sewerage System Technology on *System Failure*

At the time of the HIA, there was no official definition in New York State law nor the Suffolk County Sanitary Code that defined "failure" of an individual sewerage system[10]. General symptoms of septic system failure include "wastewater backing up into plumbing, wastewater flow/breakthrough to ground surface, and/or flow or evidence of flow into watercourses or water supply" (National Environmental Services Center, n.d.). Neither the State of New York nor Suffolk County monitor causes of system failure. Carroll et al. (2006) stress that it is crucial to understand that "failure" can occur at any stage of the individual sewerage system, such as in the plumbing/piping and storage area, in the disposal unit, or in the underlying soil and groundwater system. A system in failure may not always be visible. Researchers agree that **most failures are not due to the system itself, but due to improper siting, inadequate design, and/or improper operation and maintenance** (Carroll, et al., 2006).

In general, there are two types of failure commonly recognized: the first being *hydraulic failure* and the second being *structural failure*.

<u>Note</u>: Beal, Gardner and Menzies (2005a) characterize *treatment failure* as "an insufficient hydraulic retention time within the soil matrix, thus precluding adequate treatment of effluent before entering the groundwater." Section 4.2.7 discusses factors related to *treatment performance (and failure)*, so this section will only focus on hydraulic failure and structural failure.

Hydraulic failure occurs when "effluent loading rate into the disposal unit is greater than the infiltration rate through the biomat zone," or more generally, with surfacing and/or pooling of wastewater/effluent (surcharge) above the system, sewage pipe blockage and backup into pipes and fixtures of the home, offensive odors above the sewerage system, and excessive grass growth over the system (Beal, Gardner, & Menzies, 2005b; Carroll, et al., 2006; Conn, Habteselassie, Bloackwood, & Noble, 2012; Loomis, 2014; Friends of the Bay, 2011; National Small Flows Clearinghouse, n.d.; EPA, 2005a; Suffolk County Government, 2013b; CDM Cesspool Service, 2015; Mid Suffolk Cesspool and Rooter Service, Inc, 2015).[11] Brouwer et al. (1979), Geary (1994), and Dawes and Goonetilleke (2001) found that wastewater discharged onto the soil surface (i.e., aboveground surcharge) was a common occurrence among older and/or poorly designed septic systems. Hydraulic failure can be further confirmed using fluorescein dye tests by placing the dye in a household drain/plumbing system and observing the dye around or on top of the sewerage system (Habteselassie, et al., 2011; Conn, Habteselassie, Bloackwood, & Noble, 2012).

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[10] Article 6 of the Suffolk County Sanitary Code was amended in January 2018 (after completion of the HIA analysis) and now includes a definition of a failed system. For more information on the definition, see Appendix K.

[11] The January 2018 ammendment to Article 6 of the Suffolk County Sanitary Code defines failure of a cesspool or individual sewerage system as one "that does not adequately treat and/or dispose wastewater so as to create a public or private nuisance or threat to public health or environmental quality," and includes conditions of both hydraulic and structural failure, including above ground pooling of wastewater, pumping four or more times per year, seepage of groundwater into the individual sewerage system, etc.

There are two subcategories of hydraulic failure – catastrophic and episodic. When infiltrative surfaces are clogged and flow into the subsoil is inhibited, this type of failure is usually irrevocable and thus, referred to as a catastrophic hydraulic failure (Beal, Gardner, & Menzies, 2005a). A catastrophic failure ends in the system being repaired or replaced entirely. When there is an overload of water going into the system, as a result of peak loadings or prolonged rainfall, yet infiltration into the subsoil is still possible, this type of failure is usually temporary and referred to as an episodic hydraulic failure (Beal, Gardner, & Menzies, 2005a). This type of failure may require a short-term solution, such as pumping out the system, or may resolve on its own as wastewater eventually drains into the subsoil.

Structural failure is broadly used to describe major mechanical malfunctions of a system, but is more specifically defined in this analysis as the collapse, deterioration, and/or cover malfunction/removal (absence) of the septic tank or cesspool/leaching pool.

In a report by the Onsite Wastewater Working Group (a collaboration between Warren County Soil and Water Conservation District and Adirondack Community College in New York), the Working Group stated, “all septic systems will eventually fail – an issue compounded by the general lack of proper maintenance from homeowners” (Onsite Wastewater Working Group, n.d.). A lack of routine evacuation (pumping out) of an individual sewerage system can lead to a build-up of solids that clog the biomat and subsoil, leading to backflow of wastewater. Planting deep-rooted vegetation and/or paving above the soil field can also pose a higher risk for failure of the soil field.

Promote routine pumping of OSDS and OWTS in order to reduce the risk of hydraulic failure and retention of standing water.

Take into consideration good practice in the siting, design, installation, and maintenance of individual sewerage systems. For example, gardens and deep-root vegetation, such as large trees, should not be located near or over the individual sewerage system, since large roots and excess plant watering can be damaging to the system.

Beal, Gardner, and Menzies (2005a) note that correct design and maintenance of an individual sewerage system can substantially reduce the potential of failure. The septic tank should be watertight, the drainfield properly leveled and graded, and operating heavy equipment over the soil absorption field should be avoided (EPA, 2005a). If the septic tank is not watertight, groundwater and stormwater could mix with untreated wastewater, leading to environmental hazards and aboveground surfacing of untreated wastewater. Also, during a flood event, the septic tank can become buoyant which can lead to structural damage and unplanned mixing of wastewater with floodwaters.

Existing Conditions Regarding Individual Sewerage System Failure in Suffolk County at the Time of the HIA Analysis

Hydraulic Failure

Suffolk County estimates close to a 10% rate of hydraulic failure each year of existing individual sewerage systems (Suffolk County Government, 2015a). If there are an estimated 385,117 unsewered, single-family residences, it follows that an estimated 38,512 systems fail each year. SCDHS records and investigates nuisance complaints reporting system failures (i.e., sewage overflows – when individual sewerage systems back up into the home or surcharge aboveground). However, reported individual sewerage system failures are much lower than the estimated failure rates; see Figure 4-9 for reported complaints to SCDHS. Beal, Gardner, and Menzies (2005b) cites "the unwillingness of public to report a failure, the lack of knowledge of when a system is in failure, and/or the low perceived risk of system in failure" as potential causes for the underreporting. It is postulated that most homeowners would call a service provider to have a hydraulic failure fixed without ever notifying the health department; this would suggest that reported cases of hydraulic failure may primarily come from rental properties, which can explain some underreporting of system failure.

C Given the nature of ISS in Suffolk County (i.e. septic tank-leaching pool systems placed lower in the soil), there may be relatively little ponding of untreated wastewater above surface and thus back-up into the home could be the more likely sign of hydraulic failure.

Figure 4-9 plots the total number of reported complaints verified by SCDHS as individual sewerage systems in hydraulic failure by month over the past several years.

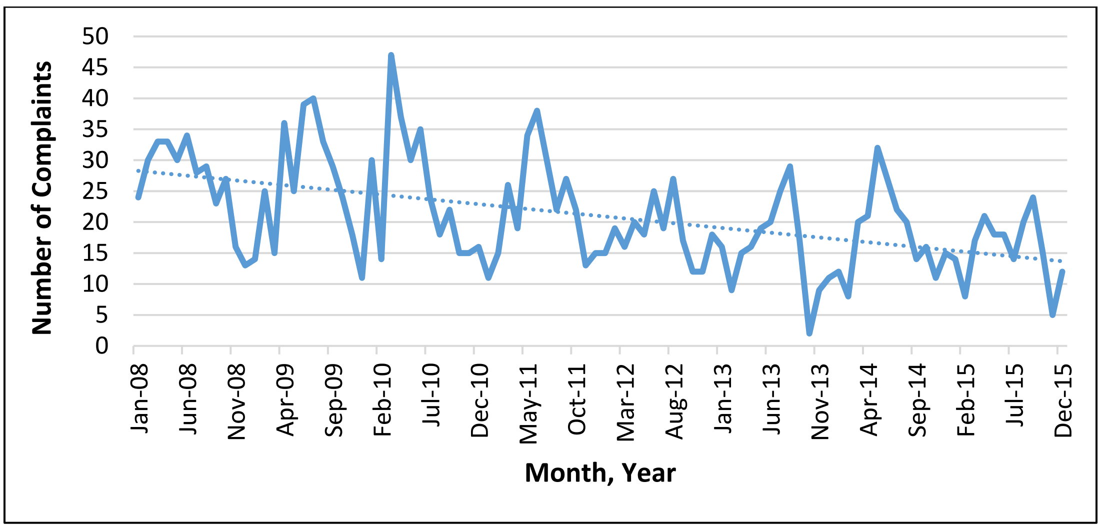


Figure 4-9. Reported complaints to SCDHS of individual sewerage system hydraulic failure from January 2008 to December 2015. It is postulated that hydraulic failure may be underreported.

There is an overall decreasing trend of reported sewerage complaints over time, with cyclic higher frequencies in summer months (May through August) and lower frequencies in winter months (October through February). When looking at average complaints by month, there is an observable peak (higher sewerage complaints) reported during the spring and summer months (i.e., during the rainy season and vacation season), as indicated in Figure 4-10. While there is no indication in the SCDHS data whether the sewerage complaints were related to episodic or catastrophic failure, the trend shown in Figure 4-10 indicates that at least some portion of the failures are likely episodic (e.g., related to higher rainfall or increased water usage).

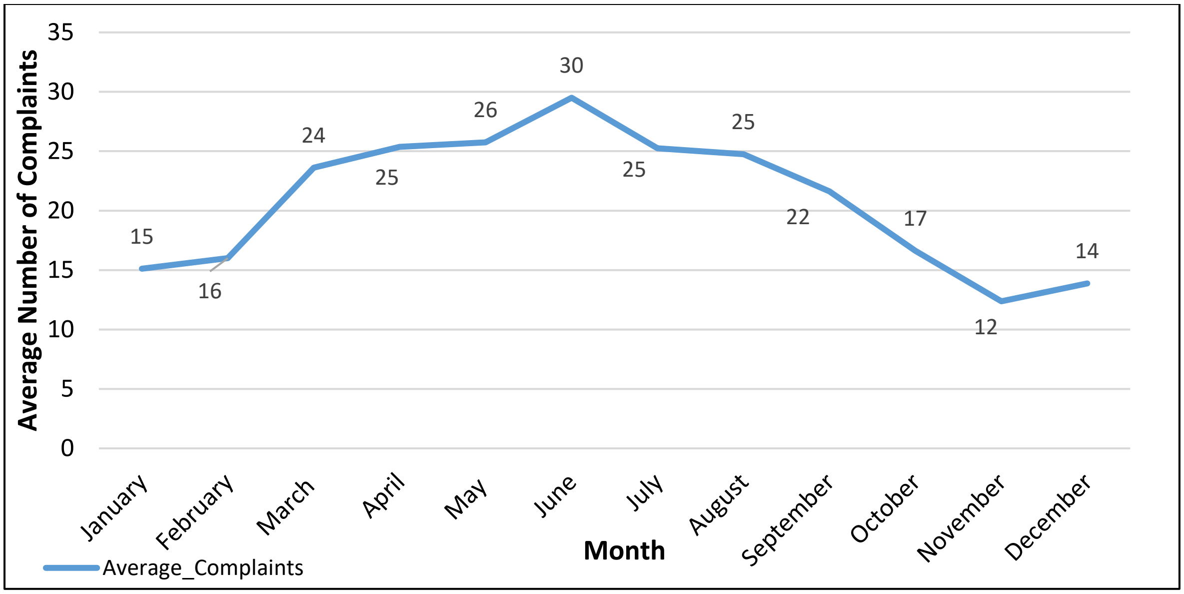


Figure 4-10. Average complaints to SCDHS of individual sewerage system hydraulic failure, by month, from January 2008 to December 2015.

Scavenger waste as a proxy for hydraulic failure

Septage waste pumped out of an individual sewerage system by a technician (i.e., scavenger waste) is transported to a treatment or holding facility. There are only a few sewage treatment plants and storage facilities in Suffolk County that accept this scavenger waste, so the waste that is received may originate from areas throughout the County. Incoming scavenger waste data were available for two sewage treatment plants in Suffolk County at the time of the HIA analysis. The HIA Research Team acquired the data directly from one sewage treatment plant and from the Suffolk County Department of Public Works for the other plant. Both of these sewage treatment plants were located in Western Suffolk County, where the majority of the complaints originated, but may accept scavenger waste from locations throughout the County. The incoming scavenger waste data were analyzed, along with reported complaints of individual sewerage system hydraulic failure, to glean information on maintenance habits and as a proxy for hydraulic system failure (as the scavenger waste received by the facilities could have been waste from routine pumping or failure of the individual sewerage systems).

Figure 4-11 plots the total incoming scavenger waste at these two sewage treatment plants over the past few years. The average total incoming scavenger waste was 32.5 million gallons per year (minimum = 30 million gallons in 2014, maximum = 36 million gallons in 2009).

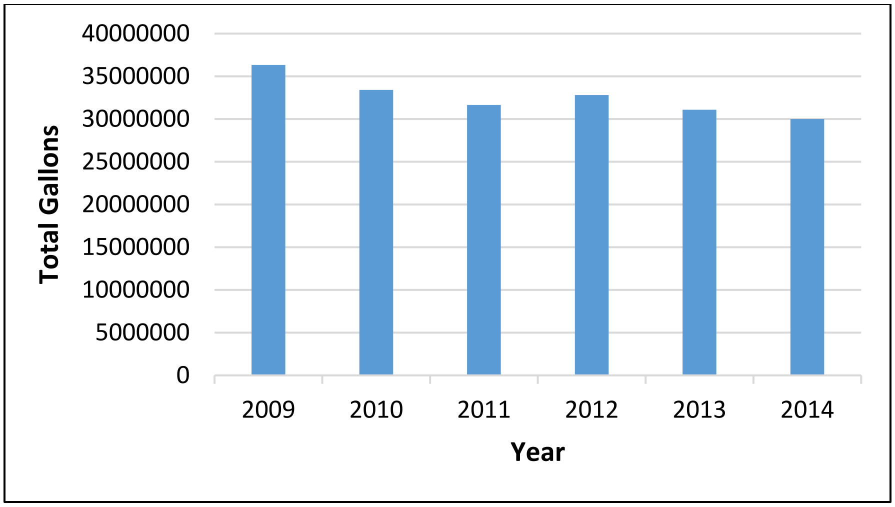


Figure 4-11. Total incoming scavenger waste to two sewage treatment plants in Suffolk County, 2009–2014.

Both treatment plants show an overall decreasing trend of incoming scavenger waste. Similar to the trend seen in individual sewerage system complaints, there is also a seasonal variation with higher scavenger waste going to the treatment plants during the spring and summer months (April to August) and lower scavenger waste going in during the fall and winter (October to March). Figure 4-12 plots the total incoming scavenger waste reported from each sewage treatment plant.

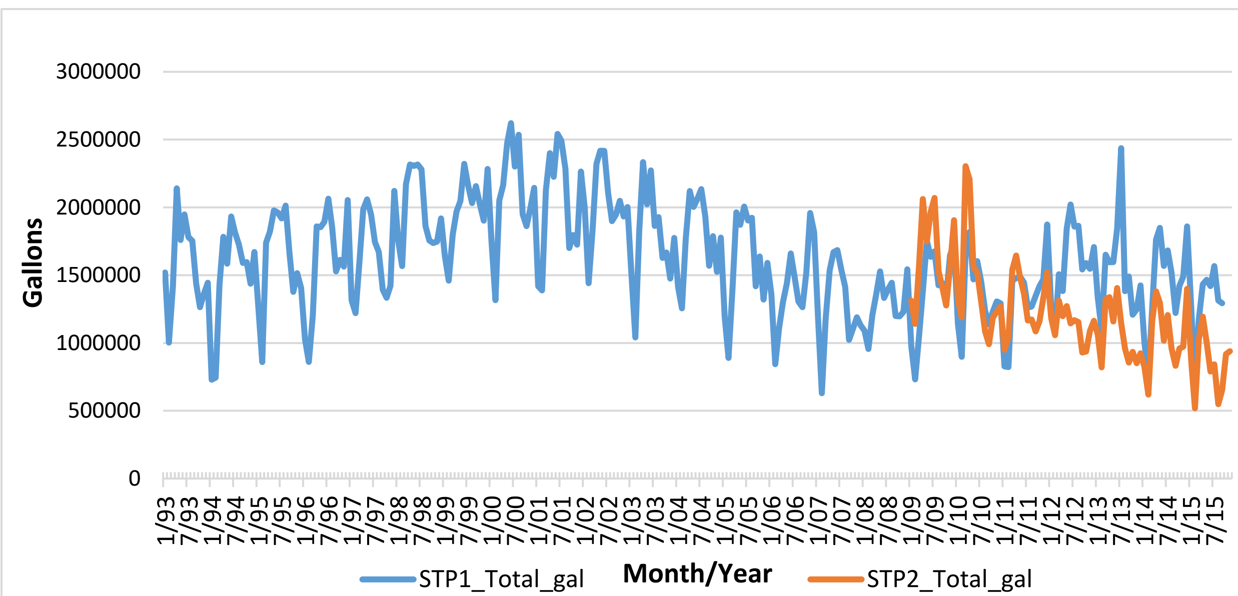


Figure 4-12. Incoming scavenger waste to each of two sewage treatment plants in Suffolk County by month from January 1993 to July 2015.

The HIA Research Team also evaluated to what extent incoming scavenger waste or complaints regarding onsite systems are affected by precipitation. Monthly precipitation data was obtained for 14 weather stations throughout Suffolk County from NOAA's Global Historical Climatology Network (NOAA, 2015a), and average annual precipitation and annual maximum monthly precipitation was analyzed for each station from 1979–2015. The locations of these weather stations coincided with locations of hydraulic failure complaints, although not all areas filing complaints had corresponding weather station data available. The data from these 14 stations was used to create an overall precipitation profile for the County, by which to compare the other data.

As precipitation increased, incoming scavenger waste and complaints about onsite systems also increased. These findings support the understanding that as average precipitation increases, some sewerage systems may need to be evacuated more frequently. During prolonged rainfall, there is an overload of water going into the system, slowing infiltration and in some cases, causing backups into the home or pooling above ground. Figure 4-13 shows incoming scavenger waste plotted across number of sewerage complaints and average monthly precipitation. The HIA Research Team found positive correlations between all three parameters (sewerage complaints, precipitation, and incoming scavenger waste). However, significance of correlation was only present between incoming scavenger waste and the number of sewerage complaints, indicating that incoming scavenger waste may be a good indicator of hydraulic failure. Average precipitation was not significantly correlated with individual sewerage system failure (i.e., reported sewerage complaints), indicating that other factors, such as changes in wastewater loading to system, maintenance, or age of the system, more likely influence the performance of the system.

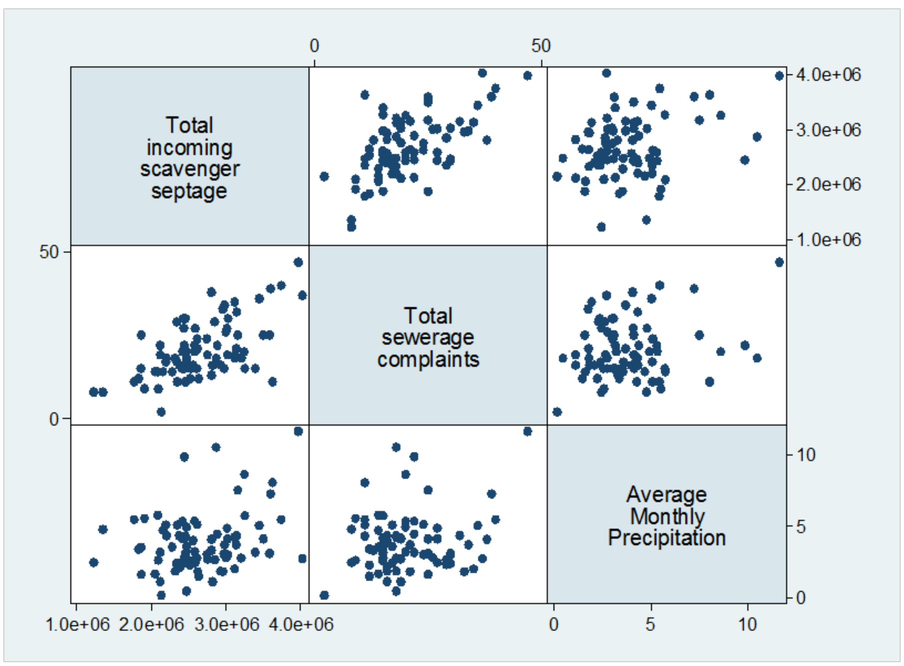


Figure 4-13. Correlational plots between incoming scavenger waste, individual sewerage system complaints, and average monthly precipitation.

Structural Failure

The HIA Research Team could not locate empirical studies on structural failure of individual sewerage systems in Suffolk County. However, existing local media articles and interviews of local Suffolk County residents and industry professionals do provide some insight. For example, in an article from East Hampton Press, a local owner of a sanitation company in Southampton, NY stated, "Eventually, the cesspool's walls give way to gravity. And, oftentimes, over-saturated soil is the tipping point, as it was in the recent flood of collapses from Westhampton to Wainscott" (Trauring, 2013).

Figure 4-14. Photo of a collapsed cesspool after a recent rain event. Photo credit: Russell Beal; Source: Trauring (2013).

No systematic reporting mechanism for structural failures of individual sewerage systems was found. While there could be more, the HIA Research Team found seven instances of individual sewerage system structural failures reported for Suffolk County in media sources through Fall of 2016 – with one incident each occurring in 1987, 2001, 2007, 2010, and 2011, and two in 2006[12]. These failures occurred for a variety of reasons including age, lawnmowers passing over the cesspool, heavy rain, and missing or removed covers. Figure 4-14 provides an indication of the size of the hole created when a cesspool collapsed after a heavy rain event in Suffolk County. It should be noted that these seven instances of structural failure found in the media did cause human injury and death (see Section 4.2.5).

L It is likely that structural failures of individual sewerage systems that occurred without human injury or death were not reported in the media and therefore, media reports probably underrepresent the actual number of structural failures in Suffolk County.

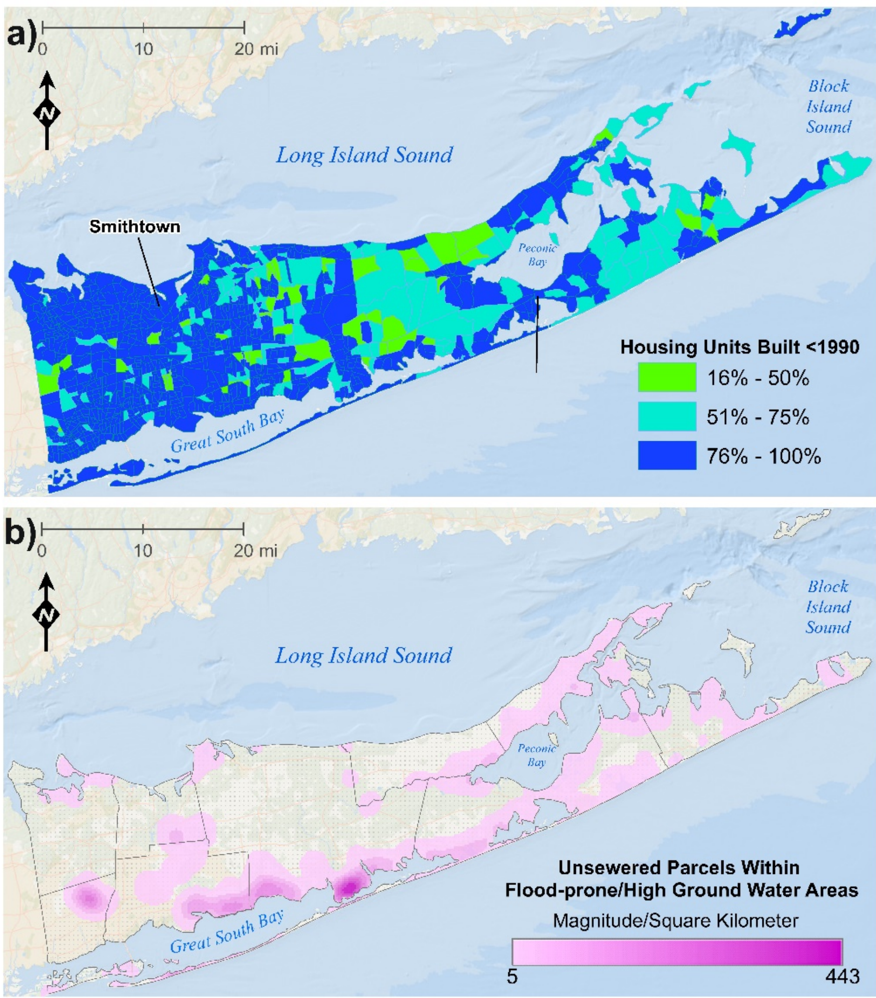
GIS Analysis to Determine Housing at Risk for Individual Sewerage System Failure

Using GIS techniques, the HIA Research Team analyzed Census data and tax parcel data to identify places with a high proportion of housing at risk for individual sewerage system failure (structural or hydraulic). Housing at risk for individual sewerage system failure was defined as: housing units (single or multi-family) built in or before 1990 (due to the potential age of the individual sewerage systems) or unsewered parcels in flood-prone/high groundwater areas (i.e., groundwater ≤ 10 feet from surface). According to 2008-2012 American Community Survey (ACS) data, about one third (30.6%) of Census block groups in Suffolk County having over 75% of homes built before 1990 are also in flood-prone/high groundwater areas (Table 4-6). Figure 4-15 shows Census block groups by a) percentage of housing units built before 1990 and b) density of unsewered residences in flood-prone/high groundwater areas.

[12] One additional structural failure (a cesspool hole collapse) was reported in the media in 2017; it is not included in the data reported above because it occurred after completion of the HIA analysis.

Table 4-6. Census Block Groups by Housing Age and Area in Flood-prone/High Groundwater Areas in Suffolk County

Percentage of Housing Units Built before 1990	Number of Block Groups	Percent Block Groups' Area in Flood-Prone/High Groundwater Areas
50% or Less	53	8.9
Between 50% and 75%	145	24.5
Over 75%	800	30.6
No Housing Units	1	N/A



Base Map: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

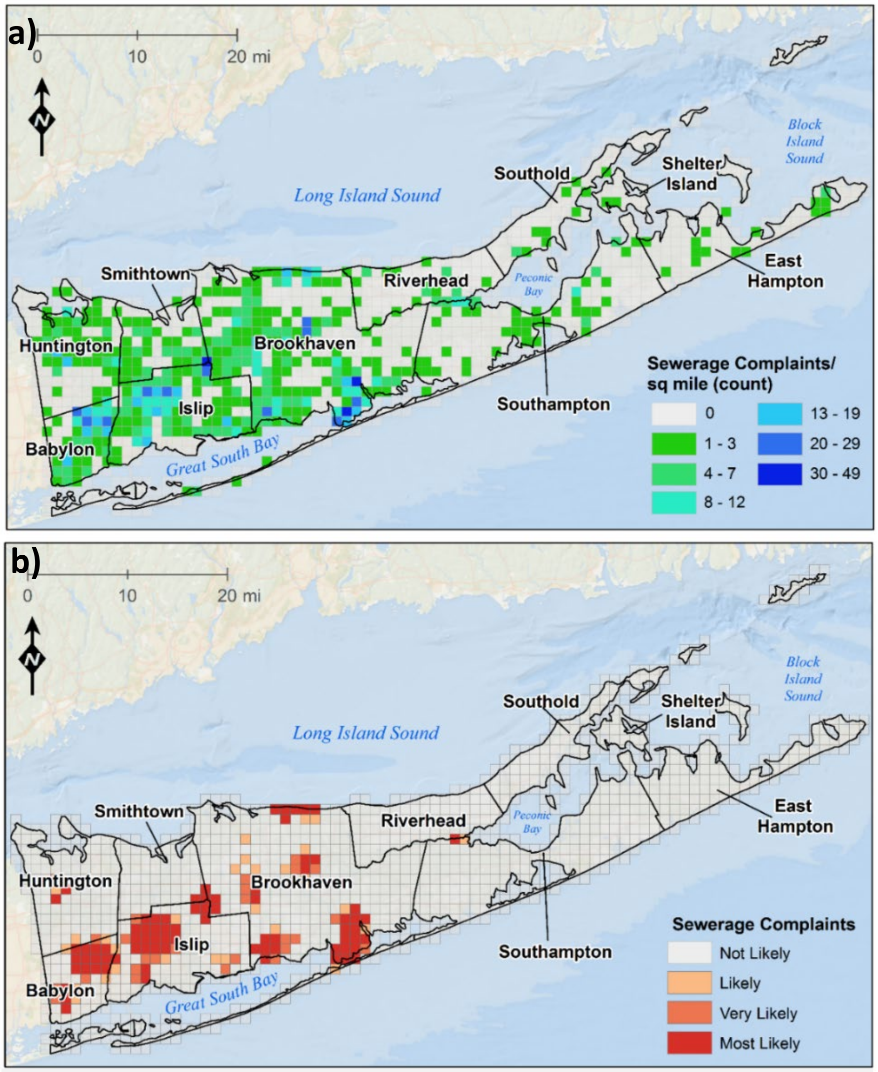
Housing Data: American Community Survey, 5-year Estimates, 2008-2012.

Sewered Areas and Parcels: Suffolk County Department of Economic Development and Planning (2012) and Suffolk County Real Property Tax Service.

Flood-prone and High Groundwater Areas: Suffolk County Comprehensive Water Resources Management Plan SLOSH Zones (2015) and USGS Hydrologic Conditions Maps for Long Island, NY, ≥10 feet to groundwater (2010),

Figure 4-15. Census block groups by a) percentage of single and multi-family housing units built before 1990 and b) density of unsewered residences in flood-prone/high groundwater areas, using a one-mile by one-mile polygon grid.

Reports of individual sewerage system failures appear countywide (Figure 4-16a), but there are noticeable areas where failures occur at a higher frequency. The HIA Research Team also performed a hot spot analysis to look at where most of the individual sewerage system complaints reported to SCDHS occurred (Figure 4-16b).



Sewerage Complaints: Suffolk County Department of Health, Division of Environmental Quality, 2008-2015.
Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors

Figure 4-16. a) SCDHS-reported complaints of individual sewerage systems across Suffolk County and b) the likelihood/frequency of individual sewerage system complaints, based on hotspot analysis showing where most of the reported complaints originated.

Comparing Figure 4-16b (the results of the hotspot analysis) to Figure 4-15 (the percentage of housing units built before 1990 and the percent unsewered parcels in flood-prone/high groundwater areas), sewerage system failures appear to occur in flood-prone/high groundwater areas. Although it should be noted, as discussed previously, that the number of complaints received by SCDHS falls well short of the 10% rate of existing individual sewerage systems malfunction estimated by Suffolk County Government (2015a).

Avoid the installation or construction of cesspool and septic tank–leaching pool systems on sites where pervasive flooding, tidal influence, and/or extreme rain events increase the risk for hydraulic and/or structural failure of an individual sewerage system. Mound systems offer an alternative option for sites where flooding and/or groundwater influences pose a high failure risk.

Table 4-7 lists the communities, identified by GIS analysis, with housing that may be more susceptible to individual sewerage system failure and those with a high frequency of reported complaints of individual sewerage systems.

Table 4-7. Communities Identified by GIS Analysis with Higher Susceptibility to Failure and Reported Individual Sewerage System Complaints

Town Within	Communities with Higher Susceptibility to Failure**	Communities with Higher Sewerage Complaints
Babylon	Deer Park, Wheatley Heights, Wyandanch, and North Babylon	Deer Park, Wheatley Heights, Wyandanch, and North Babylon, and North Amityville/Lindenhurst
Islip / Smithtown	Brentwood, Central Islip, Islandia Village, Ronkonkoma, Nesconset, Oakdale, West Sayville/Sayville, and Bayport	Brentwood, North Bay Shore, Bay Shore, Brightwaters Village, and Sayville
Brookhaven	Blue Point, North and East Patchogue, Patchogue Village, Mastic Beach Village, and Moriches	Lake Ronkonkoma area, Patchogue Village, Mastic Beach Village, Farmingville, Middle Island, Sound Beach and Shoreham Village
Southampton	Westhampton Beach Village, Quogue Village, North Haven Village, Sag Harbor Village	N/A
Riverhead	Riverhead and Jamesport	Riverhead
Huntington	N/A	Huntington Station

*Have both a high percentage of unsewered parcels in flood-prone/high groundwater areas and are located within Census block groups which have greater than 75% of residences built before 1990

Focus educational outreach and/or professional and financial assistance in areas where frequent failures are occurring and allow homeowners to upgrade/replace existing systems to more sustainable sewerage options that lower the risk of system failure.

Anticipated Change(s) to Individual Sewerage System Failure

Table 4-8 identifies the potential impacts of the proposed code changes on individual sewerage system failure for each decision alternative.

Table 4-8. Impact of Decision on Individual Sewerage System Failure

Alternatives	Potential Change(s) in Individual Sewerage System Failure
Baseline*	An estimated **38,512 systems experience hydraulic failure each year, but on average only 0.65% of those are reported.** There are isolated areas where sewerage complaints are most likely to originate. Although at-risk sewerage systems span the breadth of Suffolk County, there are 800 Census block groups with over 75% of housing built before 1990, and 30.6% of them are located within flood-prone/high groundwater areas. Older systems are subject to higher rates of structural failure and systems in flood-prone/high-groundwater areas are at higher risks of hydraulic and structural failure.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	**This alternative will eliminate use of cesspools and increase the number of systems using reinforced materials for the leaching pool, thus reducing the risk of structural failure (as long as the existing system components are no longer present or, if present, are filled with soil or gravel).† The use of a septic tank would also help prevent solids from carrying-over to the leaching pool, which could help prevent catastrophic hydraulic failure of the system.** However, flood-prone areas and areas influenced by groundwater and tidal waters still pose failure hazards (both hydraulic and structural), even for septic tank – leaching pool systems. Proper design and maintenance of the systems would be key to reducing the risk of hydraulic failure.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I, although the potential reduction in failure risk would be lower as only cesspools in priority areas would be upgraded and systems in these areas (flood-prone areas and areas influenced by groundwater and tidal waters) would still pose failure hazards (both hydraulic and structural).
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative / alternative system design.	**Installing I/A OWTS would eliminate older systems in the high priority areas and may help to reduce the risk of structural failure (as long as the existing system components are no longer present or, if present, are filled with soil or gravel) and hydraulic failure (as long as the system is designed to withstand flooding and influences from high groundwater and tidal waters and is properly maintained).**

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo would likely lead to increased hydraulic and structural failures, as systems age.

† At the time of the HIA analysis it was yet to be determined whether existing system components would be removed and a complete septic tank-leaching pooling system installed or whether a septic tank might just be added upstream of an existing cesspool to create a septic tank-leaching pool system.

Due to the design and materials used, older cesspools – especially those that have exceeded the expected life span of approximately 25 years – pose risks for illness, injury and/or death were the system to collapse, surcharge above ground, or backflow into the home. Ideally, homeowners could replace such systems with a modern design (e.g., septic tank-soil absorption system or I/A OWTS) or connect to a cluster system[13] or public sewer.

Completely fill unused or abandoned systems with soil or gravel, both to eliminate a source of standing water and to avoid potential collapse and injury.

4.2.5 Impact of Individual Sewerage System Hydraulic Failure on *Human Illness*

When untreated wastewater backs up into the home and/or surfaces (ponds above ground) it poses a direct health risk to both humans and animals. Health hazards associated with exposure to untreated wastewater include gastrointestinal illness, upper respiratory illness, rash or itchy skin, eye ailments, earache, or infected cuts (National Small Flows Clearinghouse, 1996; National Small Flows Clearinghouse, 1997; Lowe, et al., 2007; SCDHS, 2007; EPA, 2002a). Exposure can occur through incidental ingestion, direct contact, or respiration. Young children, the elderly, and those who are immunocompromised are more likely to be susceptible to these illnesses. (SCDHS, 2007).

Generally, EPA's Onsite Wastewater Treatment Systems Manual (EPA, 2002a) discloses some of the different pathogens that have been found in untreated sewage and might cause illness. The infectious bacteria include some strains of *Escherichia coli (E. coli)* that lead to gastrointestinal disease, *Leptospira* that causes leptospirosis, *Salmonella* that causes salmonellosis, *Salmonella enterica* serovar Typhi that causes typhoid fever, and *Vibrio cholerae* that causes cholera. There are also enteroviruses and noroviruses that can be found in untreated sewage that cause gastrointestinal disease, and eye infections. Protozoa, such as *Giardia duodenalis*, *Cryptosporidium*, *Entamoeba histolytica*, and parasitic worms (helminths), which are infectious and can lead to gastrointestinal illness and other health issues, may also be found in untreated sewage.

Inorganic nitrogen (nitrate-nitrogen and ammonium), volatile organic compounds, and toxic organics (e.g., polycyclic aromatic hydrocarbons [PAHs], pesticides, halogenated aliphatic compounds, polychlorinated biphenyl [PCBs], chlorobenzenes, volatile organic compounds, phenols, dioxins, furans, phthalates, and pharmaceutical chemicals), heavy metals (e.g., manganese, copper, cadmium, mercury, lead, chromium, nickel, zinc), and endocrine disruptors are also contaminants generally present in wastewater that may affect human health (EPA, 2002a).

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Whether potential chemical exposure from an individual sewerage system failure would affect health depends on many factors, including the chemical(s) present, its concentration and manner, and the duration for which the person is exposed; therefore, these impacts are difficult to characterize in a meaningful manner and are not included in the impact analysis for this HIA.

[13] Cluster systems are onsite wastewater treatment systems that serve two or more homes.

Existing Cases of Human Illness from Individual Sewerage System Failure at the Time of the HIA Analysis

There have been cases of illness associated with pathogens that can be found in human waste in Suffolk County (Section 4.1.4, Table 4-2), although exposure to the pathogens causing these diseases can be through a number of different pathways. Direct contact with sewage as a result of individual sewerage system failure (i.e., sewage back up into the home or surcharge aboveground) is only one potential source of exposure to these pathogens, but **the HIA researchers did not locate any reported cases in Suffolk County where illness occurred as a direct result of an individual sewerage system in hydraulic failure**. It should be noted, however, that illness from exposure to pathogens found in human waste likely goes unreported given the generality and self-limiting nature of the symptoms (e.g., nausea, cramps, diarrhea, and dehydration).

Anticipated Change(s) to Health

Table 4-10 identifies the potential direct impacts of the proposed code changes on health through individual sewerage system hydraulic failure for each decision alternative. This includes impacts to illness from exposure to untreated wastewater. It should be noted that whether exposure to untreated wastewater affects health depends on many factors, including the constituent(s) present in the wastewater, their concentration and manner, the dose and duration for which the person is exposed, susceptibility of the exposed individual, etc. Therefore, the impact of exposure to untreated wastewater on health and the effect the proposed code changes would have on incidences of human illness due to those exposures are difficult to characterize in a definitive, quantifiable manner.

The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-10, you must read the Likelihood and Magnitude columns together (e.g., it is possible Alternative I could benefit health for a high number of people).

For a summary of the different ways in which health could be impacted through the Individual Sewerage System Performance and Failure pathway see Section 4.2.8. Changes in the Individual Sewerage System Performance and Failure pathway as a result of the proposed code changes can also indirectly impact health through impacts to Water Quality, Resiliency, and Vector Control; these impacts are discussed further in the sections that follow.

Table 4-9. Impact of Decision on Illness from Individual Sewerage System Hydraulic Failure

Health Determinant	
Human Illness from exposure to untreated wastewater due to *hydraulic failure* (i.e., effluent loading rate into the disposal unit is greater than the infiltration rate through the biomat zone)*	**Baseline Health Status** Although direct exposure to untreated wastewater is hazardous, the number of illnesses in Suffolk County from close-contact exposure to wastewater due to a sewerage system failure is unknown. The HIA researchers did not identify reported cases in Suffolk County where illness occurred as a direct result of an individual sewerage system in hydraulic failure, but detecting water-related disease is challenging because many pathogens can also be spread in other ways (such as through food, person-to-person, or animal-to-person) and these illnesses often go unreported given the generality and self-limiting nature of the symptoms. Based on Suffolk County's projected 10% hydraulic failure rate, an estimated 38,512 systems fail each year, by backing up into the home or surfacing aboveground, but only an average 0.65% are reported to SCDHS. Most cases of illness in Suffolk County related to pathogens that can be found in human waste were caused by bacteria, such as *Shigella* and *Salmonella*, although incidence rates suggest the absence of widespread disease outbreaks. On average, approximately one in every 260,000 people are affected by harmful *Escherichia coli* each year in Suffolk County, compared to about one in every 167,000 people in New York State.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	This alternative would **benefit health** by adding a septic tank to help prevent solids from clogging the biomat or soil field (if applicable) – a cause of hydraulic failure.	The reduced likelihood of close-contact exposure to untreated wastewater, and thus human illness due to hydraulic failure, is **likely**, if the systems are properly designed and maintained. However, flood-prone areas and areas influenced by groundwater and tidal waters still pose failure hazards.	The extent of people affected would be **high.** Considering an estimated 192,558 single-family residences (50% of unsewered, single-family residences) would be required to upgrade their individual sewerage system, an estimated 564,195 people could be affected.	**See Table Footnote†**	The health implications of a hydraulic failure are **minor to moderate**.	The effects are estimated to be **long-lasting**, considering the long life span of the systems, although the effects may not be seen for a **long time**, as many years may pass between the point when the code change is enacted to the point when the sewerage system is actually upgraded.	**Limited to Strong.** There is strong evidence that exposure to untreated wastewater is linked to a number of illnesses; however, there are few studies (limited evidence) that confirm the relationship between hydraulic failure of individual sewerage systems and illness.

* Note that the Direction, Likelihood, Distribution, Severity, and Permanence of the potential impacts (as well as the Strength of Evidence) is the same for the three Alternatives; what differs is the Magnitude of the potential impact in each alternative. Because the number of illnesses in Suffolk County from close-contact exposure to wastewater as a result of an individual sewerage system failure is unknown, Magnitude could not be expressed as a change in frequency or prevalence of the illness. Magnitude is instead expressed as the number of people potentially at risk of being exposed to untreated wastewater if their individual sewerage system failed; an average of 2.93 people per household is assumed per the 2010 Census.

Assessment – Individual Sewerage System Performance and Failure

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	This alternative would **benefit health** by adding a septic tank to help prevent solids from clogging the biomat or soil field (if applicable) – a cause of hydraulic failure.	The reduced likelihood of close-contact exposure to untreated wastewater, and thus human illness due to hydraulic failure, is **likely**, if the systems are properly designed and maintained. However, flood-prone areas and areas influenced by groundwater and tidal waters still pose failure hazards.	The extent of people affected would be **high.** Considering 125,751 single-family residences would be required to upgrade their individual sewerage system, an estimated 368,450 people could be affected.	**See Table Footnote†**	The health implications of a hydraulic failure are **minor to moderate**.	The effects are estimated to be **long-lasting**, considering the long life span of the systems, although the effects may not be seen for a **long time**, as many years may pass between the point when the code change is enacted to the point when the sewerage system is actually upgraded.	**Limited to Strong.** There is strong evidence that exposure to untreated wastewater is linked to a number of illnesses; however, there are few studies (limited evidence) that confirm the relationship between hydraulic failure of individual sewerage systems and illness.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	This alternative would **benefit health** by adding an OWTS to help prevent solids from clogging the biomat or soil field (if applicable) – a cause of hydraulic failure.	The reduced likelihood of close-contact exposure to untreated wastewater, and thus human illness due to hydraulic failure, is **likely**, if the systems are properly designed and maintained. However, flood-prone areas and areas influenced by groundwater and tidal waters still pose failure hazards.	The extent of people affected would be **high.** Considering 251,502 single-family residences would be required to upgrade their individual sewerage system, an estimated 736,900 people could be affected.	**See Table Footnote†**	The health implications of a hydraulic failure are **minor to moderate**.	The effects are estimated to be **long-lasting**, considering the long life span of the systems, although the effects may not be seen for a **long time**, as many years may pass between the point when the code change is enacted to the point when the sewerage system is actually upgraded.	**Limited to Strong.** There is strong evidence that exposure to untreated wastewater is linked to a number of illnesses; however, there are few studies (limited evidence) that confirm the relationship between hydraulic failure of individual sewerage systems and illness.

†**Disproportionate impacts.** The communities most affected include those with a high proportion of unsewered residences constructed over 25 years ago (i.e., those with cesspools and/or individual sewerage systems near the end of their useful life) and in flood-prone/high groundwater areas. Young children, the elderly, and those who are immunocompromised are more likely to be susceptible to illnesses associated to exposure to pathogens found in human waste.

4.2.6 Impact of Individual Sewerage System Structural Failure on *Injury and Death*

If an individual sewerage system undergoes structural failure, the system inadvertently becomes a sinkhole filled with hazardous waste and gases posing a severe risk to human health. Falling into a collapsed chamber can lead to injury and/or death.

Existing Cases of Injury and/or Death from Individual Sewerage System Failure at the Time of the HIA Analysis

According to reports from local media articles, there have been at least seven deaths and three injuries caused by cesspool collapse or missing/removed covers in Suffolk County through Fall 2016; the earliest case reported in 1987. The deaths and injuries occurred at residential properties with exception of the 2010 death which occurred at a business. The ages of victims who died ranged from 16- to 76-years old. The deaths and injuries were caused by the physical fall into the cesspools, drowning, or being overcome by the fumes from the cesspools. Table 4-9 lists the location and date of each reported incident, along with the outcome (injury or death) from structural failure of an individual sewerage system.

Table 4-10. Location, Outcome, and Date of Incident from Reported Individual Sewerage System Structural Failure[14]

Location	Outcome	Date of Incident
Farmingville	Death (2)	6/2/2011
Smithtown	Death	3/1/2010
Deer Park	Death	6/2007
Huntington	Death	9/2001
Elwood	Death	7/18/2006
Dix Hills (in Huntington)	Death	1987
Huntington	Injuries (3)	4/1/2006

Note: There is a report of two additional injuries related to cesspools, although not specifically structural failure. Two men were burned - one severely - during an explosion following removal of the cesspool cover. The methane from inside the cesspool was ignited by a spark as the metal cover was removed, causing the explosion. The cause of this incident was suspected to be improper ventilation of the cesspool and the chance of this incident being repeated is highly unlikely.

Ensure good practice in the siting, design, installation, and maintenance of individual sewerage systems including the use of reinforced materials to help prevent human injury and/or death from structural failures.

[14] One additional death was reported in the media in 2017. This death occurred in Huntington on 5/24/2017, when a cesspool hole collapsed. It is not included in the data reported above because it occurred after completion of the HIA analysis.

Homeowners or non-licensed professionals should not approach or attempt to investigate a collapsed or failing septic tank or cesspool. Cornell University – Suffolk County Extension Office recommends that if the surface of the ground above the septic tank or cesspool is wet, the area should be fenced off and a professional called to diagnose and address the problem (Cornell University Cooperative Extension of Suffolk County, n.d.).

> The Cornell University Cooperative Extension is supported by a federal, state, and local government partnership. The Extension brings local expertise and research-based solutions on economic vitality, ecological sustainability, and social well-being for NYS families and communities. For more information, visit http://cce.cornell.edu/.

Anticipated Change(s) to Health

Table 4-11 identifies the potential direct impacts of the proposed code changes on health through individual sewerage system failure for each decision alternative. This includes impacts to illness from exposure to untreated wastewater due to hydraulic failure and injury and/or death from structural failure. It should be noted that whether exposure to untreated wastewater affects health depends on many factors, including the constituent(s) present in the wastewater, their concentration and manner, the dose and duration for which the person is exposed, susceptibility of the exposed individual, etc. Therefore, the impact of exposure to untreated wastewater on health and the effect the proposed code changes would have on incidences of human illness due to those exposures are difficult to characterize in a definitive, quantifiable manner.

The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-11, you must read the Likelihood and Magnitude columns together (e.g., it is possible Alternative I could benefit health for a high number of people).

For a summary of the different ways in which health could be impacted through the Individual Sewerage System Performance and Failure pathway see Section 4.2.8. Changes in the Individual Sewerage System Performance and Failure pathway as a result of the proposed code changes can also indirectly impact health through impacts to Water Quality, Resiliency, and Vector Control; these impacts are discussed further in the sections that follow.

Table 4-11. Impact of Decision on Injury/Death from Individual Sewerage System Structural Failure

Health Determinant	
Human Injury and/or Death from *structural failure* (i.e., the collapse, deterioration, and/or cover malfunction/ removal, or absence of, the septic tank or cesspool/leaching pool)*	**Baseline Health Status** According to reports from local media articles, there have been at least five deaths and three injuries caused by cesspool collapse in Suffolk County through Fall 2016; the earliest case was reported in 1987. Deaths and injuries were caused by falls into cesspools or people being overcome by the fumes from the cesspools. The victims who died ranged from age 16 to 76 years. Locations of deaths from structural failure of individual sewerage systems include Smithtown (2010), Deer Park (2007), Huntington (2001), Elwood (2006), and Dix Hills (1987). Three persons were reported with injuries from a structural failure in 2006 in the Town of Huntington. It is likely that other injuries have occurred, but have gone unreported in the media. Although reported incidents of structural failure are rare, the likelihood of a structural failure is considered because risk factors associated with structural failure are widespread across Suffolk County and many cesspools/leaching pools are assumed to be nearing or past the end of their life span.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	This alternative would **benefit health** by reducing risk associated with structural failure and by improving the materials used in the construction of the system.	This alternative is **highly likely** to reduce the risk of another injury or death from a structural failure once the system is upgraded, as long as the original cesspool is no longer part of the system and is removed or filled.	The extent of people affected would be **high**. Considering an estimated 192,558 single-family residences (50% of unsewered, single-family residences) would be required to upgrade their individual sewerage system, an estimated 564,195 people could be affected.	**All individuals would be affected equally** (equal risk), but the communities most affected include those with a high proportion of unsewered residences constructed over 25 years ago and in flood-prone/high groundwater areas.	The health implications of a structural failure are **moderate to severe**, considering falling into a collapsed septic tank or cesspool/leaching pool may lead to injury and/or death.	The effects are estimated to be **long-lasting**, considering the long life span of the systems, although the effects may not be seen for a **long time**, as many years may pass between the point when the code change is enacted to the point when the sewerage system is actually upgraded.	**Limited.** The evidence reflects the hypothesized relationship between variables but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship.

* Note that the Direction, Likelihood, Distribution, Severity, and Permanence of the potential impacts (as well as the Strength of Evidence) is the same for the three alternatives; what differs is the Magnitude of the potential impact in each alternative. Because the number of injuries (and possibly deaths) in Suffolk County from individual sewerage system structural failure are unknown, Magnitude could not be expressed as a change in frequency or prevalence. Magnitude is instead expressed as the number of people potentially at risk of injury or death if their individual sewerage system failed; an average of 2.93 people per household is assumed per the 2010 Census.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	This alternative would **benefit health** by reducing risk associated with structural failure and by improving the materials used in the construction of the system.	This alternative is **highly likely** to reduce the risk of another injury or death from a structural failure once the system is upgraded, as long as the original cesspool is no longer part of the system and is removed or filled.	The extent of people affected would be **high.** Considering 125,751 single-family residences would be required to upgrade their individual sewerage system, an estimated 368,450 people could be affected.	**All individuals would be affected equally** (equal risk), but the communities most affected include those with a high proportion of unsewered residences constructed over 25 years ago and in flood-prone/high groundwater areas.	The health implications of a structural failure are **moderate to severe**, considering falling into a collapsed septic tank or cesspool/leaching pool may lead to injury and/or death.	The effects are estimated to be **long-lasting**, considering the long life span of the systems, although the effects may not be seen for a **long time**, as many years may pass between the point when the code change is enacted to the point when the sewerage system is actually upgraded.	**Limited.** The evidence reflects the hypothesized relationship between variables but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	This alternative would **benefit health** by reducing risk associated with structural failure and by improving the materials used in the construction of the system.	This alternative is **highly likely** to reduce the risk of another injury or death from a structural failure once the system is upgraded, as long as the original individual sewerage system is no longer part of the system and is removed or filled.	The extent of people affected would be **high.** Considering 251,502 single-family residences would be required to upgrade their individual sewerage system, an estimated 736,900 people could be affected.	**All individuals would be affected equally** (equal risk), but the communities most affected include those with a high proportion of unsewered residences constructed over 25 years ago and in flood-prone/high groundwater areas.	The health implications of a structural failure are **moderate to severe**, considering falling into a collapsed septic tank or cesspool/leaching pool may lead to injury and/or death.	The effects are estimated to be **long-lasting**, considering the long life span of the systems, although the effects may not be seen for a **long time**, as many years may pass between the point when the code change is enacted to the point when the sewerage system is actually upgraded.	**Limited.** The evidence reflects the hypothesized relationship between variables but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship.

4.2.7 Impact of Changes in Individual Sewerage System Technology on *Treatment Performance*

Different sewage treatment technologies have different treatment performances, so requiring upgraded technologies will change the average wastewater treatment performance of individual sewerage systems across Suffolk County and the quality of effluent coming from those systems. Treatment performance is determined by an individual sewerage system's ability to control wastewater effluent constituents. Domestic wastewater can include several constituents, including chemicals and their byproducts, pharmaceutical metabolites, pathogenic and nonpathogenic microorganisms, suspended solids, fats and oils, as well as salts and nutrients, like nitrogen.

There are many kinds of pathogens that can be transmitted in wastewater, and each type of bacterium, virus or protozoan requires a different test, making analysis of pathogens, often times, impractical. In addition to the variety of pathogen types, pathogens are often observed in lower concentrations in environmental waters, making them difficult to test for individually. Instead, fecal indicator bacteria (FIB; such as *E. coli* and fecal coliforms) – naturally occurring microorganisms in the gastrointestinal systems of humans (and other warm-blooded animals) – are often used as indicators for the presence of pathogens could also be present (Francy, et al., 2011). The most common parameters analyzed in wastewater are biological oxygen demand (BOD), total suspended solids (TSS), total nitrogen (TN) or total kjeldahl nitrogen (TKN), total phosphorous (TP), and fecal coliform bacteria (Table 4-12).

Table 4-12. Wastewater Quality Parameters

Parameter	Details
Biological oxygen demand (BOD)	The amount of dissolved oxygen needed by aerobic microorganisms to break down organic matter at a given temperature over time (i.e., used as a proxy measure for organic matter content); measured as 5-day average (BOD_5) in milligrams per liter of sample (mg/L)
***Escherichia coli* (*E. coli*)**	An indicator of fecal contamination, measured as most probable number (MPN) or colony forming units (CFU) per 100 mL of sample.
Total suspended solids (TSS)	All particles suspended in water which will not pass through a filter; measured as TSS in mg/L
Total nitrogen (TN)	The total of all nitrogen compounds suspended in water: organic-nitrogen + ammonia-nitrogen + nitrite-nitrogen + nitrate-nitrogen; measured as TN in mg/L using standardized American Public Health Association (APHA, 1995) methods
Total kjeldahl nitrogen (TKN)	The total of organic-nitrogen and ammonia-nitrogen compounds suspended in water; measured as TKN in mg/L
Total phosphorous (TP)	The total of all phosphate compounds suspended in water: orthophosphates + polyphosphates + organic phosphates; measured as TP in mg/L using standardized APHA (1995) methods
Fecal coliform bacteria	Microorganisms which are found in the intestinal tract of all warm-blooded animals (often used as an indicator of fecal contamination, although less specific than *E. coli*, a type of fecal coliform); measured as most probable number (MPN) or colony forming units (CFU) per 100 mL of sample

The widely accepted levels of treatment for domestic wastewater are primary, secondary, and tertiary treatment.

- ***Primary treatment*** is the most common treatment employed. It relies on a holding tank (i.e., septic tank) where wastewater is temporarily stored and physically separated, allowing dense solids to settle at the bottom and oils and grease to float to the top. Septic tank effluent contains considerable concentrations of microorganisms, nutrients, organic and inorganic chemical components, and suspended solids (EPA, 2002a; Whittier & El-Kadi, 2009).

- ***Secondary treatment*** involves the introduction of oxygen to stimulate aerobic microorganisms into breaking down organic matter. For individual sewerage systems, this process primarily occurs in the soil, but can occur in specialized septic tanks (e.g., extended aerated-activated sewerage systems). Many microorganisms and/or pathogens can be attenuated or deactivated in a soil absorption field, specifically uncompacted, unsaturated soil; sorption is the primary means of slowing and/or halting virus transport (Whittier & El-Kadi, 2009; SUNY-Stony Brook, 1993). EPA (2002a) reported a three-order magnitude (3-$\log_{10}$ or 1000-fold) reduction in viruses in the first 2 to 3 feet of soil in the soil absorption field.

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  Note: The “conventional” septic tank-leaching pool system does not achieve the same level of secondary treatment as does a system that utilizes a soil absorption field.

- ***Tertiary treatment***, although often used in public sewer treatment systems, is not common for residences served by individual sewerage systems. However, tertiary treatment is the most effective at controlling nutrients and pathogens and may include disinfection and/or a secondary mechanism of filtration (after primary treatment) via granular media or synthetic membranes. Disinfection includes some form of ultraviolet treatment and/or chlorination of effluent (Water Resources Research Center & Engineering Solutions Inc., 2008).

Systems that are substandard or inadequately designed, sited, installed, operated, or maintained can result in poor wastewater treatment performance in which partially- or wholly-untreated wastewater enters the environment (Meeroff D. E., Bloetscher, Bocca, & Morin, 2008; Beal, Gardner, & Menzies, 2005b). **Soil characteristics, load rate to the system, age of the system, and operation and maintenance all play roles in treatment performance** (Seabloom, 1982; Geary P. , 1992; Dawes & Goonetilleke, 2003; Carroll, et al., 2006).

The ***soil's infiltration and permeability characteristics*** are often used to determine acceptability of an individual sewerage system. Clay soils have a hydraulic conductivity of about 0.6 millimeters (mm) per day for septic effluent versus sandy soils, in which septic effluent percolates into the soil at a rate of about 2 mm per day (Bouma, 1975). Individual sewerage systems sited in predominantly coarse sandy/gravel soils are less efficient at controlling suspended solids, bacteria, and other pollutants than systems sited in predominantly finely textured soils, such as silt, clay soils, and fine sand (Postma, Gold, & Loomis, 1992; Loomis, 1996; Stevik, Aa, Ausland, & Hanssen, 2004; Loomis, 2014). Finely textured soils have small pore spaces, which can strain or block the physical movement of suspended solids and bacteria and provide more opportunity for the wastewater to come into contact with the soil surface and allow secondary treatment processes to occur (Loomis, 1996; Stevik, Aa, Ausland, & Hanssen, 2004). Not enough pore space leads to ponding, anaerobic conditions, poor treatment, and favorable conditions for bacteria; and pore spaces that are too large or the presence of channeling in the soils reduces filtration and allow for wastewater to flow through the soil, with very little treatment (Loomis, 1996; Stevik, Aa, Ausland, & Hanssen, 2004).

Regardless of whether the soil is sand or clay, the limiting factor in the long-term performance of an individual sewerage system is the permeability of the biomat, which is a bacterial slime layer in the soil below the leach field or around other wastewater disposal systems (Beal, Gardner, & Menzies, 2005a; Adler, et al., 2013). The biomat is created when the pores of the native soil are clogged with wastewater or septic tank effluent and anaerobic biological activity (under the presence of no oxygen) creates 'build up' at the interface between the discharge system and the native soil. The biomat both regulates the hydraulic flow of wastewater through the system, and provides an opportunity for treatment processes, such as oxidation, adsorption, die-off, and ion exchange, via relatively long hydraulic retention times in unsaturated soil (Beal, Gardner, & Menzies, 2005a). The presence of a "well-developed" biomat correlates to higher removal efficiency for pathogens, nutrients, organics, and total suspended solids (Beal, Gardner, & Menzies, 2005b).

The depth of unsaturated soil can also play an important role in the adequate treatment of septic tank effluent (Beal, Gardner, & Menzies, 2005a). In coastal places, where the water table fluctuates between two and four feet in elevation, the lack of sufficient unsaturated soil depth can prove problematic (Meeroff D. E., Bloetscher, Bocca, & Morin, 2008). Cogger and Carlile (1984) found that effluent treatment from conventional and alternative septic systems were poorest in systems where the soil was continuously saturated with groundwater.

Loading rates to a system, determined by flow and usage, also influence performance. Maintaining consistent usage and flow play a major role in the performance of an individual sewerage system. Postma, Gold & Loomis (1992) sampled groundwater downgradient from septic systems serving summer vacation homes and concluded that fecal coliform found in high concentrations during the summer was likely due to acute heavy loading and inadequate formation of the biomat due to non-use in the off-season.

Adler et al. (2013) found that several state regulations use 75 gallons per capita (person) per day as the *peak* flow of water consumed. When designing an individual sewerage system, designers use the peak flow as a hydraulic safety factor to account for high-flow wash days, water leaks, etc. (Adler, et al., 2013). Recent studies have shown that the average daily use of water is closer to 53.5 gallons per person per day, accounting for approximately 16 gallons per person per day from leaks, outdoor irrigation, and other cases where effluent would not reach the wastewater system (Adler, et al., 2013; Mayer, et al., 1999).

Due to increased efficiency of appliances and fixtures, the average water usage per person has been on the decline for many years. As water use decreases, however, there is less solution in the wastewater to dilute pollutants and the constituent concentrations increase (Adler, et al., 2013). This implies the importance of taking into account water use and flow when determining the treatment performance of an individual sewerage system.

Age of the system affects performance. The biomat takes a few months to develop, so initial performance may not be reflective of general performance. On average, the width of a biomat ranges from 5 to 15 cm; it becomes increasingly impermeable to flow as it develops and ages (Beal, Gardner, & Menzies, 2005b).In addition to the initial time needed for establishment of the biomat, the age of the individual sewerage system itself also plays a part in the treatment performance. Korhnak & Vince (2004) found performance of individual sewerage systems declines with age, and according to Smith & Ince (1989), age of the system is one of the primary causes of treatment failure. Under optimal conditions, individual sewerage systems are designed to have a useful life of 20-30 years (Cornell University Cooperative Extension, 2013).

Operation and maintenance of a system affects its treatment performance capability. Over time, solids in the septic tank and cesspool build up and lower the amount of room for settling. The recommended maintenance or "good practice" suggests individual sewerage systems should be inspected at least every one to three years and evacuated (i.e., pumped out) at least every three to five years (Berry, 2015; SUNY-Stony Brook, 2014; Cornell University Cooperative Extension of Suffolk County, n.d.; EPA, 2002a; Loomis, Onsite Wastewater Treatment Systems, 2014; CDM Cesspool Service, 2015).

Existing Treatment Capability for Individual Sewerage Systems (in use or under consideration) in Suffolk County

Individual sewerage systems can be sited, designed, installed, and operated to meet federal and state effluent standards, and effective advanced treatment units are available to meet nutrient removal and disinfection requirements (EPA, 1997). EPA (2003a) ascertains, however, that individual sewerage systems must be implemented as part of a management program to regularly attain water quality and public health objectives.

However, the treatment performance of an individual sewerage system is highly variable even among the same technology design. Oakley, Gold, & Ocskowskil (2010) looked at three studies that evaluated the performance of decentralized sewerage systems to control nitrogen in effluent. Individual sewerage system performance ranged greatly over the 20 systems monitored and very few systems managed to meet the project's desired nitrogen effluent concentrations (<10 mg/L TN) consistently (Oakley, Gold, & Ocskowski, 2010).

It should also be noted that the treatment benefits of proper siting, design, and installation can be negated if the density of individual sewerage systems for a given area exceed the capacity of native soils to effectively manage and treat wastewater effluent (EPA, 2002a). Suffolk County's saturation population (i.e., the population expected if all available land were developed according to existing zoning) is estimated to be 1.75 million people - a 17% increase over the 2010 population; this population figure may be reached by the year 2040 (Suffolk County Government, 2011).

Given its current population and the expectation that Suffolk County may reach its saturation population, further research is needed to ascertain the capacity of Suffolk County soils to effectively manage wastewater effluent (regardless of whether systems are upgraded or not).

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Note: The treatment performance analysis focused primarily on nitrogen loading (as this was identified to be a primary concern for Suffolk County waters), but pathogen loading, to a lesser extent, is also considered.

Treatment performance of nutrients and pathogens is reported at the edge of the individual sewerage system. Treatment performance describes changes in concentrations of nitrogen and pathogens in liquid effluent—what comes directly out of the individual sewerage system, taking into account settling/treatment within the system and pumping from the system (if any)—and is reported as compared to nitrogen and pathogen concentrations in raw wastewater (Figure 4-17). Treatment performance does not take into account processes that impact the concentration of nitrogen and pathogens in the effluent once discharged from the individual sewerage system (e.g., fate and transport through soil, particle association, efficacy, etc.)

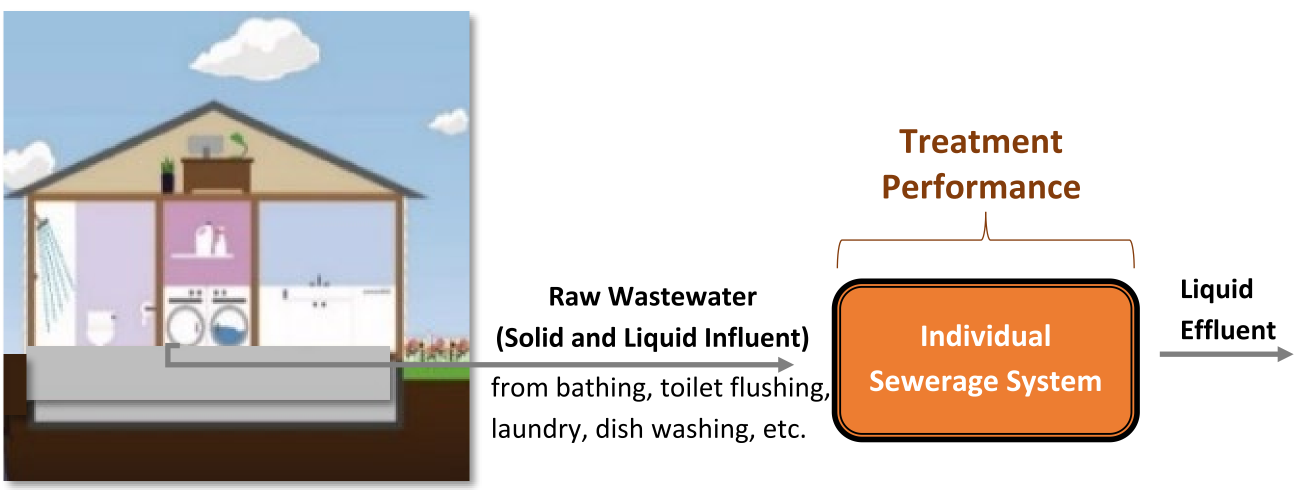

Figure 4-17. Individual sewerage system treatment performance describes changes in concentrations of nitrogen and pathogens in liquid effluent from the system—taking into account settling, treatment within the system, and pumping from the system (if any)—and is reported as compared to nitrogen and pathogen concentrations in raw wastewater.

With regard to ***cesspools/leaching pools***, **these systems are designed to provide temporary storage as the liquid portion of wastewater is absorbed into the surrounding soil.** Because cesspools and leaching pools in Suffolk County are placed relatively deep in the ground, effluent bypasses the soil layer primarily responsible for treating wastewater so there is limited reduction in nitrogen and pathogens as the effluent moves through the soil. Cesspools pre-date the County regulations for separation to groundwater and placement in sandy soils and are therefore, likely less efficient at nutrient and pathogen control than leaching pools installed per the regulations.

The quality of ***septic tank*** effluent is highly variable. Based on a review of available science on pollutant removal performance of various individual onsite wastewater treatment practices, an expert OWTS panel (Adler, et al., 2013) concluded **total nitrogen in septic tank effluent is equivalent to levels in untreated wastewater** and that the average total nitrogen load going to the disposal unit (i.e., coming from the septic tank) is 5 to 6 kg (11 to 13 lbs) TN per person per year. Due to recent declines in water use, researchers are now estimating that septic tank effluent will contain total nitrogen levels between 62 and 67 mg/L. Adler et al. (2013) recommend using 60 mg/L as the total nitrogen concentration in septic tank effluent, assuming an average flow of 60 gallons (227.1 L) per person per day of water consumed and a total nitrogen loading of 5 kg TN per person per year[15]. Lowe et al. (2009) found little overall removal in TN in septic tank effluent and a 1-$\log_{10}$ (10-fold) reduction in fecal coliform and *E. coli*; however, it should be noted that the septic tanks in this study were all dual-compartment concrete septic tanks ≤25 years old, with the majority younger than 10 years in age.

By comparison, in ***septic tanks with soil absorption fields***, effluent discharges from the septic tank into a soil drainfield through shallowly buried perforated pipes and then undergoes secondary treatment as it drains through the soil and biomat. Adler et al. (2013) found consensus among the literature that "conventional gravity-fed soil treatment systems can account for significant total nitrogen removal, typically in inverse proportion to soil grain size." In a study of the Chesapeake Bay watershed, this OWTS Expert Panel estimated an average 20% reduction in total nitrogen load within the drainfield, with the coarser sandy soils in the watershed not expected to provide as much TN removal and the tighter clay soils expected to provide better than 20% TN removal. Assuming an influent total nitrogen load to the drainfield of 5 kg per person per year, the total nitrogen load at the edge of the conventional gravity-fed drainfield would be 4 kg per person per year (Adler, et al., 2013)[16]. In Suffolk County, septic tank-soil absorption system use is limited, as previously mentioned, due to parcel size, soil conditions, and hydrogeology.

Given the additional reduction in nitrogen and pathogen loading from soil absorption drainfields and the potential for drainfields to break down many other pollutants (per the NYSDOH Residential Onsite Wastewater Treatment System Design Handbook; NYSDOH, 2012), consider changes to the Sanitary Code requiring cesspools and conventional OWTS be upgraded to septic tank-soil absorption systems when site conditions permit. At a minimum, the language in the code for Alternatives I and II could identify upgrades to a septic tank-soil absorption system, site conditions permitting, as an alternative to the C-OWTS. For residences with inadequate space for a soil absorption field, a mound OWTS, where a pile of appropriately permeable soil of a sufficient depth is placed on site, could also provide improved treatment performance over the C-OWTS.

[15] Note that the Nitrogen Loading Model used in several recent Long Island nitrogen loading studies assumes 4.8 or 4.82 kg TN per person per year and a 6% reduction in TN in septic tank effluent. The HIA uses the Adler et al. (2013) parameters in its analysis to be more conservative and protective of public health.

[16] After completion of the HIA analysis, efforts were undertaken in the County to examine conventional leaching systems and pressurized shallow drainfields. For more on these efforts, see Appendix K.

Note: The septic tank-soil absorption system provides improved treatment performance and also eliminates the risk of injury and/or death from cesspool or leaching pool collapse (as discussed in Sections 4.2.4 and 4.2.5)

As stated previously, at the initiation of the HIA in December 2014, Suffolk County was in the process of evaluating and approving ***I/A OWTS*** for general residential use in the County. The target nitrogen removal for effluent leaving these systems is no more than 19 mg/L of total nitrogen. The manufacturer-reported treatment performance of the systems under consideration at that time follow; additional systems have been tested since then and found to meet the performance requirements (see Appendix K).

1) BUSSE technology, utilizing the *membrane bioreactor treatment process*, has the ability to remove some personal care products and pharmaceutical byproducts in addition to nitrogen reduction. Busse Green Technologies reports a total nitrogen effluent of 16 mg/L for this system (SCDHS, 2014b).

2) Hydro-Action's AN Series and Norweco's Singulair TNT and Hydro-Kinetic systems utilize *extended aeration and activated sludge*. Hydro-Action Industries reported that their system yields a total nitrogen effluent of 15 mg/L; whereas Norweco reports a total nitrogen effluent of 12 mg/L for their Singulair TNT system and 9 mg/L for their Hydro-Kinetic system (SCDHS, 2014b). The Hydro-Action system was provisionally approved by Suffolk County in September 2016.

3) Orenco System's Advantex AX-RT and Advantex AX utilize a *growth packed bed reactor process*. Orenco Systems reported total nitrogen effluent of 15 mg/L for their Advantex AX-RT model and 17 and 19 mg/L for their Advantex AX model (SCDHS, 2014b).

The treatment performance capability identified for each of the various types of individual sewerage systems is under optimal conditions, which requires good operation and maintenance practices. It is important to consider that in a 2014 and 2015 survey of Suffolk County homeowners, 55% of West End survey respondents and only 18.8% of East End survey respondents (i.e., 213 respondents total) knew of or believed in good management practice (SUNY-Stony Brook, 2014; Berry, 2015). About 10% of respondents did not know which type of sewerage system was on their property. In the West End survey, 38% of the respondents who were more familiar with their system had not had their system inspected within the past five years, and 46% had not had their system pumped out within the past five years (SUNY-Stony Brook, 2014). The East End survey reported that up to 39.5% of respondents did not have their system pumped out within the last five years (Berry, 2015). Furthermore, most of the inspections and/or pump-outs in the past 5 years corresponded with system problems and/or malfunctions (SUNY-Stony Brook, 2014). The latter finding suggests that most inspections and/or pump-outs may be performed as part of a fix rather than as routine maintenance. Given the lack of routine maintenance, it is reasonable to assume that the performance of individual sewerage systems in Suffolk County may be sub-optimal.

Suffolk County could adopt a standard management plan for each system design to ensure individual sewerage systems are properly maintained and replaced/upgraded when needed[17]. The management plan could include good management practices.

Anticipated Change(s) to Individual Sewerage System Treatment Performance

Table 4-13 identifies the potential impacts of the proposed code changes on individual sewerage system treatment performance for each decision alternative.

Table 4-13. Impact of Decision on Individual Sewerage System Treatment Performance

Alternatives	Potential Change(s) in Treatment Performance[*]
Baseline[†]	**Cesspools are not specifically designed to control nitrogen or pathogens in effluent. Septic tank – leaching pool systems are not specifically designed to control nitrogen, but can offer a limited reduction in pathogens, although treatment performance can be highly variable.** If the average TN load going to the disposal unit (coming from the cesspool or septic tank) is 5 kg (11 lbs) TN per person per year, at an average 2.93 person per residence, then **TN loading to the environment from an individual cesspool or conventional OWTS would be 14.65 kg (32.30 lbs) TN per year** (see Appendix G for calculations). Lowe et al. (2009) found a limited (1-$\log_{10}$) reduction in fecal coliform and *E. coli* loading in newer dual-compartment septic tanks. However, due to the age of septic systems in Suffolk County and the predominance of cesspools, it is assumed for the baseline that there is less than a 1-$\log_{10}$ reduction in pathogens in the cesspools and septic tank – leaching pool systems currently in use in Suffolk County. The amount of pathogens released from each individual sewerage system is undetermined because "the occurrence and concentration of pathogenic microorganisms in raw wastewater depend on the sources contributing to the wastewater, the existence of infected persons in the population, and environmental factors that influence pathogen survival rates" (EPA, 2002a).
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS are required to conform to current County codes and standards, there would be **no change in TN loading** (compared to the baseline)**, as nitrogen levels in septic tank effluent are equivalent to levels in untreated wastewater** (Adler, et al., 2013). There may be a **limited (1-$\log_{10}$) reduction in pathogen loading** by adding a septic tank, due to attenuation (Lowe, et al., 2009).

[17] Article 19 of the Suffolk County Sanitary Code, adopted in July 2016, outlined the role of SCDHS as the responsible management entity (RME) for I/A OWTS; management of other individual sewerage systems is the responsibility of the homeowner.

Alternatives	Potential Change(s) in Treatment Performance[*]
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS in the high priority areas are required to conform to current County codes and standards, there would be **no change in TN loading** (compared to the baseline)**, as nitrogen levels in septic tank effluent are equivalent to levels in untreated wastewater** (Adler, et al., 2013). There may be a **limited (1-$\log_{10}$) reduction in pathogen loading** by adding a septic tank, due to attenuation (Lowe, et al., 2009).
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	If all existing and new OSDS and C-OWTS in the high priority areas are required to be upgraded to I/A OWTS, there would be **considerable improvement in the control of nitrogen.** If the upgraded sewerage systems achieve Suffolk County's requirement of 19 mg/L TN in effluent, then the resultant **TN loading from an individual I/A OWTS would be 4.63 kg (10.21 lbs) TN per year** (see Appendix G for calculations). If all existing and new OSDS and C-OWTS in the high priority areas are required to be upgraded to I/A OWTS, there is **possible improvement in control of pathogens and emerging contaminants of concern** (compared to the baseline)**, depending on the design of the systems[‡]**; it is assumed that I/A OWTS would at least achieve the minimum reduction in pathogen loading seen by adding a septic tank (i.e., a **1-$\log_{10}$ reduction).**

* Individual sewerage system nutrient and pathogen loadings reported are at the edge of the system (i.e., at the point of discharge from the system). The loading values reported reflect levels of nitrogen and pathogens in liquid effluent discharge from the individual sewerage system.

† It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would likely lead to increased loading and more frequent failures, as systems age.

‡ Some I/A OWTS can treat pathogens and emerging contaminants of concern (e.g., personal care products and pharmaceuticals) when certain components are part of or used in conjunction with the system (e.g., biofilters, microfiltration membranes, chlorination/disinfection units, and permeable reactive barriers); because the final designs of the systems are unknown, the measured pathogen control performance of the systems is unknown.

Take into consideration good practice in the siting, design, installation, and maintenance of individual sewerage systems. For example, cesspool and leaching pool systems are known to have poor performance for controlling nutrients and pathogens in system effluent. Suffolk County could consider replacing cesspools/leaching pools with the conventional shallow, soil absorption field systems, which are more effective in controlling nutrients and pathogens in system effluent. For residences with limited space for the conventional soil absorption field systems, an innovative/alternative system with proven treatment performance that would not require a large footprint could be permitted (e.g., mound OWTS).

To maximize the reduction in nitrogen loading and the possible reduction in loading of pathogens and emerging contaminants of concern expected with the use of I/A OWTS and to address any potential fairness and conformity concerns:

Consider a fourth alternative, requiring upgrade of individual sewerage systems to an innovative/alternative technology across the entire county, with prioritization given to parcels in the high-priority areas (e.g., proactive upgrades in priority areas and upgrades elsewhere in the county, upon transfer, failure/replacement, significant and new construction).

Bear in mind that **I/A OWTS require routine management and monitoring, in part due to their specialized biological, mechanical, and electrical components, in order to remain operational and effective** (EPA, 2005a). In order for I/A OWTS to be properly operated and maintained, SCDHS has suggested that "oversight of I/A OWTS maintenance will require an additional entity responsible for managing and monitoring those systems" (Suffolk County Government, 2015a). Suffolk County proposed that a responsible management entity (RME)[18] and corresponding wastewater management district be identified and prepared to function within or in concert with SCDHS (i.e., the regulatory agency) and Suffolk County Department of Public Works (SCDPW; i.e., the project engineers and implementers), based on other successful case studies (Suffolk County Government, 2015a).[19] Article 19 of the Suffolk County Sanitary Code (SCDHS, 2016b), adopted in July 2016, outlined the role of SCDHS as the RME; the Department is tasked with ensuring that I/A OWTS are properly managed and maintained and provide the intended levels of treatment. This will constitute a considerable culture change for homeowners with respect to operation and maintenance of their individual sewerage systems.

Include pathogen and/or fecal indicator bacteria monitoring for the I/A OWTS so that data could be obtained to better evaluate the treatment performance of such systems for pathogen control.

The impact of changes in individual sewerage system performance on health are discussed in the Water Quality section (Section 4.3).

[18] RME is a term developed and described by EPA in the March 2003 *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems*– a guide to help communities establish comprehensive management programs so their decentralized systems function properly. The guide focuses on public education and participation, planning, operation and maintenance, and financial assistance and funding.

[19] In February 2021, Suffolk County announced the release of a feasibility study and implementation plan to guide the establishment of a Countywide Wastewater Management District.

4.2.8 Individual Sewerage System Performance and Failure Health Impact Summary*

- The use of a septic tank in combination with a leaching pool (Alternatives I and II) or installation of an I/A OWTS (Alternative III) is **highly-likely to reduce the risk of structural failure** (as long as the original system components are no longer present or, if present, are filled with soil or gravel) and **likely to reduce the risk of hydraulic failure** and resultant close-contact exposure to untreated wastewater for people living in the single-family residences required to upgrade their systems, if the systems are properly designed and maintained. However, flood-prone areas and areas influenced by groundwater and tidal waters still pose failure hazards (both hydraulic and structural).
- These reductions in risk benefit health by **reducing the risk of injury or death** from a structural failure and **protecting people from illness** as a result of exposure to untreated wastewater. There is limited evidence in Suffolk County linking system failure to human injury, death and illness, but strong evidence, in general, that exposure to untreated wastewater is linked to a number of illnesses.
- Communities with a high proportion of unsewered residences constructed over 25 years ago and/or in flood-prone/high-groundwater areas and those more susceptible to illness (e.g., young children, the elderly and the immunocompromised) could experience a greater health benefit from individual sewerage system upgrades.
- The health benefits of upgrading individual sewerage systems are expected to be long-lasting, but may not be seen for a long time, given the potential lag in implementing the upgrades.

*The health impact summary for the Individual Sewerage System Performance and Failure pathway includes only health impacts due to individual sewerage system failure. Per the pathway diagram for this pathway (Figure 4-5), health impacts of individual sewerage system performance are discussed in the Water Quality pathway (Section 4.3).

4.3. Water Quality: Existing Conditions and Potential Impacts

Water quality relates to the physical, chemical, and biological properties of the water. There are many factors that affect water quality, including precipitation (e.g., volume, intensity, and duration); presence of pollutants; and properties of the environment in which water travels, such as surface permeability, topography and/or grade, presence of plants and animals, and soil characteristics (e.g., composition, type, size, and layering) (EPA, 2012a). Given the growing concerns in Suffolk County related to excess nitrogen, algal blooms, beach closures, and contamination and/or loss of shellfish and submerged aquatic vegetation, stakeholders participating in the *Scoping* step ranked water quality as their primary topic of concern with regard to the proposed code changes (refer to Section 3.5.2). Water resources, such as groundwater and surface waters (e.g., rivers, lakes, streams, estuaries, and coastal shorelines), provide invaluable ecosystem services, such as drinking water, habitat for food sources, recreational opportunities, protection from storms and/or tidal surges, and social/cultural benefits. Suffolk County's water resources are an integral part of its economy, social and cultural identity, and security.

Suffolk County asserts, "much of the nitrogen pollution in Suffolk County waters has been linked to unsewered, dense suburban sprawl" (Suffolk County Government, 2015a). **Local and regional experts identified nitrogen pollution from wastewater sources, such as individual sewerage systems and sewage treatment plants, as a considerable contributor of nitrogen** to the Peconic Estuary, Long Island Sound, Great South Bay, and South Shore Estuary Reserve (Kinney & Valiela, 2011; Lloyd, 2014; Stinnette, 2014; SCDHS, 2014c; Woods Hole Group Inc., 2014; Suffolk County Government, 2015a; Gobler C. J., 2016; Lloyd, Mollod, LoBue, & Lindberg, 2016). Nitrogen impairment is a driver of eutrophication, salt-marsh loss, lower dissolved oxygen levels, and persistent algal blooms (Cloern, 2001; Heisler, et al., 2008; Latimer & Charpentier, 2010; Deegan L. A., et al., 2012; SCDHS, 2014c; NYSDEC, 2015; Suffolk County Government, 2015a). Nutrients, such as nitrogen, can originate from single sources and non-point sources (EPA, 2002b). In addition to wastewater sources, agricultural activity and residential fertilizer use were also identified as major sources of pollution to Suffolk County groundwater and surface water (Suffolk County Government, 2015a). It should be noted that wastewater may be one potential source of pathogens, but stormwater runoff, wildlife populations, and pets may also serve as important sources of pathogen pollution discharging to Suffolk County surface water bodies (Suffolk County Government, 2015a).

Suffolk County issued a revised Comprehensive Water Resources Management Plan in March 2015 to include consideration of coastal resiliency, sea level rise, wastewater treatment, and ecosystem health. According to the revised Plan, Suffolk County is considering a range of solutions to address the issues related to nitrogen loading, including the expansion of sewered areas, adding sewage treatment cluster systems, broadening outreach and education about pesticide and herbicide use, providing more options for landscaping fertilizer and pesticides, restricting development in environmentally sensitive areas, and proposing changes to the County Sanitary Code for permitting I/A OWTS designed for nitrogen reduction and requiring upgrades for existing OSDS (Suffolk County Government, 2015a).

Recently, New York State announced a comprehensive study of Long Island's groundwater and aquifer system to determine possible threats to groundwater integrity, including chemical contamination and saltwater intrusion; invested $2 million to launch the New York State Center for Clean Water Technology at Stony Brook University, which will research water quality issues in coastal communities of New York (New York State, 2016); and invested $7 million in Suffolk County's Septic/Cesspool Upgrade Program Enterprise (SCUPE), designed to start up a program to mitigate nitrogen and pathogen loading from individual sewerage systems in Suffolk County (including I/A OWTS testing and implementation, research to prioritize areas in need of improved wastewater treatment, etc.).

NYSDEC and the Long Island Regional Planning Council (LIRPC) are working with stakeholders to develop an action plan to reduce nitrogen levels in the waters around Long Island. The scope of the plan will include an assessment of existing conditions, needed nitrogen-load reduction targets, and alternatives and strategies to meet those targets (NYSDEC and LIRPC, 2016). NYSDEC identified pilot nitrogen mitigation actions as a top priority in its recent New York Ocean Action Plan, 2017-2027. These actions include $3 million in grants awarded in 2016 for measures such as installation of permeable reactive barriers, cluster wastewater treatment systems, I/A OWTS, hydro modifications and more. Projects funded in Suffolk County include development of a Suffolk County Soil Health Guide and boat pumpout stations in Brookhaven (NYSDEC, 2017).

Suffolk County is managing wastewater derived nitrogen by expanding the number of parcels connected to centralized sewage treatment plants, as well as by looking at alternative technologies for onsite systems. SCDPW is in the process of conducting several larger sewering studies that aim to repair and/or expand centralized sewering across Suffolk County. In 2015, $383 million in state and federal funding was awarded to expand sewer infrastructure to approximately 10,000 parcels in several areas of Suffolk County currently served by onsite septic systems (New York State, 2014; New York State, 2015a). The sewer projects, as proposed, included:

- Parcels in Forge River that will be connected to a new wastewater treatment plant located near the Brookhaven Town Airport;
- Parcels in the Carlls River area that will be connected to the Southwest Sewer District (SWSD);
- Parcels in the Connetquot River and Nicoll Bay area that will be connected to the SWSD; and
- Parcels in the Patchogue River area that will be connected to the Patchogue Sewer District.[20]

While centralized sewering has its benefits, it should also be noted that it can lead to unintended impacts, such as increased density of development (Fulton, Pendall, Nguyen, & Harrison, 2001), if efforts to expand sewering are not considered in combination with land use planning (e.g., cluster development and other smart growth options) to preserve open greenspace. Sewering can also lead to a lowered

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[20] Since the completion of the HIA analysis, the County undertook engineering and feasibility studies. Based on the results of those studies, sewering is expected to be implemented in multiple areas including the Carlls River watershed (portions of West Babylon, North Babylon and Wyandanch), the Forge River watershed (portions of Mastic and Shirley), the Connetquot River watershed (the Great River area), and Patchogue (which will expand the existing sewer system). The sewer projects are now in the design phase.

water table, especially in areas where pumping for drinking water occurs, because centralized sewers remove wastewater from the area, preventing it from naturally replenishing groundwater (Alley, Reilly, & Franke, 1999). Suffolk County Government (2016a) acknowledges, "sewering will not be feasible for most geographic areas of the County due to cost and other logistical factors and that patchwork sewering will not be sufficient to solve the problem. Therefore, I/A OWTS will be a critical part of the solution, along with decentralized cluster systems, where viable."[21]

4.3.1 Water Quality Pathways of Impact

Figure 4-18 shows the pathways by which the proposed code changes are expected to impact water quality and ultimately health.

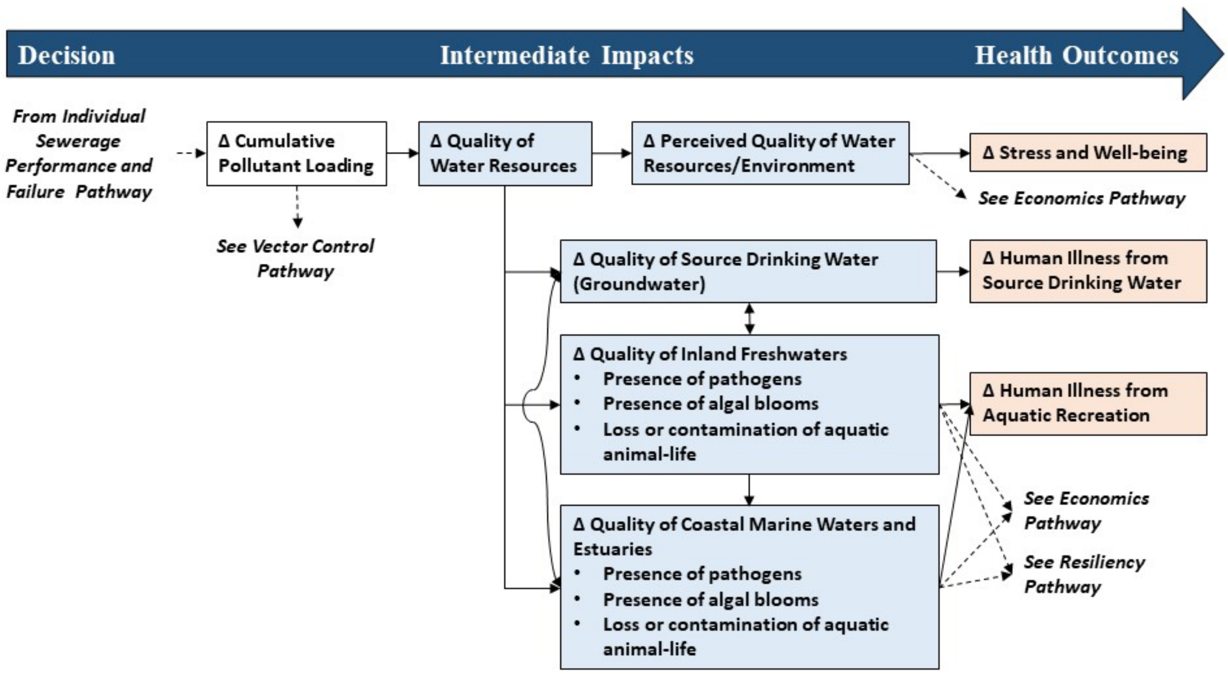

Figure 4-18. Water Quality Pathway Diagram.

The performance and/or failure of individual sewerage systems (as discussed in Section 4.2) influences the amount of pollutants transported from these systems into the environment (i.e., cumulative pollutant loading in wastewater effluent). As such, the quality of groundwater, drinking water in areas served by private and non-community drinking water wells, inland fresh surface water, and coastal (estuarine and marine) surface water can be impacted. Health may then be affected through drinking

[21] In the Subwatersheds Wastewater Plan (SWP) developed by Suffolk County, after completion of this HIA, the County does acknowledge, however, that sewering is an important element of the overall wastewater management strategy in Suffolk County and may have advantages over I/A OWTS in certain areas (e.g., areas with significant nitrogen-impaired waters, high groundwater, or poor soils; areas within close proximity to existing sewer districts; and in areas that are prone to sea level rise). The SWP explored wastewater management options and recommendations that included connection of parcels to community sewers by expanding existing sewer districts or creating new sewer districts where possible.

water or recreation. In addition to the actual changes in water quality that may occur, it is important to also consider changes in public perception of water quality and the environment, which can subsequently impact health through stress and well-being.

4.3.2 Impact of Individual Sewerage System Performance on *Cumulative Pollutant Loading*

As stated in the EPA's (1997) *Response to Congress on Use of Decentralized Wastewater Treatment Systems*, "adequately managed decentralized wastewater treatment systems are a cost-effective and long-term option for meeting public health and water quality goals, particularly in ***less densely populated areas***." NYSDOH (2012) and SCDHS also maintain that if properly designed, constructed, and maintained on a suitable site, individual sewerage systems provide for a safe, sanitary means of treating and disposing of wastewater. However, inadequate system design, siting, construction, and maintenance are problematic and may be due to lack of knowledge of good practice, limited expendable income to perform routine maintenance, and/or disagreement with or rejection of good management practices. EPA (1997) revealed that if not maintained properly, decentralized sewerage systems can pose environmental and public health risks.

Nutrient pollutants in wastewater, such as nitrogen and phosphorous, cycle through the environment in a couple of ways. Nitrogen in domestic raw wastewater occurs mostly in the form of organic matter and ammonium-nitrate (Adler, et al., 2013). After microbes have decomposed organic animal/human waste, the nitrogen in the resulting ammonium is either assimilated and used by plant roots or converted to nitrate by microorganisms in the soil to obtain energy, a process referred to as *nitrification* (Johnson, Albrecht, Ketterings, Beckman, & Stockin, 2005; EPA, 2002b). When the soil is saturated (wet and depleted of oxygen), bacteria use the nitrate as an oxygen source – converting the nitrate-nitrogen (NO_3-) to gaseous forms of nitrogen (N_2) – in a process called *denitrification* (Johnson, Albrecht, Ketterings, Beckman, & Stockin, 2005). *Volatilization* occurs, typically under higher soil pH and hot and windy days, when ammonium is converted to ammonia gas (NH_3) and released to the atmosphere where other plants, such as legumes, fix and use nitrogen out of the atmosphere through a process called *fixation*. Remaining nitrogen in the soil that is unused by plants and microbes, leaches deeper into the soil to groundwater or bedrock.

