REPORT

JUNE 2025

Orient Water Resources Study

PREPARED IN COLLABORATION WITH:

THE ORIENT ASSOCIATION

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Section 1
Water Resources Study Goals

1.1 Introduction

In 2022 the Orient Association embarked on a comprehensive study of Orient's water resources: fresh, salt and waste. We engaged a regional water expert at a global engineering firm to lead this study with the goal of producing a report detailing Orient's hydrology, the interplay of water resources, the current balances and imbalances, trends for the future and a number of different options addressing current and future areas of concern. The study draws from extensive resources including Federal, State, County, and Town agencies, as well as many stakeholders in Orient. The report is not narrowly prescriptive, but rather a deep dive into a detailed study of the underlying forces and data to help us form a firmer understanding of Orient's water resources. Our hope is that this study and report informs the community about how our water ecosystems work, presents hard data about those ecosystems, sets up the challenges and opportunities unique to Orient, and offers some options for the future. We invite the reader to join us on this deep dive into Orient's waters!

1.1.1 Orient

Orient is a small community on the easternmost tip of the North Fork of Long Island, in New York State. Connected to the larger communities to the west by a single, narrow causeway, Orient is nearly an island.

1.1.2 Water

Water is essential to Orient. The waters surrounding Orient on all sides—Long Island Sound, Gardiner's Bay, Orient Harbor, and Hallock's Bay—support local fishing and aquaculture, provide for recreation, and anchor Orient's beauty and character. The small aquifer beneath Orient, disconnected from the larger aquifers underlying communities to the west, is the only source of fresh water for Orient's residents and farmers.

1.1.3 Key Questions

Because water is so critical to Orient, and because both our surface waters and groundwater have been challenged in the past and face threats in the future (from continued development, new contaminants like Per- and Polyfluorinated Substances or PFAS, and climate change), the Orient Association, Orient's civic group, commissioned this study of our water resources. The study aims to answer three core questions, both for the current moment and projected into the next seventy years:

1. Fresh water QUANTITY: is there enough fresh water in Orient to support residents' and farmers' needs?

2. Fresh water QUALITY: does Orient's fresh water meet all drinking water standards?

3. Surface water ECOSYSTEM: are the bays that surround Orient supportive of robust populations of shellfish and finfish, and healthy for swimming and recreation?

With this assessment in hand, this study also recommends steps that should be taken to protect Orient's ground water and surrounding bays.

1.1.4 CDM Smith

The Orient Association retained CDM Smith in March 2022 to lead this project. CDM Smith is a global engineering firm with a focus on water and the environment. Through multiple engagements over the past twenty-plus years with Suffolk County and the New York State Department of Health, including collaboration with Suffolk County on the 2015 Comprehensive Water Resources Management Plan and the 2020 Suffolk County Subwatersheds Wastewater Plan, and as architect of the Suffolk County Groundwater Model, CDM Smith has developed deep expertise in the hydrology of the North Fork. CDM Smith also has extensive experience with developing water plans, at the city, county, state, and national level.

1.2 Study History, Data Sources and Development Process

The information included in this report was obtained from many different sources, including Suffolk County Department of Health Services (SCDHS), New York State Department of Environmental Conservation (NYSDEC), the United States Geological Survey (USGS), Cornell Cooperative Extension (CCE), and Stony Brook School of Marine and Atmospheric Sciences (SoMAS).

After several meetings with CDM Smith, the OA Water Committee realized that the available data from these sources lacked some hyper-local context, so in the summer of 2022, the project was placed on hold so that the OA Water Committee could interview local residents, well drillers, aquaculturalists, farmers, water managers and filtration companies about some of the unique conditions in the hamlet.

In the Fall of 2022, the SCDHS began a survey of Per- and Polyfluorinated Substances (PFAS) contamination in Orient Village that was subsequently expanded three times to encompass over 200 homes. Those homes that had water tests above the Maximum Contamination Levels (MCL) for Perfluorooctanoic acid (PFOA) and Perfluorooctane Sulfonate (PFOS) received bottled water and/or were offered a point of entry, whole house filtration system, supplied and maintained by the NYSDEC.

Having access to the PFAS survey data during the consultant's hiatus gave the OA Water Committee team a comprehensive picture of current water quality challenges in Orient Village. The OA Water Committee discovered that not only were alarmingly high levels of PFAS identified in some locations, but there were also several wells with very high chloride levels in the survey area.

While most contaminants can be filtered out relatively easily, removal of salt water by desalination is difficult to do using a home treatment system. Reverse Osmosis (RO) filtration can be used, but it has several disadvantages including: high electricity demand; a great deal of water wasted; and contaminated water is recharged into the aquifer. A whole house RO filter also requires a lot of space. In December of 2023, the Orient Association authorized CDM Smith to complete additional analyses and mapping to illustrate how saltwater intrusion would affect wells in the community in the future.

Made aware of current challenges, the OA Water Committee wanted to know more about how people in the community were coping with issues of contamination and reliability. We developed a survey that went out to the community in October of 2023. A total of 126 households responded to the survey and the results are included in this report.

It should be noted that this study represents analysis and recommendations based on the data available to the consultant at the time. Even as this study is coming to an end, the water situation is evolving in Orient. In May of 2025, the USGS completed a monitoring well on the grounds at Oysterponds School. From this point, the USGS will be able to monitor saltwater intrusion in the surrounding area. The Orient Association received notice in May 2025 that the Suffolk County Water Authority (SCWA) is performing an environmental review on a proposal to bring public water to parts of Orient Village affected by PFAS contamination.

While the Orient Water Resources Study report has taken three years to produce, the delay has offered new depth and breadth to our understanding of the challenges ahead.

1.3 Findings and Recommendations

1.3.1 Water Quantity

Findings

- **Sufficient Water Quantity Today**: The supply of fresh water in Orient is limited and the aquifer underneath Orient is thin (on average less than 40 feet thick) and fragile. Orient's use of fresh water, which includes pumping from the aquifer for residential and agricultural purposes, has been largely in balance with supply (rainfall). A key measure of freshwater availability—the height of the water table—shows annual seasonal variation, but no decline over the past sixty years.

- **Vulnerabilities:** Going forward, continuing residential development in Orient is likely to increase freshwater usage. Climate change is expected to cause sea levels to rise (21 inches by 2050, 47 inches by 2100), which will cause the salt/freshwater interface to move upwards and inland. These two phenomena will shrink the size of the aquifer by about 20 percent and will increase saltwater intrusion into shallow and near-shore wells, and could cause upconing in deeper, inland wells. As sea level rises, the most vulnerable coastal properties in Orient may lose access to freshwater altogether.

Recommendations

- Monitor Saltwater Interface: Monitor the location and movement of the saltwater interface to understand which residents' wells will be impacted and when. An additional monitored well in Orient Point is warranted.