As with nitrogen, the organic form of phosphorous must mineralize to the inorganic form to become available to plants (EPA, 2005b). Plant roots absorb phosphorous from the soil, where it travels up through the food chain, eventually returning to the soil as animal waste and decay. The main form of phosphorous in a septic tank is orthophosphate (reactive phosphate), which is an inorganic salt of phosphoric acid (Weiskel, Howes, & Huefelder, 1996). In comparison to the nitrogen cycle, phosphorous does not have an atmospheric component and is largely restricted to solid and liquid phases.

Note: Suffolk County has not included phosphorous loading in its Sanitary Code standards or in testing of I/A OWTS. While the HIA does not evaluate phosphorous loading from individual sewerage systems, the discussion of phosphorous is included because it is a contributor to harmful algal blooms, which have been experienced in County waters and have human health and economic implications.[22]

Existing Conditions Regarding Cumulative Pollutant Loading from Individual Sewerage Systems at the Time of the HIA Analysis

In Suffolk County, discharge from individual sewerage systems is often below the root zone, so there is limited uptake of nitrogen or phosphorous by plants. This means the nitrogen in the wastewater travels through the Suffolk County soil – primarily "unconsolidated cretaceous sands, gravels, silts, and clay overlain by similar glacial sediments" (SUNY-Stony Brook, 1993) – and under aerobic (i.e., unsaturated) conditions, can be converted to nitrate by microorganisms in the soil and then make its way to groundwater. Transport of pollutants from individual sewerage systems through the environment mostly occurs due to aquifer recharge and groundwater flow (Baccus & Barile, 2005; Stinnette, 2014; Gobler C. J., 2016). Stinnette (2014) and Gobler (2016) found that groundwater was responsible for 90% of nitrogen transport in 6 of the 7 subwatersheds feeding the Moriches, Quantuck and Shinnecock Bays in the eastern extent of Long Island's South Shore Estuary Reserve. The flow of groundwater on Long Island is mostly from the middle of the island to the north (towards the Long Island Sound) or to the south (towards the Great South Bay and Atlantic Ocean). Researchers attending a conference at the State University of New York, Stony Brook (SUNY-Stony Brook), stated that because of this movement, there is little to no mixing between east and west ends, except for east of William Floyd Parkway (in Suffolk County) where water flows east towards the Peconic River (SUNY-Stony Brook, 1993) Groundwater can transport the nutrients and other contaminants in wastewater to nearby drinking wells and surface waters.

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In Suffolk County, water travels relatively fast through the aquifer system. Near the surface, the groundwater on Long Island moves at a rate of about 300 feet per year, but lower in the aquifer, groundwater only moves at a rate of about 1 foot per year (SUNY-Stony Brook, 1993). While groundwater travel times along the coasts of Long Island range from 0-10 years, groundwater travel times from the middle of Long Island to the shore can take decades to hundreds of years (SUNY-Stony Brook, 1993; Kinney & Valiela, 2011; Misut & Monti, 2016). Given the long travel times from parts of the aquifer, it is important to note that some of the nutrients and contaminants entering the bays today are from past land use practices (i.e., legacy nitrogen loading), such as agriculture, industry, and residential development (Peconic Estuary Program, 2015; LISS, 2017)[23].

[22] It should be noted that while phosphorous is typically a factor in the formation of freshwater HABs, it has also been shown to play a role in HABs in Suffolk County coastal waters (Wise, 2017).

[23] Note that the Subwatersheds Wastewater Plan developed by Suffolk County, after completion of this HIA, involved countywide nitrogen loading modeling that was used to establish travel times and nitrogen loading estimates for each subwatershed, establish nitrogen load reduction goals based upon specific human health and environmental endpoints, and refine priority areas in which to focus those efforts. For more on this effort, see Appendix K.

As groundwater receives recharge from above (e.g., during periods of heavy precipitation or wastewater discharge) or in areas of tidal influence, the water table (i.e., the boundary where soil becomes saturated with groundwater) rises. As the water table rises, the depth of unsaturated soil decreases. When there is no longer an unsaturated zone, groundwater becomes surface water.

Nitrogen and pathogen loading to Suffolk County waters can come from a number of sources, and some of these sources may originate outside of Suffolk County (e.g., Nassau County or New York City). Regardless of source, consequences of **nutrient and pathogen loading to Suffolk County waters** have included:

- Private drinking wells in the Upper Glacial Aquifer testing above the EPA standard for nitrate (i.e., above the maximum contaminant level of 10 mg/L);
- Hypoxic waters in Long Island Sound and depletion of soluble oxygen;
- Reoccurring *en masse* die-off of turtles (in Flanders Bay), fish, and shellfish;
- Odors emitting from surface waters (e.g., Forge River);
- Closure of swimming/bathing beaches around lakes and bays due to harmful algal blooms and/or fecal indicator bacteria;
- Receding area of submerged vegetation (specifically eelgrass) and wetland acreage, and erosion of soils;
- Loss of revenue from tourism, aquaculture, and recreation industries, and employment loss in shellfish industry;
- Increased susceptibility to damage from storm and tidal surge and subsequent cost of damage; and
- Degradation of perceived surrounding environment and subsequent loss of property value (Suffolk County Government, 2015a).

Each of these effects will be discussed in greater detail throughout the report.

Anticipated Change(s) to Cumulative Pollutant Loading

Table 4-14 identifies the potential impacts of the proposed code changes on wastewater-derived cumulative pollutant loading for each decision alternative. It is important to note that no modeling was conducted to estimate pollutant loading to Suffolk County waters. Cumulative loading estimates for each alternative are discussed in terms of the total nitrogen and differences in the magnitude of pathogen reduction approximated in the liquid effluent at the edge of the system (i.e., at the point of discharge from the individual sewerage system; see Section 4.2.4 and 4.2.7) for all individual sewerage systems across the County.

Table 4-14. Impact of Decision on Cumulative Pollutant Loading

Alternatives	Potential Change(s) in Wastewater-derived Cumulative Pollutant Loading*
Baseline†	If TN loading to the environment from an individual cesspool or conventional OWTS would be 14.65 kg (32.30 lbs) TN per year and there are an estimated 385,117 unsewered, single-family parcels, cumulative TN loading to the environment equates to an estimated **5.64 million kg (12.41 million lbs) TN per year**; see Appendix G. An undetermined amount of pathogens may be released from each individual sewerage system because "the occurrence and concentration of pathogenic microorganisms in raw wastewater depend on the sources contributing to the wastewater, the existence of infected persons in the population, and environmental factors that influence pathogen survival rates" (EPA, 2002a); therefore, **cumulative loading of pathogens cannot easily be quantified** without a primary data collection effort, which did not occur as part of this HIA.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS are required to conform to current County codes and standards, there would be **no appreciable change in TN loading** (compared to the baseline), as nitrogen levels in septic tank effluent are equivalent to levels in untreated wastewater. There **may be a reduction in pathogen loading** from upgrading the estimated 192,558 residences served by OSDS (see Appendix G), given the **potential 1-$\log_{10}$ reduction in pathogen loading** by using a septic tank in combination with a leaching pool.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS in high priority areas are required to conform to current County codes and standards, there would be **no appreciable change in TN loading** (compared to the baseline), as nitrogen levels in septic tank effluent are equivalent to levels in untreated wastewater. There **may be a reduction in pathogen loading** from upgrading the estimated 125,751 residences served by OSDS in the high priority areas (see Appendix G), given the **potential 1-$\log_{10}$ reduction in pathogen loading** by using a septic tank in combination with a leaching pool. However, pathogen loading from the 66,807 residences served by OSDS outside of the high priority areas would continue at baseline rates.

Alternatives	Potential Change(s) in Wastewater-derived Cumulative Pollutant Loading*
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	If all existing OSDS and C-OWTS in the high priority areas are required to be upgraded to I/A OWTS, there would be **considerable improvement in the control of nutrients (nitrogen) and possibly pathogens and emerging contaminants of concern** (compared to the baseline)**,** depending on the design of the systems.‡ Per calculations in Appendix G: For an estimated 251,502 unsewered, single-family residences, at an average 2.93 persons per residence, and a loading of 1.58 kg (3.48 lbs) TN per person per year (assuming the I/A OWTS achieve Suffolk County's requirement of 19 mg/L TN loading in effluent), TN loading from upgraded systems in Suffolk County would equate to an estimated 1.16 million kg (2.56 million lbs) TN per year (see Appendix G). The 133,615 systems outside the high priority areas would continue at a loading rate of 5 kg (11 lbs) of TN per person per year, contributing an estimated 1.96 million kg (4.32 million lbs) TN per year. Overall, this would result in an estimated **cumulative reduction** in TN loading to the environment from individual sewerage systems in Suffolk County of **2.52 million kg (5.56 million lbs) TN per year.** There **may be a reduction in pathogen loading** from upgrading the estimated 251,502 residences, given the **potential 1-log$_{10}$ reduction in pathogen loading at a minimum**; a greater reduction in pathogen loading may be seen depending on the components of the I/A OWTS. However, pathogen loading from the 133,615 residences outside of the high priority areas would continue at baseline rates.

* Individual sewerage system nutrient and pathogen loadings reported are at the edge of the system (i.e., at the point of discharge from the system). The loading values reported reflect levels of nitrogen and pathogens in liquid effluent discharge from the individual sewerage system across the County to the environment; all loading estimates utilize the number of individual sewerage systems estimated in the HIA to be impacted under each alternative. Note that the Nitrogen Loading Model used in several Long Island nitrogen loading studies assumes 4.8 or 4.82 kg TN per person per year (10.5 lbs TN per person per year) and a 6% reduction in TN in septic tank effluent. The HIA uses the Adler et al. (2013) parameters – based on a review of available science on pollutant removal performance – in its analysis to be conservative and protective of public health.

† It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would likely lead to increased cumulative pollutant loading, as the systems aged.

‡ Some I/A OWTS can treat pathogens and emerging contaminants of concern (e.g., personal care products and pharmaceuticals) when certain components are part of or used in conjunction with the system (e.g., biofilters, microfiltration membranes, chlorination/disinfection units, and permeable reactive barriers); because the final designs of the systems are unknown, the measured pathogen control performance of the systems is unknown. It is assumed, however, that I/A OWTS will achieve the minimum reduction in pathogen loading seen by adding a septic tank (i.e., a 1-log$_{10}$ reduction), regardless of any additional components in the system.

4.3.3 Impact of Changes in Pollutant Loading on *Quality of Source Drinking Water (Groundwater)*

A key concern for Suffolk County is the future integrity of its sole-source for drinking water (i.e., groundwater). Suffolk County sources all of its drinking water from groundwater, and Suffolk County Water Authority (SCWA) – the main drinking water utility – is the "largest groundwater supplier in the country” (www.scwa.com/press). According to SCWA (2016), SCWA operated 583 groundwater wells across 237 wellfields, providing 69.4 billion gallons (262.7 billion L) of treated drinking water to 1.2 million people in Suffolk County in 2016. Smaller, community water supply utilities (about 1,000 wells) serve approximately 7% of residents; private (individual) wells and non-community systems serve the remaining 13% of residents. According to the 2015 Comprehensive Water Resources Management Plan (Suffolk County Government, 2015a), there are about 45,000 private, individual wells. Most of the public water supply wells in Suffolk County pump source water from the deeper Magothy Aquifer, whereas private wells pump source water from the shallower, Upper Glacial Aquifer.

Differences between drinking water delivery systems determine whether they are covered by SWAP – the Source Water Assessment Program (EPA, 2015a). The 1996 amendments to the Safe Drinking Water Act require states to create a Source Water Assessment Program for all their public drinking water systems to protect public drinking water sources from contamination. Private wells serving single households are not regulated under the Safe Drinking Water Act and are not required to be monitored.

Private drinking water wells do not typically include treatment for nitrates and rarely include treatment for pathogens. Municipal drinking water in the U.S. (i.e., the public water supply) is treated to reduce microbial pathogens in source water prior to distribution. However, treatment deficiencies and resistance of some organisms (particularly protozoa and viruses) to disinfection can result in microbial contamination of distributed water (Craun, Brunkard, Yoder, Roberts, & Carpenter, 2010).

Existing Quality of Source Drinking Water (Groundwater) at the Time of the HIA Analysis

SCDHS monitors and enforces safe drinking water regulations for the 39 community public water supplies and 254 non-community public water supplies within the County (SCDHS, 2015b). **In 2015, all public drinking waters in Suffolk County met both federal (EPA) and state (NYSDOH) standards for drinking water quality** (SCWA, 2016).

Source drinking water in Suffolk County is monitored for levels of nitrogen and the presence of fecal indicator bacteria, among other compounds. In a 2014 presentation to stakeholders on an evaluation of nitrates in Suffolk County public water supply wells, the SCDHS reported that 190 community public water supply wells screened in the Magothy Aquifer had lower nitrate concentrations than the 173 screened in the Upper Glacial Aquifer (Hime, [April] 2014). Based on groundwater sampling in 1987, 2005, and 2013, there is a linear trend of increasing average nitrate concentrations in wells from both aquifers[24]; however, the average concentrations are still well below the drinking water standard of 10 mg/L. It should also be noted that the water near the center of the Magothy Aquifer is 100 years old and almost 500 years old near the base of the Magothy; this means that much of the public drinking water

[24] Average nitrate-nitrogen levels in public water supply wells drawn from the Upper Glacial Aquifer rose over 41% from 2.54 mg/L in 1987 to 3.58 mg/L in 2013; whereas, average nitrate-nitrogen levels in public water supply wells drawn from the Magothy Aquifer rose 93.4% from 0.91 mg/L in 1987 to 1.76 mg/L in 2013 (Hime, [April] 2014). The calculated rate of increase in nitrate-nitrogen levels in public water supply wells drawn from the Upper Glacial and Magothy Aquifers was 0.03 mg/L per year from 1987 to 2005 (18-year span), and 0.04 mg/L per year from 2005 to 2013 (8-year span), respectively.

supply is groundwater recharge from before the County was extensively developed (SUNY-Stony Brook, 1993).

In late 2016, the Long Island Commission for Aquifer Protection (LICAP) released an online GIS-based water quality mapping and database tool called WaterTraq (http://liaquifercommission.com/watertraq.html). It provides both treated and untreated Long Island water test results, including nitrate, other naturally-occurring compounds, and contaminants, such as pesticides, personal care products, and pharmaceuticals. Treated water results are presented by SCWA Water Distribution Area or Suffolk Water District and identify the number of tests, range of readings (low, high, average), and whether there were any violations for each compound or contaminant. Untreated water results are from LICAP or SCWA aquifer sampling efforts or SCDHS well monitoring and can be searched by compound or by results above the standard. It should be noted that treated water results reflect the quality of drinking water for those on public drinking water supply; for those using private wells, untreated water results from the Upper Glacial Aquifer would more accurately reflect the quality of their drinking water.

According to the Suffolk County Water Authority 2016 Drinking Water Quality Report (SCWA, 2016), community supply wells are generally free of microbial contamination (i.e., in 2015, total coliforms and *E. coli* were detected in source wells for only 3 of 27 distribution areas and subsequent samples from these wells were negative). However, results of the New York State SWAP list over 20% of community supply wells as medium-high to very-high in microbial susceptibility due to the presence of wells in unsewered areas and short travel times from the water table to shallow well screens (SCWA, 2016).

Because private wells generally pump from the shallower Upper Glacial Aquifer (making them more susceptible to contamination from near surface activities) and may lack the levels of treatment, management, and testing required of public water supply systems, they are considered to be a higher-risk drinking water source (Suffolk County Government, 2015a; Fox, Nachman, Anderson, Lam, & Resnick, 2016; SCWA, 2019)**.** Since areas without public water connections are often also unsewered (Figure 4-19), co-location of private wells and individual sewerage systems increases the likelihood of contaminated groundwater intrusion. Monitoring and testing of private wells can help ensure the quality of drinking water provided from these wells. SCDHS does provide monitoring of private wells in Suffolk County on a voluntary basis at a fee of $100 for existing wells or $350 for new wells. Among 3,327 private wells tested between 2005 and 2015, pumping from the Upper Glacial Aquifer, 318 (9.6%) had positive detections of total coliforms and 20 (0.6%) had positive detections of *E. coli* (a better indicator of fecal contamination). While the SCDHS private well testing program "has discovered many instances of severe well water contamination… analyses show that the majority of wells tested in Suffolk County meet drinking water standards that have been set for health-related reasons" (Suffolk County Government, 2020). Less than 2% of private wells are tested by SCDHS each year, according to the Suffolk County Comprehensive Water Resources Plan (Suffolk County Government, 2015a).

Suffolk County's non-community public water supply systems, which serve facilities such as parks, restaurants, and schools, were cited 22 times in 2013 by NYSDOH for total coliform violations during routine monitoring (NYSDOH, 2014). This suggests that these systems, which are not typically disinfected, may be more susceptible to microbial contamination than community public water supplies.

It is important to note that detection of indicator organisms in drinking water from any source in Suffolk County cannot be directly linked to groundwater contamination from individual sewerage systems.

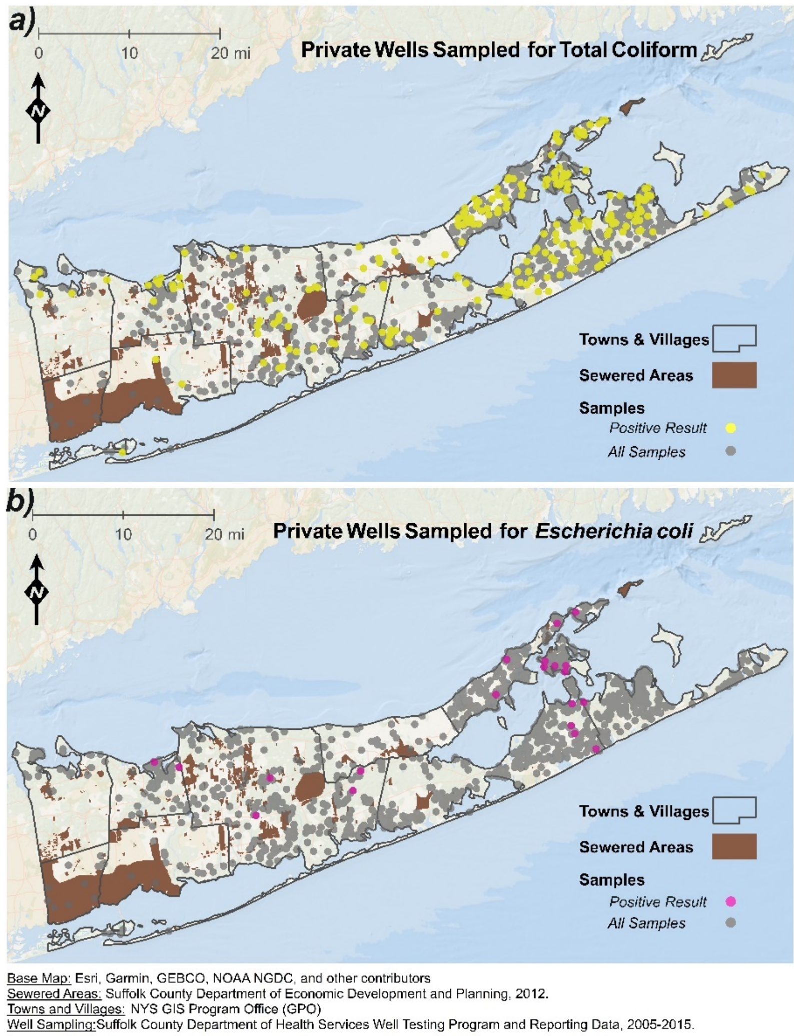

Figure 4-19. Locations of unique private wells tested 2005-2015 in Suffolk County, NY with a) positive detections of total coliforms and b) positive detections of *E. coli*. (Source: SCDHS)

There are other chemical contaminants found in drinking water (at trace levels) that derive from individual sewerage systems, such as 1,1,1 trichloroethane (TCA) – a major component of cesspool cleaners. Volatile organic compounds, such as TCA, are carbon-containing compounds that evaporate easily from water into the air at normal air temperatures. Only 22% of Suffolk County public water supply wells tested high enough to need treatment to reduce volatile organic compounds in source water (Suffolk County Government, 2015a). TCA-containing solvents were banned by Suffolk County in 1980, along with other select cesspool additives (pursuant to Local Law 12-1980).

Emerging contaminants of concern include chemical byproducts of household cleaners, personal care products, and pharmaceutical metabolites. SCDHS detected chloroform, a byproduct of household laundry bleach and household cleaners, at trace levels in 21% of private drinking wells tested between 1997 and 2007, and almost 2% of private drinking wells tested had chloroform levels that exceeded 5 µg/L (Suffolk County Government, 2015a). Investigators believe that chemicals in cleaners were interacting with organic sewage wastes and/or discharge from nearby chlorinated swimming pools, albeit the low levels of byproduct were not actionable at that time.

Anticipated Change(s) to Quality of Source Drinking Water (Groundwater)

Suffolk County identified areas in the 0-50 year groundwater contributing zone to public drinking water well fields as one of the "high priority areas" in Alternatives II and III. The upgrade of those systems in high priority areas, near well fields or in areas with shallow depth to groundwater, will have the greatest impact on drinking water. Shallow depth to groundwater could affect drinking water quality of private wells, as they draw from the shallower Upper Glacial Aquifer. **Private well water is typically not disinfected, and areas served by private water wells are typically not sewered; as a result, contaminant loading from individual sewerage systems that travels through the groundwater supply can potentially impact the quality of water in private drinking water wells.** The potential reduction in pathogen discharges associated with proposed upgrades could improve private drinking water well safety. Similar improvement could be seen in non-community supplies, which are also not typically disinfected.

SCDHS encourages residents using private wells to periodically have their well water tested and when possible, to connect to a public water utility; SCDHS is also considering policies to expand connection and testing (Suffolk County Government, 2015a). If such efforts are successful in reducing the number of residents relying on private wells, thereby lowering the potential for exposure to contaminated drinking water, the concerns associated with sewerage systems, as well as the priority for controlling pollutants from individual sewerage systems, may be lowered.

It is important for Suffolk County to remain vigilant in controlling pollution from individual sewerage systems while efforts are underway to expand connections to the public drinking water supply.

Table 4-15 identifies the potential impacts of the proposed decision on the quality of source water (groundwater) for the public water supply and private drinking water wells in Suffolk County for each decision alternative. It should be noted that individual sewerage systems are not the only source of wastewater inputs to Suffolk County groundwater, and likewise, wastewater inputs are not the only source of nitrogen and pathogen loading to groundwater in the County. This HIA, however, only considers the contributions from individual sewerage systems, as these systems are the target of the proposed code changes.

Table 4-15. Impact of Decision on Source Drinking Water (Groundwater) Quality

Alternatives	Potential Change(s) in Source Drinking Water Quality
Baseline*	**All public drinking waters met federal and state standards in 2015.** Average nitrate-nitrogen levels in public supply wells in 2013 were well below the 10 mg/L maximum contaminant level, at 3.58 mg/L in Upper Glacial and 1.76 mg/L in the Magothy Aquifer in 2013, but are increasing. The New York State SWAP lists over 20% of community supply wells as medium-high to very-high in microbial susceptibility, due to the presence of wells in unsewered areas and short travel times from the water table to shallow well screens. In 2015, total coliforms and *E. coli* were detected in source wells for only 3 of 27 distribution areas, and subsequent samples from these wells were negative. Among 3,327 private wells tested between 2005 and 2015, pumping from the Upper Glacial Aquifer, 318 (9.6%) had positive detections of total coliforms and 20 (0.6%) had positive detections of *E. coli* (a better indicator of fecal contamination).
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS are required to conform to current County codes and standards, it is **unlikely to change the quality of public drinking water** given the conditions under which public drinking water is distributed.† **For private drinking well water, it is unclear how much improvement may be gained** because of the upgrades, but because private wells are at a higher risk of drinking water contamination,‡ **there may be an improvement in the microbial quality of private drinking well water in unsewered areas**, **given the limited (1-log_{10}) reduction in pathogen loading** (Lowe, et al., 2009) by adding a septic tank. No change in nitrogen levels is expected.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS in high priority areas are required to conform to current County codes and standards, it is **unlikely to change the quality of public drinking water** given the conditions under which public drinking water is distributed.† **For private drinking well water, it is unclear how much improvement may be gained** because of the upgrades, but because private wells are at a higher risk of drinking water contamination,‡ **there may be an improvement in the microbial quality of private drinking well water in unsewered areas,** particularly in the high priority areas, **given the limited (1-log_{10}) reduction in pathogen loading** (Lowe, et al., 2009) by adding a septic tank. No change in nitrogen levels is expected.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	If all existing OSDS and C-OWTS in high priority areas are required to be upgraded to I/A OWTS, it is **unlikely to change the quality of public drinking water** given the conditions under which public drinking water is distributed†. **For private drinking well water, it is unclear how much improvement may be gained** because of the upgrades, but because private wells are at a higher risk of drinking water contamination,‡ there may be an **improvement in the nitrogen levels and microbial quality of private drinking well water in unsewered areas**, given the reduction in nitrogen and pathogen loading of I/A OWTS.§

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of

individual sewerage systems) would lead to continuing increases in nitrate-nitrogen levels in the Upper Glacial and Magothy Aquifers and microbial susceptibility of private wells.

† Given the low prevalence of fecal contamination currently observed in community supply groundwater wells; the routine monitoring of distributed water quality; the adaptive capacity of the SCWA to address degraded conditions; and the additional protections offered by well depth and disinfection of waters, the proposed code changes are unlikely to impact public drinking water quality. However, Alternatives I and II do nothing to address the nitrogen and pathogen loading of individual sewerage systems, which could lead to continuing increases in nitrate-nitrogen levels in the Upper Glacial and Magothy Aquifers and susceptibility of private wells to fecal contamination, making treatment of public drinking water more expensive.

‡ Because private wells generally pump from the shallower, Upper Glacial Aquifer and lack the levels of treatment, management, and testing required of public water supply systems, they are considered to be a higher-risk drinking water source. Because areas without public water connections are often also unsewered, co-location of private wells and individual sewerage systems increases the likelihood of contaminated groundwater intrusion.

§ Some I/A OWTS can treat pathogens and emerging contaminants of concern (e.g., personal care products and pharmaceuticals) when certain components are part of or used in conjunction with the system (e.g., biofilters, microfiltration membranes, chlorination/disinfection units, and permeable reactive barriers); because the final designs of the systems are unknown, the measured fecal indicator bacteria or pathogen control performance of the systems are unknown. It is assumed, however, that I/A OWTS will achieve the minimum reduction in pathogen loading seen by adding a septic tank (i.e., a 1-$\log_{10}$ reduction), regardless of any additional components in the system.

4.3.4 Impact of Changes in Quality of Source Drinking Water (Groundwater) on *Human Illness*

Universally, water quality is a key health determinant because living and non-living substances in the water, including pathogens (i.e., bacteria, viruses, parasites, and other organisms that cause disease) and toxic substances (e.g., heavy metals, pesticides), can cause illness in humans through direct contact and ingestion. Typical symptoms of illness manifest as gastrointestinal illness (e.g., diarrhea, vomiting, and abdominal pain), but complications can arise leading to more severe illness and even death (EPA, 2012a). A number of other health problems have been associated with chemically-contaminated water, including lung and skin irritation, cancer, kidney, liver, and nervous system damage (*www.countyhealthrankings.org, Drinking Water Violations*). According to EPA (2001a), improperly used or operated septic systems can be a significant source of groundwater contamination that can lead to disease outbreaks and other adverse health effects. A recent analysis of CDC data found improper siting or maintenance of individual sewerage systems to be the primary cause of reported disease outbreaks associated with untreated groundwater nationwide (Wallender, Ailes, Yoder, Roberts, & Brunkard, 2014). DeFelice et al. (2016) found that 99% of emergency department visits per year of acute gastrointestinal illness attributable to microbial contamination in drinking water are associated with private well contamination in North Carolina. Private wells are not regulated under the Safe Water Drinking Act; homeowners who get drinking water from a private well are responsible for ensuring the quality of their drinking water.

To reduce local risk, take into consideration good practice in the siting, design, installation and maintenance of individual sewerage systems to ensure protection of groundwater and drinking water sources, especially in areas served by private drinking water wells.

Nitrate toxicity can cause complications during pregnancy and health risks to infants and young children. Infants younger than 4 months are more susceptible to nitrite toxicity from elevated nitrate/nitrite ingestion (WHO, 2011). Infants with excessive methemoglobin in their blood appear “bluish” because of the lack of oxygen delivered to tissues, a disease commonly referred to as “blue baby syndrome” or methemoglobinemia. If left untreated, methemoglobinemia can be fatal for affected infants (EPA, 2001a; Smith R. P., 2009).

Note: Intake of some nitrate is normal, considering nitrates are also present in food, such as vegetables and preserved meats and sausages, as well as some medications and topical creams used for burn relief (CDC, 2013a).

Use of a drinking well that becomes contaminated with inadequately treated wastewater can lead to infections and illness from pathogens, including *E. coli*, *Giardia*, *Cryptosporidium*, Hepatitis A virus, *Salmonella typhi* bacteria (typhoid fever), helminths (parasitic worms), and others (Onsite Wastewater Working Group, n.d.; EPA, 2001a). Young children, the elderly, and those who are immunocompromised are more likely to become infected from these types of pathogens (SCDHS, 2015a).

Although most strains of *E. coli* are harmless and many normally live in the intestines of humans and other animals, some are pathogenic. Symptoms can manifest as diarrhea and/or other gastrointestinal distress, urinary tract infections, and respiratory illness. Most infections are mild, with improvement seen within a week and symptoms that are easily controlled with over-the-counter products. *E. coli* O157:H7 is a specific serotype of *E. coli* that produces Shiga toxins; this pathogen belongs to the Shiga toxin-producing *E. coli* (or STEC) pathotype and may also be referred to as enterohemorrhagic *E. coli* (or EHEC. *E. coli* O157 or other STEC infections can cause severe illness, including bloody diarrhea and hemolytic uremic syndrome (HUS), which is a type of kidney failure, and even death. STEC infections as well as salmonellosis and shigellosis are all infectious diseases caused by contact with feces or fecally-contaminated media, such as food or water. *Giardia duodenalis* is a common waterborne parasite in the U.S. and can be found in soil, food, or water that has been contaminated with the feces from infected humans or animals. Ingestion of water or food contaminated with Giardia can cause giardiasis or “beaver fever,” an illness characterized by diarrhea, abdominal pain, and weight loss. Enteric viruses, such as norovirus, are also transmitted via the fecal-oral route. Norovirus is a highly contagious virus and is considered to be the leading cause of acute gastrointestinal illness, both domestically and worldwide (Hall, et al., 2013; Ahmed, et al., 2014). Individuals sick with norovirus can shed large numbers of the virus in their feces; these viruses are routinely detected in municipal wastewater (Pouillot, et al., 2015).

There have been numerous case studies linking individual sewerage systems to human illness. Hrudey and Hrudey (2007) identified sewage-contamination as the major cause of 40 out of 73 published outbreaks of waterborne disease in developed countries in the past 30 years. Novello (2000) investigated a 1999 outbreak of waterborne illness and death resulting from a beverage and ice machine contaminated with *E. coli* O157:H7 and *Campylobacter jejuni* at the Washington County Fair in upstate New York; the suspected source of the pathogens was a cesspool located 38 feet away from the drinking well that supplied water to the beverage machine. Said and others (2003) identified septage-effluent as the source of waterborne disease outbreaks from contaminated drinking wells in England and Wales

(United Kingdom). Cliver (2000) found isolated outbreaks of waterborne illness related to specific individual sewerage systems in failure.

Researchers in northeastern Wisconsin found a connection between a norovirus outbreak at a restaurant and contamination from a septic system (Borchardt, et al., 2011). Importantly, this study demonstrated that there is a risk of illness even from a properly functioning septic system. Likewise, Jack, Bell and Hewitt (2013) studied a norovirus outbreak at a resort and found common strains amongst fecal samples, drinking water samples, and surface water downstream of septic systems (but not upstream). In Wyoming, a norovirus outbreak among snowmobilers, from contaminated groundwater, was believed to be due to a nearby septic system (Anderson, et al., 2003).

In 2002, researchers studied the relationship between septic system density and infectious diarrhea in children in central Wisconsin between the ages of 1 and 19. The authors demonstrated that incidence of diarrhea was significantly associated with sewerage system density in central Wisconsin. (Borchardt, Chyou, DeVries, & Belongia, 2003).

Existing Risk of Illness from Source Drinking Water at the Time of the HIA Analysis

Community supply wells in Suffolk County are generally low in fecal contamination and are thus unlikely to present a source of illness-causing pathogens. Occasional detections of total coliforms do not necessarily indicate fecal contamination or the presence of pathogens. Additionally, water is disinfected prior to distribution, reducing pathogens that may occur and providing chlorine residual to protect against contamination in the distribution system. However, although rare, cross-contamination between drinking water service lines (including those on-premises) and sewerage system discharges and/or contaminated groundwater can occur, which allows pathogens present in high concentrations or those resistant to chlorine disinfection (e.g., *Cryptosporidium*) to potentially contaminate distributed drinking water. According to the County Health Rankings (University of Wisconsin Population Health Institute, 2016), no residents in Suffolk County are served by community water systems with unsafe drinking water, based on applicable health-based drinking water standards. In comparison, neighboring Nassau County had 1% of residents at risk, and the New York State annual average was 26% (www.countyhealthrankings.org).

Private wells have unknown (and likely variable) quality with respect to microorganisms and fecal contamination. Given that these systems are typically maintained by the homeowner themselves, rather than a trained operator, and are only required to be tested upon installation and property transfer, they are considered to present a greater health risk in Suffolk County than community systems (Suffolk County Government, 2015b). Shallow wells and lack of disinfection further increase these risks. Non-community supplies, which are also not usually disinfected and have demonstrated total coliform violations, may also be vulnerable.

Table 4-2 (in Section 4.1.4) provides baseline rates of illness associated with pathogens found in human waste. Water-related exposures to pathogens causing these diseases can be through a number of different pathways, including drinking water contaminated with sewerage-derived pollutants. It should be noted that illness from exposure to pathogens found in human waste likely goes unreported given the generality and self-limiting nature of the symptoms (e.g., nausea, cramps, diarrhea, and dehydration).

Note: Use of private drinking wells and individual sewerage systems have not been associated with reported cases of disease in Suffolk County. However, the combination of risk factors suggests a possibility that current conditions could contribute to illness in the community.

In regard to nitrates, public water supplies in Suffolk County are well below the 10 mg/L drinking water standard for nitrate at this time, but some private drinking wells may pose more of a risk. As part of the ongoing, private well testing program, SCDHS sampled residential drinking water wells from 2007 to 2013 and found 7% of private wells exceeded the state standard of 10 mg/L for nitrate in drinking water; in some agricultural areas, nitrate levels doubled the nitrate standard (Suffolk County Government, 2015a). This suggests that remedial actions may be needed to reduce nitrogen contributions to Suffolk County waters from agricultural lands, as well as individual sewerage systems. There are no known cases of nitrate toxicity (methemoglobinemia or "blue baby syndrome") in Suffolk County (SCWA, 2016).

Continue expansion of connections to community supply systems to reduce dependency on private wells, which can reduce the overall magnitude of potential effects of wastewater on drinking water.

Table 4-16. Impact of Decision on Human Illness from Source Drinking Water

Health Determinant							
Human Illness from sewerage-derived pollutants in source drinking water (groundwater)	**<u>Baseline Health Status</u>** Most cases of illness in Suffolk County related to pathogens found in human waste were caused by bacteria, such as *Shigella* and *Salmonella*, although incidence rates suggest the absence of widespread disease outbreaks. On average, approximately one in every 260,000 people are affected by harmful *E. coli* each year in Suffolk County, compared to about one in every 167,000 people in New York State. The use of private drinking wells and individual sewerage systems <u>have not been associated</u> with disease outbreaks in Suffolk County. However, a combination of risk factors suggests a possibility that current conditions could contribute to sporadic or unreported illnesses. There are no known cases of nitrate toxicity (methemoglobinemia or "blue baby syndrome") in Suffolk County.						
Alternatives	**Direction**	**Likelihood**	**Magnitude***	**Distribution**	**Severity**	**Permanence**	**Strength of Evidence**
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	These alternatives will **detract from health** because there would be no appreciable reduction in nitrogen loading and a limited (1-$\log_{10}$) reduction in pathogen loading to groundwater.	**Illness from community water supply systems is unlikely,** but the **continued risk of illness from private and non-community water supply wells is possible.**	**The risk of exposure to contaminated drinking water could affect** a **high number of people**, considering private (individual) wells and non-community systems serve about 13% of residents (approx. 194,000 people). However, the number of illnesses of this type are low.	**See footnote †**	The health implications of sewerage-contaminated drinking water are **minor to moderate (gastrointestinal symptoms expected)** for most of the population; but, **severe** among pregnant women and infants less than 6 months.	The effects of illness from contaminated drinking wells may be **short-term to long-lasting**, but the changes in risk may not occur for a **long time**, considering hydrologic travel times between sewerage systems and well screens may be 0-50 years.	**Strong.** Numerous studies have linked exposure to sewerage-derived pollutants from individual sewerage systems to human illness where the exposure occurred through drinking water.

Alternatives	Direction	Likelihood	Magnitude*	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	This alternative would **benefit health by reducing the risk of illness** from sewerage-derived nitrate-nitrogen in groundwater and providing a limited to considerable reduction in pathogen loading to groundwater depending on the design of the system.	This alternative is **unlikely** to improve drinking water quality from public water supply since public water supply is already satisfactory. The **risk of illness among persons using private and non-community water supply wells is unlikely, provided that disinfection technologies are utilized.**	**The risk of exposure to contaminated drinking water could affect** a **high number of people**, considering private (individual) wells and non-community systems serve about 13% of residents (approx. 194,000 people). However, the number of illnesses of this type are low.	**See footnote †**	The health implications of sewerage-contaminated drinking water are **minor to moderate** (gastrointestinal symptoms expected) for most of the population; but, **severe** among pregnant women and infants less than 6 months.	The effects of illness from contaminated drinking wells may be **short-term to long-lasting**, but the changes in risk may not occur for a **long time**, considering hydrologic travel times between sewerage systems and well screens may be 0-50 years.	**Strong.** Numerous studies have linked exposure to sewerage-derived pollutants from individual sewerage systems to human illness where the exposure occurred through drinking water.

* Scientific literature shows a link between human illness and exposure to sewerage-derived pollutants in drinking water; however, the number of reported illnesses of this type in Suffolk County are low and it can be difficult to determine the route of infection (foodborne, waterborne, person-to-person). As stated previously, human illness from exposure to sewerage-derived pollutants can go unreported. Because the true number of illnesses in Suffolk County from sewerage derived pollutants in drinking water is unknown, Magnitude could not be expressed as a change in frequency or prevalence of illness. The Likelihood and Magnitude columns together describe the potential risk of illness where exposure occurred through drinking water (i.e., the number of people served by private and non-community drinking water systems, as it assumes these residences are also unsewered). The location of private drinking water wells was unknown, so it was not possible to determine the number of residences in high priority areas potentially at risk of illness from sewerage derived pollutants in drinking water in Alternatives II and III

† Distribution – These **health impacts would be disproportionately experienced** by those with private/non-community drinking water supply wells and individual sewerage systems, those more susceptible to water-related pathogens, and those more at risk to nitrate toxicity in drinking water. Pregnant women and infants under 6 months are more at risk to nitrate toxicity in drinking water. Young children, the elderly, and those who are immunocompromised are more likely to be susceptible to pathogens. Residences with a private well and individual sewerage system have a higher risk for drinking water contamination, especially where groundwater is shallow and/or density of unsewered residences is high

4.3.5 Impact of Changes in Pollutant Loading on *Quality of Surface Waters*

Pollutants, such as sediment, nutrients, bacteria, and toxic substances can impair the quality of surface waters – rivers, lakes, streams, estuaries, and coastal shorelines – and affect use of water resources. Pollutant loading to surface waters can come from a single point source (e.g., wastewater treatment plant) or non-point source, such as run-off from developed and agricultural lands, atmospheric deposition, and contributions from groundwater (such as individual sewerage system discharges to groundwater). With increasing understanding of the impact of anthropogenic activities on surface waters and human and aquatic life, water quality standards have been developed to protect the quality of lakes, rivers, streams, and other waterbodies. Under the Clean Water Act Sections 305(b) and 303(d), states must assess the extent to which waters are meeting the water quality standards established for them; when a water quality standard is not met (e.g., 6 NYCRR Part 703), the water is deemed impaired and actions must be taken to restore the water resource (EPA, 2017a).

Water Quality Parameters

Table 4-17 describes a number of parameters used to characterize surface water quality; some of these parameters are also those used to characterize wastewater. As noted in the Individual Sewerage System Performance and Failure Pathway, this HIA analysis focused primarily on nitrogen loading (as this was identified to be a primary concern for Suffolk County waters), but also touches on pathogen loading (as this can cause human illness), and phosphorous (a contributor to harmful algal blooms, which have been experienced in County waters and have human health and economic implications).

Table 4-17. Surface Water Quality Parameters

Parameter	Details
Biological oxygen demand (BOD)*	The amount of dissolved oxygen needed by aerobic microorganisms to break down organic matter at a given temperature over time (i.e., used as a proxy measure for organic matter content); measured as 5-day average (BOD_5) in milligrams per liter of sample (mg/L).
Chlorophyll-a	An estimate of the biomass of planktonic algae in water; measured as micrograms per L (µg/L). Chlorophyll-a can be strongly influenced by nitrogen and phosphorus, which are derived by natural and human activities.
Dissolved oxygen (DO)	The concentration of oxygen gas incorporated in water; measured as mg/L.
Enterococcus	Measured/present in **marine and fresh waters** as an indicator of fecal contamination, using standardized EPA Method 1600 (EPA, 2006a); measured as most probable number (MPN) or colony forming units (CFU) per 100 mL of sample.
Escherichia coli* (*E. coli*)	Measured/present in **fresh waters** as an indicator of fecal contamination; measured as most probable number (MPN) or colony forming units (CFU) per 100 mL of sample.†
Fecal coliforms*	Microorganisms which are found in the intestinal tract of all warm-blooded animals (often used as an indicator of fecal contamination, although less specific than *E. coli*, a type of fecal coliform); measured as most probable number (MPN) or colony forming units (CFU) per 100 mL of sample.

Parameter	Details
Secchi depth	A naked-eye measure of water clarity generally correlated with the amount of planktonic algae and/or the turbidity from suspended soil particles; measured in feet.
Total coliforms	A class of microorganisms including fecal coliforms and other environmental bacteria (often used as an indicator of fecal contamination, although less specific than *E. coli* or fecal coliforms); measured as most probable number (MPN) or colony forming units (CFU) per 100 mL of sample.[†]
Total suspended solids (TSS)[*]	All particles suspended in water which will not pass through a filter; measured as TSS in mg/L.
Total Nitrogen (TN)[*]	The total of all nitrogen compounds suspended in water: organic-nitrogen + ammonia-nitrogen + nitrite-nitrogen + nitrate-nitrogen; measured as TN in mg/L using standardized APHA (1995) methods.
Total kjeldahl nitrogen (TKN)[*]	The total of organic-nitrogen and ammonia-nitrogen compounds suspended in water; measured as TKN in mg/L.
Total Phosphorous (TP)	The total of all phosphate compounds suspended in water: orthophosphates + polyphosphates + organic phosphates; measured as TP in mg/L using standardized APHA (1995) methods.

* Surface water quality parameters that are also used to characterize wastewater.

† EPA Standard Method 9223, Enzyme Substrate Coliform Test may be used for compliance monitoring under the Revised Total Coliform Rule.

<u>**Nutrients and Algal Blooms**</u>

As previously mentioned, nutrients (e.g., nitrogen and phosphorous) play an important role in the environment. In aquatic environments, nitrogen and phosphorous support the growth of phytoplankton, algae, and aquatic plants, which provide food and habitat for fish, shellfish, and smaller organisms that live in water (Algae Biomass Organization, n.d.). However, **too much nitrogen and phosphorous can accelerate the degradation of surface waters by causing algae to grow faster than the ecosystem can balance** (www.epa.gov/nutrientpollution/problem). “Nitrates and phosphorous discharged into surface waters directly or through subsurface flows can exacerbate algal growth and lead to eutrophication” (EPA, 2002a). Excess algal growth and eutrophication result in visual changes to the water including muddles or discolored water (i.e., decreased water clarity) and in some cases, foul odors.

Algae need sunlight, slow-moving water, and nutrients (nitrogen and sometimes, phosphorous) to flourish. A dense population of algae, known as a “bloom,” involves rapid reproduction and development of extremely high biomass in a limited spatial area. Blooms can be an indication of an ecosystem imbalance, both in water and on land. The scientific consensus is that anthropogenic nutrient input (i.e., excessive input of nitrogen and phosphorous from human activity) contributes significantly to the formation of algal blooms (Paerl, Fulton, Moisander, & Dyble, 2001; Paerl & Otten, 2013;

Hattenrath-Lehmann & Gobler, 2016)[25]. See Appendix A for a description of the types of algal blooms that can occur; not all are harmful.

Some freshwater and marine species of algae or phytoplankton produce toxins or conditions that are harmful to humans, animals, and other plants. **When these algae multiply in large numbers, they can have negative impacts on humans, the environment, and coastal economies (NOAA, 2016a); these algae produce Harmful Algal Blooms (HABs).** One of the most hazardous freshwater HABs is ***cyanobacteria*** (also called blue-green algae), which are actually photosynthetic bacteria that can produce toxins that can be consumed, aerosolized, or absorbed through the skin to damage tissues of the liver, nervous system, and skin of both humans and animals (Graham, 2013). In addition, some cyanobacterial blooms give off foul odors, commonly described as smelling like "rotten eggs." Some cyanobacteria form dense algal blooms in nutrient-enriched lakes and ponds, typically during the summer and early fall months, which produce endotoxins at a level which can harm household pets (Graham, 2013).

HABs can also occur in marine and estuarine waters. Slow-draining estuaries and marine shoreline areas (i.e., coastal wetlands that have relatively long water residence times) are particularly susceptible to harmful effects of algal blooms resulting from sudden influxes of nitrogen that cannot be quickly "flushed" out of the estuary or diluted (Paerl, Pinckney, Fear, & Peierls, 1998). HABs in marine and estuarine waters, can be caused by the marine dinoflagellate *Karlodinium veneficum*, which produces a class of associated karlotoxins known to cause fish kills; the ***mahogany tide*** estuarine algae, *Prorocentrum minimum*, which produces neurotoxins toxic to marine organisms and can extend upwards into freshwater rivers; and a number of species that cause red, brown, and rust tides.

The ***red tide*** organism, *Alexandrium*, produces the neurotoxin saxitoxin that causes paralytic shellfish poison (PSP) capable of killing humans through ingestion of shellfish, marine animals, and other competitor plankton (Colin & Dam, 2003; Deeds, Landsberg, Etheridge, Pitcher, & Longan, 2008). Symptoms of PSP include numbness and tingling of lips, tongue, face, and limbs; loss of motor control; respiratory distress; and even death (Hattenrath-Lehmann & Gobler, 2016). Red tides can also be caused by *Dinophysis acuminata*, a genus that produces okadaic acid, which can cause diarrhetic shellfish poisoning (DSP) in humans that consume shellfish contaminated with the acid. Symptoms of DSP include diarrhea, vomiting, and nausea and abdominal pain (Lloyd, Duchin, Borchert, Quintana, & Robertson, 2013; Reguera, et al., 2014). The toxins produced by *Alexandrium* and *Dinophysis* can be present in

[25] There have been a number of more recent studies and reports (after completion of the HIA analysis) linking nutrient loading and algal blooms in Suffolk County, including the Suffolk County Harmful Algal Bloom Action Plan (Wise, 2017) and the Summary Report from the 2018 Suffolk County Harmful Bloom Symposium (New York Sea Grant, 2018). It should be noted that while phosphorous is typically a factor in the formation of freshwater HABs, it has also been shown to play a role in HABs in Suffolk County coastal waters. Therefore, Wise (2017) recommends that actions taken to counter HABs in Suffolk County target both nitrogen and phosphorus.

shellfish at concentrations harmful to humans without causing discoloration of the water (Hattenrath-Lehmann & Gobler, 2016).[26]

Brown tides can be caused by *Aureococcus anophagefferens*, a species that, in high concentrations, turns the water brown and reduces light penetration. This can have a severe impact on eelgrass (*Zostera marina)*, even leading to mass die-offs (Hattenrath-Lehmann & Gobler, 2016). This species can thrive using both dissolved organic and inorganic nitrogen, which gives them a unique advantage over most green plants that can only use mineralized or inorganic nitrogen. In addition to the impacts on seagrasses, brown tides can have negative impacts on the feeding, growth, and mortality of shellfish, such as bay scallops and clams, and cause a reduction in planktonic organisms (Gastrich & Wazniak, 2002). Shellfish, especially scallops, are affected by the loss of habitat caused by brown tide organisms outcompeting eelgrass beds for light and nutrients, because bay scallops require eelgrass beds as part of their developmental cycle. Nuzzi and Waters (2004) found that brown tides often occur when the ratio of dissolved organic nitrogen (DON) to dissolved inorganic nitrogen (DIN) is high, such as in areas that receive high levels of treated sewage. Sources of DON include urea, amino acids, and proteins excreted by humans and animals (i.e., untreated), whereas the sources of DIN are treated wastewater, fertilizer runoff, and atmospheric deposition.

Rust tides, caused by the dinoflagellate *Cochlodinium polykrikoides*, are hypothesized to occur when nitrogen-low waters receive a sudden influx of inorganic nitrogen, such as after an extreme rainfall event (Mulholland, et al., 2009). Rust tides are not harmful to humans, but *Cochlodinium* produces a toxin that is lethal to several species of fish and shellfish.

Mahogany tides, caused by the marine dinoflagellate *Prorocentrum minimum*, are toxic to marine animals, but not to humans. Mahogany tides create hypoxic conditions (i.e., low dissolved oxygen) and have been associated with fish and shellfish kills; however, there is also evidence that some strains of *P. minimum* produce neurotoxins, as well (Hattenrath-Lehmann & Gobler, 2016).

Green tides are caused by excessive growth of macroalgae, or seaweed; these tides often occur in estuaries impacted by eutrophication and high nutrient loading. Green tides can promote hypoxia and have been shown to cause mortality in some marine life (Hattenrath-Lehmann & Gobler, 2016).

Pathogens

In addition to increased algal bloom occurrence, **pathogens are another source of risk to surface water quality**. However, there is only a limited understanding of pathogen loading from nonpoint source contamination and the consequences to coastal environments (Stewart, et al., 2008). Pathogen monitoring in surface waters is impractical, given the relatively lower concentrations of pathogens compared to other microorganisms, and because each type of bacteria, virus or protozoan requires a

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[26] Due to prioritization of pathways in *Scoping*, this HIA does not examine the human health impacts of paralytic shellfish poisoning (PSP) or diarrhetic shellfish poisoning (DSP) through consumption of shellfish. However, PSP and DSP are discussed in the HIA because they are a result of algal blooms caused by excess nutrients, and the closing of shellfishing areas due to PSP and DSP have economic implications. For more on the economic implications of PSP and DSP, see Section 4.6.

different test (EPA, 2006b). Instead, fecal indicator bacteria (FIB) are often used to indicate that fecal contamination may have occurred. If relatively high numbers of FIB are found, there is an increased likelihood of pathogens being present (EPA, 2006b; USGS, 2017). Coliform indicators do not always infer human sewage contamination, however, because FIB can come from wildlife and other animal sources and can survive and proliferate in subsurface sands and sediment (under certain conditions) for an extended period (Stewart, et al., 2008)

Meeroff et al. (2014) compared two sets of coastal neighborhoods in Florida, with one entirely served by public sewer and one by individual sewerage systems. Results indicated consistently higher FIB levels in unsewered areas, with poorer water quality observed during seasonally high water table events as consistent with improved septic performance during dry periods. **Several studies, in locations other than Suffolk County, have demonstrated the link between elevated levels of FIB and waters impacted by individual sewerage systems.** Sowah et al. (2014) monitored FIB in 24 Georgian watersheds exhibiting a gradient from low to high density of septic systems and demonstrated a positive correlation between sewerage system density and fecal pollution levels when accounting for seasonality and land-use effects. In order to identify the source of fecal pollution (i.e., from humans or other animals) in a water catchment served exclusively by individual sewerage systems, Carroll et. al (2009) examined the antibiotic resistance profile of *E. coli* isolated from surface water and groundwater in Australia and compared them to a library of resistance patterns from known-source isolates. While the majority of sources in rural areas were non-human, the authors used regression modeling to establish that the contribution of human sources increased significantly in urbanized areas where individual sewerage systems were prevalent. Cahoon et. al (2006) examined rainfall patterns and septic densities and determined that poorly performing septic systems were the ultimate source of fecal contamination contributing to shellfishing closures in a North Carolina estuary. It should be noted that many of these studies were likely conducted on septic tank-soil absorption systems. Although these systems are technologically different from the cesspools and septic tank-leaching pool systems utilized in Suffolk County, it reasonable to expect the link between elevated levels of FIB and waters impacted by individual sewerage systems to exist in Suffolk County.

Both harmful algal blooms and pathogens can impact recreational use of waters, tourism, and the economy, including impacts to the fishing and shellfishing industries. HAB toxins can also bioaccumulate in fish and shellfish tissue, which when eaten, can cause disease in animals and humans.

Existing Quality of Suffolk County Surface Waters at the Time of the HIA Analysis

Impaired Waters

Impaired waters, according to Section 303(d) of the Federal Clean Water Act, are rivers, lakes, or streams that do not meet one or more water quality standards for a particular pollutant and are considered too polluted for their intended uses (e.g., swimming, recreation, shellfishing, fish production, etc.)**. All three major estuary systems in Suffolk County** – the Peconic Estuary, South Shore embayments, and Long Island Sound – **have been declared impaired due to pathogens and/or nitrogen contaminants** (NYSDEC, 2014b; NYSDEC, 2016a). Depleted dissolved oxygen, increased nitrogen loading, harmful algal blooms, and decreased wetland acreage have been observed in all three estuaries.

Figure 4-20 highlights the impaired waters across Suffolk County, with those impaired by potential wastewater-related causes distinguished in pink. The entire north shore and south bays of western and central Suffolk County are impaired by pollutants that could be related to point and non-point source wastewater. However, marine waters at the east end, past the Peconic Bay, are impaired by pollutants not relatable to wastewater. Waters that specifically list onsite wastewater treatment systems as an impairment source for nitrogen include the Great South Bay, Moriches Bay, Quantuck Bay, and Shinnecock Bay in the South Shore Estuary Preserve. Almost all of the near-shore fresh and brackish waters are impaired.

For more on the impact of nutrient loading and surface water quality on wetlands, see Sections 4.4.2 and 4.4.3.

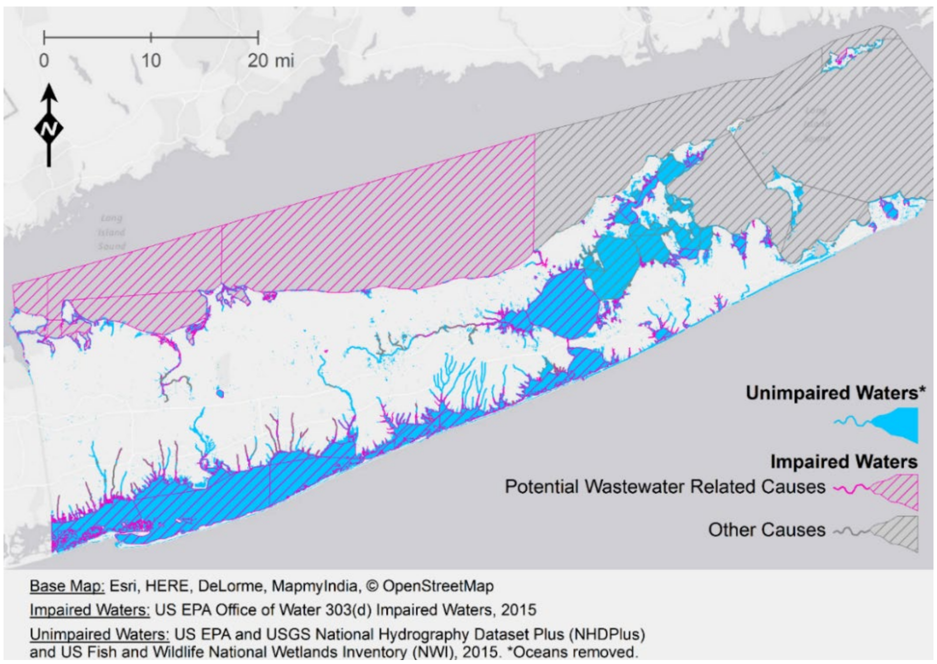


Figure 4-20. Locations of impaired waters, with those impaired by potential wastewater-related causes highlighted in pink.

Nitrogen Loading

A number of studies have been conducted on Long Island to model the sources and contribution of nitrogen loading to various waterbodies. Nitrogen loading, along with a number of physical, chemical, and biological factors, contribute to the water quality of a body of water. Nitrogen loading from individual sewerage systems is discussed in terms of potential changes to surface water quality as nitrogen loading from these systems has been identified as a source of impairment to surface water quality throughout Suffolk County.

Kinney and Valiela (2011) applied a modeling tool to estimate the contribution of nitrogen from multiple sources to 33 sub-watersheds of Great South Bay. The results from the model were compared with results from empirically-measured nitrogen levels in water and estimates from the widely applied SPARROW model developed by the U.S. Geological Survey (Latimer & Charpentier, 2010). Kinney and

Valiela (2011) estimated that total nitrogen loading to the Great South Bay was 55% (1,898,591 kg nitrogen per year) from wastewater, 98% (1,861,791 kg nitrogen per year) of which was derived from unsewered residences; 31% of total loading was from atmospheric deposition to land; and 15% was from fertilizer runoff.

Considering only land-based sources of nitrogen, Lloyd (2014) found wastewater from residential individual sewerage systems was the largest contributor of nitrogen in 25 of the 43 Peconic Estuary subwatersheds. Septic system and cesspool nitrogen loading accounted for 43% of nitrogen loading to the Peconic Estuary as a whole, followed by fertilizer (26.4%), atmospheric deposition (24%), and other wastewater contributions (6.6%). The study also found there was significant variation in the results among subwatersheds.

Stinnette (2014) and Gobler (2016) used modeling to determine the relative contribution of non-point source land-based nitrogen loading to the three Eastern Bays of the South Shore Estuary Reserve (i.e., Moriches, Quantuck and Shinnecock Bays). The study showed that 65% of the nitrogen loading to the three bays was from wastewater, 20% from fertilizer, and 15% from atmospheric deposition. Modeling also showed that groundwater was responsible for the transport of more than 90% of the nitrogen load in all but one subwatershed.

Lloyd, Mollod, LoBue, & Lindberg (2016) undertook a study to model the sources and loading rates of nitrogen in thirteen subwatersheds along the north shore of Long Island. Wastewater contributed over 33% of the nitrogen load in all of the subwatersheds and over 80% of the nitrogen load in four subwatersheds (Manhasset Bay, Huntington Harbor, Centerport Harbor, and Northport Harbor). Cesspools and septic systems were the primary source of wastewater loading in all the subwatersheds, except Manhasset Bay, where point sources loading from centralized sewage treatment plants was greater.

A 2008 study in the highly-eutrophic Lake Agawam on Long Island found that 39% of total nitrogen originated from groundwater sources (Harke, Davis, & Gobler, 2008). Groundwater nitrogen loadings to freshwater from septic tanks can be significant (Reay, 2004), and improperly maintained or installed septic systems are a widespread problem that results in further nutrient contamination (May, Place, O'Malley, & Spears, 2011).

Note: **Not all nitrogen that enters a watershed reaches receiving waters (i.e., waterbodies downgradient from the watershed).** Multiple studies have been performed to model nitrogen contributions and loading to Long Island estuaries using the Nitrogen Loading Model (NLM) available through the Nitrogen Load (NLOAD) web-based modeling tool (Bowen, Ramstack, Mazzilli, & Valiela, 2007). In a nitrogen modeling study of sub-watersheds feeding to the Great South Bay, Kinney and Valiela (2011) found that retention rates of total nitrogen entering the environment from all sources was linked to the presence of natural vegetation; in watersheds that were more urbanized, nitrogen retention decreased (Kinney & Valiela, 2011). The Nitrogen Loading Model used in many of the Long Island nitrogen modeling studies (Kinney & Valiela, 2011; Lloyd, 2014; Stinnette, 2014; Woods Hole Group Inc., 2014; Gobler C. J., 2016; Lloyd, Mollod, LoBue, & Lindberg, 2016) assumes that 35% of the nitrogen is retained in the watershed, but Lloyd (2014) noted that the NLM likely underestimates the total nitrogen loading; other experts suggest only 10-20% of the nitrogen is retained in the watershed. At the time of the HIA, the NLM modeling of individual sewerage system-derived nitrogen contributions to Long Island estuaries provided the best available data and it showed that approximately 30-40% of the nitrogen is retained in the watershed; meaning that **60-70% of the nitrogen from individual sewerage systems makes its way to Long Island estuaries** (Lloyd, Mollod, LoBue, & Lindberg, 2016)[27]. Because this was the best available data at the time of the HIA analysis, this was used to estimate nitrogen loading to surface waters for the alternatives assessed in the HIA. The countywide nitrogen loading modeling performed by Suffolk County since completion of the HIA analysis shows a fair amount of variability in nitrogen loading among subwatersheds in the County.[28]

Increasing vegetated land cover and green infrastructure[29] may prevent further transport of sewerage-derived pollutants (and other nitrogen loading) in stormwater runoff and/or shallow groundwater movement (Kinney & Valiela, 2011).

Harmful Algal Blooms

With its long coastlines and many embayments, Long Island's ecosystems are especially vulnerable to HABs (NYSDEC, 2016b). Most marine harmful algal blooms in Suffolk County have been historically referred to by their color (e.g., "red tides" or "brown tides"). Long Island has experienced near-annual outbreaks of red and brown tides since the mid-1980s, caused by *Alexandrium* spp. and *Aureococcus anophagefferens*, respectively. There are several species of toxin-producing harmful algal blooms present in Suffolk County fresh and marine waters, including the red tide organisms, *Alexandrium* and *Dinophysis*, which produce biotoxins than can cause paralytic shellfish poisoning (PSP) and diarrhetic shellfish poisoning (DSP), respectively; the "rust tide" algae, *Cochlodinium polykrikoides*, which produces a toxin that is lethal to a variety of marine organisms; the "mahogany tide" estuarine algae, *Prorocentrum minimum*, which produces neurotoxins toxic to marine organisms and can extend upwards into freshwater rivers; and freshwater cyanobacteria.

Harmful algal blooms are a major cause of fish, shellfish, and other animal die-off in Suffolk County marine waters, affecting commercial fishing and shellfishing industries, as well as causing ecological perturbation. HAB toxins can bioaccumulate in shellfish tissue, which when eaten, can cause disease in animals and humans. In addition to these impacts, **the coloring of Suffolk County waters with these algae can deter water-based recreation (e.g., boating, swimming, and fishing) and affect other sectors, such as tourism and real estate.**

[27] There is essentially no difference between a septic tank-leaching pool system and a cesspool in terms of removal of nitrogen in Suffolk County.

[28] Note that the Subwatersheds Wastewater Plan developed by Suffolk County, after completion of this HIA, involved countywide nitrogen loading modeling that was used to establish travel times and nitrogen loading estimates for each subwatershed, establish nitrogen load reduction goals based upon specific human health and environmental endpoints, and refine priority areas in which to focus those efforts. For more on this effort, see Appendix K

[29] Green infrastructure uses vegetation, soils, and other natural landscape features to manage wet weather impacts and reduce and treat stormwater at its source (EPA, 2015b).

Red tides

Significant blooms of ***red tide*** (*Alexandrium fundyense)* have occurred in Suffolk County yearly since at least 2010, when the Great South Bay, Moriches Bay, Quantuck Bay, and Shinnecock Bay were all listed as impaired water bodies due to the red tide. One of the main causes of these blooms was identified as nitrogen input from septic systems and cesspools (TNC, 2012).

Suffolk County has monitored mussel and clam tissues for the presence of PSP – caused by the biotoxin (saxitoxin) produced by *Alexandrium* – since 2006 through the NYSDEC Marine Biotoxin Monitoring Program[30]. The team samples hundreds of shellfish from suspected red tide areas to determine if PSP levels are high enough to prompt a closing of the area to shellfishing and/or issuing a shellfish consumption advisory. PSP has been detected at a hazardous level during every year of monitoring. One area of particular concern, Seymour's Boatyard, near Northport in Suffolk County was found to have a recurring outbreak of PSP every year monitored. Trends in PSP detections can be found in Figure 4-21.

Since 2006, annual toxic *Alexandrium* blooms have forced over 7,000 acres of shellfish beds on Long Island's north shore to be closed, and in 2011, forced the closure of nearly 4,000 acres along the south shore (NCCOS, 2017). In 2012, *Alexandrium* blooms were detected in new locations, including Sag Harbor.

Dinophysis, another organism that causes red tide, has been found in Suffolk County harbors since the early 1970s; however, it wasn't until 2008 that elevated levels of the algae were found and three years later, in 2011, that the first case of diarrhetic shellfish poisoning (DSP) caused by *Dinophysis* occurred (Hattenrath-Lehmann & Gobler, 2016). Beginning in 2008, targeted sampling for *Dinophysis* was conducted. The north shore of Long Island now experiences large annual blooms of toxic *Dinophysis*, raising concerns about DSP in Suffolk County shellfish. DSP caused the closure of one shellfish harvest area in 2011, but all other locations where DSP toxins exceeded action levels were already closed to shellfishing due to coliform contamination or other causes (Hattenrath-Lehmann & Gobler, 2016).

[30] Due to prioritization of pathways in *Scoping*, this HIA does not examine the human health impacts of paralytic shellfish poisoning (PSP) or diarrhetic shellfish poisoning (DSP) through consumption of shellfish. However, PSP and DSP are discussed in the HIA because they are a result of algal blooms caused by excess nutrients, and the closing of shellfishing areas due to PSP and DSP have economic implications. For more on the economic implications of PSP and DSP, see Section 4.6.

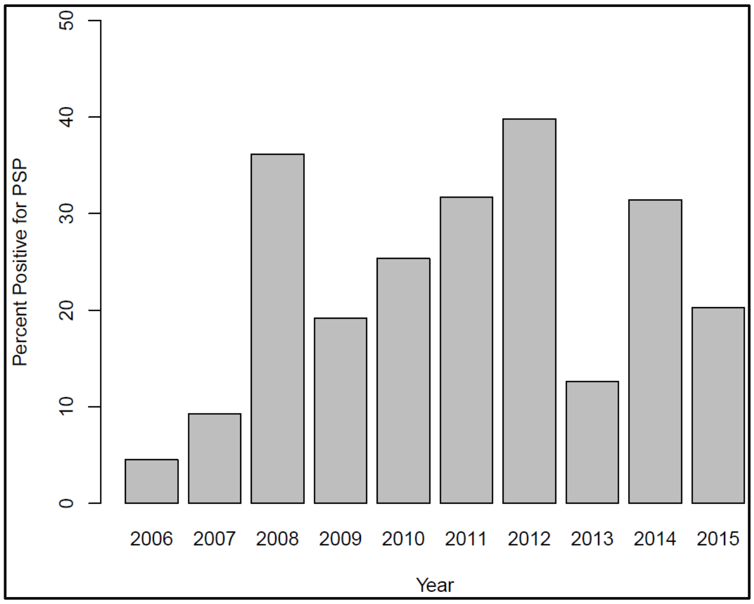


Figure 4-21. Percent of paralytic shellfish poisoning (PSP) surveillance samples testing positive in Suffolk County, NY 2006–2015. Source: (NYSDEC Marine Biotoxin Monitoring Program)

Brown tides

The well-known Suffolk County, New York "***brown tides***" of the 1980s to 1990s were an example of an *Aureococcus anophagefferens* bloom. While *Aureococcus* does not produce toxins, its impact on water quality in Suffolk County has been associated with eelgrass die-offs and impacts to shellfish, such as bay scallops and clams. Unlike other algae that have been shown to be stimulated by inorganic nitrogen, *Aureococcus* blooms in Suffolk County typically occur after these other algae "pre-bloom" and utilize the inorganic nutrients; the result is high levels of dissolved organic matter (dissolved organic nitrogen, phosphorous, and carbon), under which brown tides thrive (Gobler & Sanudo-Wilhelmy, 2001; Lomas, et al., 2001). However, availability of dissolved organic nitrogen is only one factor that contributes to brown tides; other factors include light, temperature, salinity, and water residence times (Hattenrath-Lehmann & Gobler, 2016).

Brown tide is monitored by Suffolk County in partnership with Stony Brook University. The Great South, Moriches, and Shinnecock Bays, along with the Peconic Estuary and Forge River, have been monitored (with some gaps for certain smaller areas) since 2001. A summary of brown tide surveillance samples that found Category 2 or higher blooms in Suffolk County (i.e., samples above 35,000 cells/mL) can be found in Figure 4-22. Of particular note is the large spike in detections in 2008, especially in the Great South Bay. This corresponds to an extremely devastating brown tide event, which at the time was the most extensive and longest on record (since surpassed by the 2011 blooms).

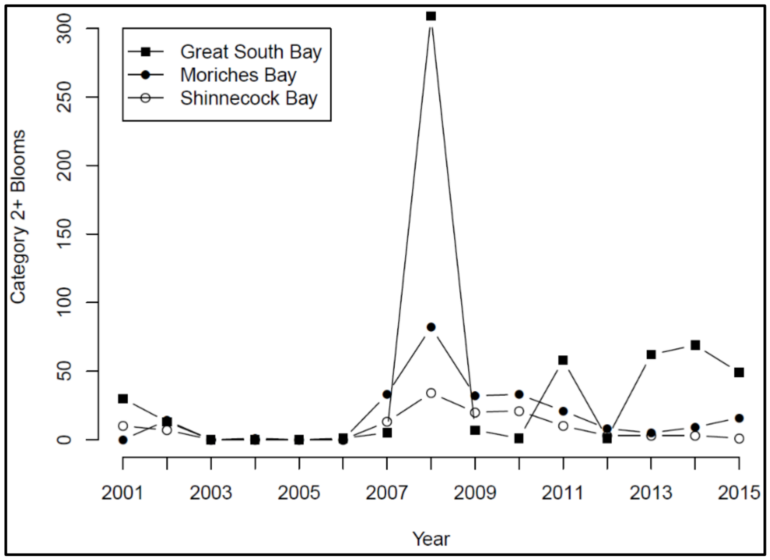


Figure 4-22. Brown tide samples above 35,000 cells/mL in Suffolk County, NY 2001–2015. Source: (SCDHS)

Beginning in 1985 and continuing to the present, brown tides have caused the demise of the bay scallop fishery along the Long Island coast (Stony Brook University, 2013; Dennison, Marshall, & Wigand, 1989). Mass die-offs of scallops, hard clams, and eelgrass were reported beginning in 2008, after the record Great South Bay bloom (Gobler C. , 2008).

Rust tides

Beginning in 2002, Long Island has experienced "***rust tides***" caused by the dinoflagellate *Cochlodinium polykrikoides* on a near-annual basis. Rust tides were prevalent in the region long before they were present in Suffolk County, causing researchers to hypothesize that environmental factors, like nitrogen loading and increased water temperatures, may be to blame for the blooms (Hattenrath-Lehmann & Gobler, 2016). Rust tides in Suffolk County have been found to be extremely toxic to finfish and shellfish and have resulted in strikingly large fish kills (Tang & Gobler, 2009).

Mahogany tides

"Mahogany tides", caused by the dinoflagellate *Prorocentrum minimum*, have historically been observed in tributaries along the South Shore, and in 2015, occurred in the Peconic River, leading to a massive fish kill. In Spring of 2016, a widespread bloom of *P. minimum* occurred in estuaries along the South Shore and led to significant amounts of foam in the Great South Bay and minor fish kills (Hattenrath-Lehmann & Gobler, 2016).

Green tides

"Green tides" and macroalgal blooms, caused by the overgrowth of the seaweed, *Ulva* (or sea lettuce), are less common in Suffolk County than other harmful algal blooms, but have occurred. Green tides were observed in Great South Bay in 1999, 2011, and 2015; in all three cases, the green tide was followed by a brown tide (Hattenrath-Lehmann & Gobler, 2016). When large amounts of seaweed wash up on shore and decompose, they can detract from the aesthetics of the area and the smell can become a public nuisance .

Cyanobacteria

Harmful algal blooms are a recurring problem in fresh surface waters of Suffolk County, typically appearing in late spring and continuing through the early winter. Currently, the dominant type of toxic freshwater algal bloom in the County is caused by ***cyanobacteria*** (SCDHS, 2016c). A 2004 lake survey conducted by Stony Brook University, as part of a Suffolk County-funded algal blooms project, found that every lake sampled contained toxic cyanobacteria and detectable microcystins, which are liver toxins produced by cyanobacteria that can also be skin, eye, and throat irritants. Five sampled lakes had microcystins levels at the "moderate-to-high" risk level (based on World Health Organization risk levels) for aquatic recreation, including Lake Ronkonkoma (SCDHS, 2016c). NYSDEC has collected reports of blue-green algal blooms since 2012, with affected water bodies archived online by county. Reports of blue-green algal blooms in Suffolk County were reported consistently beginning in 2013. Suffolk County has the largest number of freshwater bodies affected by cyanobacteria in the State of New York; a summary of blue-green algal blooms in Suffolk County is provided in Table 4-18.

Table 4-18. Summary of Cyanobacterial Blooms in Suffolk County, NY 2013–2015

Year	No. Lakes Listed	Average Consecutive Weeks Listed	Top 3 Lakes Longest Listed	Earliest Report	Latest Report
2013	5	8.8	Lake Agawam, Mill Pond, Maratooka Lake	5/8/2013	11/4/2013
2014	11	9.6	Same as above	11/3/2014	5/21/2015
2015	17	10.2	Same as above	5/22/2015	10/30/2015

Source: (NYSDEC, 2016b)

Hypoxia

The Peconic River, which feeds into the Peconic Bay on the east end of Long Island, currently experiences fluctuating periods of ***hypoxia*** (very low dissolved oxygen levels), which are attributed to oxygen depletion by algal blooms (PEP, 2001). Excess nitrogen from septic systems, fertilizer, sewage treatment plant effluent, and other sources stimulates the explosive growth of blue-green algae, which consume oxygen at night during the respiration cycle and dramatically increase biochemical oxygen demand when they decay (Tomarken, Gerstman, & Gobler, 2016). This lack of oxygen can prove fatal to fish, shellfish, and other aquatic organisms. The Peconic River has had a number of highly publicized fish kills from 1999 to the present, including several in 2015 when 300,000 adult Atlantic menhaden died due to hypoxia and algal poisoning (Young, 2016). This die-off led to a rotting smell and biological hazard that lasted for weeks, impacting tourism and outdoor recreation in the surrounding area.

Hypoxia has been observed in other Suffolk County waters as well, as several of the algae species that occur in Suffolk County are associated with or create hypoxic conditions.

Pathogens

The majority of Suffolk County 303(d) waters that are impaired for pathogens list the source of impairment as "Urban/Storm Runoff," a blanket term that encompasses many forms of point- and nonpoint-source pollution and may include influence from onsite wastewater treatment systems (EPA, 2003b). It can be difficult to discern the source of fecal contamination in surface waters because it could be one or more sources, including individual sewerage systems, sewage treatment plants, stormwater runoff, animal waste, or boating discharges. In addition to individual sewerage systems, sewage treatment plants (STPs) and wastewater treatment plants (WWTPs) are widespread across Suffolk County (Figure 4-23), and a number of those have been shown to be noncompliant with state and/or Clean Water Act effluent standards, including fecal coliform, per EPA's Enforcement and Compliance History Online (ECHO) database (https://echo.epa.gov/). In 2016, 14 STPs/WWTPs were found to have effluent violations, in which effluent limits had been exceeded one or more times within the past 3 years (Figure 4-23). It should be noted that most STPs in Suffolk County discharge to the ground, and there are a smaller number of WWTPs that discharge to surface waters.

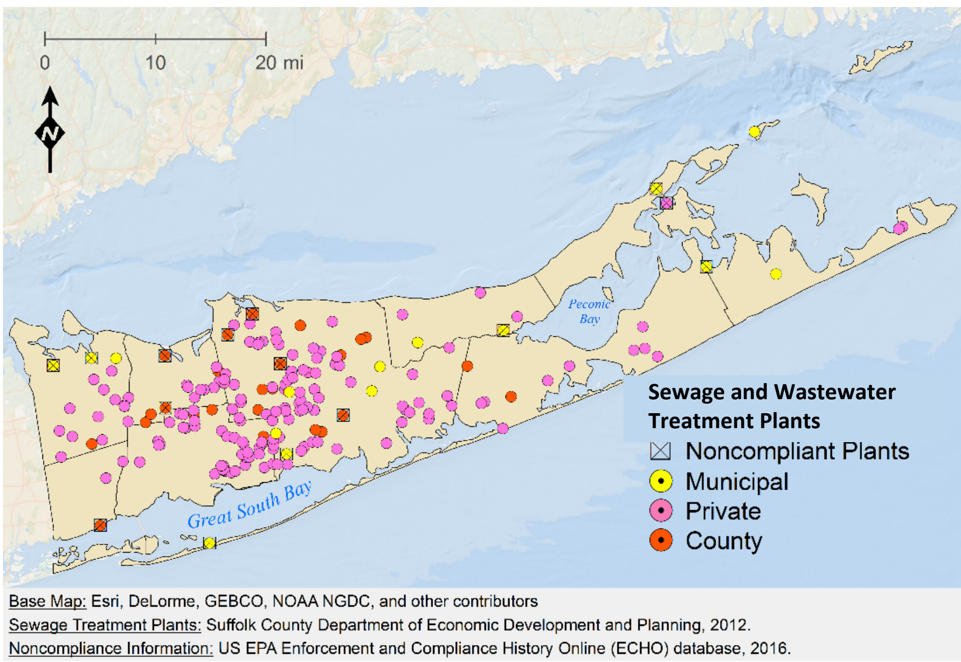
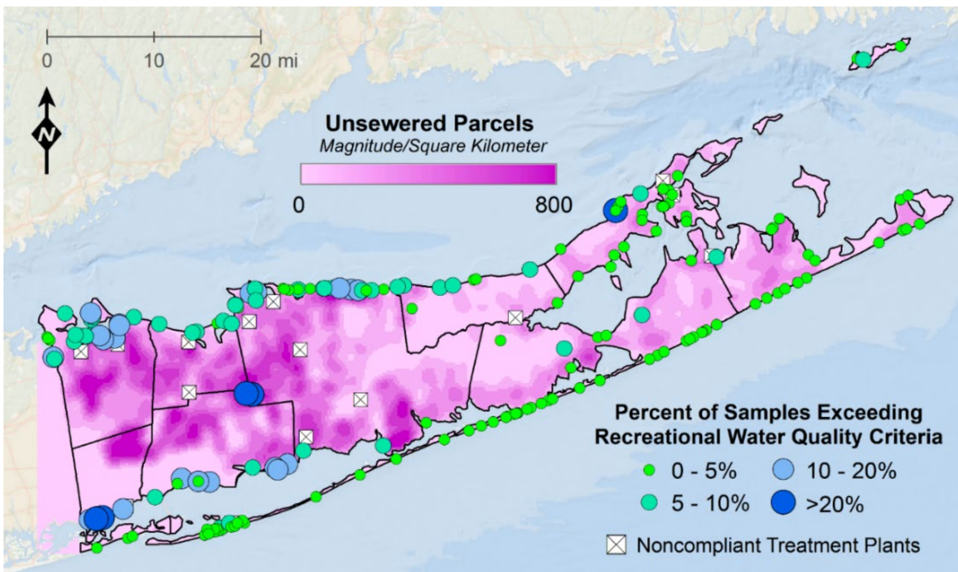


Figure 4-23. Location of sewage and wastewater treatment plants across Suffolk County, including those found to be non-compliant with Clean Water Act effluent standards at least once from 2014-2016, per EPA's ECHO database.

Pathogen contamination of Suffolk County waters has impacted several designated uses, including recreational waters and shellfishing. The marine waters around Long Island are designated for shellfishing, but many of these areas are closed to shellfishing because of water quality issues. Pathogen contamination is "responsible for 92% of the impairment found in waterbodies designated for shellfishing. **Shellfishing restrictions** affect 13% of the total estuary area classified as being otherwise appropriate for shellfishing" (NYSDEC, 2010). NYSDEC monitors the quality of shellfishing waters, and if the water quality doesn't meet state or national standards, the area is closed for shellfish harvesting. For more information on shellfish closures in Suffolk County, including maps of the impacted areas, see https://www.dec.ny.gov/outdoor/103483.html.

Figure 4-24 maps the results of routine water quality monitoring for fecal indicator bacteria conducted by SCDHS (2015c) with respect to bathing beach water quality. Of beaches with >10% of 2005-2015 samples exceeding single-sample limits for recreational water (>104 CFU *Enterococcus*/100 mL), 11 were located on the Long Island Sound and its bays/harbors and 10 were located on the Great South Bay (including the top two, Tanner Park Beach and Copiague Harbor, with 26% and 21% exceedances, respectively) (SCDHS, 2015c). It should be noted that a number of the samples exceeding recreational water quality criteria were taken at beaches found in sewered areas, indicating that individual sewerage systems are not the sole contributor to this problem.



Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors

Figure 4-24. Bathing beach water quality monitoring results for fecal indicator bacteria 2005-2015, Suffolk County, NY. Circles indicate beach locations and the percent of samples exceeding single-sample recreational water quality criteria (i.e., 104 Enterococcus/100 mL for marine waters or 235 E. coli/100 mL for freshwaters). Map is overlain with density of unsewered parcels (heat map) and locations of noncompliant sewage and wastewater treatment plants (treatment plants with one or more effluent violations from 2014-2016; squares).

Anticipated Change(s) in Surface Water Quality

Table 4-19 identifies the potential impacts of the proposed code changes on surface water quality for each decision alternative. It should be noted that individual sewerage systems are not the only source of wastewater inputs to Suffolk County surface waters, and likewise, wastewater inputs are not the only source of nitrogen and pathogen loading to surface waters in the County. This HIA, however, only assessed the contributions from individual sewerage systems, as these systems are the target of the proposed code changes. Cumulative loading estimates for each decision alternative are presented two ways: 1) in terms of the TN and pathogen loading in liquid effluent at the edge of the system (i.e., at the point of discharge from the individual sewerage system) for all individual sewerage systems across the

County; and 2) based on results of prior NLM efforts, which suggest that up to 70% of nitrogen from individual sewerage systems may load to Suffolk County estuarine and coastal waters. All loading estimates utilize the number of individual sewerage systems estimated in the HIA to be impacted under each alternative.

Table 4-19. Impact of Decision on Surface Water Quality

Alternatives	Potential Change(s) in Surface Water Quality*
Baseline	All three major estuary systems in Suffolk County – the Peconic Estuary, South Shore, and Long Island Sound – have been declared impaired due to pathogens and/or nitrogen contaminants. Depleted dissolved oxygen, increased nitrogen loading, harmful algal blooms, reduced water clarity, and decreased wetland acreage has been observed in all three estuaries and some inland freshwaters. Assuming an estimated 70% of TN loading reaches receiving waters in a watershed (i.e., 30% retention within the watershed), then about **3.95 million kg (8.70 million lbs) TN per year from individual sewerage systems could eventually reach receiving waters (e.g., estuaries and coastal waters) across Suffolk County** (5.64 million kg TN/yr, as calculated in Appendix G, x 0.70), considering groundwater travel times of 0-10 years along the coast and up to decades and even hundreds of years from the middle of Long Island. Because an undetermined amount of pathogens is released from each individual sewerage system, **cumulative loading of pathogens cannot easily be quantified** without primary data collection efforts, which did not occur as part of this HIA.†
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS are required to conform to current County codes and standards, there would be **no change in TN loading** (compared to the baseline), as it is assumed that nitrogen levels in septic tank effluent are equivalent to levels in untreated wastewater. There **may be a reduction in pathogen loading** to surface waters given the **potential 1-$\log_{10}$ reduction in pathogen loading** from each of the estimated 192,558 systems upgraded.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	If all existing OSDS in high priority areas are required to conform to current County codes and standards, there would be **no change in TN loading** (compared to the baseline), as it is assumed that nitrogen levels in septic tank effluent are equivalent to levels in untreated wastewater. There **may be a reduction in pathogen loading** to surface waters given the **potential 1-$\log_{10}$ reduction in pathogen loading** from each of the estimated 125,751 systems upgraded.

Alternatives	Potential Change(s) in Surface Water Quality[*]
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	Assuming an estimated 70% of TN loading reaches receiving waters in a watershed (i.e., 30% retention within the watershed), then about **2.19 million kg (4.82 million lbs) TN per year from individual sewerage systems could eventually reach receiving waters (e.g., estuaries and coastal waters) across Suffolk County** (3.12 million kg TN/yr, as calculated in Appendix G, x 0.70). The rate of nitrogen loading to receiving waters downgradient from areas of individual sewerage systems is unknown considering groundwater travel times of 0-10 years along the coast and up to decades and even hundreds of years from the middle of Long Island; hydrologic modeling and GIS analysis are needed to determine the net effect for each watershed and the cascading effects to coastal areas[31]. There **may be a reduction in pathogen loading** to surface waters (compared to the baseline), given the **potential 1-$\log_{10}$ reduction in pathogen loading at a minimum** from each of the estimated 251,502 systems upgraded; a greater reduction in pathogen loading may be seen depending on the components of the I/A OWTS.[‡]

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[*] The loading values reported reflect cumulative levels of nitrogen and pathogens in liquid effluent discharge from individual sewerage system across the County to the environment and parameters of previous nitrogen loading modeling in Suffolk County used to estimate nitrogen loading to Suffolk County estuarine and coastal waters; all loading estimates utilize the number of individual sewerage systems estimated in the HIA to be impacted under each alternative. This assessment of impacts to surface water quality focuses on impacts to estuarine waters, given the available modeling of nitrogen loading to Suffolk County estuaries, the documentation of algal blooms in marine waters, and the implication of estuarine and marine waters on shoreline resiliency. It is assumed that the impact of the decision alternatives would be similar for Suffolk County freshwater resources, such as rivers and lakes.

[†] It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to the continuing decline of surface waters in Suffolk County, including increasing frequency and intensity of harmful algal blooms.

[‡] Some I/A OWTS can treat pathogens and emerging contaminants of concern (e.g., personal care products and pharmaceuticals) when certain components are part of or used in conjunction with the system (e.g., biofilters, microfiltration membranes, chlorination/disinfection units, and permeable reactive barriers); because the final designs of the systems are unknown, the measured pathogen or fecal indicator bacteria control performance of the systems is unknown.

The existing impairments to Suffolk County surface waters (depleted dissolved oxygen, increased nitrogen loading, harmful algal blooms, fish and shellfish kills, advisories, shellfishing and beach closures; reduced water clarity, etc.) would continue under Alternatives I and II. The changes in water quality that would result from implementation of Alternative III could result in increased dissolved oxygen; reduced algal blooms, fish and shellfish kills, advisories, shellfishing and beach closures; increased water clarity; and more.

[31] Note that the Subwatersheds Wastewater Plan developed by Suffolk County, after completion of this HIA, involved countywide nitrogen loading modeling that was used to establish travel times and nitrogen loading estimates for each subwatershed, establish nitrogen load reduction goals based upon specific human health and environmental endpoints, and refine priority areas in which to focus those efforts. For more on this effort, see Appendix K.

4.3.6 Impact of Changes in Quality of Surface Waters on *Illness from Aquatic Recreation*

In recreational waters, **individuals can potentially be exposed to pathogens, toxins, and other irritants present in the water.** In recreational waters contaminated with fecal and biological contaminants, such as those from wastewater, the **health impacts can include gastrointestinal and respiratory illnesses, and illness of the eyes, ears, and skin** (Griffin, Lipp, Mclaughlin, & Rose, 2001; SCDHS, 2007; Mannocci, et al., 2016). The most commonly reported recreational water illness is diarrhea, which can be caused by germs such as *Cryptosporidium*, *Giardia*, *Shigella*, noroviruses, and *E. coli* O157:H7, all of which are pathogens that can be found in human waste (CDC, 2016a). States are responsible for routinely monitoring fecal indicator bacteria (FIB) around beaches and shellfisheries to protect human health from infectious diseases (LISS, 1990). It is important to note, however, that the presence of FIB or pathogens does not always correlate with incidence of disease.

Note: Some pathogenic microorganisms are naturally present in freshwater environments, while other human pathogenic species are indigenous to marine and brackish waters (Stewart, et al., 2008).

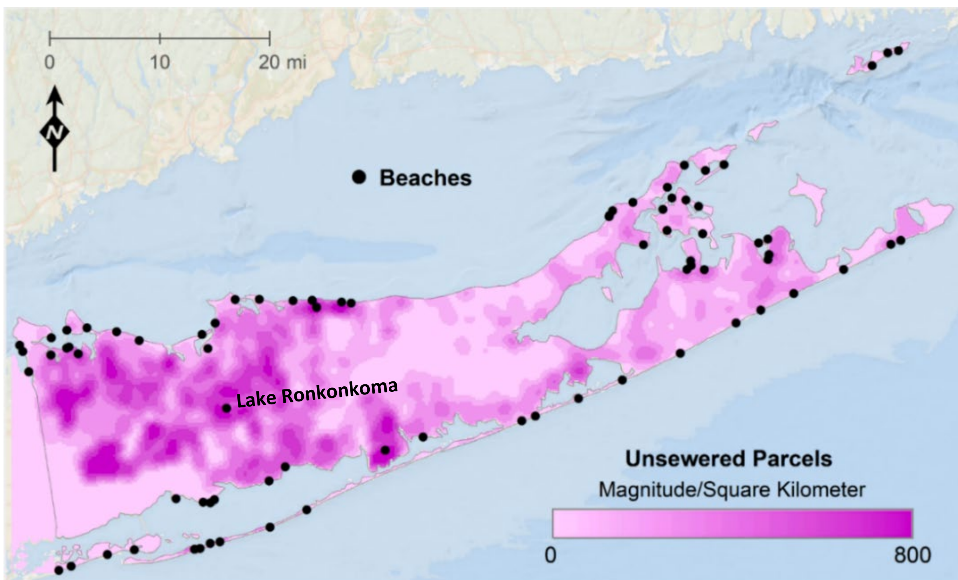
In addition to pathogens, **HABs also pose a risk of illness from aquatic recreation exposure**. Toxins produced from freshwater and marine HAB species not only endanger aquatic animal life but can also directly lead to illness in people. Cyanobacteria, also called blue-green algae, are often the cause of algal blooms in fresh water and occasionally in marine water; they are most commonly associated with illness from contact and/or inhaled HAB toxins (Codd, et al., 1999). Cyanobacteria can cause rashes and gastrointestinal illness and produce toxins that can be consumed, aerosolized, or absorbed through the skin to damage tissues of the liver, nervous system, and skin of both humans and animals (Graham, 2013; Hilborn, et al., 2014). Children are most at risk to the effects of cyanobacteria because of their lower body weight, behavior (i.e., greater time spent in the water and amount of water swallowed), and the effects of toxins on development (Weirich & Miller, 2014).

Existing Risk of Illness from Aquatic Recreation in Surface Waters at the Time of the HIA Analysis

Fecal contamination in recreational waters is associated with an increased risk of gastrointestinal illness, which is the most common form of illness associated with aquatic recreation (EPA, 2012b). According to 2014-2017 Suffolk County Community Health Assessment (SCDHS, 2015a), many cases of gastrointestinal illness from cryptosporidiosis have been related to waterborne exposure from lakes, although it should be noted that both human and animal feces can be the source of *Cryptosporidium* in waters. Table 4-2 (in Section 4.1.4) provides baseline rates of illness associated with pathogens found in human waste. Water-related exposures to the pathogens causing these diseases can be through a number of different pathways, including recreating in surface waters contaminated with sewerage-derived pollutants. It should be noted that illness from exposure to pathogens that can be found in human waste likely goes unreported given the generality and self-limiting nature of the symptoms (e.g., nausea, cramps, diarrhea, and dehydration).

The HIA Research Team used GIS mapping to identify locations of beaches used for aquatic recreation across Suffolk County and related that information to the density of unsewered parcels (Figure 4-25).

Lake Ronkonkoma, the largest lake on Long Island, is among the most polluted freshwater recreational areas in Suffolk County with respect to microorganisms found in feces. During routine monitoring by the SCDHS at two of its beaches, 34% of 2005–2015 samples exceeded single-sample fecal indicator bacteria limits for recreational water (>235 CFU *E. coli*/100 mL) (SCDHS, 2015c). Although there may be many sources of *E. coli*, including wildlife which have been noted as contributors (Brookhaven Town Board, 2008), heavily populated, unsewered areas surrounding the lake and the detection of human-specific viruses (Vaughn, Landry, Thomas, Vicale, & Penello, 1979) suggest that individual sewerage systems may contribute to this water quality degradation. Among six other monitored freshwater beaches, only Great Pond at Peconic Dunes County Park, which is immediately adjacent to the Long Island Sound on the North Fork of Long Island, had similarly high levels of fecal contamination (28% of 2005–2015 samples exceeding single-sample limits). Also in a low-lying and unsewered residential area, this pond may be influenced by local individual sewerage systems. Beaches on other small lakes in less densely populated regions (e.g., Wildwood Lake and Bellows Pond) have not shown evidence of significant fecal pollution, with 93-99% of their 2005–2015 samples below the single-sample indicator threshold (SCDHS, 2015c).



Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors
Beach Data: Adapted from Geographic Names Information System (GNIS), USGS, and US Board of Geographic Names,

Figure 4-25. Density of unsewered parcels near beaches.

In 2015, **water quality advisories and closures** were issued at 36% of Suffolk County beaches (https://watersgeo.epa.gov/beacon2/reports.html), encompassing 3.6% of total beach-days during the season (i.e., sum of days with beach actions across all beaches vs. sum of days each beach is seasonally open). The majority, 96%, were rain advisories issued preemptively due to anticipated stormwater discharges. Fourteen (14) beach closures were associated with unsafe levels of FIB. As noted previously, the presence of FIB does not always infer human sewage contamination; FIB can come from human waste, wildlife, and other animal sources.

It is important to note that the source of FIB or pathogens in Suffolk County waters has not been directly linked to individual sewerage systems (although it is reasonable to expect that link to exist), nor does the presence of FIB or pathogens always correlate with incidence of disease. Proactive advisories and closures when contamination events (from fecal pollution) are anticipated, reduce illness risks. Suffolk County uses a tiered approach to prioritize water sampling toward high-risk areas where they anticipate a contamination event. However, it is important to note that these beach monitoring and notification programs cannot prevent all recreational water-associated illnesses, which often go unreported. Children experience the greatest burden of recreational water-associated gastrointestinal illness due to their elevated exposure (i.e., greater time spent in the water and amount of water swallowed) (Arnold, et al., 2016).

Harmful algal blooms have been reported in freshwater and near-coastal systems, and absent actions to reduce nutrient loading, HABs will likely increase in frequency and intensity over time, impacting the health and quality of life of Suffolk County residents. Information on human illness as a result of recreational exposure to harmful algal blooms is difficult to collect, however, as exposure often causes general symptoms such as rashes, respiratory irritation, or eye inflammation that can easily be misdiagnosed or go unreported. In Suffolk County, the only HAB that has the potential to cause illness through recreational exposure (physical contact or water ingestion) is cyanobacteria.

A 2007 revision to the World Health Organization's *International Classification of Diseases* added a specific code for "exposure to harmful algae and toxins," simplifying surveillance efforts for tracking health care visits as a result of exposure (Buck, 2007). In the first peer-reviewed assessment of this diagnostic code, HAB-related hospital visits in New York were catalogued from 2008–2014 (Figgatt, Muscatiello, Wilson, & Dziewulski, 2016). The authors identified an average of 31 reported hospital visits per year due to HAB exposure, with the most common primary diagnoses being "effects of external causes," "contact with potentially hazardous chemicals," and "toxic effect of carbon monoxide." However, the vague/incorrect diagnoses (e.g., HABs do not produce carbon monoxide) and lack of a seasonal pattern in hospital admissions (i.e., one would expect greater admissions in warmer months when HABs are present) were found to indicate that there may be a problem with misdiagnosis of HAB exposure.

Anticipated Change(s) in Illness from Aquatic Recreation in Surface Waters

Table 4-20 identifies the potential impacts of the proposed code changes on illness from aquatic recreation in fresh and estuarine surface waters for each decision alternative. The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-20, you must read the Likelihood and Magnitude columns together (e.g., it is highly likely Alternative I could detract from health for a high number of people). For a summary of the different ways in which health could be impacted through the Water Quality pathway see Section 4.3.9.

Table 4-20. Impact of Decision on Illness from Aquatic Recreation in Surface Waters

Health Determinant							
Human Illness from aquatic recreation (e.g., bathing/ swimming, boating, fishing)	**Baseline Health Status** According to a Suffolk County Community Health Assessment (SCDHS, 2015a), "waterborne illness cases (from *Cryptosporidium* – a parasite shed in the feces of humans and other animals) have frequently been related to waterborne exposure from water parks or lakes." In the State of New York, exposure to toxic algal blooms caused an average of 31 reported hospital visits per year; however, the accuracy of these data is unknown, as there may be a problem with misdiagnosis of HAB exposure. Information on human illness from HABs and pathogen exposure is difficult to collect and diagnose, as exposure often causes general symptoms such as rashes, respiratory irritation, or eye inflammation that can easily be misdiagnosed or go unreported.						
Alternatives	**Direction**	**Likelihood***	**Magnitude***	**Distribution**	**Severity**	**Permanence**	**Strength of Evidence**
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	These alternatives will likely **detract from health** because there would be no appreciable reduction in nitrogen loading and limited reduction in pathogen loading to receiving waters.	The **continued risk of illness from aquatic recreation** due to pathogens and **HABs is possible**, given the number of individual sewerage systems and the potential for nutrient and fecal contamination from those systems.	**The positive health impacts (as a result of physical activity associated with recreation) and negative health impacts (as a result of potential exposure to pathogens and HABs), could affect a high number of people**, considering aquatic recreation is a widely practiced form of physical activity for both residents (1.5 million people) and visitors to Suffolk County. However, the number of illnesses of this type are low.	**See footnote**[†]	The health implications of exposure to HABs are **moderate to severe** (e.g., liver damage and nervous system damage), and the health implications of exposure to sewerage-derived pathogens and non-harmful algal blooms is **minor to moderate** (e.g., gastrointestinal and respiratory illnesses, and illness of the eyes, ears, and skin).	The effects of illness from aquatic recreation may be **short-term**, but the changes in risk may not occur for a **long time**, considering hydrologic travel times of 0-10 years up to decades and even hundreds of years	**Strong.** Based on numerous research studies, there is high confidence in the link between aquatic recreation and illnesses that result from pathogens associated with individual sewerage systems and cyanobacteria, a major cause of freshwater HABs.

Alternatives	Direction	Likelihood*	Magnitude*	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	This alternative will **benefit health** from the reduced nutrient loading (and potential to control other pollutants) that will slow the progress of HAB formation and the potential reduction in pathogen loading to receiving waters, depending on the design of the system.	Given the hydrologic connection between groundwater and surface waters of Suffolk County, reducing nutrients and potentially pathogens discharged to receiving waters **may possibly reduce beach closures and risk of illness** as a result of reduced exposure to fecal pollution and freshwater cyanobacteria.	**The positive health impacts (as a result of physical activity associated with recreation) and negative health impacts (as a result of potential exposure to pathogens and freshwater cyanobacteria), could affect a high number of people**, considering aquatic recreation is a widely practiced form of physical activity for both residents (1.5 million people) and visitors to Suffolk County. However, the number of illnesses of this type are low.	**See footnote†**	The health implications of exposure from toxic cyanobacteria are **moderate to severe** (e.g., liver damage and nervous system damage), and the health implications of exposure to sewerage-derived pathogens and non-toxic cyanobacteria is **minor to moderate** (e.g., gastrointestinal and respiratory illnesses, and illness of the eyes, ears, and skin).	The effects of illness from aquatic recreation may be **short-term**, but the changes in risk may not occur for a **long time**, considering hydrologic travel times of 0-10 years up to decades and even hundreds of years.	**Strong.** Based on numerous research studies, there is high confidence in the link between aquatic recreation and illnesses that result from pathogens associated with individual sewerage systems and cyanobacteria, a major cause of freshwater HABs.

* Scientific literature shows a link between human illness and recreational exposure to pathogens associated with individual sewerage systems and cyanobacteria; however, the number of reported illnesses of this type in Suffolk County are low. Because the true number of illnesses in Suffolk County from recreational exposure to sewerage-related pathogens and cyanobacteria is unknown, Magnitude could not be expressed as a change in frequency or prevalence of illness. The Likelihood and Magnitude columns together describe the potential risk of illness due to recreation in waters impacted by sewerage-derived pathogens and cyanobacteria.

† Distribution – These **health impacts would be disproportionately experienced** by recreational water users, those more at risk to the effects of toxic algal blooms, and those more susceptible to water-related pathogens. Children are most at risk to the effects of toxic algal blooms, because of their lower body weight, behavior (i.e., greater time spent in the water and amount of water swallowed), and toxic effects on development. Young children, the elderly, and those who are immunocompromised are more likely to be susceptible to pathogens.

Additional health impacts associated with changes in freshwater and marine water quality are also captured in the Resiliency and Economic Pathway sections.

4.3.7 Impact of Changes in Quality of Water Resources on *Perceived Quality of Water Resources*

Studies provide insight into how the public's perception of water quality can affect its use of the water environment and resources (Pendleton, Martin, & Webster, 2001; Nierenberg, 2010). The public's perception of environmental quality is largely influenced by perceived sensory attributes, like visual and odorous attributes, and are based on different sensitivities that various groups may have in perceiving environmental quality (House, 1996; Smith, 1995a; Smith, 1995b). Also influencing the public's perception of environmental quality are an individual's past experiences, cultural ties, socio-economic status, and the types of information to which the person is exposed (Pendleton, Martin, & Webster, 2001).

In terms of the quality of a water environment, characteristics like smell, water color, foam, oil, surface scum, and the presence of litter and other solid wastes have been shown to adversely affect the public's perception of water quality despite the actual biological, physical, or chemical quality of the water (House, 1996). Studies have found a high correlation between perceived clarity and color of water and the suitability of water, finding that turbid and brown water are unlikely to be perceived as appealing. People ranked the suitability of water sites highly based on the perceived visual quality of the water and less highly based on the actual clarity of the water (Smith, 1995a; 1995b). Studies have also found that a person's initial perception of water quality is based on aesthetics and the surrounding environment (Jensen, 2005).

Existing Perceptions of Quality of Water Resources in Suffolk County at the Time of the HIA Analysis

In 2006, a Public Perception Survey of Long Island Sound (LIS) Watershed Residents was conducted by Stony Brook University Center for Survey Research to assess residents' perceptions of water quality in the Sound. Of the four regions surveyed (Long Island, Connecticut, Bronx/Queens, and Westchester), Long Islanders held the most positive view of LIS water quality. A majority (59%) of Long Island's respondents felt it was at least somewhat safe to swim in the Sound, while about one-third (32%) thought it was unsafe. More than half (54%) of Long Island respondents thought it was safe to eat fish and shellfish from LIS, while one third did not (36%). Most respondents perceived that water quality was the same (37%) or better (27%) than it was five years ago (Stony Brook University Center for Survey Research, 2006).

When asked about the most important sources of water pollution in the LIS, Long Island residents were the most knowledgeable of the four regions surveyed, with 33% of respondents choosing three to five of the correct answers. A majority (55%) of Long Island respondents did not think that they could make any changes in their everyday behavior that would improve the LIS water quality; however, 34% and 39% responded that water quality could improve ("a great deal" or "some," respectively) if most residents changed their everyday behavior (Stony Brook University Center for Survey Research, 2006).

Anticipated Change(s) in Perceived Quality of Water Resources

Table 4-21identifies the potential impacts of the proposed code changes on perceptions of water quality for each decision alternative. It should be noted that perceived quality of water resources will not necessarily improve with reductions in nitrogen or pathogen loading, as there may be a lag in time before actual water quality improvements are seen. Likewise, the public's perception of environmental quality is also influenced by an individual's past experiences, cultural ties, socio-economic status, and the types of information to which the person is exposed (Pendleton, Martin, & Webster, 2001).

This points to the need for the public to be well informed (with accurate information), for realistic expectations to be set, and for results to be effectively communicated when improvements in water quality and its associated ecosystem services (recreation, economy, etc.) are experienced.

Table 4-21. Impact of Decision on Perceived Quality of Water Resources

Alternatives	Potential Change(s) in Perceived Quality of Water Resources
Baseline[*]	**Concerns about Suffolk County waters have been steadily increasing over time** and there is growing recognition that water quality issues should be addressed. A recent poll conducted by The Nature Conservancy says that two-thirds of Long Islanders agree that we must reverse declining water quality (Amper, 2016).
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Public perception may improve initially under the belief that the upgrades will reduce nitrogen loading and improve water quality; however, experience (continued algal blooms, fish and shellfish kills, advisories, etc.) would likely lead to a poor perception of water quality. The possible reduction in pathogen loading to Suffolk County waters as a result of the addition of a septic tank may potentially result in reduced shellfishing and beach closures, which would positively influence perception, but this outcome is uncertain.[†] **Most likely, perceptions of water quality would remain unchanged.**
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	**Public perception may improve** as a result of reduced nitrogen loading and the possible reduction in pathogen loading. Changes in water quality could result in reduced algal blooms, fish and shellfish kills, advisories, shellfishing and beach closures, all of which would positively influence perception, reduce stress regarding water quality condition, and improve overall health and well-being.[†]

[*] It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to continuing concerns and declining perceptions of water quality in Suffolk County.

[†] The perceived quality of water resources may not necessarily improve with reduced nutrient and/or pathogen loading or improved water quality metrics; it may take time and communication to actually change the perceptions and environmental attitudes of residents.

4.3.8 Impact of Perceived Quality of Water Resources on *Stress and Well-being*

Contact with nature and green space promotes positive mental health outcomes and well-being, including reduced stress, depression, and anxiety (Beyer, et al., 2014; Maller, Townsend, Pryor, Brown, & St Leger, 2006). Water is one of the most important landscape elements, both physically and visually, in the relationship between the environment and health. Water spaces can reduce stress, enhance mood, and enhance mental attention. Health and human well-being benefits from water are dependent upon perceptions of water, restoration, and recreation. Humans may also feel a spiritual and emotional connection to water. Water bodies facilitate social connections by serving as spaces for social activities. The appreciation (i.e., viewing) of water bodies has been correlated with better quality of life and may be beneficial to health (Völker, 2011).

Existing Health Status for Stress and Well-being at the Time of the HIA Analysis

Baseline community data from 2013−2014 indicates that 18.7% of Suffolk County adults were diagnosed with a depressive disorder and of those diagnosed, 88.5% sought treatment (Stony Brook Medicine, 2014). According to 2016 County Health Rankings, the age-adjusted average number of mentally unhealthy days reported in the previous 30 days in Suffolk County was 3.2, lower than the New York State average of 3.7 days (University of Wisconsin Population Health Institute, 2016).

Anticipated Change(s) in Stress and Well-being

Table 4-22 identifies the potential impacts of the proposed code changes on stress and well-being related to perceptions of water quality for each decision alternative. The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-22, you must read the Likelihood and Magnitude columns together (e.g., Alternative III may possibly benefit health for a moderate number of people). For a summary of the different ways in which health could be impacted through the Water Quality pathway see Section 4.3.9.

Additional health impacts associated with perceived changes in water quality are documented in the Economics Pathway section.

Table 4-22. Impact of Decision on Stress and Well-being from Perceived Water Quality

Health Determinant							
Stress and Well-being related to perceived quality of water resources	**Baseline Health Status** Baseline community data from 2013−2014 indicates that 18.7% of adults in Suffolk County were diagnosed with depression. According to the 2016 County Health Rankings (University of Wisconsin Population Health Institute, 2016), the age-adjusted average number of mentally unhealthy days reported in the previous 30 days in Suffolk County was 3.2, lower than the New York State average of 3.7 days.						
Alternatives	**Direction**	**Likelihood**	**Magnitude**	**Distribution**	**Severity**	**Permanence**	**Strength of Evidence**
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	These alternatives would likely result in **no change** in the perceived quality of water resources.	**Perceptions of the quality of Suffolk County water resources** (both ground and surface waters) **may possibly influence stress and well-being** among residents.	The **extent of people affected would be moderate**, considering 18.7% of adults already suffer from physician-diagnosed depressive disorder.	These **health impacts would be disproportionately experienced.** Low-income populations, recreational water users, coastal populations, and individuals with existing mental health conditions could be affected more by the perceived quality of water.	The severity of health implications from changes in stress/well-being would be **minor** and could easily change.	The effects would be **immediate** but expected to be **short-term**.	**Limited.** The evidence reflects the hypothesized relationship between health and perception of one's environment, but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	This alternative may **benefit health** from improved perceptions of water quality.	**Perceptions of the quality of Suffolk County water resources** (both ground and surface waters) **may possibly influence stress and well-being** among residents.	The **extent of people affected would be moderate,** considering 18.7% of adults already suffer from physician-diagnosed depressive disorder.	These **health impacts would be disproportionately experienced.** Low-income populations, recreational water users, coastal populations, and individuals with existing mental health conditions would be affected more by the perceived quality of water.	The severity of health implications from changes in stress/ well-being would be **minor** and could easily change.	The effects would be **immediate**, but expected to be **short-term.**	**Limited.** The evidence reflects the hypothesized relationship between health and perception of one's environment, but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship.

4.3.9 Water Quality Health Impact Summary

- Under **Alternatives I and II (installation of C-OWTS),** the **continued risk of illness from aquatic recreation** due to pathogens and algal blooms **is possible** and **illness from private and non-community drinking water supply wells is possible,** as these alternatives provide no reduction in nitrogen loading and only a limited reduction in pathogens. Under Alternatives I and II, **impacts to stress and overall health and well-being** would remain unchanged given continued perceptions and concerns of Suffolk County water quality. Given the reduction in nitrogen loading and pathogen loading expected under **Alternative III (installation of I/A OWTS), reductions in beach closures and the risk of illness** due to exposure to pathogens and algal blooms during aquatic recreation **are possible.** The risk of **illness from private and non-community drinking water supply wells is unlikely** under Alternative III**, provided that disinfection technologies are utilized**. Under Alternative III, improved water quality could positively influence perceptions of Suffolk County waters, **reduce stress, and improve overall health and well-being**. Under all alternatives, illness from public/community drinking water supplies remain unlikely.
- **The risk of exposure to pathogens in recreational waters and private drinking water could affect a high number of people**, considering private (individual) wells and non-community systems serve about 13% of residents (approx. 194,000 people). However, the number of illnesses of this type are low. Monitoring of surface waters and private drinking water wells can help minimize these risks. **Impacts to stress and well-being from perceived water quality are likely to be experienced by a moderate number of people.**
- The **health implications of exposure to sewerage-contaminated recreational and drinking water** are typically minor to moderate (e.g., gastrointestinal illness, respiratory illness, rashes, and illness of the eye, ear, and skin), but can be more severe and long-lasting for exposures to toxic algal blooms (e.g., liver damage and nervous system damage) and for those at higher risk of illness. Health impacts of stress and well-being are minor and could easily change.
- These **health impacts (or their potential reduction) would be disproportionately experienced** by recreational water users; those with private/non-community drinking water supply wells and individual sewerage systems; those more susceptible to pathogens (e.g., young children, the elderly, and the immunocompromised); those more at risk to the effects of toxic algal blooms (e.g., children); and those more at risk to nitrate toxicity in drinking water (e.g., pregnant women and infants under 6 months). **Impacts to stress and well-being would be disproportionately experienced** by low-income populations, recreational water users, coastal populations, and individuals with existing mental health conditions.

4.4. Resiliency to Natural Disasters: Existing Conditions and Potential Impacts

Resiliency is "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events" (National Research Council, 2012). The NYS 2100 Commission (2013) defined resilience as "the ability of a system to withstand shocks and stresses while still maintaining its essential functions." In coastal resiliency, this means reducing vulnerabilities and potential exposures to natural hazards (e.g., storms) and their impacts before they occur, in hopes of decreasing the consequences of the events. These vulnerabilities can affect health in a number of ways, including direct exposure to the storm, secondary hazards (e.g., falling trees, rising waters, electrocution, and carbon monoxide poisoning), disruption of services, evacuation and displacement, trauma and stress, and clean-up and recovery activities, and can range from changes in overall health and well-being to injury and death.

The highest risk natural hazards for Suffolk County include Nor'easters, severe storms, and hurricanes, and medium-risk natural hazards include coastal erosion and flooding (Suffolk County Government, 2014b). **Because of Suffolk County's location and low-lying southern coastline, it is exposed to coastal storms, their associated storm surges, and coastal and inland flooding.** While hurricanes and tropical storms are the primary cause of coastal flooding in New York (Suffolk County Government, 2014b), **nuisance or "sunny day" flooding (i.e., shallow coastal flooding in the absence of storms, caused by sea level rise) is also becoming more frequent** (NOAA, 2014a; Sweet & Park, 2014; Sweet & Marra, 2015; EPA, 2016c; Gillis, 2016).

The New York State *Recommendations to Improve the Strength and Resilience of the Empire State's Infrastructure* (NYS 2100 Commission, 2013) highlights coastal wetlands as critical protection for Long Island communities against these hazards. Coastal wetlands are considered under the purview of the state's objectives to rebuild communities that are more resilient. Anything that poses a risk to coastal wetlands is considered to negatively impact coastal community resilience. Article 25 of the New York Environmental Conservation Law established protections for tidal wetlands and led to the establishment of the tidal wetlands permit program aimed at preserving and regulating potential environmental stressors.

4.4.1 Resiliency to Natural Disasters Pathways of Impact

Figure 4-26 shows the pathways by which the proposed code changes could potentially impact resiliency to natural disasters and ultimately, health. This pathway was included in the *Assessment* based on messaging from the County and stakeholder discussions indicating that the proposed code changes would increase resiliency against future storms like Hurricane Sandy, through improvements to water quality and subsequent gains in the health and extent of coastal and tidal wetlands and eelgrass populations in Suffolk County. As a result, the analysis focused on the potential impacts of the proposed code changes on wetlands and their ability to provide protection to severe storms, storm and/or tidal surges, and coastal and inland flooding.

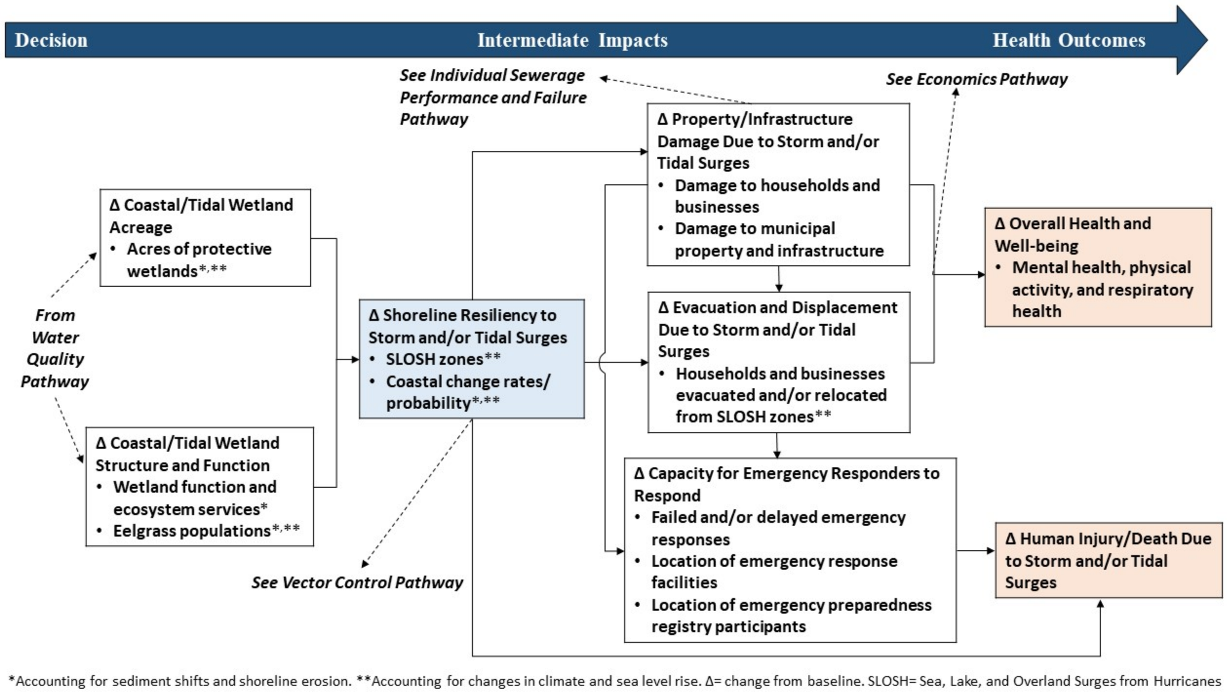


Figure 4-26. Resiliency to Natural Disasters Pathway Diagram.

A change in water quality can influence coastal/tidal wetland acreage as well as structure and function, which in turn may affect shoreline resiliency to storm and/or tidal surges. Although the impact analysis focused primarily on wetlands and eelgrass populations and their contribution to shoreline and community resiliency, the discussion was expanded to include other existing factors and features in Suffolk County that also play a role in wetland health and extent, resiliency of the shoreline to storm and tidal surges, and community resiliency. This was done because **there are stressors beyond nitrogen affecting Suffolk County wetlands and eelgrass populations and other factors beyond wetlands that determine shoreline and community resiliency.** To establish the linkage between shoreline resiliency to natural disasters and potential impacts to public health, the HIA analysis would have been remiss had it not examined some intermediate factors that also influence how natural disasters impact health. Changes in shoreline resiliency can impact the amount of property or infrastructure damage that may occur, the need for evacuation and displacement due to storm and/or tidal surges, and the capacity of emergency responders to respond. In turn, changes in any of these aspects can impact overall health and well-being, and the amount of human injury and death resulting from storm and/or tidal surges.

4.4.2 Impact of Changes in Water Quality on *Coastal/Tidal Wetland Structure and Function*

Wetlands

Wetlands are commonly viewed as transition areas between land (terrestrial ecosystems) and water (aquatic systems), where the water table is usually at or near the surface or the land is covered by shallow water (Cowardin, Carter, Golet, & LaRoe, 1979; EPA, 2017b). Wetland characteristics vary widely because of regional and local differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance. Coastal wetlands can include riparian wetlands (i.e., wetlands along rivers and streams), freshwater and salt marshes, mangrove swamps, bottomland hardwood swamps, seagrass beds, and more (Cowardin, Carter, Golet, & LaRoe, 1979; Bruland, 2008; Stedman, Linn, & Kutschenreuter, 2010; Dahl & Stedman, 2013; EPA, 2016b; NOAA, n.d.-a).

Wetlands provide a number of ecosystem services (e.g., ecological, economic, and social benefits) **including:** regulating the movement of water within watersheds; **holding and slowly releasing precipitation, flood water, and snow melt; *recharging groundwater*; acting as filters to cleanse water of impurities and sediment; recycling nutrients, such as nitrogen; reducing nitrogen; and providing habitat for fish, wildlife, and a variety of plants.** Wetlands are nurseries for many saltwater and freshwater fishes and shellfish of commercial and recreational importance and provide recreation and wildlife viewing opportunities for millions of people (USFWS, 2016a). Brackish and saltwater coastal wetlands also help **provide protection from wave erosion and provide a natural buffer from storm and tidal surges and coastal flooding.**

Surface water is supplied to wetlands through normal streamflow, flooding from lakes and rivers, overland flow and runoff, *groundwater discharge*, and tides. The quality of water discharged into a wetland influences the water chemistry of that receiving wetland and potentially, its structure (e.g., the plants that are able to grow) and function (e.g., *ability to filter water of sediments and impurities, recycle nutrients*, and perform other functions). Groundwater recharge and surface water flow from wetlands, subsequently, influences the chemistry of water in the adjacent aquifer (Carter, 1996).

Research has shown that increased nutrient loading has negative impacts on wetland structure, function and substrate condition, especially that of salt marshes (Turner, et al., 2009; Turner, 2011; Deegan L. , et al., 2012; Pennings, 2012; Watson, et al., 2014; Wigand, et al., 2014). Elevated nutrient loading causes marsh grass to allocate more biomass production above ground at the expense of below ground growth – initially becoming greener and growing taller. The tall marsh grasses, however, produce fewer roots and rhizomes, which are critical to stabilizing the edges and soils of marshlands. The poorly-rooted grasses eventually grow too tall and then fall over, destabilizing the creek edge or bay edge of the wetland, causing it to slump and exposing its soils to erosive forces. The destabilization of creek-edge and bay-edge marshes makes these areas more susceptible to the tugging and pulling of waves, accelerating erosion, and the ultimate loss of stabilizing vegetation (Morris & Bradley, 1999; Wigand, Brennan, Stolt, Holt, & Ryba, 2009; Turner, 2011; Deegan L. , et al., 2012; Watson, et al., 2014; Wigand, et al., 2014; NYSDEC, 2014c). Deegan, et al. (2012) found that nutrient-enhanced marsh grasses were heavier and taller but contained only about half of the structural tissue of unfertilized grasses. These changes make nutrient-enriched grass blades fall over limp instead of standing up to dissipate wave energy. Deegan, et al. (2012) also documented that the nutrient-enriched grasses contained higher concentrations of nitrogen in their tissues. Other studies have shown that this nutrient enrichment can increase the vulnerability of marsh plants to predation by herbivores (Bertness, Holdredge, & Altierei, 2009).

Excess nutrients and sediments are a significant cause of seagrass loss and on Long Island, eelgrass in particular (Figure 4-27). Eelgrass beds can help to slow currents and waves, trap sediments, and stabilize the seafloor to prevent shoreline shifting and erosion. In addition, they sequester nutrients such as nitrogen to help them grow, and trap sediments in the water column, to improve water quality. Latimer and Rego (2010) found that eelgrass coverage decreases significantly at nitrogen loading rates above 50 kg/hectares/yr and at loading rates above 100 kg/hectares/yr, eelgrass fails completely. Available light, salinity, and temperature are also important factors in determining eelgrass distribution and performance (Cornell University Cooperative Extension of Suffolk County, 2012a). Additionally, the availability of nitrogen increases the production of phytoplankton and macroalgae, which reduces water clarity. Eelgrass growing in turbid conditions with poor water and sediment quality require more light to survive (Kenworthy, Gallegos, Costello, Field, & di Carlo, 2014), making diminished water clarity and harmful algal blooms a contributor to the reduction of seagrass worldwide (Boesch, 2002).

Figure 4-27. Eelgrass (*Zostera marina*)

Climate change predisposes tidal marshes to sudden dieback resulting from increased infestation of pathogens and herbivores, changes in water salinity, and metal toxicity from changes in soil chemistry (Elmer, et al., 2013). Extreme salinity fluctuations and warm temperatures are a serious distress for eelgrass. Exceptionally warm temperatures have resulted in extensive seagrass die-off, especially eelgrass, which thrives in cold water (Cornell University Cooperative Extension of Suffolk County, 2012a; Salo & Pedersen, 2014). Brown tides, urchin overgrazing, and disease have also led to large-scale losses of seagrass, acting in concert with suspended sediments, nutrients, and effects of climate change (Orth, et al., 2006).

Coastal vegetated areas globally serve as a carbon sink equivalent to that of terrestrial forests, off-setting greenhouse gas emissions even though coastal vegetated areas represent only 3% of that covered by forests (Duarte, Losada, Hendriks, Mazarrasa, & Núria, 2013). Coastal wetlands are able to sequester carbon as part of their growth process. Because much of their soil is submerged under water, carbon in the soil of these coastal wetlands decomposes very slowly and remains for long periods of time (NOAA, n.d.-b). These high carbon burial rates raise the seafloor, buffering against the impacts of rising sea levels associated with climate change (Duarte, Losada, Hendriks, Mazarrasa, & Núria, 2013).

Knutson et al. (1982) estimated that **more than half of *normal* wave energy is dissipated within the first three meters of marsh vegetation**, while other studies concluded that wave height can be reduced by 80% over distances of 50 meters, as waves travel through marsh vegetation (Ysebaert, et al., 2011). Emergent vegetation (i.e., vegetation reaching the water surface and above) is more effective at reducing wave height than submerged vegetation such as eelgrass, indicating that water depth is critical to wave attenuation (Möller, Spencer, French, Leggett, & Dixon, 1999; Augustin, Irish, & Lynett, 2009; Anderson, Smith, & McKay, 2011; Ysebaert, et al., 2011). This indicates that tidal wetlands need to maintain their relative elevation in the face of sea level rise in order to provide these services.

Storm surge is considerably different from normal wave action. Bradley and Houser (2009) found **as storm waters became more turbulent and wave heights increased, the ability of seagrass to attenuate waves decreased** because as they oscillated, the seagrass tended to remain bent in the direction of the wave flow rather than providing resistance to the waves. Jadhav and Chen (2012) collected data during a tropical storm along the northern coast of the Gulf of Mexico and measurements showed that marsh vegetation submerged under a surge over 1 meter was still able to provide some attenuation of waves, although this decreased with increasing wave height. Fonseca and Cahalan (1992) also observed reduced wave attenuation as water depths increased, but suggested that even a small reduction in waves can be significant across larger, broad wetlands.

Although **wetlands and eelgrass beds cannot be expected to stop storm surges and flooding associated with large storm events, like hurricanes, the friction provided by the vegetation can reduce wave energy somewhat, which is important for reduced wave damage, flooding, and erosion, especially during lower-intensity storms and coastal/tidal flooding** (e.g., nuisance "sunny day" flooding that occurs in the absence of storms due to rising sea levels), which are experienced more regularly (National Research Council, 2014).

Existing Coastal/Tidal Wetland Structure and Function in Suffolk County at the Time of the HIA Analysis

Wetlands make up 45% of the approximately 67,574 acres of Suffolk County's land area that exists in coastal or riverine floodplains (NOAA, 2016b). Although Suffolk County wetlands can't be expected to stop flooding associated with extreme storm events like Hurricane Sandy, they can provide protection from flooding during lower-intensity storms and nuisance "sunny day" flooding. In addition, freshwater wetlands often serve as groundwater discharge and recharge sites and help to improve water quality of groundwater, surface waters, and marine receiving waters by absorbing and cycling nutrients.

Both freshwater and tidal wetlands in Suffolk County provide habitat for fish and shellfish species that are part of the local food supply and commercial fishing and shellfish industries (NOAA, 2016b) and they also support recreational and charter fishing, birdwatching, boating, and other recreational opportunities. Eelgrass beds are also valuable habitat for several species that are important to Long Island's seafood and fishing industries, such as bay scallops, crab, striped bass, sea bass, and more (Cornell University Cooperative Extension of Suffolk County, 2012c).

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Tiner & Herman (2015) estimated that 9,600 acres of the tidal wetlands that exist in Suffolk County today are grid ditched (Figure 4-28) – a method practiced in the 1930s to remove standing water on the surface as a means of controlling mosquito populations (Cashin Associates, PC, 2006; Potente, 2007). This method has proven to be an unsuccessful form of mosquito control, and these wetlands now require routine larvicide applications to control for mosquito populations (Cashin Associates, PC, 2006). In addition, the grid ditching has compromised the integrity and function of these wetlands by fragmenting the marshes, altering the hydrology, allowing invasive plant species to colonize in the ditches, and reducing waterfowl and fish habitat (Potente, 2007; Tonjes, 2013).

Figure 4-28. Grid ditched wetland. Source: Tiner & Herman (2015).

A USFWS inventory of wetland restoration sites on Long Island (Tiner & Herman, 2015) found 12,543 acres of impaired Suffolk County wetlands that may be able to be repaired to bring back lost or reduced function, the vast majority of which (almost 9,664 acres) are partly drained (ditched) estuarine wetlands. A 2004 study conducted by the USFWS in the Wertheim National Wildlife Refuge (Suffolk County, NY) showed that grid ditched marshes that were restored to re-establish tidal flow and eliminate invasive plant species flourished, not only regaining absorption and habitat functioning, but also resulted in a 70% reduction in mosquito spraying when compared to remaining grid ditched marshes in the refuge (Leuzzi, 2015). By restoring the natural hydrology and plant communities of these grid-ditched salt marshes and implementing integrated marsh management techniques for mosquito control (see Vector Control section), Suffolk County can regain function in a large number of its wetlands. See Appendix H for more details on these Suffolk County wetland restoration efforts.

Protect, restore, and create freshwater and coastal/tidal wetlands or other green infrastructure alternatives to improve resiliency and restore wetland functions. The USFWS inventory (Tiner & Herman, 2015) identified 12,543 acres of impaired Suffolk County wetlands that may be eligible for restoration.

Anticipated Change(s) in Coastal/Tidal Wetland Structure and Function

It is critical for Suffolk County's planning efforts to improve water quality, protect and restore wetlands, and provide the necessary space and sediment flow to allow wetlands the opportunity to be self-sustaining in the face of sea level rise so that they can continue to provide long term benefits for both human and natural communities.

Table 4-23 identifies the potential impacts of the proposed decision alternatives on coastal/tidal wetland structure and function. As noted earlier, individual sewerage systems are not the only source of wastewater inputs to Suffolk County waters, wastewater inputs are not the only source of nitrogen loading to Suffolk County waters, and nitrogen loading is only one of many factors affecting coastal/tidal wetland structure and function across Suffolk County; therefore, there are uncertainties predicting the potential impacts of the proposed decision on coastal/tidal wetland structure and function.

Table 4-23. Impact of Decision on Coastal/Tidal Wetland Structure and Function

Alternatives	Potential Changes in Coastal/Tidal Wetland Structure and Function
Baseline*	Nitrogen loading to coastal/tidal wetlands from individual sewerage system wastewater inputs would **continue to contribute to loss of coastal/tidal wetland structure and function**. When combined with the expected acceleration of sea level rise, other present-day nitrogen loading, and legacy nitrogen loading (due to the long travel time of some groundwater through the aquifer), the impact of nitrogen loading on Suffolk County wetland structure and function could be magnified.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	There would be no change in nitrogen loading from individual sewerage systems, and hence, **no change expected** in the contribution of wastewater inputs from these systems to coastal/tidal wetland structure and function. When combined with the expected acceleration of sea level rise, the impact of nitrogen loading on Suffolk County wetland structure and function could be magnified.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	A decrease in nitrogen loading from individual sewerage systems would result in decreased wastewater contributions to coastal/tidal wetlands; this **should create conditions conducive to restoration of wetland structure and function**. **However, there are other competing factors contributing to loss of wetland structure and function across the County,** including accelerated sea level rise, other present-day nitrogen loading, and legacy nitrogen loading (due to the long travel time of some groundwater through the aquifer). **Given these factors, it is uncertain the degree to which improvements in coastal/tidal wetland structure and function** would be seen across the County under this alternative. Should there be an attributable improvement in water quality and subsequently in coastal/tidal wetland structure and function due to the decision, it is unknown how long it would take for this improvement to be seen, considering groundwater travel times of 0-10 years along the coast and up to decades and even hundreds of years from the middle of Long Island.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to continuing loss of wetland structure and function in Suffolk County.

4.4.3 Impact of Changes in Water Quality on *Coastal/Tidal Wetland Acreage*

Loss of wetlands across the U.S. has occurred as a result of both human activity and natural causes (EPA, 2001b; Dahl & Stedman, 2013), but because over half of the U.S. population lives in coastal areas, the stress on coastal wetlands is much greater than on wetlands in inland areas (NOAA, 2004; Dahl & Stedman, 2013). Human causes of coastal wetland loss (Osmond, et al., 1995; EPA, 2001b; EPA, 2010; Dahl & Stedman, 2013) include:

- *Development* – converting wetlands to residential and commercial areas and their associated infrastructure (e.g., roads, buildings, parking lots), runoff from impervious surfaces, point source pollution (e.g., factories, sewage treatment plants), and shoreline hardening (e.g., bulkheads and seawalls, which cause erosion and prevent migration of wetlands inland in response to rising sea levels)
- *Agriculture* – converting wetlands to agricultural land, draining wetlands, and runoff from agricultural fields
- *Hydrologic Alterations* – direct alterations to hydrology, such as draining, dredging, channelization, filling, levees, and ditching or impoundments of wetlands (e.g., as part of mosquito control practices); indirect alterations to hydrology, such as changes in overland flow and connectivity
- *Pollutants and Water Quality Degradation* – changes in water quality due to runoff from agricultural, urban, and commercial lands, ***nutrient enrichment*** (e.g., excess nitrogen), and sedimentation.

Natural causes of coastal wetland loss, although sometimes influenced by human activity, include:

- Erosion – wave action and storm events can cause wetland soils to erode, causing loss of vegetation and even conversion to open water
- Sea Level Rise – **as sea level rises, wetlands must grow vertically and horizontally to avoid submersion (i.e., being converted from vegetated wetland to unvegetated mud flat or even open water)**
- Droughts – the timing and delivery of water and sediment during times of drought can cause sudden diebacks of wetland plants and even the subsidence of wetlands
- Climate Change **–** it is clear from the literature that climate change will magnify the impacts of these natural process. Because of climate change, future storm events may produce stronger wave action, larger storm surges, and extreme precipitation, resulting in greater inundation and increased coastal erosion.

Existing Coastal/Tidal Wetland Acreage and Stressors in Suffolk County at the Time of the HIA Analysis

All wetlands in Suffolk County are coastal wetlands, as defined by NOAA (n.d.-a) and EPA (2016b). Between the early 1900s and 2004, Suffolk County lost more than 21,000 acres of freshwater and tidal wetlands, including over 51% of its freshwater wetlands and 39% of its tidal wetlands (Tiner, McGuckin, & Fields, 2012).

The population boom in Suffolk County between 1940 and 1970 led to the destruction of many of its freshwater and tidal wetlands, which were drained, dredged, and/or filled to support the residential, commercial, and industrial development that accompanied the boom. Recent studies have pointed to **excess nitrogen nutrient loading** from wastewater (i.e., individual sewerage systems and wastewater treatment plants), fertilizer, and atmospheric deposition – **as a significant factor in coastal/tidal wetland loss in Suffolk County** (Gobler C. J., 2014; Suffolk County Government, 2015a; Kosinski & Isaacson, 2017).

Water quality, and specifically nutrient-related water quality, is an important factor in maintaining wetlands' health and their ability to grow vertically to keep up with sea level rise. As sea level rises, wetlands must grow vertically and horizontally to avoid submersion (i.e., being converted from vegetated wetland to unvegetated mud flat or even open water). Although nutrient enrichment stimulates above-ground plant growth, recent studies show that nutrient enrichment compromises a wetland's ability to grow vertically by reducing below-ground root and rhizome biomass (which help stabilize wetland shores against erosion and wetland plant stability against storms and wave action), organic matter accumulation, and peat formation (Turner, Swenson, & Milan, 2000; Turner, et al., 2009; Kirwan, et al., 2010; Deegan L. , et al., 2012; Watson, et al., 2014; Weston, 2014). In addition to the impact of nutrients on a wetland's ability to grow, Watson et. al. (2014) estimated that 87% of Northeastern salt marshes (a type of wetland) exist at elevations at which growth is limited by inundation (i.e., flooding), suggesting linkages between sea level rise and current tidal wetland loss.

Loss of Long Island salt marshes has accelerated in recent decades, especially along the south shore. In western Long Island, wastewater, dredging, groundwater removal, and global warming are contributors to that wetland loss. Studies of estuaries in western Long Island and Rhode Island have both shown direct relationships between rises in human population and coastal watershed development and nitrogen levels present in soil, plant, and/or animal tissue (Wigand, et al., 2014).

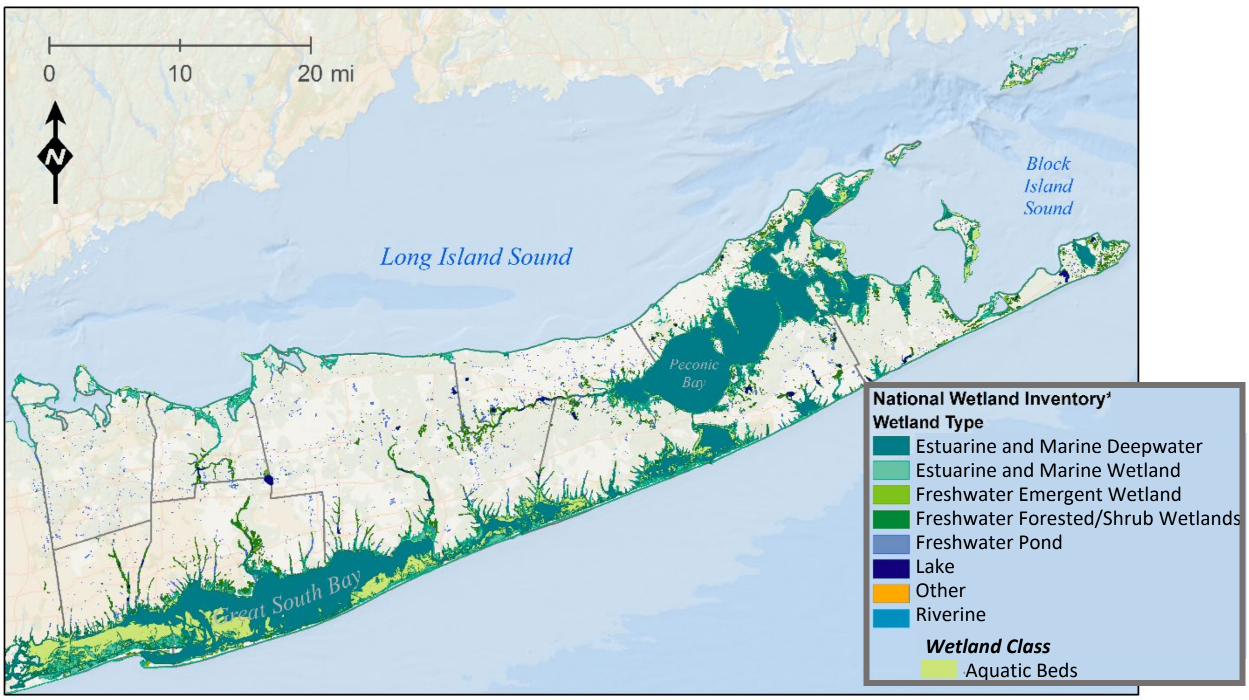
From 1974-2001, there was an 18–36% loss in tidal wetlands in the Great South Bay as a result of factors including excess nitrogen entering the watershed (NYSDEC, 2014c). Local and regional experts have identified nitrogen pollution from wastewater as a considerable contributor of nitrogen to the Peconic Estuary, Long Island Sound, Great South Bay, and South Shore Estuary Reserve (Kinney & Valiela, 2011; Lloyd, 2014; Stinnette, 2014; SCDHS, 2014c; Woods Hole Group Inc., 2014; Suffolk County Government, 2015a; Gobler C. J., 2016; Lloyd, Mollod, LoBue, & Lindberg, 2016).

In addition to climate change and nutrient loading, another factor influencing the ability of Suffolk County's coastal/tidal wetlands to keep up with sea level rise is their ability to grow horizontally. **Many of the shorelines in Suffolk County are hardened (i.e., lined with riprap, seawalls, or bulkheads), which prevents wetlands from being able to migrate landward (i.e., grow horizontally) to compensate for increasing water levels.**

There has also been considerable pressure on a unique wetland feature in Suffolk County – eelgrass beds (i.e., aquatic beds or submerged aquatic vegetation [SAV]). Historic photography and records indicate that there may have been as many as 200,000 acres of eelgrass in Suffolk County in 1930, but today, less than 22,000 acres remain (NYSDEC, 2004; New York State Seagrass Task Force, 2009; USFWS, 2015). An epidemic called wasting disease hit eelgrass populations in the North Atlantic Ocean in 1931, resulting in a large-scale (almost 90%) dieback of the eelgrass population (Rasmussen, 1977; Cornell

University Cooperative Extension of Suffolk County, 2012b). Eelgrass populations recovered, but not to the same levels as before the epidemic. **A number of stressors continue to lead to eelgrass population decline**, including algal blooms (e.g., brown tide), sediment and nutrient runoff, disease, physical disturbance (e.g., from boating, dredging, shellfishing, and normal use of sea grass beds by animals, such as crabs and waterfowl), hardened shorelines, climate change, and sea level rise (Cornell University Cooperative Extension of Suffolk County, 2012b).

Figure 4-29 shows the wetlands in Suffolk County based on the 2015 National Wetlands Inventory (NWI), which is the federal standard for wetland classification (USFWS, 2015). The 2015 NWI, using aerial imagery from 2004, shows a total of 33,748 acres of wetlands in Suffolk County [over half of which are estuarine (16,593 acres), marine (3,439 acres), or tidal riverine (37 acres) wetlands] and 159,509 acres of deepwater habitat (excluding the oceans).



Wetlands: National Wetland Inventory - U.S. Fish and Wildlife Service 2015. * Oceans removed.
Base Map: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors.

Figure 4-29. Current-day Suffolk County wetlands coverage per the 2015 National Wetland Inventory (USFWS, 2015).

Wetland restoration in Suffolk County has included programs aimed at restoring eelgrass along Long Island, restoring salt marshes as part of Hurricane Sandy recovery and resiliency efforts, and restoring tidal wetlands (Brank, 2015). These wetland restoration efforts have been funded and undertaken by a number of organizations, including the Federal Emergency Management Administration (FEMA), National Fish and Wildlife Foundation (NFWF), Natural Resources Conservation Service (NRCS), U.S. Fish and Wildlife Service (USFWS), NYSDOS, and NYSDEC. A recent USFWS inventory of potential wetland restoration sites by Tiner & Herman (2015) found 760 acres of former wetlands in the southern portion of Suffolk County as possible sites for wetland re-establishment. Approximately 47% of these former wetlands (356 acres) are filled land (i.e., disposal sites for dredged material) capable of restoration; another 41% (315 acres) were once wetlands, but are now open water (due to tidal restrictions, impoundment, or excavation); and the remaining 12% (92 acres) are farmed former wetlands (Tiner & Herman, 2015).

Protect, restore, and create freshwater and coastal/tidal wetlands or other green infrastructure alternatives to improve shoreline resiliency and improve wetland functioning, including attenuation of nutrients. The USFWS inventory (Tiner & Herman, 2015) identified 760 acres of potential wetland restoration sites in southern Suffolk County.

Anticipated Change(s) to Coastal/Tidal Wetland Acreage

Table 4-24 identifies the potential impacts of the proposed decision on coastal/tidal wetland acreage for each decision alternative. As noted earlier, individual sewerage systems are not the only source of wastewater inputs to Suffolk County waters; wastewater inputs are not the only source of nitrogen loading to Suffolk County waters; and nitrogen loading is only one of many factors affecting coastal/tidal wetland loss across Suffolk County; therefore, there are uncertainties in predicting the potential impacts of the proposed decision on coastal/tidal wetland acreage.

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Regardless of the decision alternative chosen, the loss of coastal/tidal wetlands in Suffolk County is expected to continue given other stressors. In addition to direct impacts from human activity, there are also a number of natural stressors influenced by human activity, including more frequent and severe storms, extreme precipitation, and accelerated rates of sea level rise (National Research Council, 2010; Kunkel, et al., 2013; Melillo, Richmond, & Yohe, 2014). Regulation 6 NYCRR Part 490, Projected Sea-Level Rise (adopted February 3, 2017) projects that Long Island could experience sea level rises (above the 2000-2004 baseline) of 2-10 inches by the 2020s and 15-72 inches of sea level rise by 2100 due to the effects of global warming. Without room to migrate inland, it is possible that many wetlands will be inundated with accelerated rates of sea level rise and flooding due to more severe storms and extreme precipitation.

Table 4-24. Impact of Decision on Coastal/Tidal Wetland Acreage

Alternatives	Potential Change(s) in Coastal/Tidal Wetland Acreage
Baseline*	Nitrogen loading to coastal/tidal wetlands from individual sewerage system wastewater inputs would **continue to contribute to the loss of protective coastal/tidal wetlands**. When combined with the expected acceleration of sea level rise, other present-day nitrogen loading, and legacy nitrogen loading (due to the long travel time of some groundwater through the aquifer), the impact of nitrogen loading on Suffolk County wetland loss could be magnified.

Alternatives	Potential Change(s) in Coastal/Tidal Wetland Acreage
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	There would be no change in nitrogen loading from individual sewerage systems, and hence, **no change expected** in the contribution of wastewater inputs from these systems to coastal/tidal wetland loss. When combined with the expected acceleration of sea level rise, the impact of nitrogen loading on Suffolk County wetland loss could be magnified.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	A decrease in nitrogen loading from individual sewerage systems would result in decreased wastewater contributions to coastal/tidal wetlands; this **should lead to a decrease in coastal/tidal wetland loss and create conditions conducive to eelgrass restoration**. However, there are other competing factors contributing to wetland and eelgrass loss across the County, including accelerated sea level rise, other present-day nitrogen loading, and legacy nitrogen loading (due to the long travel time of some groundwater through the aquifer). Given these factors, it is **uncertain the degree to which improvements in coastal/tidal wetland acreage across the County would be seen under this alternative**; modeling and long-term monitoring are needed to make this determination. Should there be an attributable improvement in water quality and subsequently in coastal/tidal wetland acreage due to the decision, it is unknown how long it would take for this improvement to be seen, considering groundwater travel times of 0-10 years along the coast and up to decades and even hundreds of years from the middle of Long Island.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to continuing wetland loss in Suffolk County.

4.4.4 Impact of Coastal/Tidal Wetlands on *Shoreline Resiliency to Storm and/or Tidal Surges*

Shoreline resiliency to storm and/or tidal surges is primarily dependent on a number of physical factors (e.g., geomorphology, coastal slope, relative sea-level change, shoreline erosion, mean tide, mean wave height) and the presence of natural habitats (e.g., wetlands, dunes, beaches) and engineered solutions (e.g., seawalls, bulkheads, jetties, and rip-rap-walls).

As noted previously, wetlands do play a role in shoreline resiliency. Although **wetlands and eelgrass beds** cannot be expected to stop storm surges and flooding associated with large storm events, like hurricanes, the friction provided by the vegetation can reduce wave energy somewhat, which is

important for reduced wave damage, flooding, and erosion, especially during lower-intensity storms and coastal/tidal flooding (e.g., nuisance "sunny day" flooding that occurs in the absence of storms due to rising sea levels).

Coastal areas with low-lying land are particularly vulnerable to these storm surges, especially in light of rising sea levels (Figure 4-30).

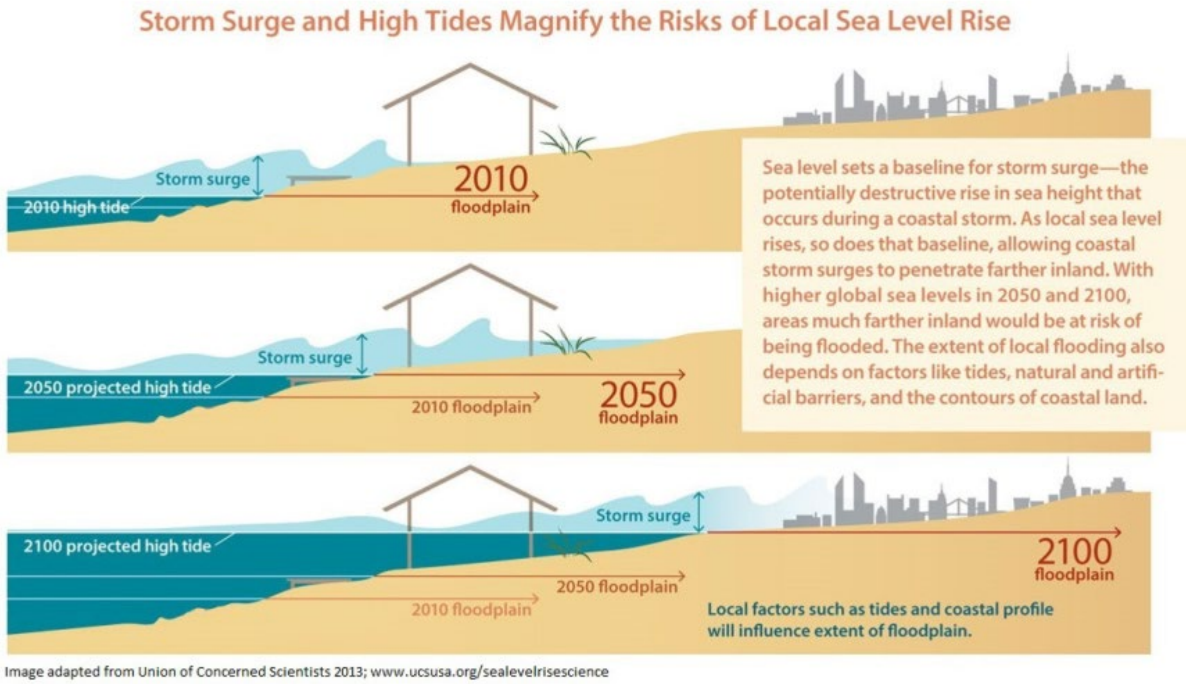

Figure 4-30. Storm surges are amplified by sea level rise. Adapted from Union of Concerned Scientists (2013).

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Sea level rise not only amplifies storm surges, but also allows normal waves to reach further inland, increasing the risk of erosion, barrier island loss, inundation, and nuisance flooding in the absence of storms (New York State Sea Level Rise Task Force, 2010; Union of Concerned Scientists, 2013; EPA, 2016c). Due to rising sea levels, nuisance flooding (Figure 4-31) has become more frequent (NOAA, 2014a; Sweet & Park, 2014; EPA, 2016c; Gillis, 2016). Nuisance tidal flooding occurs when the water level at a NOAA water level gauge exceeds the local threshold for minor impacts, such as road closures, reduced storm-water drainage, etc. (Sweet & Marra, 2015). It is rarely life-threatening, but can cause property and infrastructure damage.

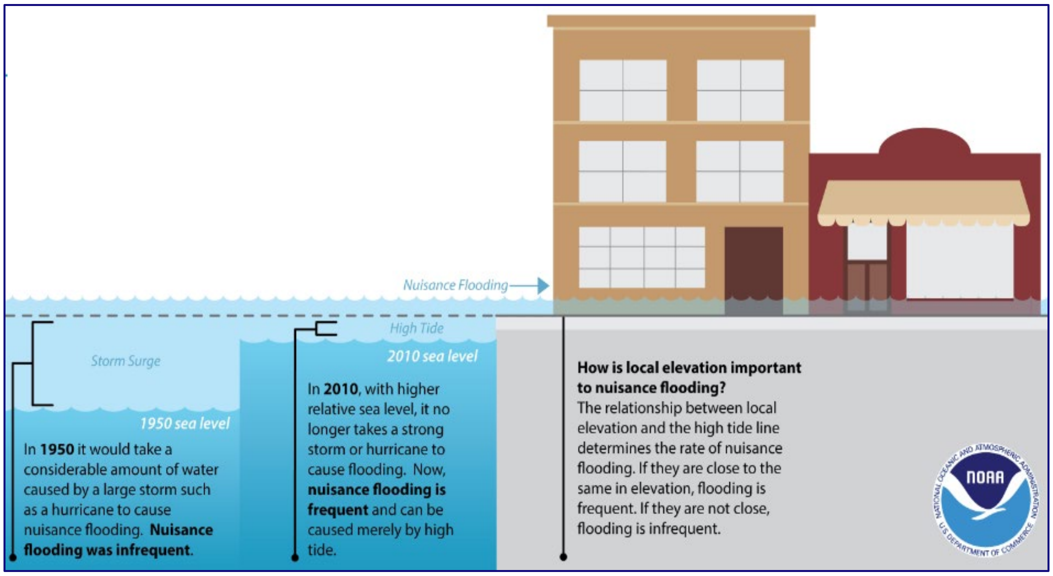


Figure 4-31. The impact of rising sea level on nuisance flooding. Taken from NOAA (2014b).

A traditional approach to protecting shorelines from storms, flooding, and erosion has been to "harden" or "armor" shorelines by adding engineered features, such as vertical bulkheads and seawalls. In recent years, however, the importance of natural habitats, such as coastal wetlands and seagrass beds, in protecting shorelines has become more widely accepted (National Research Council, 2010; Arkema, et al., 2013; National Research Council, 2014). Actions to protect and restore salt marshes and eelgrass beds in order to increase shoreline resiliency have become more common, but they may be unsuccessful unless accompanied by actions to mitigate the multitude of forces causing their decline, including development, overall nitrogen loading, sediment regime changes, wave action, erosion, severe storms and extreme precipitation, and possibly most importantly, sea level rise (National Research Council, 2014).

Integrate wetland protection priorities into community planning.

Protect, restore, and create freshwater and coastal/tidal wetlands or other green infrastructure alternatives to improve resiliency.

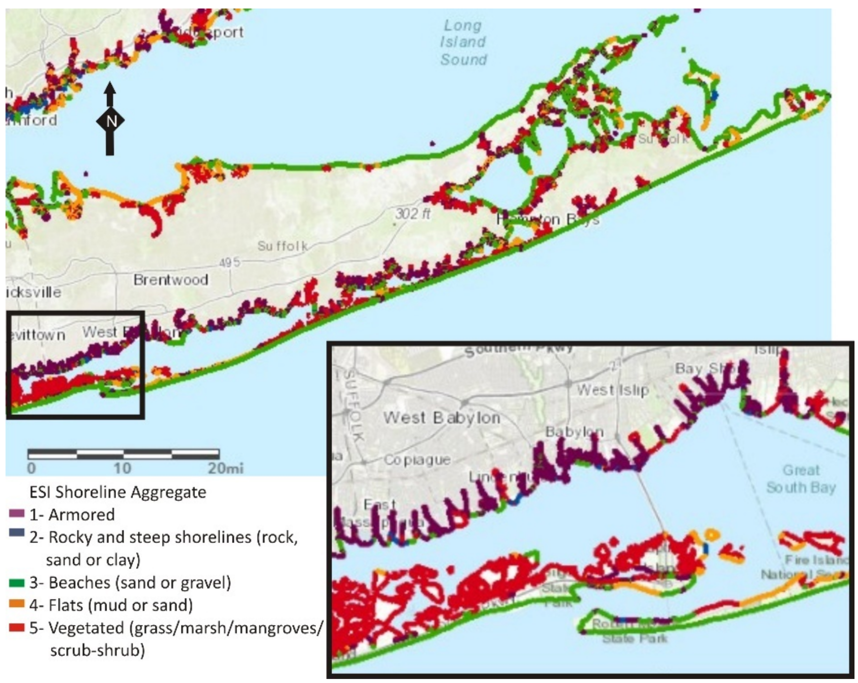
Evaluate the use of hybrid approaches that combine natural habitats and built defense structures to improve resiliency.

Inundation of wetlands from sea level rise, storm events, and flooding can result in direct wetland loss as wetlands are converted to muddy flats and even open water (Morris, Sundareshwar, Nietch, Kjerfve, & Cahoon, 2002; Nicholls, 2004). Inundation can also result in an increase in standing water for mosquito habitat. Historically, the loss of wetlands to sea level rise was offset if the wetland could maintain its relative elevation and had the ability to migrate landward. Hardened shorelines, and the development they are meant to protect, now hinder the landward migration of wetlands and have modified the sediment input needed to help wetlands maintain their elevation.

Existing Shoreline Resiliency to Storm and/or Tidal Surges at the Time of the HIA Analysis

Suffolk County shorelines are predominantly beach and vegetated areas (e.g., wetland, seagrass bed), although there are also mud or sand flats in some of the bays. There is also extensive armoring along the southern shore, especially in the western portion of the County (Figure 4-32).

Suffolk County's coastline is vulnerable to a number of natural factors known to cause shoreline change. The Coastal Vulnerability Index calculated by the U.S. Geological Survey (USGS) (Thieler & Hammar-Klose, 1999) shows the susceptibility of the Suffolk County coast to sea level rise (using historical relative sea level rise rates at tide gauge stations along the coast) and the nature of that risk – flooding, shoreline retreat, material transport, erosion, etc. (Figure 4-33). Long Island's shores are also affected by land subsidence – the sinking of an area of land due to subsurface geologic processes (Tanski J. , 2012; Karegar, Dixon, & Engelhart, 2016).



ESRI Shoreline Aggregate: NOAA's ESI_Shoreline_Aggregate MapServer, accessed March 2017

Figure 4-32. Suffolk County shoreline types per NOAA's Environmental Sensitivity Index.

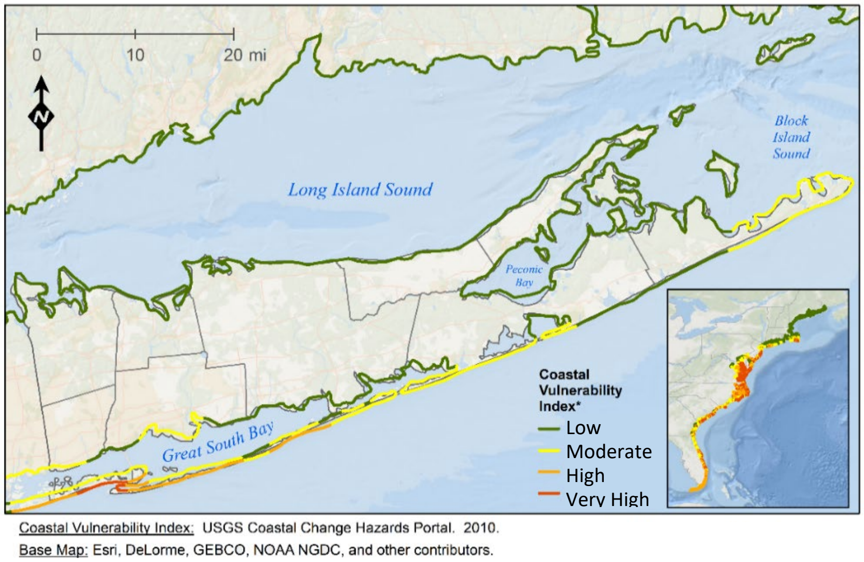
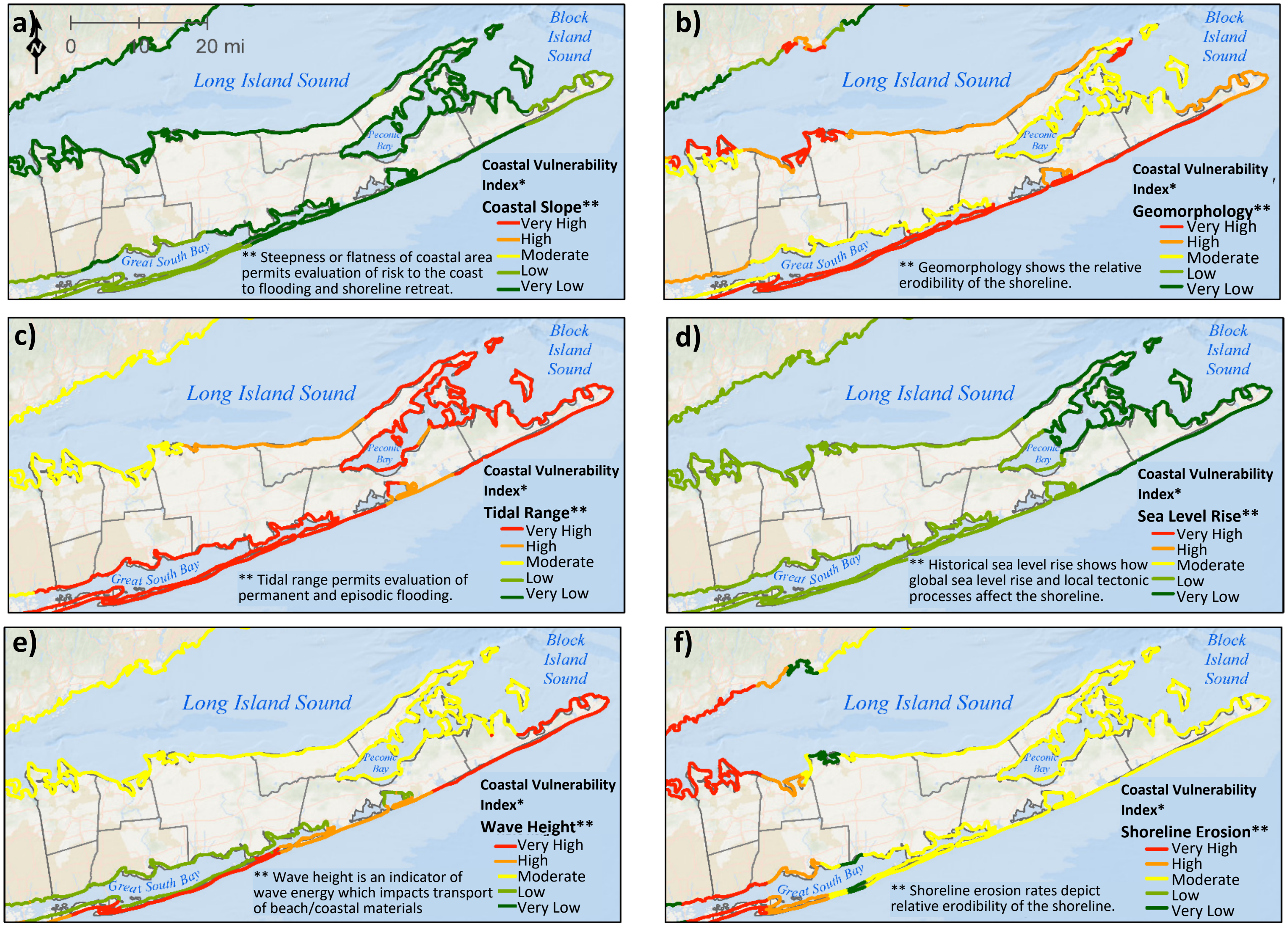


Figure 4-33. The USGS Coastal Vulnerability Index shows the relative susceptibility of the Suffolk County coast to sea level rise when compared to the entire Atlantic coast.

The southern shore of Suffolk County is a very high energy coastline, while the northern shore sees more moderate wave heights (Figure 4-34e). However, both shorelines are subjected to high tidal ranges (Figure 4-34c), indicating an intermittent and permanent inundation hazard. The beach, vegetated, and mud and/or sand flat geomorphologies along both coasts are moderately to very highly erodible (Figure 4-34b), according to the ranking of USGS's Coastal Vulnerability Index (Thieler & Hammar-Klose, 1999), yet the erosion rates for the Suffolk County shoreline are shown to primarily be moderate, with some areas of low and high to very high erosion (Figure 4-34f).



<u>Coastal Vulnerability Index</u>: USGS Coastal Change Hazards Portal. 2010
<u>Base Map</u>: Esri, DeLorme, GEBCO, NOAA, NGDG, and other contributors

* Coastal Vulnerability Index (calculated by USGS) shows the relative susceptibility of the coast to sea level rise for the Atlantic Coast.

Figure 4-34. Ranking of physical variables considered in the USGS Coastal Vulnerability Index for Suffolk County – (a) coastal slope risk, (b) geomorphology, (c) tidal range, (d) historical sea level rise, (e) wave height, and (f) shoreline erosion.

As part of the USGS's National Assessment of Shoreline Change, Hapke, Himmelstoss, Kratzmann, List, & Thieler (2011) showed that historically, the average rate of erosion for Long Island in the long term was -0.6 m/yr and in the short term was -1.0 m/yr; however, the net shoreline change rates were positive in both the long term and short term (Table 4-25) due to the extent of beach nourishment projects and other activities undertaken on Long Island. (Hapke, Himmelstoss, Kratzmann, List, & Thieler, 2011).

Table 4-25 . Long Island Long-term and Short-term Shoreline Change Rates (Taken from Hapke, Himmelstoss, Kratzmann, List & Thieler, 2011)

Shoreline Change	Average of rates (m/yr)	Percent eroding (%)	Average rate of erosion (m/yr)	Percent eroding more than -1 m/yr (%)	Percent eroding more than -3 m/yr (%)
Long-term (1830—2007)	0.08 ± 0.2	60	-0.6	9	3
Short-term (1983—2000)	0.8 ± 0.09	36	-1.0	15	1

While numerous storm events occurred during the timeframes examined by Hapke, Himmelstoss, Kratzmann, List & Thieler (2011), the shoreline change rates are averaged over time and therefore do not reflect the probability of shoreline change due to a particular storm event. The USGS created coastal change forecasts for extreme storms (i.e., hurricanes and Nor'easters) by modeling storm-induced water levels (e.g., surge and waves) compared to the elevations of "first line of defense" dunes and beaches every 1-km along the U.S. coast. These coastal change forecasts show the probability of erosion of dunes and sandy beaches along the southern coast of Suffolk County due to collision, overwash, and inundation during a subset of extreme storm conditions. Collision during these extreme storms is inevitable and occurs when storm waves hit the shoreline, causing erosion along the front of the dune or beach. When storm surge and waves increase in height, they topple over the top of the dune or beach berm (i.e., overwash), causing erosion along the back side of the shoreline and pushing sand landward. The most severe coastal change occurs during inundation, when the height of the surge and waves exceeds the elevation of the shoreline and submerges the area. This can lead to severe erosion, breaching of barrier islands, and flooding. Figure 4-35 illustrates each of these coastal change regimes.

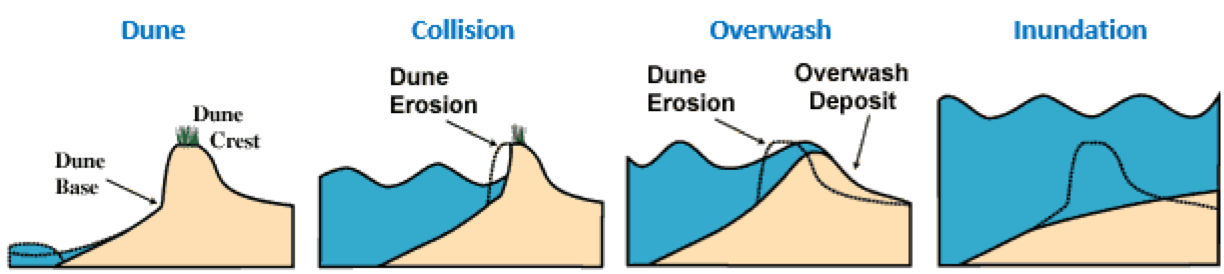


Figure 4-35. Illustration of dune erosion due to collision, overwash, and inundation.Taken from (USGS, 2015).

While the USGS's coastal change forecasts show the probability of inundation, they do not indicate the extent of that inundation. NOAA, however, has developed a model to estimate Sea, Lake, and Overland Surges from Hurricanes (SLOSH).

Figure 4-36 shows the SLOSH zones expected from Category 1, 2, 3, and 4 hurricanes (i.e., the extent of the storm surge from these hurricanes).

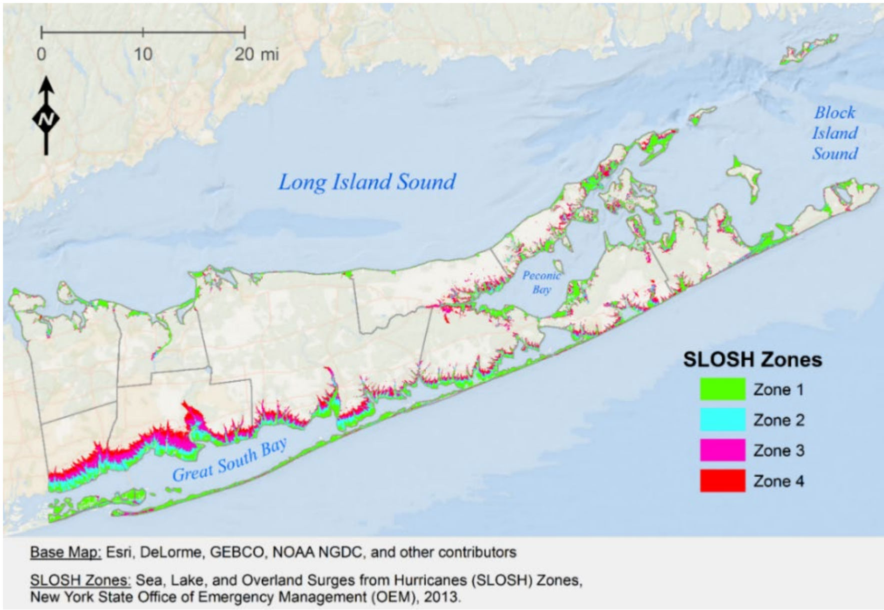


Figure 4-36. Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Zones 1-4 showing the extent of inundation expected from the corresponding category of hurricane (Category 1 hurricane being the least severe and Category 4 being the most severe).

Similar surge extent modeling for Nor'easters and other severe storms doesn't exist; however, the NOAA tidal gauge at the eastern tip of Long Island (Montauk, NY), does give a glimpse into the surge and wave heights associated with Class 1, 2, and 3 Nor'easters (Table 4-26).

Table 4-26. Observed Non-Tidal Surge and Significant Wave Height Associated with Nor'easters at Montauk, NY. Taken from (Birchler, Dalyander, Stockdon, & Doran, 2015)

Nor'easter	Mean Non-Tidal Surge (m)*	Mean Significant Wave Height (m)†
Class 1	0.75	3.10
Class 2	0.90	4.09
Class 3	1.38	5.91

* NOAA Tidal Gage 8510560, Time Period 1979 – 2009

† NOAA Wave Buoy 44017, Time Period 2002 – 2009

Inundation of the shoreline isn't just happening during storm events; sea level has risen over time and, when combined with the land subsidence being experienced on Long Island (Tanski J. , 2012; Karegar, Dixon, & Engelhart, 2016), is now at the point that a high tide or a windy day, can cause inundation (NOAA, 2014a; Corum, 2016; Gillis, 2016). Figure 4-37 shows the areas of Suffolk County currently exposed to shallow coastal flooding and the rise in these nuisance flooding events as measured at the Montauk, NY tide gage in Eastern Suffolk County.

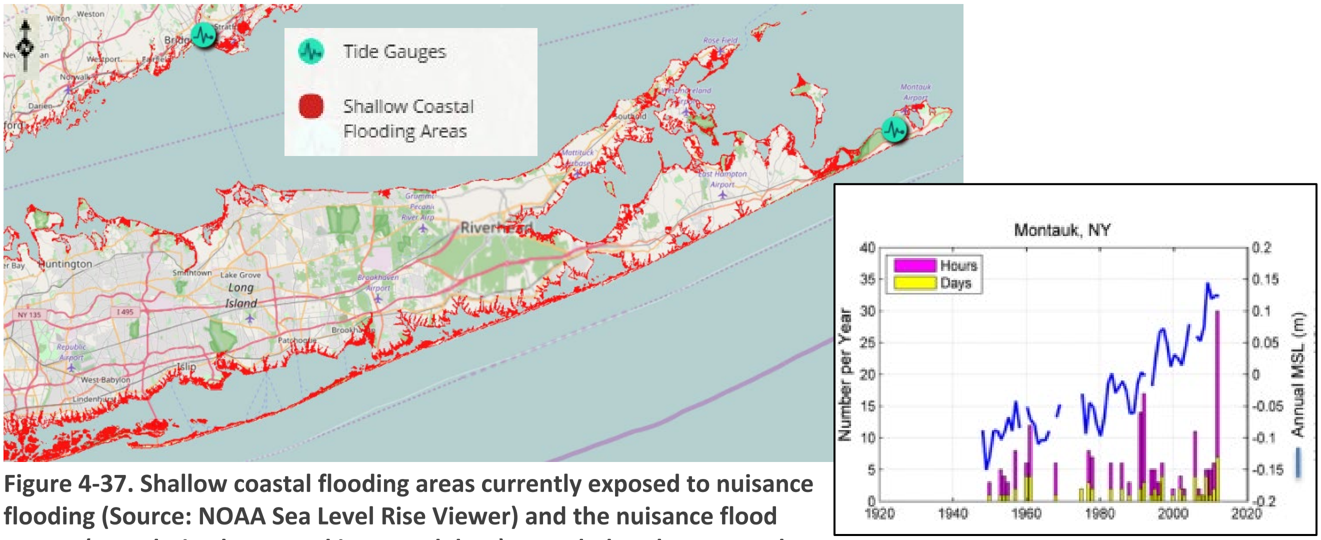


Figure 4-37. Shallow coastal flooding areas currently exposed to nuisance flooding (Source: NOAA Sea Level Rise Viewer) and the nuisance flood events (cumulative hours and impacted days) recorded at the Montauk, NY tide gage. Source: (NOAA, 2014a). Note: If the number of hours and days are numerically equivalent, only days are shown.

In September 2014, the Community Risk and Resiliency Act (CRRA) was enacted to ensure that decision-makers use the best available science and consider sea level rise, storm surge, and flooding when issuing certain state funding and permits. One provision of CRRA was the development of official sea level rise projections. Regulation 6 NYCRR Part 490, Projected Sea-Level Rise (adopted February 3, 2017) forecasts accelerated sea level rise for the Long Island Region (Table 4-27).

Table 4-27. Forecast of Accelerated Sea Level Rise for Long Island, NY(Source: 6 NYCRR Part 490)

	Region	Long Island Inches of rise relative to 2000-2004 baseline				
	Descriptor	Low	Low-medium	Medium	High-medium	High
Time Interval	2020s	2	4	6	8	10
	2050s	8	11	16	21	30
	2080s	13	18	29	39	58
	2100	15	21	34	47	72

With the projected sea level rise for Long Island, not only will the frequency of intermittent flooding increase, but areas of Suffolk County will be permanently flooded. This permanent flooding will erode beaches and barrier islands, alter the shoreline, submerge wetlands and low-lying areas, and increase the area vulnerable to storm surge and nuisance flooding (Tanski J. , 2010; RPA, 2016; EPA, 2016c). The barrier islands and “back bay” communities on Suffolk County’s south shore are the most vulnerable to these rising sea levels (RPA, 2016).

Anticipated Change(s) in Shoreline Resiliency to Storm and/or Tidal Surges

Table 4-28 identifies the potential impacts of each proposed decision alternative on shoreline resiliency to storm and/or tidal surges through impacts to wetlands (discussed previously in Sections 4.4.2 and 4.4.3). As RPA (2016) notes, many of the efforts currently being undertaken to improve shoreline resiliency to severe storms and coastal flooding may only offer short-term, limited protection due to sea level rise, more severe storms, and extreme precipitation.

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Regardless of the decision scenario chosen, efforts should be taken to promote shoreline adaption to the rapid acceleration of sea level rise projected for the region. Natural coastal features, such as wetlands, are dynamic ecosystems that provide significant benefits, but they are also among the most susceptible ecosystems to sea level rise (LISS, 2015).

Undertake planning efforts and secure funding that addresses sea level rise adaptation of wetlands and other natural shoreline types (e.g., beaches and dunes) in order to enhance shoreline resiliency to storm and/or tidal surges for the long term.

Table 4-28. Impact of Decision on Shoreline Resiliency to Storm and/or Tidal Surges

Alternatives	Potential Changes in Shoreline Resiliency
Baseline*	The presence, structure, and function of coastal/tidal wetlands has an impact on the resiliency of the shoreline to storm and/or tidal surges and coastal flooding. Although **wetlands and eelgrass beds cannot be expected to stop storm surges and flooding associated with large storm events, like hurricanes, the friction provided by the vegetation can reduce wave energy** somewhat, which is important for reduced wave damage, flooding, and erosion, especially during lower-intensity storms and coastal/tidal flooding. But there are factors beyond the nitrogen loading examined in this assessment that impact the ability of wetlands to buffer surges and flooding, and there are other features beyond wetlands that impact the resiliency of the shoreline to storms and flooding (such as beaches and dunes). When combined with the expected acceleration of sea level rise, the protection coastal/tidal wetlands provide against storm and/or tidal surges and coastal flooding could be diminished if actions aren't taken to promote wetland adaption to sea level rise.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	There would be no change in nitrogen loading from individual sewerage systems, and hence, no change expected in the contribution of wastewater inputs from these systems to coastal/tidal wetland structure, function, or loss. As a result, **no impact on shoreline resiliency to storm and/or tidal surges** is expected. When combined with the expected acceleration of sea level rise, the impact of nitrogen loading on Suffolk County shoreline resiliency could be magnified.

Alternatives	Potential Changes in Shoreline Resiliency
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	While a decrease in nitrogen loading from individual sewerage systems should **create conditions that allow coastal/tidal wetlands and eelgrass to reduce wave damage, flooding, and erosion, especially during lower-intensity storms and coastal/tidal flooding,** competing factors contributing to loss of wetlands and wetland structure and function exist across the County, including accelerated sea level rise and legacy nitrogen loading (due to the long travel time of some groundwater through the aquifer). Given these factors, it is **uncertain the degree to which improvements in shoreline resiliency to storm and/or tidal surges across the County would be seen under this alternative**. Should there be an attributable improvement in water quality and subsequently in shoreline resiliency due to the decision, it is unknown how long it would take for this improvement to be seen considering groundwater travel times of 0-10 years along the coast and up to decades and even hundreds of years from the middle of Long Island.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to continued decreases in shoreline resiliency in Suffolk County.

4.4.5 Impact of Shoreline Resiliency on *Property/Infrastructure Damage Due to Storm and/or Tidal Surges*

The Nature Conservancy (TNC, 2016) estimates that there are almost 12 million people and trillions of dollars of property and infrastructure in New York's coastal counties along the Atlantic Coast. Erosion, storms and/or tidal surges, and flooding do not only bring about changes in the shoreline, but also impact coastal infrastructure and development, including facilities and infrastructure that are critical to the health and welfare of the population, especially during and following a storm event or other hazard (Suffolk County Government, 2014b).

Severe weather and inundation can cause extensive and expensive damage to coastal properties, and in some cases, can debilitate entire communities. Property damage can be the direct result of storm and/or tidal surges and flooding or it can occur more gradually, through erosion or saltwater inundation from rising sea levels (New York State Sea Level Rise Task Force, 2010). Damage can include weakened structures, damaged electrical or plumbing systems, mold, contamination, foundation failure, and even complete structural loss. Infrastructure damage can include flooded and impaired roadways and transportation systems; overwhelmed and/or failed stormwater, drinking water and wastewater systems; damaged gas lines, and communication and power systems; deteriorated infrastructure not designed to withstand exposure to salt water; and more. All of these have potential health implications, as exposure to hazards, living conditions, housing expenditures, and loss of services are factors known to impact health.

Site characteristics, such as depth to groundwater, potential for persistent flooding and rising groundwater due to storms and/or tidal surges, pose a risk for structural and hydraulic failure for individual sewerage systems. Heavy rains, flooding, and storm and/or tidal surges can cause the ground to become saturated, keeping individual sewerage systems from operating properly. Under these conditions, the soil around the sewerage systems is unable to provide any treatment capability and contaminants from wastewater can make their way into groundwater and surface waters (National Small Flows Clearinghouse, 2006; CDC, 2016b; EPA, 2016c). If the ground becomes too saturated and there is no place for the wastewater in individual sewerage systems to drain, hydraulic failure of the systems can occur, causing wastewater and solid waste to back up into homes or pool above ground, mixing with floodwaters and stormwater runoff (National Small Flows Clearinghouse, 2006; CDC, 2016b; EPA, 2016c). Under flooded conditions, individual sewerage systems can also collapse or even float out of position (CDC, 2016b). Storm and/or tidal surges and flooding can also impact and cause damage to public wastewater treatment facilities and infrastructure, causing the release of untreated or partially treated wastewater; overwhelm stormwater systems; and impact private wells, public water treatment plants, and water distribution systems (Chisolm & Matthews, 2012). If hydraulic or structural failure of individual sewerage systems or public wastewater treatment infrastructure occurs, it is important to remember that nearby drinking water wells and surface waters may be impacted by wastewater. Section 4.2.5 outlined the human health effects of individual sewerage system failure and Section 4.3 discussed the impact of pollutant loading from individual sewerage system on drinking water, surface water, and human health.

Property and infrastructure damage isn't limited to flooding from severe storms. Nuisance flooding can inundate streets and homes, reduce stormwater drainage, and deteriorate infrastructure not designed to withstand inundation or exposure to salt water. Many coastal areas have developed hardened shorelines (e.g., building rip rap walls, bulkheads, and seawalls; Figure 4-38) or instituted policies, such as setback requirements and natural shoreline protection measures, to try to protect coastal properties and infrastructure from storm and/or tidal surges and inundation (National Research Council, 2014).

Figure 4-38. Example of a hardened shoreline.

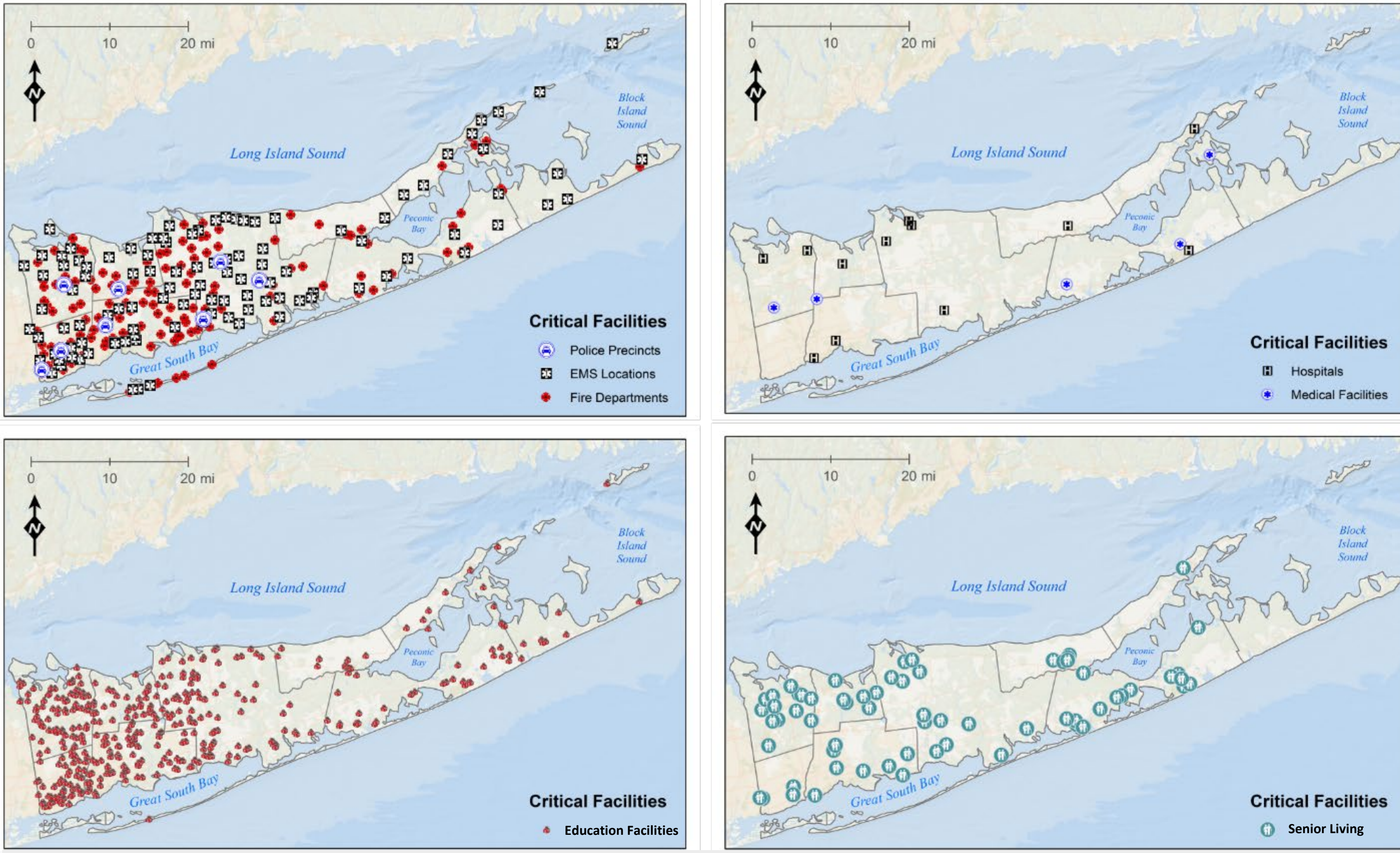
Land use planning may be the most promising approach for hazard mitigation (Mileti, 1999; Burby, Nelson, Parker, & Handmer, 2001; Tanski, 2010; National Research Council, 2014; RPA, 2016; TNC, 2016). Mileti (1999) notes that research conducted over the past two decades suggests that if local governments make the right choices in crafting land use planning programs to avoid and/or reduce hazard impacts, communities will be less likely to suffer severe losses of lives and property in natural disasters.

Existing Property/Infrastructure Damage Due to Storm and/or Tidal Surges at the Time of the HIA Analysis

The Suffolk County Government (2014b) Multi-jurisdictional Hazard Mitigation Plan Update used the FEMA Hazards U.S. Multihazard (HAZUS-MH) model to identify the Suffolk County population, general building stock, and critical facilities at risk of exposure to various hazards, by jurisdiction. General building stock includes both residential and commercial structures, and critical facilities include facilities essential to a full recovery following a hazard event, such as police, fire, EMS, schools/colleges, shelters, senior facilities, and medical facilities (Figure 4-39); transportation systems; utilities such as potable (drinking) water, wastewater treatment, power, and communication; county government facilities; and more.

Coastal flooding, erosion, storm and/or tidal surges, and sea level rise can also impact some of the many beaches, parks, and recreation areas along Suffolk County's shores (Figure 4-40). This limits their use and economic contributions.

The risk of population, building, and critical facility exposure to flooding, coastal erosion, and storm surges is summarized at the county level in the sections that follow, along with a narrative on the risk of exposure to sea level rise. It should be noted that all of the projections of exposure are based on 2010 population and infrastructure statistics and do not take into account the population and development changes expected in the County.



Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors
Suffolk Critical Facilities: Suffolk County, NY 2014-2015

Figure 4-39. A subset of critical facilities in Suffolk County deemed essential, some of which are at risk of exposure to coastal hazards.