- Conserve and Protect: Limit water use, especially in near shore locations during the growing season and during droughts, as over-pumping can cause salt water intrusion and upconing.

1.3.2 Water Quality

Findings

- Vulnerable: Orient fresh groundwater quality is vulnerable to contamination from overlying land uses. There are problems with high nitrogen (18 percent of tested households in Orient are above the maximum contaminant level (MCL)), and localized issues with high chlorides (impacting about 4 percent of households). Also, there is a current disturbing issue with PFAS, discovered in 2022: PFAS concentrations were above the MCL in 48 percent of the residential wells tested in the village. Going forward, additional contaminants of concern may be identified.

- Potential for Chloride Levels to Increase: Sea level rise will cause high chloride levels and water table rise. For some properties, the raised water table will put the bottom of the septic system too close to the top of the water table, increasing the chance of bacterial contamination of household wells and surrounding water bodies.

Recommendations

- Home monitoring and filtration: homeowners should test water yearly and maintain filtration systems.

- Education: community education on the fragility of Orient's aquifer and best practices to avoid introducing contaminants into the water supply.

- Improve Septic Systems: Maintain existing septic systems, or even better, replace them with innovative/alternative on-site wastewater treatment systems (I/A OWTS) engineered to accommodate future increases in the water table elevation.

- Public Water: Consider future options for public water from up island.

- Public Report: OA recommends that we request that the Suffolk County Department of Health Services provide an annual aggregated report on contaminant levels for all tested Orient wells to highlight potential or growing problems.

1.3.3 Surface Water: Ecological Health

Findings

- Decline in Species: There has been enormous decline in a number of visible anchor species over the past 50 years including eel grass, clams, scallops, oysters, lobsters and horseshoe crabs. There have also been a number of harmful algal blooms, though not as devastating or frequent as in neighboring western bays.
- Orient Harbor Largely Healthy: The chemical makeup of our bay, Orient Harbor, is largely healthy. Nitrogen, the key contaminant of surface waters in up-island inlets and bays, is in the normal range in Orient—there are relatively few houses around the bay, and it is flushed regularly by the tide. While low concentrations of oxygen are another key cause of stress for sea life, oxygen is at a healthy level in Orient Bay. However, as water temperature is rising, the amount of oxygen that the water can hold will decrease.
- Other Contributing Factors: Much of the decline in flora and fauna in Orient Bay is caused by exogenous factors such as overfishing and temperature rise.

Recommendations

- Improve Septic Systems: Maintain existing septic systems or even better, replace them with innovative/alternative on-site wastewater treatment systems (I/A OWTS) engineered to accommodate future increases in the water table elevation.
- Household Products: Be mindful of household products that filter into both the aquifer and the surface waters. Everything that goes down the drain or onto your lawn can impact water.
- Stormwater Impact: Be mindful that stormwater runoff can flush anything on or near the street including pet and animal waste directly into the Sound and bays.
- Supportive Ecological Mitigants: Support oystering, scallop restoration and other aquaculture that filter, reduce nitrogen and provide oxygen.
- Septic System Alternatives: Consider future options for clustered wastewater systems based on possible regulatory changes that would allow them.
- Infrastructure Improvements: OA recommends supporting infrastructure improvements to:
    - Control Village Lane runoff.
    - Improve waterfront septic at base of Village Lane to reduce bacteria in key waterfront areas.
    - Broad Meadows project to improve flushing of upper reaches of Hallocks Bay (Narrow River).

1.4 OA Water Committee

Members of the thoughtful, dedicated and engaged OA Water Committee who led the Orient Water Resources Study, providing insight, information and guidance are listed below along with the Water Project Fundraising Committee who garnered support and funding for the study.

OA Water Committee

- Drianne Benner
- Glynis Berry
- Barbara Friedman
- Erin Latham Stanton
- Daniel Watts
- Chris Wedge
- Bob Deluca (Advisory)

Water Project Fundraising Committee

- Ambriel Floyd
- Daniel Watts
- Chris Wedge

1.5 Acknowledgements

The Orient Association would like to acknowledge the water project donors who made the project possible.

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- John and Martha Watts
- Jeanne Markel and Chris Wedge
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- And Several Anonymous Donors

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Section 2

Existing and Anticipated Future Conditions

This section describes Orient's existing and future ground and surface water resources to provide the information necessary to address three main questions:

- Evaluate whether the existing groundwater supply is sufficient to meet existing and future anticipated needs, considering the anticipated effects of climate change,
- Evaluate the existing and potential future quality of Orient's groundwater supply with respect to drinking water standards, and
- Consider the factors affecting the quality of Orient's surface waters, particularly as necessary to support a healthy ecosystem.

2.1 Groundwater

Groundwater stored within the pore spaces of the gravel, sand, silt and clay sediments beneath Orient's land surface is the only source of Orient's potable water supply. Orient's groundwater supply originates as precipitation that infiltrates down through the ground to recharge the underlying aquifer, the top of which is called the water table. The elevation of the water table rises and falls based on the amount of recharge (inflows) and pumping (outflows). The quality of the groundwater supply can be impacted as the recharging precipitation carries contaminants introduced at (e.g., fertilizers or pesticides) or below (e.g., contaminants from septic systems) the ground surface down to the underlying aquifer.

Because Orient's groundwater supply is limited and vulnerable to over pumping, salt water intrusion and contamination from overlying land uses, protection of both groundwater quantity and quality is essential to provide Orient residents with a reliable potable water supply.

2.1.1 Existing and Future Groundwater Quantity

Is the groundwater beneath Orient sufficient to meet residential, agricultural and commercial needs? How close does current water use come to consuming the available supply of fresh water? How does this picture change in the future, with potential increased residential development and with anticipated impacts of climate change? These questions were answered by developing water balances to compare the amount of water flowing into and out of the aquifer, by reviewing long term trends in the elevation of the water table and by considering the potential impacts of sea level rise on Orient's groundwater system.

2.1.1.1 Aquifer Description

Orient, like the rest of Long Island, is underlain by consolidated bedrock, which does not store or yield any significant amount of groundwater. Groundwater is stored within the pore spaces of the wedge of the unconsolidated gravel, sand, silt and clay sediments that overlie the bedrock floor. Further west in Suffolk County, Nassau County and New York City, the thickness of the unconsolidated sediments increases from zero feet where bedrock is at the ground surface (along the north shore in Queens), up to about 2,000 feet (along the south shore barrier islands of Suffolk County). In Orient, the thickness of the fresh water aquifer varies from zero feet along the coast up to about 85 feet south of Main Road near Platt Road.