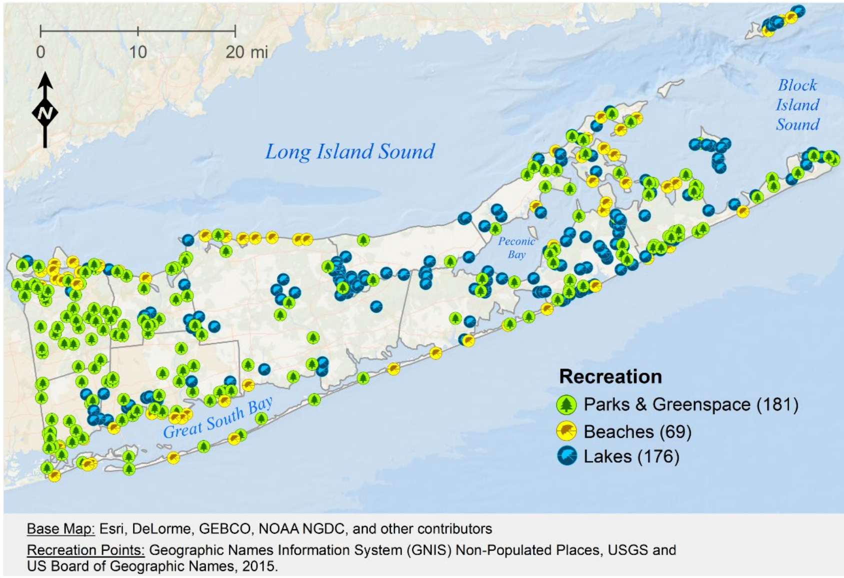


Figure 4-40. Suffolk County parks, greenspace, beaches, and lakes, some of which are at risk of exposure to coastal hazards.

Figure 4-41 shows the FEMA ***flood zone areas*** in Suffolk County (see Appendix H for a more detailed discussion of the flood zone areas). As is expected, the southern shore of the Suffolk County, part of which is Fire Island, is primarily a high flood risk (Zone AE) or extremely high flood risk and wave velocity hazard (Zone VE).

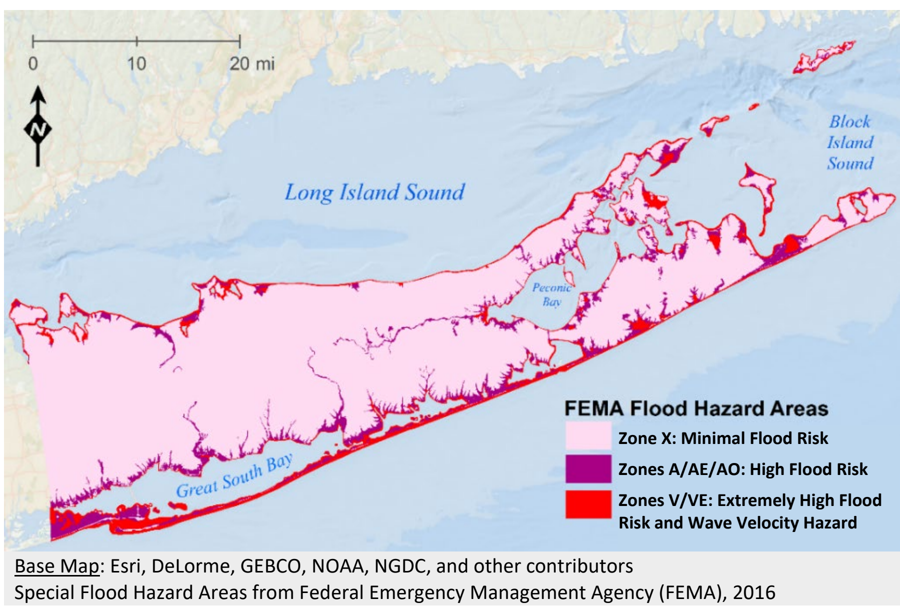


Figure 4-41. FEMA Flood Hazard Areas for Suffolk County.

Table 4-29shows the people, buildings, and critical facilities at risk of exposure to coastal (and riverine) flooding in Suffolk County. These statistics do not take into account storm surge, so should coastal flooding occur in conjunction with a Nor'easter, hurricane, or other severe storm, these numbers would greatly underestimate the at-risk population and property. The County is expected to experience increased property and infrastructure damage from flooding, especially in the light of sea level rise (Table 4-29).

Table 4-29. Risk of Exposure to Flooding in Suffolk County. FEMA HAZUS-MH results taken from: (Suffolk County Government, 2014b)

Suffolk County	Exposed to Flooding		
	100-Year Special Flood Hazard Area (SFHA) - Zones A and V	100-Year SFHA with 3 inches Sea Level Rise	100-Year SFHA with 24 inches Sea Level Rise
Resident Population *	43,968	44,588	60,300
General Building Stock (# buildings) †	27,837	32,637	42,591
Critical Facilities	130	No data	No data

* Total Suffolk County population - 1,493,350 (2010 Census); total population and population exposed do not include tourist or seasonal populations.

† Total of 617,436 residential and commercial structures in Suffolk County's general building stock.

Flooding is a reality for many households, as 26,090 of the 27,837 buildings in the 100-year SFHA are residential. The flooding damage and losses endured by Suffolk County residences are evident in the National Flood Insurance Program (NFIP) statistics presented in Table 4-30.

Table 4-30. FEMA National Flood Insurance Program Statistics for Suffolk County from January 1, 1978– January 31, 2014. Taken from: (Suffolk County Government, 2014b)

# NFIP Policies	# NFIP Policies in the 100-Year SFHA	# NFIP Claims (Losses)	Total NFIP Loss Payments*	# Repetitive Loss Properties†	# Severe Repetitive Loss Properties†
38,165	14,699	31,595	$1,012,752,084	2,393	455

* Loss payments (building and contents) from FEMA Region 2 claims file.

† Repetitive loss properties have two or more NFIP claim payments over $1,000 each; severe repetitive loss properties have at least four NFIP claim payments over $5,000 each (over $20,000 cumulatively) or have at least two NFIP payments, with the building portion of the claims cumulatively exceeding the market value of the building.

Critical facilities most at risk of flooding include potable (drinking) water facilities, Suffolk County Government facilities, ferry terminals, and wastewater treatment facilities. As previously discussed, flooding can also have drastic impacts on sewerage system failure and cause the mixing of wastewater with flood waters.

Coastal erosion has significant impacts in Suffolk County. Although it is not usually considered a public safety hazard, it does have a significant impact on property, infrastructure, environmental resources, and the economy. Risk is designated for several erosion hazard areas (Figure 4-42), as defined by Suffolk County Government (2014b):

- State-designated *Coastal Erosion Hazard Areas* (CEHA; areas that have natural protective features, such as beaches, dunes, bluffs, and near-shore areas and areas with high erosion vulnerability). There are 20 communities in Suffolk County that are certified CEHA communities, including Babylon, Belle Terre, North and South Brookhaven, East Hampton, Huntington, Lloyd Harbor, Ocean Beach, Old Field, Port Jefferson, Quogue, Riverhead, Sagaponack, Saltaire, Shoreham, Town of Southampton, Village of Southampton, Southold, West Hampton Dunes, Westhampton Beach (NYSDEC, 2012),
- *Extreme Risk Areas* (areas at current risk of frequent inundation, likely to be inundated due to sea level rise, and vulnerable to erosion in the next 40 years),
- *High Risk Areas* (areas outside the Extreme Risk Areas that are currently at risk of infrequent inundation or at risk of future inundation from sea level rise),
- *Moderate Risk Areas* (areas outside the Extreme and High Risk Areas at moderate risk of infrequent inundation currently or in the future due to sea level rise).

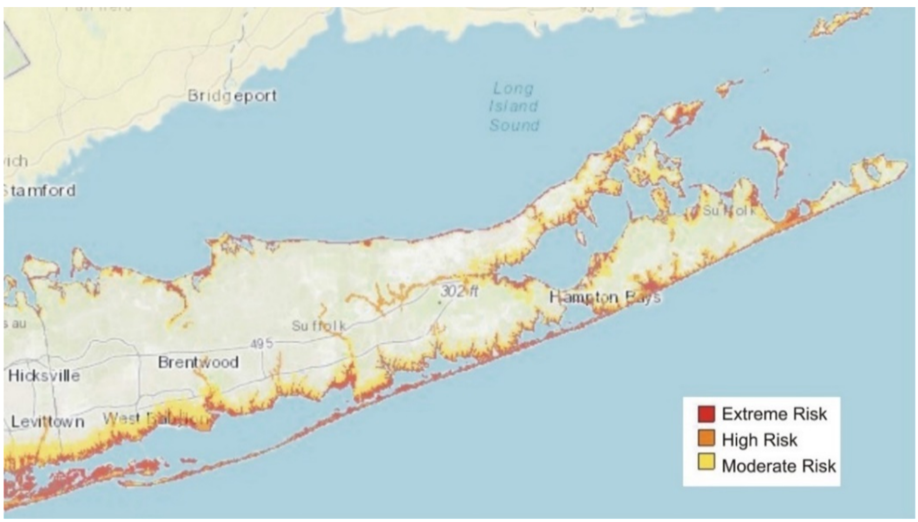


Figure 4-42. Suffolk County extreme risk, high risk, and moderate risk erosion hazard areas.

Table 4-31 shows the people, buildings, and critical facilities at risk of exposure to coastal erosion in Suffolk County

Table 4-31. Risk of Exposure to Coastal Erosion in Suffolk County. FEMA HAZUS-MH results taken from: (Suffolk County Government, 2014b)

Suffolk County	Exposed to Coastal Erosion*			
	CEHA with Buffer	Extreme Risk Area	High Risk Area	Moderate Risk Area
Resident Population†	1,747	25,152	20,757	111,790
General Building Stock (# buildings)‡	4,754	15,483	17,417	55,787
Critical Facilities	7	49	79	208

* Exposure to coastal erosion, as defined by the criteria of the respective coastal erosion hazard/risk area.

† Total Suffolk County population - 1,493,350 (2010 Census); total population and population exposed do not include tourist or seasonal populations.

‡ Total of 617,436 residential and commercial structures in Suffolk County's general building stock.

The critical facilities most at risk of exposure to coastal erosion are drinking water facilities and wastewater treatment facilities. A number of roads and infrastructure are also at severe risk of coastal erosion in the CEHA, including 10.1 miles of parkway, county, and state roads; 61.7 miles of secondary roads; and 2 bridges (Suffolk County Government, 2014b).

Hurricanes, Nor'easters, and other tropical storms can all bring high winds and surge inundation resulting in similar impacts on the population, buildings and infrastructure, and the economy.

Table 4-32 shows the number of people, buildings, and critical facilities located in Suffolk County SLOSH zones and, therefore, at risk of exposure to ***storm surge***. For the purposes of this assessment, the building/facility data presented include only those structures with their centroid in the SLOSH zone, and the population data include only those block groups whose centroid fall within the SLOSH zone. As a result of this approach, the buildings and population exposed to storm surges is likely underestimated. SLOSH Zones 1-4 show the extent of inundation expected from the corresponding category of hurricane (Category 1 hurricane being the least severe and Category 4 being the most severe). All analyses for exposure of population, general building stock, and critical facilities to storm surge are cumulative. For example, if a population or facility is located within the Category 1 SLOSH zone it is also located within the Category 2 SLOSH zone. The assumption is that if a population or facility is affected by a Category 1 storm it would also be affected by a Category 2, 3, or 4 storm event. Therefore, to calculate the population and number of buildings/facilities at risk of exposure to storm surge from a Category 2 hurricane, you would add the number located in SLOSH zones 1 and 2.

Table 4-32. Risk of Exposure to Storm Surges in Suffolk County. FEMA HAZUS-MH results taken from: (Suffolk County Government, 2014b)*

Suffolk County	Located in SLOSH Zone			
	Zone 1	Zone 2	Zone 3	Zone 4
Resident Population †	27,659	86,705	161,858	224,404
General Building Stock (# buildings)‡	15,398	49,126	86,403	116,574
Critical Facilities	98	203	341	485

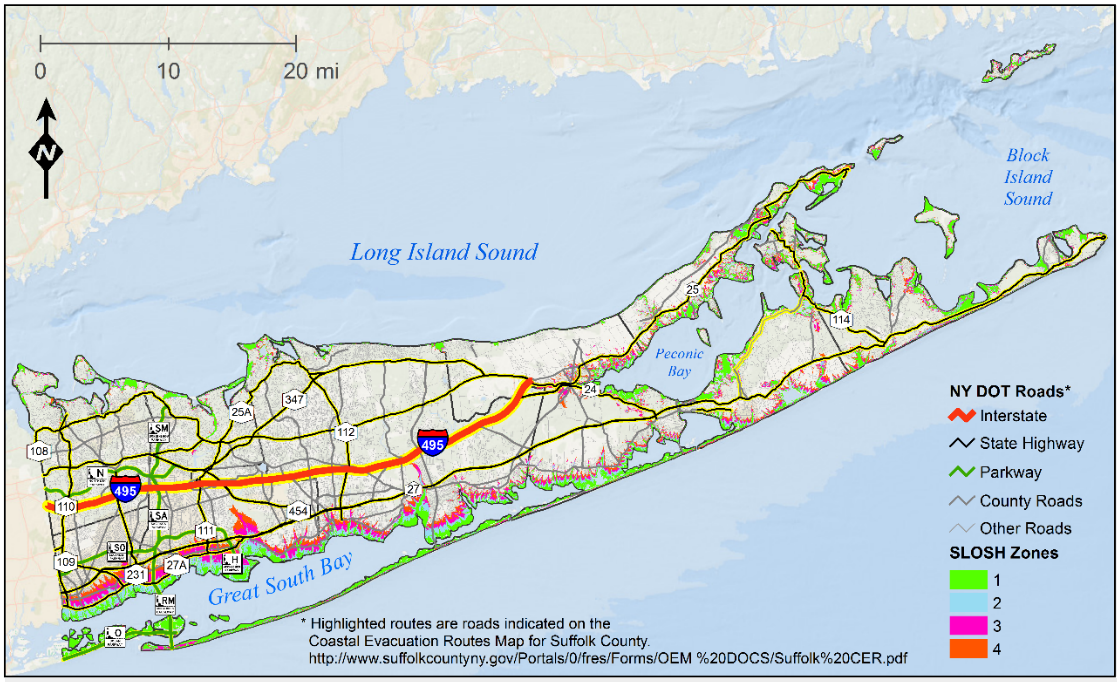
* Analyses of population, building stock, and critical facilities exposed to storm surge are cumulative. To calculate the population and number of buildings/facilities at risk of exposure to storm surge from a Category 2 hurricane, you would add the number located in SLOSH zones 1 and 2; to calculate the population and number of buildings/facilities at risk of exposure to storm surge from a Category 3 hurricane, you would add the number located in SLOSH zones 1, 2, and 3; and so on.

† Total Suffolk County population - 1,493,350 (2010 Census); total population and population exposed do not include tourist or seasonal populations.

‡ Total of 617,436 residential and commercial structures in Suffolk County's general building stock.

The critical facilities most at risk of storm surge are potable (drinking) water facilities, fire facilities, schools, wastewater treatment facilities, and Suffolk County Government facilities. Like with flooding and coastal erosion, a number of roads and infrastructure along Suffolk County's southern shore are also at severe risk of inundation by storm surges as illustrated in Figure 4-43. Some of the roads impacted by these coastal hazards are evacuation routes, which can hamper evacuation efforts, as well as emergency response.

During Superstorm Sandy, onsite sewerage systems were flooded by the rising groundwater, causing sanitary wastewater and solid waste to wash out of the systems and sewage contaminants to enter groundwater and surface waters (New York State, 2015b).



Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors
Roads: NY DOT April 2016
SLOSH Zones: Sea, Lake, and Overland Surges from Hurricanes (SLOSH)

Figure 4-43. Suffolk County roads, including those located in SLOSH Zones and likely impacted by storm surge and other coastal hazards.

As *sea levels rise*, Suffolk County may see increased erosion, greater extent and frequency of coastal flooding, and storm surges that extend further inland. This could result in inordinate increases in the number of people, buildings, and critical facilities affected, along with increased property losses (New York State Sea Level Rise Task Force, 2010; Shepard, et al., 2012; NOAA, 2014a; National Research Council, 2014). Shepard, et al. (2012) indicated that a moderate 19.7-inch rise in sea level by 2080 is estimated to result in a 33% increase in the amount of land inundated, a 47% increase in the number of people impacted by storm surge, and a 73% increase in property damage along the southern shores of Long Island over present day levels in the case of a Category 3 hurricane.

Unlike with storms, flood waters due to sea level rise will not recede; instead, areas will become permanently inundated (Napolitano, 2013; RPA, 2016). The Regional Planning Association (RPA, 2016) projects that 7,122 residents on Long Island could be permanently inundated with 12 inches of sea level rise; 41,023 residents with 36 inches of sea level rise; and 164,592 residents with 72 inches of sea level rise. These projections loosely correlate with the 6 NYCRR Part 490 low (15 inches), medium (34 inches), and high (72 inches) sea level rise forecasts for 2100 (http://www.dec.ny.gov/

regulations/103877.html). Most areas permanently inundated by one foot of sea level rise (which is projected to occur as early as the 2050s) are located in the Suffolk County towns of Brookhaven, Islip, and Babylon, and the town of Hempstead in Nassau County (RPA, 2016). At three feet of sea level rise, the permanent inundation reaches further inland, and with six feet of sea level rise, "no community along the south shore is left untouched and the long stretches of sandy barrier beaches… will be reduced to thin slivers of sand;" communities on Fire Island are nearly all lost and areas along the north shore start experiencing permanent inundation with six feet of sea level rise (RPA, 2016). Napolitano (2013) also projects that low-lying areas like the hamlet of Mastic, in the Town of Brookhaven, and others will be under water by the end of the century.

Many believe that changes in land use planning and development policies (e.g., adjusting building code and zoning requirements, establishing setbacks, limiting and/or restricting development in potentially hazardous areas, instituting property buyout programs, etc.) are necessary for long-term community resilience, in conjunction with sea level rise adaptation investments (e.g., wetland and beach restoration, shoreline hardening for critical infrastructure protection, pumps to keep the water out, elevated buildings and infrastructure, hazard-resistant infrastructure design and construction, redundancies in critical system, permanent relocation, etc.) to mitigate against the rapid acceleration of sea level rise (Mileti, 1999; Burby, Nelson, Parker, & Handmer, 2001; Nicholls, 2006; Colten, Kates, & Laska, 2008; Miami-Dade Government, 2014; National Research Council, 2014; RPA, 2016).

Anticipated Change(s) to Property/Infrastructure Damage Due to Storm and/or Tidal Surges

Table 4-33 identifies the potential impacts of the proposed decision on property/infrastructure damage due to storm and/or tidal surges for each decision alternative. The pathway through which the decision could potentially impact property and infrastructure damage is through impacts to shoreline resiliency. However, potential reductions in nitrogen loading to coastal/tidal wetlands as a result of the proposed code changes does not mean improved shoreline and community resiliency to storm and/or tidal surges, flooding, or other hazards, due to the many factors affecting resiliency.

C Regardless of the decision alternative chosen, it should be noted that property and infrastructure damage from flooding and storm and/or tidal surges in Suffolk County is expected to increase unless something is done to offset the severe storms, extreme precipitation, and rapid acceleration of sea level rise projected for the region (National Research Council, 2010; Kunkel, et al., 2013; Melillo, Richmond, & Yohe, 2014) and other factors affecting wetlands and shoreline resiliency.

Although not related to the proposed code changes directly, the following recommendations are offered to address the County's desire for improved resiliency to natural disasters:

Ensure that the impacts of accelerated sea level rise and increased storm frequency and intensity are adequately examined and accounted for in the initial phases of all planning efforts.

Undertake planning efforts and secure funding that addresses sea level rise adaptation in order to ensure shoreline resiliency to storm and/or tidal surges for the long term.

Consider activities, such as voluntary buyouts, that encourage local (town/village) land use and zoning regulations, and County-level disincentives to development, to reduce the infrastructure and people in vulnerable coastal areas and create more naturally-functioning coastal floodplains and provide space for coastal/tidal wetlands to retreat and expand.

Table 4-33. Impact of Decision on Property/Infrastructure Damage Due to Storm and/or Tidal Surges

Alternatives	Potential Changes in Property/Infrastructure Damage
Baseline*	Due to the dense development of Suffolk County's coasts, there are a lot of people, property, and infrastructure in harm's way of storm and/or tidal surges and other coastal hazards. **Nitrogen loading has led to changes in water quality and wetland structure and function, impacting shoreline resiliency and protection of property/infrastructure**. However, there are many factors that affect shoreline resiliency and its ability to provide protection from storm and/or tidal surges, beyond nitrogen loading from individual sewerage systems. Shoreline resiliency and the protections it provides will be diminished if actions aren't taken to adapt to accelerated sea level rise and associated flooding. Under the sea level rise, storm, and precipitation scenarios projected for the region (National Research Council, 2010; Kunkel, et al., 2013; Melillo, Richmond, & Yohe, 2014), there will be storms of greater frequency and intensity and greater extent and frequency of coastal flooding; in addition, some areas currently experiencing intermittent coastal flooding due to high tides and storms may become permanently inundated with the rising sea levels. This will result in greater property and infrastructure damage and put more people in harm's way.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	There would be no change in nitrogen loading from individual sewerage systems, and hence, **no change expected to shoreline resiliency or protection of property/infrastructure from storm and/or tidal surges**, flooding, or sea level rise.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.

Alternatives	Potential Changes in Property/Infrastructure Damage
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	It is **uncertain the degree to which a decrease in nitrogen loading from individual sewerage systems would result in improvements in shoreline resiliency and the protections it provides** to Suffolk County property and infrastructure because of the many competing factors that determine both shoreline and community resiliency. Any potential improvements in shoreline resiliency and its protection of property and infrastructure attributable to the decision could be lost due to storm surges and flooding of greater intensity and permanent inundation of low-lying areas due to accelerated sea level rise.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to continued decreases in shoreline resiliency and protection of property and infrastructure from storm and/or tidal surges and other coastal hazards.

4.4.6 Impact of Shoreline Resiliency and Property/Infrastructure Damage on *Evacuation and Displacement Due to Storm and/or Tidal Surges*

While the code changes do not impact evacuation and displacement due to storm and/or tidal surges, the need for evacuation and displacement in the face of storm and/or tidal surges are two variables that must be considered when evaluating resiliency and its connection to health. There are many factors that influence the need for an evacuation and the risk of displacement (e.g., strength of storm, tidal surge, or flood; topography; building and infrastructure vulnerabilities; and road access).

Over time, the need for evacuation and risk of displacement are expected to rise because there will be more frequent and intense storms, increased coastal erosion, more frequent coastal flooding, and accelerated sea level rise. The impact of storm and/or tidal surges and coastal flooding on the life and safety of residents is dependent upon several factors, including the severity of the event, whether or not adequate warning was provided, and whether evacuation orders were heeded.

Existing Evacuation and Displacement Due to Storm and/or Tidal Surges at the Time of the HIA Analysis

The population living and working in the Suffolk County SLOSH zones are directly affected by storm and/or tidal surge. There are also are **certain subpopulations that are particularly vulnerable to storm surge and the need for evacuation and/or displacement**. These include:

- those on the barrier islands with limited evacuation routes and locations nearer to storm paths;
- low-income populations, who are likely to weigh the risks of the storm against the economic impact to their family and may not have the funds to evacuate;
- the linguistically isolated, who may not understand emergency communications, evacuation notices, or the related risks of the storm; and
- the elderly and mentally and physically disabled, as they may have difficulty evacuating, likely require extra time or outside assistance to evacuate, and are more likely to need medical attention which may not be available due to isolation in a storm event.

To estimate the prevalence of these vulnerable populations in the SLOSH Zones and potential for their exposure to storm surge, Census block groups were overlaid on the SLOSH zones, and any block group whose centroid lied within a SLOSH zone was selected and the demographic indicators identified in Table 4-34 were tallied. It is important to remember that all of the projections of population exposure shown here are based on 2010 population figures and, therefore, underestimate the populations impacted. In addition, all analyses for exposure of vulnerable populations are cumulative. For example, if a population is located within the Category 1 SLOSH zone, it is also located within the Category 2 SLOSH zone. The assumption is that if a population is affected by a Category 1 storm it would also be affected by a Category 2, 3, or 4 storm event. Therefore, to calculate the vulnerable populations at risk of exposure to storm surge from a Category 2 hurricane, you would add the number located in SLOSH zones 1 and 2.

Table 4-34. Vulnerable Populations to Storm Surge by SLOSH Zone[*]

Demographic Indicator	Estimated Population Residing in SLOSH Zones			
	Zone 1	Zone 2	Zone 3	Zone 4
Resident Population[†]	27,659	86,705	161,858	224,404
Over 65 Years	7,865	7,580	8,941	7,078
Linguistically Isolated[‡]	306	569	1,166	602
Low Income	5,379	8,849	10,872	8,833
Emergency Preparedness Registry Participant[§]	5	41	143	191

* Sea, Lake, and Overland Surges from Hurricanes (SLOSH) Zones 1-4 show the extent of inundation expected from the corresponding category of hurricane (Category 1 hurricane being the least severe and Category 4 being the most severe). Analyses of population exposed to storm surge are cumulative, the assumption being that the population affected by a Category 1 storm, would also be affected by a Category 2, 3, or 4 storm event. To calculate the population at risk of exposure to storm surge from a Category 2 hurricane, you would add the number located in SLOSH zones 1 and 2; to calculate the population at risk of exposure to storm surge from a Category 3 hurricane, you would add the number located in SLOSH zones 1, 2, and 3; and so on.

† Total Suffolk County population - 1,493,350 (2010 Census); total population and population exposed do not include tourist or seasonal populations.

‡ Limited English Speaking Households in the SLOSH Zones included Spanish (n=1687), Other Indo-European (n=635), Asian and Pacific Island (n=278), and Other Languages (n=43).

§ Residents who might need special assistance during evacuation can register with the Suffolk County Emergency Preparedness Registry. This registry identifies for emergency management personnel the locations of individuals who may require assistance during an emergency event, as well as any special resources that may be necessary to accommodate the individuals during sheltering.

Although not related to the proposed code changes directly, the following recommendation is offered to address the County's desire for improved resiliency to natural disasters:

Prioritize resiliency efforts (e.g., habitat restoration, shoreline management, and planning activities) based on risk of exposure and social and economic vulnerability to sea level rise, severe storms, and storm and/or tidal surges.

In addition to these populations, individuals in schools, hospitals, and senior living facilities located within the SLOSH zones can also be particularly vulnerable to evacuation and displacement. As a note, senior citizens (age 65 or older) make up 14% of the Suffolk County population in 2010 and their population is rising. Many of these seniors live alone and Suffolk County has dedicated a great deal of housing stock for seniors – 175 multi-family housing complexes and more than 25,000 housing units in condos, apartments, or co-ops (Suffolk County Government, 2011).

Shepard et al. (2012) calculated a Community Vulnerability Index that shows those areas along Suffolk County's southern shore that are most vulnerable to coastal hazards, regardless of the strength or extent of the event (Figure 4-44). The two components of the Community Vulnerability Index – social vulnerability (demographics such as population, housing density, age, income, education, etc.) and the vulnerability of critical facilities and infrastructure – were evaluated separately and then combined to form the index.

Evacuations and property damage can lead to the need for temporary shelter (Figure 4-45), and in more severe cases, can lead to displacement of populations. Numerous factors affect evacuation, including timely and effective communication and individuals having the capacity, resources and willingness to evacuate (CDC, 2013b).

Although not related to the proposed code changes directly, the following recommendation is offered to address the County's desire for improved resiliency to natural disasters:

Undertake efforts in emergency management planning and outreach to ensure that individuals receive and comprehend evacuation messages and have the necessary capacity and resources to comply with them.

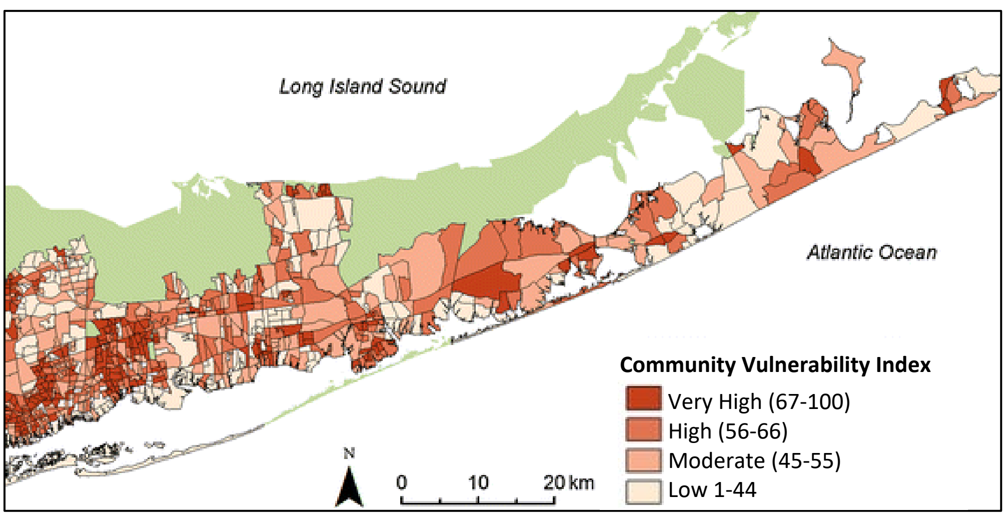
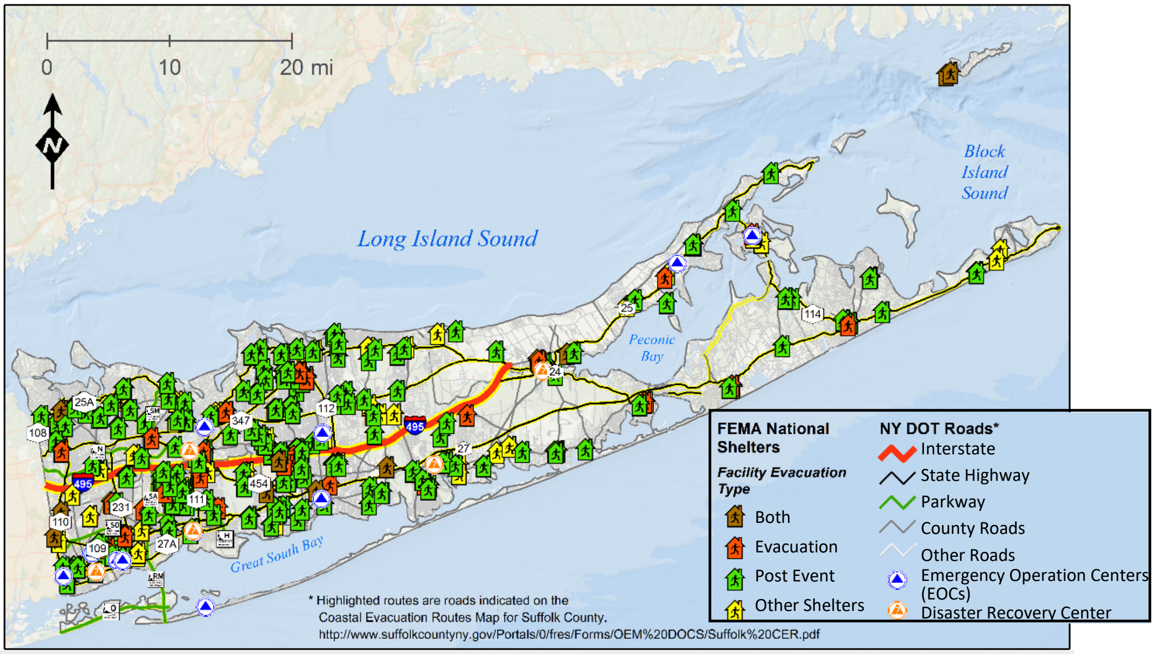


Figure 4-44. Ranking of community vulnerability to coastal hazards, which takes into account social vulnerability (demographics) and vulnerability of critical facilities and infrastructure. Taken from Shepard et al. (2012).



Roads: NY DOT April 2016 FEMA National Shelters System: FEMA, 2016
Other Shelters: Suffolk County, NY 2014-2016 Basemap: Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors

Figure 4-35. Emergency shelters and evacuation routes in Suffolk County.

The risk of displacement and short-term sheltering in Suffolk County due to storm surge is predicted by the FEMA HAZUS-MH model and is shown in Table 4-35.

Table 4-35. Risk of Displacement and Short-Term Sheltering Due to Storm Surges in Suffolk County. FEMA Hazus-MH data taken from (Suffolk County Government, 2014b)

Suffolk County*	Storm Surge (by SLOSH Zone)			
	Category 1	Category 2	Category 3	Category 4
Displaced Households	15,308	34,660	61,757	81,402
Displaced Population	39,648	89,769	159,951	210,831
Short-Term Shelter Population	35,425	87,927	164,080	219,914

* Estimates are based on the Suffolk County population in 2000 (1,419,369) and are assumed to be lower than the population displaced and in need of sheltering in 2010 (the population used in all other risk and impact calculations in this resiliency analysis).

Anticipated Change(s) to Evacuation and Displacement Due to Storm and/or Tidal Surges

The proposed code changes are not expected to impact evacuation and displacement due to storm and/or tidal surges. This variable was considered in the analysis of Suffolk County resiliency to natural disaster, as both evacuation and displacement have strong implications for public health and safety in times of natural disaster.

4.4.7 Impact of Changes in Property/Infrastructure Damage and Evacuation on *Capacity for Emergency Responders to Respond*

Although the proposed code changes will not directly have an impact on emergency response, the health impacts related to resiliency can be mitigated by emergency preparedness and the capacity for emergency responders to respond. Emergency preparedness measures increase a community's ability to respond when emergencies or disasters hit. Emergency preparedness activities include educating citizens of the potential hazards and the steps to take in the event of emergency, training responders and citizens, conducting disaster drills, and establishing evacuation plans, shelters, and emergency response support agreements.

Police, fire, emergency medical personnel, emergency management personnel, and sometimes public works personnel initiate emergency response actions. Emergency response actions can be carried out immediately before, during, or after an emergency event and are aimed at reducing injury, saving lives, and minimizing economic losses. Emergency response actions can include issuing forecasts and warnings; establishing emergency operations centers and emergency shelters; evacuating threatened populations; mobilizing emergency personnel and resources; and post-event, can include rescue and relief efforts (Cutter S. L., 2003; Colten, Kates, & Laska, 2008; Haddow, Bullock, & Coppola, 2014; Miami-Dade Government, 2014).

One hurdle to emergency response actions can be the unwillingness of individuals to heed evacuation notices. This puts individuals and emergency responders in harm's way and can cause an unnecessary burden on emergency response organizations, as resources have to be diverted and re-assigned to assist in evacuations and rescues.

Existing Capacity for Emergency Responders to Respond at the Time of the HIA Analysis

Appendix H provides a snapshot of Suffolk County's emergency response capacity and infrastructure. Some of Suffolk County's emergency response infrastructure (i.e., fire, police, EMS, and hospitals) are located in areas along Long Island's southern shore – areas that are vulnerable to storm and/or tidal surges and flooding (see Figure 4-39). Even if these emergency response facilities themselves are spared, during large-scale disasters or emergencies, professional emergency responders can't be everywhere, emergency services can easily become overwhelmed, and response actions be delayed, for example by property or infrastructure damage.

Anticipated Change(s) to Capacity for Emergency Responders to Respond

As noted previously, no change in emergency response capacity is expected due to the proposed code changes. This variable was considered in the analysis of Suffolk County resiliency to natural disaster, as it has strong implications for public health and safety.

4.4.8 Impact of Changes in Resiliency to Storm and/or Tidal Surges on *Human Injury and Death*

In addition to causing significant property and infrastructure damage, storm and/or tidal surges and flooding have resulted in human injuries and death. Before 1990, most hurricane-related deaths in the U.S. were caused by drowning due to storm surge during the storm event. In recent years, drowning from storm surges has decreased (but not been eliminated) and wind has become another major cause of deaths during storm events. Deaths also occur post storm due to hazards like electrocution from drowned power lines, motor vehicle fatalities, chain-saw injuries, blunt trauma from falling trees, and carbon monoxide poisonings in households using generators for heat (Abramson & Redlener, 2012; Lane, et al., 2013; Shultz, 2005).

Despite decreasing trends in drownings, deaths (and injuries) from storm surges still occur, as was witnessed during Hurricane Katrina in Louisiana (2005), Hurricane Ike in Texas (2008), and Hurricane Sandy (2012) (Abramson & Redlener, 2012; CDC, 2013b). Recent hurricanes have also highlighted the vulnerability of elderly people to the impacts of storms and tidal surges. Forty-nine percent (49%) of Katrina's victims were 75 years and older (Brunkard, Namulanda, & Ratard, 2008) and close to 50% of Sandy's victims were age 65 or older. Additionally, people with pre-existing health conditions, like respiratory illness; the disabled; non-English speakers; and persons living in chronic care facilities are all vulnerable to the health effects of storm and/or tidal surges (Abramson & Redlener, 2012; McArdle, 2014).

Injuries and death from flooding (not in combination with a severe storm) are usually limited based on weather forecasting, warnings, and precautions (e.g., blockades).

Existing Human Injury and Death from Storm and/or Tidal Surges at the Time of the HIA Analysis

Despite advances in hurricane warning and evacuation systems, drowning remains a major cause of hurricane-related deaths historically (i.e., 49% of human causalities from hurricanes are historically due to storm surge). Although 14 deaths were reported on Long Island due to Hurricane Sandy, 7 of which were in Suffolk County, drowning was not a major cause of death in this superstorm. The major causes of death were falling trees (n=5), carbon monoxide poisoning (n=3), and vehicle accidents (n=3). The median age of the deceased from Hurricane Sandy was 65 years of age.

Anticipated Changes in Human Injury and Death from Storm and/or Tidal Surges

Given the many factors that contribute to making a community resilient to natural disasters, **it is uncertain the degree to which the proposed decision will have an impact on Suffolk County resiliency to storm and/or tidal surges or the associated health impacts of these events,** especially in light of the accelerated sea level rise projected for the region (Table 4-36). Modeling and long-term monitoring will be necessary to make this determination.

The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-36, you must read the Likelihood and Magnitude columns together (e.g., it is highly likely that storm and/or tidal surges would continue to detract from health for a low to moderate number of people under Alternatives I and II). For a summary of the different ways in which health could be impacted through the Resiliency to Natural Disasters pathway see Section 4.4.10.

Table 4-36. Impact of Decision on Human Injury and Death from Storm and/or Tidal Surges

Health Determinant							
Human Injury and Death from storm and/or tidal surges	**Baseline Health Status** Historically, 49% of human casualties from hurricanes are due to storm surge. Riverine flooding due to rainfall, falling trees due to high winds, trauma from flying debris, and indirect impacts like falls, carbon monoxide poisoning, burns, and electrocution, can also cause injury and death. Despite advances in hurricane warning and evacuation systems, drowning remains one of the leading causes of hurricane-related deaths. Fifty-three (53) deaths were reported in NY due to Hurricane Sandy (14 of which were on Long Island), with 80% of those deaths due to drowning. The median age of the deceased from Hurricane Sandy was 65 years of age; in 2010, persons age 65 or over comprised 14% of Suffolk County's population.						
Alternatives	**Direction**	**Likelihood**	**Magnitude**	**Distribution**	**Severity**	**Permanence**	**Strength of Evidence**
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	**No change** to injury and death from storm and/or tidal surges is expected. There is no evidence that these alternatives would impact shoreline or community resiliency to natural disasters or their associated health impacts; therefore, storm and/or tidal surges would **continue to detract from health**.	**Injury and death are highly likely**, as evidenced by past natural disasters, and likely to increase with increased storm frequency and intensity, and greater extent and frequency of coastal flooding due to sea level rise.	The extent of people affected would be **low to moderate**. Although the magnitude of people at risk of injury and death is high, advances in warning and evacuation systems reduce the number of people who actually experience these impacts.	**Populations living and working in the SLOSH zones are disproportionately affected** by severe storm events and storm and/or tidal surges, but there are **certain subpopulations that are particularly vulnerable**, including those on the barrier islands, the elderly, physically disabled, low income populations, and the linguistically isolated.	The health implications of storm and/or tidal surges are **minor to severe**. Impacts can range in severity from minor injuries to injuries requiring medical treatment or intervention, and even disabling injury or death.	Injury and death from storm and/or tidal surges are often **immediate** (or shortly following the event), but can also occur a**long time** after, during clean-up and recovery. Impacts can range from **short-term** injury to **long-lasting** or permanent disabling injury and death.	**Strong.** Based on numerous research studies, there is high confidence in the link between storm and/or tidal surges and injury and death.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	**Uncertain** that any change to injury and death from storm and/or tidal surges would be seen with this alternative. While this alternative could lead to conditions that improve shoreline resiliency, especially during lower-intensity storms and coastal/tidal flooding, it is uncertain there would be an impact to community resiliency to natural disasters or their associated health impacts due to the confounding factors affecting community resiliency, including climate change, sea level rise, coastal development, and individual behaviors (such as willingness to evacuate). Storm and/or tidal surges could **continue to detract from health**.	**Injury and death are highly likely**, as evidenced by past natural disasters, and likely to increase with increased storm frequency and intensity, and greater extent and frequency of coastal flooding due to sea level rise.	The extent of people affected would be **low to moderate**. Although the magnitude of people at risk of injury and death is high, advances in warning and evacuation systems reduce the number of people who actually experience these impacts.	**Populations living and working in the SLOSH zones are disproportionately affected** by severe storm events and storm and/or tidal surges, but there are **certain subpopulations that are particularly vulnerable,** including those on the barrier islands, the elderly, physically disabled, low income populations, and the linguistically isolated.	The health implications of storm and/or tidal surges are **minor to severe**. Impacts can range in severity from minor injuries to injuries requiring medical treatment or intervention, and even disabling injury or death.	Injury and death from storm and/or tidal surges are often **immediate** (or shortly following the event), but can also occur a**long time** after, during clean-up and recovery. Impacts can range from **short-term** injury to **long-lasting** or permanent disabling injury and death.	**Strong.** Based on numerous research studies, there is high confidence in the link between storm and/or tidal surges and injury and death.

4.4.9 Impact of Changes in Resiliency to Storm and/or Tidal Surges on *Overall Health and Well-being*

Health effects from storm and/or tidal surges may occur through a number of pathways including: direct exposure, evacuation, post-impact hazards from power outages and inadequate housing, disruption of services, secondary hazards (such as standing water, which can harbor mosquitoes), displacement, mental health effects from traumatic and stressful experiences, and clean-up and recovery activities (Lane, et al., 2013).

Besides physical injury and death, loss of shelter is one of the most significant risks facing populations living in coastal communities. (New York State Sea Level Rise Task Force, 2010). Storms and/or tidal surges can significantly impact a number of factors known to directly and indirectly impact health, such as housing quality, living conditions, household expenditures, employment, temporary or permanent loss of services and amenities (including healthcare), and a sense of stability and belonging. All of these can lead to stress and poor mental health, while some can have other far-reaching effects and impact household and community economics, opportunity for physical activity, and disease.

Storm surges and other flooding events can result in a number of environmental health hazards as well, including increased risk of exposure to pathogens from drinking water and wastewater system failures (which has implications for health) and bacterial and fungal contamination of soil and housing. Water damage to homes and businesses from floodwaters create moist conditions where mold spores can grow and multiply. This **mold contamination can lead to health effects such as respiratory illness** (e.g., chronic obstructive pulmonary disorder, bronchitis, and other respiratory infections); wheezing and difficulties breathing; cough; congestion; throat, eye, and skin irritation; and headaches (Barbeau, Grimsley, White, El-Dahr, & Lichtveld, 2010; Schmeltz, et al., 2013; NYSDOH, n.d.). Populations vulnerable to health effects from mold contamination are persons with allergies, asthma, and other breathing conditions (CDC, 2015; NYSDOH, n.d.).

Disaster-related displacement, relocation, loss of property and personal finances, injury, and loss of life have all been shown to be associated with mental health problems (e.g., anxiety, posttraumatic stress disorder [PTSD], and depression) in victims, emergency responders, and those in the healthcare field (Rodriguez & Kohn, 2008; Neria & Shultz, 2012; Schreiber, Yin, Omaish, & Broderick, 2014; EPA, 2016c). **Storm and/or tidal surges and other natural disasters may worsen existing mental health conditions, contribute to new ones,** and impact interpersonal relationships. A year after Hurricane Katrina, mental health conditions were present throughout the population and anxiety and mood disorders were elevated. Following Hurricane Sandy, one study found substantial population-level risk for mental health disorders amongst affected populations in New York, including high risk levels in areas that did not necessarily experience the greatest physical damage (Schreiber, Yin, Omaish, & Broderick, 2014). A study by Harville et al. (2011) found that exposure to multiple natural disasters among women was associated with worse mental health conditions. Factors like low social support and higher minor daily hassles, may contribute to worse health outcomes, while self-reported resilience traits, such as the ability to bounce back from stress, may mitigate the effects of stressful experiences on mental health outcomes (Harville, et al. 2011). Acute psychosocial responses to disasters are common and expected, but lasting posttraumatic impacts are not common among the majority of people (Davidson & McFarlane, 2006). It is important to note that following natural disasters, when it is needed most, delivery of mental health services may be interrupted (Rodriguez & Kohn, 2008).

Immediately following storms and/or tidal surges, displacement, infrastructure damage, closed recreational areas and schools, safety concerns, and other factors can alter normal routines, including physical activity. It has been shown that parks may play a role as a coping resource post-disaster by providing opportunities for physical activity (Rung, Broyles, Mowen, Gustat, & Sothern, 2011). Physical activity can also be important to those working in the healthcare field dealing with the immediate and long-term effects to their work after a natural disaster. In one study, general practitioners reported physical exercise was an important coping mechanism following a natural disaster (Johal, Mounsey, Tuohy, & Johnston, 2014). The evidence supporting the health benefits that are gained from regular, moderate physical activity is strong and well-established. Physical activity is directly related to preventing chronic diseases, like obesity and cardiovascular diseases, and premature death; positive mental health outcomes; and a better quality of life (U.S. Department of Health and Human Services, 1996). For individuals with existing chronic disease, like diabetes, getting daily physical activity is an important part of controlling their disease. A disruption to the normal routine of care caused by natural disasters can make managing chronic conditions difficult (Cefalu, Smith, Blonde, & Fonseca, 2006). In children, sedentary activity is associated with decreased academic achievement and lower self-esteem (Lai, La Greca, & Llabre, 2014).

Existing Overall Health and Well-being at the Time of the HIA Analysis

The **impacts of storm and/or tidal surges and natural disasters on overall health and well-being** are well documented in the literature. Studies following natural disasters have offered a glimpse into the real-time impacts. For instance, an analysis from the CDC found that, of the people relocated to New Jersey shelters after Hurricane Sandy, more than 5,100 reported a health care visit. Reasons for the visit included acute illness (52%); follow-up care (32%); worsening chronic illness (13%); and injury (3%) (Rettner, 2013). Likewise, a Gallup-Healthways poll found that in the most affected areas of New York, New Jersey, and Connecticut, there was a 25% increase in diagnoses of depression in adults in the six weeks following Hurricane Sandy.

What follows is a description of existing health status of the Suffolk County population in terms of overall health and well-being, respiratory illness, mental health, and physical activity – all aspects of health known to be impacted by natural disasters.

The County Health Rankings (University of Wisconsin Population Health Institute, 2016) ranked Suffolk County 9th out of 62 New York counties for overall health outcomes (length and quality of life) and 5th overall for health factors, such as personal behaviors, clinical care, social and economic factors, and physical environment. The percentage of adults reporting fair or poor health (age-adjusted) in Suffolk County was only 12% in 2014; only 10% of counties in the U.S. are doing better.

Overall, data from the New York State Department of Health from 2011-2013 indicates that Suffolk County fares better in respiratory disease mortality and hospitalization rates (per 100,000 individuals) than the New York State rates, with the exception of crude rates of mortality from chronic lower respiratory disease. County rates of mortality from chronic lower respiratory disease during this time period were 32.7 (age-adjusted) compared to the state rate of 30.7. According to the *Suffolk County Community Health Assessment 2014-2017*, in 2011, chronic lower respiratory diseases was one of the leading causes of death (i.e., responsible for 585 deaths). The rate of hospitalization from asthma for children under the age of four, 37.9, in Suffolk County was significantly lower than the state rate of 50.5. Age-adjusted rates of asthma deaths in Suffolk County were also significantly lower than the state rate of 1.3, with a rate of 0.7 (SCDHS, 2015a).

Baseline community data from 2013 to 2014 indicates that 18.7% of Suffolk County total population adults were diagnosed with depression and of those diagnosed with depression, 88.5% sought treatment (Stony Brook Medicine, 2014). From 2013 to 2014, 14% of Suffolk County residents reported having 14 or more mental health days in last month (SCDHS, 2015a).

According to County Health Rankings, self-reported physical inactivity levels by adults aged 20 and over in Suffolk County was 22% in 2012 (University of Wisconsin Population Health Institute, 2016). Compared to New York state and the U.S., Suffolk County falls in the middle of the two, with more people reporting no leisure time physical activity in the past month than the U.S., but less than New York state (Stony Brook Medicine, 2014; BRFSS). Additionally, slightly more people (78.7%) reported leisure time physical activity in the past month than New York State (75.3%) (SCDHS, 2015a; BRFSS).

Anticipated Changes to Overall Health and Well-being

Given the many factors that contribute to making a community resilient, it is uncertain the degree to which the proposed decision will impact Suffolk County resiliency to storm and/or tidal surges or the associated health impacts of these events (Table 4-37).

The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-37, you must read the Likelihood and Magnitude columns together (e.g., it is highly likely that storm and/or tidal surges would continue to detract from health for a high number of people under Alternatives I and II). For a summary of the different ways in which health could be impacted through the Resiliency to Natural Disasters pathway see Section 4.4.10.

For more on the potential health impacts of property and infrastructure damage and evacuation and displacement due to changes in household and community economics, see the Economics Pathway (Section 4.6).

Table 4-37. Impact of Decision on Overall Health and Well-being from Storm and/or Tidal Surges

Health Determinant	
Overall Health and Well-being from storm and/or tidal surges (including mental health, physical activity, and respiratory health)	**<u>Baseline Health Status</u>** The percentage of adults reporting fair or poor health (age-adjusted) in Suffolk County was 12% in 2014 and baseline community data from 2013 to 2014 indicates that 18.7% of adults in Suffolk County were diagnosed with depression. The health benefits from regular, moderate physical activity are strong and well-established, including chronic disease prevention, improved mental health, and a better quality of life. However, immediately following natural disasters and storm events, physical activity can be difficult due to evacuation and displacement, infrastructure and property damage, closed recreational areas and facilities, and safety concerns. A Gallup-Healthways poll found that in the most affected areas of New York, New Jersey, and Connecticut, there was a 25% increase in diagnoses of depression in adults in the six weeks following Hurricane Sandy. Impacts to respiratory health are also a concern due to mold contamination resulting from water damage.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	**No change** to overall health and well-being as a result of storm and/or tidal surges is expected. There is no evidence that these alternatives would impact shoreline or community resiliency to natural disasters or their associated health impacts.	Regardless of the decision alternatives, natural disasters are **highly likely to impact overall health and well-being**, as evidenced by past natural disasters, and impacts are likely to increase with increased storm frequency and intensity, and greater extent and frequency of coastal flooding due to sea level rise.	The extent of people affected would be **high**. **Thousands of people live and work in each of the four SLOSH Zones** (areas affected by Sea, Lake, and Overland Surges from Hurricanes) and could experience impacts to overall health and well-being from hurricanes, severe storms, and their associated storm surges.	**Populations living and working in the SLOSH zones are disproportionately affected** by hurricanes and storm events, but there are **certain subpopulations that are particularly vulnerable**, including those on barrier islands, the elderly, physically disabled, those with pre-existing conditions, low income populations, and the linguistically isolated.	The health implications of storm and/or tidal surges are **minor to moderate**. Impacts to overall health and well-being can range in severity and may or may not require medical treatment or intervention.	Impacts to overall health and well-being are likely **immediate**, but can potentially be **long-lasting** (e.g., mental health impacts).	**Strong.** Based on numerous research studies, there is high confidence in the link between storm and/ or tidal surges and overall health and well-being.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative /alternative system design.	**Uncertain** that any change to overall health and well-being as a result of storm and/or tidal surges would be seen with this alternative. While this alternative could lead to conditions that improve shoreline resiliency, especially during lower-intensity storms and coastal/tidal flooding, the degree of impact to community resiliency to natural disasters or their associated health impacts is unknown due to the confounding factors affecting community resiliency, including climate change, sea level rise, coastal development, and individual behaviors (such as willingness to evacuate).	Regardless of the decision alternative, natural disasters are **highly likely** to impact overall health and well-being, as evidenced by past natural disasters, and impacts are likely to increase with increased storm frequency and intensity, and greater extent and frequency of coastal flooding due to sea level rise.	The extent of people affected would be **high**. **Thousands of people live and work in each of the four SLOSH Zones** (areas affected by Sea, Lake, and Overland Surges from Hurricanes) and could experience impacts to overall health and well-being from hurricanes, severe storms, and their associated storm surges.	**Populations living and working in the SLOSH zones are disproportionately affected** by hurricanes and storm events, but there are **certain subpopulations that are particularly vulnerable**, including those on barrier islands, the elderly, physically disabled, those with pre-existing conditions, low income populations, and the linguistically isolated.	The health implications of storm and/or tidal surges are **minor to moderate.** Impacts to overall health and well-being can range in severity and may or may not require medical treatment or intervention.	Impacts to overall health and well-being are likely **immediate**, but can potentially be **long-lasting** (e.g., mental health impacts).	**Strong.** Based on numerous research studies, there is high confidence in the link between storm and/ or tidal surges and overall health and well-being.

4.4.10 Resiliency to Natural Disasters Health Impact Summary

- The **negative health impacts of storm and/or tidal surges and coastal flooding are highly likely to continue regardless of the decision scenario chosen**, due to the confounding factors affecting community resiliency and its associated health impacts, including climate change, sea level rise, coastal development, and individual behaviors (such as willingness to evacuate).
- **Thousands of people live and work in the Suffolk County SLOSH Zones** (areas affected by Sea, Lake, and Overland Surges from Hurricanes) and **would be disproportionately affected** by hurricanes and storm events. However, advances in warning and evacuation systems reduce the number of people who experience these impacts. There are **certain subpopulations, however, that are particularly vulnerable to storm and/or tidal surges and coastal flooding** regardless of these advances, including those on barrier islands, the elderly, physically disabled, those with pre-existing conditions, low income populations, and the linguistically isolated.
- The health implications of storm and/or tidal surges and coastal flooding can range in severity from minor injuries and illness to mental health problems, disease, and injuries that require medical treatment or intervention, and even disabling injury and death. While these impacts are likely to be experienced immediately, many can potentially be long lasting (e.g., permanent disabling injury and death, mental health impacts, etc.).

4.5. Vector Control: Existing Conditions and Potential Impacts

Mosquitoes affect human health and well-being in Suffolk County, not only through their irritating biting activity, but also through the spread of mosquito-borne disease (Suffolk County Government, 2016b). Mosquito-borne disease has become a prominent public health issue in the U.S., with the appearance of emerging diseases such as those from West Nile virus (WNV), Eastern Equine Encephalitis virus (EEEV), and Zika virus. Although occasionally viewed as a public health crisis in Suffolk County, much effort has been devoted to educating the public about avoiding being bitten by mosquitoes, keeping yards free from mosquito habitats, and eliminating standing water. Some sources of mosquito habitat such as marshlands and wetlands cannot be drained, requiring the application of pesticides to inhibit or eliminate mosquito populations. These methods are not perfect, and so the threat of serious mosquito-borne disease remains a problem. It is therefore important to avoid actions which encourage the spread of mosquito habitat and breeding grounds.

The Suffolk County Division of Vector Control is responsible for controlling mosquito infestations of "public health importance" and has instituted an integrated pest management (IPM) program for controlling mosquito populations in the County (Cashin Associates, P.C., 2006; Suffolk County Government, 2016b). This program involves education, water management, surveillance activities by the Department of Health Services and Department of Public Works (i.e., epidemiological and environmental surveillance), and larvicide and adulticide application.

4.5.1 Vector Control Pathways of Impact

Figure 4-46 shows the pathways by which the proposed code changes are expected to impact vector control and ultimately, health.

The performance of individual sewerage systems, water quality, and changes in resiliency affect mosquito habitat and infestation. A change in mosquito populations influences the need for insecticide application, which can in turn influence the extent of human illness resulting from vector-borne pathogens. In addition, the perceived quality of the environment because of mosquito presence affects people's stress and well-being.

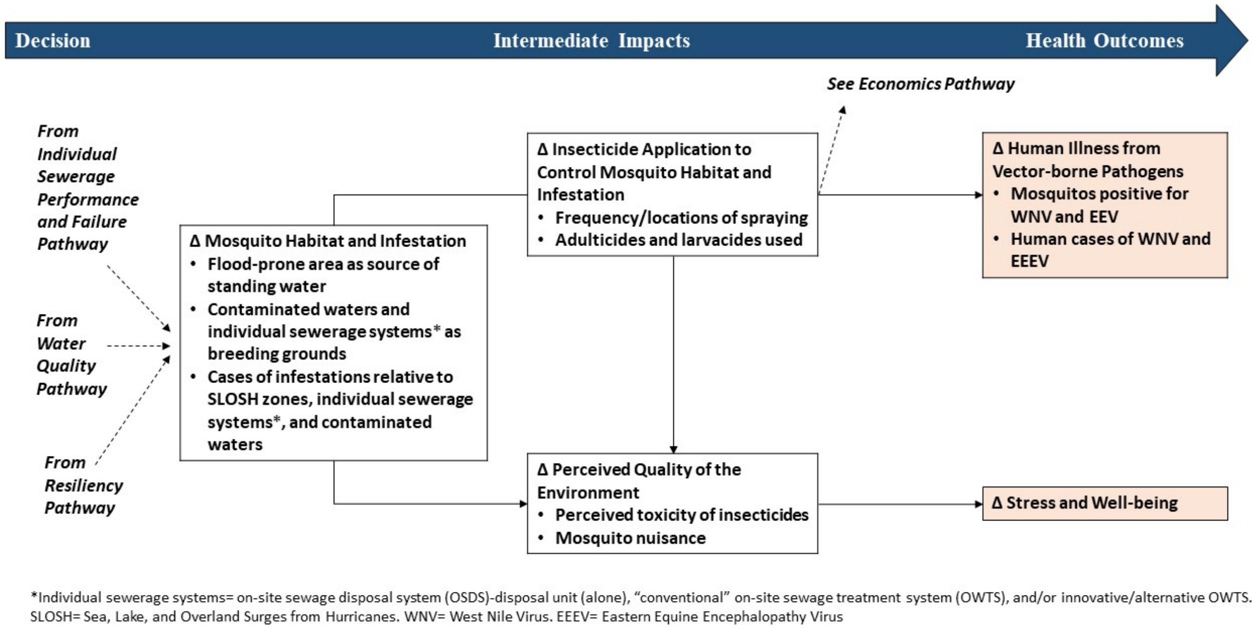


Figure 4-46. Vector Control Pathway Diagram.

4.5.2 Impact of Changes in Individual Sewerage Performance and Failure, Water Quality, and Resiliency on *Mosquito Habitat and Infestation*

In general, **improperly maintained septic tanks and cesspools can serve as fertile breeding habitat for mosquitoes, producing hundreds to thousands of mosquitoes daily** (CDC, 2013c; CDC, 2016c; Barrera, et al., 2008; Burke, Barrera, Lewis, Kluchinsky, & Claborn, 2010). Their larvae can thrive in water that would not sustain normal aquatic life, such as the wastewater is found in cesspools and septic tanks. The primary mosquito that transmits WNV in New York, *Culex pipiens*, feeds on organic detritus and biofilms in its larval form (Beketov & Liess, 2007) and often selectively breeds in polluted water, including septage. Barrera et al. (2008) found in a study examining the productivity of septic tank habitats in Puerto Rico that sampled septic tanks could produce up to 170,000 adult *Culex spp.* mosquitoes per day. A subsequent study in the same area found that productivity of mosquitoes was associated with cracked septic tank walls and improperly fitted septic tank covers, a problem that plagues older septic systems (Burke, Barrera, Lewis, Kluchinsky, & Claborn, 2010). And the unsealed septic tanks or septic tanks with unscreened short vent pipes were shown to produce large numbers of *Aedes and Culex* mosquitoes throughout the year, regardless of rainfall (Mackay, Amador, Diaz, Smith, & Barrera, 2009). A study conducted in Australia placed the amount of mosquitoes breeding in subterranean wastewater containment in urbanized areas as high as 78% (Kay, et al., 2000)[32]. In addition to accessing open or cracked septic tanks, the CDC (2016c) and NYSDOH (2016) also cite unsealed septic tanks (e.g., unsealed tank cover, uncovered ventilation pipe) as a possible route for mosquito access to these types of

[32] There is not a lot of research into this topic on Long Island, but mosquitoes behave similarly no matter their location, so this study was included for reference.

systems. The CDC (2013c; 2016c) recommends some steps homeowners can take to prevent mosquito production in septic tanks:

Owners of individual sewerage systems should inspect their systems for cracks, leaks, and loose manhole covers. Any cracks or gaps between the blocks should be patched with cement. Vent pipes should be covered by screen mesh, broken pipes should be repaired, and joints should be sealed to deny mosquitoes access to the water within. Abandoned or unused septic tanks should be filled with dirt or gravel.

In general, wastewater pollution from individual sewerage systems and other sources can seep into surface waters, either through overland transport during heavy precipitation and overflow events, or via subsurface flow, as previously discussed. Normally, subsurface flow contributes to denitrification and treatment of wastewaters (Neralla, Weaver, Lesikar, & Persyn, 2000). However, if the water does not travel far before rejoining surface water, contaminants can remain in the water and surface. *Culex* species breed prolifically in organically enriched fresh water (Pratt & Moore, 1993), and their mosquito larvae are highly tolerant to organic pollution, being able to survive in water that is too contaminated to support fish or other predators (Resh & Rosenberg, 2008). This tolerance is a survival mechanism, as mosquito larvae though plentiful, are fairly defenseless and often form a significant part of aquatic food webs. Experimental investigation has found that *Culex* larval survival in water containing natural predators was 2.6%, but went up to 46% in ditches that were too polluted to sustain predator species (Marten, Nguyen, Mason, & Giai., 2000). Sanford, Chan, & Walton (2005) found adult *Culex* mosquito production was nine times greater in nitrogen-enriched wetlands than in controls.

In addition to the *Culex* mosquitoes, storm surges and ocean encroachment provide pools of brackish water that serve as temporary habitats for several species of saltwater mosquito. These include various species in the genera *Aedes* and *Anopheles*. These floodwater mosquitoes lay their eggs in moist soil, where they can lay dormant for, in some cases, up to a year before hatching *en masse* during flood conditions. The frequent biter and potential EEEV and WNV vector, *Aedes vexans*, falls into this category.

Existing Conditions Mosquito Habitat and Infestation at the Time of the HIA Analysis

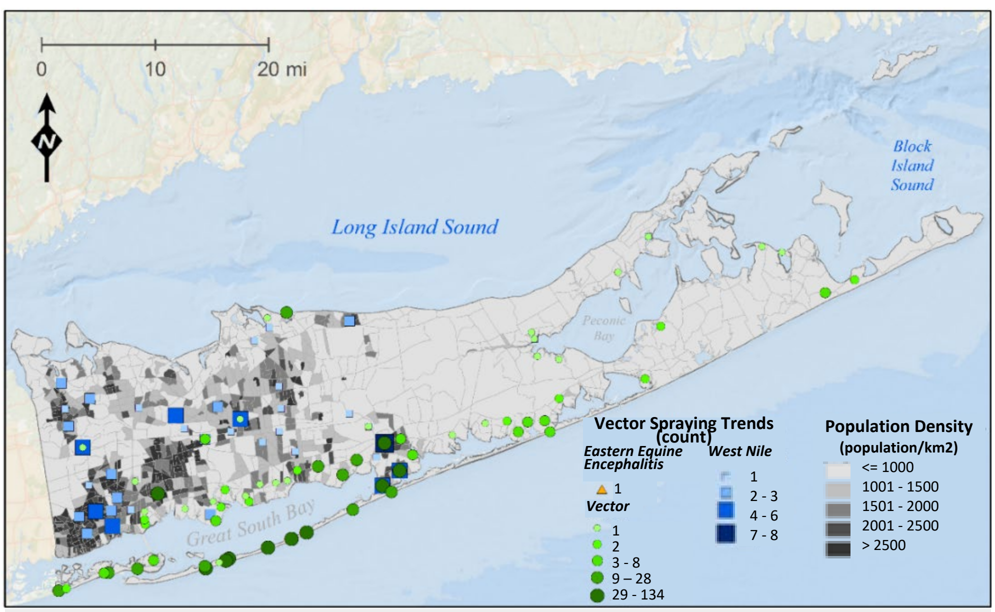
According to SCDHS, **Suffolk County is currently home to approximately 50 species of mosquitoes.** Mosquitoes can be characterized by their preferred breeding environment, as follows:

- <u>Container breeders</u> – these mosquitoes, including the **WNV carriers *Culex pipiens, C. restuans,* and *Aedes albopictus*** (Nasci, et al., 2001)., lay their eggs in shallow, stagnant water near human dwellings. Flower pots, discarded tires, wheelbarrows, unsealed septic tanks and cesspools, and rain gutters are among their larval habitats. These mosquitoes often lay their eggs in polluted, organically-rich water, as their larvae are more tolerant to suboptimal conditions than predator species.
- <u>Freshwater breeders</u> –these mosquitoes lay their eggs in natural freshwater environments, such as wetlands, puddles, drainage basins, or ponds. There is significant overlap between these and

container breeding mosquitoes. Some freshwater mosquitoes, such as *Anopheles*, can also breed in brackish water.

- Saltwater/salt marsh breeders – these mosquitoes lay their eggs in damp marshland, which then hatch *en masse* following tidal or rainfall events that inundate marshes. These include the nuisance biter and potential EEEV and WNV vector *Aedes vexans*, *Aedes sollicitans*, as well as several species in the genera *Anopheles*. As their bites can transmit serious disease, vector control measures do target these mosquitoes in Suffolk County.

Culex spp. are the prime WNV vector in Suffolk County; however, the transient nature of container breeders' habitats makes them difficult to quantify, so it is helpful to examine the focus of mosquito-related pesticide applications across the County (Figure 4-47). Records of mosquito treatment in Suffolk County are categorized by type, with general vector control treatments marked separately from those related to the specific prevention of WNV, EEEV, or other mosquito-borne disease. The frequency of West Nile-related spraying in areas with higher population density illustrates the correlation between human population and the presence of the container-breeding mosquitoes that transmit WNV. Saltwater and marsh mosquitoes are more of a concern in areas that are close to the coast, as they require inundation with brackish water to hatch. On the barrier islands, especially, these mosquitoes are the focus of handheld insecticide spraying. Aerial application of larvicide is conducted yearly by helicopter over coastal saltmarshes to control nuisance mosquitoes that are not known to spread disease (SCDHS, 2015d). These treatments are not illustrated in Figure 4-47.



Population: American Community Survey, 5-year Estimates, 2008-2012
Spraying Data: Suffolk County Department of Public Works, Division of Vector Control, October 2015
Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors

Figure 4-47. Spatial Trends in Vector Control Treatment in Suffolk County, 2001-2012.[33]

[33] The vector control treatment data provided by the County at the time of the HIA analysis was for the years 2001-2012. This was the most current data available at the time and was used throughout the Vector Control analysis.

Individual sewerage systems can contribute to nutrient loading and creation of mosquito habitat when wastewater ponds above ground (during hydraulic failure) and when nutrient- wastewater effluent seeps into surface waters, either through overland transport during heavy precipitation and overflow events, or via subsurface flow. Mosquito larvae can thrive in water that would not sustain normal aquatic life, such as wastewater. As noted previously, **improperly maintained septic tanks and cesspools can also serve as fertile breeding habitat for mosquitoes**. Although individual sewerage systems in Suffolk County are typically placed lower in the soil than conventional OWTS in other locales, cesspools and septic tank-leaching pools in Suffolk County are equipped with vent pipes/chimneys and covers to allow access to the systems for inspection, maintenance, and sewage removal. It is through these components, when they are not airtight, that mosquitoes may be able to access individual sewerage systems and the systems can become prime mosquito habitat. Although there are no data on the prevalence of cracked, uncovered, or unsealed individual sewerage systems in Suffolk County, several Suffolk County septic vendors do note individual sewerage system repairs include pipe repairs and resealing, tank lid replacement and sealing, and inspection for cracks (Cesspool Service Long Island, 2015; Quality Cesspools, 2015; Zuidema Septic Service, 2015; EZ Cesspool, 2017; Certified Cesspool and Drain, Inc., 2018; Evergreen Drainage and Cesspool, 2018). No studies have been conducted on Long Island specifically linking septic tanks as breeding habitats for mosquitoes, although a study conducted in Suffolk County following completion of the HIA analysis showed an association between high septic system density and increased WNV infection in mosquitoes (Meyer, Campbell, & Johnston, 2017).

Conduct public outreach to emphasize the role individual homeowners can take to help prevent mosquito infestation, including mosquito production in individual sewerage systems.

Innovative/alternative onsite wastewater treatment systems under consideration by the County could be evaluated to ensure that they do not provide breeding habitat for mosquitoes. Ideally, the innovative/alternative systems chosen will innately discourage mosquito breeding by incorporating access-restricting features, such as screened vents and inspection ports, crack-resistant construction, and tightly-fitting manholes.

Anticipated Change(s) in Mosquito Habitat and Infestation

If upgrades to County standards are made to existing onsite sewage disposal systems, it is anticipated that mosquito habitat will be reduced by eliminating cracked, uncovered, and/or failing systems. Adoption of I/A OWTS to reduce nitrogen pollution will lead to a further reduction in mosquito habitat and infestation by improving the quality of surface water and supporting predator species that consume mosquito larvae. Table 4-38 identifies the potential impacts of the proposed code changes on mosquito habitat and infestation for each decision alternative.

Table 4-38. Impact of Decision on Mosquito Habitat and Infestation

Alternatives	Potential Changes in Mosquito Habitat and Infestation
Baseline*	Old and improperly maintained septic tanks and cesspools can serve as breeding habitat, producing hundreds to thousands of mosquitoes daily. Nutrient and organic wastewater pollution from individual sewerage systems and other sources provide habitat for mosquitoes, as do pools of water from storm and tidal surges, ocean encroachment, and other sources.

Alternatives	Potential Changes in Mosquito Habitat and Infestation
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Upgrading cesspools to newer OWTS would reduce the number of old, failing cesspools in the County, thereby reducing potential breeding habitat and potentially reducing the population of mosquitoes near residential areas, if the new systems are properly maintained. There would be no change in nitrogen loading and hence, no change expected in mosquito populations associated with nitrogen impaired waters and/or pools of water from storm and tidal surges, ocean encroachment, and other sources.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	In addition to the potential reduction in mosquito populations near residential areas as a result of the upgrades to newer OWTS, upgrading to innovative/alternative systems would lead to a further reduction in mosquito populations by reducing nitrogen loading. There is evidence that reduced nitrogen pollution from OSDS leads to healthier surface waters, which in turn reduces mosquito populations naturally by supporting the presence of predators. Reduced nitrogen loading can potentially impact shoreline resiliency to coastal and nuisance flooding, which provides temporary habitat for saltwater mosquitoes.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) could lead to increases in available mosquito breeding habitat in Suffolk County.

4.5.3 Impact of Changes in Mosquito Habitat and Infestation on *Insecticide Application to Control for Mosquitoes*

Suffolk County implements an integrated vector control program that utilizes public complaints and formal surveillance of mosquito populations, habitats, and occurrence of vector-borne disease to inform and focus the control measures. The control measures include preventative activities such as public education, water management, larvicide (i.e., insecticide that is specifically targeted against the larval life stage) application, and when other measures have proven infeasible or unsuccessful, adulticide (i.e., insecticide that is specifically targeted against the adult life stage) application.

Existing Conditions Regarding Insecticide Application to Control for Mosquitoes at the Time of the HIA Analysis

The Suffolk County Division of Vector Control's Annual Plan of Work (Suffolk County Government, 2016b) outlines the vector control measures that will be used to control mosquito populations in the County:

- Public Education and Outreach – These efforts focus on eliminating standing water in yards and property through the distribution of pamphlets and other literature, site visits, and presentations to citizen groups. Because the primary vectors of West Nile virus, *Culex pipiens*, and the invasive species *Aedes albopictus* and *japonicus,* are container-breeding mosquitoes, the cooperation of residents in removing vessels that collect rainwater is essential to limiting larval habitat. According to the Division of Vector Control, this aspect of vector control is anticipated to take on greater importance in coming years. Recently as part of the New York's 2016 Zika Action Plan, the NYSDOH and SCDHS conducted the first countywide Mosquito Control Day to demonstrate mosquito control techniques and distribute free larvicide.

- Water Management – Suffolk County maintains structures that are in place to drain surface water and/or allow predatory fish access to larval mosquito habitat (e.g., tidal channels, ditches, culverts) in order to minimize mosquito production and the need for insecticide applications. These maintenance activities are done in consultation with NYSDEC to ensure conservation of the state's wetland resources.

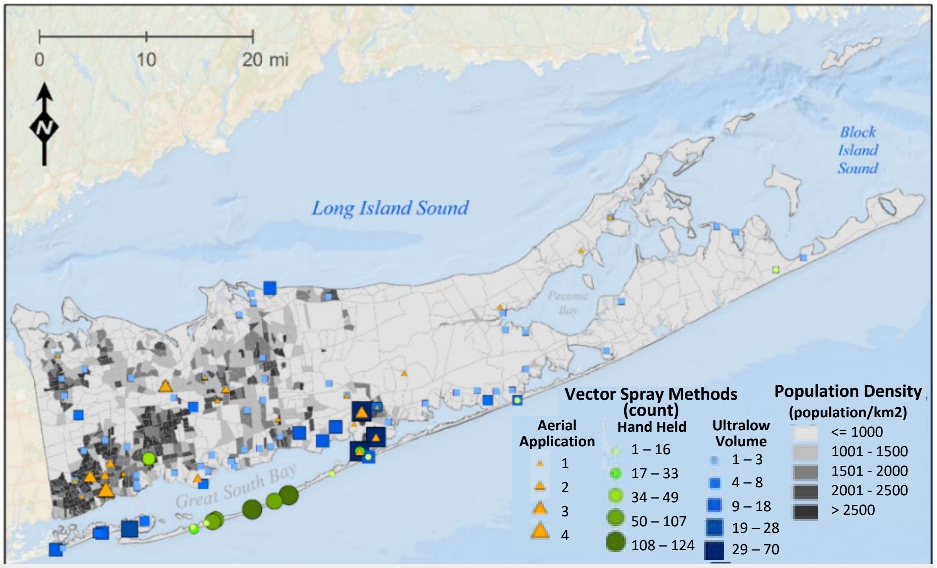
  Suffolk County could continue measures to rehabilitate and restore wetland structure and function, while also reducing mosquito production, under the integrated marsh management (IMM) framework, with oversight from the Wetlands Stewardship Committee (WSC), Council for Environmental Quality (CEQ), and NYSDEC.

- Control of Mosquito Larvae and Adults – Larval control is the second most important vector control method utilized by the County and involves surveillance and control of major larval habitats, such as wetlands, ditches, recharge areas, and other sites in the County. Approximately 1,500 of 2,077 major larval habitats are surveyed by the Division of Vector Control field crews on a regular basis; the remaining major larval habitats and any artificial larval sites throughout the County are addressed if public complaints are received and resources permit. Surveillance and control of these sites is important because of their proximity to residential areas. Larvicides are applied when inspection of a site shows or has the potential for significant larval production.

  Suffolk County used three larvicidal compounds, in a variety of preparations, in the treatment of mosquito-harboring water bodies in 2016: the bacteria *Bacillus thuringiensis israelensis* (B.t.i.), *Bacillus sphaericus,* and the juvenile hormone mimic methoprene (SCDHS, 2013; SCDHS, 2015d; Suffolk County Government, 2016b). B.t.i. and *B. sphaericus* produce toxins that are extremely potent to insect larvae, yet are regarded as practically non-toxic to humans and other mammals. Methoprene is a compound that mimics a metamorphosis-regulating hormone in juvenile insects, preventing them from reaching adulthood. It is nontoxic in humans and other mammals (EPA, 1991), and when used at label rates, does not impact non-target organisms.

  The final line of defense used in Suffolk County vector control is adulticide application, which is only carried out when mosquito infestations are severe and widespread (i.e., a public health nuisance) and/or to respond to the presence of vector-borne disease (Suffolk County Government, 2016b). Criteria have been established to help inform the decision to apply adult control to ensure that adulticides are only used when the need and benefits are clear. In order to guide the application of adulticides, Suffolk County maintains a mosquito surveillance program administered by the Arthropod-Borne Disease Laboratory which surveys approximately 2,500 traps per year. Mosquito surveillance for adult population counts and arboviral presence guides the application of mosquito control efforts in the County and allows estimation of the efficacy of current actions. Mosquito adulticide compounds used in Suffolk County in 2016 included Anvil® and Duet®, which contain the synthetic pyrethroids D-phenothrin (sold as sumithrin) and prallethrin (Suffolk County Government, 2016b). These compounds have very low mammalian and bird toxicity, and low persistence in soil and water (Klaasen & Watkins, 2010). The low human toxicity and short environmental persistence of synthetic pyrethroids has led to their widespread adoption for public health protection. All vector control insecticides considered for use in Suffolk County undergo a rigorous toxicity review as mandated by the State Environmental Quality Review Act (SEQRA). Summaries of these reviews can be found in the Suffolk County Vector Control and Wetlands Management Revised Long-Term Plan (Cashin Associates, P.C., 2006). Public notification of adulticide spraying is provided through the County website, fax notifications to over 150 interested parties, news outlets, and the CodeRED (automated calling and messaging) system, advising residents to stay inside during spray hours, close windows and screen doors, and wash garden vegetables to remove spraying residue before consumption (Suffolk County Government, 2016b). For those residents who wish to exempt themselves from routine spraying, the County maintains a Do Not Spray Registry that lists addresses to avoid. A public health emergency that requires the use of adulticide spraying, however, overrides the Do Not Spray registry.

The insecticides used by Suffolk County for control of larval and adult mosquitoes are commercially available and are applied through a number of methods– hand ultra-low-volume (ULV) spraying, truck ULV application, or by aerial ULV spraying. Over 90% of the larvicide used in Suffolk County is applied aerially to major salt marshes and other wetlands, both fresh and saltwater (Suffolk County Government, 2016b). Adulticide applications are normally made by truck, but aerial application is possible in cases of widespread problems. Figure 4-48 illustrates spatial trends in the methods of reported adulticide vector control spraying. Truck and aerial ULV applications are more common on the main island, while handheld ULV application is used on the barrier islands. Adulticide mosquito control spraying by application type and year is presented in Table 4-39.



Population: American Community Survey, 5-year Estimates, 2008-2012
Spraying Data: Suffolk County Department of Public Works, Division of Vector Control, October 2015
Base Map: Esri, DeLorme, GEBCO, NOAA, NGDC, and other contributors

Figure 4-48. Methods of Adulticide Vector Control Treatment in Suffolk County, 2001-2012.

Table 4-39. Number of Adulticide Vector Control Treatments by Application Method in Suffolk County, 2001-2012*

Year†	Adulticide Application Type			
	ULV	Handheld	Aerial	Total
2001	62	71	2	135
2002	18	60	3	81
2003	94	83	4	181
2005	36	64	2	102
2006	37	72	3	112
2007	23	71	0	94
2008	32	69	4	105
2009	53	73	1	127
2010	46	83	15	144
2011	43	58	0	101
2012	12	76	5	93
Total	**456**	**697**	**39**	**1275**

* Data provided by Suffolk County Dept of Public Works, Division of Vector Control, October 2015
† Treatment data was unavailable for 2004.

Anticipated Change(s) to Insecticide Application to Control for Mosquitoes

It is anticipated that changes in onsite sewage disposal systems will reduce the need for chemical treatment of mosquitoes, by reducing the overall number of suitable mosquito breeding areas. A reduction in nitrogen pollution from the adoption of I/A OWTS will lead to improved surface water quality throughout the County, providing better habitat for predators that feed on mosquito larvae and further reducing the need for insecticide treatments to combat the spread of both nuisance and disease-spreading mosquitoes. Table 4-40 identifies the potential impacts of the proposed code changes on insecticide application to control for mosquitoes for each decision alternative.

Table 4-40. Impact of Decision on Insecticide Application to Control for Mosquitoes

Alternatives	Potential Changes in Insecticide Application
Baseline*	**Larvicide and adulticide application will continue as prescribed** in the 2016 Vector Control Work Plan.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	It is anticipated that upgrading cesspools will reduce and/or eliminate the potential for mosquito breeding in failing and open systems, leading to a **potential reduction in mosquito populations and hence a reduced need for pesticide application, potentially**.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	Reductions in nitrogen loading from the adoption of innovative/ alternative systems will lead to improvements in surface water quality, with a commensurate increase in the natural control of mosquito populations through predation. Furthermore, it is anticipated that the reduction in mosquito populations as a result of reductions in available habitat (i.e., old individual sewerage systems, surface waters degraded by nitrogen contamination, and potentially temporary habitat resulting from coastal and nuisance flooding) will lead to a **reduced need for pesticide application**, since the County bases their application schedule partly on mosquito population estimates from surveillance trapping.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) could lead to increases in available mosquito breeding habitat and the need for increased vector control measures in Suffolk County.

4.5.4 Impact of Mosquito Habitat and Infestation and Insecticide Application on *Perceived Quality of the Environment*

Perceptions of environmental quality problems can affect the health of a community by influencing decisions to exercise and partake in outdoor activities or causing mental and social distress. Environments that are seen as unpleasant or unsuitable for recreation are less likely to be used as such. Mosquito bites are regarded as a nuisance, and the presence of mosquitoes can have an effect on quality of life (Suffolk County Government, 2016b) and a significant deterrent effect on willingness to spend time outdoors (Read, Rooker, & Gathman, 1994). In a study of areas with a high mosquito density, up to 54% of respondents to a phone survey indicated that they reduced or eliminated outdoor activities due to the nuisance factor of mosquito bites (Carrieri, et al., 2008).

However, the desire to avoid exposure to mosquito control pesticides is also a reason that people may reduce outdoor activities. Vector control measures can impact perceptions of environmental quality if communication with residents is insufficient; the perception of insecticides and other control measures as unsafe may influence activity decisions.

Existing Conditions Regarding Vector Control and Perceived Quality of the Environment at the Time of the HIA Analysis

Suffolk County uses mosquito control methods that are widely agreed upon by toxicologists, medical doctors, and environmental regulators to be safe for humans. Mosquito adulticide treatments used by Suffolk County are practically non-toxic to humans and other mammals, even in doses that far exceed levels used to treat for mosquitoes. Prallethrin and D-phenothrin are pyrethroid-class pesticides which affect invertebrates by interrupting sodium channels in nerves, inducing acute neurotoxicity, and causing death by overexcitation of the nervous system. Mammalian livers and kidneys are highly efficient at detoxifying and removing pyrethroids (Sodurlund, et al., 2002), and the mechanism of toxicity is such that warm-blooded animals' nervous systems are far less affected, by a factor of one thousand times or more (Narahashi, Zhao, Ikeda, Nagata, & Yeh, 2007).

In Suffolk County, adulticide is primarily applied using ULV spraying from trucks, which drive down roads applying aerosol treatments. Opt-out of routine preventative adulticide ULV spraying is available through the County's No Spray Law Registry, as some households are concerned about the possible health effects of pesticide application. Individual households may request exemption under the No Spray Law, which guarantees that "reasonable caution" will be used in avoiding their property under routine spraying. Since its inception in 2002, there have been 500 locations or less in Suffolk County on the list each year, including apiaries and organic farms. The no spray exemption does not, however, cover larvicide spraying or emergency application of adulticide to combat a public health emergency such as a West Nile outbreak (Personal Communication, Dr. Scott Campbell, Suffolk County Department of Health Services, Arthropod-Borne Disease Laboratory, October 21, 2015).

Research on how pesticide usage affects the perception of environmental quality is sparse, and no scientific study or survey has been conducted on Long Island to determine local attitudes. However, an Internet search for "Long Island pesticide health effects" reveals that some citizens are opposed to adulticide spraying, arguing that the health risks of chronic exposure outweigh the benefits of mosquito control, and that larvicide application is a more efficient control strategy (Long Island Neighborhood Network, 2011). Larvicide application is not without controversy either, as a 2015 East Hampton Star article reported: a Town Trustees meeting was held in which a "vocal opponent of the County's vector control methods" raised several concerns with the efficacy and non-target toxicity of the juvenile hormone mimic methoprene (Walsh, 2015). Several Suffolk County legislators and town supervisors have recently voiced opposition to the spraying of methoprene as well, as reported in a February 2016 feature story by the Shelter Island Reporter (Grossman, 2016).

Anticipated Change(s) in Perceived Quality of the Environment

Table 4-41 identifies the potential impacts of the proposed code changes on perceived quality of the environment for each decision alternative. We anticipate that upgrading cesspools to more modern OSDS will reduce mosquito populations near residential areas by eliminating potential habitat and by leading to reductions in nitrogen impairment of surface waters. **Reduced mosquito populations lead to improved perception of the environment as safer from infectious disease and free of nuisance mosquitoes.** Additionally, reduced mosquito populations lead to fewer applications of pesticides, as the County uses a surveillance-based approach for pesticide use. Residents with concerns related to insecticide application will experience an **improved perception of their environment if fewer insecticides are applied**.

Table 4-41. Impact of Decision on Perceived Quality of the Environment

Alternatives	Potential Changes in Perceived Quality of the Environment
Baseline*	Mosquito presence and insecticide application continue as normal; therefore, **no change in perception of environmental quality**.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Upgrading cesspools is expected to reduce nuisance mosquitoes, and potentially reduce the need for pesticide application near homes, **alleviating a possible source of distress in perception of environmental quality**.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	In addition to reduced nuisance mosquitoes near the homes as a result of reductions in available habitat, the reduction in nitrogen loading from innovative/alternative systems will further reduce mosquito populations and the need for pesticide application, leading to **additional reductions in negative environmental perceptions**.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) could lead to increases in available mosquito breeding habitat and the need for increased vector control in Suffolk County, resulting in increased negative environmental perceptions.

4.5.5 Impact of Changes in Vector Control on *Human Illness from Vector-borne Pathogens*

Mosquito-borne disease is a recurring problem on Long Island, owing both to its large amount of surface water and proximity to New York City, which is a hub for international travel and shipping. Mosquito-borne diseases can be transferred from distant locations, such as in the initial 1999 West Nile Virus outbreak when the virus was found to be most similar in serotype to a strain from Israel (Lanciotti, et al., 1999). **Of the vector-borne diseases found in Suffolk County, the most serious are those caused by WNV and EEEV**. These diseases can cause encephalitis, or swelling of the brain, and are difficult to treat. Many who survive are left with brain damage that lasts for years or is permanent (Kilpatrick, Kramer, Jones, Marra, & & Daszak, 2006). **While EEEV was detected in mosquitoes on Long Island in 2008, there have been no other reports of EEEV as of 2015; WNV, however, continues to be detected in both mosquitoes and humans in Suffolk County annually** (Suffolk County Tick and Vector-Borne Diseases Task Force, 2015).

Existing Cases of Human Illness from Vector-borne Pathogens at the Time of the HIA Analysis

WNV and EEEV are spread from avian hosts to mosquitoes and subsequently to humans. Different species of birds are more susceptible to these viruses, including the American robin; some birds become ill and show symptoms of disease, while others carry the disease without showing any symptoms. WNV infection in humans most often manifests as West Nile Fever, which causes fever and flu-like symptoms and often goes undiagnosed. However, in the old, very young, or immunocompromised, the disease can become more severe and lead to West Nile Encephalitis, which can cause swelling of the brain and death. The majority of those infected with WNV develop no symptoms and about 1 in 5 develop minor symptoms; however, WNV can lead to permanent brain injury and death in a very small percentage (<1%). The first outbreak of WNV in the United States occurred in New York City in 1999 (Lanciotti, et al., 1999) and spread throughout the United States in the following years. NYC and its surroundings continue to be a hotspot of WNV activity, prompting the development of a WNV surveillance program in Suffolk County, administered by the Department of Health Services' Arthropod-Borne Disease Laboratory. Surveillance data for 2008-2015 are summarized in Table 4-42, and maps illustrating cases of WNV from 2005-2015 can be found in Figure 4-49 and Figure 4-50.

Table 4-42. Mosquito-Borne Disease Surveillance in Suffolk County, 2008-2015*[34]

	Year							
	2008	2009	2010	2011	2012	2013	2014	2015
Birds Tested for WNV	137	53	110	122	89	39	99	51
WNV-Positive Birds	91	24	74	33	38	10	11	11
Total Mosquitoes Collected	49,584	78,358	126,305	145,308	105,327	236,032	191, 557	122,802
Mosquito Pools Sent for Testing	1,526	1,465	2,323	1,801	1,438	1,515	1,476	1,526
Mosquitoes Sent for Testing	47,491	48,538	65,571	69,562	55,347	59,259	62,591	56,316
WNV/EEEV Positive Mosquito Pools†	41/3	17	295	81	210	178	186	200
WNV-Positive Horses‡	1	0	0	0	1	0	0	0
WNV Positive Humans (Deaths)	9	1	25(3)	4	14	5	1	5

*Adapted from Suffolk County Tick and Vector-Borne Disease Task Force, 2015; data from SCDHS Arthropod-Borne Disease Laboratory

† EEEV was found in mosquitoes in Suffolk County in 2008, but not detected again through 2015.

‡ Equine vaccines for WNV and EEEV reduce horse cases

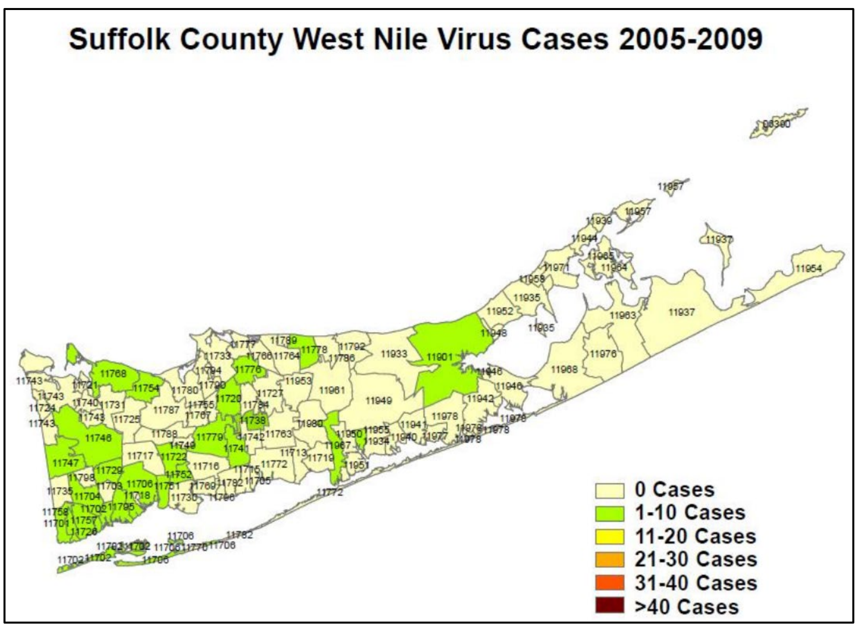


Figure 4-49. Cases of West Nile Virus in Suffolk County, 2005-2009 by zip code. Figure reproduced from (Suffolk County Tick and Vector-Borne Diseases Task Force, 2015); data from NYSDOH Communicable Disease Electronic Surveillance System (CDESS).

[34] The data presented here was the most current at the time of the HIA analysis. It should be noted that in 2016 there were 125 WNV positive mosquito pools and 5 WNV human cases (no deaths); in 2017, there were 119 WNV positive mosquito pools, 4 EEEV positive mosquito pools, and 7 WNV human cases, including 2 deaths (SCDHS, 2017; SCDHS, 2018).

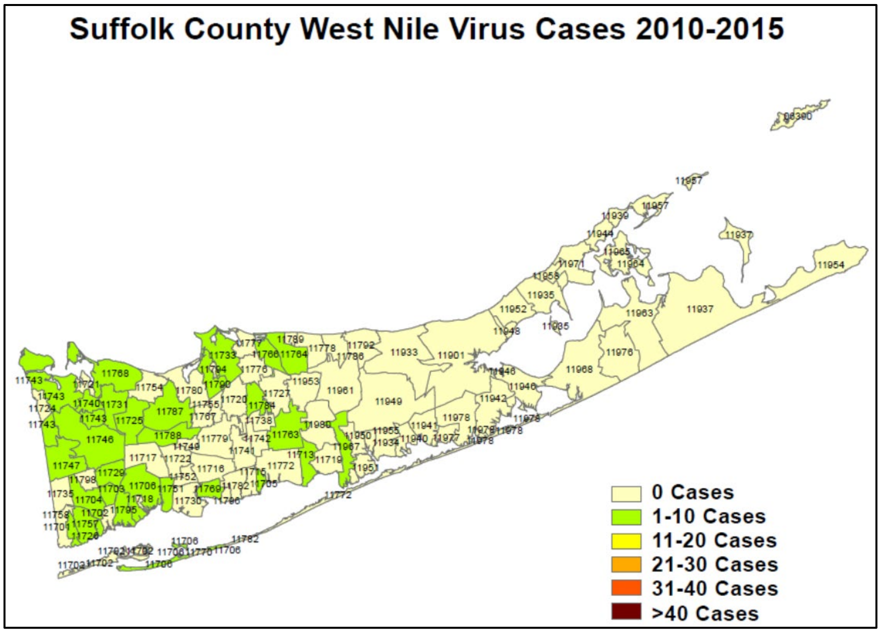


Figure 4-50. Cases of West Nile Virus in Suffolk County, 2010-2015 by zip code. Figure reproduced from (Suffolk County Tick and Vector-Borne Diseases Task Force, 2015); data from NYSDOH Communicable Disease Electronic Surveillance System (CDESS).

EEEV was detected in mosquitoes in Suffolk County in 2008, and despite no other reports of EEEV as of 2015, monitoring continues due to the significant chance of mortality associated with the disease. EEEV causes swelling of the brain, much like West Nile Encephalitis, and commonly results in death within 2 to 10 days of the onset of symptoms. Survivors are often left with permanent intellectual impairment, personality disorders, and seizures. There have been five human cases of EEEV in New York since 1971, and all were fatal (Suffolk County Tick and Vector-Borne Diseases Task Force, 2015). No human cases of EEEV have been reported in Suffolk County. The disease cannot be transmitted from human to human, and there is an effective vaccine for horses, which are highly susceptible to the virus and can, like birds, serve as a reservoir species that infects mosquitoes that bite them.

Other mosquito-borne diseases found in Suffolk County include: malaria, chikungunya, and dengue fever. While these diseases are extremely common in equatorial regions of Asia, Africa, and Central America, their emergence in northern regions is a more recent phenomenon (with the exception of malaria, which was previously endemic to the United States). Malaria, spread by the *Anopheles* mosquito, was eliminated as a “significant public health problem” in the United States by the CDC in 1949, following a massive nationwide dichlorodiphenyltrichloroethane (DDT) spraying campaign (CDC, 2010). However, some sporadic cases do continue to occur as a result of travel to endemic areas. These are typically easily treatable with a variety of widely-available medications, and consequently malaria is not considered a major threat in Suffolk County. Chikungunya and dengue fever, vectored by *Aedes aegypti*, are historically tropical diseases that are beginning to expand in range with the advent of widespread world travel and, to a smaller extent, climate change. They have similar symptoms, including very high fevers, joint pain, vomiting, and muscle fatigue. Neither disease has a specific treatment or vaccine and can result in death if left untreated. These diseases are not currently a major concern in

Suffolk County, but some cases do occur. A summary of Suffolk County cases of mosquito-borne diseases can be found in Table 4-43.

Table 4-43. Mosquito-Borne Disease Cases in Suffolk County, 2008-2014*

	Year						
	2008	2009	2010	2011	2012	2013	2014
WNV Fever	4	0	11	2	7	2	0
WNV Encephalitis	5	1	14	2	7	3	1
WNV Total	9	1	25	4	14	5	1
EEEV	0	0	0	0	0	0	0
Malaria[†]	11	5	7	11	4	10	1
Chikungunya[†, ‡]	NA	NA	NA	NA	NA	NA	2
Dengue Fever[†]	2	1	4	3	2	13	4

* Adapted from Suffolk County Tick and Vector-Borne Disease Task Force, 2015; data from NYSDOH Communicable Disease Electronic Surveillance System (CDESS)

† There have been no local cases of these diseases with exception of one locally-acquired case of dengue fever in 2013; all other cases have been travel-related

‡ Data does not exist for cases of Chikungunya before 2014

Anticipated Change(s) in Human Illness from Vector-Borne Pathogens

It is anticipated that upgrading cesspools to newer OWTS will reduce mosquito populations near residential areas by eliminating potential habitat and that reductions in nitrogen impairment of surface waters as a result of I/A OWTS will further reduce mosquito populations. Reducing the population of mosquitoes near residential areas reduces the risk of being bitten by a mosquito, while improvements in surface water quality encourage a healthy and diverse avian community, reducing the likelihood of disease transmission from host birds to mosquitoes (Ezenwa, et al., 2007). However, it should be noted that no direct link has been shown between mosquito population size and disease incidence for WNV.

Table 4-44 identifies the potential impacts of the proposed code changes on human illness through the vector control pathway for each decision alternative. The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-44, you must read the Likelihood and Magnitude columns together (e.g., it is possible Alternative I would benefit health for a moderate number of people). For a summary of the different ways in which health could be impacted through the Vector Control pathway see Section 4.5.7.

Table 4-44. Impact of Decision on Human Illness from Vector-Borne Pathogens

Health Determinant							
Illness from vector-borne pathogens including West Nile virus and Eastern Equine Encephalitis virus	**Baseline Health Status** The Suffolk County Department of Health conducts yearly surveillance of mosquitoes through the monitoring network developed by the Arthropod-Borne Disease Laboratory. Trends in West Nile Virus (WNV) surveillance reveal that on a yearly basis from 2008–2015 the range of mosquito traps testing positive for the virus was 3.5% to 19.2%. In the same time period, 64 people contracted WNV resulting in 3 deaths. Eastern Equine Encephalitis Virus (EEEV) was found in mosquitoes in Suffolk County in 2008, but not detected again through the completion of the HIA analysis in 2016; there have been no human cases of EEEV in Suffolk County. No locally-transmitted cases of Zika have been reported.						
Alternatives	**Direction**	**Likelihood**	**Magnitude**	**Distribution**	**Severity**	**Permanence**	**Strength of Evidence**
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	The reduction in and/or elimination of potential container-breeding mosquito habitat (i.e., old and/or failing individual sewerage systems) may **benefit health** by reducing mosquito populations.	It is **possible that there would be a decrease in illness from vector-borne pathogens**; however, there is no direct link between mosquito population size and disease incidence for WNV.	Changes in illness from vector-borne pathogens would affect a **moderate** number of people. There are relatively few cases of mosquito-borne disease in Suffolk County; however, significant resources are expended controlling for mosquitoes that could be spent elsewhere, affecting many residents.	The young, the elderly, the immunocompro-mised, and those who live in proximity to mosquito breeding areas would be **disproportionately affected**. Will have a lesser effect on those who live in sewered areas.	The health implications of mosquito-borne disease are **minor to severe**. The majority of those infected with WNV develop no symptoms and about 1 in 5 develop minor symptoms. WNV can lead to permanent brain injury and death in a very small percentage (<1%).	The changes in mosquito populations will occur in years subsequent to the change in sewerage disposal systems, as their population follows a yearly seasonal trend. Therefore, any health effects may not occur for a **long time**, but are expected to be **long-lasting**, considering the long life span of OWTS.	**Limited.** The evidence reflects the hypothesized relationship between variables, but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship. Further research may change the confidence or the estimate of effect.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative / alternative system design.	Reduced nutrient pollution in Suffolk County waters and the reduction in and/or elimination of potential container-breeding mosquito habitat (i.e., old and/or failing individual sewerage systems) will **benefit health** by leading to better predation of mosquito larvae and reducing mosquito populations.	It is **possible that there would be a decrease in illness from vector-borne pathogens** given that the mosquito implicated in the spread of WNV in Suffolk County breeds in impaired and polluted water. Several studies document increased mosquito populations in nitrogen polluted water as well; however, the direct link between increased mosquito population size and increased disease incidence for WNV has not been shown.	Changes in illness from vector-borne pathogens would affect a **moderate** number of people. There are relatively few cases of mosquito-borne disease in Suffolk County; however, significant resources are expended controlling for mosquitoes that could be spent elsewhere, affecting many residents.	The young, the elderly, the immunocompromised, and those who live in proximity to mosquito breeding areas would be **disproportionately affected**. Will have a lesser effect on those who live in sewered areas.	The health implications of mosquito-borne disease are **minor to severe**. The majority of those infected with WNV develop no symptoms and about 1 in 5 develop minor symptoms. WNV can lead to permanent brain injury and death in a very small percentage (<1%).	The changes in mosquito populations will occur in years subsequent to the change in sewerage disposal systems, as their population follows a yearly seasonal trend. Therefore, any health effects may not occur for a **long time**, but are expected to be **long-lasting**, considering the long life span of OWTS.	**Limited.** The evidence reflects the hypothesized relationship between variables, but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship.

4.5.6 Impact of Changes in Vector Control on *Stress and Well-being*

Public perception of the environment influences choices of where, when, and how often to engage in outdoor activities. A healthy and enjoyable natural environment has long been considered crucial to relaxation and well-being. Studies show that exposure to nature and partaking in outdoor activities is an important part of maintaining good mental health (Beyer, Kaltenbach, Szabo, Bogar, & al, 2014; Maller, Townsend, Pryor, Brown, & St Leger, 2006)**. Spending more time in the outdoors or even simply viewing a natural environment has been linked to a wide variety of mental, psychological, and emotional health benefits (Bedimo-Rung, Mowen, & Cohen, 2005), as well as lowered blood pressure, more positive outlooks on life, and better overall health (Ulrich, 2002).**

Studies have also shown that participating in outdoor recreation leads to decreases in stress, lowers the chance of obesity and high blood pressure (Rosenberger, Bergerson, & Kline, 2009), and increases feelings of overall "wellness" (Godbey, 2009). Running and walking in a green, outdoor setting has been linked to both a reduction in and faster recovery from mental fatigue (Bodin & Hartig, 2003). Being near nature improves psychological health in children and can alleviate the symptoms of attention deficit disorder (ADD) while improving concentration (Taylor, Kuo, & Sullivan, 2001). Stress and mental fatigue have been implicated as a causative factor in the development of heart disease and hypertension (Pickering, 2001) and are associated with decreased overall mental and physical health (Taylor, Lerner, Sage, Lehman, & Seeman, 2004).

The decision to spend time outdoors is influenced by perceptions of the environment, and an area that is perceived negatively is less likely to be used. Areas that are perceived as having a high-quality environment can command higher home and property prices and encourage residents to interact more often outside the home (Phaneuf, Smith, Palmquist, & Pope, 2008).

Mosquitoes and other insects are considered a nuisance because of their itchy and irritating bites. Even those species that do not spread disease in Long Island can impact health by causing allergic reactions to their bites and discouraging people from going outside. In particular, the container-breeding mosquito *Aedes albopictus* is known for its daytime feeding behavior and repeated, frequent biting. A study conducted in New Jersey found that a majority of interviewed residents considered mosquitoes to be an important factor in determining their ability to relax outdoors and had been prevented from enjoying outdoor activities by mosquitoes at least once in a typical week. Surprisingly, respondents in the study rated the importance of enjoying the outdoors without mosquitoes to be higher than the importance of a clean neighborhood and at the same level as the importance of neighborhood safety (Halasa, et al., 2014)***.***

Existing Conditions Regarding Mosquitoes and Stress and Well-being at the Time of the HIA Analysis

Nuisance mosquitoes and the threat of vector-borne disease can cause distress and discourage participation in outdoor activities. While scientific surveys or research on the effects of mosquitoes on mental well-being in Suffolk County is lacking, it is well-known that in warmer months, mosquitoes can be a significant nuisance and quality-of-life issue. Suffolk County is home to about 50 species of mosquitoes, including the day-biting vector species *Aedes albopictus* (SCDHS, 2016d). The Division of

Vector Control recommends limiting outdoor activities between dusk and dawn in mosquito-prone areas and wearing long sleeved shirts, pants, closed-toed shoes and socks when mosquitoes are active (Suffolk County Dept. of Public Works, 2016). These precautions, while necessary, can have a limiting effect on common summer recreational activities such as swimming or fishing. Unfortunately, the health risks of mosquito-borne disease have the potential to overshadow the health benefits of recreation and appreciation of nature.

Pesticide spraying as a result of mosquito infestation can cause stress and limit outdoor activity participation, as well. During and immediately after mosquito spraying, residents (especially children and pregnant women) are advised by the County to remain inside and close doors and windows. While the insecticides used by the Department of Vector Control undergo stringent assessments of their potential toxicity to humans and have been found to cause no ill effects in the doses used, many residents feel that all pesticides are toxic, as evidenced by several articles published on the Internet and in local papers (Long Island Neighborhood Network, 2011; Walsh, 2015; Grossman, 2016). Some residents may experience stress due to perceived loss of environmental quality and safety and engage in fewer outdoor activities when pesticides are applied.

Anticipated Change(s) in Mosquito Related Stress and Well-being

It is anticipated that reductions in mosquito habitat as a result of upgrading cesspools to newer OWTS and reductions in nitrogen pollution as a result of upgrading to I/A OWTS will lead to lowered mosquito populations (both nuisance mosquitoes and carriers of disease), and subsequently, to fewer applications of insecticide. Due to lowered mosquito populations and fewer insecticide applications, residents may be more likely to engage in outdoor activities and enjoy the many health benefits they provide. Additionally, by reducing insecticide application, a significant source of stress to some residents who find mosquito spraying controversial, will likewise be reduced.

Table 4-45 identifies the potential impacts of the proposed code changes on stress and well-being through the vector control pathway for each decision alternative. The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-45, you must read the Likelihood and Magnitude columns together (e.g., it is possible Alternative I would benefit health for a low number of people). For a summary of the different ways in which health could be impacted through the Vector Control pathway see Section 4.5.7.

For more on the economic impacts of changes in insecticide application for control of mosquito habitat and infestation, see the Economics Pathway (Section 4.6).

Table 4-45. Impact of Decision on Stress and Well-being

Health Determinant	
Stress and well-being as a result of mosquito presence, pesticide application, and mosquito-borne disease	**Baseline Health Status** Some citizen groups and lawmakers express concern that insecticides used in mosquito control efforts are unsafe for children. Mosquito populations, especially near wetland areas or after floods, reach nuisance status in warm months. Both can have an effect on stress and well-being by increasing concern about the state of the community's outdoor resources and by discouraging outdoor activity. Worries about contracting mosquito-borne diseases including West Nile virus may cause stress and discourage outdoor activity, as well. Public perception of the environment influences choices of where, when, and how often to engage in outdoor activities. Studies have shown that participating in outdoor recreation leads to decreases in stress, lowers the chance of obesity and high blood pressure, and increases feelings of overall "wellness."

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	The reduction in and/or elimination of potential container-breeding mosquito habitat (i.e., old and/or failing individual sewerage systems) **may reduce mosquito populations (both nuisance and disease carrying mosquitoes) and subsequently, the need for pesticides.** Fewer mosquitoes could likely lead to increased enjoyment of the outdoors, resulting in a **benefit to health.**	It is **possible** that there will be a health benefit. Reduced nuisance mosquitoes have been shown to increase willingness to engage in outdoor activities, although mosquitoes alone likely account for a relatively minor part of discouraging these activities. Studies linking decreased pesticide application and improved perceptions of the environment are lacking.	Changes in stress and well-being will affect a **low** number of people. Less than one percent of Suffolk County properties are listed on the Do Not Spray Law listing, indicating that concern over pesticide application is relatively low. Participation in outdoor activities may increase due to changes in vector control, but the extent of that impact is unknown.	Those who live in proximity to mosquito breeding areas and/or insecticide application areas would be **disproportion-ately affected**.	The health implications of reduced stress due to mosquitoes and vector borne disease are **minor**. Engaging in outdoor activity and exercise is valuable for the prevention of obesity and other sedentary diseases, decreases stress, and increases feelings of overall "wellness."	The changes in mosquito populations will occur in years subsequent to the change in sewerage disposal systems, as their population follows a yearly seasonal trend. Therefore, any health effects may not occur for a **long time**, but are expected to be **long-lasting**, considering the long life span of OWTS.	**Limited to Strong.** The evidence reflects the hypothesized relationship between variables, but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship. The link between enjoyment of the outdoors and stress reduction is supported by decades of research; however.

Alternative	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	Improved natural control of mosquito populations through improvements in water quality **reduces the need for pesticide application and reduces nuisance. Fewer mosquitoes** would likely lead to increased enjoyment of the outdoors, which reduces stress and increases general well-being, resulting in a **benefit to health.**	It is **possible** that there will be a health benefit. Reduced nuisance mosquitoes have been shown to increase willingness to engage in outdoor activities, although mosquitoes alone likely account for a relatively minor part of discouraging these activities. Studies linking decreased pesticide application and improved perceptions of the environment are lacking.	Changes in stress and well-being will affect a **low** number of people. Less than one percent of Suffolk County properties are listed on the Do Not Spray Law listing, indicating that concern over pesticide application is relatively low. Participation in outdoor activities may increase due to changes in vector control, but the extent of that impact is unknown.	Those who live in proximity to mosquito breeding areas and/or insecticide application areas would be **disproportionately affected**.	The health implications of reduced stress due to mosquitoes and vector borne disease are **minor**. Engaging in outdoor activity and exercise is valuable for the prevention of obesity and other sedentary diseases, decreases stress, and increases feelings of overall “wellness.”	The changes in mosquito populations will occur in years subsequent to the change in sewerage disposal systems, as their population follows a yearly seasonal trend. Therefore, any health effects may not occur for a **long time**, but are expected to be **long-lasting**, considering the long life span of OWTS.	**Limited to Strong.** The evidence reflects the hypothesized relationship between variables, but is limited in depth or replication. There are consistent conclusions, but few studies that confirm the relationship. The link between enjoyment of the outdoors and stress reduction is supported by decades of research.

4.5.7 Vector Control Health Impact Summary

- It is possible that decreases in mosquito populations, as a result of the reduction in and/or elimination of old and/or failing individual sewerage systems and in Alternative III, the added reduction in nutrient pollution in Suffolk County waters, **could lead to a decrease in illness from vector-borne pathogens**, although there is no direct link between mosquito population size and disease incidence for WNV. **Decreased mosquito populations and subsequently reduced pesticide applications may also benefit health** by increasing the willingness of residents to engage in outdoor activities and reducing stress related to mosquitoes, vector-borne disease, and pesticides. However, mosquitoes alone likely account for a relatively minor part of discouraging outdoor activities, and studies linking decreased pesticide application and improved perceptions of the environment are lacking.
- These potential benefits may have a lesser effect on those who live in sewered areas, but would **disproportionately benefit** the young, the elderly, the immunocompromised, and those who live in proximity to mosquito breeding areas and insecticide application areas.
- The benefits to decreased mosquito populations and pesticide applications include a reduced risk of stress, mosquito bites, and mosquito-borne diseases such as WNV and EEEV.

4.6 Community and Household Economics: Existing Conditions and Potential Impacts

Conditions in the environments where people live, work, learn, and play can impact their health (Braveman, Egerter, & Williams, 2011; Braveman, Egerter, & Barclay, 2011; Helman, 2015; Marmot, 2005; WHO, 2003; Anderson, Scrimshaw, Fullilove, & Fielding, 2003). As such, **community and household economics both contribute to the overall health and well-being of an individual and a community.** Many health determinants are directly related to the economic vitality of the community and the availability of community services, such as neighborhood safety, mobility and access to goods and services, physical activity and social engagement, and many others. On an individual level, household income, combined with housing costs (generally the largest expense for a household), often determine an individual's ability to afford essential health-related goods and services, such as food, clothing, utilities, healthcare, and childcare. Community and household economics are interrelated as a result of the exchange of taxes, social services, and spending by both the individual household and the government in the economy.

Regulations can boost the economy or deter economic growth, and when considering new regulations, such as the proposed changes to the Suffolk County sanitary code, the impacts to both community and household economics should be considered.

4.6.1 Community and Household Economics Pathways of Impact

Figure 4-51 shows the pathways by which the proposed code changes are expected to potentially impact community and household economics in Suffolk County.

Household economics are affected by costs of an individual sewerage system, employment opportunities within the individual sewerage system industry, residential property values, employment opportunities in the commercial fishing and recreational industries, and costs due to storm and flooding damage and influences household food security and ultimately, nutrition-based health problems and overall health and well-being. Overall health and well-being are also affected by community economics, which are impacted by community costs/revenues from inspection and certification, residential property values, costs/revenues from commercial fishing and recreational industries, costs of storm and flooding damage, and the cost of vector control.

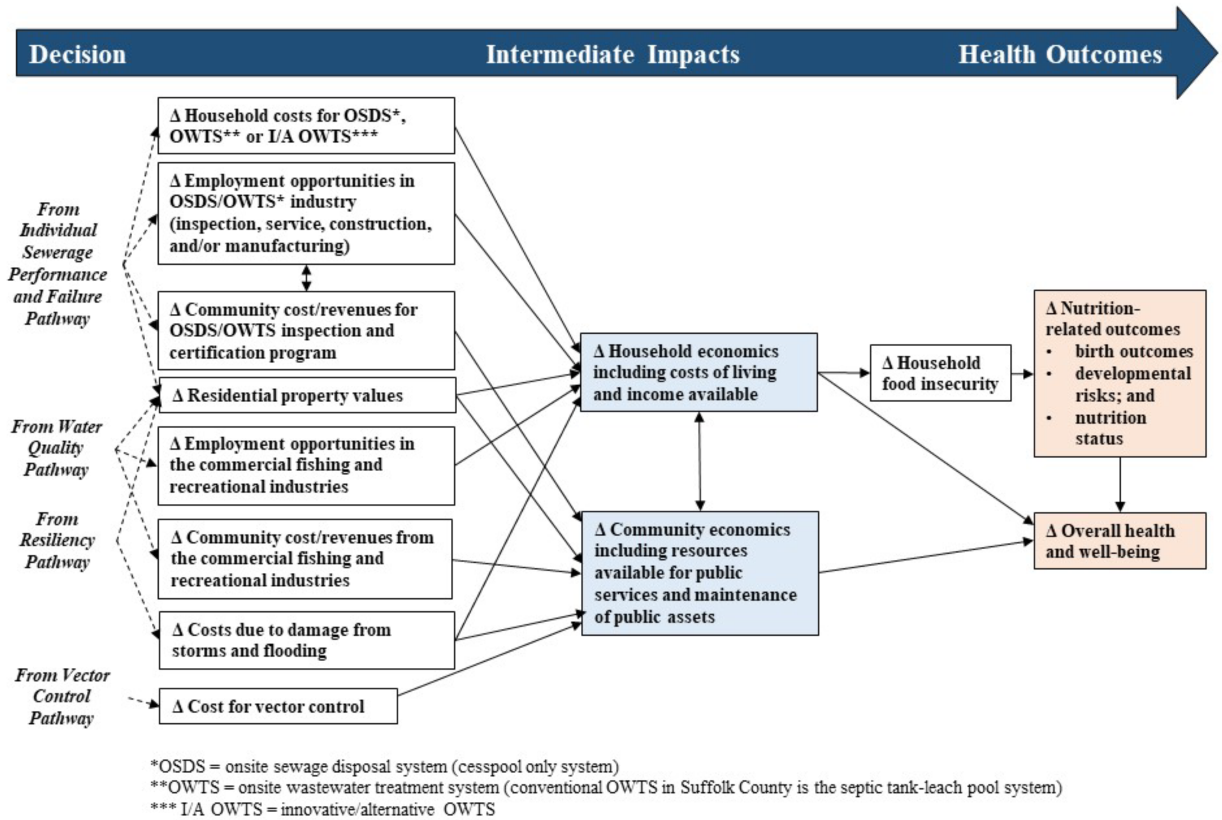


Figure 4-51. Community and Household Economics Pathway Diagram.

4.6.2 Impact of *Changes in OWTS and I/A OWTS Community Costs/Revenues and Household Costs* on Community and Household Economics

Government policies on infrastructure, energy, sanitation, and water resources all impact the health outcomes of the families and communities they address. Changes in regulation, such as the proposed changes to the sanitary code, often require funding for implementation and oversight. Depending on the sources of this funding, these additional costs can potentially impact the health services the community is able to provide.

Changes in regulation can impact household economics directly, if there are costs or fees associated with the changes, or indirectly, through potential impacts to property values. Household income can impact health through a variety of pathways which include: differential access to healthcare; environmental exposures; health behaviors; and differential exposure to stress associated with instability in employment, housing, and food access (Braveman, Egerter, & Barclay, 2011). Braveman, Egerter, and Barclay (2011) propose that “increases in income are linked to greater health improvements at the lower end of the income scale.” The sanitary code changes are meant to ameliorate current household expenditures in the event of a failed system causing seepage, back up and or damage to the home; however, a high water table may necessitate more frequent pumping if that water enters the individual sewerage system.

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A review of available literature suggests that housing is an important social determinant of overall health and well-being (Nabihah, 2014). The proportion of a household's income remaining after housing costs can determine the ability to afford essential health-related goods and services such as food, clothing, healthcare, and childcare. Households facing high housing costs are often forced to cut back on these essentials (Joint Center for Housing Studies of Harvard University, 2015a). These kinds of cutbacks are strongly linked to poor health outcomes.

Generally, a household is considered cost-burdened when total housing costs (mortgage, rent, insurance, utilities, taxes, etc.) exceed 30% of the household income (Coleman-Jensen, Gregory, & Rabbitt, 2016). A home spending 30–49.9% of household income on housing is considered moderately burdened, and 50% or more of household income spent on housing is considered severely burdened (Schwartz & Wilson, 2008; Pew Charitable Trusts, 2016). In a county with a high cost of living, like Suffolk County, it is not uncommon for households, particularly renters, to fall within these categories.

Analysis of the U.S. Bureau of Labor Statistics' 2011 consumer expenditure survey suggests, in general, that some cost-burdened households spend one-fifth the amount that non-burdened households spend on healthcare (Joint Center for Housing Studies of Harvard University, 2015a). For example, adults in cost-burdened households are more likely not to fill a prescription or not follow through with medical treatment due to cost (Nabihah, 2014). These trends would increase if more money were spent on household improvements.

Existing Community and Household Economics at the Time of the HIA Analysis

In order to assess the potential impacts of the proposed code changes, the existing state of community and household economics and the housing market in Suffolk County were closely evaluated.

Community Economics

In Suffolk County's 2015 Comprehensive Annual Financial Report, real property taxes were reported to have provided over $100 million in revenue for the County in 2015 (Table 4-46) – 5.9% of total County revenues (Office of the Comptroller, 2016). That Report (Office of the Comptroller, 2016) also indicated an overall shortfall between revenues and expenditures of $2 billion. As a note, the primary expenditures for the County include Public Safety (21%), Economic Assistance and Opportunity (21%), and Employee Benefits (21%).

Table 4-46. Suffolk County Revenues for Year Ending December 31, 2015 (Office of the Comptroller, 2016)

Revenues	Budgeted Amounts (U.S. dollars, $)			
	Original	Final	Actual	Variance with Final Budget
Real Property Taxes	93,171,277	93,171,277	**111,549,335**	18,378,058
Sales and Use Tax	1,256,823,016	1,256,823,016	**1,189,242,493**	-67,580,523
New York State Aid	238,285,668	244,620,458	**233,950,994**	-10,669,464
Federal Aid	223,274,644	227,869,009	**217,912,214**	-9,956,795
Licenses, permits, fines, fees, etc.	138,066,036	138,066,036	**134,533,331**	-3,532,705

Revenues	Budgeted Amounts (U.S. dollars, $)			
	Original	Final	Actual	Variance with Final Budget
Interest on investments	376,099	376,099	**2,124,582**	1,748,483
Miscellaneous	12,245,997	12,783,497	**12,506,353**	-277,144
Total Revenues	1,962,242,737	1,973,709,392	**1,901,819,302**	-71,890,090

A number of County-financed, in-progress and proposed economic development projects are described in the 2015 Report (Office of the Comptroller, 2016) that are closely related to tourism and the waterfront. The Long Island Convention and Visitors Bureau and Sports Commission's 2015 Mid-year Report stated that tourism generated $202 million in local tax revenue for Suffolk County in 2015 (Long Island Regional Development Council, 2015). Traveler spending across all of Long Island was $5.5 billion in 2015, up $200 million from 2014. However, **increasing beach closures, algal blooms, and perceived degradation of waters which are used for aquatic recreation, place revenue streams from tourism and recreation at risk for decline.**

In addition, Suffolk County Executive Steve Bellone reported thousands of job losses in the shellfishing industry due to declining shellfish populations (Suffolk County Government, 2014c). The 2013 NOAA Coastal County Snapshot for Suffolk County reported that the number of commercial fishing jobs in the County was 1,054 and revenue from commercial fishing totaled $57.7 million (NOAA, 2016c). **In taking action, the County can prevent the further decline of water quality and the fishing, recreation, and tourism industries in the area.**

SCDHS spent $195 million in 2015, with the Office of Wastewater Management representing a fraction of this total. As with other departments in the County, SCDHS spent more than it earned, having a 2015 end of year deficit of $116 million.

The environmental regulatory efforts that go into enforcing the current drinking water and groundwater management regulations and programs in Suffolk County include water sample testing, processing applications for new residential construction, industrial waste inspections, hazardous waste tank testing, hazardous waste tank removal, and sewage treatment plant inspections. In 2015, just 1,094 individual sewerage system construction applications were processed by the County.

Household Economics

A number of American Community Survey (ACS) measures regarding households and income were used to characterize the household economics of Suffolk County (Table 4-47). According to the ACS, of the total estimated occupied households in Suffolk County in 2012 (496,349), 80.1% were owner-occupied structures, and 19.9% were renter-occupied. Families (average size of 3.40 people) make up 75.6% of the total number of occupied households, occupying 80.2% of owner-occupied structures and 56.8% of renter-occupied structures. The remaining 24.4% of occupied households are non-families (i.e., a householder living alone or with non-relatives only), with an average size of 1.27 people; non-families occupy 19.8% of owner-occupied structures and 43.2% of renter-occupied structures (Table 4-47).

Table 4-47. Households and Income in Suffolk County

Variable	Entire County (average household size of 2.93)	Family Household (average size 3.40 people)	Non-family Household (average size of 1.27 people)
Occupied Households*	496,349 (+/- 1,683)	374,995 (+/-2,008) (75.6%)	121,354 (+/- 1,764) (24.4%)
Homeownership*	80.1% (+/- 0.4%) owner-occupied structures	Occupy 80.2% (+/- 0.4%) of owner-occupied structures	Occupy 19.8% (+/-0.4 %) of owner-occupied structures
Rate of home rental*	19.9% (+/- 0.4%) renter-occupied structures	Occupy 56.8% (+/- 1.2%) of renter-occupied structures	Occupy 43.2% (+/- 1.2%) of renter- occupied structures
Median Income*	$87,778 (+/- $859)	$100,179 (+/- $865)	$46,476 (+/- $1,083)
Mean Income*	$108,149 (+/- $825)	$120,397 (+/- $1,043)	$63,323 (+/- $1,353)
Number and percentage of households under $50,000[†]	132,315 (+/- 2426) or 26.7% (+/- 0.5%)	--	--
Median income as a percentage of MIT Living Wage Calculator	158%[‡]	181%	102%
Number and percentage of households earning Food stamps/SNAP benefit*	24,513 (+/- 1,111) or 4.9% (+/- 0.2%)	--	--
Percentage of the population, for whom poverty status is determined, whose income in the past 12 months is below the poverty line*	6.1% (+/- 0.3%)	With related children under 18: 7.0% (+/- 0.5%)	Unrelated individuals 15 years and over: 17.9% (+/- 0.7%)
Percentage of households who are housing cost burdened*	44.5% owner-occupied housing costs exceed 30% of income 54.1% renting households exceed 30% of income		

* 2012 American Community Survey 5-year (2008-2012) estimates, (U.S. Census Bureau, 2012).

† The Massachusetts Institute of Technology (MIT) Living Wage Calculator estimates Suffolk County Living Wage as follows: $55,432 for household of 3 (1 working adult, 1 nonworking adult, and 1 child) and $45,552 for nonfamily household (two working adults) (Glasmeier, 2016).

‡ Calculated with income for household of 3, $55,432.

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County-level data are used in the economics analysis because the geographic location of specific types of individual sewerage systems was unknown at the time of the HIA analysis; therefore, geographic-specific income statistics could not be determined for each alternative.

Household income for families is much higher than non-family households. In Suffolk County, families have a median household income of $100,179 and a mean income of $120,397, while non-families have a median household income of $46,476 and a mean income of $63,323 (U.S. Census Bureau, 2012). In Suffolk County, the living wage for a household of 3 (1 working adult, 1 non-working adult, and 1 child) is $55,432 (Glasmeier, 2016). The standard measure for housing cost burden is 30% of household income (Pew Charitable Trusts, 2016). In Suffolk County, roughly 44.5% of owner-occupied households have housing costs that exceed 30% of their income, while roughly 54.1% of renting single-family households have housing costs that exceed 30% of their income (Table 4-47).

C

This alone does not give the most accurate representation of the at-risk population. With the high property values and relatively high median income in Suffolk County, it is likely that many higher income households with additional financial assets and capital may elect to live in a house that costs more than 30% of their household income without having to make the types of tradeoffs that result in poor health outcomes.

The median household income for the County is $87,778, and the median income of households with families is $100,179 (U.S. Census Bureau, 2012). **Looking at the regionally-specific income limits for public assistance programs yields a more accurate image of the population placed at risk of the cost-burdened population. Based on these metrics, 23-26.7% of households in Suffolk County are likely cost-burdened**; it should be noted that a portion of the cost-burdened population does reside in sewered areas and therefore would not be impacted by the proposed sanitary code changes. For Section 8 housing,[35] a household of three in Suffolk County is considered low income if their household income is $76,480 or less, and very low income if it is $47,800 or less (HUD, 2016a). The number of households earning under $50,000 a year is estimated to be around 26.7%, according to the 2012 American Community Survey. Based on this metric, at least 26.7% of households in the County would be low income or very low income (and likely cost-burdened).

To qualify for the state's Home Energy Assistance Program, a household of three must have an annual income of less than $43,500 (New York State, n.d.). These figures suggest that households in Suffolk County with incomes near or below $45,000, while earning more than twice the federal poverty level, are still in a precarious financial situation and are at the greatest risk of a negative impact, should their housing costs increase. County wide, this group is roughly 23% of the total number of households. The University of Wisconsin Population Health Institute's (2016) County Health Rankings also estimate that 23% of Suffolk County households are at risk of adverse health effects due to high housing costs, (HUD, 2016b).

Anticipated Change(s) in Community and Household Economics

<u>Community Economics</u>

At the community level, Suffolk County can expect to generate more revenue through the permits, licenses, and fees associated with new septic system installations and maintenance. However, there will

[35] Section 8 is the common name for the Housing Choice Voucher Program, funded by the U.S. Department of Housing and Urban Development, which allows private landlords to rent apartments and homes at fair market rates to qualified low income tenants, with a rental subsidy.

also be extra costs to the County for implementing and maintaining the program, including an increased workload and the need for more staff. In addition, water resources are an integral part of life among Suffolk County residents and a critical resource for the local economy. **The County may also see some benefits to the local economy depending on the code's ability to address nitrogen and pathogen loading to Suffolk County waters**. Impairment in the quality of water resources places revenue streams for Suffolk County services at risk for decline. If Alternatives I or II is selected, the County may have to consider other actions to reduce nitrogen load to the groundwater, freshwater, and marine waters surrounding Long Island (since these alternatives do not address nitrogen loading); and these efforts may increase costs to the County. However, **benefits to the local economy would be expected with the reduction in nutrient and pathogen loading associated with implementation of Alternative III**. These benefits could include increases in real property values and revenues from recreation, tourism, and commercial and recreational fishing and shellfishing due to improved water quality and other environmental conditions.

In the 2014 IBM Smarter Cities report, the authors recommend the need for a recurring revenue source through a unified wastewater management district (IBM Corporate Citizenship & Corporate Affairs, 2014). This represents one method for securing the funding needed to implement the sanitary code changes and maintain the program.

If Suffolk County mandates that between 125,751 (Alternative II) and 251,502 (Alternative III) households have to update their septic systems, the Suffolk County Department of Health Services will have an enormous growth in its responsibility and workload and the County's costs will increase. As discussed in the *Employment Opportunities* sections that follow, this will also create employment opportunities.

C The SCDHS 2015 end of year deficit will make it difficult for the County to enforce these new regulations without increasing revenues, either through charges for fees and services or through operating grants and contributions[36].

With enactment of changes to the sanitary code, the expenses in both the SCDHS and SCDEQ would likely increase. If Alternative I is adopted, 192,558 households, which are considered cesspool only, would be required to install new septic tank-leaching pool systems. This would equate to nearly 200,000 construction applications. Depending on the strategy for implementing the proposed code changes (i.e., failure of existing OSDS, property transfer, or fixed schedule), the number of applications each year would vary, with the total number spread across multiple years. For example, if replacement of a home's sewerage system is triggered by property transfer, based on an average countywide sale rate of 5%, there would be an increase of 9,628 applications per year under Alternative I; this would be equivalent to increasing the amount of applications and the effort to process each one by nearly 9 fold over 2015 efforts (i.e., 1,094 applications in 2015) (HUD, 2017).

[36] See Appendix K for grants and other funding sources secured since completion of the HIA analysis for implementation of I/A OWTS upgrades.

Alternative II requires fewer households to take action (125,751). Given the same assumptions, this would increase the amount of construction applications by 6,288, or an almost 6-fold increase over the 2015 totals. Alternative III would require the most construction applications, with 251,502 households subject to the regulation. If all households subject to Alternative III had to replace their systems at time of property transfer, based on a 5% annual sale rate, the annual number of construction applications increases by 12,575, well over a 10-fold increase.

Issuing OWTS construction permits is just a fraction of the role the County would play in implementing these new regulations. Other actions include enforcement, record keeping, inspection, and financial management of any loan programs. **Oversight of the C-OWTS and I/A OWTS companies may also be needed to ensure they are not taking advantage of the demand created by the code changes by charging much higher rates for inspections, repairs, and installations.**

In addition to the costs associated with the proposed code changes, **Suffolk County can also expect to generate more revenue through the issuance of permits, licenses, and fees associated with C-OWTS or I/A OWTS installation and maintenance.** The County can increase the rates for each to cover the increased cost of permit issuance and management. However, it is unrealistic to expect these charges to cover the entire anticipated increase in workload. The County may also see some increases in real property values due to improved water quality and other environmental conditions as a result of upgraded OWTS. Further, if water quality is improved and the commercial and recreational fishing industries grow, there may be more sales tax revenues as a result.

In the near term, it is not expected that the anticipated code changes will result in a net financial gain for the County, since many households will require assistance to comply with the regulations. Enforcement will also be a challenge, with up to 251,502 households needing to update their individual sewerage systems.

To avoid unintended health impacts, regardless of the alternative chosen, Suffolk County could ensure that the increased cost to implement and oversee the proposed changes to the sanitary code does not impact or pull funding away from other social and health services/programs. The County could seek operating grants and contributions, both from State and Federal entities, to defray costs. More information on existing federal funding opportunities is outlined in Appendix I[37].

<u>**Household Economics**</u>

The proposed changes to the sanitary code will result in costs to individual households for County fees, installation, and operation and maintenance of individual sewerage systems[31]. These costs

[37] Since the completion of the HIA analysis, funding (grants and loans) has been secured by the County for homeowners upgrading to I/A OWTS – the individual sewerage system called for in Alternative III. For more information on these funding opportunities, see Appendix K. Since completion of the HIA analysis, Suffolk County has also established that there is no plan to move forward with wastewater upgrades unless a stable, recurring revenue source is established to help reduce financial impacts to individual households and ensure that County services are not jeopardized by the costs of wastewater upgrade implementation.

depend on a number of factors including the type of upgrade required, the amount of labor required to install the upgrade, and the operating costs of the new system. Under the Suffolk County Sanitary Code at the time of this HIA, when an existing system (cesspool or C-OWTS) failed, the property owner could replace the system in-kind; however, there was no requirement to replace an operational OSDS. The primary maintenance for an existing OSDS or C-OWTS is the pumping out of the unit. The operational costs are minimal, as these systems typically do not require any monthly expenditures, such as electricity, to run the system. Based on cost of pumping a 1,000-gallon unit at the recommended frequency of every 3 years for a household size of 4 people, the annualized cost to pump/maintain an OSDS or C-OWTS is around $100; this cost will vary based on tank and household size and volume of solids in the wastewater.

According to HomeAdvisor (2016a), in a survey of homeowners who used the site to find a company to complete their septic tank installation, the national average cost to install a septic tank in 2016 was $4,610 (Table 4-48). Based on 49 cost profiles from New York State, the average cost was $3,893, and for Babylon, New York, the average cost was $3,754, according to 42 cost profiles; composite Suffolk County data was not available (HomeAdvisor, 2016a). The average cost to repair an existing septic tank was $1,435 nationally, $2,074 in New York State, and $2,042 in Babylon, NY (HomeAdvisor, 2016b). Harvard Joint Center on Housing Studies cited a higher national average cost for repair, at $3,328 in 2013, with over 176,000 septic tank repairs reported (Joint Center for Housing Studies of Harvard University, 2015b).

Table 4-48. Estimate Household Costs for Septic Tank Installation and Repair

Location	Septic Tank Installation*		Septic Tank Repair†	
	Average Reported Cost	No. of Cost Profiles	Average Reported Cost	No. of Cost Profiles
National	$4,610	316	$1,435	584
New York State	$3,893	49	$2,074	54
Babylon, NY‡	$3,754	42	$2,042	48

* Source: (HomeAdvisor, 2016a)

† Source: (HomeAdvisor, 2016b)

‡ Refers to zip code 11702

Alternatives I and II require replacement of an existing OSDS with a C- OWTS; however, the homeowner may opt to install an approved I/A OWTS. For homes with existing OSDS, the timing of the costs to install a C-OWTS or I/A OWTS would not be upon failure of the existing system; it would vary depending upon the implementation scheme chosen by the County. The associated costs for the upgrade would be greater if a household with an OSDS chose to install an I/A OWTS, as I/A OWTS have increased installation, operation, and maintenance costs (Table 4-49).

Alternative III would require the replacement of existing systems with an approved I/A OWTS. **For I/A OWTS, beyond the installation costs, there is a requirement for routine maintenance through a maintenance contract and there are increased operational costs, mainly due to the electricity needed to run the system.** Installation costs for I/A OWTS, presented in Table 4-49, are based on the existence of an operational septic tank and assumes no challenges for site access or drainage fields. If a home has an existing OSDS, then the cost for installation of an I/A OWTS would increase due to the need to install a septic tank, resulting in costs as high as $22,000; costs may be even greater for challenging sites. The life expectancy for I/A OWTS varies and is based on components of the system including aerators, pumps and control panels. Life expectancy of I/A OWTS components is less than the life expectancy of an OSDS or C-OWTS; however, replacement costs for components would be less than installation of a full system. For example, replacement of an aerator could range from $500 to $600 and the cost of a control panel would be around $300 (numbers based on estimates gathered from I/A OWTS vendors).

Table 4-49. Estimated Household Costs for Individual Sewerage Systems by Proposed Alternative*

Cost Category	Baseline	Alternative I	Alternative II	Alternative III†
County Fee‡	$125	$125	$125	$125
Installation	$4000–$5000	$4000–$5000	$4000–$5000	$11,000–$17,000§
Annual Operation	$0	$0	$0	$120–$300
Annual Maintenance	$100‖	$100‖	$100‖	$250–$400, plus costs of pumping every 3–6 years
Life Expectancy of the System	25–30 years	25–30 years	25–30 years	7–20 years for individual components

* Sources for cost estimates and life expectancy include information from I/A OWTS vendors, presentations and published reports. As with any costs, these may vary over time.

† These values represent the range of costs associated with a number of I/A OWTS alternatives. Note that updated cost information for I/A OWTS was made available through the County, following completion of the HIA analysis. This cost information can be found in Appendix K.

‡ County fee is for update or renewal and is based on Suffolk County 2016 Office of Wastewater Management Fee Schedule: http://www.suffolkcountyny.gov/Portals/0/Documents%20and%20Forms/Health%20Services/Wastewater%20Management/Forms/Fee%20Schedule.pdf.

§Some installation cost estimates assume an existing functioning septic tank. The absence of the tank would add to the installation cost.

‖Based on pumping cost of a 1,000-gallon tank at the recommended frequency of every 3 years for a household size of 4 people. This cost will vary based on tank and household size and volume of solids in the wastewater.

The cost of an upgrade, plus additional annual operational and maintenance costs, could have significant impacts on the health of households if households are forced to further cut spending on food, healthcare, and energy (University of Minnesota, 2017). Sanitary code changes that would require the installation of a C-OWTS or I/A OWTS may fit into a wealthier homeowner's budget, but **it is highly unlikely lower income homeowners would be able to budget for the installation without financial assistance.**

For a family with a median annual income of $100,179, **an investment of $5,225 (Alternative I/II)** would be equivalent to 5% of their annual income; **to comply with Alternative III, it could cost $17,825**, or 18% of their annual income. Installation would be much more of a burden for non-families, which represent 24% of households in the County and have a lower income. For non-families having a median household income of $46,476, the $5,225 investment would be equivalent to 11% of their annual income, and the cost to upgrade to an I/A OWTS would be roughly over a third of their annual income at 38%. As previously stated, total housing costs greater than 30% of the household income is considered a cost burden, and all efforts should be taken to assist cost-burdened households in the replacement of their OSDS. Note households may already be spending money on system repairs, so the replacement of a failing system would eliminate the cost of managing a failed system, although maintenance would still be required. The cost to repair a broken septic tank is cited at around $2,100 and annual maintenance is cited at around $100, while maintenance for an I/A OWTS system $240- $400 a year plus the cost of pumping every 3-6 years (HomeAdvisor, 2016a) (maintenance based on estimates gathered from I/A OWTS vendors).

Although households in renter-occupied structures would not have to install these OWTS systems themselves, the cost associated with their installation and maintenance may cause an increase in their rent. Septic tank repairs and replacements are generally considered improvements to the property and, therefore must be capitalized and depreciated over time, rather than being used as a one-time deduction (Hall L. , 2014).

C There are regional examples that Suffolk County can follow to mitigate the cost burden of individual sewerage system upgrades to residents.

For example, the New York State Energy Research and Development Authority offers three programs to help residents make improvements to their homes in order to reduce energy consumption and reduce utility costs. For a three-person household in Suffolk County, an income of less than $78,480 qualifies for up to a 50% discount on the improvement costs, and an income of $42,528 or less qualifies that household to have all of the improvement costs paid for by the state. Households with incomes higher than $78,480 qualify for a 10% discount on the improvement costs (New York State Energy Research and Development Authority, 2016).

Review of the Rhode Island and Maryland programs may provide Suffolk County with guidance on implementation of a program in Suffolk County, including the triggers for replacement of systems and loan and grant programs for households to assist with costs associated with installation and operation of new systems. More details on these State programs are provided in Appendix J.[38]

Suffolk County could seek outside funding to reduce the costs of individual sewerage system upgrades for individual households. Obtaining funding could occur at the county level, as well as at the local municipality level[39]. Assistance for cost-burdened and low-income households

[38] Since completion of the HIA analysis, funding (grants and loans) has been secured by the County for homeowners upgrading to I/A OWTS and these efforts were modeled after programs in both Maryland and Rhode Island. Rental properties are not eligible for the Septic Improvement Program (SIP) funding. For more information on these funding opportunities, see Appendix K.

[39] In addition to the funding secured since completion of the HIA analysis by the County for homeowners upgrading to I/A OWTS , several eastern Suffolk County towns also have their own grant programs. For more information on these funding opportunities and their criteria, see Appendix K.

and property owners renting to low income households[34] could be prioritized. Assistance could be made available for all household types, including non-family households, which have a much lower median income than family households. Following other states' examples, Suffolk County may consider low-interest, long-term loans for landlords so they are not faced with an immediate upfront cost.

Suffolk County should work with communities and OWTS vendors to plan concurrent upgrades to neighboring properties to reduce construction costs and take advantage of block grant opportunities.

Table 4-50 identifies the potential impacts of the proposed code changes on County costs and revenues and household costs for each decision alternative.

Table 4-50. Impact of Decision on County Costs/Revenues and Household Costs

Alternatives	Potential Changes
Baseline[*]	**Community Economics.** No anticipated changes in costs or revenues to the County due to implementation of the sanitary code. However, if other measures are not enacted to protect Suffolk County waters, County revenue streams may be at risk. **Household Economics.** No anticipated changes in costs to households due to installation, operation or maintenance of individual sewerage systems.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	**Community Economics.** Per Suffolk County Sanitary Code, installation of a new individual sewerage system would require a permit. If all existing OSDS are required to be upgraded (i.e., 192,558 households[†]), there would be an average increase in permits issued of 9,268 a year over the next 20 years;[‡] this represents just a fraction of the increased governing load of the County in the event of Alternative I implementation. The County should not expect a net gain in revenue from this proposed change. **Household Economics.** This would cost households with an existing OSDS an estimated $5,125 upfront and an approximate total cost of $8,125 over 30 years, or $271 a year. This would affect 50% of all unsewered households in Suffolk County, or 192,558 households.

Alternatives	Potential Changes
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current Sanitary Code and standards (in place as of September 2016).	**Community Economics.** Per Suffolk County Sanitary Code, installation of a new individual sewerage system would require a permit. If all existing OSDS in high priority areas are required to be upgraded (i.e., 125,751 households[†]), there would be an average increase in permits issued of 6,288 a year over the next 20 years;[‡] this represents just a fraction of the increased governing load of the County in the event of Alternative II implementation. The County should not expect a net gain in revenue from this proposed change. **Household Economics.** This would cost households located in high priority areas with an OSDS an estimated $5,125 upfront and an approximate total cost of $8,125 over 30 years, or $271 a year. This would affect 32.7% of all unsewered households in Suffolk County, or 125,751 households.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	**Community Economics.** Per Suffolk County Sanitary Code, installation of a new individual sewerage system would require a permit. If all existing OSDS and C-OWTS in high priority areas are required to be upgraded (i.e., 251,502 households[†]), there would be an average increase in permits issued of 12,575 a year over the next 20 years;[‡] this represents just a fraction of the increased governing load of the County in the event of Alternative III implementation. The County should not expect a net gain in revenue from this proposed change. **Household Economics.** Without financial assistance, this would cost households located in high priority areas with an OSDS or C-OWTS an estimated $17,825 upfront and an approximate total cost of $38,825 over 30 years, or $1,294 a year.[§] This would affect 65.3% of all unsewered homes, because 75% of the total housing stock is estimated to be in the high priority areas or 251,502 households.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to the continuing decline of surface waters and associated revenue streams in Suffolk County.

[†] See Appendix G for the methodology used to determine the number of households affected by each decision alternative.

[‡] These calculations are based on the following assumptions: A property transfer trigger for individual sewerage system upgrade and a 5% annual average sale rate in the County.

[§] For more information on financial assistance put in place after completion of the HIA analysis and updated I/A OWTS costs, see Appendix K.

4.6.3 Impact of *Change in Employment Opportunities in OSDS/OWTS Industry* on Community and Household Economics

Employment and wages are key factors of household income. **The increase in demand for individual sewerage system upgrades may lead to more job opportunities in the sewerage system service and manufacturing industries**; although, the locations of these opportunities may not be limited to Suffolk County. There may also be additional opportunities for employment by Suffolk County's Department of Health Services to meet the increased demands for implementation and management of the code changes. Improved employment in the County in any capacity supports the overall economy in the area.

Existing Employment Opportunities in OSDS/OWTS Industry at the Time of the HIA Analysis

At the county level, the responsible department for implementing and managing the code changes is the SCDHS, which includes the DEQ and the Office of Wastewater Management. The number of County employees in DEQ averaged between 50 in 2005 to 53 in 2011, the last year data was available (Office of the Comptroller, 2015). SCDHS employs over 1,000 people. In Suffolk County, the unemployment rate was 4.8% in 2015, having declined three percentage points since it peaked in 2012 (Office of the Comptroller, 2016). Before the economic recession, the unemployment rate ranged from 4.2% in 2005 to 4.9% in 2008 (Office of the Comptroller, 2015). With a 2015 population estimate of 1,501,587, the estimated number of unemployed individuals in Suffolk County is 72,076 (Office of the Comptroller, 2016).

A survey of online resources produced a list of 71 companies that provide cesspool and septic services on Long Island. The U.S. Census Bureau 2014 County Business Patterns identified 65 businesses related to "Septic Tank and Related Services" in Suffolk County. The OSDS/OWTS industry represents a $17.7 million industry in Suffolk County alone. According to the County Business Patterns, 348 people were employed in the industry in Suffolk County in 2014 (United States Census Bureau, 2016).

Employment opportunities in this industry have already been on an upward trend since 2012. According to the North American Industry Classification System (NAICS), between 2012 and 2014 the number of people employed in the "Septic Tank and Related Services" industry in Suffolk County increased from 328 to 348 people. This is a 6% increase, and if this trend continued to 2016, there would be an estimated 369 people working in the field. The annual payroll for these employees also increased, from $15,520,000 in 2012 to $17,712,000 in 2014 (United States Census Bureau, 2016).

In June 2016, the County passed a law requiring licensed liquid waste professionals to acquire training and certification for septic tank plumbing, cleaning and maintenance; waste line cleaning and inspection; bulk liquid waste transportation; vactor (pump/vacuum) services; conventional septic system maintenance inspection; conventional septic system installation; I/A OWTS installation; and I/A OWTS service provider, among other endorsements (LILWA, 2016). LILWA and SCDHS provide the required training, in cooperation with the University of Rhode Island New England Onsite Wastewater Training Program, and LILWA issues most of the endorsements through their certification program (LILWA, 2016). For I/A OWTS installation, an LILWA endorsement is required and installation training certification from the manufacturer of the specific technology being installed[40]; I/A OWTS service providers must be certified by the manufacturers of each technology to be serviced (LILWA, 2016). Continuing education is also required upon license renewal.

Anticipated Change(s) in Employment Opportunities in OSDS/OWTS Industry

Since there are an estimated 192,558 households that would have to be updated to meet the new standards in Alternative I, 125,751 households in Alternative II, and 251,502 households in Alternative III, an update in sanitary code represents an opportunity for growth in the OSDS/OWTS industry in all sectors – inspection, service, construction, and manufacturing. While there are currently approximately 70 septic system businesses on Long Island, it is likely that given the high rate of demand created by the proposed code changes, companies from other parts of New York and the surrounding areas may extend service to Suffolk County to meet the demand. In addition, Suffolk County residents may open more septic system installation and repair companies, grow their current operations or be hired by non-local companies. These local companies may also hire those from out of the County, limiting local job growth but still contributing to the overall growth of this sector of the economy. Growth in inspection, installation, maintenance, and repair would just be a fraction of the job growth in this sector, as manufacturing and shipping of individual sewerage systems would also grow. Even with these industries based outside of the County itself, the increased economic activity brought into Suffolk County will positively impact the local service economy.

Employment opportunities at SCDHS and the Office of Wastewater Management may also increase with the greater demand for inspectors, permit evaluation, and loan management associated with the proposed code changes. These offices and departments should expect to hire more people as implementation of the County's code change is rolled out.

Suffolk County could take steps to encourage OWTS businesses to locate and hire within the county. Possible strategies include tax incentives and decreases in certification fees for OWTS companies that locate in the County and support of a community jobs program to train local residents in OWTS and I/A OWTS technology installation, maintenance, repair, and inspection. Consider working with local community colleges to include training courses in this field.

Suffolk County could send out maintenance reminders to residents to help provide a stable market for the companies.

Suffolk County could select a timeline for implementation that will encourage tempered growth of the OSDS/OWTS industry, minimizing the risk of a spike in the cost of installation and unsustainable industry growth.

Table 4-51 identifies the potential impacts of the proposed decision on the OSDS/OWTS industry for each decision alternative.

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[40] As of July 2018, 400 workers have graduated from the training (Moran, 2018).

Table 4-51. Impact of Decision on Employment in the OSDS/OWTS Industry

Alternatives	Potential Changes
Baseline	**No change in job opportunities** in the OSDS/OWTS industry.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	An estimated 50% of unsewered single family residences (192,558) will be required to install a new individual sewerage system, so this may result in a big boon to the OSDS/OWTS industry. **Job growth would be greater than the baseline and Alternative II, but less than Alternative III.** **Employment in SCDHS may also increase** with the greater demand for inspectors, permit evaluation, and loan management to support implementation and management of the code changes.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current Sanitary Code and standards (in place as of September 2016).	Approximately 125,751 single family residences in the high priority areas will be required to install a new individual sewerage system. **Job growth in the OSDS/OWTS industry is expected in response to this alternative, higher than the baseline, but less than Alternative I or III.** **Employment in the local SCDHS may also increase** with the greater demand for inspectors, permit evaluation, and loan management to support implementation and management of the code change.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	Approximately 251,502 single family residences are unsewered in the high priority areas, so this alternative represents the **greatest opportunity for job growth in the OSDS/OWTS industry** (as the greatest number of households would require installation) **Employment in the SCDHS may also increase** with the greater demand for inspectors, permit evaluation, and loan management to support implementation and management of the code change.*

* The SCUPE grant currently provides funding to support the I/A OWTS program implementation.

4.6.4 Impact of *Change in Employment Opportunities and Community Costs/ Revenues from Commercial Fishing and Recreational Industries* on Community and Household Economics

To have a healthy fishing economy, there must be healthy, intact fish habitat for mating, egg laying, and rearing and good water quality to support the industry (Dlugolecki, 2012). A study conducted in Chesapeake Bay found that the effect of deteriorating water quality (e.g., eutrophication) on striped bass would have significant adverse economic impacts on the fishing industry (Lipton & Hicks, 1999). The same has been reported in the media for Long Island, and this remains a primary environmental concern for the public, according to responses gained during the community engagement and outreach portion of this HIA.

The recreational fishing industry's direct economic impact is driven by sales, jobs, income, and value added. Sales come from the purchasing of fishing equipment, ice, and bait and expenditures related to taking the trip, like gas, food, and lodging. These sales expenditures require jobs that generate income

(Pendleton & Rooke, 2006; Southwick Associates, 2015). Fishing license fees also support local and state tax revenues (Dlugolecki, 2012).

Commercial fishing is a billion-dollar industry in the U.S. that provides thousands of jobs and is a significant contributor to coastal and state economies in states like New York (Henry, et al., 2013). Commercial fishing's economic impact derives from each step of the value chain from harvesting seafood to the final consumer, as each step involves jobs, sales, income, and value added that contribute to the overall economic impact. Commercial fishermen harvest the fish which then pass through primary processors and dealers, secondary wholesalers and distributors, and finally retail outlets like grocers and restaurants. As with recreational fishing, water quality can also affect commercial fisheries, with conditions like increased nitrogen loading affecting the timing of commercial fishing seasons as well as the size of catches (Keeler, et al., 2012).

Existing Employment Opportunities and Community Costs/Revenues in Commercial Fishing and Recreational Industries at the Time of the HIA Analysis

NOAA includes fishing-related industry and recreation in their "Ocean and Great Lakes Jobs" category, which includes industries that use the oceans and Great Lakes as inputs directly (like fishing) and indirectly (like beach tourism). NOAA recently published the Ocean and Great Lakes Jobs Snapshot in March of 2015; these estimates do not include self-employed individuals, but do include part-time workers, highlighting the seasonal and/or part-time nature of several of these industries (NOAA, 2015b).

In 2013, NOAA estimated 31,569 employees in the ocean jobs industries in Suffolk County overall, earning approximately $887 million in wages and creating $1 billion in goods and services (NOAA, 2016c). Suffolk County Ocean Jobs are comprised of tourism and recreation (88.5%), marine transportation (10.4%), living resources (including shellfishing and marine fishing; 1%), and offshore mineral extraction (less than 0.1%; Figure 4-52). Tourism and recreation jobs experienced the greatest growth from 2005 to 2013, increasing by 33.7% (NOAA, 2016c). The Long Island Regional Development Council (2015) stated that traveler spending across all of Long Island was $5.5 billion in 2015, and tourism generated $202 million in local tax revenue for Suffolk County in 2015.

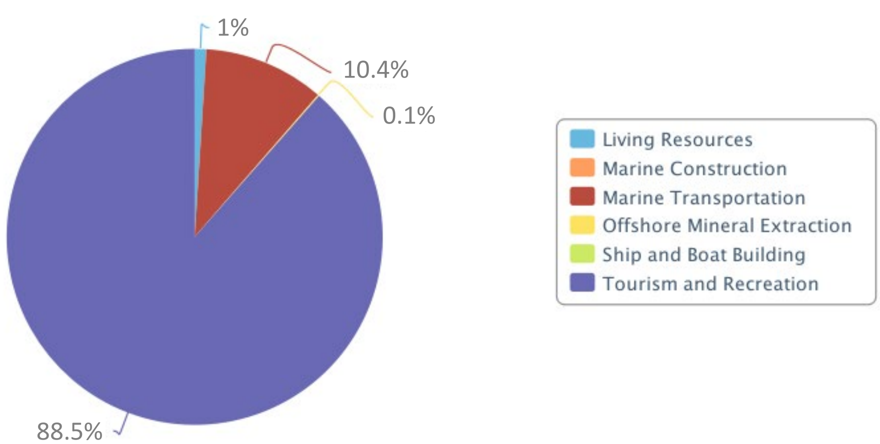


Figure 4-52. Ocean jobs in Suffolk County 2013. Source: (NOAA, 2016c)

C NOAA developed a set of social indicators of fishing community vulnerability and resilience (NOAA, n.d.-c). Included in the set of measures are fishing engagement and reliance indices that portray the importance or level of dependence of commercial or recreational fishing to coastal communities.

Commercial fishing engagement measures commercial fishing activity through permits and vessel landings and commercial fishing reliance looks at the activity relative to the population of the community. Recreational fishing engagement looks at recreational fishing through fishing activity estimates and the reliance measure is relative to the community population. For each indicator, a high rank indicates more engagement or reliance. These indices were calculated for the ten towns in Suffolk County (Table 4-52). Babylon and Huntington both have high indicators for recreational fishing engagement and 4 out of the 10 towns have medium to medium-high indicators for commercial fishing reliance. For these towns, recreational and commercial fishing make up a larger share of the jobs and economy relative to other towns in Suffolk County.

Table 4-52. Fishing Engagement and Reliance Indicators for Select Suffolk County Towns. Source: (NOAA, n.d.-c)

Town	Commercial Fishing Engagement	Commercial Fishing Reliance	Recreational Fishing Engagement	Recreational Fishing Reliance
Babylon	Low	Medium	High	Medium
Brookhaven	Low	Low	Low	Low
East Hampton	Medium	Medium	Medium	Medium
Huntington	Low	Medium	High	Low
Islip	Medium	Medium High	Low	Low
Riverhead	Low	Medium	Low	Low
Shelter Island	Low	Low	Low	Low
Smithtown	Low	Low	Low	Low
Southampton	Low	Low	Low	Low
Southold	Low	Low	Medium High	Medium

The decreased economic activity caused by the decline in water quality has raised the concern of many citizens, scientists, and politicians in Suffolk County. “Our economic and ecological well-being is tied to the health of our oceans, the productivity of our bays, and the recreational opportunities at our beaches. Harmful algal blooms pose a real threat to those assets and we must continue to fund the research projects and strategy plans that will lead to wise, water quality stewardship,” County Executive Steve Bellone said when announcing the plan to develop a Harmful Algal Bloom Action Plan and Strategy in 2014 (Suffolk County Government, 2014c). The Suffolk County Executive Office cited ocean-related jobs as 4.4% of the total jobs in the County in 2011.

Anticipated Change(s) in Employment Opportunities and Community Costs/Revenues in Commercial Fishing and Recreational Industries

C The impact of the proposed code changes on employment in the commercial fishing and recreational industries is dependent on the code's ability to address nitrogen and pathogen loading to Suffolk County waters.

As outlined in the Water Quality pathway (Section 4.3), Alternatives I and II do not address the nitrogen contributions from individual sewerage systems and provide a limited (1-$\log_{10}$) reduction in pathogens; therefore, these alternatives would not substantially reduce the negative impact of harmful algal blooms and pathogen loading on the commercial fishing and recreational industries. If Alternative I or II are selected, the County will need to invest in other actions to reduce nutrient and pathogen loading. **Unless nitrogen and pathogen pollution is addressed, towns with a higher reliance on commercial and recreational fishing and tourism industries may continue to be impacted.** The tourism industry relies on tourists coming to Long Island to enjoy its beaches and recreational fishing opportunities and fresh seafood. Without a healthy environment, the decreased fishing potential and closed beaches will reduce the number of tourists, thereby reducing the employment opportunities in the tourist and services industries. **As the population in the east end of Suffolk County nearly doubles in the summer months** (New York State Comptroller, 2006; SCDEP, 2008)**, any reduction in tourism may lead to a significant decrease in summer employment opportunities and revenues for the County.**

From the community economics perspective, Suffolk County could weigh the costs and benefits of implementing Alternative III as a means to address nitrogen and pathogen loading to Suffolk County waterbodies. Although the upgrade to I/A OWTS adds additional costs to individual households, it would positively impact the commercial fishing and recreational industries by improving water quality. There are creative ways to cover the necessary investment to implement Alternative III, such as Maryland's Bay Restoration (Septic) Fund Program (see Appendix J). In taking action, the County can prevent the further decline of water quality and the potential elimination of commercial fishing in the area. Recreational fishing is based on reputation, and if the County wants to reverse the trend of declining recreational fishing in the future, it has to take action now to reduce future nitrogen loading. If the water quality continues to worsen, neither tourists nor commercial fishing companies will want to remain or move to the County.

If Alternative I or II is selected, the County may need to invest in other measures to reduce nutrient enrichment and protect water resources. Commercial fishing and recreational industries are influenced by the quality of the surrounding environment. Declining water quality may decrease employment opportunities associated with both sectors, which will in turn impact county revenue and household income from commercial fishing and recreational industries.

If Alternative III is selected, the County could consider towns with a greater reliance on commercial and recreational fishing in the prioritization of areas for implementation of the code.

Table 4-53 identifies the potential impacts of the proposed code changes on employment opportunities and community costs/revenues in the commercial fishing and recreational industries for each decision alternative.

Table 4-53. Impact of Decision on Employment Opportunities and Community Costs/Revenues in Commercial Fishing and Recreational Industries

Alternatives	Anticipated Changes
Baseline*	Nitrogen and pathogen loading to Suffolk County waters from individual sewerage systems would continue, putting employment opportunities and revenues from the commercial fishing and recreational industries at risk for decline.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Per the Water Quality pathway assessment, there would be no change in total nitrogen loading and a limited (1-$\log_{10}$) reduction in pathogen loading to Suffolk County waters (Table 4-19); therefore, the **employment opportunities and revenues from the commercial fishing and recreational industries would be at continued risk for decline**.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	Per the Water Quality pathway assessment, there would be a reduction in nitrogen loading and the potential for a greater reduction in pathogen loading from individual sewerage systems; however, the rate of loading to receiving waters downgradient from these systems is unknown. Although an improvement in water quality is expected, it is unknown how long it would take for this improvement to be seen, considering groundwater travel times of 0-10 years along the coast and up to decades and even hundreds of years from the middle of Long Island (Table 4-19); hydrologic modeling and GIS analysis are needed to determine the net effect for each watershed (including travel times and attenuation) and the cascading effects to coastal areas[41]. Improvements in water quality **may contribute to maintaining or increasing opportunities for employment and revenues** in the commercial fishing and recreational industries in Suffolk County.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of

[41] Note that the Subwatersheds Wastewater Plan developed by Suffolk County, after completion of this HIA, involved countywide nitrogen loading modeling that was used to establish travel times and nitrogen loading estimates for each subwatershed, establish nitrogen load reduction goals based upon specific human health and environmental endpoints, and refine priority areas in which to focus those efforts. For more on this effort, see Appendix K.

individual sewerage systems) would lead to the continuing decline of surface waters and opportunities for employment and revenue in the commercial fishing and recreational industries in Suffolk County.

4.6.5 Impact of *Change in Residential Property Values* on Community and Household Economics

A functioning individual sewerage system is usually expected when purchasing a home, so installing a new system to replace an aging but functioning system is not expected to increase the property value. One exception would be if the home is located in an area that is required by law to upgrade their individual sewerage system; in this case, a house that has already upgraded their system would likely be more valuable than had they left that expense for the new homeowner. The proposed code changes may increase the salability of the average home in Suffolk County and may stimulate housing economy by increasing sales. As water quality improves as a result of the sequestration of nitrogen in Alternative III, housing sales may also increase as demand for waterfront and beach access neighborhoods increases.

Waterbodies near properties provide a number of benefits to property owners, such as aesthetics, recreational opportunities, economic impacts through property prices, and other ecosystem services (Michael, Boyle, & Bouchard, 1996; Walsh, Milon, & Scrogin, 2011). Additionally, higher property values generate higher property taxes, which translate into greater revenue for communities (Dlugolecki, 2012). The most studied characteristic of water bodies and its impact on property values is water quality.

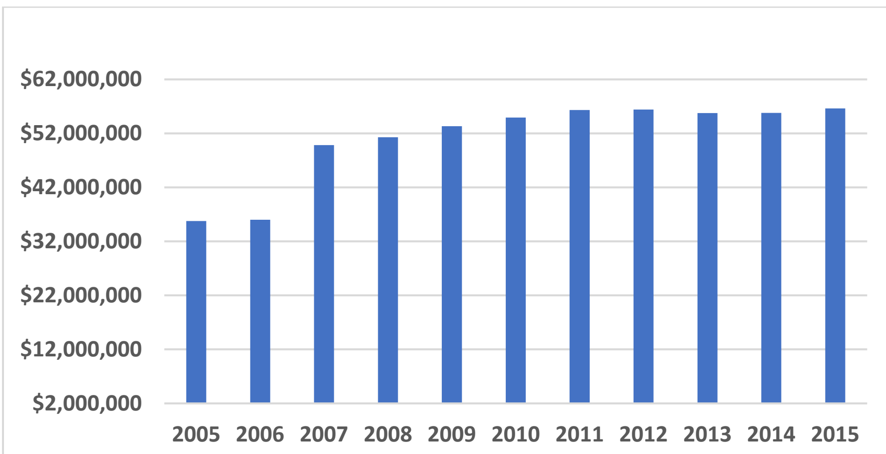
Researchers Dr. Anthony Dvarskas (Stony Brook University) and Dr. Elizabeth C. Smith (The Nature Conservancy) have conducted research on the economic benefits of improving water quality in Suffolk County. Although their data was limited to four towns – Riverhead, Smithtown, Southampton, and Southold – they found that **water quality, measured as water clarity, affects housing values at a rate of 2% for every 1-foot increase in water transparency. Further, they found that having waterfront access has a dominant effect on price, suggesting that increases in water clarity can significantly impact the value of residential property in Suffolk County** (Dvarskas & Smith, 2016).

The results of the Dvarskas and Smith (2016) research are supported by similar studies in other geographic areas. A study by Gibbs et al. (2002) in New Hampshire found that the overall decline in water quality from eutrophication had a negative impact on waterfront property values and that the economic ramifications of this decline could negatively impact local property tax revenues and state taxes. Additionally, in Florida, researchers found that improved surface water quality, measured as water clarity, had a notable impact on waterfront properties and did affect property values on properties located just beyond waterfront and quickly diminished the further the distance from the waterfront (Walsh, Milon, & Scrogin, 2011). Overall, improved water quality has a positive influence on residential property values, which in turn, adds to both the household and community economies. Beach quality is also an important determinant of coastal property values, although fewer studies have looked at this relationship (Pompe & Rinehart, 1995).

Homeownership is the most common mechanism in the United States to increase a household's wealth. The Joint Center for Housing Studies at Harvard University published a report in 2013 titled, "Is Homeownership Still an Effective Means of Building Wealth for Low-Income and Minority Households? (Was it Ever?)." The authors concluded that homeownership continues to represent an opportunity for families and individuals of limited means to accumulate wealth (Herbert, McCue, & Sanchez-Moyano, 2013).

Existing Residential Property Values at the Time of the HIA Analysis

Residential property values in Suffolk County increased from $35.76 million in 2005 to $56.61 million in 2015 (Figure 4-53), which in turn increases the County's tax base. Assessed value is used here rather than true value because it is reliably tracked and is part of the discussion of tax base. A growing tax base is a high priority for a local government because taxes provide critical revenue for county services. Stable or increasing property values also provide a greater level of stability for personal wealth, thus supporting household economics for homeowners.



*The assessed value of property is determined by totaling the assessed valuation of the component towns. Data for the Town of Brookhaven was not available for 2006.

Figure 4-53. Assessed value of residential property in Suffolk County, 2005–2015. Source: (Office of the Comptroller, 2016).

Though housing prices have risen in the last 10 years, the assessed value of residential property has not risen more than $1.5 million per year, except for the $14 million jump between 2006 and 2007. Figure 4-54 shows the trend in assessed value of residential property in Suffolk County from 2008–2015. The decrease in assessed value of residential property (i.e., depreciation) in 2012 and 2013 bears the mark of Hurricane Sandy, which hit the East Coast on October 26th, 2012 (Henry, et al., 2013). Since 2013, though, the percent increase in assessed value of residential property has continued on a positive trend, reaching 1.49% in 2015 (Office of the Comptroller, 2016).

Real property taxes provided over $100 million in revenue for the County in 2015. According to the Office of the Comptroller's Annual Comprehensive Financial Report for the year ending December 2015, revenue was higher than expected for real property taxes, but below budget for every other source of revenue (Office of the Comptroller, 2016).

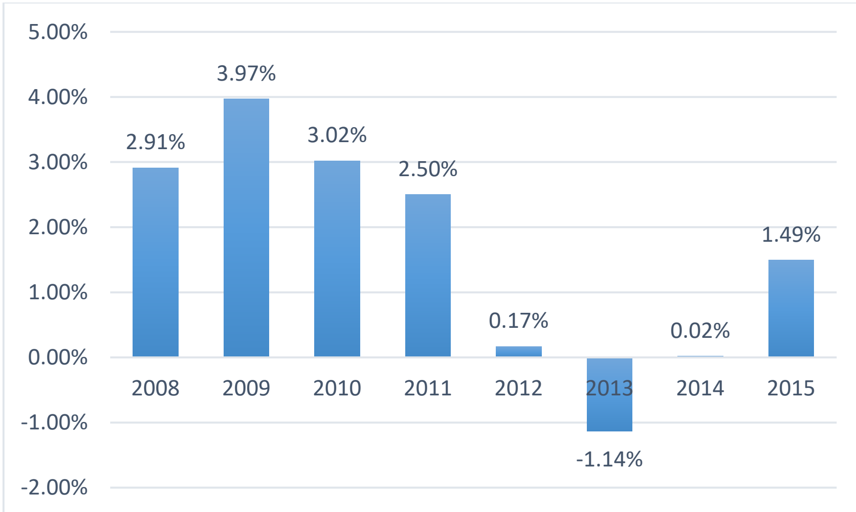


Figure 4-54. Percentage change in assessed value of residential property in Suffolk County, 2008–2015. Source: (Office of the Comptroller, 2016).

Anticipated Change(s) in Residential Property Values

Research shows that increased (good) water quality does have a positive impact on real estate value, and Dvarskas and Smith (2016) demonstrated the potential for that impact in Suffolk County. Suffolk County has nearly 1,000 miles of coastline, so beach and water quality can have dramatic impacts on the overall economy through their effect on residential property values. The question remains whether the proposed code changes will help address the cause of the deterioration in Suffolk County water quality.

There would be no reduction in the amount of total nitrogen leaving the individual sewerage system in Alternatives I and II, so these alternatives could have a limited impact on water quality. Unless Alternative III is implemented and/or other actions are taken to decrease nitrogen loading, property values are expected to be impacted by declining water quality. If Suffolk County takes action to improve water quality, property values could increase as a result of proximity to the waterfront; demand for vacation homes could increase due to recreation and tourism; and the County's reputation could grow as a desirable, healthy, safe place to live; however, there are other variables that would also factor into determining the value of properties in the County and whether a net increase in property values occurs.

If Alternative I or II is selected, the County will need to invest in other measures to reduce nutrient enrichment and protect water resources. Property values are influenced by the quality of the surrounding environment and declines in property values may impact county revenue from property taxes, as well as personal wealth and household income of county residents.

Table 4-54 identifies the potential impacts of the proposed code changes on residential property values for each decision alternative.

Table 4-54. Impact of Decision on Residential Property Values

Alternatives	Potential Changes
Baseline*	No change in nitrogen and pathogen contributions from individual sewerage systems; poor water quality could lead to declines in property values.
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Per the Water Quality pathway assessment, there would be no change in total nitrogen loading and a possible reduction in pathogen loading to Suffolk County waters (Table 4-19); therefore, **no abatement of the potential impact of poor water quality on property values**.
Alternative II All existing OSDS in the high priority areas must be upgraded to conform to current Sanitary Code and standards (in place as of September 2016).	Same as Alternative I.
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/alternative system design.	Per the Water Quality pathway assessment, there would be a reduction in nitrogen loading and possible reduction in pathogen loading from individual sewerage systems; however, the rate of loading to receiving waters downgradient from these systems is unknown. Although an improvement in water quality is expected, it is unknown how long it would take for this improvement to be seen, considering groundwater travel times of 0-10 years along the coast and up to decades and even hundreds of years from the middle of Long Island (Table 4-19); hydrologic modeling and GIS analysis are needed to determine the net effect for each watershed and the cascading effects to coastal areas[42]. Improvements in water quality **may potentially contribute to an appreciation in property values**.

* It should be noted that the Baseline does not represent the future state if no upgrades to individual sewerage systems are made. It is assumed that maintaining the status quo (i.e., doing nothing to address the nitrogen and pathogen loading of individual sewerage systems) would lead to the continuing decline of surface waters in Suffolk County, which could lead to further declines in property value.

[42] Note that the Subwatersheds Wastewater Plan developed by Suffolk County, after completion of this HIA, involved countywide nitrogen loading modeling that was used to establish travel times and nitrogen loading estimates for each subwatershed, establish nitrogen load reduction goals based upon specific human health and environmental endpoints, and refine priority areas in which to focus those efforts. For more on this effort, see Appendix K.

4.6.6 Impact of *Costs Due to Damage from Storms and Flooding* and *Costs Due to Vector Control* on Household and Community Economics

The economic impacts the decision alternatives could have as a result of changes in damage due to storms and flooding and vector control have been combined in this section, because the impacts and discussion are limited.

The full economic impact of storm and/or tidal surges and inundation goes beyond direct damage and losses. Property and infrastructure damage at the household level can strain personal finances for a variety of reasons including the costs associated with an evacuation, the costs of repair, rebuilding, and replacing belongings and interruptions in and/or loss of employment and income. Some of these expenses may be covered by insurance and for extreme events, state or federal aid, but household economics are strained as individuals try to sort out the damages and get back on their feet. The effect on personal finances can even lead to the loss of permanent residences, as houses go into default or foreclosure.

Direct physical damages can have severe consequences for a community's revenue stream. Harder to measure are the economic costs associated with indirect losses such as loss of power, disruption of transportation services, and washed-out roadways. In addition, local resources can become taxed, as money is diverted to aid in recovery and reconstruction. However, natural disasters can also stimulate the economy if local workforces and businesses are employed in the cleanup, recovery, and reconstruction (Economics and Statistics Administration, 2013).

Both resiliency and the decision alternatives themselves have implications for vector control measures, including the costs of surveillance, water management, and pesticide applications.

Existing Costs Due to Damage from Storms and Flooding and Costs Due to Vector Control at the Time of the HIA Analysis

Storms and Flooding

As of January 2014, the National Flood Insurance Program has made $1,012,752,084 in loss payments to residents of Suffolk County. For some households, property damage from storms and/or tidal surges and flooding are a recurrent problem. Suffolk County has noted that there are 2,848 repetitive loss or severe repetitive loss residential properties in the County as of January 2014, over 92% (i.e., 2,628 properties) are single family residences (Suffolk County Government, 2014b). Flood insurance can provide some relief to offset these losses.

While the proposed code changes are not expected to impact resiliency to storms like Hurricane Sandy, the economic impact of this type of storm is more fully understood than that associated with Nor'easters and coastal flooding, and so it is presented here for reference. The economic impact of Nor'easters may not be as severe as that experienced with Hurricane Sandy (although the conditions that made Hurricane Sandy particularly destructive might make a Nor'easter just as damaging), and economic impacts of coastal flooding would be assumed to be several magnitudes lower. It should be noted, however, that damages from both of these types of storms may not reach thresholds that qualify for FEMA assistance.

According to FEMA's Modeling Task Force (FEMA MOTF, 2014), Hurricane Sandy damaged or destroyed a total of 24,489 structures in Suffolk County, 13,835 of which were residences. FEMA Individual Assistance (IA) verified losses in Suffolk County totaled $184,460,599.

Immediately following Hurricane Sandy, unemployment in New York and New Jersey rose 2.8%, but returned to pre-storm levels within four weeks (Abel, Bram, Deitz, & Orr, 2013). A year after Hurricane Sandy, default notices and foreclosures in Suffolk County were both up 28% and bank-owned properties rose 50% (Renwood RealtyTrac LLC, 2013). The counties most affected by Sandy (including Suffolk County) saw the lowest rise in home prices the year following the event, despite a steady rise in home prices in the years preceding the storm (Renwood RealtyTrac LLC, 2013).

A study by the Economics and Statistics Administration (2013), examining unemployment claims, payroll data, and industrial production data in New York and New Jersey following Hurricane Sandy, found that the economic hit caused by direct damage and interruptions to businesses and industries at the community level were for the most part, short-lived and fully recovered from several months after the storm. An assessment conducted by NOAA showed that commercial and recreational fishing sectors took a big hit in New York, with damages totaling $19 million and $58 million, respectively, but fishing industry economics were able to rebound after the storm (NOAA, 2013). No long-term losses to the travel and tourism industry were noted for Long Island as a result of Hurricane Sandy.

Vector Control

Additionally, the County may have additional costs for vector control because storm and/or tidal surges and inundation can lead to standing water, which serves as temporary habitat for mosquitoes. Currently, mosquito control is the responsibility of the Department of Public Works in Suffolk County. The total acreage sprayed for larval and adult mosquitoes varies year to year. Over the past 10 years the highest number of acres sprayed was 77,239 in 2010. In 2015, the total was 25,350 acres (Office of the Comptroller, 2016).

Anticipated Change(s) in Costs Due to Damage from Storms and Flooding and Costs Due to Vector Control

Storms and Flooding

Based solely on the proposed changes to the sanitary code, there is no expectation that costs due to damage from storms and flooding or costs due to vector control will change. However, it is still important for the County to consider the costs incurred due to storm events by individual households and the costs for flood insurance in high-risk zones as they move to implement changes to the code. Households located in high-risk zones for storms and flooding have higher flood insurance premiums and the added costs to update their individual sewerage systems may place these households at a greater risk to become cost-burdened than homes in PRP zones.

Tourism Economics (2012) indicates that travel and tourism is a $5.1 billion industry in Long Island and accounts for 6.2% of all employment in Long Island. Although Hurricane Sandy did not have a major impact on this industry, the more recurrent and long-term impacts from coastal flooding, erosion, and sea level rise could lead to impacts. Likewise, more frequent and stronger intensity storms are expected to produce greater property and infrastructure damage and therefore, greater impacts to household and community economics.

Vector Control

Both resiliency and the proposed code changes themselves have implications for vector control measures, including the costs of surveillance, water management, and pesticide applications. Upgrading of individual sewerage systems can lead to a reduction in potential breeding habitat for mosquitoes in residential areas if the new systems are properly maintained (Barrera, et al., 2008; Mackay, Amador, Diaz, Smith, & Barrera, 2009; Burke, Barrera, Lewis, Kluchinsky, & Claborn, 2010), and in the case of Alternative III may result in improved water quality and a commensurate improvement in mosquito populations associated with nitrogen impaired waters (Marten, Nguyen, Mason, & Giai., 2000; Resh & Rosenberg, 2008); however, these may be offset partially or in total by the increase in mosquito habitat caused by storm and/or tidal surges, inundation, and most concernedly, accelerated sea level rise.

4.6.7 Impact of Changes in Household Economics on *Nutrition-related Outcomes (Food Insecurity and Health)*

Research indicates that as overall housing costs (including heating and cooling) increase, food insecurity increases (Fletcher, Andreyeva, & Busch, 2009; Cook, et al., 2010; Moses, 2008; Pannell & Yeakey, 2011). Food insecurity is a state in which a household reports reduced quality of diet and/or disrupted eating patterns and reduced food intake (Coleman-Jensen, Gregory, & Rabbitt, 2016).

Food insecurity has been shown to increase the risk of a multitude of physical and mental health issues for both children and adults. Food insecurity is a serious issue for expecting parents as it is associated with preterm births and low birth weights (Olson, 1999; Bhattacharya, DeLeire, Haider, & Currie, 2003; Bhattacharya, Currie, & Haider, 2004; Whitaker, Phillips, & Orzol, 2006). During childhood, food insecurity can further hinder important developmental points in the child's life and can lead to delays in the development of mental and cognitive health (RTI International, 2014). Elderly populations are also vulnerable to the effects of energy insecurity due to rising energy costs. For some households, the additional cost burden for upgrading, operating, and maintaining OWTS or I/A OWTS may put them at increased risk for food insecurity.

Existing Nutrition-related Health (Food Insecurity) at the Time of the HIA Analysis

In Suffolk County's Community Health Assessment (SCDHS, 2015a), food insecurity and hunger were identified as a health concern for financially-challenged residents. The Supplemental Nutrition Assistance Program (SNAP), soup kitchens and food pantries provide food resources to families in the county. Since 1975, SCDHS has sponsored the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) to provide nutrition assistance for families in Suffolk County.

Data on health outcomes associated with food insecurity, such as low birth weight and developmental problems, were included in the Suffolk County Community Health Assessment 2014-2017 and the 2014 Community Needs Assessment by Stony Brook Medicine (Stony Brook Medicine, 2014; SCDHS, 2015a). In Suffolk County, the percent of low birth-weight infants was 7.7%, which is lower than the full statewide rate of 8.2%. The percent of pre-term births (< 37 weeks' gestation) in Suffolk County in 2011 was 11.5% – above the statewide rate of 10.7– but dropped to 7.6% for births associated with SCDHS Health Center services. The County Health Assessment (SCDHS, 2015a) identifies pre-term birth as the "primary reason infants die before their first birthday in Suffolk County." The Division of Services for Children with Special Needs Early Intervention Program provided intervention services to nearly 6,000 infants and toddlers in 2012, with speech and language as the dominant services; these services are cost shared by the State and County. Children aged 3 to 5 are screened for preschool services and 80% of the 4,328 evaluated in 2012 were eligible.

Anticipated Change(s) in Nutrition-related Health (Food Insecurity)

As discussed in the section on Household Economics, the proposed changes to the sanitary code will result in costs to individual households for county fees, installation, operation and maintenance of individual sewerage systems. Without financial assistance, the cost burden to families for upgrading an individual sewerage system under the proposed code changes ranges from 5% of their annual income for Alternatives I and II to 18% for Alternative III. For non-families, who occupy 19.8% of owner-occupied households, the cost burden is higher, ranging from 11% for Alternatives I and II to as high as 38% for Alternative III, based on median annual household income in the County[43,44]. **For households**

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[43] Median average household income in the County is used because the geographic location of OSDS was unknown at the time of the HIA analysis; therefore, geographic-specific income could not be determined.

[44] Since completion of the HIA analysis, funding (grants and loans) has been secured by the County for homeowners upgrading to I/A OWTS. For more information on these funding opportunities and their criteria, see Appendix K. Suffolk County has established that there is no plan to move forward with wastewater upgrades unless a stable, recurring revenue source is established to help reduce financial impacts to individual households and ensure that County services are not jeopardized by the costs of wastewater upgrade implementation.

that are already experiencing difficulty, the increase in household expenditures for compliance with the code changes may increase their risk for food insecurity and the associated health outcomes. This is a high cost burden to place on these residents and all efforts should be taken to assist cost-burdened households in the replacement of their individual sewerage systems.

Table 4-55 identifies the potential impacts of the proposed code changes on nutrition-related health outcomes (food insecurity) for each decision alternative. The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-55, you must read the Likelihood and Magnitude columns together (e.g., it is highly likely Alternative I would detract from health for a moderate number of people). For a summary of the different ways in which health could be impacted through the Community and Household Economics pathway see Section 4.6.9.

Table 4-55. Impact of Decision on Nutrition-related Outcomes (Food Insecurity and Health)

Health Determinant							
Nutrition-related Outcomes related to food insecurity	**Baseline Health Status** In Suffolk County's Community Health Assessment (SCDHS, 2015a), food insecurity and hunger were identified as a financially-caused health challenge among residents. Preterm births, low birthweights, and developmental delays are associated with poor nutrition and/or food insecurity. In Suffolk County, the percent of low birth weight infants was 7.7% (percent of live births 2006-2012), which is lower than the statewide rate of 8.2%. The percent of pre-term births in Suffolk County in 2011 was 11.5% – above the statewide rate of 10.7% – but dropped to 7.6% for births associated with SCDHS Health Center services (SCDHS, 2015a). The County Health Assessment identifies pre-term birth as the "primary reason infants die before their first birthday in Suffolk County."						
Alternatives	**Direction**	**Likelihood**	**Magnitude**	**Distribution**	**Severity**	**Permanence**	**Strength of Evidence**
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	Without financial assistance, the increased cost of the proposed upgrades could **detract from health by** increasing household costs and potentially food security by **reducing the amount of expendable income** available for nutrition.	The risk for food insecurity is **highly likely** since the evidence shows that cost-burdened households experience a greater degree of food insecurity and nutrition-related health impacts.	The extent of people affected would be **moderate** and is dependent on the number of cost-burdened households that will need to upgrade their individual sewerage systems.	**Individuals with fixed/low income and/or high housing costs,** elders, children, and pregnant women would be **disproportionately impacted** more than others, without financial assistance.	Healthy adults forced to cut back on their food budget may experience **minor to severe** health impacts. Outcomes for infants with low birthweights and preterm births could be **severe**.	Increased risk for food insecurity could occur as soon as households begin installing the required systems. The risk for food insecurity may be **short-term**; however, some health impacts related to poor nutrition may be **long-lasting**, such as developmental delays in infants and children.	**Strong.** Based on numerous research studies, there is high confidence that as overall housing costs increase, food insecurity increases, and food insecurity is linked to a number of health outcomes.

Alternatives	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	Without financial assistance, the increased cost of the proposed upgrades could **detract from health** by increasing household costs and potentially food insecurity by reducing the amount of expendable income available for nutrition.	Without financial assistance, the risk for food insecurity is **highly likely** since the evidence shows that cost-burdened households experience a greater degree of food insecurity and nutrition-related health impacts.	The extent of people affected would be **moderate to high** and is dependent on the number of cost-burdened households that will need to upgrade their systems. The higher costs associated with I/A OWTS will increase the number of cost-burdened households relative to Alternatives I and II.	**Individuals with fixed/low income and/or high housing costs,** elders, children, and pregnant women would be **disproportionately impacted** more than others, without financial assistance.	Healthy adults forced to cut back on their food budget may experience **minor to severe** health impacts. Outcomes for infants with low birthweights and preterm births could be **severe**.	Increased risk for food insecurity could occur as soon as households begin installing the required systems. The risk for food insecurity may be **short-term to long-lasting** due to on-going annual costs for inspection and maintenance. Some health impacts related to poor nutrition may be **long-lasting**, such as developmental delays in infants and children.	**Strong.** Based on numerous research studies, there is high confidence that as overall housing costs increase, food insecurity increases, and food insecurity is linked to a number of health outcomes.

4.6.8 Impact of Changes in Community and Household Economics on *Overall Health and Well-being*

As detailed previously in this section, community and household economics both contribute to the overall health and well-being of individuals and a community. Local municipalities (county, town, village, etc.) provide many of the essential services that support the health of its residents, including employment, parks and recreation, environmental protection, police and law enforcement, transportation, and public health education and protection. The capacity to provide these services is directly tied to the economic vitality of the community.

Household economics is closely related to the overall health and well-being of its family members. Housing is generally the largest expense for a household. **The proportion of a household's income remaining after housing costs are covered can determine a family's ability to afford essential goods and services, such as food, clothing, utilities, healthcare, and childcare. The inability to afford these essentials can increase the risk of poor health outcomes,** such as chronic disease, infectious disease, exposure to environmental toxins, and mental distress. Children can have additional risks such as preterm births, low birthweights, developmental delays, and mental/behavioral problems. Households with affordable housing costs can spend more on these essentials, and generally have better health outcomes than other households with the same income level.

Existing Overall Health Conditions at the Time of the HIA Analysis[45]

According to the 2016 County Health Rankings, Suffolk County ranked 10th best of all 62 counties in the state of New York for length of life as indicated by the rate of premature death (University of Wisconsin Population Health Institute, 2016), and the rate has been declining since 1997. The County was ranked 20th best of all 62 New York counties for self-reported quality of life, and an estimated 11% of residents reported poor to fair health (University of Wisconsin Population Health Institute, 2016) . Those experiencing poor to fair health as adults were more likely to be low-income and over age 40. In 2011, the leading causes of death and premature death in the Suffolk County population overall were cardiovascular disease and cancers (Stony Brook Medicine, 2014).

Data reported on the prevalence of multiple chronic conditions among Medicare beneficiaries indicated that in 2011, the prevalence of Suffolk County residents reporting 0 to 1 conditions was 27.8%, lower than the 30% reported for the State of New York. For residents reporting 6 or more conditions, the prevalence for Suffolk County was 16.9%, which is similar to the percentage reported for New York State (16.6%) (SCDHS, 2015a).

[45] County-level health data are used throughout this analysis because the geographic location of specific types of individual sewerage systems was unknown at the time of the HIA analysis; therefore, geographic-specific health statistics could not be determined for each Alternative. Regardless of the Alternative chosen, it would be beneficial to establish a more geographic-specific profile of conditions (e.g., health, demographics and socio-economic status, water quality, resiliency, vector control, economics, etc.) for the area(s) targeted by the code change to inform implementation and allow a baseline to be established against which changes can be compared. This would allow the effectiveness of the code changes in meeting their established goals to be assessed.