Sediment layers that are capable of storing, transmitting and yielding large quantities of water are called aquifers. **Figure 2-1** provides a general north-south cross section through mid-Suffolk County depicting the variable thickness of the three major aquifers of water supply importance, from top to bottom, the upper glacial, Magothy and Lloyd aquifers. Suffolk County Water Authority (SCWA) has over 600 wells that provide potable supply (source: SCWA, pages 31-32.pdf (instanturl.net) to County residents. While the thickness of the Magothy aquifer varies from north to south, many of the SCWA wells that withdraw public supply from the Magothy aquifer are screened hundreds of feet below the ground surface.

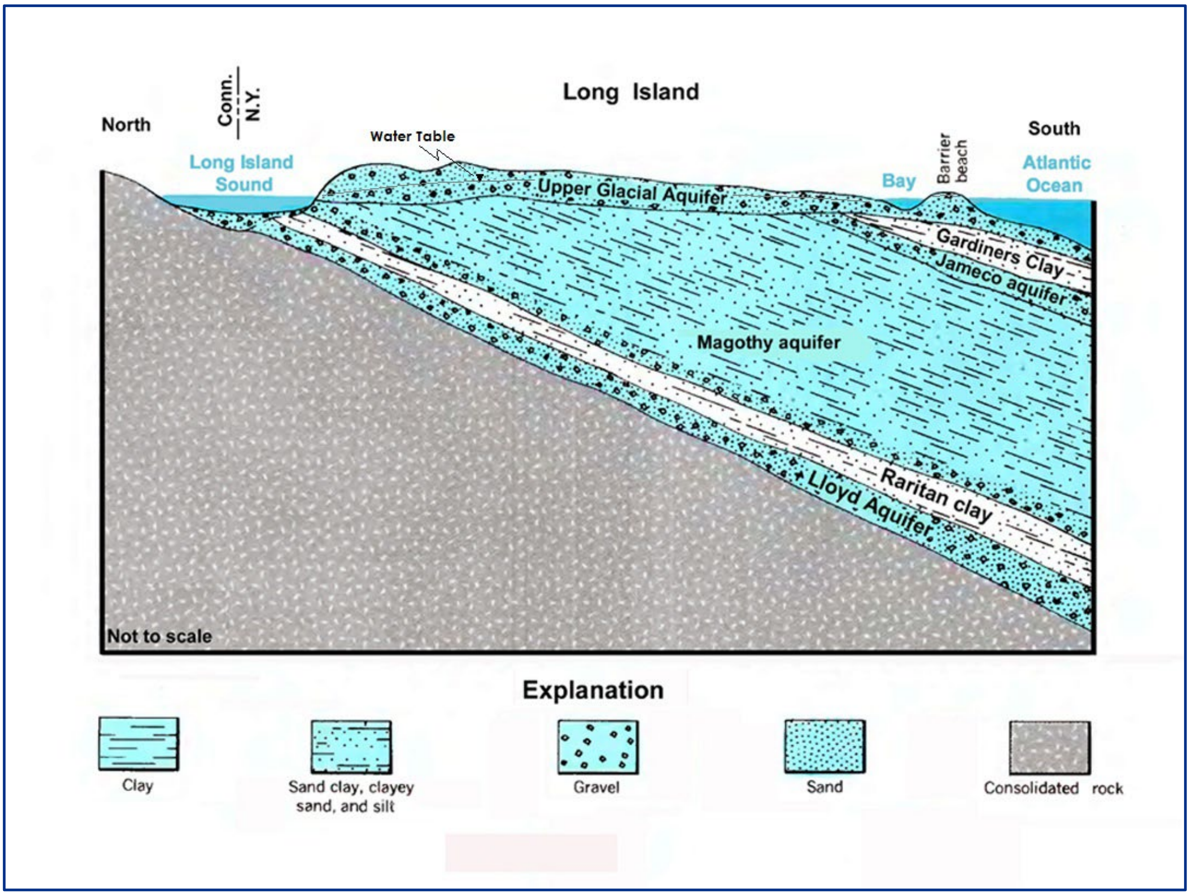


Figure 2-1 Generalized North-South Cross Section through Suffolk County Shows Three Aquifers of Water Supply Importance to the County (Source: NYSDEC)

Currently, SCWA supplies public water to Town of Southold customers from 60 wells within the Town. Most of the relatively shallow wells withdraw water from the shallow upper glacial aquifer because east of Mattituck, chloride levels in the underlying Magothy aquifer are too

high to use as a public water supply. The SCWA wells in Southold are under stress during periods of peak demands and are increasingly threatened with salt water intrusion.

Orient relies on a very thin freshwater lens within the upper glacial aquifer, as depicted by the west to east cross section shown by **Figures 2-2a** and **2-2b**. The cross section was developed based upon borings, wells and computer modeling to define the interface between fresh groundwater and the underlying salt water. Because the aquifer is so thin, it is impossible to see the freshwater aquifer on a figure where the horizontal and vertical scales are the same. It is even challenging to discern the aquifer thickness after increasing the vertical scale to ten times the horizontal scale as shown on **Figure 2-2a.**

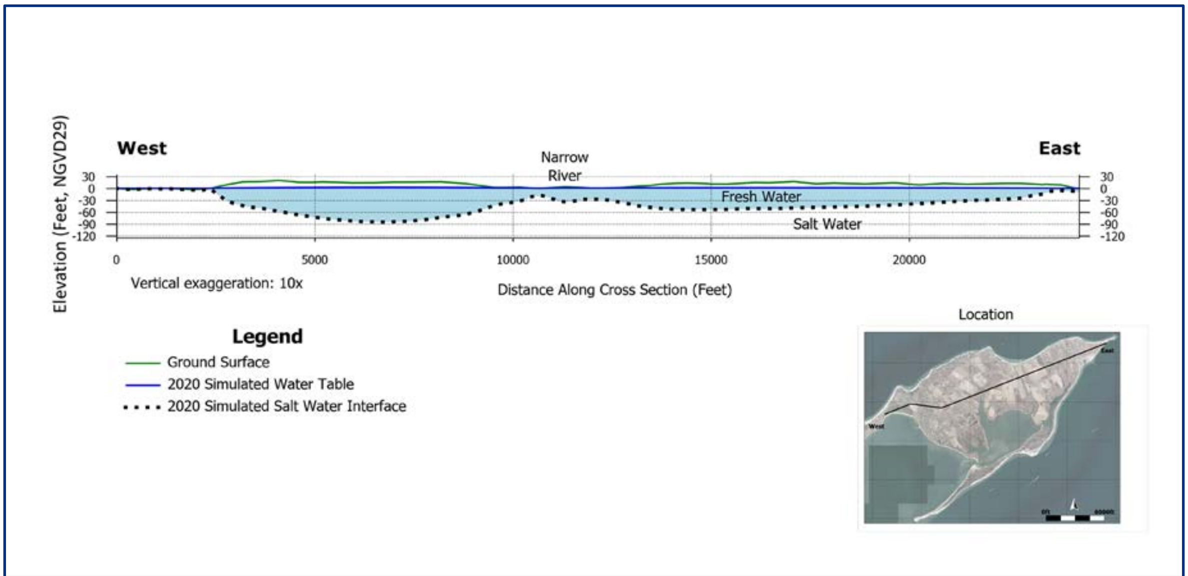


Figure 2-2a West-East Cross Section through Orient Aquifer System Illustrates the Limited Fresh Water Supply

Figure 2-2b, with a vertical scale that is 50 times greater than the horizontal scale, shows that the freshwater aquifer is only approximately 85 feet thick at its thickest location beneath Main Road, west of Narrow River.