Mental health is an essential component of overall health and well-being. In Suffolk County, baseline community data from 2013 to 2014 shows 18.7% of the total population in Suffolk County were diagnosed with depression and of those diagnosed, 88.5% sought treatment (Stony Brook Medicine, 2014). During the same time frame, 14.8% of residents reported having 14 or more mental health days in the last month (SCDHS, 2015a). Based on the County Health Rankings, the age-adjusted average number of mentally unhealthy days reported in past 30 days was 3.2 in Suffolk County, lower than the New York State average of 3.7 days; data are for 2014 (University of Wisconsin Population Health Institute, 2016).

The 2014 Suffolk County Community Needs Assessment, conducted by Stony Brook University, listed the top-ranked health related issues for Medicaid members and uninsured residents as 1) mental health; 2) access to housing; 3) substance abuse; 4) nutrition, physical activity, and weight; 5) tobacco use; and 6) access to health care services (Stony Brook Medicine, 2014).

Anticipated Change(s) in Overall Health

If enacted, the proposed changes to the sanitary code in Suffolk County will affect the public health of county residents through changes in community and household economics in both beneficial and potentially harmful ways. The Community and Household Economics pathways indicate that **regardless of the alternative chosen, households with fixed or low income and/or high housing costs will be at greatest risk for adverse health outcomes without financial assistance.** In addition, if County costs to implement the program are not offset by other sources of revenue, there is a possible risk that health-related services provided by the County will be reduced or unavailable.[46] Households that rely on County health-related services, irrespective of whether the home is targeted for an upgraded system, may experience adverse health outcomes due to lack of access to County services. However, the potential increase in opportunities for employment in the OSDS industry will provide a positive health benefit for those who gain employment.

The Community and Household Economics pathways show the connections between water quality, revenue streams for the County (e.g., commercial fishing and recreational industries, residential property values, and taxes), and overall health. Implementation of Alternatives I and II, which are not expected to improve water quality, may place water quality revenue streams at risk, which could limit funding available for the County to provide other services to its residents, including health-related services. Alternative III would lead to water quality improvement and provide a level of protection for these revenue streams. Those households that rely on health-related services from the County will be impacted, either positively or negatively, based on which alternative is implemented, if funding for health services does not increase to meet the potential increased demand from households facing a greater cost-burden from their housing. There are Federally Qualified Health Centers in the County, but it should not be assumed that they will be able to absorb the potential increased demand of services,

[46] Since completion of the HIA analysis, Suffolk County has established that there is no plan to move forward with wastewater upgrades unless a stable and recurring revenue source is established. A stable recurring revenue source will reduce financial impacts to individual households and ensure that County services are not jeopardized by the costs of wastewater upgrade implementation.

given the number of households impacted by the sanitary code changes. The pathway also supports the connections between water quality, employment opportunities in the commercial fishing and recreational industries, household economics, and health. Alternative III would lead to improvement in water quality and provide support for continued opportunities for employment in the commercial fishing and recreational sectors, providing a positive health benefit for those who gain employment.

Table 4-56 lists the potential impacts of the proposed code changes on overall health through the community and economics pathway for each decision alternative. However, the change in a specific endpoint, such as cardiovascular disease or mental illness, is uncertain due to a number of factors, including the health status of individuals, other avenues to gain access to health-related goods and services, and decisions on the type and amount of publicly-available health-related services that are supported.

The criteria used to characterize the potential health impacts of the decision alternatives are explained in depth in Section 4 (page 31). To understand the risk of the decision alternatives benefiting or detracting from health as described in Table 4-56, you must read the Likelihood and Magnitude columns together (e.g., it is possible Alternative I would detract from health for a low to high number of people). For a summary of the different ways in which health could be impacted through the Community and Household Economics pathway see Section 4.6.9.

Table 4-56. Impact of Decision on Overall Health and Well-being Due to Changes in Community and Household Economics*

Health Determinant							
Overall Health and Well-being	**Baseline Health Status** According to The University of Wisconsin Population Health Institute's (2016) County Health Rankings, Suffolk County is ranked 9th best of New York's 62 counties for overall health outcomes (i.e., length and quality of life), and 5th best for overall health factors related to social, economic, environmental, and behavioral determinants of health. In 2014, the age-adjusted average number of mentally unhealthy days reported in past 30 days was 3.2 in Suffolk County, lower than the New York State average of 3.7 days.						
Alternatives†	**Direction**	**Likelihood**	**Magnitude**	**Distribution**	**Severity**	**Permanence**	**Strength of Evidence**
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016).	These alternatives would **detract from health** based on the potential for water quality to continue to decline and the associated risks to property values, employment in the fishing and recreational industries, and revenue streams for County services.	The risk to property values, employment in the fishing and recreational industries, and revenue streams for the County is **possible**; however, other actions may be taken to offset these impacts.	The extent of people affected would be **low to high.** A decrease in County revenue streams could impact the overall population of Suffolk County due to changes in County services, where the opportunity for employment would impact only a **few** individual households. The number of households affected by increased household costs would be **moderate**	**Individuals who are employed by the OSDS/OWTS industry or by the fishing and recreational industries may be disproportionately impacted** (both positive and negative) more than others. Individuals who rely on publicly-provided health-related services may be **disproportionately impacted** more than others without financial assistance.	Severity of impacts to overall health and well-being is uniform across the three alternatives and is discussed below.	Households may experience a **short-term** increased risk for reduced resources for health-related goods and services as soon as households begin installing the required systems. The County may experience a **short-term to long-lasting** increased risk to revenue streams due to impaired water quality and the resources needed to implement the code change.	**Strong.** Numerous research studies have linked household income to overall health and well-being. Multiple studies also support the connection between essential services provided by local municipalities and the overall health and well-being of their residents.

Alternatives†	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative III All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	This alternative would **benefit health** based on the potential for water quality to improve and contribute to property values, employment in the fishing and recreational industries and revenue streams for County services.	It is **possible** that the water quality improvement would contribute to maintaining or increasing property values, employment in the fishing and recreational industries and revenue streams for the County. It is possible those increased resources could be allocated to increasing health services.	The extent of people affected would be **low to high**. Maintaining or increasing revenue streams to support County services could impact a **high** percentage of the population of Suffolk County, where the opportunity for employment would impact only a **few** individual households. The number of households affected by increased household costs would be **moderate to high**. The higher costs associated with I/A OWTS will increase the number of cost-burdened households relative to Alternatives I and II.	**Individuals who are employed by the OSDS/OWTS industry or by the fishing and recreational industries may benefit** more than others. Individuals who rely on publicly-provided health-related services may **benefit** more than others, if County revenue sources are maintained, and/or may be **disproportionately impacted** more than others if resources decrease due to costs to implement the code changes.	Severity of impacts to overall health and well-being is uniform across the three alternatives and is discussed below**.**	Households may experience a **short-term** increased risk for reduced resources for health-related goods and services as soon as households begin installing the required systems. Ongoing annual costs for inspection and maintenance may extend this risk to **long-lasting**. The County may experience a **short-term to long-lasting** increased risk to resources based on resources needed to implement the code change. However, this risk may be offset by improvements in water quality and the associated benefits to revenue streams.	**Strong**. Numerous research studies have linked household income to overall health and well-being. Multiple studies also support the connection between essential services provided by local municipalities and the overall health and well-being of their residents.

Alternatives[†]	Direction	Likelihood	Magnitude	Distribution	Severity	Permanence	Strength of Evidence
Alternative I All existing OSDS must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative II** All existing OSDS in the high priority areas must be upgraded to conform to current County Sanitary Code and standards (in place as of September 2016). **AND** **Alternative III** All existing OSDS and C-OWTS in the high priority areas must be upgraded to an innovative/ alternative system design.	The costs for upgrades could **detract from health by reducing the amount of household expendable income and County-level resources for health-related goods and services.** **Potential increases in job opportunities in the OSDS/ OWTS industry would benefit health.**	A decrease in household level health-related goods and services is **highly likely** given the potential increase in the number of cost-burdened households. A decrease in County-level funds for health-related goods and services is **possible** based on resources needed to implement the code changes. Increased employment opportunities are **possible** and would increase access to health-related goods and services.	The number of households affected by increased household costs is dependent on the number of households that would become cost-burdened due to required upgrades.	**Individuals with fixed/low income and/or high housing costs, would be disproportionately impacted** more than others.	The health implications of reduced resources for health-related goods and services, either at the household level or the County level, are **minor to severe** Factors that contribute to the severity of the impact are the extent and duration of reduced expendable income, the overall health and well-being of an individual, and the type of health-related services that are unavailable.	The health impacts associated with reduced resources for health-related goods and services, either at the household level or the county level, may be **short-term to long-lasting.** Benefits from employment are expected to be **long-lasting**, considering the demand in the OSDS/OWTS industry will last for several years.	**Strong**. Numerous research studies have linked household income to overall health and well-being; Multiple studies also support the connection between essential services provided by local municipalities and the overall health and well-being of their residents.

* Since completion of the HIA analysis, Suffolk County has established that there is no plan to move forward with wastewater upgrades unless a stable and recurring revenue source is established. A stable recurring revenue source will reduce financial impacts to individual households and ensure that County services are not jeopardized by the costs of wastewater upgrade implementation.

† Potential impacts that are shared by all three alternatives are combined as an extra entry in the table (Alternative I and II and III) for improved readability

4.6.9 Community and Household Economics Summary of Health Impacts

- The costs associated with upgrading, operating, and maintaining new individual sewerage systems in **all three alternatives could negatively impact health by reducing the amount of household expendable income**, which could lead to cost burdens and food insecurity. The higher costs associated with I/A OWTS (Alternative III) will increase the number of cost-burdened households relative to Alternatives I and II. However, the potential **increases in job opportunities** in the OSDS/OWTS industry (and other industries, should there be improvements in water quality) **would benefit health by increasing access to health-related goods and services.**
- **Alternatives I and II** will not reduce nitrogen loading and, as a result, have the potential to **detract from health through further declines in water quality and the associated risks** to the local economy (property values; employment in the recreation, tourism, fishing and shellfishing industries; and revenue streams for County services). **Alternative III would benefit health based on the potential for water quality improvements** and the associated economic benefits (increases to property values, employment in the recreation, tourism, fishing and shellfishing industries and revenue streams for County services).
- **Individuals with fixed/low income and/or high housing costs would be disproportionately impacted by the costs of system upgrades** and could be forced to cut back on health-related goods and services, **if financial assistance is not provided**. This impact would be magnified if publicly provided health-related-services decrease due to the County resources needed to implement the code changes.[47] **Employment and its associated health benefits would be disproportionately experienced** (positively or negatively) by individuals employed in the various sectors (e.g., OSDS/OWTS, recreation, tourism, fishing and shellfishing).
- The **availability of household income and health-related goods and services are strongly linked to overall health and well-being.**

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[47] Since completion of the HIA analysis, Suffolk County has established that there is no plan to move forward with wastewater upgrades unless a stable and recurring revenue source is established. A stable recurring revenue source will reduce financial impacts to individual households and ensure that County services are not jeopardized by the costs of wastewater upgrade implementation.

5. Recommendations: Considerations for Managing Impacts of the Decision

In general, during the *Recommendations* step of HIA, specific actions are identified that could be taken to avoid, minimize, or mitigate harmful effects identified during the course of the HIA or to take maximal advantage of opportunities for a proposal to improve health. Depending on the nature of the proposal being assessed and the specific impacts, recommendations can take various forms:

- A major alternative to a proposal;
- Mitigation measures that are intended to minimize a potential harm identified in the HIA or promotion measures to maximize a potential health benefit identified;
- Health-supportive measures that generally support health, but are not tied directly to a specific impact of the proposal; or
- Adopting a position for or against a proposal (National Research Council, 2011)[48].

The recommendations provided in the final HIA report should document available supporting evidence, stakeholder input, and a health-management plan, which should do the following:

- Discuss what entity has the authority or ability to implement each measure and document any commitments to do so (see Section 5.2).
- Propose appropriate indicators for monitoring (see Section 7.3).[49]
- Propose a system to verify that measures are being implemented as planned (see Section 7.2).

5.1 Developing the Recommendations

The HIA Project Team used a step-wise approach to develop the recommendations. First, members of the HIA Project Team identified measures to help manage predicted changes to each health determinant assessed, so that potential benefits were maximized, and potential harms were avoided and/or minimized. Next, the HIA Project Team, as a group, verified whether the proposed mitigation actions were appropriate, based on the assessment findings, and identified additional opportunities to mitigate or avoid potential harmful consequences of the proposed project, and maximize co-benefits and ensure equitable impact.

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[48] In this HIA, proposal alternatives, mitigation measures, promotion measures, and health-supportive measures were all developed.

[49] Some of the indicators identified for outcome evaluation (i.e., the impact of decision implementation on health) are proximate health determinants that relate to the Recommendations presented in this section; otherwise, indicators were not identified for monitoring implementation of Recommendations. Impact evaluation (i.e., the impact of the HIA on the decision, including implementation of HIA Recommendations) was planned to be carried out as a survey or interview of Suffolk County officials rather than as a monitoring activity, due to resource constraints.

The HIA Project Team prepared posters to present the preliminary findings and initial recommendations of the HIA to community residents and stakeholders and elicit their feedback (see Appendix D). Despite the Team's best efforts, no stakeholders or members of the public attended the community meetings. More on this in Section 7.1.3. Feedback on the preliminary HIA findings and recommendations was solicited and received from Technical Advisory Committee (TAC) members during and following the final TAC meeting. The HIA findings and recommendations were further refined based on the TAC input received.

5.2 Final Recommendations to Decision-Makers

Table 5-1 presents the final evidence-based recommendations that the HIA Project Team proposes for adoption and implementation as part of decision-making and/or execution of the proposed code changes. **It should be noted that the HIA recommendations are not regulatory in nature; they are offered as suggestions for future action to improve the impact of the decision on health. Adoption of the recommendations is at the discretion of the County, as they must balance health considerations with the other technical, social, political, and economic considerations related to the decision.**

General recommendations are offered as well as recommendations related to:

- Planning and Implementation of the Proposed Code Changes;
- Outreach and Communication;
- I/A OWTS Evaluation;
- System Siting, Design, and Installation;
- System Maintenance;
- Cost Control and Funding Measures;
- Employment and Hiring; and
- Protection of Water Resources

In addition to the recommendations related to the proposed sanitary code changes themselves (including handling of existing individual sewerage systems, implementation of sewerage system upgrades, and protection of water resources from sewerage-derived pollutants), additional recommendations beyond the code changes are offered in Table 5-2 to address some of the issues identified by the County (e.g., nutrient loading and resiliency). These health-supportive measures relate to Wetland Protection/Restoration and Wetland/Green Infrastructure Creation and Resiliency Planning.

The wording of the final recommendations in the tables was modified from the original appearance in the report sections, when appropriate, for clarity and simplicity. Recommendations are listed, along with their intended purpose, target (i.e., what the recommendation will impact), pathway, and a reference that points the reader to the section(s) of the document where the recommendation originated (for context).

Since completion of the HIA analysis and reporting of preliminary findings and recommendations to the decision-makers and stakeholders in the fall of 2016, Suffolk County entered into a period of robust activity working to change the local nutrient pollution paradigm (see Appendix K). Some of those activities were also recommendations identified in this HIA for potential adoption and implementation as part of decision-making and/or execution of the proposed code changes; those Recommendations are highlighted in Table 5-1 and are discussed more in Section 7.2. The HIA Team did not examine activities undertaken by Suffolk County after completion of the HIA analysis aimed at wetland protection/restoration, wetland/green infrastructure creation, and resiliency planning (HIA recommendations beyond the code changes; Table 5-2).

Table 5-1. Final Recommendations Related to the Proposed Code Changes[50]

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
General Recommendations					
1a	A fourth alternative could be considered, requiring upgrade of individual sewerage systems to an innovative/alternative technology across the entire county, with prioritization given to parcels in the high-priority areas (e.g., proactive upgrades in priority areas and upgrades elsewhere in the county, upon transfer, failure/replacement, significant and new construction).	Proposal alternative	Sanitary code and policy implementation Equity	Individual Sewerage Performance and Failure (ISPF)	Page 42
Planning and Implementation of Proposed Code Changes[51]					
2a	Ensure that sites with individual sewerage systems that are required to be upgraded as part of the changes to the Suffolk County Sanitary Code tie into sewer if they fall within a sewer district and the approved sewer system is accessible and has capacity.	Proposal alternative	Sanitary code and policy implementation	ISPF	Page 40
3a	Consider potential barriers to implementing and enforcing policies related to individual sewerage systems and develop strategies to overcome such barriers.	Mitigation measure	Sanitary code and policy implementation	ISPF	Page 41
4a	Develop tools that cesspool/septic service contractors can easily and consistently deploy to determine whether a system is in need of maintenance, repair, or upgrade and document the issue(s), such as a checklist or logic framework for use in the field and/or an open-access, web-based platform for documenting issues and reporting properties that need to upgrade their individual sewerage systems.	Promotion measure	Sanitary code and policy implementation	ISPF	Page 42

[50] Suffolk County Government and departments within are thought to have the authority and/or ability to implement any of the recommendations, unless otherwise stated. Adoption and/or implementation of recommendations is at the sole discretion of Suffolk County; they are non-binding.

[51] The Subwatersheds Wastewater Plan developed by Suffolk County, after completion of this HIA, will guide future policy and implementation procedures. For more information on these efforts, see Appendix K.

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
5a	Create an inventory of existing individual sewerage systems, including their geolocation, design type, and (if possible) maintenance schedule to aid in identifying residences affected by the decision and enforcing the code change. This inventory can be accomplished through sewage industry reporting of cesspool, septic tank and I/A OWTS pump outs, retrofits, and replacements.[52]	Mitigation measure	Sanitary code and policy implementation	ISPF	Page 46
6a	Given its current population and the expectation that Suffolk County may reach its saturation population, further research is needed to ascertain the capacity of Suffolk County soils to effectively manage wastewater effluent (regardless of whether systems are upgraded or not).	Mitigation measure	Wastewater treatment performance	ISPF	Page 52
7a	Select a timeline for implementation that will encourage tempered growth of the OSDS/OWTS industry, minimizing the risk of a spike in the cost of installation and unsustainable industry growth.	Mitigation measure	Employment opportunities	Community/ Household Economics	Page 212
8a	If Alternative III is chosen, towns with a greater reliance on commercial and recreational fishing could be considered in the prioritization of areas for implementation of the code.	Promotion measure	Employment opportunities	Community/ Household Economics	Page 216
Outreach/Communication					
9a	Perform homeowner outreach early and often and provide information on each system design, including the average life span, operation and maintenance needs, average treatment performance, signs of system failure, and the benefits of routine inspections and maintenance (e.g., increase in system longevity, reduced costs over the life of the system).	Promotion measure	Education/ expectation of individual sewerage system technologies	ISPF	Page 51

[52] The Wastewater Information System Tool (TWIST) is a downloadable, user-friendly management tool for inventorying and managing individual sewerage systems (https://www.epa.gov/septic/wastewater-information-system-tool-twist).

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
10a	To achieve improvements in perception of water quality, engage and inform the public with accurate information, set realistic expectations of outcomes, and effectively communicate results when improvements in water quality and its associated ecosystem services (recreation, economy, etc.) are experienced.	Promotion measure	Education/ expectation of water quality improvements	Water Quality	Page 123
11a	Focus educational outreach and/or professional and financial assistance in areas where frequent failures are occurring and allow homeowners to upgrade/replace existing systems to more sustainable sewerage options that lower the risk of system failure.	Mitigation measure	Individual sewerage system failures	ISPF	Page 63
I/A OWTS Evaluation					
12a	Pathogen or fecal indicator bacteria monitoring could be conducted for I/A OWTS, so that data can be obtained to better evaluate pathogen control of these systems. Pathogens have implications for human health and the economy.[53]	Promotion measure	Wastewater treatment performance Human illness Community Economics	ISPF	Page 52
13a	I/A OWTS under consideration by the County could be evaluated to ensure that they do not provide breeding habitat for mosquitoes.	Promotion measure	Mosquito habitat and infestation Human illness from vector-borne pathogens	Vector Control	Page 179

[53] Although Suffolk County has not performed pathogen monitoring of I/A OWTS systems to date, the Suffolk County Subwatersheds Wastewater Plan, developed after completion of this HIA, does recommend that pathogen data be collected as part of the SCDHS I/A OWTS testing program to determine the ability of local soil to remove pathogens.

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
System Siting, Design, and Installation					
14a	Given the additional reduction in nitrogen and pathogen loading from soil absorption drainfields and the potential for drainfields to break down many other pollutants (per the NYSDOH Residential Onsite Wastewater Treatment System Design Handbook; NYSDOH, 2012), consider changes to the Sanitary Code requiring cesspools and conventional OWTS be upgraded to septic tank-soil absorption systems when site conditions permit. At a minimum, the language in the code for Alternatives I and II could identify upgrades to a septic tank-soil absorption system, conditions permitting, as an alternative to the C-OWTS. For residences with inadequate space for a soil absorption field, a mound OWTS could provide improved treatment performance over the C-OWTS.	Proposal alternative	Wastewater treatment performance Human illness	ISPF	Page 52

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
15a	Take into consideration good practice in the siting, design, installation, and maintenance of individual sewerage systems.[54] For example: • Cesspool and leaching pool systems are known to have poor performance for controlling nutrients and pathogens in system effluent. Consider replacing cesspools/leaching pools with the conventional shallow, soil absorption field systems, which are more effective in controlling nutrients and pathogens in system effluent. For residences with limited space for the conventional soil absorption field systems, an innovative/alternative system with proven treatment performance that would not require a large footprint could be permitted (e.g., mound OWTS). • Gardens and deep-root vegetation, such as large trees, should not be located near or over the individual sewerage system, since large roots and excess plant watering can be damaging to the system. • Avoid installation and/or construction of conventional OWTS on sites where pervasive flooding, tidal influence, and/or extreme rain events increase the risk for hydraulic and/or structural failure of an individual sewerage system. Mound systems offer an alternative option for sites where flooding and/or groundwater influences pose a high failure risk. • Use of reinforced materials and proper system design may prevent human injury and/or death from structural failures. • Proper siting, design, construction, and operation of individual sewerage systems can ensure protection of groundwater and drinking water sources, especially in areas served by private drinking water wells.	Mitigation measure	Wastewater treatment performance Individual sewerage system failure Water quality Human injury and death Human health and well-being	ISPF Water Quality	Pages 52, 53, 64, **Error! Bookmark not defined.**, 95

[54] Guidance and technical resources for those involved in the design, construction, operation, maintenance, and regulation of individual sewerage systems are available at https://www.epa.gov/septic.

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
System Maintenance					
16a	Adopt a standard management plan for each system design to ensure individual sewerage systems are properly maintained and replaced/upgraded when needed. The management plan could include good management practices.	Promotion measure	Wastewater treatment performance	ISPF	Page 52
17a	Perform routine pumping of OSDS and OWTS in order to reduce the risk of hydraulic failure, retention of standing water, and associated health impacts.	Mitigation measure	System failure Human illness	ISPF	Page 53
18a	Due to the design and materials used, older cesspools – especially those that have exceeded the expected life span of approximately 25 years – pose risks for illness, injury and/or death were the system to collapse, surcharge above ground, or backflow into the home. Ideally, homeowners could replace such systems with a modern design (e.g., septic tank-soil absorption system or I/A OWTS) or connect to a cluster system or public sewer.	Mitigation measure	System Failure Human illness Injury and death	ISPF	Page 63
19a	Completely fill unused or abandoned systems with soil or gravel, both to eliminate a source of standing water and to avoid potential collapse and injury.	Mitigation measure	System failure Mosquito habitat and infestation Injury and death	ISPF Vector Control	Page 63
20a	Homeowners or non-licensed professionals should not approach or attempt to investigate a collapsed or failing septic tank or cesspool. Cornell University – Suffolk County Extension Office recommends that if the surface of the ground above the septic tank or cesspool is wet, the area should be fenced off and a professional called to diagnose and address the problem.	Mitigation measure	Injury and death Human health and well-being	ISPF	Page 64

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
21a	Ensure that owners of onsite wastewater treatment systems inspect their systems for cracks, leaks, and loose manhole covers. Use cement to patch any cracks or gaps between the blocks; cover vent pipes with screen mesh; repair broken pipes; and seal joints to deny mosquitoes access to the water within.	Mitigation measure	Mosquito habitat and infestation Human illness from vector-borne pathogens Stress and well-being	Vector Control	Page 177
22a	Conduct public outreach to emphasize the role individual homeowners can take to help prevent mosquito infestation, including mosquito production in individual sewerage systems.	Mitigation measure	Mosquito habitat and infestation Human illness from vector-borne pathogens Stress and well-being	Vector Control	Page 180
23a	Send maintenance reminders to residents to help provide a stable market for the companies.	Promotion measure	Employment opportunities	Community/ Household Economics	Page 212
Cost Control and Funding Opportunities					
24a	To avoid unintended health impacts, action could be taken to ensure that the increased cost to implement and oversee the proposed changes to the sanitary code does not impact other programs or pull funding away from other social and health services. Operating grants and contributions could be sought from both State and Federal entities to defray costs.	Mitigation measure	Community economics Overall health and well-being	Community Economics	Page 205

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
25a	Outside funding could be sought to reduce the costs of individual sewerage system upgrades for individual households. Assistance for cost-burdened and low-income households and property owners renting to low income households could be prioritized. Assistance could be made available for all household types including non-family households, which have a much lower median income than households of families.	Mitigation measure	Household economics Overall health and well-being Food insecurity and health	Household Economics	Page 208
26a	Work with communities and OWTS vendors to plan concurrent upgrades to neighboring properties to reduce construction costs and take advantage of block grant opportunities.	Promotion measure	Household economics	Household Economics	Page 209
27a	Review of the Rhode Island and Maryland programs may provide Suffolk County with guidance on implementation of individual sewerage system upgrades, including the triggers for replacement of systems and loan and grant programs for households to assist with costs associated with installation and operation of new systems. More details on these State programs are provided in Appendix J.	Promotion measure	Household economics	Household Economics	Page 208
Employment/Hiring					
28a	Steps could be taken to encourage OWTS businesses to locate and hire within the County. Possible strategies include tax incentives and decrease of certification fees for OWTS companies that locate in the County and support of a community jobs program to train local residents in OWTS and I/A OWTS technology installation, maintenance, repair and inspection. Consider working with local community colleges to include training courses in this field.	Promotion measure	Employment opportunities	Community/ Household Economics	Page 212
Protection of Water Resources					
29a	Increasing vegetated land cover and green infrastructure between individual sewerage systems may prevent further transport of sewerage-derived pollutants (and other nitrogen loading) in stormwater runoff and/or shallow groundwater movement (Kinney & Valiela, 2011).	Mitigation measure	Cumulative pollutant loading	Water Quality	Page 108

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
30a	Vigilance in controlling pollution from individual sewerage systems is important, especially when individuals are obtaining drinking water from private wells. Continue efforts to expand public drinking water supply.[55]	Mitigation measure	Drinking water Human illness	Water Quality	Page 93
31a	Expansion of connections to community supply systems could continue to reduce dependency on private wells, which can reduce the overall magnitude of potential effects of wastewater on drinking water.[59]	Mitigation measure	Drinking water Human illness	Water Quality	Page 97
32a	If Alternative I or II is selected, other measures could be taken to reduce nutrient enrichment and protect water resources to mitigate the impact of declining water quality on employment opportunities associated with the commercial fishing and recreational industries and property values, both of which have the potential to impact both county revenues and household income.	Mitigation measure	Employment opportunities Residential property values Overall health and well-being	Community/ Household Economics	Pages 216, 220

[55] The Suffolk County Subwatersheds Wastewater Plan includes similar recommendations to this for protection of private drinking water wells, noting three options for nitrogen management: connection to community supply systems, wellhead treatment, or wastewater management and fertilizer management (including conversion of existing septic systems on private well sites to I/A OWTS).

Table 5-2. Final Recommendations Beyond the Proposed Code Changes[56]

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
Wetland Protection/Restoration and Wetland/Green Infrastructure Creation					
1b	Protect, restore, and create freshwater and coastal/tidal wetlands or other green infrastructure alternatives to improve shoreline resiliency and improve wetland functioning, including attenuation of nutrients. The USFWS inventory (Tiner and Herman, 2015) identified 760 acres of potential wetland restoration sites in southern Suffolk County and 12,543 acres of impaired Suffolk County wetlands that may be eligible for restoration.	Health-supportive measure	Wetland acreage Wetland structure/function Shoreline resiliency	Resiliency	Pages 138, 133, 141
2b	Measures to rehabilitate and restore wetland structure and function and to reduce mosquito production under the Integrated Marsh Management (IMM) framework could continue.	Health-supportive measure	Insecticide application	Vector Control	Page 181
Resiliency Planning[57]					
3b	Integrate wetland protection priorities into community planning.	Health-supportive measure	Shoreline resiliency to natural disasters	Resiliency	Page 141
4b	Evaluate the use of hybrid approaches that combine natural habitats and built defense structures to improve resiliency.	Health-supportive measure	Shoreline resiliency to natural disasters	Resiliency	Page 141
5b	Undertake planning efforts and secure funding that address sea level rise adaptation in order to ensure shoreline resiliency to storm and/or tidal surges for the long term.	Health-supportive measure	Shoreline resiliency to natural disasters	Resiliency	Pages 148, 158

[56] Suffolk County Government and departments within are thought to have the authority and/or ability to implement any of these recommendations, unless otherwise stated. Adoption and/or implementation of the recommendations is at the sole discretion of Suffolk County; they are non-binding. These health supportive measures may provide opportunities for the creation of new partnerships within the County.

[57] The Suffolk County Subwatersheds Wastewater Plan (SWP), developed after completion of this HIA, addresses the need for the wastewater management strategy to be adaptive and to consider sea level rise. The SWP also recommends development of an overall sea level rise protection strategy for wastewater management that could include a number of tactics in sea level protection areas, including clustering/sewering of parcels, purchasing parcels through Open Space, and providing incentives to property owners to transfer development rights (to minimize development in these protection areas). Efforts are also underway to install sewers in communities in unsewered, low-lying, areas along the south shore of Suffolk County to improve water quality and protect against future storm surges by strengthening wetlands.

No.	Final Recommendations	Intended Purpose	Target	Pathway	Discussion Context
6b	Ensure that the impacts of accelerated sea level rise and increased storm frequency and intensity are adequately examined and accounted for in the initial phases of all planning efforts.	Health-supportive measure	Property/ infrastructure damage Overall health and well-being Injury and death	Resiliency	Page 158
7b	Undertake planning efforts and secure funding that addresses sea level rise adaptation of wetlands and other natural shoreline types (e.g., beaches and dunes) in order to enhance shoreline resiliency to storm and/or tidal surges for the long term.	Health-supportive measure	Property/ infrastructure damage Overall health and well-being Injury and death	Resiliency	Page 159
8b	Consider activities, such as voluntary buyouts, that encourage local (town/village) land use and zoning regulations, and County-level disincentives to development, to reduce the infrastructure and people in vulnerable coastal areas and create more naturally-functioning coastal floodplains and provide space for coastal/tidal wetlands to retreat and expand.	Health-supportive measure	Property/ infrastructure damage Overall health and well-being Injury and death	Resiliency	Page 163
9b	Prioritize resiliency efforts (e.g., habitat restoration, shoreline management, and planning activities) based on risk of exposure and social and economic vulnerability to sea level rise, severe storms, and storm and/or tidal surges.	Health-supportive measure	Evacuation and displacement Overall health and well-being Injury and death	Resiliency	Page 163
10b	Undertake efforts in emergency management planning and outreach to ensure that individuals receive and comprehend evacuation messages and have the necessary capacity and resources to comply with them.	Health-supportive measure	Evacuation and displacement Overall health and well-being Injury and death	Resiliency	Page 162

6. Reporting

The overall goal of the *Reporting* step is to develop the HIA report, inform stakeholders on the progress of the HIA, and communicate HIA findings and recommendations to decision-makers, the population affected by the decision, and other stakeholders.

6.1. HIA Reporting Activities

Several *Reporting* activities were performed to communicate and disseminate this HIA. The HIA Project Team was able to implement the reporting activities, as planned in *Scoping.* The HIA Project Team raised awareness about this HIA within the Agency and outside the EPA through many avenues. Management in the EPA Region 2 Office were briefed on the progress of the HIA and any materials that would be shared outside the Agency. In addition, the ORD HIA Project Lead also met with ORD management to report on the HIA's progress and share information about the HIA with fellow colleagues at the EPA. Several presentations were given on the HIA to inform different communities of practice.

Examples of the communications materials and documentation from the public stakeholder engagement meetings can be found in Appendix D**.** These were in addition to regular (monthly/bi-monthly) meetings with the Technical Advisory Committee (TAC) during the *Assessment* step of the HIA to report on HIA progress and gather stakeholder input to inform the analysis and impact characterization. The HIA Project Team used a standardized format or "brand" for almost all of the HIA communication materials. The use of branding helped increase recognition and consistency of HIA materials. Before materials were shared outside the team, several steps were followed. First, the materials were developed and reviewed by the HIA Project Team. Once comments and edits were addressed, HIA materials were sent to the HIA Project Leads for final approval. Once cleared, the materials were shared with members of the TAC and general public. In addition to the flyers, factsheets, handouts, and PowerPoint presentations, members of the HIA Project Team developed this HIA Report as the final *Reporting* output of the HIA. The document was reviewed by the Technical Editor, EPA ORD Management, the HIA Project Team, TAC, and two external peer-reviewers. An electronic copy of this report will be shared with Suffolk County Government, EPA Region 2, the HIA Project Team, and TAC. The HIA Report will be made available to the public and other stakeholders upon request and uploaded to EPA's HIA website (https://www.epa.gov/healthresearch/health-impact-assessments).

Table 6-1 lists the key public reporting activities performed to support this HIA, the date each was performed, its intended purpose, and the primary target audience.

Note: The HIA Project Team recognizes that this HIA Report is an extensive document and due to the level of detail provided in the report may not be easy to manage or use for advocacy and/or raising awareness within the community. Therefore, a summary of the full HIA Report and a fact sheet on the findings of the HIA have been produced, as well.

Table 6-1. Summary of Key HIA Public Reporting Activities

Reporting Outlet	Date	Purpose	Primary Audience
HIA Kickoff Meeting*, Suffolk County Office, Yaphank, New York	December 19, 2014	EPA and Suffolk County Government co-hosted a kickoff meeting to launch the HIA on December 19, 2014 at the Suffolk County Office in Yaphank, NY. The launch event started with a half-day HIA 101 training (short course) that introduced participants to the concept of HIA, the importance of HIA in decision-making, and the principles and methods used in HIA practice. The training also introduced a few examples of completed HIAs and opportunities for HIA in the New York/New Jersey area. Following the training, a workshop was held that included an introduction to the HIA in Suffolk County and a series of exercises to kick off the *Scoping* step of the HIA (see Appendix D for meeting notes).	Select stakeholders
1st Community Meeting Flyer	Released February 2015	This one-page flyer was developed to inform the public and resident stakeholders about the upcoming HIA and invite them to participate in the process by attending the first community stakeholder engagement meeting.	All stakeholders
1st Community Meeting*, (Cold Spring Harbor, Riverhead, and Brentwood, New York) - Due to inclement weather, the meeting in Brentwood was cancelled	March 4-5, 2015	The purpose of this public meeting was to inform community residents and stakeholders about the HIA, its intended purpose, and encourage participation in the HIA. Meeting activities were focused on gathering input on residents' opinions about health, interest and/or concerns related to their community and the proposed changes to the County code, and thoughts on how the proposed changes might affect daily life in the community. The input from this meeting was used to guide the HIA scope.	All stakeholders
Summary of the 1st Community Meeting	Released April 2015	This eleven-page handout was developed to provide a summary of the discussions and activities that occurred during the first community meeting (see Appendix D).	All stakeholders
Invitation Letter to Participate in the Technical Advisory Committee or Community Stakeholder Steering Committee	Released July 7, 2015	The HIA Project Leads prepared an invitation to key stakeholders that provided background information about the HIA and invited interested parties to participate in a major role.	Key stakeholders

Reporting

Reporting Outlet	Date	Purpose	Primary Audience
2nd Community Meeting/ HIA TAC Meeting* (Community: Riverhead, Brentwood, Port Jefferson; TAC: Suffolk County Office, Yaphank, New York)	August 16-18, 2016	The purpose of these meetings was to update the community residents and stakeholders on the HIA's progress; report the preliminary findings and initial recommendations from the HIA; and elicit feedback on those findings and recommendations (see Appendix D for meeting materials from the TAC meeting).	All stakeholders (although no residents or stakeholders attended the community meetings)
HIA Fact Sheet for Septic Week	September 15, 2016	The Suffolk County Director of Planning expressed an interest in having the Suffolk County HIA (or a summary of the HIA) available for EPA Septic Week, which was held September 19-23. The HIA Leadership Team developed and made available a fact sheet that presents the purpose of the HIA, the methodologies employed, general findings, and a sampling of HIA recommendations.	General public
HIA Presentation to Suffolk County	July 2017	Members of the HIA Project Team presented the HIA findings and recommendations and draft HIA Report to the Director of Planning for Suffolk County (Sarah Lansdale).	Decision-makers
Draft HIA Report Review	July 2017	The draft HIA Report documenting the details of the HIA process, including the methods used, persons involved, and outputs of the HIA, was transmitted to the Technical Advisory Committee for review.	Decision-makers and key stakeholders
Discuss Resolution of Draft HIA Report Comments and HIA Product Path Forward	December 2018	The HIA Leadership Team met with Suffolk County to review resolution to their comments and	Decision-makers
Draft HIA Summary of Key Findings and Recommendations and Draft HIA Fact Sheet Review	November 2019	The draft HIA Summary Report and Fact Sheet were transmitted to Suffolk County for review.	Decision-makers
Final HIA Report	August 2021	The final HIA Report documents the details of the HIA process, including the methods used, persons involved, and outputs of the HIA.	All stakeholders
Final HIA Summary of Key Findings and Recommendations	August 2021	The Summary of the HIA Report highlights the main findings and recommendations of the HIA. As a supplement to the full HIA Report, this Summary Report aids in sharing and distributing the results of the HIA.	All stakeholders

Reporting Outlet	Date	Purpose	Primary Audience
Final HIA Fact Sheet	August 2021	As a supplement to the full HIA Report, this fact sheet aids in sharing and distributing the results of the HIA.	All stakeholders

*Documentation of these meetings is provided in Appendix D.

6.2. Reporting of HIA Findings and Recommendations

6.2.1. Input Solicited on Preliminary Findings and Recommendations

The HIA Project Team scheduled three meetings to present the preliminary HIA findings and initial recommendations to the public and gather their input, but no one showed to any of the three public meetings, despite flyers being posted in libraries in the three meeting locations and issued to the Technical Advisory Committee (TAC) to distribute to their community counterparts. This was an unexpected outcome; more on this in Section 7.1.3. The HIA Project Team also scheduled a final TAC meeting to present and gather input on the preliminary HIA findings and recommendations. Meeting attendees included members of the HIA Project Team and Technical Advisory Committee. A short PowerPoint presentation was given at the beginning of the meeting, which provided an overview of the HIA process, what had been done for this HIA, and a short profile of the existing population in the community. Next, TAC members were asked to visit each of the posters staged around the room, which contained specific information about each of the health determinants assessed. A member of the HIA Project Team stood at each of the posters to answer questions and facilitate discussions about the predicted impacts of the proposed project on that health determinant. The poster presentation strategy allowed for a more individualized discussion about the assessment performed and provided direct access for TAC members to those who performed the assessment. The meeting agenda and poster presentations are provided in Appendix D. After the poster presentation was completed, the HIA Project Team solicited feedback and comments from the TAC about the assessment and findings presented[58].

The HIA Project Team discussed the TAC input received at and following the meeting and modified the verbiage of findings and/or recommendations, as needed.

6.2.2 Draft HIA Report

The HIA Report was prepared over the duration of the HIA and a draft completed following the meeting with the TAC. The Draft HIA Report was transmitted to the HIA Research Team for review, and following resolution of their review comments was transmitted to the TAC and two external peer-reviewers (an HIA practitioner and a nutrient transport and coastal waters expert) for their review and comment.

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[58] The TAC was very technically-minded and was interested in the details of the *Assessment*, which were only summarized on the posters. TAC members were able to review and comment on the specific details of the *Assessment* during the review of the Draft HIA Report (see Section 6.2.2).

6.2.3 Final HIA Reporting

Comments and were received from the TAC and external peer reviews, and the HIA Report was revised to address comments, as appropriate. Following completion of comment resolution, the report was transmitted through the Agency review process and cleared for publication. Once the HIA Report was made 508-compliant, it was posted to EPA’s HIA webpage: https://www.epa.gov/healthresearch/health-impact-assessments.

7. Monitoring and Evaluation

After the HIA completion, several follow-up activities should occur. The design and implementation of the HIA should be evaluated (i.e., perform a process evaluation). There should be a follow-up on the result of the decision to determine whether the HIA influenced the decision-making process and/or final decision (i.e., perform an impact evaluation). To some extent, the effect(s) of the final decision on health and/or determinants of health should also be included in the follow-up activities (i.e., perform monitoring to inform an outcome evaluation).

Monitoring is an important follow-up activity to the HIA process and is performed after the HIA findings and recommendations have been reported. If monitoring is not included in the original HIA work plan, the HIA project team should provide a plan for monitoring the decision and health impact after the HIA is completed. There are two main aspects of monitoring – one is to follow up on the decision and/or decision-making process, and the other involves following up on the health impacts predicted in the HIA. These follow-up activities inform whether the HIA influenced the decision-making process and/or final decision (i.e., informs the impact evaluation) and help assess the effects of the final decision on health (i.e., informs the outcome evaluation).

7.1 Plan for Process Evaluation

Process evaluation considers whether the HIA was carried out according to the plan of action and applicable standards (National Research Council, 2011).

After the HIA analysis was complete, the HIA Project Team and an external third-party HIA practitioner (peer reviewer) evaluated the ability of the HIA to meet its stated goals and the *Minimum Elements,* and *Practice Standards of HIA* (Bhatia, et al., 2014). Evaluating the design and execution of the HIA results in valuable information that can be used to help refine methods and approaches used in HIA and advance the HIA community of practice. Early in the HIA process, the HIA Project Team developed a plan for evaluating the HIA, which included an Agency administrative review and an external peer-review by an HIA practitioner and a nutrient transport and coastal waters expert. In addition, the HIA Project Team identified successes, challenges, and lessons learned.

7.1.1 HIA Goals Achieved

At the completion of this HIA, the HIA Project Team reviewed the original goals established in the *Scoping* step and evaluated whether those goals were achieved or not achieved. The results of this evaluation are documented in Table 7-1.

Table 7-1. Evaluation of HIA Goal Achievement

HIA Goal	Achieved?	Documentation
Develop a comprehensive HIA that addresses stakeholder concerns for sustainability, resiliency, environmental justice, and health equity.	Yes	The HIA assessment was able to evaluate the sustainability of the proposed code changes and the effectiveness of those changes to improve water quality and resiliency to natural disasters. The HIA Project Team assessed the proposed code changes for their potential to affect other environmental, social, and economic health determinants and took into account the equity of those health impacts on the population.
Bring evidence-based information to help inform Suffolk County's decision on proposed code changes regarding OSDS.	Yes	The final HIA recommendations are based on evidence found in the literature and/or are a result of the analyses performed during the HIA and identify which of the proposed alternatives will achieve reductions in nitrogen loading from individual sewerage systems and what impact, if any, the alternatives would have on resiliency to natural disasters. The recommendations suggest actions Suffolk County could take to maximize potential benefits and minimize and/or avoid potential adverse effects from implementing the proposed code changes, including impacts to water quality, resiliency, vector control, and community and household economics. Additional recommendations are also suggested for health-supporting actions that could be taken to achieve reduced nitrogen loading and improved resiliency beyond the proposed code changes.
Provide a neutral and inclusive platform for stakeholders to discuss the needs and issues in Suffolk County related to the proposal, founded on a common objective to advocate for health and wellness, and enhance stakeholder consensus and ownership of the decisions made.	Yes/No	EPA was able to solicit participation during the HIA from a broad perspective of stakeholder groups, including representatives from the community, decision-makers, universities, national and state government agencies, and non-government organizations. In addition, the input provided by the stakeholders was used to inform the scope of the HIA and was incorporated into the HIA findings and recommendations. Participation of community members and residents waned throughout the HIA, however. This did not allow the HIA to reach its full potential as an inclusive platform and consensus building tool.

HIA Goal	Achieved?	Documentation
Raise awareness of HIA as a decision-support tool that considers direct and indirect consequences, both benefits and harms, before the decision is made.	Yes	Through the HIA process, EPA was able to raise awareness among the community and different stakeholder groups of the proposed code changes and the use of HIA as a decision-support tool to consider the impacts of those changes prior to implementation. Stakeholders and community members were engaged in the HIA process, and documentation of the HIA was made available through various outlets, including a fact sheet at EPA Septic Week. In addition, the HIA Project Team hosted an HIA 101 training and *Scoping* workshop for select stakeholders as part of the kick-off meeting held on December 19, 2014.

7.1.2 Successes Identified by the HIA Project Team

The HIA Project Team identified successes experienced in carrying out this HIA. Those successes are provided below.

- Branding materials helped to increase recognition of materials coming from the HIA and created a unified format that expedited material production.
- Reviewing previous HIA Reports and practice guidelines helped in the development of this HIA and in ensuring that the HIA achieved the *Minimum Elements and Practice Standards* (Bhatia, et al., 2014).[59]
- A full-day HIA training/workshop was held at the beginning of the HIA process for stakeholders. This training helped to acquaint stakeholders with HIA and the HIA process, since the process is unique and different from other commonly used impact assessments.
- Messaging that the HIA is neutral and is meant to make the relationships between ecosystem services and health more explicit, helped ensure the HIA advocated only for health and well-being.
- As a federal Agency, EPA might appear to be removed from the community in which the assessment occurred. Having the HIA co-led by the EPA regional office, with 1-2 respected stakeholders on the HIA Leadership Team, helped to alleviate this challenge and bring to light the culture in the County around septic.
- Hosting public meetings at libraries in the community helped to ensure accessibility for community residents and other stakeholders to become engaged in the HIA process.
- This HIA used a single person as the gatekeeper for sharing information between groups. This strategy helped streamline the sharing of information and the recognition of materials coming from

[59] In addition to reviewing the HIA *Minimum Elements and Practice Standards* and other practice guidelines, members of the HIA Leadership Team examined the successes, challenges, and lessons learned from past EPA HIAs and examined other HIA reports where best practices had been identified.

the HIA. Furthermore, this strategy provided a clear point of contact for community-based groups and other stakeholders.

7.1.3 Challenges Identified by the HIA Project Team

The HIA Project Team identified challenges faced during this HIA. The HIA Project Team utilized several strategies to counteract unanticipated challenges. Those challenges are provided below.

- Overall, the nature of being a federally-led HIA posed some unique challenges regarding expectations about the assessment and its intended purpose. One expectation was that EPA would perform a scientific evaluation of the proposed code changes; although the HIA process uses science-based methods, it is not a scientific process. In addition to this, having multiple EPA-led projects being conducted in Suffolk County simultaneously led to confusion as to the purpose of the HIA and how the various projects were related, if at all. The HIA Project Team used multiple strategies to manage expectations, such as providing an HIA training workshop, holding one-on-one meetings with individuals functioning under a misconception, and explicitly defining the purpose, scope, and limitations of the HIA for each stakeholder engagement activity.
- Delays in data acquisition and unavailability of data essential to the analysis of impact magnitude (i.e., the types of individual sewerage systems installed at unsewered Suffolk County single-family residences and parcel data) contributed to overall project delays.
- The unavailability of data needed to assess the magnitude and geographic scope of the decision’s impacts (i.e., the geographic locations of the individual sewerage systems targeted by the code changes) affected the ability of the HIA Project Team to determine the socioeconomic status and demographics of the populations affected by the decision and therefore, perform a true characterization of the distribution of impacts, including impacts to vulnerable populations.
- As a federally led HIA, the HIA Project Team proactively tried to *avoid* the misconception that the recommendations from the HIA would have a regulatory component. Although EPA led the HIA, the HIA Project Team included members outside the Agency. The HIA Project Team made it very explicit that the recommendations coming from the HIA were given as suggestions. Recommendations were developed under the assumption that they could be adopted or not adopted at the discretion of the County. The recommendations and monitoring plan from the HIA are not regulatory in nature and were posed only as a suggestion for future action.
- The individual on the HIA Leadership Team who served full-time as the gatekeeper for information sharing and led development of the HIA Report left the project for other employment following the August 2016 Community and TAC Meetings. The lack of continuity in this position through the completion of the project and competing Agency priorities resulted in significant delays in finalization of the HIA Report.
- There was limited public participation following the initial HIA meetings (i.e., the CSSC had to be combined with the TAC) and no public participation in the final round of community meetings the HIA Project Team held. This could be due to a number of reasons: the perception that a decision had already been made; the lack of a “local” person to act as the liaison with the community; and for in-person meetings, the geographic scale of the affected population. The HIA Project Team held public

meetings at multiple locations throughout the County to address the geographic scale, but even so was not successful in drawing attendees to the final community meetings.
- Some of the HIA participants found it difficult to maintain a neutral position and provide evidence-based information rather than opinion regarding potential impacts and recommendations. The HIA Leadership Team maintained the need for neutrality.
- Certain HIA participants repeatedly challenged the Rules of Engagement established for the HIA, including their roles and responsibilities and the process established for decision-making and communication.

7.1.4 Lessons Learned Identified by the HIA Project Team

Based on the success and challenges experienced during this HIA, the HIA Project Team offers the following list of lessons learned for future HIA practice.

- Consider commitment requirements (e.g., time, personnel, funding) for both stakeholders and those performing the HIA. Although one of the EPA contractors that worked on this project from the *Scoping* step to the completion of the *Assessment* step was dedicated full-time to this HIA, it should be noted that this HIA was only one of many projects in which other members of the HIA Project Team and TAC were involved. As such, scheduling conflicts and competing work priorities were a common cause of delay in the HIA timeline. Thus, future HIA project managers need to account for the amount of time participants can commit to the HIA when establishing the HIA project team. Furthermore, there need to be different levels of participation intensity in the HIA for stakeholders who have limited and/or varying levels of resources but want to participate.
- Incorporate reporting and evaluation aspects of HIA early on in the process (i.e., as early as *Screening*) to ensure documentation of the process is thorough and to avoid too much time lapse between the completion of the HIA and reporting to stakeholders.
- Develop the HIA timeline to allow extra time for potential unexpected delays, scheduling conflicts, or other unexpected complications that may arise during implementation of the HIA.
- Continue vigilant communications with stakeholders and decision-makers throughout the process to avoid unmet expectations and scheduling conflicts.
- Develop a core team of individuals responsible for performing the HIA that have multiple skills and expertise so that the various tasks in the HIA process can be accomplished.
- Ensure there is an adequate understanding of the political climate in which the decision is being made.
- When working with EPA Regions, ensure that they understand that the HIA is not a policy document and will not contain policy recommendations (i.e., any recommendations provided by the HIA are not considered EPA policy, but are merely offered to decision-makers as suggestions to improve the impact of the decision on public health).
- Rules of Engagement, when produced, need to be enforced; this includes removal of individuals from the HIA Project Team that are repeatedly in opposition to the rules outlined.
- Stakeholder engagement should solicit participation from community-based organizations, community residents, and other stakeholders. Representatives from both the community and the decision-makers should be at the table.

- The identification of context considerations (i.e., information unique to the locale or decision under consideration, extenuating circumstances, etc.) helps to frame the analysis and its findings.

7.1.5 External Peer Review of HIA

Scientific peer review of the HIA Report was performed by two invited, non-EPA subject matter experts (i.e., external peer reviewers), Dr. Michael Piehler and James Dills, to provide an experienced perspective outside of those directly involved in the process and/or the decision. The external peer reviewers were charged with evaluating the HIA against the *HIA Minimum Elements and Practice Standards* (Bhatia, et al., 2014) and providing input on the soundness of the evidence regarding nutrient transport and coastal waters. Dr. Piehler is the Program Head of Estuarine Ecology and Human Health at the UNC Coastal Studies Institute and a professor of Marine Sciences and Environmental Sciences and Engineering at the University of North Carolina at Chapel Hill. He studies transport and transformation of nutrients in coastal systems, ecology and biogeochemistry of the tidal freshwater zone, and microbial processes in shallow coastal waters. James Dills is a Research Associate II at the Georgia Health Policy Center who works to advance a health in all policies perspective in decision-making. He is an expert in HIA and serves on the Steering Committee of the Society of Practitioners of Health Impact Assessment.

The external peer reviewers provided comments and proposed revisions, which the HIA Project Team considered and incorporated into the HIA Report, as appropriate.

7.2 Plan for Impact Evaluation

Impact evaluation seeks to understand the impact of the HIA itself on the decision-making process or on other factors outside the specific decision being considered (National Research Council, 2011).

The HIA Project Team identified several questions that could be used to determine whether the HIA influenced the decision, decision-making process, and/or decision-making climate (i.e., inform an impact evaluation):

- Were the proposed code changes implemented as originally outlined or were there changes made? If changes were made, what were the changes and why were they made?
- Did Suffolk County adopt and implement the recommendations of the HIA? If not, was there rationale provided for why the recommendation(s) were not adopted?
- Does Suffolk County credit the HIA with informing their decision-making process (e.g., discussion of HIA findings in decision-making) or influencing the decision-making climate regarding health considerations?

Each of these questions can be answered in a short survey or by interview of a representative from Suffolk County after the decision has been implemented. The questions and responses should be documented and preserved. If Suffolk County does not implement the proposed code changes, then they should provide an explanation to the public explaining why this was the final decision and whether information from the HIA was used to make this decision.

Because finalization of the HIA Report lagged significantly behind completion of the HIA analysis and the communication of the HIA findings and recommendations to the stakeholders, and decision-makers, members of the HIA Leadership Team were able to conduct a partial impact evaluation. Through input from the County and a subsequent internet/literature search, the HIA Leadership Team was able to document the period of robust activity Suffolk County entered into after the HIA analysis was complete in fall 2016 to change the local nutrient pollution paradigm, including changes made to the Sanitary Code (see Appendix K). Some of those actions taken were also identified as recommendations in this HIA also recommendations identified in this HIA for potential adoption and implementation as part of decision-making and/or execution of the proposed code changes. Table 7-2 shows the HIA recommendations that correspond to activity by the County. The HIA Leadership Team did not examine activities undertaken by Suffolk County after completion of the HIA analysis aimed at wetland protection/restoration, wetland/green infrastructure creation, and resiliency planning (HIA recommendations beyond the code changes).

Table 7-2. Crosswalk of HIA Recommendations and Suffolk County Activity

No.	Final HIA Recommendation	Suffolk County Activity
1a	A fourth alternative could be considered, requiring upgrade of individual sewerage systems to an innovative/alternative technology across the entire county, with prioritization given to parcels in the high-priority areas (e.g., proactive upgrades in priority areas and upgrades elsewhere in the county, upon transfer, failure/replacement, significant and new construction).	In the Subwatersheds Wastewater Plan (SWP), issued in July 2020, Suffolk County identified a countywide wastewater management strategy to replace cesspools and C-OWTS in Suffolk County with I/A OWTS, sewering, or clustering. This would be implemented in a phased approach, with prioritization given to parcels in high priority areas. In addition, Suffolk County amended the sanitary code on October 15, 2020, to require I/A OWTS in all new home and commercial construction, and for single family home renovations that increase the number of bedrooms to more than five and increase the building’s footprint or floor area.

No.	Final HIA Recommendation	Suffolk County Activity
2a	Ensure that sites with individual sewerage systems that are required to be upgraded as part of the changes to the Suffolk County Sanitary Code tie into sewer if they fall within a sewer district and the approved sewer system is accessible and has capacity.	Suffolk County is considering a range of solutions to address the issues related to nitrogen loading, including the expansion of sewered areas, adding sewage treatment cluster systems, etc. In addition to the use of I/A OWTS, wastewater management options and recommendations explored in the SC SWP included connection of parcels to community sewers by expanding existing sewer districts or creating new sewer districts where possible. The SWP acknowledged that sewering may have advantages over I/A OWTS in certain areas (e.g., areas with significant nitrogen-impaired waters, high groundwater, or poor soils; areas within close proximity to existing sewer districts; and in areas that are prone to sea level rise).
4a	Develop tools that cesspool/septic service contractors can easily and consistently deploy to determine whether a system is in need of maintenance, repair, or upgrade and document the issue(s), such as a checklist or logic framework for use in the field and/or an open-access, web-based platform for documenting issues and reporting properties that need to upgrade their individual sewerage systems.	Per Article 6 of the Suffolk County Sanitary Code, beginning July 1, 2018, contractors or developers holding an active Liquid Waste License must notify SCDHS of all pump-outs, replacements, and retrofits of cesspools, septic tanks, I/A OWTS, grease traps, and leaching structures; reporting is done through the Septic Haulers Information Portal (SHIP; https://ship.suffolkcountyny.gov/).

No.	Final HIA Recommendation	Suffolk County Activity
5a	Create an inventory of existing individual sewerage systems, including their geolocation, design type, and (if possible) maintenance schedule to aid in identifying residences affected by the decision and enforcing the code change. This inventory can be accomplished through sewage industry reporting of cesspool, septic tank and I/A OWTS pump outs, retrofits, and replacements.	Per Article 6 of the Suffolk County Sanitary Code, beginning July 1, 2018, contractors or developers holding an active Liquid Waste License must notify SCDHS of all pumping, replacements, or retrofits of cesspools, septic tanks, I/A OWTS, grease traps, and leaching structures; and beginning July 1, 2019, a SCDHS permit will be required for replacements or retrofits of existing systems. In Fall of 2019, Suffolk County launched their Environmental Health Information Management System (EHIMS), which provides a centralized, GIS linked database to support permitting and oversight of I/A OWTS installations and maintenance. Per the SC SWP, the EHIMS portal will eventually be used for "tracking and organization of system performance, number of systems, O&M, and property owner registrations."
6a	Given its current population and the expectation that Suffolk County may reach its saturation population, further research is needed to ascertain the capacity of Suffolk County soils to effectively manage wastewater effluent (regardless of whether systems are upgraded or not).	As part of the SWP effort, Suffolk County modeled future nitrogen loading should all potential buildout in the County occur and found that nitrogen loading would increase anywhere from 0 to >20% in watersheds over the baseline. The modeling showed that in some watersheds, use of I/A OWTS alone may not be sufficient to address nitrogen loading and recommended that policymakers consider coupling wastewater management with other measures such as purchasing open space, revising local zoning, increasing minimum Article 6 lot size, and/or transfer development rights programs that limit development in select areas.
7a	Select a timeline for implementation that will encourage tempered growth of the OSDS/OWTS industry, minimizing the risk of a spike in the cost of installation and unsustainable industry growth.	The Suffolk County SWP identified a phased approach to countywide wastewater upgrades that would be implemented over 50+ years, with an initial 5-year ramp-up period.

No.	Final HIA Recommendation	Suffolk County Activity
8a	If Alternative III is chosen, towns with a greater reliance on commercial and recreational fishing could be considered in the prioritization of areas for implementation of the code.	The results of the Suffolk County SWP modeling efforts and baseline water quality were used to establish tiered priority areas for implementing the recommended wastewater alternatives in a phased approach.
9a	Perform homeowner outreach early and often and provide information on each system design, including the average life span, operation and maintenance needs, average treatment performance, signs of system failure, and the benefits of routine inspections and maintenance (e.g., increase in system longevity, reduced costs over the life of the system).	The Reclaim Our Water website (https://www.reclaimourwater.info/) was created by Suffolk County to distribute information to residents. The website contains information on the Septic Improvement Program; I/A OWTS designs, operation and maintenance requirements, and performance data; news and upcoming events; annual technology reports; and links to the Sanitary Code, Department Standards, and publications related to I/A OWTS and the Reclaim Our Water Initiative.
14a	Given the additional reduction in nitrogen and pathogen loading from soil absorption drainfields and the potential for drainfields to break down many other pollutants (per the NYSDOH Residential Onsite Wastewater Treatment System Design Handbook; NYSDOH, 2012), consider changes to the Sanitary Code requiring cesspools and conventional OWTS be upgraded to septic tank-soil absorption systems, when site conditions permit. At a minimum, the language in the code for Alternatives I and II could identify upgrades to a septic tank-soil absorption system, conditions permitting, as an alternative to the C-OWTS. For residences with inadequate space for a soil absorption field, a mound OWTS could provide improved treatment performance over the C-OWTS.	Suffolk County is demonstrating a pressurized shallow drainfield and other alternative leaching technologies and has updated the standards to include use of a pressurized shallow drainfield in conjunction with an I/A OWTS. The initial recommendations for pathogens in the SC SWP identify the use of pressurized shallow drainfields to be an effective method for the removal of pathogenic organisms from wastewater effluent.

No.	Final HIA Recommendation	Suffolk County Activity
15a	Take into consideration good practice in the siting, design, installation, and maintenance of individual sewerage systems. For example: • Cesspool and leaching pool systems are known to have poor performance for controlling nutrients and pathogens in system effluent. Consider replacing cesspools/leaching pools with the conventional shallow, soil absorption field systems, which are more effective in controlling nutrients and pathogens in system effluent. For residences with limited space for the conventional soil absorption field systems, an innovative/alternative system with proven treatment performance that would not require a large footprint could be permitted (e.g., mound OWTS). • Gardens and deep-root vegetation, such as large trees, should not be located near or over the individual sewerage system, since large roots and excess plant watering can be damaging to the system. • Avoid installation and/or construction of conventional OWTS on sites where pervasive flooding, tidal influence, and/or extreme rain events increase the risk for hydraulic and/or structural failure of an individual sewerage system. Mound systems offer an alternative option for sites where flooding and/or groundwater influences pose a high failure risk. • Use of reinforced materials and proper system design may prevent human injury and/or death from structural failures. • Proper siting, design, construction, and operation of individual sewerage systems can ensure protection of groundwater and drinking water sources, especially in areas served by private drinking water wells.	Plans, permits, and approvals are addressed in the Standards, including siting, subsoil, and groundwater criteria and conditions that prohibit the use of individual sewerage systems. The SC SWP, developed by Suffolk County after completion of this HIA, does acknowledge that sewering may have advantages over I/A OWTS in certain areas (e.g., areas with significant nitrogen-impaired waters, high groundwater, or poor soils; areas within close proximity to existing sewer districts; and in areas that are prone to sea level rise). The SWP explored wastewater management options and recommendations that included connection of parcels to community sewers by expanding existing sewer districts or creating new sewer districts where possible.
16a	Adopt a standard management plan for each system design to ensure individual sewerage systems are properly maintained and replaced/upgraded when needed. The management plan could include good management practices.	Article 19 of the Suffolk County Sanitary Code established SCDHS as the Responsible Management Entity (RME) for I/A OWTS in the County.

No.	Final HIA Recommendation	Suffolk County Activity
18a	Due to the design and materials used, older cesspools – especially those that have exceeded the expected life span of approximately 25 years – pose risks for illness, injury and/or death were the system to collapse, surcharge above ground, or backflow into the home. Ideally, homeowners could replace such systems with a modern design (e.g., septic tank-soil absorption system or I/A OWTS) or connect to a cluster system or public sewer.	Article 6 was amended to prohibit the installation of new cesspools in Suffolk County as of July 2019 (i.e., existing systems will no longer be replaced in-kind), as all OSDS will have to be upgraded to meet the SCDHS standards (a septic tank-leaching pool or I/A OWTS).
24a	To avoid unintended health impacts, action could be taken to ensure that the increased cost to implement and oversee the proposed changes to the sanitary code does not impact other programs or pull funding away from other social and health services. Operating grants and contributions could be sought from both State and Federal entities to defray costs.	Suffolk County made it clear in the SWP that implementation of code changes that require individual property owners to upgrade to I/A OWTS is contingent on establishing a stable and recurring revenue source.
25a	Outside funding could be sought to reduce the costs of individual sewerage system upgrades for individual households. Assistance for cost-burdened and low-income households and property owners renting to low income households could be prioritized. Assistance could be made available for all household types including non-family households, which have a much lower median income than households of families.	In July 2017, the County announced a new incentive program – the Septic Improvement Plan (SIP) – that provides grants and low-interest financing to make the installation of I/A OWTS more affordable for homeowners of single-family residences. In conjunction with the grant, a low-interest loan program, administered by the Community Development Corporation of Long Island, is also available under SIP to help homeowners finance the remaining costs of installing the I/A OWTS. Outside funding was also obtained from the New York State Septic System Replacement Fund. Multiple outside funding sources have been obtained. For the SIP grant, households with an adjusted gross income ≤ $300,000/year are eligible for 100% of grant. Suffolk County made it clear in the SWP that implementation of code changes that require individual property owners to upgrade to I/A OWTS is contingent on a stable recurring revenue source to reduce financial impacts to property owners.

No.	Final HIA Recommendation	Suffolk County Activity
27a	Review of the Rhode Island and Maryland programs may provide Suffolk County with guidance on implementation of individual sewerage system upgrades, including the triggers for replacement of systems and loan and grant programs for households to assist with costs associated with installation and operation of new systems. More details on these State programs are provided in Appendix J.	Funding (grants and loans) has been secured by the County for homeowners upgrading to I/A OWTS and these efforts were modeled after programs in both Maryland and Rhode Island.
28a	Steps could be taken to encourage OWTS businesses to locate and hire within the County. Possible strategies include tax incentives and decrease of certification fees for OWTS companies that locate in the county and support of a community jobs program to train local residents in OWTS and I/A OWTS technology installation, maintenance, repair and inspection. Consider working with local community colleges to include training courses in this field.	Suffolk County has worked with the Long Island Liquid Waste Association (LILWA) to ensure there are qualified individuals capable of installing and providing maintenance for I/A OWTS in the county. In 2016, the County passed a law requiring liquid waste professionals to acquire training and certification. LILWA and SCDHS provide the required training, in cooperation with the University of Rhode Island New England Onsite Wastewater Training Program.
32a	If Alternative I or II is selected, other measures could be taken to reduce nutrient enrichment and protect water resources to mitigate the impact of declining water quality on employment opportunities associated with the commercial fishing and recreational industries and property values, both of which have the potential to impact both county revenues and household income.	Suffolk County has not chosen to implement Alternative I or II, but rather a countywide program to replace cesspool and C-OWTS with I/A OWTS, sewering, or clustering.

7.3 Plan for Outcome Evaluation

Outcome evaluation focuses on the changes in health status or health indicators resulting from implementation of the proposal (National Research Council, 2011).

Monitoring health impacts is not typically done as a part of the HIA, because the HIA is completed to inform the decision, and it may take years before changes to health are actually observed and reported. Monitoring changes in health outcomes and/or health determinants is a time-intensive process. Furthermore, it is difficult to attribute a change in health to any specific decision, simply because a person's health is affected by various factors that may or may not have been assessed as part of this

HIA. Since the timeframe of this HIA was limited, the HIA Project Team provides a plan for monitoring changes to health and/or determinants of health that result from the decision (i.e., inform an outcome evaluation).

Note*: If one or more of the health determinants and/or health outcomes are found to be too impractical to monitor, a proximate health determinant should be considered as a substitute. For example, water-related illness can be difficult to diagnose and monitor, given that most illness is not reported and is treated with over-the-counter medications. A more practical and highly recommended option is monitoring water quality.*

Monitoring activities are often determined by the amount of resources available, but should be performed in interval periods (e.g., every 6 months, every year, every other year) after the proposed project it completed in its entirety. Utilizing members from the community (i.e., citizen-participatory research) in follow-up activities allows for limited resources to be used more efficiently, improves specificity by targeting specific areas of concern, accelerates early detection of issues and remediation actions, and increases community buy-in.

There are many chronic diseases or cause-specific health outcomes monitored at the county and state levels. There is an opportunity for partnerships between the County and local/regional 501(c)(3) hospitals[60] to conduct periodic community health needs assessments (CHNA) in the community. CHNAs incorporate individual characteristics with community characteristics, including strengths and needs, to investigate the health status of a community and identify intervention opportunities aimed at improving public health. CHNAs are generally performed at the regional or metropolitan statistical area; however, a neighborhood or community level assessment could be incorporated into a larger CHNA dataset.

Regardless of methods or tools used in follow-up activities, the HIA Project Team stresses the importance of collaboration between stakeholders to perform monitoring. For this reason, the HIA Project Team prepared a list of outcomes that should be monitored after the final decision is made and identified potential partners for carrying out those activities (Table 7-2).

Note: The purpose of this exercise is to provide a more focused approach for stakeholder collaboration in future monitoring efforts. The HIA Project Team did not account for feasibility (i.e., cost, personnel available, timing) in the proposed monitoring plan, because the entities performing the monitoring were not yet identified. The HIA Project Team did identify potential partners for monitoring outcomes so that stakeholders could initiate conversations regarding follow-up activities.

[60] Requirements under the Affordable Care Act (passed in 2010) state that in order for 501I(3) hospital organizations to keep their tax-exempt status, they must perform a CHNA, publicly report the findings, and adopt an implementation strategy to address identified needs at least once every three years.

Table 7-2. Proposed Plan for Monitoring Health Impacts Post-decision[61]

Health Determinant	Potential Indicators, including Health Outcomes	Potential Data Sources	Potential Partners
Individual Sewerage System Failure	• Number and location of reported individual sewerage system hydraulic or structural failure • Reported cases of illness, injury, or death from individual sewerage system failure	• Reports of individual sewerage system pumpouts, retrofits, and replacements • Complaints of system failures filed with SCDHS (or incoming scavenger waste volumes to sewage treatment facilities as a proxy) • Media reports of individual sewerage system structural failure • Community Health Needs Assessment or health services data regarding illness, injury or death	• Sewage industry professionals • SCDHS • Local hospitals • Academia (e.g., Cornell University Cooperative Extension of Suffolk County, SUNY-Stony Brook)

[61] Potential partners are identified for monitoring so that stakeholders can initiate conversations regarding follow-up activities.

Health Determinant	Potential Indicators, including Health Outcomes	Potential Data Sources	Potential Partners
Water Quality	• Number, location and type of individual sewerage system upgrades • Modeled pollutant loading from individual sewerage systems • Nitrate, fecal coliform, and/or *E. coli* levels in public water supply and private wells • Nitrate, total nitrogen, fecal coliform and/or *E. coli* levels in Suffolk County surface and marine waters • Reported cases of algal blooms • Number and location of water quality advisories and beach closures • Reported cases of water-related illness	• SCDHS individual sewerage system applications • Sewage industry reports of upgrades • GIS modeling and manufacturer-provided treatment performance or effluent monitoring results • SCWA public water supply data • SCDHS private well monitoring data • Media reports • SCDEQ water quality advisories and beach closure data • Hospital and/or SCDHS water-related illness data	• SCDHS • SCDEQ • Sewage industry • SCWA • NYSDEC • Community residents • Academia (e.g., Cornell University Cooperative Extension of Suffolk County, SUNY-Stony Brook) • Local hospitals
Resiliency	• Location and acreage of wetlands restored and/or created • Acres of eelgrass restored • Number of nuisance/sunny-day floods • Reports of property/infrastructure damage from storm and/or tidal surges and flooding	• New York and National Wetlands Inventory • Cornell University Cooperative Extension of Suffolk County eelgrass restoration data • NOAA sea level gauges • National Flood Insurance Program claims	• SCDEQ • NYSDEC • The Nature Conservancy • FSWS • Academia (e.g., Cornell University Cooperative Extension of Suffolk County, SUNY-Stony Brook) • NOAA • FEMA • SC Office of Emergency Operations

Health Determinant	Potential Indicators, including Health Outcomes	Potential Data Sources	Potential Partners
Vector Control	• Volume/acreage of insecticide application • Mosquito population size • Location and number of mosquito complaints • Location and number of cases of illness from vector-borne pathogens	• Suffolk County Division of Vector Control surveillance and insecticide application data • Mosquito complaints filed with the SCDHS • Suffolk County Tick and Vector-Born Disease Task Force disease data	• Suffolk County Division of Vector Control • SCDHS
Household Economics	• Reported costs of individual sewerage system upgrades • Number and dollar amount of aid for system upgrades • Employment rate in OSDS/OWTS, commercial fishing, and recreational industries • Households living below federal poverty level • Annual household income • Monthly housing costs (renter and homeowner) • Number of cost –burdened households • Mean and median residential property values • Location affordability index	• SCDHS upgrade implementation/management data • Office of the Comptroller economic data • NOAA Ocean and Great Lakes Jobs data • Industry Reporting • U.S. Census Bureau/American Community Survey • HUD location affordability index (http://www.locationaffordability.info/lai.aspx)	• SCDHS • Suffolk County Government • Local hospitals • Academia (e.g., SUNY-Stony Brook) • Fishing and Recreation industries
Community Economics	• Real estate transaction value • Real property taxes • Mean and median residential property values • Commercial fishing, recreation, and tourism revenues	• Office of the Comptroller economic data • Industry reports	• Suffolk County Government • Fishing, Recreation, and Tourism Industries • Academia • The Nature Conservancy

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Appendix A: Glossary of Terms Regarding Sewerage Systems and Algal Blooms

A.1 Sewerage System Terminology

Based on the assorted definitions found, the HIA will be using the following terms to describe individual systems in Suffolk County.

- ***Individual Sewerage System*** to describe the overall category of individual (onsite) systems used to treat and/or dispose of wastewater from single-family residences in Suffolk County
- ***Onsite Sewage Disposal System (OSDS)*** to describe the pre-1973 type of individual (onsite) sewerage system that includes a disposal unit alone (i.e., a cesspool) serving single-family residences in Suffolk County
- ***Conventional Onsite Wastewater Treatment System (C-OWTS)*** to describe the post-1973 type of individual (onsite) sewerage system that includes a septic tank and disposal unit (leaching pool) serving single-family residences in Suffolk County
- ***Innovative/Alternative Onsite Wastewater Treatment System (I/A OWTS)*** to describe the innovative (pending approval) type of individual (onsite) sewerage system designed for nitrogen reduction/control used as an alternative to the C-OWTS serving single-family residences in Suffolk County

A.2 Algal Bloom Terminology

Throughout the HIA report, you will find discussion of algal blooms; however, not all algal blooms are the same. The HIA will use the following terms to describe the algal blooms that occur in Suffolk County:

- ***Algal blooms*** to describe those blooms that occur as part of the normal growth and senescence cycle of phytoplankton communities (i.e., communities of microscopic floating algae). These algal blooms are <u>not</u> harmful. In fact, phytoplankton are a naturally occurring part of the food chain in both marine and freshwater ecosystems, and many aquatic animals rely on algae for food.
- ***Toxic algal blooms*** to describe blooms of algae that produce toxins harmful to human or animal life. According to NOAA (2016a), "less than one percent of algal blooms actually produce toxins;" however, there are several algae present in Suffolk County that are toxic.
- ***Harmful algal blooms (HABs)*** to describe those algal blooms that grow quickly in large quantities and can have negative impacts on humans, marine and freshwater environments, and coastal economies. Harmful algal blooms include toxic algal blooms and blooms of non-toxic algae that have harmful effects on marine and freshwater ecosystems.

Appendix B: The Proposed Code Changes

Proposed Sanitary Code Policy Changes for Upgrading Existing OSDSs, Rev. 2: 8-15-14[62]

Overview: 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. The estimated population of Suffolk County in 2013 is 1.5 million with 568,943 housing units. Many of Suffolk County's residences utilize an onsite sewage disposal system (OSDS) as means of sewage disposal and the effluent from these systems discharge directly into the ground. The Suffolk County Sanitary Code Article 6 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). Suffolk County is proposing to amend the current Sanitary Code to include requirements for upgrading existing OSDSs when no new construction is proposed.

Suffolk County Department of Health Services OSDS Requirements: Per Article 6 of the Suffolk County Sanitary Code, property owners desiring to construct a new building including additions to existing buildings or changes of use of existing buildings with an OSDS are required to obtain a permit from the Suffolk County Department of Health Services. The permit is usually for a proposed new OSDS conforming to current standards. In some cases, where an addition or change of use is proposed the permit may be to simply verify the existing system meets current standards and is acceptable for the proposed addition or change of use. The following is a brief history of Suffolk County Department of Health Services Standards:

In 1958 the first Suffolk County Health Department Standards went into effect, requiring block cesspools for single family homes. Up until 1972 these cesspools (also known as leaching pools) were permitted to be installed without a septic tank. 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 pools known as cesspools were constructed from concrete blocks and are highly susceptible to collapse.

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 a conventional OSDS). Septic tanks are watertight chambers used for settling, stabilizing and anaerobic decomposition of sewage. Today all new

[62] These were the proposed code changes under consideration by Suffolk County during the HIA. Subsequent to the completion of the HIA analysis and reporting of preliminary findings and recommendations to the decision-makers, stakeholders, and community in the fall of 2016, Suffolk County entered into a period of robust activity working to change the local nutrient pollution paradigm. This included, among other things, consideration of different sanitary code changes than those assessed in the HIA. For more information on these changes, see Appendix K.

construction including additions to existing buildings or changes of use of existing buildings are required to install a conventional OSDS when a community sewage disposal system is not available.

Currently property owners with older OSDSs such as cesspools are not required to make an application to the Suffolk County Department of Health Services to upgrade their system to current standards. When either a cesspool fails or a conventional OSDS fails, the property owner has the right to re-install the system in-kind without obtaining a permit from the Suffolk County Department of Health Services. However, as stated in the current residential construction standards, the Suffolk County Department of Health Services recommends property owners follow the standards as a guideline for re-construction of a failing system.

Some Important Facts Regarding OSDS within Suffolk County:

- There are approximately 365,000 homes that currently utilize OSDSs as means of sewage disposal.
- Approximately 252,000 of these systems were installed prior to 1972 and are assumed to be cesspools only.
- Approximately 209,000 homes with OSDS are located in areas considered to be high priority areas. High priority areas are as follows:
  - 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
  - Areas located in a SLOSH zones (Sea, Lake, and Overland Surges from Hurricanes)
  - Areas located in an area where groundwater is less than 10 feet below grade.

Proposed Code Changes: The Suffolk County Sanitary Code Article 6 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). However, the code does not provide the authority to Suffolk County to enforce upgrading of existing OSDSs to conventional or innovative/alternative OSDSs when no new construction is proposed. Suffolk County is proposing three (3) possible changes to the Suffolk County Sanitary Code to permit the enforcement of OSDS upgrades as follows:

1) Require upgrading of all existing cesspools to conventional OSDSs.
2) Require upgrading of all cesspools for lots located in identified high priority areas.
3) Requiring upgrading of all existing OSDSs to innovative/alternative systems for lots located in identified high priority areas (either cesspool or conventional OSDS).

Method of Implementing the Sanitary Code Changes in Order to Facilitate the Upgrading of Existing Onsite Sewage Disposal Systems: The proposed methods that will be used to implement the proposed code changes are still under investigation, but the following three (3) proposed pathways or combination of pathways are examples of possible methods to implement the code changes requiring OSDS upgrades:

Failure of existing OSDS – As part of their license obligations, cesspool contractors will be required to report to the Suffolk County Department of Health Services when a system has been pumped or when a system is in need of replacement. When the system has been pumped multiple times in a given period of time or is in need of replacement the Suffolk County Department of Health Services will then send a legal notice to the property owner ordering them to submit an application to obtain a permit to upgrade their OSDS.

Property Transfer – In order for a property owner to initiate the sale of their property they will be required to obtain a certificate from the Suffolk County Department of Health Services indicating their existing OSDS complies with current codes (certificates will be valid for a 1-year period). If their OSDS does not comply with current codes, they will be required to submit an application to the Suffolk County Department of Health Services to upgrade their OSDS prior to sale.

Upgrading of OSDS based on a fixed schedule by region – Suffolk County will prioritize areas of the County that utilize OSDSs. Each area will be assigned a fixed schedule for property owners to upgrade their OSDS or provide proof to the Suffolk County Department of Health Services that their system complies with current standards.

Expected Water Quality Improvements Due to Sanitary Code Changes Requiring Upgrading of Existing OSDSs: The primary water quality improvements will be due to reduced nitrogen discharge to groundwater. By reducing the nitrogen load, partly due to OSDS upgrades, Suffolk County hopes to decrease nitrogen levels in the aquifer, increase the dissolved oxygen in impaired water bodies (e.g., Forge River), decrease the threat of harmful algal blooms, and revitalize eelgrass and wetlands to improve coastal resiliency.

Secondary water quality improvements are due to emerging technologies that have the ability to remove prescription drugs and personal care products from wastewater, which are being discovered in drinking water supplies. In addition, the proposed code changes will require existing sanitary systems located in groundwater to be placed above groundwater allowing soils to filter harmful pathogens from the effluent wastewater that could potentially affect water quality.

Appendix C: Innovative/Alternative OWTS Under Consideration at the Time of the HIA Analysis and Development of Sanitary Code Article 19[63]

C.1 Innovative/Alternative OWTS Under Consideration

Suffolk County Chooses Four Vendors for Round One of Demonstration of Innovative Alternative Onsite Wastewater Treatment Systems Program

(Suffolk County, NY-February 4, 2015) –Suffolk County has selected four firms with proprietary nitrogen removal technology– BUSSE Green Technologies, Hydro-Action Industries, Norweco and Orenco Systems – to participate in Round One of the Suffolk County's demonstration of innovative/alternative OSDS program.

The selection followed a thorough review conducted by the selection committee consisting of representatives from the County Departments of Economic Development and Planning, Health Services, and Public Works. As part of the evaluation, selection team looked at the applicants' system approvals on national and state level, financials, treatment process, effluent testing data, performance in comparable climate conditions, as well as the costs of the installed system and annual maintenance. All of the selected vendors previously demonstrated average effluent concentrations of total nitrogen equal to or below 19 mg/l (i.e., nitrogen reduction of 50% or more).

Three vendors (BUSSE, Hydro-Action and Norweco) have been recommended for demonstration of their systems on private residential properties. The fourth vendor (Orenco) was recommended for demonstration of its systems on county municipal property. The self-reported costs of advanced treatment systems proposed by three firms ranged from $5,000 to $16,500 installed; the cost of a system proposed by the fourth firm was $23,000 installed. The annual maintenance cost for all systems ranged from $200 to $600 per year. In addition, one non-proprietary treatment technology – constructed wetlands – has been added to the demonstration program and is expected to be tested on select county parkland residencies and town park settings. Additional information about four selected vendors is provided below.

- BUSSE technology has been installed in Maine and Massachusetts. It was also approved in Maryland and New Jersey. **BUSSE MF**, the system proposed for demonstration, utilizes Membrane Bio Reactor (MBR) treatment process. MBR technology combines biological treatment with a membrane filtration into one unit process and, as such, requires smaller footprint.

[63] Note that this Appendix presents the I/A OWTS under consideration at the time of the HIA analysis. Since that time, additional I/A OWTS technologies have been considered, tested, and approved for residential use in Suffolk County (see Appendix K).

- Hydro-Action technology has been installed in Illinois and Ohio (n = 7,700 systems in IL and 5,600 systems in OH) and several other states, according to the firm. **Hydro-Action AN Series**, the system proposed for demonstration, uses extended aeration activated sludge process in which microorganisms that treat wastewater remain in the treatment process for longer period of time (more than 24 hrs.).
- Norweco technology has been approved and installed in Massachusetts (n = 140 systems), Maryland, Ohio and Rhode Island. **Norweco Singulair TNT** and **Hydro-Kinetic** are two systems proposed for demonstration project; both of these systems use extended aeration activated sludge process.
- Orenco technology has been approved and installed in Massachusetts (56 systems), Maryland, Rhode Island and several other states. According to the firm, more than 20,000 Orenco systems have been installed in the U.S. and Canada. Two systems proposed for the demonstration, **Orenco Advantex AX-RT** and **Advantex AX**, use attached growth packed bed reactor process where microorganisms responsible for biological treatment are attached to textile media.

Bellone Announces Lottery for Second Phase of Suffolk County Septic Demonstration Pilot Program

Additional Homeowners to Receive Free State-of-the-Art Septic System to Reduce Nitrogen Pollution & Enhance Water Quality

(Hauppauge, NY-March 21, 2016) –Suffolk County Executive Steve Bellone announced today a lottery which will be held for the second phase of the County's Septic Demonstration Program for single family homeowners. Applications for the second lottery are due **Friday, April 8, 2016**, and winners will receive a free advanced wastewater treatment system – which includes free installation, monitoring and maintenance for five years.

The program is part of Suffolk County's *Reclaim Our Water* initiative, a comprehensive plan to improve the region's water quality by reducing nitrogen pollution through the implementation of advanced on-site wastewater treatment systems and means of sewering in targeted areas.

"Suffolk County has made tremendous strides in reclaiming our water since we launched this initiative nearly two years ago," said Suffolk County Executive Steve Bellone. "The first phase of the septic demonstration program has been extremely successful to date as we have received tremendous feedback from our residents who are currently participating in the program and from our wastewater experts who are managing the program. This second phase will be essential to our region as we intend to integrate new wastewater technologies to Suffolk County to help combat our region's nitrogen pollution crisis."

The application for the second lottery of the Suffolk County Septic Demonstration Program can be found on www.suffolkcountyny.gov, http://www.suffolkcountyny.gov/Departments/Planning/ReclaimOurWaterInitiativeUpdate.aspx or by emailing septicdemo@suffolkcountyny.gov.

Minimum requirements for Suffolk County residents include year-round residency, living in a household with 3-9 people and not residing in a sewer district.

In December 2014, County Executive Bellone and officials conducted an initial lottery for the first phase of the state-of-the-art pilot program. Nineteen homeowners out of more than 150 applicants were randomly selected to receive a free advanced wastewater treatment system on their property.

Eighteen of the nineteen systems were installed over a nine-month period, and are currently being monitored by the Suffolk County Department of Health Services and wastewater industry experts. The 19th system will be installed this April and includes a pressurized shallow drain field to provide further treatment and disposal. Based on early results, some of the installed systems could be provisionally approved by the Department of Health Services for residential use by the end of the Summer.

The systems that were used for the first phase of the program were donated by four national manufacturers, all of whom have extensive experience across the country in removing excess nitrogen from residential and commercial properties, and consisted of six different technologies. The advanced wastewater treatment systems were each valued at up to $16,000 per system.

The second phase of the County's septic demonstration program is designed to utilize two types of innovative alternative onsite wastewater treatment systems that are designed to reduce total nitrogen in septic system effluent to 19 mg/l or less.

One of the technologies that will be incorporated in the second phase is a pressurized shallow narrow drain field system, which will distribute treated effluent where nutrient adsorption is at its highest. The shallow narrow drain field technology is being used in one of the systems installed in the first phase of the program.

The number of homeowners who will be selected for the second lottery will be based upon the number of responses received by the County in regards to two Request for Expressed Interest (RFEI) that were issued to manufacturers nationwide. Applications for the RFEIs are due to the County on April 8, 2016 as well.

The majority of the advanced wastewater treatment systems that will be installed in the first and second phases of the Suffolk County Septic Demonstration Program were observed by county experts on a tour of septic programs conducted in other states in the northeast. Suffolk County is modeling its homeowner education program on a successful program that has been established in Rhode Island over the past fifteen years.

For more information on Suffolk County's septic demonstration program and information on the second lottery for single family homeowners, log onto www.suffolkcountyny.gov or email SepticDemo@SuffolkCountyNY.gov.

Bellone Announces Key Milestone in Suffolk County Septic Demonstration Pilot Program

First Alternative Wastewater Treatment System to Be Approved in County's History during National Septic Smart Week

(Suffolk County, NY-September 20, 2016)– Suffolk County Executive Steve Bellone was joined by regional water quality experts and environmental advocates to announce that for the first time an on-site advanced wastewater treatment system has been provisionally approved for residential use in Suffolk County, marking a significant moment in Suffolk County's Septic Demonstration Pilot Program.

The program is part of the County's *Reclaim Our Water* initiative, which is designed to eliminate the region's nitrogen pollution crisis through the installation of advanced on-site wastewater treatment systems and sewering where viable and appropriate.

"This is yet another victory for all of us in Suffolk County and is a true indication that we are committed to reducing nitrogen levels in our waters. In the past few weeks, we have taken several steps forward to ensure that clean water will continue to be a top priority." said Suffolk County Executive Steve Bellone. "We are extremely grateful to the 39 homeowners who are currently participating in the septic demonstration program. Their participation has been essential in achieving this step, and we anticipate that additional treatment systems will be approved by the end of the year for provisional use."

"Septic systems are a major source of nitrogen pollution in Long Island, threatening water quality and valuable coastal water resources," said EPA Regional Administrator Judith A. Enck. "An estimated three out of four households in Suffolk County rely on septic systems and even those systems that are working properly release large amounts of nitrogen into the groundwater. Innovative technologies provide an important opportunity to cut nitrogen pollution on Long Island."

"Thanks to the leadership of County Executive Steve Bellone, the Suffolk County Departments of Health and Planning the water quality of the county will now, with the use of these emerging technologies, improve into the future," said Suffolk County Legislator Al Krupski.

"As Co-Managers of the Long Island Nitrogen Action Plan, the Long Island Regional Planning Council salutes Suffolk County and County Executive Bellone on its initiative of advancing state-of-the-art onsite wastewater treatment technology for the purpose of reducing nitrogen discharges into our ground and surface waters. The County's approval of the first commercial installation of Innovative/Alternative technology will enable the County to thoroughly evaluate the effectiveness of these systems and to assess the operational reliability in actual residential applications," said John Cameron, Long Island Regional Planning Council Chairman.

The approved system, manufactured by Hydro-Action Industries, was one of the initial technologies to be used when the Septic Demonstration Pilot Program launched in December 2014. The system has reduced nitrogen levels to 19 mg/l for six consecutive months effectively. Currently, more than 14,000 of these particular systems have been installed in homes throughout the Midwest and in Maryland.

Suffolk County has granted provisional residential approval for the installation of the Hydro-Action system. Any single-family homeowner will be able to install this specific system at their home without having the apply for a variance from the Suffolk County Department of Health Services. The department will continue to monitor performance of these systems for at least two years with bimonthly samples before general approval is issued.

The approval of the Hydro-Action technology is based on the state of Massachusetts' regulatory model.

The announcement comes nearly six weeks after Suffolk County Executive Steve Bellone signed Article 19 of the County's Sanitation Code in law, granting the Suffolk County Department of Health Services the authority to formulate procedures and protocols in order to approve the use of wastewater treatment systems throughout the county. The amendment also established procedures to ensure that the alternative wastewater treatment systems will function in the long-term and to monitor its effects on the environment.

Since the launch of the Suffolk County Septic Demonstration Pilot Program, more than 330 Suffolk County homeowners have entered two lotteries and 39 homeowners have been selected to receive a free system – which includes free installation, monitoring and maintenance for five years.

Suffolk County has more than 360,000 individual cesspools and septic systems – more than the entire state of New Jersey. As part of the solution, clean water experts project that tens of thousands of onsite wastewater treatment systems will need to be installed throughout the county to effectively treat the region's declining water supply.

The announcement came during National Septic Smart Week, designated by the United States Environmental Protection Agency.

For more information on the Septic Demonstration Pilot Program and the County's *Reclaim Our Water* initiative, log on towww.facebook.com/stevebellone or www.suffolkcountyny.gov.

C.2 Suffolk County Sanitary Code Article 19 (SCDHS, 2016b)

In July 2016, Suffolk County amended the Sanitary Code, adding Article 19, which gave SCDHS the authority to develop procedures, protocols, and standards for approving the use of I/A OWTS throughout the County and establishing effluent total nitrogen concentrations of 19 mg/L or less as a requirement for I/A OWTS approval. In addition, Article 19 does the following:

- Establishes a framework for SCDHS, as the Responsible Management Entity, to evaluate, approve, register, oversee, and facilitate the use of I/A OWTS to ensure that I/A OWTS continue to function effectively over the long-term and to benefit the environment.
- Establishes that SCDHS shall have the legal authority and technical capacity to ensure/enforce the long-term operation, maintenance and management of all I/A OWTS (e.g., monitoring, operation and maintenance, and data management)
- Establishes that SCDHS shall develop standards and methods for evaluating the performance of I/A OWTS in meeting this effluent standard at each stage of the approval process. SCDHS shall also establish procedures for the periodic evaluation of new I/A OWTS technologies to ensure that performance verification standards represent the best available technologies. This evaluation shall occur, at a minimum, on an annual basis, and more frequently if advances in technology so warrant.

Note: Nothing in Article 19 affects the operation of Article 6 of the Suffolk County Sanitary Code. I/A OWTS shall be considered individual sewerage systems under Article 6 of the Suffolk County Sanitary Code, and shall not be considered sewering, community sewerage systems, or modified subsurface sewage disposal (denitrification) systems by the Department under Article 6.

Responsibilities under Article 19

The responsibilities of SCDHS, property owners, and services providers are outlined in Article 19.