Orient's only source of fresh water is groundwater within the upper glacial aquifer; the water in the underlying Magothy aquifer is salt water. In Orient, the water table or top of the fresh groundwater surface ranges from mean sea level in coastal areas to approximately 3 feet above mean sea level, as shown by **Figure 2-3,** which reflects recent conditions of precipitation, recharge and water supply pumping. The water table elevation varies seasonally, and is generally lowest at the end of the summer growing season, and highest at the end of the winter non-growing season.

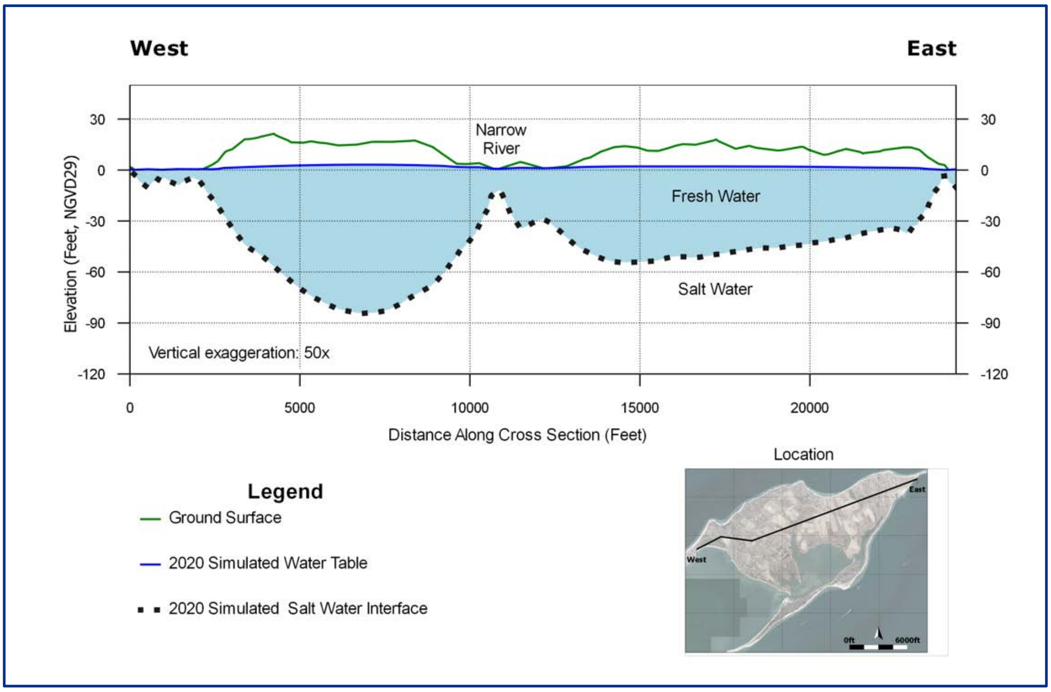


Figure 2-2b West-East Cross Section through Orient Aquifer System with Exaggerated Vertical Scale Shows that the Aquifer in Orient is Less than 100 Feet Thick

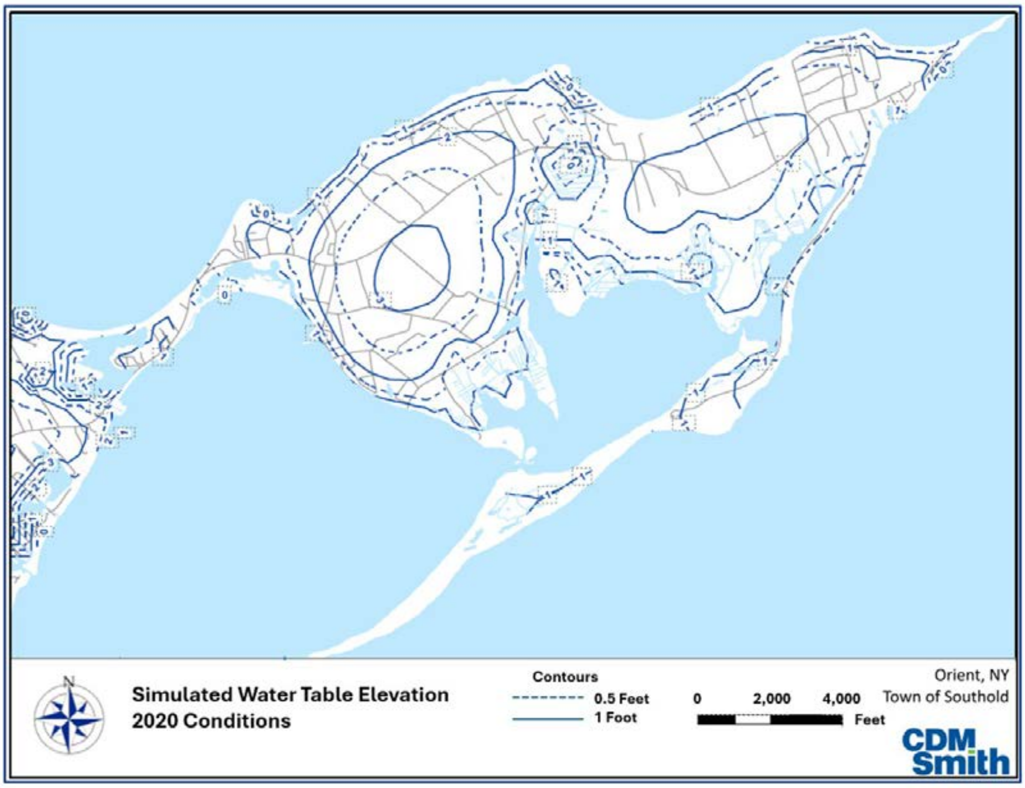


Figure 2-3 Groundwater Model-Simulated Water Table Elevation Shows the Limited Aquifer Extent Above Mean Sea Level (Simulated Water Table 2020)

The water table is very close to the ground surface in low lying areas along the southern coast (Bay) and the depth to the water table increases to about 100 feet below the ground surface in areas where the ground surface elevation is highest such as the area near Browns Hills. **Figures 2-4a** and **2-4b** depict the aquifer thickness in western and eastern Orient respectively, showing that aquifer thickness ranges from less than 5 feet along the coastline to over 85 feet in western Orient.

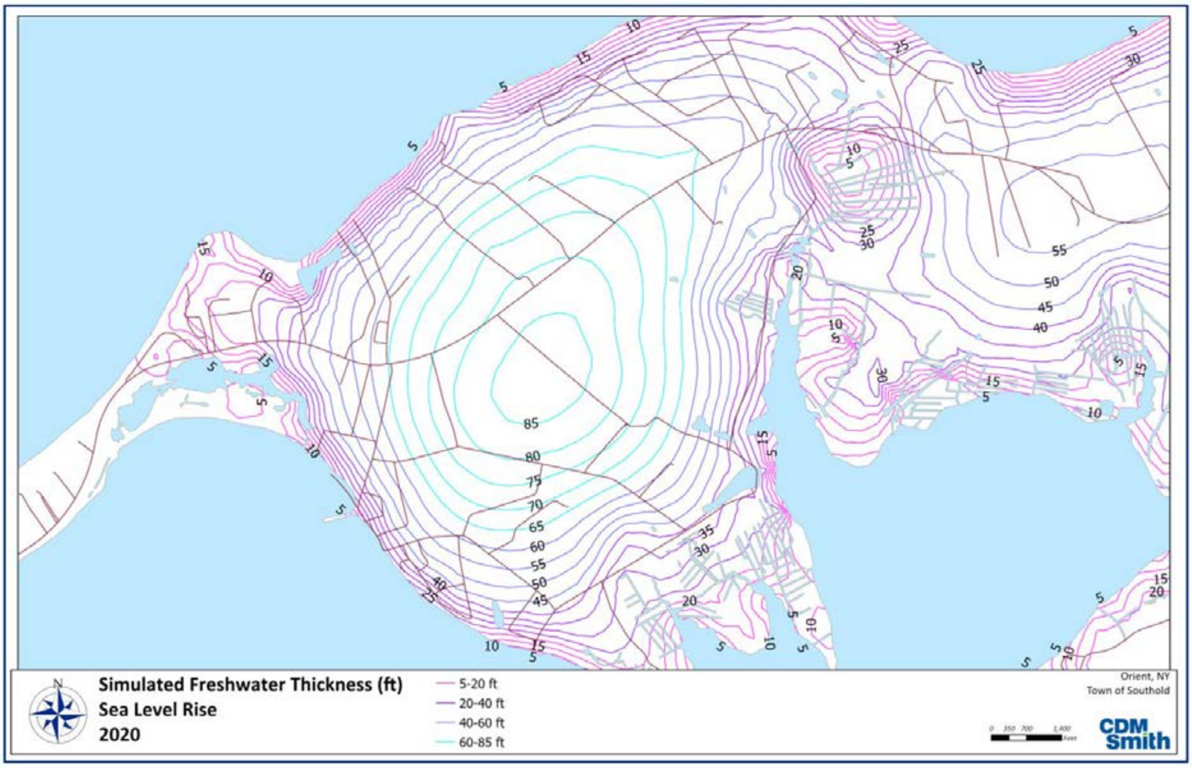
2.1.1.2 Existing Water Balance

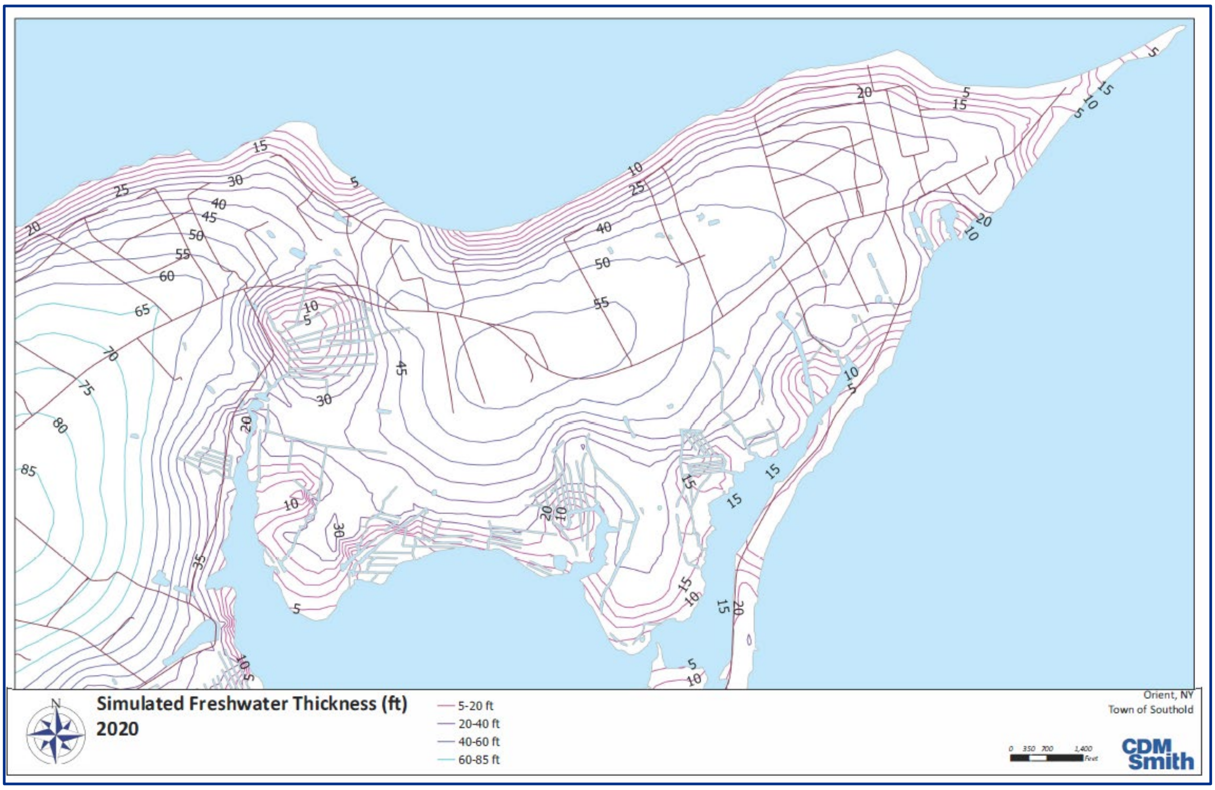
A water balance can be used to describe the flow of water into and out of the aquifer system, as well as changes in the volume of water stored. Orient's groundwater system is dynamic; it responds to changes in precipitation or water supply pumping by seeking a new state of equilibrium or a new balance between water flowing into the aquifer system and water flowing out. A water balance is developed to help to understand the ability of the aquifer to continue to yield a reliable supply of fresh water, through sustainable water supply pumping without causing any undesired effects. If pumping is increased to an unsustainable rate, the resulting lowered water table could reduce the water available to shallow wells and/or reduce fresh water baseflow to coastal waters that could change local surface water salinity and impact ecological habitats.