- SCDHS responsibilities include:
    - Serving as the Responsible Management Entity (RME) of I/A OWTS
    - Overseeing Installation and operation and maintenance (O&M) of the systems

  - Promulgating Procedures, Standards, & Protocols for I/A OWTS
  - Enforcement

- Property owner responsibilities include:
  - Maintaining current O&M contract
  - Implementing requirements to ensure system function
  - Registering I/A OWTS with the County prior to construction, upon property transfer, and every 36 months after initial registration

- Service provider responsibilities include:
  - Maintaining Liquid Waste Endorsement K
  - Performing annual O&M
  - Notifying SCDHS w/ 30 days when O&M contract is canceled or not renewed
  - Reporting all O&M, recommendations, & emergency services

Appendix D: Key HIA Community and Public Meetings

D.1 HIA Kickoff Meeting Agenda and Notes

December 19, 2014
Suffolk County Office, Yaphank, New York

Meeting Agenda

8:45	Welcome, Introductions, and Overview
8:50	**HIA 101 Training** Objectives What's the Connection? Programs, Policies, Plans, Projects and Health
8:55	Introduction to HIA - What is HIA? - Why HIA? - History of HIA - Types of HIA - Context of HIA - Intervention Points of HIA
9:15	HIA Process Overview - Steps of HIA - HIA Process/Minimum Elements - Principles and Values of HIA - Equity and Stakeholder Participation - Stakeholder and Community Engagement - Communication in HIA - HIA Outcomes
9:35	**Q&A**
9:40	HIA Examples
9:45	Screening
09:55	Scoping
10:25	**Break**
10:40	Assessment
11:30	Recommendations
11:40	Reporting
11:45	Monitoring and Evaluation
12:00	**Lunch**
12:00-12:15	Over-lunch Discussion: Concurrent Projects in Suffolk County, NY
1:00	**HIA Scoping Workshop** Background About Suffolk County - Current issues facing Suffolk County - Existing policies regarding Onsite Sewage Disposal Systems in Suffolk County - Proposed Policy Changes and Potential Decision Outcomes
1:15	Health Impact Assessment (HIA) of Proposed Policy Changes for Onsite Sewage Disposal Systems in Suffolk County, NY Screening the HIA - Anticipated Value Added - Feasibility of Performing an HIA - Timeliness and Opportunity for HIA to Inform the Decision
1:35	Scoping the HIA
1:40	- Task A: Establishing HIA Participant Groups and Rules of Engagement
1:45	- Task A Exercise
2:10	**Break**
2:20	- Task B: Defining the Boundaries (Scope) of the HIA
2:30	- Task B Exercise
2:50	- Task C: Identifying Potential Impacts to Health
3:00	- Task C Exercise and Discussion

4:00	**Q&A**
4:10	- Task D: Solidifying the Assessment Plan
4:20	- Task D Exercise and Discussion
4:50	**Wrap-up and Charge to Participants**
5:00	**Adjourn**

Meeting Overview

After an informal meet and greet session, EPA's Florence Fulk gave the welcome and opening remarks and led the attendees in brief introductions. This was followed by an HIA 101 training presentation that introduced the concept of HIA, the importance of HIA in decision-making, and the principles and methods used in HIA practice. Facilitators highlighted each step of the six-step HIA process using an example HIA performed in Vinton, Texas. The Healthy Vinton/Vinton Saludable HIA appraised the health and economic impacts of a proposed municipal drinking water and sewering project.[64] The HIA 101 training was followed by lunch and an informal talk about other projects occurring in Suffolk County.

The afternoon of the HIA Kickoff Meeting was devoted to an HIA Scoping Workshop in which participants were introduced to the proposed code changes and asked to walk through some of the tasks associated with the Scoping step of the HIA process. Walter Dawydiak, Acting Director of Suffolk County's Division of Environmental Quality, provided background information about why the changes were proposed. Attendees used the information given to identify the individuals that will be affected by the decision and/or have an interest in the result of the final decision (i.e., stakeholders) and to identify the environmental, social, and economic pathways or mechanisms through which the "no change" alternative (Alternative 1) could affect health.

At the conclusion of the meeting, attendees were asked to share the information they received with fellow stakeholders and invite them to participate in the HIA.

Meeting Attendees

Of the twenty (20) attendees at the HIA Kickoff Meeting, five (5) represented county government, seven (7) represented an environmental advocacy group, six (6) represented a federal government agency, one (1) represented a local university, and one (1) was a federal government contractor.

Meeting Attendees and Organizations Represented

Attendee(s)	Organization(s) Represented
Adrienne Esposito	Citizens Campaign for the Environment
Lauren Adkins	CSS-Dynamac (contractor to the EPA)
John Halfon	Federal Emergency Management Agency (FEMA)
Kevin McDonald, Liz Smith	The Nature Conservancy
Dan Gulizio	Peconic Bay Keeper
Alison Branco	Peconic Estuary Program
Glynis Berry	Peconic Green Growth
Marshall Brown	Save the Great South Bay
Anthony Dvarskas	Stony Brook University, School of Marine and Atmospheric Sciences

[64] More information about this HIA can be found online at https://www.pewtrusts.org/-/media/assets/external-sites/health-impact-project/utep-hia-report.pdf.

Attendee(s)	Organization(s) Represented
Amy Juchatz, Chris Lubicich, John Sohngen	Suffolk County Department of Health Services
Sarah Lansdale	Suffolk County Department of Planning
Walter Dawydiak	Suffolk County Division of Environmental Quality
Florence Fulk, Kristina Heinemann, Anhthu Hoang, John Johnston, Rabi Kieber	U.S. EPA

About the Health Impact Assessment

The U.S. Environmental Protection Agency (EPA) is leading a health impact assessment (HIA) in Suffolk County, New York (NY). The HIA will evaluate proposed changes to the Suffolk County Sanitary Code Article 6 regarding existing onsite sewage disposal systems (OSDS). Suffolk County Department of Health Services proposed the code changes as one of many actions to address the growing issues from nitrogen overloading in the county's surface waters and groundwater.

The "No Change" Alternative and Three Proposed Changes to the Suffolk County Sanitary Code

Alternative 1	Alternative 2	Alternative 3	Alternative 4
No change (policy not updated)	Required upgrading of all existing cesspools to conventional OSDS	Required upgrading of all cesspools for lots (parcels) located in identified high priority areas	Required upgrading of all existing OSDS (cesspool or conventional OSDS) to innovative/alternative OSDS for lots (parcels) located in identified high priority areas

Why is EPA Leading an HIA?

The purpose of the HIA is to help inform Suffolk County's decision regarding the proposed changes to the County Sanitary Code Article 6 by advocating for health and wellness of all stakeholders. EPA is evaluating HIA as a decision-support tool for promoting sustainable and healthy communities. The Federal Emergency Management Agency (FEMA), who is also considering HIA to promote resilient communities, partnered with EPA to perform the HIA.

HIA 101 Training Short-Course

The HIA 101 Training presentation covered what HIA is and why it is performed, the history behind the HIA process, differences between the different types of HIA, the sectors in which they have been implemented, and the points in the decision-timeline where an HIA can provide value. The meeting facilitators also provided an overview of the HIA process, including the steps of HIA and the guiding principles for the process, stakeholder engagement, and communications. Before going further in depth on each of the tasks associated with each HIA step, the facilitators discussed some of the shared outcomes from completing an HIA.

Participants had many questions related to stakeholder engagement, most notably: *How does the HIA team achieve equity in the stakeholder engagement process*? Democracy is one of the guiding principles that each HIA project strives to uphold and it is essential that the HIA accepts and utilizes diverse stakeholder input. Practitioners have developed guidance and best practices for stakeholder engagement in HIA that describe many tools, methods, and examples for identifying and engaging key stakeholder groups.[65] Most notably, practitioners must use multiple avenues to solicit input. For example, EPA is identifying stakeholders to participate in this HIA by soliciting contact information from the decision-makers (i.e., Suffolk County elected officials and representatives) and existing partners in the region, performing a desktop search of organizations, agencies, research institutions, and advocacy groups active in the area, and releasing public flyers to local community gatekeepers.

Other questions included what proposals make good HIA candidates and who can initiate and/or perform an HIA. It is important to note that not all proposals are appropriate for the HIA process. The proposal must be developed enough so that an assessment can be performed and in advance of the decision for the HIA to be relevant once completed. Any individual and/or group can initiate or lead an HIA. However, most successfully completed HIAs are led by a team that includes an HIA practitioner or advisor. Although most HIAs have been initiated by grassroots organizations, HIAs have also been led by local, state, and federal agencies, advocacy or decision-support groups, research institutions, or were integrated with other studies. EPA is leading only a few HIAs to evaluate the potential for HIA as a decision-support tool.

Audience Questions and Responses from EPA

Question Raised	EPA's Response
How does the HIA team intend to achieve equity in the stakeholder engagement process?	In order to ensure transparency and equitable stakeholder engagement, EPA will enact a Rules of Engagement Agreement for HIA participants, offer different roles of various commitment levels for stakeholders (e.g., HIA Research Team, Community Stakeholder Steering Committee, and Technical Advisory Committee), and ensure diversity in stakeholder outreach. The HIA community of practice also developed Equity Metrics for HIA (Revision 1) to ensure equitable stakeholder engagement throughout the process.
What is expected to come from the HIA and how will that information be used to inform the decision? Will the HIA look at other alternatives that have not been proposed?	The purpose of the HIA is to bring health considerations into the decision-making processes in Suffolk County. The HIA is evaluating the three proposed code changes and the "no change" alternative to determine their potential impacts to health and provide recommendations to manage the potential health impacts of these alternatives. Thus, the HIA is limited to evaluating only the options that are under consideration and will not advocate for a specific alternative.
How does the HIA plan to address any potential differences between actual and perceived conditions?	Stakeholder input will be used in each step of the HIA process, including assessing impacts and developing recommendations. There are generally-accepted methods to capture and interpret qualitative (non-numeric) information, as well as quantitative (numeric) data. In regards to perceptions, the HIA Project Team will be responsible for following standard methods of data collection and interpretation and ensuring accurate representation of the information. Thus, it is critical that the stakeholders participating in the HIA are representative of the populations affected by the proposed decision. To ensure this, EPA is performing a stakeholder analysis and will invite stakeholders to participate in the HIA through a variety of roles.

HIA Scoping Workshop

Information gleaned from the HIA Scoping Workshop would be used to inform the HIA scope. In the HIA Scoping Workshop, participants identified several pathways in which health could be affected if no

[65] The guidance and best practices for stakeholder engagement in HIA can be found online at http://www.hiasociety.org/documents/guide-for-stakeholder-participation.pdf.

changes were made. The discussions focused mainly on the environmental aspects of those pathways, which indicates that environmental health is a priority concern in this area. The HIA Project Team will use the stakeholder interests and/or concerns identified in the meeting to inform the HIA scope. The next steps in the HIA will be to reach out to community residents and stakeholders to solicit their input on the proposed code changes, document their priority concerns and/or interests, and establish the HIA Project Team.

The HIA Scoping Workshop was intended to:

- Explore the principles of HIA and how this tool can be used to inform decisions;
- Develop an understanding of what HIA is and the steps involved in the HIA process; and
- Build capacity for conducting an HIA on the proposed changes to the Suffolk County Sanitary Code.

As a group, attendees and facilitators walked through two major tasks associated with the Scoping step:

- Identifying individuals that will be affected by the decision and/or have an interest in the result of the final decision (i.e., stakeholders), and
- Identifying environmental, social, and economic pathways or mechanisms through which the decision could affect health, although this task was only completed for the "no change" alternative (Alternative 1) at this meeting.

The key stakeholder groups identified in the first task included the decision-makers (Suffolk County elected officials and representatives); homeowners and renters; local civic organizations and governments; federal and state tribes; environmental advocacy groups; realtors and real estate property builders and developers; and business owners and workers in the tourism, recreation, and sanitary waste industries. In the second task, attendees developed pathways of impact through which the decision could affect health in the "no change" alternative.

If no changes are made to the Suffolk County Administrative Code regarding onsite sewage disposal systems, individual and community health could be affected through:

- *A change in **risk of illness** from toxics and/or pathogens in the water and soil;*
- *A change in **physical activity** (a health-related behavior) as a result of beach closures, fish advisories, and the avoidance of recreational spaces due to the spread of harmful algal blooms (HABs);*
- *A change in **outdoor air quality** as a result of increased vehicle emissions, because residents have to travel farther to reach safe beaches and other recreational areas;*
- *A change in **employment/unemployment** as a result of decreased demand on fishing, shellfish, and recreation industries due to beach closures, fish advisories, and loss of patronage;*
- *A change in **diet/nutrition**, specifically the consumption of fish and shellfish, as a result of the increased spread of HABs and die-off of native species;*
- *A change in **housing security/insecurity** as a result of the increased risk of flooding and storm damage from reduced shoreline resiliency;*
- *A change in **costs of living** as a result of increasing property insurance costs, increased municipal costs to remove pollutants and pathogens from drinking water, and reduced real estate tax from loss in property values;*

- *A change in **funding available for public services** (e.g., sanitation, public works, recreation management) as a result of reduced tax revenue; and*
- *A change in **blight and/or crime** resulting from increased transience and decreased stewardship of the community due to loss of perceived quality of the environment and community.*

Meeting Wrap-up

After the scoping workshop, the meeting concluded with an overview of the HIA's next steps and some final considerations and assignments for the participants. As a next step, the HIA Leadership Team planned to provide the same information shared today with residents in a series of public meetings. The goals of the public meetings were to engage community stakeholders in the HIA process, hear their interests and/or concerns about the proposed policy changes, and solicit further participation in the HIA. Once that task was completed, the HIA team would take the input provided and finalize the scope of the HIA, develop an assessment plan, and initiate the Assessment step. The HIA Leadership Team requested that meeting attendees review the (draft) HIA Rules of Engagement Agreement, discuss the HIA with fellow residents and colleagues, and look for upcoming materials and meeting invites.

D.2 March 2015 Public Meetings Agenda and Notes

March 4 – 5, 2015
Suffolk County, New York

Meeting Agenda

Meeting Agenda	Cold Spring Harbor, NY Meeting	Riverhead, NY Meeting
Meet and Greet Session	12:30 PM	5:30 PM
Welcome - **Introductions** - Meeting Agenda - **Meeting Objectives** - Ground Rules	1:00 PM	6:00 PM
What's the Connection? - **FEMA, EPA, and HIA** - **What is a Health Impact Assessment?** - **Why perform an HIA?**	1:10 PM	6:10 PM
Overview of HIA Process - **Steps of HIA** - **Guiding Principles and Core Values**	1:25 PM	6:25 PM
About the HIA in Suffolk County - **Background about Suffolk County, NY** - **Proposed Code Changes** - **HIA First Steps**	1:40 PM	6:40 PM
Break for Q & A	2:00 PM	7:00 PM
HIA Scoping Workshop - **Group Exercise: Identifying Interests and/or Concerns** - **Group Exercise: Prioritizing Interests and/or Concerns**	2:30 PM	7:30 PM
Meeting Wrap-up - **Next Steps in the HIA** - **Charge to Participants** - **Thank You**	3:20 PM	8:20 PM

Meeting Overview

The U.S. Environmental Protection Agency (EPA) is leading a health impact assessment (HIA) to evaluate proposed changes to the Suffolk County Administrative Code Article 6 regarding onsite sewage disposal systems (OSDS). The purpose of the HIA is to identify the potential health impacts that may result from the final decision and provide recommendations to manage those impacts. The HIA Leadership Team held a set of public meetings to provide information to stakeholders about the HIA and the proposed policy changes, and to solicit their input. The HIA Project Leads scheduled three meetings March 4-5, 2015 in Cold Spring Harbor, Riverhead, and Brentwood, New York. Unfortunately, EPA had to cancel the last community meeting in Brentwood due to inclement weather. The following information documents the activities and discussions from those meetings.

Both meetings opened with a welcome from the HIA Leadership Team, represented by Florence Fulk of EPA's National Exposure Research Laboratory (NERL). At the HIA Kickoff Meeting in December 2014, the HIA Leadership Team reached out to community and County representatives to inform the community about the plan to perform an HIA and invite fellow stakeholders to attend this meeting. The objectives for the public meeting included:

- Building awareness about the proposed changes to the Suffolk County Administrative Code and the developing HIA;
- Developing an understanding of what HIA is and the steps involved in the HIA process;
- Identifying community stakeholder interests and/or concerns regarding the proposed changes and related health outcomes; and
- Encouraging community stakeholder participation in the HIA.

Meeting Attendees

The audience was composed of Suffolk County residents, non-residents, leaders and/or representatives of groups in the community, having local knowledge or expertise about the areas, and/or professional or non-professional expertise related to the waste management industry, ecosystem and/or public health, and/or economic development. Meeting facilitators and representatives of the HIA Leadership Team included Florence Fulk from EPA NERL and Lauren Adkins from CSS-Dynamac (contractor to U.S. EPA).

*Attendees and Organizations Represented**

Cold Spring Harbor Meeting Attendee(s)	Organization(s) Represented	Riverhead Meeting Attendee(s)	Organization(s) Represented
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***** Names and organizations redacted for publication in report.

About this HIA

FEMA, EPA, and HIA: What's the Connection?

The Federal Emergency Management Agency (FEMA) and EPA are collaborating to help communities rebuild from disasters in ways that protect the environment, create long-term economic prosperity, and enhance neighborhoods. FEMA and EPA also help communities incorporate strategies into their hazard mitigation plans that improve quality of life for all populations and help promote environmental justice. In 2010, EPA and FEMA signed a Memorandum of Agreement (MOA) to make it easier for the two agencies to work together to fulfill common goals.

Shortly after Hurricane Sandy (2012), the EPA, FEMA, New York State Department of State and Department of Environmental Conservation, Nassau and Suffolk Counties, and the Metropolitan Transit Authority began a partnership to collaborate on several efforts on Long Island aimed at promoting more resilient and sustainable recovery. HIA is one of the many tools used to help communities reach their sustainability and resiliency goals.

Health Impact Assessment Background

HIA is a six-step, systematic process that uses an array of data sources and analytic methods and considers input from stakeholders to determine the potential effects of a proposed policy, plan, program, or project on the health of a population and the distribution of the effects within the population; and provides recommendations on monitoring and managing those effects. The ultimate goal of all HIAs is to promote health and wellness, regardless of the final decision.

Question from the audience: Is there going to be an environmental impact assessment (EIA) performed on the proposed code changes?

There is no EIA planned to evaluate the proposed code changes. Although they are similar in some aspects, EIAs are different from HIAs. EIAs are used to evaluate the potential environmental impacts from proposals and to encourage and provide recommendations to mitigate anticipated harmful effects. EIAs are required if the proposal is an action of the federal government and has the potential to result in significant environmental and/or health effects. HIAs are voluntary (except in a few local and state jurisdictions), and focus on health impacts, both beneficial and adverse, of a proposal. HIAs can be used to evaluate any proposed policy, plan, project, or program, not just federal actions. Furthermore, HIAs provide recommendations, that the decision-makers can choose to adopt or reject, and can be led by entities other than the proponents of the proposal.

Question from the audience: What is the criteria for performing an HIA?

The HIA community of practice developed a set of Minimum Elements and Practice Standards for HIA (Available at http://hiasociety.org/wp-content/uploads/2013/11/HIA-Practice-Standards-September-2014.pdf). These minimum elements and practice standards follow the five guiding principles of HIA: a comprehensive approach to health issues, sustainable development, democracy in the decision-making process, equity in the opportunity for healthy living, and ethical use of the evidence that ensures transparent and rigorous methods are used.

Question for the Audience: What is “health?”

The audience responded with a list of aspects to health, including physical health, economic health, mental health, community health, environmental health, the absence of disease, and the ability to enjoy the natural environment. The internationally accepted definition of health, from the World Health Organization, states that “health is a state of complete physical, mental, and social well-being; not merely the absence of disease and infirmity.”

HIA acknowledges that an individual’s health status is attributable to a number of factors, including health behaviors, clinical care, physical environment, and socio-economic factors. These factors, known to directly or indirectly affect human health, are referred to as determinants of health. HIA evaluates a proposal’s potential to affect determinants of health, which lead to health outcomes, and provides recommendations to manage those health impacts.

HIAs follow a six-step process that includes screening, scoping, assessment, recommendations, reporting, and monitoring and evaluation. This HIA is in the Scoping step, in which stakeholders identify which health effects are considered in the assessment and set the HIA parameters.

About Suffolk County, New York

Questions for the Audience: When you think of Suffolk County, what comes to mind?

The audience responded with a list of favorable assets and conditions in Suffolk County, including beaches, bays, the ocean, parks and natural areas, farms and vineyards, good air quality (better than in the city), and diverse lifestyles. Some of the listed unfavorable conditions in Suffolk County included susceptibility to storms surges (e.g., the damage from Hurricane Sandy), a population over the carrying capacity for the geographic area, and the mass loading of nitrogen in the environment.

Suffolk County is experiencing challenges with nitrogen overloading in surface waters, spreading of harmful algal blooms, losses in shellfish populations and jobs in the shellfish industry, and receding eelgrass boundaries. All of these challenges have implications for reduced resiliency to severe storm surges, contaminated foods, and increased exposure to water-borne pathogens and toxins. One of the causes identified for overloading of nitrogen is waste coming from residential OSDS.

Members in the audience informed the presenters that there was updated (newer) data and graphics than those presented in the PowerPoint. Since the HIA is not yet in the Assessment step, that information would be very valuable to the HIA Research Team. Ms. Adkins invited those persons to share where the new data could be obtained (if available) or contact information for those with access to up-to-date data with the HIA Leadership Team. In addition, stakeholders were invited to participate on the HIA Research Team to collect and analyze that information.

The Proposed Code Changes

Suffolk County Department of Health Services proposed changes to the County Sanitary Code Article 6, regarding existing OSDS. The final decision can result in Suffolk County choosing to enact one or more of these alternatives.

Potential Alternatives Considered by Suffolk County

Alternative 1	Alternative 2	Alternative 3	Alternative 4
No change (code not updated)	Required upgrade of all existing cesspools to conventional OSDS	Required upgrade of all existing cesspools to conventional OSDS for parcels located in high priority areas[1]	Required upgrade of all existing OSDS (cesspool and conventional systems) to innovative/alternative OSDS for parcels located in high priority areas[1]

[1] Suffolk County designates the high priority areas as parcels located in a 0-25 year contributing zone to surface water; 0-50 year contributing zone to groundwater; Sea, Lakes, and Overland Surges from Hurricanes (SLOSH) zone; and/or groundwater located within 10 feet below grade (ground level).

It is important to note that alternatives 2-4 may also result in changes to related (in-house) policies, such as Suffolk County General Guidance Memorandum #12- Guidelines for issuing approval of sewage disposal systems and water supplies for existing residences (pre-1973). These changes are only one of many approaches Suffolk County is considering to address the legacy of policies contributing to the growing environmental issues related to nitrogen loading.

Question from the audience: Will the HIA consider options other than the proposed code changes?

EPA acknowledges that there are many alternatives to addressing the issue of nutrient overloading in the environment. However, HIAs are applied to inform specific decisions in which a proposal has been established. Within the context of the proposed code changes, the HIA will evaluate the different alternatives and provide recommendations for managing impacts, should any one of them be selected.

Question from the audience: What type of innovative/alternative systems is Suffolk County considering?

The list of acceptable innovative/alternative systems was not included in the initial proposal, because Suffolk County is still in the process of developing that list. Suffolk County is leading a formal evaluation of innovative/alternative OSDS capable of denitrification and is in the pilot testing phase. The systems that pass the pilot testing and further monitoring phases and meet denitrification standards will be approved for general use in Suffolk County. The HIA Leadership Team will follow up with Suffolk County on the innovative/alternative systems considered for general use.

Additional questions related to the details of the proposed code changes:

Members of the audience stated that the proposal does not provide enough specifics regarding the actions residents will be required to take. For example, is there going to be inspection and/or maintenance requirements for OSDS? Currently, there are no standards for inspections, nor requirements for maintaining existing OSDS. Furthermore, when would residents be required to upgrade their system from the code changes (e.g., a year after adoption, within three years after adoption)? There was uncertainty whether the proposal accounted for the parcels that are located in areas where sewering is planned. The HIA Leadership Team will follow up with Suffolk County regarding these concerns.

HIA Scoping Workshop

Group Activity: Identifying Stakeholder Interests and/or Concerns

Stakeholder input is a critical piece to the HIA process. Engaging stakeholders helps to gain local knowledge of health and existing conditions in the community, identify areas of concern that may not be readily apparent, and gain contextual/cultural perspectives and experiences related to the pending decision. One of the essential activities in the Scoping step is to identify stakeholder interests and/or concerns related to the proposal and use that input in a meaningful way. For this HIA, the HIA Leadership Team plans to use stakeholder interests and/or concerns to inform the pathways of impact evaluated in the assessment. Attendees were given a Scoping Workbook to help facilitate the discussion of health impacts.

Question for the Audience: How might the proposed changes to the County code affect daily life in my community?

The following responses from the audience are grouped by decision alternative.

Audience-identified Potential Impacts From The "No Action" Alternative

Decision Alternative	**"No action" or "business as usual" alternative where no changes are made**
Social Impacts	There could eventually be social disruption in valued ecosystem-based assets (e.g., gardens, environmental quality).
Economic Impacts	There would be an immediate financial benefit for the property owner in the sense of avoided expenditures to upgrade the OSDS. However, there could be long-term costs to the environment and property owner. For example, the home may loose monetary value as a non-sewered home with an outdated sewage disposal system. Considering the pollution of Forge River, residents and environmental advocates argued that the odor was also affecting property values in the area. If property values are depreciating, that can lead to less tax revenue and shift to higher tax burden for everyone else. Furthermore, the loss of jobs in the aquaculture industry will continue to rise and may expand to the tourism/recreation industry.
Environmental Health Impacts	There is evidence that supports that nutrient overloading in waters (eutrophication from nitrogen) can lead to increased toxicity levels of the water from harmful algal blooms. Therefore, this alternative may result in increased illnesses from eating unhealthy shellfish and fish that live in polluted waters and illness from contact with polluted waters.

Audience-identified Potential Impacts From The Two Alternatives That Require Cesspool Upgrades

Decision Alternative	**All cesspools are required to be upgraded (either countywide or in the high priority areas)**
Social Impacts	Residents may feel the government is applying too much oversight and choose not to upgrade their system (i.e., ignore County policy/law). This may lead to more penalties and/or violations of the ordinances and/or a shift in political support. The residents' perceived benefit of upgrading their system may change.
Economic Impacts	There could be a perceived risk that establishing the boundaries of "high priority areas" may lead to changes in jurisdiction boundaries and may result in additional taxes. The financial burden and increased inconveniences that come with upgrading OSDS for the property owner will be high (i.e., septic systems require more maintenance than being sewered but less maintenance than a cesspool). The property owners may pass on the additional OSDS upgrade and maintenance costs to renters, which will increase housing costs for renters. The changes in housing costs may lead to gentrification (i.e., low-income populations moving out of areas and higher-income households moving in to the area). There will be a minimum environmental impact among the different upgrade alternatives, but a high cost to homeowners (i.e., a cost-benefit analysis may show high costs with little to no benefit). The homeowner may adopt a *perceived* increase in the monetary value of the home if the OSDS is upgraded that may not be realized in the market.
Environmental Health Impacts	There may be negligible or minimum environmental impact from upgrading cesspools to conventional septic systems, since conventional systems do not have high nitrogen-removing efficiencies compared to innovative/alternative systems.

Audience-identified Potential Impacts from the "All OSDS Upgraded to Innovative/Alternative Systems" Alternative

Decision Alternative	**All OSDS are required to be upgraded to innovative/alternative systems in high priority areas**
Social Impacts	This alternative may be a perceived benefit from the changes in attitudes and home-management behaviors of residents.
Economic Impacts	There will be a greater cost for the homeowners, because these systems are typically more expensive to install than conventional septic systems. There may be a greater maintenance requirement and/or increased inconvenience for homeowners, since these systems typically require more maintenance than conventional systems. However, the increased demand for OSDS in the area may lead to the creation of a new industry/market (e.g., manufacturing for OSDS) in Suffolk County. The additional work/services needed may lead to job creation and/or expansion in the waste management industry.
Environmental Health Impacts	Assuming that these systems will yield a significant reduction in total nitrogen effluent, there may be a measurable environmental benefit.

After the discussion, the facilitators asked attendees to write their interests and/or concerns related to and post those items on a flip chart labeled with overarching topic categories.

List of Stakeholder-identified Interests and/or Concerns Related to the Proposal

Topic	Cold Spring Harbor	Riverhead
Economics	• Economic benefits of quality of life on Long Island • Financial impact on property owners • Household economies (cost of upgrading your system and maintain it) • Public-private partnerships • Financial impacts on the individual household	• Cost to homeowners, renters, all environmental justice related issues • Equitable cost structure (most important) • Cost of this versus government building small sewage treatment plants
Industry	• Creation of new industry- installation, monitoring, maintenance • Monitoring and maintenance • Loss of maritime culture due to loss of fishing/shellfishing industry	• Job potential for installing and building new systems • Potential to improve public and environmental health from improved systems • Healthy shellfish
Lifestyle	• Overall high- quality of life with less nitrogen in aquifers and bays by upgrading to advanced treatment	• Better water quality means increased recreation and better outlook • Less money because of cost means less quality food • Fresh food, local food and preservation of agricultural resources • Healthy natural resources, e.g., forests, wetlands, drinking water
Culture/Social	• None	• Retroactive law very controversial and costly • Social impacts of retroactive law
Safety/Security	• Resiliency to storms	• Preserving farmland to grow produce and produce other food is a public safety/security issue (e.g., when gas prices are high on roads, transport infrastructure cut off, food can't get here) • Water quality and safe drinking water
Housing / Infrastructure	• None	• Potential for increased density and all associated impacts • Cost to homeowners
Environment / Ecosystem Health	• Peace of mind knowing that the environmental issues caused by the issues are being solved • Upgrading to advanced treatment would result in improvement to marine system- good for the environment and ecology • Loss of shoreline communities due to flooding and/or marsh loss • Nitrogen reduction in receiving waters and drinking water aquifer • Impacts to the natural systems like beaches and bays, water quality • Restoration and Protection of drinking water supply	• Resilient shoreline

Topic	Cold Spring Harbor	Riverhead
Nature and Recreation	• Upgrading to advanced treatment means healthier waters making bays and harbors safer for me and my family to recreate (swim, eat shellfish) • Restoration of surface waters (fishing, swimming, recreation), shellfishing, etc. • Maintenance and invigoration of businesses that rely on clean water, recreation, fishing, beaches, etc.	• Hiking, nature and scenic views • Natural environment • Shellfish industry

Group Activity: Prioritizing Stakeholder Interests and/or Concerns

The facilitators asked each attendee to write, on an index card, the top three needs for their community and reasons to be most proud of their community. The items written will be considered in the prioritization of health effects included in the assessment.

Stakeholder-identified Community Needs and Assets

What are the top 3 needs for your community?	What are you most proud of in your community?
Cleaner water for drinking wells	Great public schools
Cleaner marine coastal water	Access to water and can make it part of our everyday lives
Smart growth/sustainable development/coastal resiliency	Great diversity on land use purposes
Diversity of population	Great golf courses
Additional sewers	Nearby oceans and bays for recreation
Public access to waterways	Close to waterways, diverse area
Clean water-reduce nonpoint source pollution	Bays and beaches
Environmental justice-make sure poorer communities don’t get negatively impacted by environment	Parks, farms, vineyards
More public access to natural areas, parks, etc.	Active downtowns
Improvement in water quality-groundwater and local bays	The big ducts
Economic development	The Peconic Bay
Preservation of environmental quality.	Bob Bourgignon- the scallop seller
More diverse housing opportunities	The Fire Department
Flanders needs affordable septic systems- we’re a low-income community on Reeves Bay that sits over the high quality groundwater in the Pine Barrens.	Farmland to grow food
Better water management-stop polluting waterways	Healthy environment
Housing is way too expensive	Serene environment
Taxes too high	Beaches, bays, fishing, boating, etc.
Waterless systems	Parks and natural areas
Cost analysis- get rid of sewer systems and equipment and replace with an advanced systems component or cluster for $1/3 the price.	Schools
Wildlife and natural systems being destroyed by current flood systems	Vibrant down town revitalization
Find a way to help homeowners upgrade cesspools to stop pollution or rivers, bays and Long Island Sound-too big of a job for local government	Wild lands left
South shore sewage treatment plants clean up	Organic treatment of greens
Extend New York City outflow pipe 40 miles out	All new developments are required to have hookups to sewage treatment plants, but I am not sure if the current treatment plants can handle the density.

What are the top 3 needs for your community?	What are you most proud of in your community?
I have more of an interest in seeing help for protecting and restoring coastal wet lands, eel grass, zebra mussels, clams, oysters, snails, etc. They filter salt water extremely efficiently. Some new oyster farms are cleaning lots of water around them.	[Blank]

Additional Discussions

The following items were not originally included in the meeting agenda, but were documented using the flip chart, titled "Parking Lot."

<u>Considerations for the Assessment Step</u>

Members of the audience suggested the HIA Project Team consider the following as the HIA moves forward into the Assessment step:

- In the assessment, the HIA Research Team needs to consider whether there is evidence of a correlation between high nitrogen levels and toxic levels of harmful algal blooms and pathogens in the water (potential source for information: Chris Gobler).
- The HIA Research Team should include an analysis of existing policies and/or laws that may be applicable (e.g., New York's State Environmental Quality Review Act and the National Environmental Protection Act) and existing zoning codes, uses, and jurisdictions to understand
- Consider performing a cost analysis for the different alternatives, especially for low-income communities. For example, it would cost an estimated $197 million (by Martin Shirley) to implement stage I and II (of IV) sewering. Whereas, for a third of that cost, every home could be given a compost toilet, which would provide greater benefit for environmental health.
- Consider the difference in the nitrogen reduction performance between the systems. There are different levels of sophistication between the septic system and the alternative/innovative systems that will yield different efficiencies in nitrogen reduction. In addition, the HIA Research Team needs to consider whether measuring the nitrogen-reduction efficiencies of each system will also comprise the draining field components. The HIA Research Team should also include cumulative pounds of nitrogen avoided when assessing the different alternatives.
- There was a development boom in Long Island in the 1950s and 1960s that is still contributing to the nutrient loading. If the cesspools are all taken out and the leaks stopped, you maybe won't see a change for a long time. Therefore, monitoring environmental impacts may be time-dependent, because it takes years for the nutrients to syphon through the ecosystem. Thus, the HIA Project Team should consider sub-stratifying the high priority areas by travel time to recreational areas and private versus public wells.
- The HIA Project Team should look to equations and/or models available for estimating source-contributions for nutrient loading in Suffolk County (e.g., there were methods used to estimate nutrient source contribution in the Forge River and Cape Cod water sampling analyses).

Question from the audience: How do you (the HIA Project Team) plan to account for differences between perception (subjective data) and facts (objective data) in the assessment?

HIAs use a variety of data sources and methods to evaluate health impacts of a proposal. Most HIAs use a combination of measurable (quantitative) and non-measurable (qualitative) information in the analyses. There are scientific and/or standardized protocols for analyzing this type of information that is available through peer-reviewed social and public health research. One of the Core values (guiding principles) of HIA is the ethical use of the evidence and ensuring transparent and rigorous methods are used. The HIA Research Team will be charged with providing caveats/cautions wherever the evidence is limited or uncertainty exists. Furthermore, stakeholder committees will review information used in the HIA and provide feedback prior to publication.

Question from the audience: How do you avoid how the information from the HIA is used politically (for example, November 2015 is an election year)? It is important to note the timing of the HIA relative to the upcoming elections.

The purpose of all HIAs is to inform the decision. That said, the HIA Project Team (or EPA) cannot control how the different stakeholder groups will use the information gained from the HIA. Misrepresentation of the HIA findings and recommendations is best avoided by publicly releasing the information and providing consistent outreach and messaging to the different stakeholder groups.

Considerations for the Recommendations Step

Members of the audience suggested the HIA Project Team and Suffolk County consider the following as the HIA moves forward into the Recommendations step:

- The HIA Project Team should consider the recommendation of lowering the nitrogen standard to protect ecological resources (i.e., adverse effects are seen at levels lower than 10 ppm).
- Suffolk County should consider greater enforcement and penalties for existing systems that don't meet current code requirements and/or are no longer functioning as intended.
- The HIA Project Team and Suffolk County should consider drinking water quality (groundwater) as the #1 priority when developing recommendations.
- Suffolk County should consider offering incentives to upgrade existing OSDS, such as tax abatements (see New Jersey Pinelands program for new systems and cost sharing example).
- Suffolk County should consider a stage-approach when requiring upgrades, such as establishing time schedules by area for residents required to upgrade their OSDS and guidance for how and where a system should be implemented.

Next steps of the HIA

The next activities of the HIA include completing the Scoping step and initiating the Assessment step. The HIA Leadership Team will prepare notes documenting the discussions and activities from the public meetings and solicit individual stakeholders to participate in a formal role of the HIA. Once the HIA Project Team and stakeholder committees are established, work can begin to complete the scope of the HIA. The HIA Leadership Team charged the attendees with sharing the information they received today with other community stakeholders and look for upcoming materials and invites to participate in the HIA.

D.3 August 2016 Community and TAC Meetings Notes

August 16 – 18, 2016
Suffolk County, New York

Meeting Agenda:

5 minutes	Welcome - Meeting Agenda - Meeting Objectives
15 minutes	About the HIA in Suffolk County - FEMA, EPA, and HIA - What is Health Impact Assessment (HIA)? - First Steps of the HIA in Suffolk County
50 minutes	Poster Presentations — Key Preliminary Findings
35 minutes	Poster Presentations — Key Preliminary Recommendations
10 minutes	Priority Recommendations — Comment Cards
5 minutes	Next Steps in the HIA and Wrap-up
120 minutes	Adjourn

Meeting Overview: The purpose of these meetings was to update the community residents and stakeholders on the HIA's progress; report the preliminary findings and initial recommendations from the HIA; and elicit feedback on those findings and recommendations.

Meeting Attendees:

No one showed to any of the three public meetings, despite flyers being posted in libraries in the three meeting locations and issued to the TAC to distribute to their community counterparts. Meeting attendees at the final TAC meeting included members of the HIA Project Team and Technical Advisory Committee.

TAC Meeting Attendees and Organizations Represented

Attendee(s)	Organization(s) Represented
Alison Branco	Peconic Estuary Program
Chris Clapp	The Nature Conservancy
Steven Colabufo	Suffolk County Water Authority
Julie Hargrave	Central Pine Barrens
Chris Lubicich, Ken Zegel	Suffolk County Department of Health Services
Kevin Moran	Long Island Builders Institute
Sean O'Neill	Peconic Baykeeper
Kristina Heinemann,	U.S. EPA
Lauren Adkins	HIA Leadership Team/Pegasus Technical Services (contractor to the EPA)
Florence Fulk, Rabi Kieber, Grace Musumeci	HIA Leadership Team/U.S. EPA
Mark Meyers	HIA Research Team/ORISE Fellow

Meeting Presentation:

Two posters were staged around the room for each pathway one describing the findings of the assessment and the other identifying the preliminary recommendations. A member of the HIA Project Team stood at each of the posters to answer questions and facilitate discussions about the predicted impacts of the proposed project on that health determinant. After the poster presentation was completed, the HIA Project Team solicited feedback and comments from stakeholders about the assessment and findings presented. Stakeholders were asked to respond to the following prompt questions:

- *What are your thoughts on the findings? Did anything "stand out" to you?*
- *Was there anything that was presented today that you had not seen/heard before?*
- *Do you agree with what was observed or what the findings showed?*
- *Do you have any concerns/issues with what was presented?*

The posters presented at the meeting follow.

ENVIRONMENT | INDIVIDUAL SEWERAGE SYSTEM PERFORMANCE AND FAILURE

How is the performance and/or failure of individual sewerage systems related to health?

Structural failure (i.e., the collapse, deterioration, and/or cover malfunction/removal) of a system is a falling hazard that may lead to human injury and/or death. Historically, cesspools were constructed with brick and mortar or concrete blocks that break down over time, making them increasingly susceptible to collapse. Newer-age leach pools can be constructed with reinforced precast concrete, which make them less susceptible to collapse. When untreated wastewater surfaces (ponds above ground) it poses a direct health risk to humans and animals. Health hazards associated with exposure to untreated wastewater include gastrointestinal illness, upper respiratory illness, rash or itchy skin, eye ailments, earache, or infected cut. Flood-prone/high groundwater areas appear to be the best predictor of sewerage system failure – both hydraulic and structural failures.

Key Preliminary Findings Summary

The Decision:

Scenarios	Details
Baseline	The existing conditions and trends (note: not static).
Alternative I	All new AND existing individual (onsite) sewage disposal systems (OSDS) serving single-family residences must conform to current County Sanitary Code and standards.
Alternative II	All new AND existing OSDS serving single-family residences in high priority areas* must conform to current County Sanitary Code and standards.
Alternative III	All new AND existing individual sewerage systems, either cesspool-only systems or conventional onsite wastewater treatment systems (OWTS), serving single-family residences in high priority areas* must be upgraded to innovative/alternative OWTS.

*high priority areas include areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in SLOSH zones (Sea, Lake, and Overland Surges from Hurricanes), and areas located where groundwater is less than 10 feet below grade. High priority areas constitute 72% of total land in Suffolk County.

Existing Conditions and Potential Impacts:

Cesspools, septic tanks, and leach pools are not designed to control/reduce nutrients (nitrogen and phosphorous) or pathogens, since they are placed below the "treatment zone" of the soil, and effluent from these systems is considered equivalent to untreated wastewater. Estimated total nitrogen (TN) loading to the environment from each individual sewerage system would be 14.65 kg (32.23 pounds) TN per year, assuming no attenuation occurs. Loss in fecal coliform counts range 1-3 orders of magnitude ($n \times 10^1$ to 10^3).

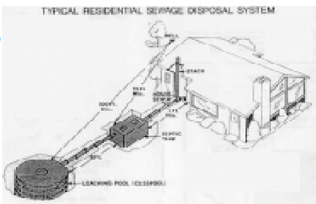
If the upgraded sewerage systems achieve Suffolk County's goal of **50% reduction in concentration of current TN in effluent** (60 mg/L), at an average flow of 60 gal/person/day, the resultant TN loading from an individual sewerage system would be **7.29 kg (16.06 pounds) TN per year**. The ability to control fecal coliform beyond the conventional sewerage system is unknown at this time.

Neither Suffolk County Department of Health Services (SCDHS) nor Department of Public Works (SCDPW) inspects or monitors existing individual sewerage systems after the system is backfilled. The homeowner is entirely responsible for monitoring and maintaining their individual sewerage system once installed.

Currently, **maintenance of existing individual sewerage systems varies widely, but more often is performed as part of a fix** rather than as routine maintenance.

Innovative/alternative OWTS are similar to mini-sewage treatment plants and **require intensive management and monitoring** to remain operational and effective.

Most of the pre-1973, single-family homes are located in the high priority areas, such that there would be **little difference (estimated 17.3%) choosing between requiring upgrades across the county versus only in high priority areas.**



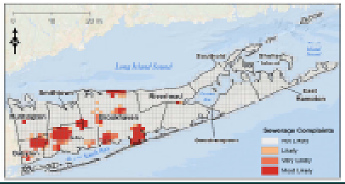
Potential Health Impacts of Proposed Code Changes

Injury and/or Death from *structural failure* (i.e., the collapse, deterioration, and/or cover malfunction/ removal, or absence of, the septic tank or cesspool/leach pool)

Baseline Health Status

According to reports from local media articles, there have been at least five deaths and three injuries caused by cesspool collapse in Suffolk County; the earliest case was reported in 1987. Deaths and injuries were caused by falls into cesspools or people being overcome by the fumes from the cesspools. The victims who died ranged from age 6 to 76 years. Locations of deaths from structural failure of individual sewerage systems include Smithtown (2010), Deer Park (2007), Huntington (2001), Elwood (2006), and Dix Hills (1987). Three persons were reported with injuries from a structural failure in 2006 in the Town of Huntington. Although rare, the likelihood of a structural failure is high and likely to increase, considering risk factors associated with structural failure are wide-spread across Suffolk County, and many cesspools/leach pools are assumed to be nearing or past the end of their life span.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Alternatives I, II, and III: All alternatives **would benefit health** by reducing risk associated with structural failure and by improving the materials used in the construction of the system.	All of the alternatives are **highly likely** to reduce the risk of another injury or death from a structural failure, once the system is upgraded.	**Alternative I:** The extent of people affected would be **high** (an estimated 558,418 people, at an average 2.93 people per household), considering an estimated 192,558 single-family residences (50% of unsewered, single-family residences) would be required to upgrade their individual sewerage system. **Alternative II:** The extent of people affected would be **high** (an estimated 368,450 people), considering 125,751 single-family residences would be required to upgrade their individual sewerage system. **Alternative III:** The extent of people affected would be **high** (an estimated 736,900 people), considering 251,502 single-family residences would be required to upgrade their individual sewerage system.	**All individuals would be affected equally** (equal risk), but the communities most affected include those with a high proportion of unsewered residences constructed over 25 years ago and in flood-prone/high groundwater areas.	The health implications of a structural failure **are severe**, considering falling into a collapsed septic tank or cesspool/leach pool may lead to injury and/or death.	The effects are estimated to be **long-term**, considering the long life span of the systems, although many years may pass between the point when the code change is enacted to the point when the sewerage system is actually upgraded.



Illness from exposure to untreated wastewater due to *hydraulic failure* (i.e., effluent loading rate into the disposal unit is greater than the infiltration rate through the biomat zone)

Baseline Health Status

Although direct exposure to untreated wastewater is hazardous, the number of illnesses from close-contact exposure to wastewater due to a sewerage system failure is unknown. At the estimated 10% failure rate, an estimated 38,512 systems fail each year, by backing up into the home or surfacing aboveground, but only an average 0.65% are reported to SCDHS.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
All alternatives would **benefit health** by adding a septic tank to help prevent solids from clogging the biomat/soil field (if applicable).	The likelihood of close-contact exposure to untreated wastewater, and thus the benefit of a reduced risk, is **very low** (except for service technicians/ professionals).	Same as above	Same as above	The health implications of a hydraulic failure are **low to moderate** (if exposure occurs at the surface).	Same as above

ENVIRONMENT

INDIVIDUAL SEWERAGE SYSTEM PERFORMANCE AND FAILURE

How is the performance and/or failure of individual sewerage systems related to health?

Structural failure (i.e., the collapse, deterioration, and/or cover malfunction/removal) of a system is a falling hazard that may lead to human injury and/or death. Historically, cesspools were constructed with brick and mortar or concrete blocks that break down over time, making them increasingly susceptible to collapse. Newer-age leach pools can be constructed with reinforced precast concrete, which make them less susceptible to collapse. When untreated wastewater surfaces (ponds above ground) it poses a direct health risk to humans and animals. Health hazards associated with exposure to untreated wastewater include gastrointestinal illness, upper respiratory illness, rash or itchy skin, eye ailments, earache, or infected cut. Flood-prone/high groundwater areas appear to be the best predictor of sewerage system failure – both hydraulic and structural failures.

Key Preliminary Recommendations	Community Input
Regardless of the alternative chosen, Suffolk County should: • Create an inventory of existing individual sewerage systems, including their location, design type, and (if possible) maintenance schedule (e.g., last inspection and/or evacuation). • Create a checklist or logic framework that cesspool/septic service contractors can easily and consistently deploy to determine whether a system is in need of maintenance, repair, or needs to be upgraded. • Develop an open-access, web-based platform for cesspool/septic service contractors to report properties that need to upgrade their sewerage systems and cited issue(s). • Ensure adequate County personnel and funds are in place to accommodate the anticipated increased demand for sewerage system permits and compliance certifications (based on the inventory of existing systems). • Establish auditing and enforcement strategies to address scenarios when cesspool/septic service contractors, OWTS system manufacturers, and/or homeowners fail to meet statutory requirements (e.g., failed to report a system needing to be upgraded or in failure, certification of compliance deadline is approaching and system has not been certified or certification of compliance was not acquired). • Require good practice in the siting, design, installation, and maintenance of individual sewerage systems. • Perform homeowner outreach early and often that provides information on each system design, including the average life span, operation and maintenance needs, average treatment performance, signs of system failure, and the benefits of routine inspections and maintenance (e.g., increase in system longevity, reduced costs over the life of the system, etc.). • Allow homeowners to upgrade/replace existing systems to more sustainable sewerage options that lower the risk of system failure in the event of a flood, extreme weather event (e.g., high precipitation), and/or tidal surge. **If Alternative III is chosen**, Suffolk County should: • Ensure OWTS management plans are followed by the service professionals. • Include pathogen (or indicator microbial) monitoring for the I/A OWTS so that data can be obtained to better judge the treatment performance of such systems for pathogen control. • Not allow the elimination or reduction of the drain field/disposal footprint without ensuring optimal design for wastewater loading, siting, and maintenance.	

ENVIRONMENT

WATER QUALITY (QUALITY OF WATER RESOURCES)

How is water quality related to health?

Pollutants from individual sewerage systems travel through the environment in aquifer recharge and/or stormwater runoff. Pollutant loading to groundwater, which is Suffolk County's source for drinking water, and receiving waters (water bodies downgradient in the watershed) can affect the risk of waterborne illness from toxins and pathogens, including bacteria, viruses and protozoa. Ingesting too much nitrate from drinking water can be harmful by reducing the blood's ability to carry and deliver oxygen to tissues. In aquatic environments, nitrogen (N) and phosphorous (P) support the growth of algae and aquatic plants, which provide food and habitat for finfish, shellfish, and smaller organisms that live in water. However, too much N and P discharged into surface waters directly or through subsurface flows can exacerbate algal growth (some of which can be toxic), degrade water quality, and cause loss or contamination of aquatic animal life. Water is one of the most important landscape elements, both physically and aesthetically, considering water spaces can reduce stress, enhance mood, and enhance mental attention. However, human stress and wellbeing effects from water spaces are dependent upon perceptions of water, restoration, and recreation.

Key Preliminary Findings Summary

Growing concerns related to increasing algal blooms, beach closures, contamination and/or loss of shellfish and submerged vegetation, and the future integrity of the sole-source for drinking water are driving **forces of the perceived quality of water resources** in Suffolk County.

For both Alternatives I and II, there would be **no appreciable change in nutrient or pathogen loading to the environment**. If the average total nitrogen (TN) load going to the disposal unit (coming from the septic tank) is 5 kg (11 pounds) TN per person per year, at an average 2.93 persons per residence and a total of 385,117 unsewered, single-family parcels, cumulative **TN loading to the environment equates to 5.64 million kg** (12.41 million pounds) **TN per year**.

For Alternative III, there would be **considerable reduction in nutrient (specifically nitrogen) loading to the environment**. If the upgraded innovative/alternative onsite wastewater treatment systems (OWTS) achieve Suffolk County's goal of 50% reduction in effluent TN concentration from each system, then the **cumulative reduction in TN loading to the environment from systems in high priority areas, would be 1.83 million kg** (4.04 million pounds) **TN per year**. More information is needed to discern pathogen control of innovative/alternative OWTS.

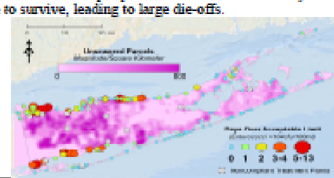
All public drinking waters in Suffolk County met both federal (EPA) and state (NYDOH) standards for drinking water quality. The quality of source water used by public supply systems is satisfactory (generally free of pathogen-indicating microorganisms and nitrate-nitrogen levels far below the standard of 10 mg/L) and largely disinfected prior to distribution. The quality of source water used in private drinking systems is unknown and likely to be highly variable in quality. However, nitrogen levels in drinking water wells are increasing (average nitrate-nitrogen concentrations rose by 40.9% in the Upper Glacial Aquifer and by 93.2% in the Magothy Aquifer from 1987 to 2013). **Most private and noncommunity drinking water wells pump source water from the shallower Upper Glacial Aquifer**, whereas, public water supply wells pump source water from the deeper Magothy Aquifer.

Not all sewerage-derived TN loading to the environment reaches receiving waters. Even as nitrogen loading varies widely across sub-watersheds, only an estimated 10 to 30% of original TN loading reaches receiving waters. Wastewater influences the quality of receiving waters by further **enhancing the effect of eutrophication, dissolved oxygen (DO) consumption, and loading of microorganisms**. Unsewered parcels and impaired waters are widespread across Suffolk County.

Nitrogen impairment, depleted DO, algal blooms, and decreased wetland acreage have been observed in all three Suffolk County estuaries. Recreational waters in Suffolk County are frequently impacted by microbial contamination, resulting in beach closures and/or health risk advisories. Several beaches on the north and south shores tested above the allowable limit for bathing/swimming for several days. Beaches that had several days over the allowable limit were **located in both highly dense, unsewered areas and less dense, unsewered and sewered areas.**

Algal blooms, which occur in both fresh and marine waters of Suffolk County, cause harm by "starving" other plants by out-competing them for nutrients and blocking out sunlight. **Some algae, in fresh and marine waters, produce toxins** that are hazardous to humans and other animals. When the algae in algal blooms die, the decomposition of biomass causes the **consumption of DO** at such a rapid pace that it reduces the ability of finfish and other aquatic animal life to survive, leading to large die-offs.

In Suffolk County, it is difficult to discern whether the source of fecal contamination is individual sewerage systems or sewage treatment plants, considering both discharge to groundwater and both are widespread across Suffolk County.



Potential Health Impacts of Proposed Code Changes

Illness from aquatic recreation (e.g., bathing/ swimming, boating, fishing, etc.)

Baseline Health Status

According to the most recent Suffolk County Community Health Assessment (2015), "waterborne illness cases have frequently been related to waterborne exposure from water parks or lakes." In the State of New York, exposure to toxic algal blooms caused an average of 31 reported hospital visits per year. However, information on human illness from harmful algae is difficult to collect, as exposure often causes general symptoms such as rashes, respiratory irritation, or eye inflammation that can easily be misdiagnosed or go unreported.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Alternatives I and II: These alternatives will **detract from health** because there would be no appreciable reduction in pollutant loading to receiving waters. Alternative III: This alternative will **benefit health** from the reduced nutrient loading (and potential to control other pollutants) that slow the progress of algal bloom formation and lessen habitats suitable for waterborne pathogens.	Alternatives I and II: The continued risk of illness from aquatic recreation due to pathogens or HABs is **highly likely**. Alternative III: Given the hydrologic connection between groundwater and surface waters of Suffolk County, reducing nutrients (and potentially pathogens) discharged to receiving waters may **possibly** reduce beach closures and exposure to toxic algal blooms.	The extent of health impact, both positive and negative, would be **high**, considering aquatic recreation is a widely practiced form of physical activity for both residents (1.5 million people) and visitors to Suffolk County.	Children are most at risk to the effects of toxic algal blooms, because of their lower body weight, behavior, and toxic effects on development. Young children, the elderly, and those who are immunocompromised are more likely to become infected by waterborne pathogens.	The health implications of toxin exposure from HABs is **severe**, whereas the health implications of exposure to sewerage-derived pathogens is **low to moderate**.	The effects of waterborne illness from aquatic recreation may be **short-term**, but the changes in risk may not occur for **a long time**, considering hydrologic travel times between sewerage systems and receiving waters may be 0-25 years.

Illness from sewerage-derived pollutants in source water (groundwater)

Baseline Health Status

Most cases of waterborne illness in Suffolk County were caused by bacterium, such as *Shigella* and *Salmonella*, although incidence rates suggest the absence of widespread disease outbreaks. On average, approximately one in every 260,000 people are affected by harmful *Escherichia coli* each year in Suffolk County, compared to about one in every 167,000 people in New York State. The use of private drinking wells and individual sewerage systems have not been associated with a disease outbreak in Suffolk County. However, the combination of risk factors suggests a possibility that current conditions may contribute to sporadic or unreported illnesses. There are no known cases of nitrate toxicity (Methemoglobinemia or "blue baby syndrome") in Suffolk County.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Alternatives I and II: These alternatives will **detract from health** because there would be no appreciable reduction in pollutant loading to groundwater. Alternative III: This alternative would **benefit health** by reducing the risk of illness from sewerage-derived nitrate-nitrogen in drinking water. It is unclear whether improvement in pathogen loading may occur.	Alternatives I and II: Waterborne illness from community water supply systems is **unlikely**, but illness from private and non-community water supply wells is **possible**. Alternative III: Risk of waterborne illness among persons using private and non-community water supply wells is **highly likely** to decrease. This alternative is **unlikely** to improve drinking water quality from public water supply, since public water supply is already satisfactory.	The extent of people affected would be **high**, considering public and community water supply serves 87% of the total population (approx. 1.3 million people) and private (individual) wells and non-community systems serve about 13% of residents (approx. 194,000 people).	Pregnant women and infants under 6 months are more at risk to nitrate toxicity in drinking water. Young children, the elderly, and those who are immunocompromised are more likely to become infected by waterborne pathogens. Residences with a private well and individual sewerage system have a higher risk for drinking water contamination, especially where groundwater is shallow and/or density of unsewered residences is high.	The health implications of sewerage-contaminated drinking water is **low to moderate** (gastrointestinal symptoms expected) for most of the population; but, **severe** among pregnant women and infants less than 6 months.	The effects of waterborne illness from contaminated drinking wells may **be short to long-term**, but the changes in risk may not occur for **a long time**, considering hydrologic travel times between sewerage systems and well screens may be 0-50 years.

Stress and Wellbeing related to perceived quality of water resources

Baseline Health Status

Baseline community data from 2013-2014 indicates that 18.7% of adults in Suffolk County were diagnosed depression. According to County Health Rankings, the age-adjusted average number of mentally unhealthy days reported in past 30 days in Suffolk County in was 3.2, lower than the New York state average of 3.7 days.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Alternatives I and II will **detract from health**, due to the perceived degradation of water resources. Alternative III may **benefit health** from improved perceptions of water quality.	Perceptions of the quality of water resources (both ground and surface waters) of Suffolk County may **possibly** influence stress and wellbeing among residents.	The extent of people affected would be **moderate**, considering 18.7% already suffer from an existing mental health condition.	Low-income populations, coastal populations, and individuals with existing mental health conditions would be affected more by the perceived quality of water.	The severity of health implications from changes in stress/wellbeing would be low and could easily change.	The effects would be **immediate/short-term**.

ENVIRONMENT	WATER QUALITY (QUALITY OF WATER RESOURCES)

How is water quality related to health?

Pollutants from individual sewerage systems travel through the environment in aquifer recharge and/or stormwater runoff. Pollutant loading to groundwater, which is Suffolk County's source for drinking water, and receiving waters (water bodies downgradient in the watershed) can affect the risk of waterborne illness from toxins and pathogens, including bacteria, viruses and protozoa. Ingesting too much nitrate from drinking water can be harmful by reducing the blood's ability to carry and deliver oxygen to tissues. In aquatic environments, nitrogen (N) and phosphorous (P) support the growth of algae and aquatic plants, which provide food and habitat for finfish, shellfish, and smaller organisms that live in water. However, too much N and P discharged into surface waters directly or through subsurface flows can exacerbate algal growth (some of which can be toxic), degrade water quality, and cause loss or contamination of aquatic animal life. Water is one of the most important landscape elements, both physically and aesthetically, considering water spaces can reduce stress, enhance mood, and enhance mental attention. However, human stress and wellbeing effects from water spaces are dependent upon perceptions of water, restoration, and recreation.

Key Preliminary Recommendations	Community Input

The Decision:

Scenarios	Details
Baseline	The existing conditions and trends (note: not static).
Alternative I	All new AND existing individual (onsite) sewage disposal systems (OSDS) serving single-family residences must conform to current County Sanitary Code and standards.
Alternative II	All new AND existing OSDS serving single-family residences in high priority areas* must conform to current County Sanitary Code and standards.
Alternative III	All new AND existing individual sewerage systems, either cesspool-only systems or conventional onsite wastewater treatment systems (OWTS), serving single-family residences in high priority areas* must be upgraded to innovative/alternative OWTS.

*high priority areas include areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in SLOSH zones (Sea, Lake, and Overland Surges from Hurricanes), and areas located where groundwater is less than 10 feet below grade. High priority areas constitute 72% of total land in Suffolk County.

Regardless of the alternative chosen, Suffolk County should:

- Require good practice in the siting, design, installation, and maintenance of individual sewerage systems.
- Look at increasing vegetated land cover between individual sewerage systems and receiving waters, which may prevent further transport of sewerage-derived pollutants in stormwater runoff and/or shallow groundwater movement.
- Remain vigilant in controlling pollution from individual sewerage systems while efforts are underway to expand public drinking water supply. If such efforts are successful in reducing the number of residents relying on private wells, thereby lowering the risk of drinking water contamination, the concerns associated with sewerage systems as well as the priority for controlling pollutants from individual sewerage systems may decrease.
- Develop a plan that standardizes disinfection practices (chlorination of source water) that will accommodate increasing nitrogen levels and lower the potential for unwanted disinfection byproducts in drinking water, which are associated with the increasing risk of certain cancers and adverse reproductive outcomes.

If Alternatives I or II are chosen, Suffolk County should implement management strategies to minimize or avoid the harmful health impacts associated with declining water quality.

ENVIRONMENT

RESILIENCY TO NATURAL DISASTER

How is resiliency related to health?

According to the Natural Research Council, resiliency is "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events." In coastal resiliency, this means reducing vulnerabilities and potential exposure to natural hazards (e.g., severe storms and storm and/or tidal surges) and their impacts before they occur, in hopes of decreasing the consequences of the event. Severe storms and their surges can affect health in a number of ways, including direct exposure to the storm, secondary hazards (e.g., falling trees, rising waters, electrocution, and carbon monoxide poisoning), disruption of services, evacuation, displacement, trauma and stress, and clean-up and recovery activities, and can range from changes in overall health and wellbeing to injury and death.

Key Preliminary Findings Summary

The Suffolk County Multi-Jurisdictional Hazard Mitigation Plan states the highest risk natural hazards for Suffolk County, as a whole, are: **nor'easters**, severe winter storms, **severe storms**, **hurricanes**, and coastal erosion. Because of Suffolk County's orientation to the Atlantic Ocean and low-lying southern coastline, it is exposed to coastal storms that head up the East Coast and their associated storm surges.

Wetlands provide a number of ecosystem services (e.g., ecological, economic, and social benefits). Wetlands regulate the movement of water within watersheds; **hold and slowly release precipitation and flood waters**; recharge groundwater; **act as filters to cleanse water** of impurities and sediment; **recycle nutrients such as nitrogen**; **reduce erosion**; act as carbon sinks, off-setting greenhouse gas emissions (one of the major causes of global warming); and provide habitat for fish, wildlife, and a variety of plants. In addition to these services, **coastal/tidal wetlands** also help **protect shoreline areas from wave erosion** and provide a **natural buffer from storm and tidal surges**.

The most well-documented **causes of wetland loss** in Suffolk County are **development** and other dredge and fill activities. It is estimated by 2004 that Suffolk County had lost more than 21,000 acres of freshwater and tidal wetlands that existed there in the early 1900s. Recent studies have also pointed to **excess nutrient nitrogen loading** as a significant factor in coastal/tidal wetland loss in Suffolk County. Excess nitrogen loading overwhelms the capacity of wetlands to remove nitrogen; leads to the **decline of stabilizing vegetation**; alters the sediment regime; and, in concert with other factors (wasting disease, algal blooms, climate change, dredging, boating, and shellfishing), contributes to eelgrass decline. Coastal/tidal wetlands are also stressed by **wave action and sea level rise**. As sea level rises, wetlands must grow vertically and horizontally to avoid submersion (i.e., converted from vegetated wetland to unvegetated mud flat or even open water). In New York, some coastal/tidal wetlands seem to be keeping pace with sea level rise, but many are not.

The **proposed code changes may reduce nitrogen loading to coastal/tidal wetlands, but that** ***does not mean improved community resiliency to natural disasters,*** because...

While studies have shown that more than half of normal wave energy is dissipated within the first three meters of marsh vegetation, **storm surge is considerably different from normal wave action**.

Natural shoreline habitats (such as barrier beaches, eelgrass beds, wetlands, dunes, bluffs and cliffs, and reefs), as well as **hardened shorelines** (such as rip rap walls, bulkheads, and seawalls) **provide varying levels of protection**.

Continued loss of coastal/tidal wetlands is expected due to the rapid acceleration of sea level rise. NY Department of Environmental Conservation projects that Long Island could see **sea level rises of 2-10 inches (above the 2000-2004 baseline) in the 2020s and 13-58 inches of sea level rise in the 2080s** due to the effects of global warming. This is compared to a global sea level rise of about 8 inches since the year 1880.

As sea levels rise, Suffolk County will see **greater extent and frequency of coastal flooding from storms**, even if storms don't get any stronger, because storm surges will be added on top of a higher "baseline" water level. But climate models project **storms of greater frequency and intensity** due to global warming.

With the **dense development** of Suffolk County's coasts, a **great number of people, property, and infrastructure are in harm's way** of these natural hazards, and the population of Suffolk County is projected to continue to increase.

Potential Health Impacts of Proposed Code Changes

Overall Health and Wellbeing

- Mental health
- Physical activity
- Respiratory health

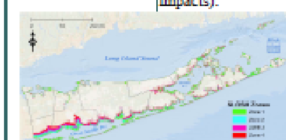
* Note: Hurricane Sandy was actually a post-tropical cyclone when it made landfall in New Jersey.

Baseline Health Status

The percentage of adults reporting fair or poor health (age-adjusted) in Suffolk County was 12% in 2014 and baseline community data from 2013 to 2014 indicates that 18.7% of adults in Suffolk County were diagnosed with depression.

The health benefits from regular, moderate physical activity is strong and well-established, including chronic disease prevention, improved mental health, and a better quality of life. However, immediately following natural disasters or storm events, physical activity can be difficult due to evacuation and displacement, infrastructure and property damage, closed recreational areas and facilities, and safety concerns. Impacts to respiratory health are also a concern due to mold contamination resulting from water damage. A Gallup-Healthways poll found that in the most affected areas of New York, New Jersey, and Connecticut, there was a 25% increase in diagnoses of depression in adults in the six weeks following Hurricane Sandy*.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
No Change Although the proposed code changes may reduce nitrogen loading to coastal/tidal wetlands, there is no evidence that this would impact community resiliency to natural disasters or their associated health impacts due to the confounding factors affecting community resiliency, including climate change, sea level rise, coastal development, and individual behaviors (such as willingness to evacuate).	**Highly Likely** Natural disasters are highly likely to impact overall health and wellbeing, as evidenced by past natural disasters, and impacts are likely to increase with increased storm frequency and intensity, as well as greater extent and frequency of coastal flooding due to sea level rise. A moderate 19.7-in. rise in sea level by 2080 is estimated to result in a 47% increase in the number of people impacted by storm surge and a 73% increase in property damage on the southern shores of Long Island over present day levels.	**High** Thousands of people live and work in each of the four SLOSH Zones (areas affected by Sea, Lake, and Overland Surges from Hurricanes) and could experience impacts to overall health and wellbeing from hurricanes, severe storms, and their associated storm surges.	**Disproportionate** Populations living and working in the SLOSH zones are disproportion-ately affected by hurricanes and storm events, but there are certain subpopulations that are particularly vulnerable, including those on barrier islands, the elderly, physically disabled, those with pre-existing conditions, low income populations, and the linguistically isolated.	**Minor to Moderate** Impacts to overall health and wellbeing can range in severity and may or many not require medical treatment or intervention.	**Immediate to Long-term** Impacts to overall health and wellbeing are likely immediate, but can potentially persist long-term (e.g., mental health impacts).

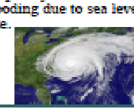


Human Injury/Death

* Note: Hurricane Sandy was actually a post-tropical cyclone when it made landfall in New Jersey.

Baseline Health Status

Historically, 49% of human causalities from hurricanes are due to storm surge. Riverine flooding due to rainfall, falling trees due to high winds, trauma from flying debris, and indirect impacts like falls, carbon monoxide poisoning, burns, and electrocution, can also cause injury and death. Despite advances in hurricane warning and evacuation systems, drowning remains one of the leading causes of hurricane-related deaths. Fifty-three (53) deaths were reported in NY due to Hurricane Sandy* (14 of which were on Long Island), with 80% of those deaths due to drowning. The median age of the deceased from Hurricane Sandy was 65 year of age; in 2010, persons age 65 and over comprised 14% of Suffolk County's population.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
No Change Although the proposed code changes may reduce nitrogen loading to coastal/tidal wetlands, there is no evidence that this would impact community resiliency to natural disasters or their associated health impacts due to the confounding factors affecting community resiliency, including climate change, sea level rise, coastal development, and individual behaviors (such as willingness to evacuate).	**Highly Likely** Injury and death are highly likely, as evidenced by past natural disasters, and likely to increase with increased storm frequency and intensity, as well as greater extent and frequency of coastal flooding due to sea level rise. 	**Low to Moderate** Although the magnitude of people at risk of injury and death is high, advances in warning and evacuation systems reduce the number of people who actually experience these impacts. 	**Disproportionate** Populations living and working in the SLOSH zones are disproportion-ately affected by hurricanes and storm events, but there are certain subpopulations that are particularly vulnerable, including those on the barrier islands, the elderly, physically disabled, low income populations, and the linguistically isolated.	**Minor to High** Impacts from storm and/or tidal surges can range in severity from minor injuries to more moderate injuries requiring medical treatment or intervention, and even disabling injury or death.	**Immediate to Long-term** Injury and death from storm and/or tidal surges often occur immediately or shortly following the event, but can also occur longer term, during clean-up and recovery. Impacts can range from temporary injury to permanent disabling injury and death.

ENVIRONMENT	RESILIENCY TO NATURAL DISASTER

How is resiliency related to health?

According to the Natural Research Council, resiliency is "the ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events." In coastal resiliency, this means reducing vulnerabilities and potential exposure to natural hazards (e.g., severe storms and storm and/or tidal surges) and their impacts before they occur, in hopes of decreasing the consequences of the event. Severe storms and their surges can affect health in a number of ways, including direct exposure to the storm, secondary hazards (e.g., falling trees, rising waters, electrocution, and carbon monoxide poisoning), disruption of services, evacuation, displacement, trauma and stress, and clean-up and recovery activities, and can range from changes in overall health and wellbeing to injury and death.

Key Preliminary Recommendations	Community Input
(see below)	

The Decision:

Scenarios	Details
Baseline	The existing conditions and trends (note: not static).
Alternative I	All new AND existing individual (onsite) sewage disposal systems (OSDS) serving single-family residences must conform to current County Sanitary Code and standards.
Alternative II	All new AND existing OSDS serving single-family residences in high priority areas* must conform to current County Sanitary Code and standards.
Alternative III	All new AND existing individual sewerage systems, either cesspool-only systems or conventional onsite wastewater treatment systems (OWTS), serving single-family residences in high priority areas* must be upgraded to innovative/alternative OWTS.

*high priority areas include areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in SLOSH zones (Sea, Lake, and Overland Surges from Hurricanes), and areas located where groundwater is less than 10 feet below grade. High priority areas constitute 72% of total land in Suffolk County.

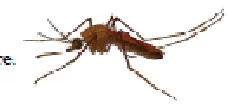
Regardless of the alternative chosen, Suffolk County should:

- Prioritize resiliency efforts (e.g., habitat restoration, shoreline management, and planning activities) based on risk of exposure and social and economic vulnerability to sea level rise, severe storms, and storm and/or tidal surges.
- Ensure that the impacts of accelerated sea level rise and increased storm frequency and intensity are adequately examined and accounted for in the initial phases of all planning efforts.
- Undertake activities, such as voluntary buyouts, land use and zoning regulations, and disincentives to development, to reduce the infrastructure and people in vulnerable coastal areas and create more naturally-functioning coastal floodplains, and provide space for coastal/tidal wetlands to retreat and expand.
- Protect, restore, and create freshwater and coastal/tidal wetlands or other green infrastructure alternatives to improve resiliency.
- Evaluate the use of hybrid approaches that combine natural habitats and built defense structures to improve resiliency.
- Undertake efforts in emergency management planning and outreach to ensure that individuals receive and comprehend evacuation messages and have the necessary resources to comply with them.

ENVIRONMENT VECTOR CONTROL

How is vector control related to health?

Insect vectors, especially mosquitoes, spread diseases such as West Nile Fever, Eastern Equine Encephalopathy, and Zika.
Nuisance and irritation from the presence of biting insects can deter participation in outdoor activities, discouraging exercise and appreciation of nature.
Excessive insect populations and high-visibility pesticide application can create a negative perception of the environment and the community.



Key Preliminary Findings Summary

Mosquitoes in Suffolk County are vectors, or disease-transmitting organisms, of the potentially deadly viruses **West Nile Virus (WNV)** and Eastern Equine Encephalopathy. The species complex implicated in the spread of WNV, *Culex pipiens-restuans*, breeds in **impaired and polluted water**. Sources of polluted water include containers such as flowerpots, old tires, and kiddie pools, as well as ponds, culverts, drainage ditches, and storm drains. The invasive Asian tiger mosquito, *Aedes albopictus*, while not implicated in the spread of WNV, breeds in large numbers following seasonal flooding of its saltwater wetland habitat and is known for aggressive biting behavior during the daytime. Other prominent mosquito species, of the approximately 50 found in Suffolk, include *Aedes vexans* and *Anopheles*.

Nuisance from mosquito bites can be a significant **barrier to outdoor activity**, and at its most severe can cause avoidance of the worst-affected areas altogether. Outdoor recreational areas and parks, especially in Suffolk County, are often in close proximity to water bodies such as lakes, ponds, creeks, or wetlands. While scientific study of attitudes towards mosquitoes in Suffolk County has not been attempted, anecdotal examination of local news articles reveals that summer mosquitoes are a commonly-cited irritant.

On-site sewage disposal systems can contribute to mosquito populations in several ways. Old or improperly maintained individual sewerage systems can **crack, flood, or collapse**, providing access to polluted water that serves as an ideal breeding ground for mosquitoes. Their natural predators such as mosquitofish and small predatory copepods cannot survive in such adverse conditions. **Nitrogen contamination** from individual systems degrades the quality of surface waters and brackish wetlands, encouraging the growth of mosquito larvae and the loss of predator species. Even low to moderate levels of organic nutrient pollution can lead to a significant increase in the survival of mosquito larvae, and subsequently increase adult mosquito populations.

The County has instituted a program for controlling mosquito populations that involves education, water management, monitoring and surveillance, and larvicide and adulticide application. **Annual applications of mosquito larvicide and adulticide** are conducted to limit mosquito populations and combat the spread of disease. Insecticide compounds used to control mosquito larvae include methoprene, an insect hormone inhibitor, and the bacterial controls *Bacillus thuringiensis* and *Bacillus sphaericus*. Adulticides currently include resmethrin, prallethrin and sumithrin, which are synthetic pyrethroids that imitate the effect of compounds found in chrysanthemums. These insecticides are widely agreed-upon by toxicologists, medical doctors, and environmental regulators to be **safe for humans**. Some residents, as evidenced by minutes of town hall meetings, local news articles, and social media posts, are concerned about potential health effects of mosquito insecticide treatment. These residents may be discouraged from going outside in areas that have recently received treatment, and may experience stress from **perceived health** risks of insecticide exposure.

Potential Health Impacts of Proposed Code Changes

Illness from Vector-borne Pathogens

Baseline Health Status

The Suffolk County Department of Health conducts yearly surveillance of mosquitoes through the monitoring network developed by the Arthropod-Borne Disease Laboratory. Trends in West Nile Virus surveillance reveal that on a yearly basis, from 2008-2015, the range of mosquito traps testing positive for the virus was 3.5% to 19.2%. In that same time period, 65 people contracted WNV, resulting in 3 deaths. Eastern Equine Encephalopathy has not been detected in mosquitoes since 2008. No locally-transmitted cases of Zika have been reported.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Unsure	**Possible**	**Moderate**	**Disproportionate**	**Minor to High**	**Long-term**
Because the mosquito implicated in the spread of WNV in Suffolk County breeds in impaired and polluted water, the chosen alternative could impact mosquito populations; however, a direct link between mosquito population and disease incidence for WNV has not been shown.	It is possible to contract WNV from mosquitoes in Suffolk County, but the likelihood of contracting the disease is low.	There are relatively few cases of mosquito-borne disease in Suffolk County, but a moderate number of individuals are co-located in areas where WNV-positive mosquitoes have been found.	The young, the elderly, the immunocompromised, and those in proximity to WNV-positive mosquitoes would be affected more.	The majority of individuals infected with WNV do not develop any symptoms and about 1 in 5 will develop minor symptoms. In a very small percentage (<1%), WNV can result in death or permanent mental injury.	Mosquito populations would be altered in the year(s) following changes to sewage disposal systems, and any related health impacts would be expected to be long-lasting, given the long life spans of the systems. Impacts from WNV can range from temporary to permanent.

Stress and Wellbeing

Baseline Health Status

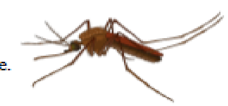
Some citizen groups and lawmakers express concern that insecticides used in mosquito control efforts are unsafe for children and the allergic. Mosquito populations, especially near wetland areas or after floods, reach nuisance status in warm months. Both can have an effect on stress and wellbeing by increasing concern about the state of the community's environment. Public perception of the environment influences choices of where, when, and how often to engage in outdoor activities. Studies have shown that participating in outdoor recreation leads to decreases in stress, lowers the chance of obesity and high blood pressure, and increases feelings of overall "wellness."

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Benefit to Health	**Possible**	**Low**	**Disproportionate**	**Minor**	**Long-term**
Newer sewerage systems and/or improved water quality are expected to help control mosquito populations, reducing nuisance and the need for insecticide application. Fewer mosquitoes lead to increased enjoyment of the outdoors, which reduces stress and increases general wellbeing.	Reduced nuisance mosquitoes have been shown to increase willingness to engage in outdoor activities, although mosquitoes alone likely account for a relatively minor part of discouraging these activities. Studies linking decreased insecticide application and improved perceptions of the environment are lacking.	Less than one percent of Suffolk County properties are listed on the Do Not Spray Law listing, indicating that concern over perceived environmental quality due to insecticide is relatively low. Participation in outdoor activities may be increased, but the extent of that impact is unknown.	Individuals who live in proximity to mosquito breeding areas and/or insecticide application areas could be affected more.	Nuisance mosquitos and perceived toxicity of insecticides will have minor impacts to stress and wellbeing.	Mosquito populations would be altered in the year(s) following changes to sewage disposal systems, and any related health impacts would be expected to be long-lasting, given the long life spans of the systems. Stress can have lasting effects on wellbeing.

ENVIRONMENT | VECTOR CONTROL

How is vector control related to health?

Insect vectors, especially mosquitoes, spread diseases such as West Nile Fever, Eastern Equine Encephalopathy, and Zika.
Nuisance and irritation from the presence of biting insects can deter participation in outdoor activities, discouraging exercise and appreciation of nature.
Excessive insect populations and high-visibility pesticide application can create a negative perception of the environment and the community.



Key Preliminary Recommendations

The Decision:

Scenarios	Details
Baseline	The existing conditions and trends (note: not static).
Alternative I	All new AND existing individual (onsite) sewage disposal systems (OSDS) serving single-family residences must conform to current County Sanitary Code and standards.
Alternative II	All new AND existing OSDS serving single-family residences in high priority areas* must conform to current County Sanitary Code and standards.
Alternative III	All new AND existing individual sewerage systems, either cesspool-only systems or conventional onsite wastewater treatment systems (OWTS), serving single-family residences in high priority areas* must be upgraded to innovative/alternative OWTS.

*high priority areas include areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in SLOSH zones (Sea, Lake, and Overland Surges from Hurricanes), and areas located where groundwater is less than 10 feet below grade. High priority areas constitute 72% of total land in Suffolk County.

Regardless of the alternative chosen:

- Owners of onsite wastewater treatment systems should **inspect their installations** for cracks, leaks, and loose manhole covers. Any cracks or gaps between the blocks should be patched with cement. Vent pipes should be **covered by screen mesh** to deny mosquitoes access to the water within.
- Unused or abandoned systems should be **filled completely with soil**, both to eliminate a source of standing water and to avoid potential collapse and injury.
- Existing systems should be **routinely pumped**, as this reduces the risk of flooding and excessive retention of standing water.
- **Public outreach** should emphasize the role **individual homeowners** can take in helping prevent mosquito infestation.

If Alternative III is chosen:

- Innovative/alternative onsite wastewater treatment systems under consideration by the County should be **evaluated to ensure that they do not provide breeding habitat** for mosquitoes. Ideally, the innovative/alternative systems chosen will innately discourage mosquito breeding by incorporating access-restricting features, such as screened vents and inspection ports, crack-resistant construction, and tightly-fitting manholes.

Community Input

ECONOMY | HOUSEHOLD ECONOMICS

How is Household Economics related to health?

Housing is generally the largest expense for an individual household. The proportion of a household's income remaining after housing costs can determine the ability to afford other essential health-related goods and services, such as food, clothing, utilities, healthcare, and childcare. The inability to afford these essentials can increase the risk of poor health outcomes, such as chronic disease, infectious disease, exposure to environmental toxins, mental distress, and preterm births and infant low birthweights among expecting families. Children of low-income households and households displaced by financial insecurity have a higher risk for developmental delays and mental/behavioral problems, than those in non-cost burdened households. Households with affordable housing costs generally have better health outcomes than other households with the same income level.

Key Preliminary Findings Summary

The proposed code changes will **result in additional costs to individual households** for county fees, installation, operation, and maintenance related to individual sewerage systems. However, the cost amounts are dependent on the type of upgrade that is required. Estimated costs can range from $5,000 to $23,000 for installation, $100 to $500 dollars per year for maintenance, and no cost to $300 a year for operation. After the system has been upgraded, additional considerations include when the system will need to be repaired/replaced (i.e., what is the life expectancy of the system and the costs associated with replacing a failed system).

A household is considered **cost-burdened** when total housing costs (i.e., including mortgage, rent, insurance, utilities, taxes, etc.) exceeds 30% of total household income. In Suffolk County, an estimated 42.6% of owner occupied housing units and 59.3% of renter-occupied housing units have costs that exceed 30% of their income. This suggests that a **higher proportion of renters than homeowners would be negatively affected** if housing costs increase.

According to MIT's Living Wage Calculator, the living wage for a household of three (representative of the typical family: two adults and one child) is $55,432 for Suffolk County. The median household income for families in the County is $102,125 or 184% of the estimated living wage. The estimated living wage for a household of two adults (representative of the typical non-family household) is $45,552. The median household income for non-families is $45,411 or 99.6% of the estimated living wage. This indicates that **non-family households are at a greater risk**.

Given the high property values and relatively high median income in Suffolk County, **using cost burden alone is not an accurate means of determining the percentage of the population that would be negatively impacted by increased household costs**. For example, households at the higher extreme of the income scale may also spend over 30% of income on housing costs, but may not be cost-burdened. Regionally, specific income limits for public assistance programs yield a more accurate indicator of subgroups more affected by increased housing costs. For Section 8 housing, a household of three is considered low-income if their total household income is $68,150 or less, and very low-income if $47,800 or less. To qualify for the state's Home Energy Assistance Program (HEAP), a household of three must have an annual income of less than $43,500. Thus, households included in HEAP would be more vulnerable to increasing housing costs. Households with incomes near or below $45,000, while earning more than twice the federal poverty level are still in a precarious financial situation and are at the greatest risk of a negative impact if their housing costs increase. Countywide, this group is **estimated to be 23% of the total number of households**.

Considering most of the homes in Suffolk County are older (more than half built before 1970) and heated with fuel oil (54%), it is likely that many of these structures also have inefficient appliances and/or inadequate insulation, leading to higher utility bills and an overall higher cost of living. **Improving the energy efficiency of homes could significantly help cost-burdened households.**

Employment and wages are key factors of household income. The increase in demand for sewerage system upgrades may lead to **more job opportunities** in the sewerage system service, construction, and manufacturing industries; although, the location of such opportunities may not be limited to Suffolk County.

Potential Health Impacts of the Proposed Code Changes

Overall Health and Wellbeing

Baseline Health Status

According to The University of Wisconsin Population Health Institute's County Health Rankings, Suffolk County is ranked 9th best of New York's 62 counties for overall health outcomes (i.e., length and quality of life), and 5th best for overall health factors related to social, economic, environmental, and behavioral determinants of health. Suffolk County's worst ranking (54th of 62) was the proportion of households with severe housing problems (i.e., lack of kitchen/ plumbing facilities, overcrowding, or high housing costs) at 23%.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Benefit Potential increases in job opportunities associated with the upgrades would benefit health.	**Possible** Increased employment opportunities are highly likely to make health-related goods and services, such as healthcare and quality nutrition, more accessible.	**Low** The number of households benefiting from increased employment opportunities would be small.	**Disproportionate** Employment opportunities will only affect those working in sewerage system service, construction, and manufacturing industries.	**Minor to Moderate** Health impacts may occur across a spectrum depending on the extent and duration of financial insecurity and the type of household, as well as baseline health status and pre-existing conditions.	**Immediate** Benefits from employment could start immediately and are expected to be long-term, considering the demand for upgrades will last for several years.
Harm The cost of the upgrades could detract from health by reducing the amount of expendable household income available for other essential health-related goods and services.	**Highly Likely** There is a strong body of evidence that links high housing cost burden to poor overall health outcomes, and the potential costs associated with system upgrades will likely exacerbate existing conditions among cost-burdened households.	**Moderate/High** More than 20% of households are already struggling with high housing costs, and the number of severely cost-burdened households may increase.	**Disproportionate** Those with fixed/low-incomes and/or high housing costs, renters, children, and some minorities would be impacted more than others.	**Minor to High** Health impacts may occur across a spectrum depending on the extent and duration of financial insecurity and the type of household, as well as baseline health status and pre-existing conditions.	**Immediate to Long-term** The cost burden of the proposed upgrades would be immediate, but some associated health outcomes may take years to develop.

Nutrition-related Health Outcomes

Baseline Health Status

In Suffolk County's Community Health Assessment, food insecurity and hunger was identified as a financially-caused health challenge among residents. Preterm births, low birthweights, and developmental delays are associated with poor nutrition and/or food insecurity. In Suffolk County, the percent of low birth weight infants was 7.7% (percent of live births 2006-2012) which is lower than the statewide rate of 8.2%. The percent of preterm births in 2011 was 11.5% for Suffolk County as a whole compared to a statewide rate of 10.7%, but 7.6% for births associated with Suffolk County Department of Health Services. The county health assessment identifies preterm birth as the "primary reason infants die before their first birthday in Suffolk County."

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Harm The increased cost of the proposed upgrades would detract from health by reducing the amount of expendable household income available for nutrition.	**Highly Likely** Many studies indicate that severely cost-burdened households are forced to cut back on the amount they spend on food.	**Moderate to High** The number of affected persons depends on those in cost-burdened households that will also need to upgrade their individual sewerage system, both of which are numerous in Suffolk County.	**Disproportionate** Vulnerable populations including those with fixed/low-incomes and/ or high housing costs, renters, children, and some minorities will be impacted more than others.	**Minor to High** Healthy adults forced to cut back on their food budget may experience minor to severe health impacts. Outcomes for infants with low birthweights and pre-term births could be severe and in some cases, fatal.	**Immediate to Long-Term** The effect could occur as soon as households begin installing the required systems. Some health impacts related to poor nutrition may be long-lasting, such as developmental delays.

ECONOMY	HOUSEHOLD ECONOMICS

How is Household Economics related to health?

Housing is generally the largest expense for an individual household. The proportion of a household's income remaining after housing costs can determine the ability to afford other essential health-related goods and services, such as food, clothing, utilities, healthcare, and childcare. The inability to afford these essentials can increase the risk of poor health outcomes, such as chronic disease, infectious disease, exposure to environmental toxins, mental distress, and preterm births and infant low birthweights among expecting families. Children of low-income households and households displaced by financial insecurity have a higher risk for developmental delays and mental/ behavioral problems, than those in non-cost burdened households. Households with affordable housing costs generally have better health outcomes than other households with the same income level.

Key Preliminary Recommendations	Community Input

The Decision:

Scenarios	Details
Baseline	The existing conditions and trends (note: not static).
Alternative I	All new AND existing individual (onsite) sewage disposal systems (OSDS) serving single-family residences must conform to current County Sanitary Code and standards.
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*high priority areas include areas in the 0-50 year groundwater contributing zone to public drinking water wells fields, areas in the 0-25 year groundwater contributing zone to surface waters, areas located in SLOSH zones (Sea, Lake, and Overland Surges from Hurricanes), and areas located where groundwater is less than 10 feet below grade. High priority areas constitute 72% of total land in Suffolk County.

Regardless of the alternative chosen, Suffolk County should:

- Seek outside funding to reduce the costs for individual households. Assistance funding could occur at the county level, as well as at the local municipal level. Assistance should be made available for all household types (both family and non-family), but prioritized for cost-burdened and low-income households and property owners renting to low-income households.
- Consider protection for renters, such as rent control. Preventing rent from increasing is crucial for the housing security of at-risk residents of Suffolk County, given the number of at risk renters, the extreme scarcity of vacant rental properties, and rental practices employed by some property owners.
- Educate cost-burdened households about the benefits of improving home energy efficiency. There are several federal, state, and local assistance programs that help low- and middle-income households make improvements to their homes and reduce utility costs. For many low-income households, these improvements could be done at no cost to the homeowner and/or renter.
- Work with communities and OWTS vendors to plan concurrent upgrades to neighboring properties to help reduce construction costs.

If Alternative III is chosen, Suffolk County should take steps to encourage I/A OWTS businesses to locate and hire within the county. The demand for installation, maintenance, repair, and inspection of I/A OWTS will significantly increase in Suffolk County, providing new opportunities for employment. Possible strategies include, tax incentives and waivers or decreases in certification fees for I/A OWTS companies that locate in Suffolk County and support a community jobs program to train local residents in I/A OWTS technology installation, maintenance, repair, and inspection.

ECONOMY

COMMUNITY ECONOMICS

How is community economics related to health?

Local municipalities (County, Town, Village, etc.) provide many of the essential services that support the overall health and wellbeing of their residents, including (but not limited to) education, employment, parks and recreation, environmental protection, police and law enforcement, transportation, and public health education and protection. The capacity to provide these services is directly tied to the economic vitality of the community, specifically the revenue generated and the ability to remain solvent. The public services provided are a reflection of the community's priorities and the administrative policies and commitments to the community that it serves.

Key Preliminary Findings Summary

Water resources are an integral part of life among Suffolk County residents and a **critical resource for the local economy**, especially for commercial fishing and shellfishing, recreation and tourism, and the contribution to the desirability of living in Suffolk County.

Decline in the quality of water resources places **revenue streams for Suffolk County services at risk for decline**. In Suffolk County's 2015 Comprehensive Annual Financial Report, **Real Property Taxes and Sales and Use Tax** were identified as the **primary revenue sources for the County (68%)** totaling $2.03 billion in revenue. The report also included a statement that **home prices in the county increased 4.3% in 2015**. Numerous studies have linked real estate values to localized environmental quality including water quality. One preliminary analysis of the contribution of property characteristics to home sale prices for four towns in Suffolk County concluded that **clearer water translates to higher housing values**, especially for properties near waterfronts.

The primary expenditures for the county are **Public Safety** (21%), **Economic Assistance and Opportunity** (21%), and **Employee Benefits** (21%). The **top three employment sectors** in Suffolk County are **local government, food services/drinking places, and professional technical services**.

In the 2015 Annual Financial Report, the County describes a number of in-progress and proposed economic development **projects financed by the County that are closely related to tourism and the waterfront**. The potential return on the county's investment could be directly impacted, both positively or negatively, by changes in water quality.

The 2015 Mid-Year Report by Long Island Convention and Visitors Bureau and Sports Commission stated that **tourism generated $202 million in local tax revenue for Suffolk County**. Traveler spending across all of Long Island was $5.5 billion in 2015 and $5.3 billion in 2014, adding to the overall economic vitality of the region. Increasing beach closures, algal blooms, and perceived degradation of waters used for aquatic recreation places revenue streams from tourism and recreation at risk for decline.

Jobs in accommodations and food services; arts, entertainment and recreation; and health care and social assistance had significant growth (>25%) from 2001 to 2012. The 2013 NOAA Coastal County Snapshot for Suffolk County reported that **the number of commercial fishing jobs in the County was 1,054** and revenue from commercial fishing totaled $57.7 million. Suffolk County Executive Steve Bellone reported thousands of job losses in the shellfishing industry due to declining shellfish populations.

The proposed changes to the Suffolk County Sanitary Code will lead to **increased revenue and costs** for administering the County sewerage system inspection and certification program, due to the increased demand for permits, inspections, and certifications of compliance.

Increased demand for administering the code changes may also present **opportunities for employment with the County**. The increase in demand for sewerage system upgrades may lead to **more job opportunities in the sewerage system service and manufacturing industries**; although, the location of such opportunities may not be limited to Suffolk County.

Installing innovative/alternative onsite wastewater treatment systems (I/A OWTS) under Alternative III will result in significant reductions in nitrogen loading to the environment, which **may slow the degradation of water resources**, such as formation of algal blooms, loss of aquatic animal life, and/or beach closures in surface waters. County resources expended on vector control may be reduced, due to the reduction in habitats suitable for mosquitoes, and used for other public services.

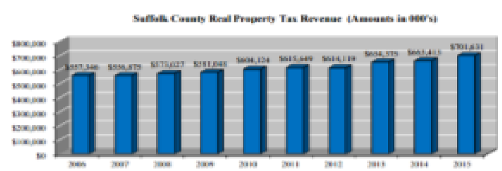
Potential Health Impacts of Proposed Code Changes

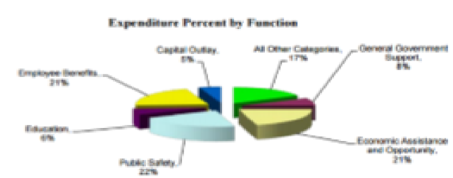
Overall Health and Wellbeing

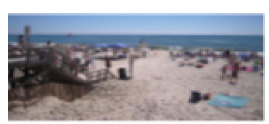
Baseline Health Status

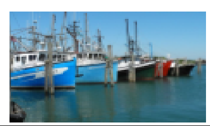
According to The University of Wisconsin Population Health Institute's County Health Rankings, Suffolk County is ranked 9th best of New York's 62 counties for overall health outcomes (i.e., length and quality of life), and 5th best for overall health factors related to social, economic, environmental, and behavioral determinants of health. In 2014, the age-adjusted average number of mentally unhealthy days reported in past 30 days was 3.2 in Suffolk County, lower than the New York state average of 3.7 days.