A three-dimensional computer model was used to develop an annual average water balance for Orient that is summarized on **Table 2-1** and **Figure 2-5**. Average annual flows into the aquifer (inflows) and out of the system (outflows) are shown in units of gallons per day (gpd). Each is briefly summarized below.

Table 2-1 Annual Average Orient Water Balance for Range of Agricultural Pumpage Estimates

Water Balance Component	Inflows (gpd)	Outflows Low Estimate of Agricultural Pumpage (gpd)	Outflows High Estimate of Agricultural Pumpage (gpd)
Recharge from Precipitation	4,200,000	-	-
Recharge from Septic Systems/Cesspools	157,000	-	-
Residential water use (showers, laundry, toilets, cooking, cleaning, lawn watering	-	557,000	557,000
Agricultural pumpage	-	110,000	550,000
Commercial pumpage (Orient State Park, Cross-Sound Ferry, etc.)	-	8,500	8,500
Subsurface flow to coastal waters including Long Island Sound, Orient Harbor and Hallock's Bay	-	3,681,500	3,241,500
Total	**4,357,000**	**4,357,000**	**4,357,000**





Figures 2-4a and 2-4b – Model-Simulated Aquifer Thickness in Western and Eastern Orient Shows That Aquifer Thickness Declines towards the Coast

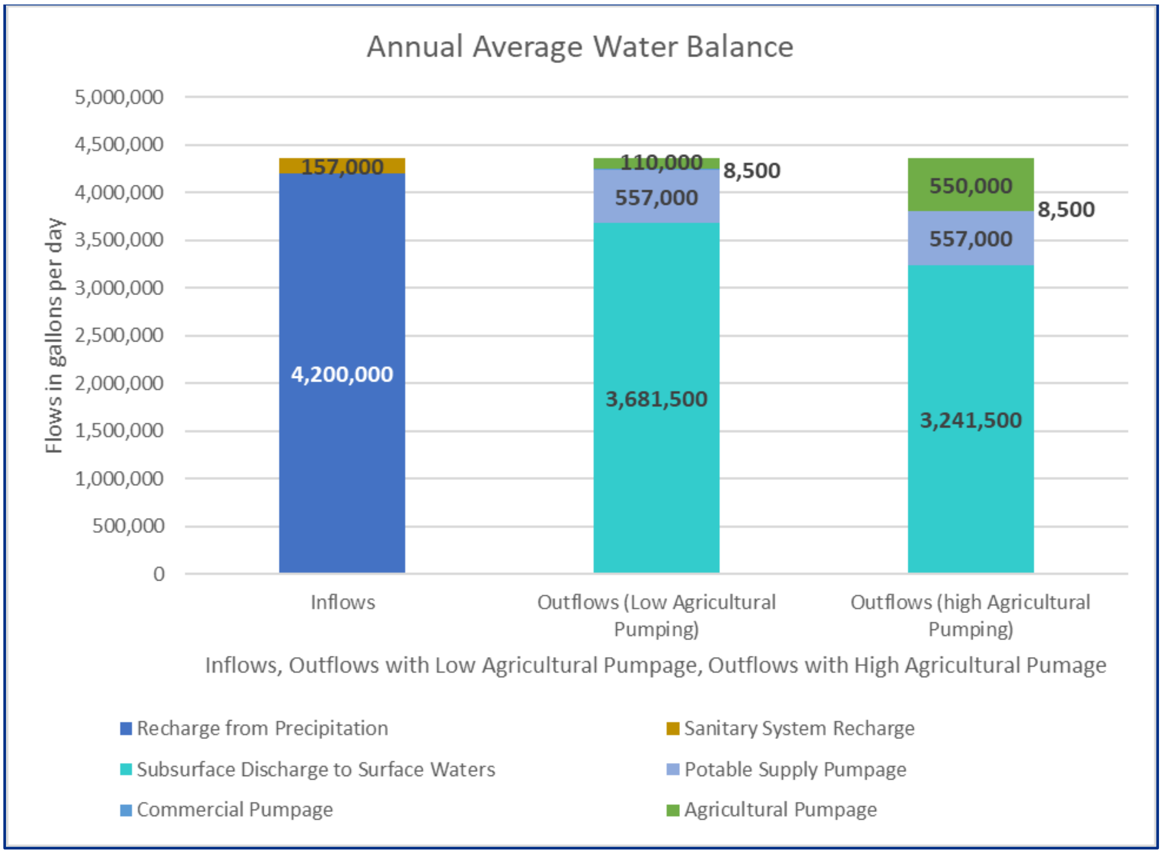


Figure 2-5 Average Annual Orient Water Balances for Average and High Estimates of Agricultural Pumping Estimates Show that Recharge from Precipitation Exceeds Water Supply Pumpage

Note: Orient's Commercial Water Supply Pumpage is such a small fraction of the total aquifer outflow that it is not discernable on the figure.

2.1.1.2.1 Inflows

Like the rest of Suffolk County, inflow to the aquifer is comprised primarily of recharge from precipitation. Based on an annual average precipitation rate of 46.7 inches per year (measured at the Orient Point and Mattituck gages) approximately 1,533 million gallons of water is recharged to the aquifer during an average year. Unlike precipitation, which is distributed rather evenly throughout the year, recharge varies with the seasons, with most recharge occurring during the non-growing season when less precipitation is lost to evapotranspiration. On an annual average basis, 4.2 million gallons per day (MGD) of precipitation recharges Orient's aquifer; this varies from approximately 72,000 gallons per day (gpd) in September to 10,800,000 gpd in January.

Potable water supply that is pumped from the aquifer and returned via on-site wastewater disposal systems, such as septic systems and cesspools, is also included as an inflow to the aquifer system. This recharge is typically estimated to be 85 percent of indoor water use, or non-growing season water supply pumpage, and is a small fraction of Orient's recharge.

Of the 4.36 MGD of average daily recharge to the Orient aquifer, 4.2 million gallons is contributed by recharged precipitation, with the remaining 4 percent is recharged from on-site wastewater disposal systems.

2.1.1.2.2 Outflows

Flows out of the Orient aquifer system include residential water supply pumpage (water used for showers, laundry, cooking and cleaning and toilets as well as lawn watering), pumping from non-community water supply wells (e.g., Orient ferry, Oysterponds Elementary School, etc.), agricultural pumping and subsurface flow from the groundwater system to the surrounding coastal water bodies. While community supplies are metered, allowing accurate estimates of groundwater withdrawn and delivered to users, private residential and agricultural wells are typically not metered, and groundwater withdrawals must be estimated. These estimates recognize that water supply pumpage in Orient varies considerably throughout the year in response to seasonal population variations and agricultural water supply needs during the growing season.

Based on extrapolation of the 107 gpd per-capita water use in the SCWA Browns Hills water district, which is metered, an Orient winter population of 800 and a peak summer population of 3,400, residential water supply pumpage was estimated to range from 77,000 to 1,700,000 gpd, with an average annual pumpage of 557,000 gpd. (Please note that the USGS reported public and domestic water use in the **North Atlantic Coastal Plain Study 2010-Present**, Masterson, et al, 2013, 2016) was estimated at over 125 gpcd). Details of the calculations are summarized in **Appendix A**. On average, residential pumpage comprises almost 13 percent of the outflow from the aquifer system.

Non-community water supply use is summarized on **Table 2-2**. Non-community water supply pumping is much less than one percent of the total outflow from Orient's aquifer system.

Table 2-2 Non-Community Water Supply Pumping

Non-Community Suppliers	Pumpage (gpd)
Cross Sound Ferry	3,000
Oysterponds Elementary School	1,000
Orient Country Store	1,000
Orient Beach State Park	2,000
Orient by the Sea	500
Orient Ice Cream Parlor	500
Orient Yacht Club	500
Total	**8,500**

The amount of water withdrawn from the aquifer for agricultural use can vary significantly from year to year based on precipitation, the water needed for the crops being grown in each field, and the irrigation method used. Because most agricultural wells are not metered, agricultural pumpage is estimated. As shown by **Figure 2-5**, estimates of agricultural pumpage vary significantly, ranging from 110,000 gpd which is significantly lower than

estimated residential water supply pumping, up to 550,000 gpd, which is equivalent to residential pumpage.

The first estimate was based on data available from seven agricultural wells indicating that 220,000 gpd is pumped during the growing season, so that annual agricultural water use would be 110,000 gpd. Assuming this pumpage is used to irrigate the 194 acres of farmland associated with the seven wells, agricultural pumpage in Orient would be approximately 567 gpd/acre. Assigning this irrigation rate to all agricultural parcels, average annual agricultural pumpage in Orient would be 550,000 gpd. This is believed to be a worst-case/high estimate of pumpage, as not all agricultural acreage is actively farmed, and some crops require less water. Based on these low-end and high-end estimates of agricultural irrigation, agricultural pumpage comprises between 2.5 percent and 12.6 percent of the outflows from the system.

Groundwater continually flows from the higher elevations found further in-land to discharge to the surrounding coastal waters. Incorporating the estimated rates of aquifer recharge and pumpage from the aquifer, the groundwater model estimates that on average, 3,681,600 gpd (low estimate of agricultural pumpage) to 3,241,000 gpd (high estimate of agricultural pumpage) of groundwater discharges to the coastal waters surrounding Orient. Underflow to surrounding surface waters is estimated to be the largest outflow from the aquifer system, ranging from 74 to 84 percent of the total outflows from the aquifer system, depending on agricultural pumpage. This outflow helps to maintain the off-shore saltwater position in the aquifer, and maintain the salinity levels needed to maintain estuarine ecosystems.

2.1.1.2.3 Orient Water Supply Sustainability

On an annual average basis, water supply pumping for residential, non-residential and agricultural use is estimated to range from between 16.1 and 26.5 percent of recharge from precipitation, and overall, the aquifer system is capable of providing an adequate supply of fresh water for community needs.

Water supply and agricultural pumpage are much higher in the summer than during other seasons as a result of the increased seasonal population, filling of swimming pools and lawn and farm field irrigation. During the summer months, most precipitation is lost to evapotranspiration and is not available to recharge the aquifer, and the elevation of the water table declines as a result of the reduced aquifer recharge and the increased aquifer withdrawals. During the winter months when water supply pumpage is reduced, agricultural pumpage is not required for irrigation, and precipitation recharges the aquifer, the elevation of the water table increases. This seasonal variation in water table elevation is illustrated further in Section 2.1.1.4 below.

As water levels and groundwater discharge to surrounding surface waters are reduced, the fresh water-salt water interface can be drawn inland by pumping in coastal areas, and the salt water beneath the fresh aquifer can be drawn vertically upwards (upconing) into wells pumping further inland. While on a community-wide basis, the 6.8 billion gallons of fresh water in storage in the aquifer can sustain potable requirements, throughout periods of low precipitation and recharge and increased pumping, shallow coastal supply wells in particular are vulnerable.

2.1.1.3 Projected Future Water Balance

The quantity of groundwater available to meet Orient's needs in the future depends on several factors, including population projections and climate change. Climate change may affect both the amount of precipitation available to recharge the aquifer, and perhaps more importantly for Orient, sea level rise, and is discussed further in Section 2.1.3.

Increased future water supply pumpage was estimated based on Suffolk County Department of Economic Development and Planning's (SCDEDP) build-out projections (2018), assuming that new residences are constructed on all existing available land in accordance with existing building codes and sanitary regulations, resulting in approximately 329 additional residences. As shown by **Figure 2-6** and **Table 2-3**, the projected increased population results in increased potable use of 791,700 gpd. Because a number of these potential residences could be built on over 200 acres of land currently used for agricultural purposes, the worst-case existing condition agricultural pumpage would be reduced by up 120,600 gpd, which would offset some of the projected increased potable supply pumping. (1) **Table 2-3** and **Figure 2-6** summarize estimated future inflows to and outflows from the Orient aquifer; conservatively assuming that precipitation and recharge remain constant. This is a conservative assumption, as projections do indicate that precipitation in the northeast part of the United States is anticipated to increase as a result of climate change over the next century (Climate Change Effects and Impacts - NYS Dept. of Environmental Conservation).

Table 2-3 Projected Future Water Budget for Full Development Scenario

Water Balance Component	Inflows (gpd)	Outflows (Low Agricultural Pumpage) (gpd)	Outflows (High Agricultural Pumpage) (gpd)
Recharge from Precipitation	4,200,000		
Recharge from Septic Systems/Cesspools	219,940		
Residential water use (showers, laundry, toilets, cooking, cleaning, lawn watering		783,200	783,200
Agricultural pumpage		110,000	429,400
Commercial pumpage (Orient State Park, Cross-Sound Ferry, etc.)		8,500	8,500
Subsurface flow to coastal waters including Long Island Sound, Orient Harbor and Hallock's Bay		3,518,240	3,198,840
Total	**4,419,940**	**4,419,940**	**4,419,940**

(1) It should be noted that the Orient Association Water Committee did not agree with this projection, however it was the only official estimate available at the time this study was prepared. The reasons that the Orient Association Water Committee did not agree with the full development projection were:
  a. Browns Hills is not necessarily representative of the community at large.
  b. Future subdivisions could include residential AND agricultural use, so agricultural water uses will not necessarily be replaced by residential water use.