Direction	Likelihood	Magnitude	Distribution	Severity	Permanence
Alternatives I and II will **detract from health** based on the lack of reduction in nitrogen loading, the potential for water quality to continue to degrade, and possible impacts to revenue streams for county services.	Changes in Suffolk County revenue and cost streams make it **possible** for overall health and wellbeing to be affected from changes in health-related public services. However, the county may take other actions to improve water quality and create and protect revenue streams to minimize impacts to county services.	The number of people affected would be **high**, since all residents (about 1.49 million) utilize multiple services provided by the county.	Subgroups who are highly dependent on health-related public services would be **disproportionately effected** if those services are reduced or eliminated.	The health effects will range from **minor to severe** depending on the ability of the county to provide health-related public services.	Overall health and wellbeing of residents could be affected on a **short-term or long-term** basis, depending on other actions taken by Suffolk County to manage impacts to revenue, cost streams, and services provided.
Alternative III will **benefit health**, considering water resources support major revenue streams for health-related public services, and improvements to water quality will help safeguard revenue streams.	The likelihood of the benefit is **highly likely**. However the benefits are dependent on successful implementation of the program, including installation, monitoring, and maintenance of the I/A OWTS in single-family residences required to upgrade.	Same as above	Same as above	Same as above	Same as above









ECONOMY | COMMUNITY ECONOMICS

How is community economics related to health?

Local municipalities (County, Town, Village, etc.) provide many of the essential services that support the overall health and wellbeing of its residents, including (but not limited to) education, employment, parks and recreation, environmental protection, police and law enforcement, transportation and public health education and protection. The capacity to provide these services is directly tied to the economic vitality of the community, specifically the revenue generated and ability to remain solvent. The public services provided are a reflection of the community's priorities and the administrative policies and commitments to the community that it serves.

Key Preliminary Recommendations	Community Input

The Decision:

Scenarios	Details
Baseline	The existing conditions and trends (note: not static).
Alternative I	All new AND existing individual (onsite) sewage disposal systems (OSDS) serving single-family residences must conform to current County Sanitary Code and standards.
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Regardless of the alternative chosen, Suffolk County should:

- Continue to make **protection of water resources a high priority.** High quality water resources support recreational and tourist activities in Suffolk County, which provide essential tax revenue. In addition, property values are influenced by the quality of the surrounding environment and declines in property value may impact county revenue from property tax.
- Use the revenue gained from fees due to code changes to support costs of the OWTS program (i.e.; inspections, training, administrative needs). **Self-sufficiency of the program would be ideal**, in order to not detract from other essential services provided by Suffolk County.

If Alternative III is chosen, Suffolk County should take steps to encourage I/A OWTS businesses to locate and hire within the county. The demand for installation, maintenance, repair, and inspection of I/A OWTS will significantly increase in Suffolk County, providing new opportunities for businesses and employment. Possible strategies include tax incentives and waivers or decreases in certification fees for I/A OWTS companies that locate in Suffolk County and support a community jobs program to train local residents in I/A OWTS technology installation, maintenance, repair, and inspection.

Appendix E: HIA Rules of Engagement

RULES OF ENGAGEMENT AGREEMENT

In order to participate in the health impact assessment (HIA) in an official capacity, individuals must understand and agree to the following rules. The rules of engagement (ROE) cover a number of topics, including commitments and information sharing, which are critical to the overall success of the HIA. Members of the HIA Leadership Team, HIA Research Team, Technical Advisory Committee, and Community Stakeholder Steering Committee must understand and agree to the following ROEs.

A. HIA Roles and Responsibilities

As a participant in this HIA, I will:

1. Fulfill all the responsibilities of my role, as described in Table 1.

Table E1. HIA Roles and Associated Responsibilities

HIA Role	Responsibilities
HIA Leadership Team	Members will meet bimonthly (more often if needed), either in person or by phone. Members are responsible for discussing and managing HIA progress; planning logistics for upcoming HIA activities; designing the HIA processes; attending HIA Leadership Team, Research Team, Technical Advisory Committee, Community Stakeholder Steering Committee, and other HIA meetings; contributing to the development of HIA materials; approving HIA materials for distribution; and managing specific HIA tasks. The HIA Project Leads are responsible for securing funding vehicles and personnel to perform HIA activities, schedule and lead HIA meetings, lead group discussions, communicate with stakeholders, distribute final HIA products, and make final decisions regarding HIA activities.
HIA Research Team	Members will meet monthly (more often if needed), either in person or by phone. Members are responsible for assisting in the development and completion of the assessment plan and performing other specific tasks related to collecting, synthesizing, and analyzing data; contributing to the development of HIA materials; attending HIA Research Team meetings; and identifying initial recommendations. Members will also be responsible for appraising the HIA Leadership Team of the progress of and any challenges completing specific tasks.
Technical Advisory Committee	Members will meet monthly (more often if needed), either in person or by phone. Members are responsible for advising the HIA Project Team on technical aspects of the proposed changes (e.g., implementation, enforcement, funding); attending TAC meetings (or provide a representative); and providing input and feedback on the HIA goals, assessment plan, recommendations, follow-up activities, HIA materials, and implementation of the HIA process.
Community Stakeholder Steering Committee*	Members will meet monthly (more often if needed), either in person or by phone. Members are responsible for advising the HIA Project Team on non-technical aspects of the proposed changes (e.g., local knowledge, history, and interests and/or concerns of other community stakeholders); attending CSSC meetings (or provide a representative); and providing input and feedback on the HIA goals, assessment plan, recommendations, follow-up activities, HIA materials, and implementation of the HIA process.

*The CSSC was later combined with the TAC due to low participation.

2. Acknowledge that the HIA will be led by Florence Fulk (EPA Sustainable and Healthy Communities Research Program) and Rabi Kieber (EPA Region 2 Green Building/Sustainability Coordinator) and performed by the HIA Project Team, which includes members of the HIA Leadership Team and HIA Research Team.
3. Recognize that I may serve in more than one role, but must fulfill the responsibilities for each role.

4. Recognize that the responsibilities for each role may include voluntary or assigned sub-tasks essential to the forward progress of the HIA.
5. Operate in a proactive manner to anticipate potential issues and work to prevent them from occurring.
6. Only agree to do work that I am qualified and capable of doing in the time allowed.
7. Conduct my work with integrity and perform duties in an ethical and timely manner.
8. Keep other team members informed of any changes or challenges that arise.

B. Decision-making Related to HIA Activities

As a participant in this HIA, I will:

1. Remain neutral to the decision result and advocate only for health and wellness.
2. Agree that all decisions specific to the HIA process will be made by the HIA Project Team (which includes the HIA Leadership Team and Research Team), with input from the TAC and CSSC.
3. Agree that all decisions regarding the HIA will be documented with supportive rationale and made public through the HIA report.
4. Agree that the final authority in all HIA-related decision-making is reserved for the HIA Project Leads (Florence Fulk and Rabi Kieber), especially in the event of a decision crossroads between participant groups.

C. Commitments

As a participant in this HIA, I will:

1. Make every effort to meet the commitments promised in the HIA.
2. Hold one another accountable for work completion and time commitment.
3. Agree to serve in my role until the completion of the HIA or find and secure a replacement.
4. Be responsive and timely to requests for outreach or information regarding the HIA.
5. Be responsive to the needs of the decision timeline and commit to set deadlines.
6. Recognize and accept the purpose of the HIA.
   NOTE: *The purpose of this HIA is to help inform Suffolk County's decision regarding the proposed changes to the Sanitary Code Article 6 and other County policies regarding existing onsite sewage disposal systems by advocating for health and wellness of all stakeholders.*

D. Meeting Procedures

As a participant in this HIA, I will:

1. Understand that all HIA meetings will be documented, via scribe and/or pictures.
2. Agree to schedule HIA meetings well in advance of a set date (i.e., at least two weeks prior to the meeting) and distribute any material that will be discussed prior to meeting.
3. Agree to begin and end meetings on time and be prepared for meetings.
4. Send a representative with authority to make decisions, if unable to attend a meeting.

E. Communication

As a participant in this HIA, I will:

1. Be clear, concise, and keep discussions on track.
2. Practice active, effective listening skills.
3. Use visual means such as drawings, charts, and tables to facilitate discussion.
4. Be mindful and respectful of the view and opinions of all other participants, when communicating one's own view or opinion.

F. Information Sharing and Material Review

As a participant in the HIA, I will:

1. Understand that, by default, all information provided or developed during the HIA will be documented and shared with others. Sensitive information must be noted as such prior to being shared.
2. Recognize that all HIA materials will undergo an internal review process (Level 1) that will encompass review and editing by the HIA Project Team (see Figure 1).
3. Recognize that HIA materials will undergo an external review process (Level 2) in which stakeholders outside the HIA Project Team will have an opportunity to provide feedback/input on the information shared and propose edits to the HIA materials (see Figure 1).
4. Recognize that HIA materials may undergo an external review by the Agency (EPA) and/or peer-review (Level 3) for quality assurance (see Figure 1).
5. Recognize that feedback not provided by the assigned due date will not be considered. Reviewers will receive a minimum of two weeks and maximum of one month to review materials and provide feedback (see Figure 1).
6. Accept that not all input or suggestions received will be incorporated into HIA materials. Any significant changes proposed must be accompanied by evidence-based rationale. Information that is not evidence-based will be incorporated at the discretion of the HIA Project Team.

   <u>NOTE</u>: *All interim (draft) materials from the HIA must be approved first by the HIA Project Leads (Florence Fulk and Rabi Kieber) before being distributed or shared with other groups and/or individuals outside the HIA Project Team. This is to help prevent the dissemination of misinformation and/or miscommunication between stakeholder groups. Figure 1 outlines the flow of materials and how the decisions regarding dissemination of such materials will be made.*

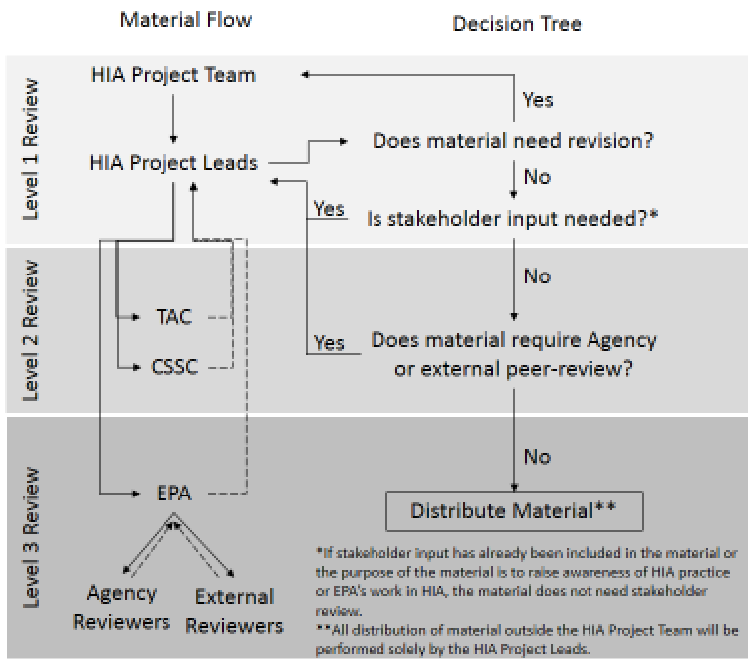

Figure 1. The process outline for communicating and sharing HIA information and material review.

G. Conflict Resolution

As a participant in this HIA, I will:

1. Seek first to understand and then be understood.
2. Agree that disagreements are expected, but a common ground should always be sought.
3. Agree to be respectful of one another and make a collaborative effort so that conflicts can be resolved as quickly as possible.
4. Agree to be inclusive and respectful of others, regardless of differing priorities, viewpoints, or concerns.

NOTE**:** *In the event of a persistent conflict or disruption (i.e., participant is not abiding by the ROE), the participant may be asked to serve in a less committed role or be relieved of responsibilities. The authority to relieve responsibilities of another participant rests with the HIA Project Leads.*

Appendix F: Pathways Excluded from the Final Scope of the HIA

Due to the large number of potential impacts, the HIA Project Team agreed that the HIA could not evaluate all of the pathway categories identified within the project timeframe. The HIA Leadership Team asked the Advisory Committee members to rank the pathway categories on a scale from most important (1) to least important (10) and ordered the average rank for each pathway category to help prioritize which pathways to include in the HIA *Assessment*. The pathways excluded from assessment, the means of influence and/or impact on health, and potential health outcomes, based on that prioritization exercise, are included here for transparency.

Pathway	Means of Influence/Impact	Potential Health Outcome(s)
Food Safety and/or Security	• Waters contaminated with sewage and/or harmful algal blooms can disrupt the prosperity and productivity of aquatic animal-life (e.g., shellfish, finfish, reptiles) in addition to introducing toxic and/or pathogenic contaminants to a food source for human consumers. • Food washed with sewage-contaminated drinking water poses a human health risk for illness. • In Suffolk County, shellfish, finfish and crustaceans are a food source and part of the social and economic culture. Therefore, the quality (safety) and availability of local aquatic foods may determine diet and nutrition at the household and individual-level. • Household economics, such as housing costs and income available, is a strong driver in the selection and quality of food consumed in the household. Households which are highly dependent on local aquatic food sources as their primary means of diet or as their primary means of income may see changes in nutrition and diet.	**Food-borne illness** from consumption of contaminated food **Nutrition-related outcomes** from changes in food availability and/or (financial) security
Aquatic Recreation (Physical activity)	• The actual quality and/or perceived quality of waters used for recreation, as a result of frequent beach closures and/or posted hazard advisories, are major drivers in the long-term recreational use of the water body, such as avoidance of the area or travel to other recreational destinations. • Changes in the long-term recreational use of the water body, coupled with the accessibility of other recreational destinations may affect physical activity levels at the household and (later) community level.	**Overall health** (mental health and physical health [obesity/ overweight, cardiovascular health, etc.]) from physical activity level

Pathway	Means of Influence/Impact	Potential Health Outcome(s)
Social Beliefs and/or Norms	• The quality of collective water resources, both ground and surface waters, affects a person's perceived quality of their surrounding environment, which is internalized as a stressor. • The perceived safety or perceived risk to self and/or property in an area affected by a storm and/or tidal surge also acts as a stressor. • Mosquito infestations and/or the perceived health risks associated with application of insecticides to large areas, which may already be under environmental stress, can be internalized through a person's perceived quality of the environment. • Perceived risks and internalization of environmental stressors are drivers of human behavior, attitudes, and feelings of overall well-being, which can determine priorities and values. • The collective social priorities/shared values and identity of the community, whether in agreement (i.e., social cohesion) or disagreement (i.e., social discord), influence social norms and/or beliefs, which drive public policy.	**Mental and/or behavioral health** related to perceived risks and environmental stressors **Overall health** related to behaviors, attitudes and well-being
Housing Quality	• In cases of severe damage to residences from storms and/or tidal surges, the decision of those to stay in the home or the relocation/displacement of residents to alternative housing may have health consequences, depending on the quality (e.g., presence of mold, sewage-contaminated flood waters, pest invasion) and affordability of the living space after the storm event. • Changes to housing costs for renter households will affect their affordability for healthy housing.	**Respiratory illness** from exposures in the home **Overall health** related to environmental stressors
Air Quality	• Households that choose to travel to other recreational destinations, as a result of the perceived quality of local water resources may change the air emissions and traffic patterns across Suffolk County. • Air emissions include pollutants that, at certain concentrations, have direct human health consequences.	**Respiratory and cardiovascular illness** from travel-related air pollutants
Crime and Perceived Safety and/or Security	• The extent of investment/disinvestment in the community (e.g., extent of blight, vacant and/or derelict properties, and resident longevity) coupled with changes to social norms and/or beliefs (e.g., the priority of environmental stewardship) may affect crime, which can have direct health consequences. • Crime and blighted areas affect the perceived safety and security of a community, which acts as an environmental stressor.	**Injury and/or death** related to crime **Overall health** related to environmental stressors

Appendix G: Quality Assurance: Peer Review, Data Sources, and HIA Methodology

Prior to conducting this HIA, EPA reviewed over 80 existing HIAs to determine the current state of the science and to identify best practices and areas for improving HIA implementation (EPA, 2013). The findings from EPA's review, along with several HIA practice documents, were used to direct the HIA process and promote quality assurance (QA); the HIA practice documents reviewed included:

- Bhatia, R. (2011). Health Impact Assessment; A Guide for Practice. Oakland, CA: Human Impact Partners.
- Bhatia R, Farhang L, Heller J, Lee M, Orenstein M, Richardson M and Wernham A. (2014). Minimum Elements and Practice Standards for Health Impact Assessment, Version 3.
- Green, L, et al. (2019). Development of a quality assurance review framework for health impact assessments, Impact Assessment and Project Appraisal, 37:2, 107-113.
- National Research Council. (2011). Improving Health in the United States; The Role of Health Impact Assessment. Washington, D.C.: The National Academies Press.
- Quigley, R, et al. (2006). Health Impact Assessment; International Best Practice Principles, Special Series No. 5. Fargo, USA: International Association for Health Impact Assessment (IAIA).
- WHO. (1999). Health Impact Assessment; Main Concepts and Suggested Approach. Gothenburg Consensus Paper. Brussels (Belgium): World Health Organization (WHO), Regional Office for Europe, European Center for Health Policy.

The HIA Project Team used these documents to manage the execution of the HIA. In addition, the HIA Leadership Team, including an HIA advisor, continuously monitored and guided the process to ensure the HIA followed the minimum elements and practice standards set forth by the North American HIA Practice Standards Working Group (Bhatia, et al., 2014) and best practices in the field based on professional expertise.

Additionally, QA audits were conducted annually throughout the lifespan of the research by CSS-Dynamac/Pegasus Technical Services, contractor to EPA, in their roles on the HIA Leadership and Research Teams. No findings or corrective actions were identified during these annual audits. For more information on roles and responsibilities of the HIA Project Teams, see Section 3.3.1 of the full HIA Report.

PEER REVIEW

Upon completion, the HIA Report underwent extensive review by three EPA members and one non-EPA member of the HIA Research Team. In addition, eight members of the Technical Advisory Committee (TAC) from the following organizations contributed to the review process: Suffolk County Government, New York State Department of State, FEMA, Suffolk County Water Authority, Stony Brook University, Earlham College, the Nature Conservancy, and EPA Region 2 Water Division.

Furthermore, scientific peer review was performed by two invited non-EPA subject matter experts, Dr. Michael Piehler and James Dills, to provide an experienced perspective outside of those directly involved in the process and/or the decision. The non-EPA scientific peer-reviewers were charged with evaluating the HIA against the *HIA Minimum Elements and Practice Standards* (Bhatia, et al., 2014) and providing input on the soundness of the evidence regarding nutrient transport and coastal waters. Dr. Piehler is the Program Head of Estuarine Ecology and Human Health at the UNC Coastal Studies Institute and a professor of Marine Sciences and Environmental Sciences and Engineering at the University of North Carolina at Chapel Hill. He studies transport and transformation of nutrients in coastal systems, ecology and biogeochemistry of the tidal freshwater zone, and microbial processes in shallow coastal waters. James Dills is a Research Associate II at the Georgia Health Policy Center who works to advance a Health-in-All-Policies perspective in decision-making. He is an expert in HIA and serves on the Steering Committee of the Society of Practitioners of Health Impact Assessment (SOPHIA). The external peer reviewers provided comments and proposed revisions, which the HIA Leadership Team considered and incorporated into the HIA Report, as appropriate.

DATA SOURCES

The HIA Project Team established Suffolk County, New York as the study area, given that the policy and/or decision being evaluated in this HIA is at the county-level. Data were matched to the spatial extent of the study area and the most recent health and demographic data available at the time of the assessment step (2014-2016) were used to characterize the population.

The HIA Research Team developed an Assessment Workplan that identified the following for each variable in the five pathways (1. Individual Sewerage System Performance and Failure; 2. Water Quality; 3. Resiliency to Natural Disasters; 4. Vector Control; 5. Household and Community Economics) evaluated in this HIA:

- Baseline research question – to identify the current conditions in Suffolk County related to the variable
- Impact research question – to determine how the proposed decision alternatives would potentially impact the variable
- Indicators and data sources – to be used to answer the research questions
- Approach or methods – to be used to answer the research questions
- Data gaps and/or data acquisition needs
- Task Lead – individual(s) responsible for leading and carrying out the assessment of that variable.

The Assessment Workplan was presented to the TAC to gather their input and help identify potential data sources that could be used in the *Assessment*.

This HIA utilized both quantitative and qualitative metrics retrieved from existing data sources to characterize the demographics, physical characteristics, or other properties of the Suffolk County geographic extent. However, the HIA did not involve any primary data collection efforts, such as water sampling, water quality testing, or administration of human health surveys. Data sources included the following:

- Esri Data and Maps
- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmospheric Administration (NOAA)
- National Flood Insurance Program
- New York State Department of Health
- New York State Department of Health Communicable Disease Electronic Surveillance System
- New York State Department of Environmental Conservation
- New York Department of Transportation
- New York State GIS Program Office (GPO)
- New York State Office of Emergency Management
- Suffolk County Community Health Assessment, 2014-2017
- Suffolk County Department of Economic Development and Planning
- Suffolk County Department of Health Services
- Suffolk County Department of Public Works, Division of Vector Control
- Suffolk County Office of Comptroller
- United States Department of Agriculture
- United States Geological Survey
- US Census Bureau, American Community Survey, 5-year estimates, 2008-2012
- US Census Bureau, National Decennial Census, 2010
- US EPA Enforcement and Compliance History Online (ECHO) database
- US EPA EJSCREEN
- US Fish and Wildlife National Wetlands Inventory

In all the above listed data sources, the Federal, State, and Local government agencies with statutory authority to collect these data were used. Federal data sets undergo extensive scrutiny and quality control measures prior to being posted for public distribution. CSS-Dynamac/Pegasus Technical Services, contractor to EPA, verified that data from federal sources were satisfactory for use according to “A Summary of General Assessment Factors for Evaluating the Quality of Scientific and Technical Information” (EPA, 2003) and determined federal data sources satisfy the five assessment criteria in the following ways:

1. *Soundness*
    a. The data are reasonable and consistent with the design of the intended application.
    b. The data sets are based on sound scientific, statistical, or econometric principles.
2. *Applicability and Utility*
    a. The data sets’ purpose, design, outcome measures and results are relevant to EPA’s intended use of the analysis.

   b. The domains (e.g., duration, species, exposure) of the data, models, or results are valid and useful to EPA's application.
3. *Clarity and Completeness*
   a. The documentation clearly and completely describe the underlying scientific, statistical, or economic theory and the statistical and analytic methods used.
   b. The complete data sets are accessible, including metadata, data-dictionaries and embedded definitions.
4. *Uncertainty and Variability*
   a. Appropriate statistical techniques have been employed to evaluate variability and uncertainty.
   b. The studies or data sets identified potential uncertainties such as those due to inherent variability in environmental and exposure-related parameters or possible measurement errors.
5. *Evaluation and Review*
   a. There have been independent verification or validation of the data sets and results.
   b. The procedures, methods, or models have been used in similar, peer reviewed studies.

Although state and local data sets do not necessarily have the same standards as data collected by federal agencies, the data used from New York State and Suffolk County come from the government agency with the statutory authority to collect these data and, to our knowledge, are the only data of their kind. For details on how the HIA Research Team managed data regarding the presence, age, and design of individual sewerage systems (ISS) in Suffolk County, see section 'Methodology for Estimating Residences Affected, Persons Affected, and Total Nitrogen Loading' below.

In addition, the HIA Project team evaluated data sets from State and local sources for the assessment criteria described above on an as-needed basis. Table G1 was used to evaluate whether the data could be used without additional qualification.

Table G1. Criteria to evaluate State and Local data sources for use in Suffolk County HIA analyses

Criteria	**Data Relevance**	**Geography**	**Timeframe**
Good	Data directly represent needed information, such as pollution concentration measurements to assess pollution levels.	Data directly represent the geographic area of interest with representative coverage.	Data coincide with timeframe of interest and have appropriate temporal resolution. (within 5 years)
Adequate	Data are related to needed information but not a direct representation, such as age of homes to indicate type of	Data can be used to garner information of the area of interest but with limitations, such as zip code data applied to	Timeframes do not necessarily coincide but are close enough (within 10

	ISS in use to manage wastewater.	neighborhoods. Must cover 50% of area of interest	years) in time to provide relevant information.
Deficient	Data have no association to needed information.	Data are too far removed geographically from area of interest to be relevant.	Data represent a timeframe that is too old to be representative or do not have adequate resolution. (>10 years)

Generally, only Good or Adequate data were used; however, if only Deficient data could be found, the data and interpretation were sufficiently qualified in the HIA Report using the clearly identified symbols along with descriptions of the caveat:

C Context Clue – indicates information unique to Suffolk County and/or extenuating circumstances (e.g., effect of sea level rise, climate change, and soil erosion)

L Limitation – indicates assumptions made and/or limits of data and/or analysis

METHODOLOGY FOR ESTIMATING RESIDENCES AFFECTED, PERSONS AFFECTED, AND TOTAL NITROGEN LOADING

Residences Affected

At the time of this analysis, Suffolk County did not have the known presence, age nor design of individual sewerage systems. Some towns and hamlets tracked this information, but not consistently. To overcome this challenge, the HIA Research Team used parcel shapefiles from the Suffolk County Real Property Tax Agency Service and overlaid them with the best available data from the U.S. Census Bureau, U.S. Geological Survey (USGS), National Oceanic and Atmospheric Association (NOAA), Suffolk County Government (and others) using GIS-based methods. This approach is consistent with the approach used in other studies performed in Suffolk County, including Kinney & Valiela (2011) and Lloyd (2014).

Residential parcel boundaries that were not contained within or did not intersect sewered areas were examined for their geographic proximity to high priority areas; impaired waters; Sea, Lake and Overland Surges from Hurricanes (SLOSH) zones; sewage treatment plants; flood-prone and/or high groundwater areas; and waterfronts.

Tax Parcel Data

Information on building structure age, sewage connection, or sewerage service type was not included in the tax parcel data obtained from the Suffolk County Real Property Tax Agency Service; only the parcel outlines and land use classification codes. We assumed that residential properties were classified using the New York State Office of Real Property Services classification codes (https://www.tax.ny.gov/research/property/assess/manuals/prclas.htm). We selected all parcels with classification codes of 200 (residential) except for 220 (Two-family, Year-round Residential), 230 (Three-family, Year-round Residential), and 242 (Recreational, n = 1). We then added Vacant Residential (classification codes 310; 311), Vacant Residential with Small Improvement (code 312), Subdivided land (code 317), and code 318 (n = 18), which, based on a visual inspection, appeared to contain residential properties. **Our final count of single-family residential parcels was 488,375.**

Note: The total number of residential parcels was slightly different (0.3% difference) than Suffolk County's estimated 487,082 residential parcels smaller than or equal to one half acre (Suffolk County Government, 2015a). The selection of codes and/or variations in the GIS techniques may account for this difference. There were some classification codes in the parcel data that did not match a value in the NYS classification system, but the data set did not include metadata to explain such variations. We assumed that the non-matching numbers belonged to the matching hundreds place category (e.g., 213 does not match a subdivision, but since it is 2##, it is a residential lot).

Sewered Polygons and Unsewered Parcels

The sewered area polygons and point locations of sewage treatment plants were obtained from the Suffolk County GIS Portal (https://gisportal.suffolkcountyny.gov/gis/home/). The sewered area data were made up of six separate files. We merged the files into one coverage to designate areas that are sewered. In order to identify the unsewered areas we started with the residential parcels and then removed the parcel polygons intersecting or contained within the sewered area polygons (Figure 1). **Our final count of unsewered, single-family residential parcels was 385,117 (Table G2).**

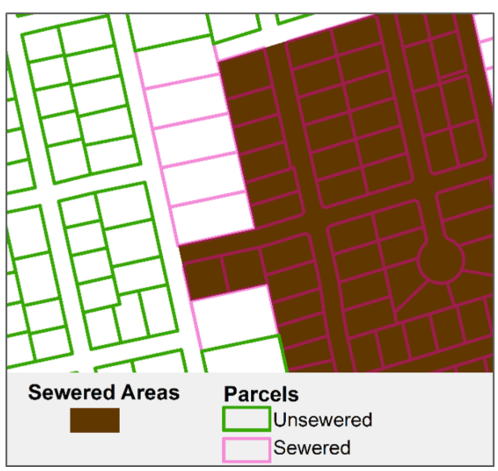

Figure 1. Parcel polygons overlaid with sewered polygons.

Note: The total number of unsewered, single-family residences was slightly different (7.0% change) than Suffolk County's estimated 360,000 parcels (Suffolk County Government, 2015a). The selection of codes and/or variations in the GIS techniques may account for this difference. This approach assumes parcels not intersecting or contained within sewered areas are unsewered and does not distinguish "unsewered parcels" further into individual or cluster wastewater systems. It is also important to consider that only single-family residences were included in the analyses, which does not address multifamily and commercial parcels with onsite wastewater systems (i.e., underestimates number of OSDS present in Suffolk County).

High Priority Areas

The high priority area data were defined in the Suffolk County Comprehensive Water Resources Management Plan (Suffolk County Government, 2015a). The data were created or obtained from the following sources: 1) 0–25 year baseflow contributing areas to surface waters, provided by Suffolk County, 2) the 0–50 year estimated groundwater travel time to public water supply wells, digitized from Suffolk County (2015a) ; and 3) land with <10-feet depth to groundwater downloaded from USGS Hydrologic Conditions Maps for Long Island, NY, 2010; and 4) parcels in SLOSH zones, which were downloaded from the State of New York and needed no pre-processing. We selected unsewered polygons intersecting and within high priority areas and tallied the numbers. Table G2 lists the counts for the unsewered residential parcels intersecting and within high priority areas. Suffolk County's Department of Economic Development and Planning (SCDEDP) estimates from Suffolk County (2015a) are included for reference. The counts of parcel polygons within the high priority areas were closer to Suffolk County's numbers, so the HIA Research Team decided to use those numbers going forward, but it should be noted that this may be underestimating the number of residential parcels affected. **Our final count of unsewered, single-family residential parcels in high priority areas is 251,502 (Table G2).**

Table G2. Counting of Unsewered, Single-family Parcels in High Priority Areas

Unsewered, Single-family Residential Parcels	*Suffolk County Estimate*[*]	*HIA Estimate*	Difference |n|	Percent Difference
None (Total Unsewered Parcels)[†]	360,000	385,117	25,117	6.7%
High Priority Areas				
0-25 Year Baseflow Contributing Areas to Surface Waters	155,939	201,200[‡]	45,261	25.3%
		183,850[§]	27,911	16.4%
0-50 Year Estimated Groundwater Travel Time to Public Water Supply Wells	55,169	73,698[‡]	18,529	28.8%
		62,497[§]	7,328	12.5%
≤ 10 Feet Depth to Groundwater	38,143	71,397[‡]	33,254	60.7%
		31,743[§]	6,400	18.3%
≤ 10 Feet Depth to Groundwater[‡] AND EITHER 0-25 Year Baseflow Contributing Areas to Surface Waters OR 0-50 Year Estimated Groundwater Travel Time to Public Water Supply Wells	30,250	60,455[‡]	30,205	66.6%
		24,938[§]	5,312	19.3%
Total unsewered parcels in high priority areas 0-25 feet baseflow contributing areas to surface waters OR 0-50 year estimated groundwater travel time to public water supply wells OR ≤ 10 feet to Groundwater OR in SLOSH zones.	209,000[‖]	282,477[‡]	73,477	29.9%
		251,502[§]	42,502	18.5%

* Source: (Suffolk County Government, 2015a)

[†] SCDEDP total residential parcels: 487,082. HIA calculation: 488,375 parcels

[‡] Polygon Intersect, [§] Polygon Within

[‖] Does not include unsewered parcels in SLOSH zones, but instead "unsewered parcels with densities greater than what is permitted in Article 6 of the Suffolk County Sanitary Code."

<u>Older (pre-1973) Systems versus Newer (post-1973) Systems</u>

Prior to 1973, individual sewerage systems for single-family homes in Suffolk County consisted of a cesspool without a septic tank (i.e., an OSDS), but in 1973, that requirement changed to require both a septic tank and leaching pool (i.e., a conventional onsite wastewater treatment system). As discussed above, the data are limited such that identifying where older systems (i.e., cesspool-only) are located within Suffolk County cannot be determined. To overcome this challenge, the HIA Research Team used existing data from national and local surveys to estimate what percent of the existing unsewered, single family residential parcels are likely to be served by cesspools alone. Considering existing Suffolk County policies allow for structures built prior to 1973 to be replaced in-kind, it can be assumed that a large percentage of housing structures built prior to 1970 are likely to still be served by OSDS (i.e., cesspools only). Suffolk County Department of Economic Development and Planning (SCDEDP) estimates that 252,530 of the unsewered parcels pre-date the requirement for a septic tank, using 1970 Census data (Suffolk County Government, 2015a). The HIA Research Team used the 2008-2012 American Community

Survey 5-year estimates in analysis, which show that approximately 53.9% of the 568,570 total housing units in Suffolk County at that time (n= 315,602) were built before 1970. This is consistent with estimates of percent OSDS used in other studies performed in Suffolk County, including Stinnette (2014), Lloyd (2014), and Gobler (2016). The nitrogen load modeling conducted for 43 subwatersheds in the Peconic Estuary (Lloyd S. , 2014) "assumed that any unsewered residence constructed before 1973 has its waste handled by a cesspool rather than a septic system because residences constructed after 1973 are required by the County to install septic systems. This year-built information, unfortunately, was only consistently tracked by the Town of Southampton in the parcel data, and so this cesspool rate (53%) estimate was applied across the study area." The nitrogen loading study of the South Shore, Eastern Bays by Stinnette (2014) and Gobler (2016) noted that a large portion (nearly 50%) of the homes in the study area had cesspools. Based on the data available, **a reasonable estimate** for the number of existing, individual sewerage systems that preclude (and therefore do not conform to) the 1973 standards, would be **at least 50% of unsewered, single-family residential parcels**. To calculate the number of unsewered, single family residential parcels assumed to be served by OSDS alone in total and in high priority areas only, the total number of unsewered, single-family residential parcels and the final count of unsewered, single-family residential parcels in high priority areas, were halved, respectively (Table G3).

Persons Affected

According to the U.S. Census Bureau 2010 Census summary file, the total population in Suffolk County in 2010 was 1,493,350 and the average household size was 2.93 persons. To calculate the number of persons affected, it was assumed that one single-family residential parcel contained one household (Table G3).

Table G3. Number of Single-family Residential Parcels and Persons Affected

HIA Counts	Total	Persons Affected*	50% of Total (Assumed to have a cesspool)	Persons Affected*
Unsewered, Single-family Residential Parcels	385,117 (Baseline)	1,128,392.81	**192,558 (Alternative I)**	564,194.94
Unsewered, Single-family Residential Parcels in High Priority Areas	**251,502 (Alternative III)**	736,900.86	**125,751 (Alternative II)**	368,450.43

*Average no. persons per household = 2.93; assumed that one single family residential parcel contained one household

Note: The HIA Research Team applied GIS techniques to help get a better understanding of where the older residences may be. Figure 2 maps the Census block groups ranked by a) the number of housing units built before 1970, b) the number of housing units that are single-family, and c) those two indicators grouped by quartiles and shown relative to the location of high priority areas in Suffolk

County. The areas highlighted in pink in Figure 2 are the most likely to have many residences that are both single-family and older homes (built before 1970); thus, they are also more likely to have a high proportion of residences served by OSDS. As shown in the map, the majority of Census block groups that are more likely to have a high proportion of single-family residences served by OSDS are also located in high priority areas.

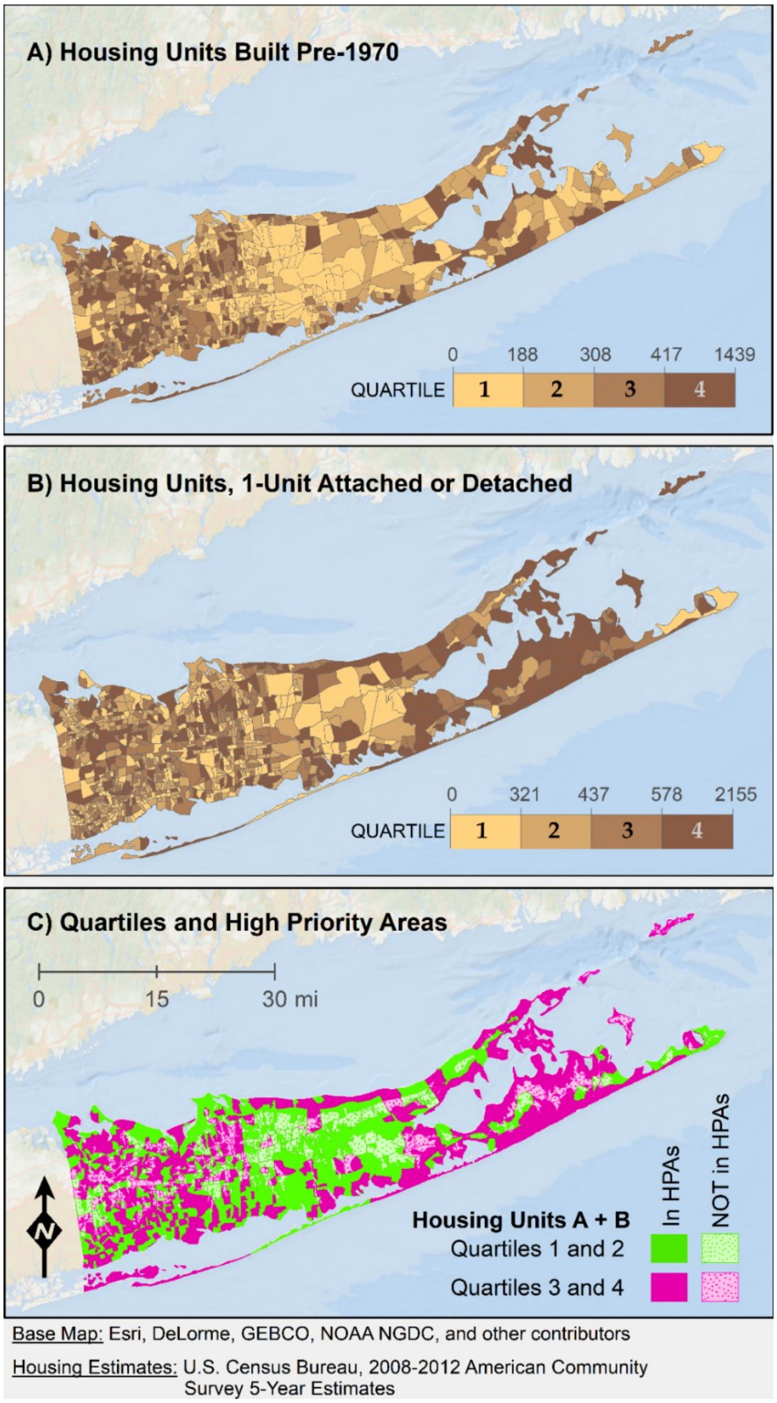

Figure 2. Census block groups ranked by a) number of housing units built before 1970 and b) number of housing units that are single-family, and c) a compilation of those two indicators relative to the location of high priority areas (HPAs) in Suffolk County.

Nitrogen Loadings from Individual Sewerage Systems (at the edge of the system)

An OWTS Nitrogen Reduction Technology Expert Review Panel (Adler, et al., 2013) was charged with reviewing the available science on pollutant removal performance of various individual onsite wastewater treatment practices and providing concise definitions and percent reductions for nitrogen loading for those practices. Based on their review, Adler et al. (2013) recommended using the minimum, average mass loadings of total nitrogen (TN) of 5 kg TN per person per year (or 11 lbs per person per year) the minimum, average TN concentration in effluent from an OWTS (60 mg/L), assuming an average flow of 60 gallons per person per day[1], for septic tank effluent.

[60 mg TN/L] X [60 gal/person/day] X [365 days/yr] X [1 L/0.264172 gal] X
[1 kg/1,000,000 mg] = 4.974 kg TN/person/year ~ 5 kg TN/person/yr

We assume, as Adler et al. (2013) also recommended, that TN concentrations in septic tank effluent is equivalent to TN concentrations in untreated wastewater (i.e., no TN reduction in septic tank effluent from incoming wastewater), and that no attenuation occurs from the house to the edge of the cesspool/leaching pool (i.e., the point of discharge from the system)[2].

Nitrogen loading from an individual cesspool or conventional OWTS

If the average TN load going to the disposal unit is 5 kg (11 lbs) TN per person per year, at an average 2.93 persons per residence in Suffolk County (U.S. Census Bureau, 2010), **TN loading to the environment from an individual cesspool or conventional OWTS would be 14.65 kg (32.30 lbs) TN per year**, assuming no TN reduction in septic tank effluent from incoming wastewater.

TN mass loading from an individual cesspool or conventional OWTS:

[1 unsewered, single-family residence] X [2.93 persons/household] X [5 kg TN/person/yr] =
14.65 kg TN/residence/yr

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[1] The Suffolk County Stormwater Management Program claims typical flow rates of 55-75 gallons per person per day (Suffolk County Government, 2013c); therefore, the 60 gallons per person per day used by Adler et al. (2013) is reasonable to use in the HIA analysis.

[2] Note that the Nitrogen Loading Model used in several recent Long Island nitrogen loading studies assumes 4.8 or 4.82 kg TN per person per year and a 6% reduction in TN in septic tank effluent. The HIA uses the Adler et al. (2013) parameters in its analysis to be conservative and protective of public health.

Nitrogen loading from an individual innovative/alternative OWTS

If the upgraded, innovative/alternative OWTS achieve Suffolk County's requirement of 19 mg/L TN in effluent, at an average flow of 60 gallons per person per day per Adler et al. (2013), the resultant **TN loading from an individual I/A OWTS would be 4.63 kg (10.21 lbs) TN per year**.

TN mass loading from an individual innovative/alternative OWTS:

[19 mg TN/L] X [60 gal/person/day] X [365 days/yr] X [1 L/0.264172 gal] X [1 kg/1,000,000 mg] = 1.58 kg TN/person/year

[1 unsewered, single-family residence] X [2.93 persons/household] X [1.58 kg TN/person/yr] = 4.63 kg TN/residence/yr

Nitrogen loading from individual sewerage systems across Suffolk County

Table G4 provides the cumulative TN loading from individual sewerage systems in Suffolk County under the baseline and three alternatives, using the number of single-family residential parcels affected by each decision scenario, as calculated previously. Note that Alternative I and II assume the same TN nitrogen loading as the baseline, because nitrogen levels in septic tank effluent are assumed to be equivalent to levels of untreated wastewater (i.e., no attenuation or treatment occurs from the house to the edge or point of discharge from the cesspool/leaching pool).

Table G4. Cumulative TN Loading from Individual Sewerage Systems in Suffolk County

Decision Scenario	Number of Unsewered, Single-family Residential Parcels	Total Nitrogen Loading (kg TN/year)*	Difference in Total Nitrogen Loading from Baseline (kg TN/year)
Baseline	385,117	5,641,964.05‡	---
Alternative I	192,558	5,641,964.05‡	0
Alternative II	125,751†	5,641,964.05‡	0
Alternative III	251,502†	3,121,763.11§	(2,520,200.94)

* Average no. persons per household = 2.93, Average flow of 60 gallons/person/day

† In high priority areas

‡ Average TN Mass Loading = 5 kg TN/person/yr, assuming 60 mg TN/L in system effluent

§ Average TN Mass Loading = 1.58 kg TN/person/yr, assuming 19 mg TN/L in system effluent

Baseline:

[385,117 parcels] X [2.93 persons/household] X [5 kg TN/person/yr] = 5,641,964.05 kg TN/yr

Alternative I:

[192,558 parcels] X [2.93 persons/household] X [5 kg TN/person/yr] = 2,820,974.70 kg TN/yr

[385,117 – 192,558 parcels] X [2.93 persons/household] X [5 kg TN/person/yr] = 2,820,989.35 kg TN/yr

2,820,974.70 kg TN/yr + 2,820,989.35 kg TN/yr = 5,641,964.05 kg TN/yr

Alternative II:

[125,751 parcels] X [2.93 persons/household] X [5 kg TN/person/yr] = 1,842,252.15 kg TN/yr

[385,117 – 125,751 parcels] X [2.93 persons/household] X [5 kg TN/person/yr] = 3,799711.90 kg TN/yr

1,842,252.15 kg TN/yr + 3,799711.90 kg TN/yr = 5,641,964.05 kg TN/yr

Alternative III:

[251,502 parcels] X [2.93 persons/household] X [1.58 kg TN/person/yr] = 1,164,303.36 kg TN/yr

[385,117 – 251,502 parcels] X [2.93 persons/household] X [5 kg TN/person/yr] = 1,957,459.75 kg TN/yr

1,164,303.36 kg TN/yr + 1,957,459.75 kg TN/yr = 3,121,763.11 kg TN/yr

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Appendix H: Resiliency Pathway Supporting Materials

H.1 Suffolk County Wetland Restoration Efforts

The Cornell Cooperative Extension of Suffolk County has implemented an eelgrass program, with funding from various partners, aimed at restoring eelgrass along Long Island (Cornell University Cooperative Extension of Suffolk County, 2009). There have also been efforts made to restore salt marshes in Suffolk County by the USFWS and others as part of Hurricane Sandy recovery and resiliency efforts (e.g., Lido Beach and Wertheim National Wildlife Refuge; USFWS (2016a), and in 2015, Suffolk County undertook efforts to restore 500 acres of tidal wetlands (Brank, 2015). A USFWS inventory of wetland restoration sites on Long Island (Tiner & Herman, 2015) found 12,543 acres of impaired Suffolk County wetlands that may be able to be repaired to bring back lost or reduced function. Table 1 shows the acreage of freshwater and estuarine (e.g., tidal) wetland sites in Suffolk County that could potentially be restored to regain wetland function. Impairments included wetlands that were tidally restricted (i.e., where tidal flow is restricted by roads, undersized culverts, tide gates, and other structures), partly drained (ditched), excavated, impounded (diked), or farmed (i.e., partly drained for agriculture, but still wet enough to be considered a wetland). As the table shows, the vast majority of these wetlands (almost 9,664 acres) are partly drained (ditched) estuarine wetlands. A 2004 study conducted by the USFWS in the Wertheim National Wildlife Refuge (Suffolk County, NY) showed that grid ditched marshes that were restored to re-establish tidal flow and eliminate invasive plant species flourished, not only regaining absorption and habitat functioning, but also resulted in a 70% reduction in mosquito spraying when compared to remaining grid ditched marshes in the refuge (Leuzzi, 2015). By restoring the natural hydrology and plant communities of these grid-ditched salt marshes and implementing integrated marsh management techniques for mosquito control (see Vector Control section), Suffolk County can regain function in a large number of wetlands.

Table H1. Acreage of Potential Wetland Restoration Sites in Suffolk County, NY

Type of Restoration Site	Suffolk County (acres)
Estuarine Excavated	2.2
Estuarine Impounded	4.6
Estuarine Partly Drained	9,663.6
Farmed	19.3
Freshwater Excavated	429.2
Freshwater Impounded	1,163.9
Freshwater Partly Drained	405.6
Estuarine Tidally Restricted	583.3
Freshwater Tidally Restricted	271.2
Total	*12,542.9*

H.2 FEMA Flood Hazards and the National Flood Insurance Program

As part of the National Flood Insurance Program (NFIP), the Federal Emergency Management Agency (FEMA) has designated flood zones based on the probability of areas being inundated by flooding of different magnitudes in a given year; flood insurance rates and regulations are then based on these mapped zones. If a structure is in a Special Flood Hazard Area (i.e., a high-risk zone), the structure must be insured against flooding and any new construction or structural renovations have to meet certain regulations and building codes (FEMA, 2017). Special Flood Hazard Area (SFHA) Zones A and V (Figure 1) are areas that have a 1% annual chance of being flooded and a 26% chance of being flooded over the life of a 30-year mortgage by what is considered a “100-year flood” (base flood); Zone V takes into account not only the flooding hazard, but also the additional hazard of storm waves (Manning, Carnevale, & Rubinoff, 2014; FEMA, 2017). Some FEMA flood insurance rate maps (FIRM) will also show a Limit of Moderate Wave Action (LiMWA), where breaking waves 1.5 feet in height are expected from the 100-year flood, as these breaking waves have the potential to cause foundation failure (FEMA, 2016). It should be understood that the “100-year flood” is not a flood that occurs every 100 years; it is the flood that has a one-percent chance of being equaled or exceeded each year. As FEMA (2016) notes, flooding doesn’t only occur in these high risk zones, however; people in low to moderate risk zones (Zone X) are responsible for filing over 20% of the claims and receive a third of disaster assistance for flooding through the NFIP.

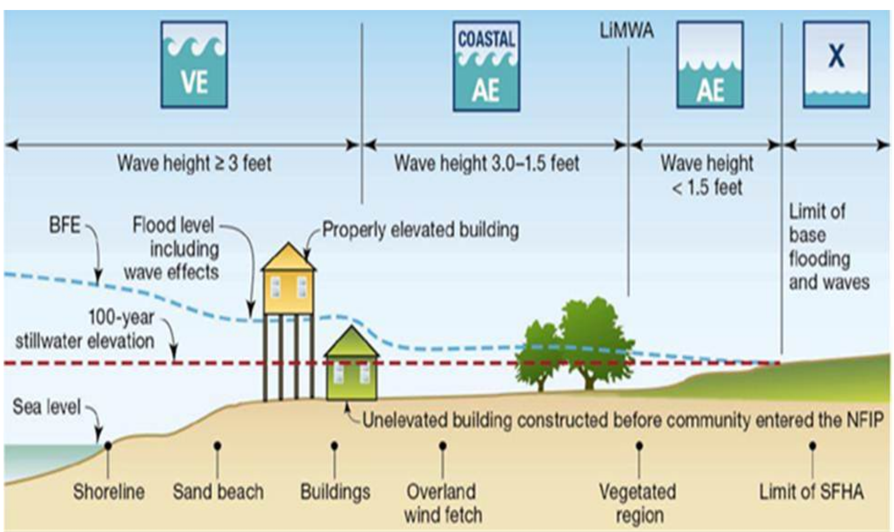

Figure 1. Schematic of FEMA Flood Hazard Zones used in determining coastal flood risk. Taken from (FEMA, 2016).

H.3 Suffolk County Emergency Management

Forecasts from the National Weather Service and National Hurricane Center, and in the case of storm surges, the SLOSH Zone maps and HURREVAC software, are used in emergency planning to determine the need and routes for evacuation, identify where shelters should be located, and where resources should be staged in preparation for the storm. Suffolk County also provides the SLOSH Zone maps in an interactive mapping feature on the County's website to help build awareness and provide the general public the information needed to determine if they are in a storm surge zone and if evacuations orders are given, what shelters are nearby (Suffolk County Government, 2016b).

In the event of an emergency, the Suffolk County Office of Emergency Management communicates information and instructions, including evacuation notices, via several outlets including radio, television, the CodeRED Emergency Notification System, the Suffolk County's Public Information for Emergency Events website, and the Suffolk County Department of Fire Rescue and Emergency Services Facebook and Twitter pages (Suffolk County Government, 2016c). The CodeRED Emergency Notification System is a high-speed, mass notification service that allows emergency notifications to go out to residents and businesses by telephone, cell phone, text message, email, and social media (Suffolk County Government, 2016d). The notification system uses information available in public databases, but individuals in Suffolk County are encouraged to enroll online or by calling the Suffolk County Office of Emergency Management to ensure their contact information is in the system (Suffolk County Government, 2016d).

Evacuation routes are established by the Suffolk County Office of Emergency Management and posted on the county website. As Figure 4-42 showed, some of the major evacuation routes along the coast are actually located in designated SLOSH zones, exposing them to flooding, surges, and erosion. As discussed previously, any of these coastal hazards can make roads impassable, causing issues during evacuation and hampering emergency response actions. It is also important to note that officials in Suffolk and Nassau Counties acknowledge that due to the population of Long Island and the limited east-west roadways on the island, it would be impossible to evacuate the entire island should there be an extreme, large-scale event that warranted it (Von Zielbauer, 2005).

It is important for public health and safety that individuals are prepared for emergencies and heed evacuation notices. As the CDC (2013b) notes, a successful evacuation depends on the timely and effective communication of evacuation orders, on affected individuals receiving the evacuation order, and on those individuals having the capacity, resources and willingness to evacuate. When Hurricane Sandy hit in 2012, advanced notice and mandatory evacuations were ordered for New York City's Evacuation Zone A based on storm surge predictions. Yet 45% of the drowning deaths in New York related to Sandy occurred in flooded homes in Evacuation Zone A (CDC, 2013b). These deaths were all preventable. Given the inability and/or unwillingness of some individuals to evacuate, more research is needed to identify barriers, motivators, and effective interventions to prevent senseless surge-related injury and death.

H.4 Suffolk County Emergency Response Capacity

In the early stages of response, it is important for emergency response mobilization to be made based on the best available information, but sometimes even with the best planning, emergency response actions can be slowed and even thwarted by road and infrastructure flooding and damage, downed trees, and more, leaving emergency response routes impassable and residents stranded.

Figure 2 shows how emergency preparedness and the initial emergency response actions (rescue and relief) fit into the emergency management cycle. Following rescue and relief efforts, emergency response transitions to recovery and reconstruction. During this phase of the process, efforts are aimed at restoring the affected areas physically, economically, and socially to pre-emergency conditions, taking into account potential mitigation measures in reconstruction to reduce the vulnerability of the area to emergency events and/or the potential damage caused by those events (Colten, Kates and Laska 2008). In storm and/or tidal surge and flooding events, recovery efforts may include risk communication; disease control (e.g., ensuring a safe food and potable water supply, sewage treatment, and vector control); restoration of services such as electricity, water, and phones; cleanup of debris; rebuilding of roads, buildings, and key infrastructure; reuniting separated family members; financial assistance to individuals and the community; care of displaced individuals, animals, and businesses; facilitating the permanent return of residents; and addressing the long-term needs of affected individuals (Colten, Kates, & Laska, 2008; Miami-Dade Government, 2014).

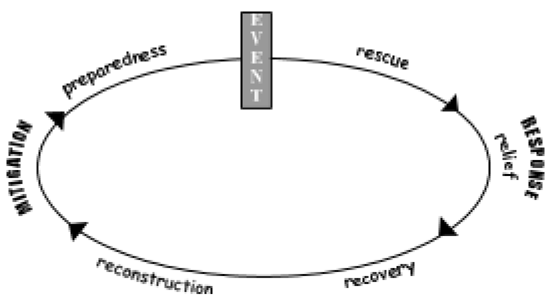

Figure 2. Phases of emergency management. Taken from: (Cutter 2003).

In December 2015, Ed Schneyer, Director of Emergency Preparedness in Suffolk County, outlined the County's emergency response capacity and infrastructure (Personal communication). Suffolk County's emergency response services and infrastructure at that time included:

- Suffolk County Government
- 10 Townships
- 33 Villages
- 23 Police Departments, with 3,800 sworn officers
- 109 Fire Departments and 27 EMS Companies, with 11,000 Fire/EMS personnel
- 12 Hospitals, with 3,200 beds / 160 intensive care unit (ICU) beds

- 141 Evacuation Shelters
- Community Emergency Response Team (CERT), with 500 members
- Auxiliary Police, with 150 members
- Medical Reserve Corp, with 200 members
- Community-based volunteer organizations (approximately 200 faith-based organizations, non-governmental organizations, and private non-for-profits) coordinated through the Long Island Health and Welfare Council and the Long Island Voluntary Organization Active in Disaster (LIVOAD)

The County also has a 42-ft Major Emergency Response Vehicle that is designed to support long-term emergency incidents, provide mass casualty response and transport, medical evacuations, triage, and firefighter and EMS rehabilitation and medical support ; and access to similar vehicles operated by Nassau County, New York City, and others, as part of an Urban Area Securities Initiative agreement.

In Suffolk County, the CERT program trains citizens to provide for the well-being and safety of themselves and those around them until the professional responders arrive. The SLOSH maps and HURREVAC software allows emergency managers to determine where emergency response efforts and resources need to be focused to minimize impacts to human life. During Sandy, Suffolk County emergency response personnel rescued 250 people from flooded homes and evacuated two major hospitals and several adult homes.

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Appendix I: Federal Funding Opportunities to Support Implementation of Proposed Code Changes.[68]

The Federal Government provides funding to local municipalities through many avenues. Funding may flow directly from the federal government to an individual household or to federally supported State Revolving Funds managed by state governments. Suffolk County has a dual responsibility to pursue federal funding to support these new regulations and facilitate the towns and citizens of the County in their effort to seek funding directly. This is an additional capacity need for the County. Potential Sources for funding support include:

- Section 319 Nonpoint Source Management Program: EPA provides guidance and grants for states, tribes and territories to implement their approved nonpoint source management programs. Activities supported by the grants include technical assistance, financial assistance, education, training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects. The New York State Department of Environmental Conservation (NYSDEC) manages and implements the EPA Nonpoint Source Section 319 Grant through a Performance Partnership Grant Agreement (NYSDEC, n.d.-b; NYSDEC, 2013). All of this nonpoint source funding passes from the federal level to the state who distributes it to eligible applicants, which include state, local and inter-municipal agencies, academic institutions, and the private sector.
- Clean Water State Revolving Fund (CWSRF): EPA sponsored funding to support a wide range of water infrastructure projects. EPA provides grants to capitalize state CWSRF loan programs, and the states provide an additional 20% in matching funds and manage the CWSRF loan programs in their states. Onsite wastewater treatment systems are just one example of the projects eligible for funding. New York has had a CWSRF since 1990. In July 2016, the New York State DEC and the Environmental Facilities Corporation (EFC) published the Clean Water State Revolving Fund Federal Fiscal Year 2017 Draft Intended Use Plan, and it includes 46 projects for Suffolk County. These projects include those focused on sanitary sewer and sewage treatment projects and range from $900,000 to $136 million.
- The US Department of Housing and Urban Development, the Federal Housing Administration and the USDA Rural Development Program[69] provide low cost financing for both multi-family and single family homes to address health or safety concerns in their homes (Executive Office of Energy and Environmental Affairs, 2016). Individual households in Suffolk County may apply directly for funding to support OWTS or I/A OWTS installation. Suffolk County Department of Health Services may consider implementing a program to help households apply for this funding.

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[68] See Appendix K for federal, state, and local funding sources secured following completion of the HIA analysis to support implementation of cesspool and septic system upgrades.

[69] Note that only a small portion of northwestern Suffolk County (e.g., Mattituck, Southold, Greenport, Shelter Island) meets the USDA Rural Development Program criteria for “rural” property and grants and loans through this program have strict income limits.

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Appendix J: Case Studies: Rhode Island and Maryland Onsite Sewage Disposal System Replacement Programs

J.1 Rhode Island Cesspool Act of 2007 and Amended Act of 2015

Regulation

According to the Rhode Island Department of Environmental Management, Office of Water Resources, the Rhode Island Cesspool Act of 2007 mandated that all cesspools would have to be replaced upon this schedule:

1. Cesspool must be removed from service within one year of the closing date.
2. If the cesspool has failed an inspection, it has to be replaced within a year of the failure, or more quickly if it poses an imminent threat to public health.
3. If the property is a non-residential facility or multifamily dwelling, then the cesspool should be replaced following current DEM and EPA regulations.
4. Replacement is required by January 1, 2014 if the cesspool falls under the following conditions:
   - Within 200 feet of an inland edge of all shoreline features bordering tidal water areas (i.e., Coastal Resources Management Council's jurisdiction);
   - Within 200 feet of all public wells; or
   - Within 200 feet of a water body with an intake for a drinking water supply. (Rhode Island Department of Environmental Management, 2015)

On July 09, 2015, the Act was amended, increasing the impact of the 2007 Cesspool Act by mandating that beginning January 01, 2016, all purchasers of property in RI must replace the cesspool with a septic system within one year of the purchase date, whether or not it was a failed cesspool system (Rhode Island General Assembly, 2015). The updated bill also applied to all property owners in the event of a failed inspection and cited an estimate of 25,000 cesspools that still needed to be replaced as of 2013, half of the amount estimated in 2006. The amended bill added detail regarding which households are eligible for a waiver of the requirement because of undue hardship, which is defined as "having an annual income of less than or equal to eighty percent of the appropriate household size area median income determined by federal Housing and Urban Development standards for the community within which the cesspool is located" as long as the cesspool has not failed (Rhode Island General Assembly, 2015).

In addition, the State of Rhode Island coupled this 2015 cesspool update requirement with an overall plan to increase the amount of households on a sewer system. Households in neighborhoods with a plan to be sewered are exempt from requirements to replace their septic system in the event of:

- The cesspool has not failed;
- The property will be sewered no later than January 1, 2020;

- The household will not expand its flow of wastewater by adding a bedroom, etc. prior to the installation of the sewers;
- The city or town has obtained bonding authorization for expansion of sewers to the area;
- The household provides certification that it will be connected to the sewer system within 6 months of receipt of notification to connect (Rhode Island Department of Environmental Management, 2015).

Financing

The RI Department of Natural Resources, Office of Water Resources estimated the average cost to replace a cesspool with a conventional septic system is approximately $10,000 - $15,000, noting that sites with small lots or in close proximity to wells or water bodies may affect the price and ability to install a conventional system. They also quoted the cost to tie into a sewer system at $2,000 to $4,000, which could include any required re-plumbing in the home.

In order to facilitate the removal and replacement of the cesspools, Rhode Island is providing 2% interest short term loans for eligible homeowners through the RI Infrastructure Bank, formerly known as the RI Clean Water Finance Agency (Rhode Island Department of Environmental Management, 2015). The RI Infrastructure Bank was founded in 1989 as a quasi-public agency to administer federal and state funding programs relating to municipal or community waste water and drinking water (Rhode Island Infrastructure Bank, 2016a). There are infrastructure banks in 31 states, including the state of New York. The Rhode Island Infrastructure Bank administers the Water Pollution Control and the Rhode Island Water Pollution Control Revolving Fund (RIWPCRF) loan funds sent to the state as part of Title VI of the Federal Clean Water Act (i.e., funds known as the Clean Water State Revolving Fund). The RIWPCRF is intended to finance water pollution abatement projects that do not qualify for the federal revolving fund program. These funds are also available for municipal projects. The Clean Water State Revolving Fund is made up of federal EPA funds and an irrevocable 20% commitment from the State of Rhode Island to match the fund (Rhode Island Infrastructure Bank, 2016a).

The Community Septic Service Loan Program (CSSLP) began in 1999 to provide funding for community member repair or replacement of failed septic systems and is administered by RI Infrastructure Bank (Rhode Island Housing, 2017a). The CSSLP program provides communities without wastewater treatment facilities the opportunity to access low-interest loans for the cost of repairing or replacing failing or substandard septic systems. In order for a community to be eligible, it must first complete an On-site Wastewater Management Plan, after which the community can negotiate for a loan with the RI Infrastructure Bank. Once RI Infrastructure Bank approves the community, residents can then apply for a low interest loan.

<u>Loan Terms for the Community Septic Service Loan Program (CSSLP)</u>

- No income limits for program participants
- Can be used for residential properties with up to 4 units
- One-time $300 origination fee to Rhode Island Housing and a 1% service fee on the outstanding loan balance that is split between Rhode Island Housing and Rhode Island Infrastructure Bank for servicing the loan
- Other program criteria vary somewhat from community to community. However, most programs cap loans at $25,000, require a debt-to-income ratio for borrowers of no more than 45% and allow non-owner occupants, as well as homeowners whose primary residence can benefit from CSSLP, to participate
- Funding can generally cover engineering costs, as well as system replacement costs
- Funding is released to the homeowner when Rhode Island Housing receives a Department of Environmental Management Certificate of Conformance after the work is completed
- Work must by a completed by a state-licensed installer (Rhode Island Housing, 2017a)

As of February 2017, the following communities participate in this program: Bristol, Charlestown, Coventry, Glocester, Hopkinton, Jamestown, Johnston, Narragansett, New Shoreham, North Kingston, Portsmouth, Scituate, South Kingstown, Tiverton, Warren, and Westerly (Rhode Island Housing, 2017a).

Rhode Island Housing, a public agency that generates its own funding through its loan services and reinvests its profits into its program of providing low-interest loans, grants, education, advocacy, and consumer counseling on real estate rental, buying, and selling, provided the following statistics for the CCSLP (Rhode Island Housing, 2017b). The RIH keeps track of the real estate market in Rhode Island and provides clear facts about the progress of these federal and state partnership loans.

- $13 million in loan funds provided to communities through the CSSLP since 1999
- 670 loans closed
- Average loan amount: $15,108
- Monthly Payment for a $15,000 loan with a 10-year term would be $131 (Rhode Island General Assembly, 2015)

Recently, the RI Infrastructure Bank implemented a new program, the Sewer Tie-In Loan Fund (STILF), to assist households who are able to join the municipal sewerage system. These loans are also available at 2% interest, with up to $10,000 to borrow for 5 years (Rhode Island Infrastructure Bank, 2016b). The Rhode Island Infrastructure Bank provides loans of up to $150,000 to sewer system owners who then provide the funds to individual homeowners. Participating Rhode Island communities include: Coventry, North Smithfield, Tiverton, and Warwick (Rhode Island Housing, 2017a).

<u>Loan Terms for the Sewer Tie-In Loan Fund Program</u>

- Maximum loan amount is $10,000, with a term of up to five years
- Most other loan terms are the same as the CSSLP
- Funding is released to the homeowner when Rhode Island Housing receives a DEM Certificate of Conformance after the work is completed
- Cost to properly abandon the existing septic system (pumping out its contents and filling it with sand) are also STILF-eligible (Rhode Island Housing, 2017a)

As of February 2017, the Rhode Island Housing website listed the following participation statistics for the Sewer Tie-In Loan Fund Program:

- 41 loans closed for a total of $146,970
- Average loan amount: $3,585
- Monthly payment for a $4,000 loan with a 5-year term would be $68 (Rhode Island Housing, 2017a).

J.2 The Bay Restoration (Septic) Fund Program Implementation Guidance for Fiscal Year 2017

Maryland has created a thorough implementation guide for their plan to update and replace their aging septic systems with the best available technology (BAT) to address nitrogen pollution. Using the Bay Restoration Fund, the Maryland Department of Environment has upgraded over 12,000 conventional septic systems by installing BAT or by connecting to a public sewer system. On November 24, 2016, Maryland Department of the Environment finalized the regulations regarding the implementation of BAT installation from a universal requirement to include an exemption for households outside of the Critical Area (within 1,000 feet of tidal waters). Installation of BAT for nitrogen removal would still be required for septic systems with a design flow of greater than 5,000 gallons per day and local governments would not be pre-empted.

The Bay Restoration Septic Fund was established in 2004 to provide grants for wastewater treatment facilities to reduce nitrogen pollution. The Bay Restoration Fund is managed by the Maryland Department of Environment Capital Program, “comprised of the Water Quality Revolving Loan Fund, the Drinking Water Revolving Loan Fund, the Bay Restoration Fund, the Biological Nutrient Removal Program, the Water Supply Financial Assistance Program, and a new program for fiscal 2017 – the Energy-Water Infrastructure Program” (Maryland Department of the Environment, 2016). The Maryland Water Quality Financing Administration (WQFA), part of the Maryland Department of the Environment (MDE) administers all of these programs. The table below is taken from the WQFA website and explains the purpose of each financial program (MDE Water Quality Financing Administration, 2016).

Table J1. Financial programs administered by the Maryland Department of Environment Water Quality Financing Administration (MDE Water Quality Financing Administration, 2016).

Financial Program	Purpose
Water Quality Revolving Loan Program (WQRLF)	Provides low-interest loans to local governments to finance wastewater treatment plant upgrades, nonpoint source projects, and other water quality and public health improvement projects.
Drinking Water Revolving Loan Program (DWRLF)	Provides low-interest loans to local governments to finance water supply improvements and upgrades.
Water Supply Assistance Grant Program	Helping communities meet their water supply needs.
Biological Nutrient Removal Cost -Share Grant Program	Upgrade of publicly-owned wastewater facilities with biological nutrient removal.
Bay Restoration Fund Wastewater Grant Program	• ENR upgrade at major or minor wastewater treatment plants. • Improvements to existing wastewater conveyance systems. (New) • Sewer extension to connect homes on septic systems to a BNR/ENR wastewater treatment plant. (New) • Nutrient-reducing BAT shared community septic systems. (New) • Storm water (MS4) projects by local governments with a system of charges. (New)
Bay Restoration Fund - Septic System Grant Program	Upgrades of existing septic systems to best available technology for nitrogen reduction to the Bay.
Linked Deposit Program	Water quality capital improvements

Following the 2002 State Executive Order 01.01.2002.24, Maryland established a policy to achieve the nutrient reductions necessary to restore the Chesapeake Bay and satisfy the requirements of the Chesapeake Bay 2000 Agreement. While initially these efforts were contained to wastewater treatment plants, in 2015, Senate Bill 133 extended use of the Bay Restoration Fund Wastewater fund to include combined sewer overflow abatement, rehabilitation of exciting sewer systems, and upgrading conveyance systems (Maryland Department of the Environment, n.d.-a). Beginning Fiscal Year 2018, once 67 significant wastewater treatment plants are updated with enhanced nutrient removal technology, the remaining funds will be allocated base on priority ranking of the following projects:

- Improvements to existing wastewater systems (e.g., combined sewer overflow [CSO]/sanitary sewer overflow [SSO] abatement and sewer rehabilitation);
- Sewer extensions to connect homes on septic [systems]s to a biological nutrient removal (BNR)/enhanced nutrient removal (ENR) wastewater treatment plant (WWTP);

- Nitrogen reduction using best available technology at shared community septic systems; and Storm water (MS4) projects undertaken by local governments with a system of charges (Maryland Department of the Environment, n.d.-a).

The Bay Restoration (Septic) Fund Program Implementation Guidance for Fiscal Year 2017 outlines how funding on septic systems will be executed. This seven-page document outlines the following: Prioritization (of grant recipients); Income Based Grant Eligibility; Eligible Projects for Bay Restoration Fund (Septic) Fund Grant Funding; Options for Connecting to Wastewater Treatment Plant; MDE Approved best available technology (BAT) for Nitrogen Removal; and Grant Recipient BAT Selection, Procurement, and Price (Maryland Department of Environment, n.d.-b). The plan could be seen as a model for Suffolk County implementation, as the state has a similar number of unsewered households, 421,766 in the entire state of Maryland versus 385,117 in Suffolk County.

Applications for financial assistance are prioritized based on the following:

1. Failing OSDS in the Critical Areas
2. Failing OSDS outside the Critical Areas
3. Non-Conforming OSDS in the Critical Areas
4. Non-conforming OSDS outside the Critical Areas
5. Other OSDS in the Critical Areas, including new construction
6. Other OSDS outside the Critical Areas, including new construction (Maryland Department of the Environment, 2017)

The Fund provides details on what type of assistance, loans or grants, and the eligibility requirements of grant assistance. If a household earns less than $300,000 a year, they are eligible for a grant up to 100% of the cost, while a household with over $300,000 income a year may be eligible for up to 50% of the cost. Households may use the funding for the cost to upgrade an existing conventional septic system with the installation of the BAT for nitrogen removal; or for the cost differential between installing a new onsite disposal system (OSDS) and one that includes the BAT (Maryland Department of the Environment, 2017)

The Implementation Guidance also outlines special assistance opportunities for low-income households including eligibility for a 50% grant to cover the annual operations and maintenance costs beyond the initial 5 years' operations and maintenance covered at the time of BAT installation.

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Appendix K: Activities that Have Occurred in Suffolk County Since the HIA Analysis was Complete

This appendix summarizes the actions that have been taken in Suffolk County to change the nutrient paradigm, since the completion of the HIA analysis and communication of preliminary findings and recommendations in fall of 2016. Information was taken from Suffolk County communications or their Reclaim Our Water website (http://www.reclaimourwater.info/), unless otherwise noted.

K.1 Sanitary Code, Standards, Policy, and Guidance

In the fall of 2016 (after the completion of the HIA analysis and communication of the preliminary HIA findings and recommendations), a work group was formed, consisting of County legislators and staff, staff from various towns/villages, non-governmental organizations, and the public, to begin the process of developing amendments to Article 6 of the Suffolk County Sanitary Code. Article 6 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) and divisions of land.

Residential Standards for Construction of Sewage Disposal Systems

On December 29, 2017, Suffolk County adopted revised "Standards for Approval of Plans and Construction for Sewage Disposal Systems for Single Family Residences." These standards were updated to keep up to date with the progress of the I/A OWTS program and technology advances, including the use of a pressurized shallow drainfield with I/A OWTS.

Standards for the Management and Approval of I/A OWTS

On December 29, 2017, Suffolk County adopted revised "Standards Promulgated Under Article 19 for the Approval and Management of Innovative and Alternative Onsite Wastewater Treatment Systems." These standards outline how Suffolk County Department of Health Service (SCDHS) is to administer Article 19 of the Suffolk County Sanitary Code, including the development and use of innovative alternative onsite wastewater treatment systems (I/A OWTS) to benefit the environment and public health (i.e., meet maximum treated effluent concentrations for total nitrogen (TN) of 19 mg/L) and its role as a Responsible Management Entity (RME) for I/A OWTS in the County.

Article 6

Suffolk County, with input from the work group, amended Article 6 in January 2018 to include requirements for replacements and retrofits of existing onsite sewage disposal systems and requirements to use an I/A OWTS as means of sewage disposal for certain cases. The changes implemented by this amendment are considered short-term policy changes (Phase 1 policy changes); additional (Phase 2) changes to Article 6 are expected when the Suffolk County Subwatersheds

Wastewater Plan (SC SWP) and General Environmental Impact Statement (GEIS) findings are complete. This amendment sets the stage for Suffolk County to move from the use of cesspools to septic systems and I/A OWTS. Beginning July 1, 2018, contractors or developers holding an active Liquid Waste License must notify SCDHS of all pumping, replacements, or retrofits of cesspools, septic tanks, I/A OWTS, grease traps, and leaching structures; and beginning July 1, 2019, a SCDHS permit will be required for replacements or retrofits of existing systems. With the July 2019 permit requirement, the installation of new cesspools in Suffolk County will be prohibited (i.e., existing systems will no longer be replaced in-kind), as all OSDS will have to be upgraded to meet the SCDHS standards (a septic tank-leaching pool or I/A OWTS).[70] This amendment to Article 6 also defines failure of a cesspool or individual sewerage system as one "that does not adequately treat and/or dispose wastewater so as to create a public or private nuisance or threat to public health or environmental quality," and includes conditions of both hydraulic and structural failure, including above ground pooling of wastewater, pumping four or more times per year, seepage of groundwater into the individual sewerage system, etc.

SCDHS General Guidance Memorandum #34

This general guidance memo. "Procedures for the Evaluation and Approval of Single-Family Residential Innovative and Alternative Onsite Wastewater Treatment Systems", issued on January 3, 2018, serves as a procedure to guide the SCDHS's review and approval of single-family residential I/A OWTS and elaborates on the methodology to be used to determine whether an I/A OWTS technology is able to achieve the desired 19 mg/L TN in effluent. The statutory authority for the guidelines can be found in Article 19 and the Standards Promulgated Under Article 19.

Standards for Replacement and Retrofits of Existing Sewage Disposal Systems

On July 11, 2019, Suffolk County adopted "Standards for Procedures for the Replacement and Retrofits of Existing Sewage Disposal Systems for Single-Family Residences and Other Than Single Family Residences." These standards outline the process and requirements for replacing or retrofitting existing systems and reinforces the requirement prohibiting the installation of new cesspools; a septic tank-leaching pool system or I/A OWTS must be used.

Amendment to Sanitary Code to Require I/A OWTS for All New Construction

On October 15, 2020, Suffolk County amended the sanitary code to require I/A OWTS in all new home and commercial construction, and for single family home renovations that increase the number of bedrooms to more than five and increase the building's footprint or floor area. The amendment will also

[70] With this revision of Article 6, it appears that individual sewerage system upgrades to meet the current Suffolk Sanitary Code and standards (septic tank-leaching pool or I/A OWTS) will not be mandatory, as was originally proposed in the Alternatives analyzed in the HIA, but will be implemented as homeowners replace existing systems. Future revisions to the Sanitary Code could reflect other methods of implementing upgrades, including by mandate (e.g., for priority areas), upon property transfer, etc.

allow greater flexibility for the use of small sewer plants in downtown business districts. The new requirements take effect in July 2021.

K.2 I/A OWTS Demonstration Program [part of Septic/Cesspool Upgrade Program Enterprise (SCUPE) grant from NYSDEC].

Various I/A OWTS technologies were installed in Suffolk County as part of the Demonstration Program (initiated in 2014) to assess the design, installation, operation, and maintenance of the systems and their ability to meet the County's nitrogen reduction goals. As part of the program, I/A OWTS vendors install, test, and maintain the systems at little to no cost to the homeowner. The Demonstration Program was administered in two phases, and technologies received provisional approval for use in Suffolk County if 75% of the installed units achieved a combined average TN effluent value of 19 mg/L or less.

Residential Phase 1 - Septic Demo Program

Four (4) manufacturers were selected to install six (6) types of systems. A total of 19 systems were installed at single family residences; homes were selected throughout the County by lottery. Systems installed included:

- HydroAction
- Norweco Singulair TNT
- Norweco Hydro-Kinetic
- Orenco Advantex AX-RT
- Orenco Advantex AX-20
- BUSSE MBR

Residential Phase 2 - Septic Demo Program

Six (6) manufacturers were selected to install eight (8) types of systems. A total of 23 systems were installed at single-family residences. Systems installed included:

- PremierTech Aqua's Ecoflow Coco Filter
- Ampridrome by F.R Mahoney & Associates
- microFAST by BioMicrobics
- BioBarrier by BioMicrobics
- SeptiTech STAAR by BioMicrobics
- Waterloo Biofilter
- Fuji Clean CEN
- Pugo Systems

Residential Phase 2 - Alternate Leaching Demonstration

A number of alternate leaching systems were selected for demonstration in Suffolk County. These systems serve as an alternate to the use of the conventional leaching pool and are designed to evenly disperse effluent into the soil just below the ground surface where biological activity is greatest. Alternate leaching systems being demonstrated include:

- Seven (7) pressurized shallow drainfields (Spring 2017)
- Three (3) drip irrigation drainfields (Spring 2017)
- One (1) gravity fed gravelless trench (February 6, 2017)
- Six (6) additional gravelless trench (Spring 2017)

As of January 2019, the I/A OWTS Demonstration Program resulted in provisional use approval of six (6) systems*:

- HydroAction - September 2016
- Norweco Singulair TNT – October 2016
- Orenco AX-RT – March 2017
- Norweco Hydro-Kinetic – April 2017
- Fuji Clean CEN – January 2018
- SeptiTech STAAR – July 2018

Two systems provisionallyapproved during the timeframe of the HIA analysis

There is no cap on the number of these systems that can be installed in the County. The first 20 provisionally-approved year around systems must be sampled every month for 24 months and all others must be sampled every 12 months. The 2016, 2017, 2018, and 2019 *Report on the Performance of I/A OWTS* in Suffolk County are available at: https://reclaimourwater.info/Regulatory.aspx.

K.3 Cost Information for I/A OWTS Upgrades

The **average** total cost for approved systems, including engineering and design services, purchase, and installation, is approximately $19,200, although costs vary on a case-by-case basis. For more detailed information on estimated engineering costs and vendor costs, see http://www.reclaimourwater.info/septicimprovementprogram.aspx.

In addition to the initial costs of having an I/A OWTS installed, there are costs associated with owning an I/A OWTS, including:

- **Operation and Maintenance**: The first three years are covered as part of the manufacturer's warranty. However, homeowners will need to sign yearly maintenance contracts and will be responsible for maintenance costs after the 3-year warranty expires. It is anticipated that operation and maintenance (O&M) will cost approximately $300 a year.
- **Annual Electrical Costs**: Depending on the treatment process and manufacturer's system, the system either runs continuously or on-demand. Based on information provided by manufacturers, the systems that are provisionally approved have approximate annual electric costs ranging from $57 to $266 per year.
- **Pumping Costs**: Although these systems provide advanced treatment, they will still need to be occasionally pumped by a septage hauler. Depending on use of the system, it is estimated that the average system would need to be pumped out every 3-5 years. This increases the treatment and useful life of any sewage disposal system including I/A OWTS. A typical pump-out is estimated to cost $300 - $500.
- **Repair and Replacement Costs**: Homeowners should be aware that although I/A OWTS have a long track record of use in the US, they do contain components such as pumps, floats, air

compressors, and controls that may need to be replaced at some point during the useful life of the system. These component repair and replacement costs could range from \$50 to \$200.

K.4 Financial Assistance for I/A OWTS Upgrades[71]

Septic Improvement Program Summary[72]

In July 2017, the County announced a new incentive program – the Septic Improvement Plan (SIP) – that provides grants and low-interest financing to make the installation of I/A OWTS more affordable for homeowners of single-family residences. The program is currently funded at \$2 million/year through the year 2021. Under the program, grants up to \$11,000 (\$10,000 for an I/A OWTS and \$1,000 for a pressurized shallow drainfield used to improve distribution of wastewater from the systems) are available to homeowners with an adjusted gross income ≤ \$500,000/year that meet certain criteria:

- The single-family residence is the owner's primary residence, occupied by the owner year around, and is not a rental property or new construction.
- The residence is served by a cesspool or septic tank, is not connected to sewer, and is not located in a current or proposed sewer district
- No in-home businesses are run at the residence
- No residents of the home are employees of Suffolk County, elected officials, or office holders of a political party
- The residence has a valid Certificate of Occupancy or Certificate of Zoning Compliance
- Verification of income (copy of federal tax returns) is provided
    - Adjusted gross income ≤ \$300,000/year – eligible for 100% of grant
    - Adjusted gross income \$300,000-\$500,000/year – eligible for 50% of grant.

In conjunction with the grant, a low-interest loan program, administered by the Community Development Corporation of Long Island, is also available under SIP to help homeowners finance the remaining costs of installing the I/A OWTS (which costs between \$14,500-\$17,500 in total). Homeowner may be eligible for a loan of up to \$10,000 at a 3% interest rate and loan terms up to 15 years.

Under SIP, preferential consideration is given to residences in environmentally-sensitive areas (i.e., Priority Critical Areas or Critical Areas) or with failed systems. Priority Critical Areas include high- and medium-density residential parcels less than one acre in size within the 0–2 year groundwater travel time to surface waters or high- and medium-density residential parcels within 1,000 feet of enclosed

[71] Financial assistance to homeowners performing upgrades of their individual sewerage systems was captured in several of the recommendations of this HIA. The funding described here is funding available as of October 2018, but is limited. The County's Septic Improvement Program combined with the money from New York State's Septic System Replacement Fund is capable of providing grants for approximately 2,000 residences. Additional funding will need to be secured in order to continue to offset the costs of I/A OWTS installation for the close to 200,000 residences assumed to be served by cesspool alone.

[72] Suffolk County's Septic Improvement Program grant was modeled after Maryland's Bay Restoration Fund - Septic System Grant Program and the low-interest loan program was modeled after Rhode Island's Community Septic Service Loan Program (CSSLP).

water bodies. Critical Areas include high- and medium-density residential parcels less than one acre in size within the 2-25 year groundwater travel time to surface waters.

As of April 16, 2020, 370 I/A OWTS systems have been installed under the SIP program, 187 installations are in progress, and another 205 installations are pending. There have also been an additional 418 systems installed outside the SIP program, some of which were funded through other means, as described in the next section (NYSDEC, 2020).

Other Funding

New York State allocated $10 million from its State Septic System Replacement Fund to Suffolk County in February 2018 to help expand the grant program. Beginning October 12, 2018, Suffolk County's Septic Improvement Program grants can be coupled with NY State Septic System Replacement Program grants. Through this effort, Suffolk County residents were eligible for combined grants of up to $21,000 to install an I/A OWTS ($20,00 toward the purchase, engineering, design, and installation of a SCDHS-approved I/A OWTS and leaching structure and an additional $1,000 toward the installation of pressurized shallow drainfields). In December 2018, the law that established the County's SIP program was amended to expand the eligibility requirements and the amount of funding available through the program. Increased staffing for SCDHS was included in Suffolk County's budget to administer the expanded program, which is expected to draw up to 1,000 applicants per year. The revised law became effective on January 22, 2019 and allowed County and State grants to be combined for up to $30,000 towards the purchase and installation of an I/A OWTS.

Several eastern Suffolk County towns, including East Hampton, Southampton, and Shelter Island, have their own grant programs through the Peconic Bay Community Preservation Fund (CPF). The CPF is funded by town-approved taxes on real estate transactions and allows the towns to offer grants up to $16,000 to residents who qualify based on need (Dooley & Schwartz, 2018).

K.5 I/A OWTS Industry Certification and Training

Suffolk County has worked with the Long Island Liquid Waste Association (LILWA) to ensure there are qualified individuals capable of installing and providing maintenance for I/A OWTS in the county. In 2016, the County passed a law requiring liquid waste professionals to acquire training and certification for septic tank plumbing, cleaning and maintenance; waste line cleaning and inspection; bulk liquid waste transportation; vactor (pump/vacuum) services; conventional septic system maintenance inspection; conventional septic system installation; I/A OWTS installation; and I/A OWTS service provider, among others (LILWA, 2016). LILWA and SCDHS provide the required training, in cooperation with the University of Rhode Island New England Onsite Wastewater Training Program (LILWA, 2016). As of July 2018, 400 workers have graduated from the training (Moran, 2018).

K.6 Suffolk County Subwatersheds Wastewater Plan (SC SWP)

In accordance with Suffolk County's Reclaim Our Water initiative and the Long Island Nitrogen Action Plan (LINAP), Suffolk County is pursuing proactive measures to reduce nitrogen pollution to our waters.

The Suffolk County Comprehensive Water Resources Management Plan (Suffolk County Government, 2015a) characterized negative trends in the quality of groundwater in the upper glacial and Magothy aquifers in recent decades. Suffolk County Government (2015a) linked increasing nitrogen levels in groundwater not only to drinking water, but also to surface waters, including significant adverse impacts of nitrogen on dissolved oxygen, harmful algal blooms (HABs), eelgrass and other submerged aquatic vegetation, wetlands, shellfish, and, ultimately, coastal resiliency. For the first time, the Comprehensive Water Resources Management Plan established an integrated framework to address the legacy problem of onsite wastewater disposal systems in a meaningful manner; with acknowledgement that patchwork sewering will not be sufficient to solve the problem.

The Suffolk County Subwatersheds Wastewater Plan (SC SWP) will provide a recommended wastewater management strategy to reduce nitrogen pollution from non-point wastewater sources. The SC SWP is considered an early action/initial step of the overall long-term LINAP program. In addition to being a guide for establishing County wastewater policy, the primary objective of the SC SWP will be to provide critical information regarding data gaps, areas requiring further detailed study, and ultimately to provide data that can support long-term LINAP scope refinement and focus and other related initiatives ongoing throughout Suffolk County (e.g., Long Island Sound Study, Peconic Estuary Program, South Shore Estuary Reserve, and related Town/Village initiatives). In alignment with these objectives, the SC SWP will be executed on an accelerated timetable and will not include the generation of new, sophisticated models that are typically used for Total Maximum Daily Load (TMDL) studies. Rather, the SC SWP will build, expand, and unify existing individual models and studies from the wealth of resources that already exist.

To support development of the recommended wastewater management strategy, a sequenced, technically-driven series of evaluations will be completed as follows:

- Delineation of the County's priority subwatersheds (~189 individual surface water receiving bodies) using the existing Suffolk County Groundwater Model. The groundwater model provides a common platform of assumptions and boundary conditions to ensure a uniform and consistent set of subwatersheds boundaries. A parallel evaluation will be completed for the protection of groundwater and public and private supply wells. The evaluation will use the Suffolk County Groundwater Model to estimate predicted nitrogen concentrations in public supply wells and groundwater and required load reduction through wastewater management to reduce nitrogen concentrations to agreed upon endpoints.
- Generation of land use based annual nitrogen loading rates for each of the subwatersheds using the existing Suffolk County Groundwater Model mass transport module. The SC SWP will calculate the total nitrogen loads from all major sources (e.g., wastewater, residential fertilizer, agriculture, deposition, and pet wastes) and be used to support the identification of areas where legacy nitrogen may be of concern, although the SC SWP evaluations will not include the legacy nitrogen in its evaluation. While all nitrogen loads will be considered in the determination of an overall first order reduction goal for a water body, the focus of the SC SWP will be assigning nitrogen load reduction goals for non-point wastewater sources to support achievement of the overall load reduction goals. LINAP and/or other related future initiatives

will further consider these loads and reductions and will expand on alternate available management measures such as permeable reactive barriers and in-water aquaculture.

- Development of surface water residence times for each of the 189 surface water bodies using the Environmental Fluids Dynamic Code (EFDC) modeling software (https://www.epa.gov/ceam/environmental-fluid-dynamics-code-efdc).
- Establishment of baseline water quality using existing, readily-available surface water data from available studies and monitoring programs completed within Suffolk County.
- Establishment of tiered priority areas for wastewater management upgrades, using the results of the modeling efforts and baseline water quality. The objective of establishing tiered priority areas is to provide a framework for implementing the recommended wastewater alternatives in a phased approach . This would allow the allocation of funding and resources to be focused on the highest priority areas.
- Development of preliminary load reduction goals for each surface water body using empirical data relationships, existing regulatory target guidelines, and other readily available data sources from related studies.
- Development of recommendations for wastewater management upgrades will be provided for each priority tier based upon the ability to meet nitrogen load reduction goals. Recommended wastewater upgrades will focus on the use of I/A OWTS, the use of sewering at locations where existing sewer feasibility studies indicate sewering is cost effective, and the use of decentralized/clustered systems (e.g., small pre-packaged treatment plants or I/A OWTS that connect multiple tax lots or buildings together). The SC SWP cost benefit analysis will, amongst other evaluations, identify the criteria and locations where the use of decentralized/clustered systems represent the most cost-beneficial wastewater management approach. In addition, the SC SWP will evaluate and provide preliminary recommendations on how to overcome some of the potential challenges associated with implementing these systems (e.g., existing setback constraints, long-term O&M responsibility, approval process, etc.). Finally, increase of the minimum lot size may be considered in select subwatersheds where sufficient undeveloped land exists to provide a meaningful environmental benefit. The recommended implementation plan developed as part of the SC SWP will balance the need for providing a program acclimation period (e.g., hire staff for Responsible Management Entity, training of industry, industry market preparation, and funding source identification) with providing an aggressive implementation approach that provides meaningful environmental benefit.

The County determined that implementation of the recommendations in the SC SWP may have a significant impact on the environment, so a General Environmental Impact Statement (GEIS) was prepared to accompany the implementation of the SC SWP. Work on the SC SWP began in summer 2016, with a draft plan expected in January 2018 and a final plan in March 2018.

The draft SC SWP was issued in July 2019 and the public comment period for the draft GEIS ran August 14, 2019 through October 16, 2019 (https://www.reclaimourwater.info/TheSubwatershedsWastewaterPlan.aspx). A revised SWP and a Final Generic Environmental Impact Statement (FGEIS) incorporating public comments and comments received by the Suffolk County Council on Environmental Quality (CEQ) was posted in February 2020. After minor revisions to address requirements of the NYSDEC Nine Element (9E) Watershed Plan program (see the NYSDEC website for more details on 9E plans), the final SC SWP (SCDHS, 2020) was published in July 2020. Approval of the SC SWP as a 9E Plan will make Suffolk County eligible for additional state and federal funding to advance water quality improvements.

The SC SWP identified a phased countywide strategy to replace cesspools and C-OWTS in Suffolk County with I/A OWTS, sewering, or clustering. This $4 billion approach would be implemented over 50+ years, with an initial 5-year ramp-up period (Phase I) that includes establishing a countywide wastewater management district and a new, yet to be specified, $50-75 million recurring annual funding stream. With the establishment of a stable and recurring funding source, Phase II would require upgrades to systems in the highest priority areas (i.e., the near shore 0-2 year groundwater contributing zone to surface waters and watersheds with the most impaired or vulnerable waterbodies). Implementation would continue in Phase III upgrading systems in the remaining priority areas, and in Phase IV, upgrades to the remaining systems (primarily in Central Suffolk County) would take place. As of the time of the SWP, a funding source had not yet been secured for the upgrades. However, as documented in the SWP, Suffolk County has made it clear that the implementation of a countywide wastewater upgrade program is contingent on identification of a stable and recurring revenue source to make the program affordable to homeowners.

Suffolk County Wastewater Management District

In February 2021, Suffolk County announced the release of a feasibility study and implementation plan to guide the establishment of a Countywide Wastewater Management District. Next steps in the process are development of an implementation strategy and timeline.

Suffolk County Harmful Algal Bloom Action Plan

In September 2017, SCDHS released its Harmful Algal Bloom Action Plan, which includes a comprehensive strategy to address harmful algae blooms that threaten both Suffolk County's environment and economy (Wise, 2017).

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