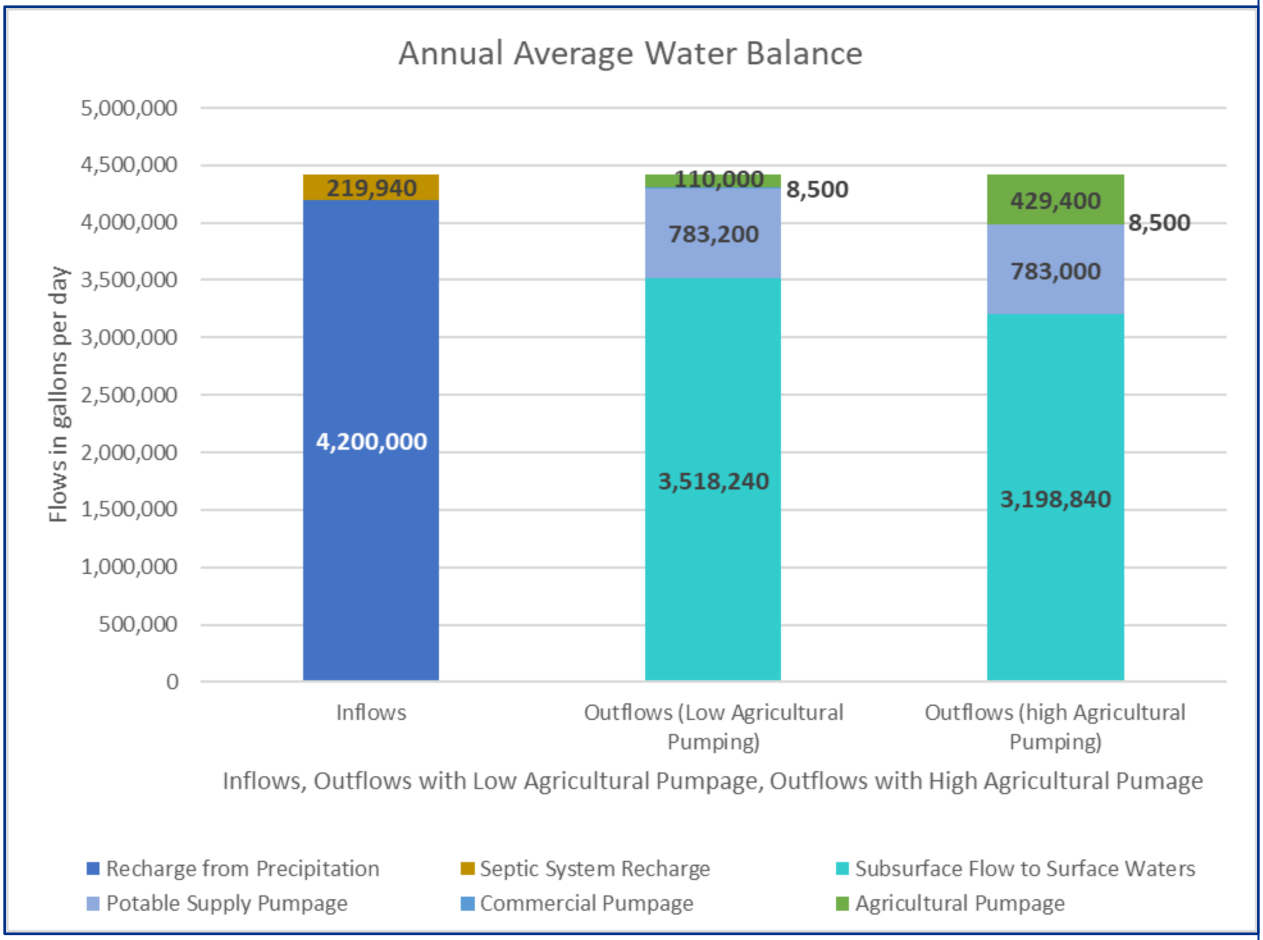


Figure 2-6 Recharge from Precipitation Is Projected to Continue to Meet Orient's Water Supply Needs Based on the Future Water Budget with High and Low Agricultural Pumpage
Note: Orient's Commercial Water Supply Pumpage is such a small fraction of the total aquifer outflow that it is not discernable on the figure.

Similar to existing conditions, overall, the community of Orient is projected to have sufficient fresh water to supply projected future needs. Nevertheless, wells in localized areas may be affected by salt water intrusion; this is further described in Section 2.1.3.

2.1.1.4 Water Level Trends

The water balance shows that residential water supply pumping is believed to be the largest demand on Orient's aquifer. The historical population data shown in **Table 2-4** illustrates that the population of Orient has been stable for over 130 years but has increased significantly over the past decade.

Table 2-4 Orient Population

Year	Orient Population
1880	786
1890	808
1900 – 1930	Data unavailable
1940	572
1950	Data unavailable
1960	697
1970	709
1980	855
1990	817
2000	709
2010	743
2020	999 - 1023

Source: **Southold Comprehensive Plan**, Orient (Suffolk, New York, USA) - Population Statistics, Charts, Map, Location, Weather and Web Information Orient, New York Population 2024

Water levels have been measured by the USGS at monitoring well S-16787, located south of Main Road since 1958 as shown on **Figure 2-7**. The data shown in the figure illustrate the seasonal and year-to-year water table fluctuations that result from variations in precipitation and recharge, but do not show any evidence of a declining water table or reduction in the amount of water available for potable supply as a result of water supply pumping.

The impacts of the seasonal variations in pumpage and recharge result in a winter or non-growing season water table that is two to three feet higher than the summer/growing season water table as shown on **Figure 2-7**.

As mentioned above, increased potable supply and agricultural pumpage during the summer months, combined with limited recharge reduces the elevation of the water table, and the fresh water discharge to the coast that prevents the landward movement of salty groundwater. Supply wells located near the coast are susceptible to saltwater intrusion as the salty groundwater migrates landward, as shown by **Figure 2-8**.

As a whole, Orient has sufficient fresh water to supply existing needs. The water balance indicates that groundwater withdrawals are in reasonable balance with inflows (e.g., recharge). The elevation of the groundwater table shown in **Figure 2-7** has not declined since 1958, indicating that current levels of water supply pumping are sustainable without depleting the aquifer. However, it is important to recognize that the aquifer is a limited resource that is vulnerable to localized over-pumping and to contamination, as described below in Section 2.2. While the aquifer has sufficient fresh water to supply the community as a whole, wells in localized areas may be affected by salt water intrusion; this is further described in Section 2.1.3.

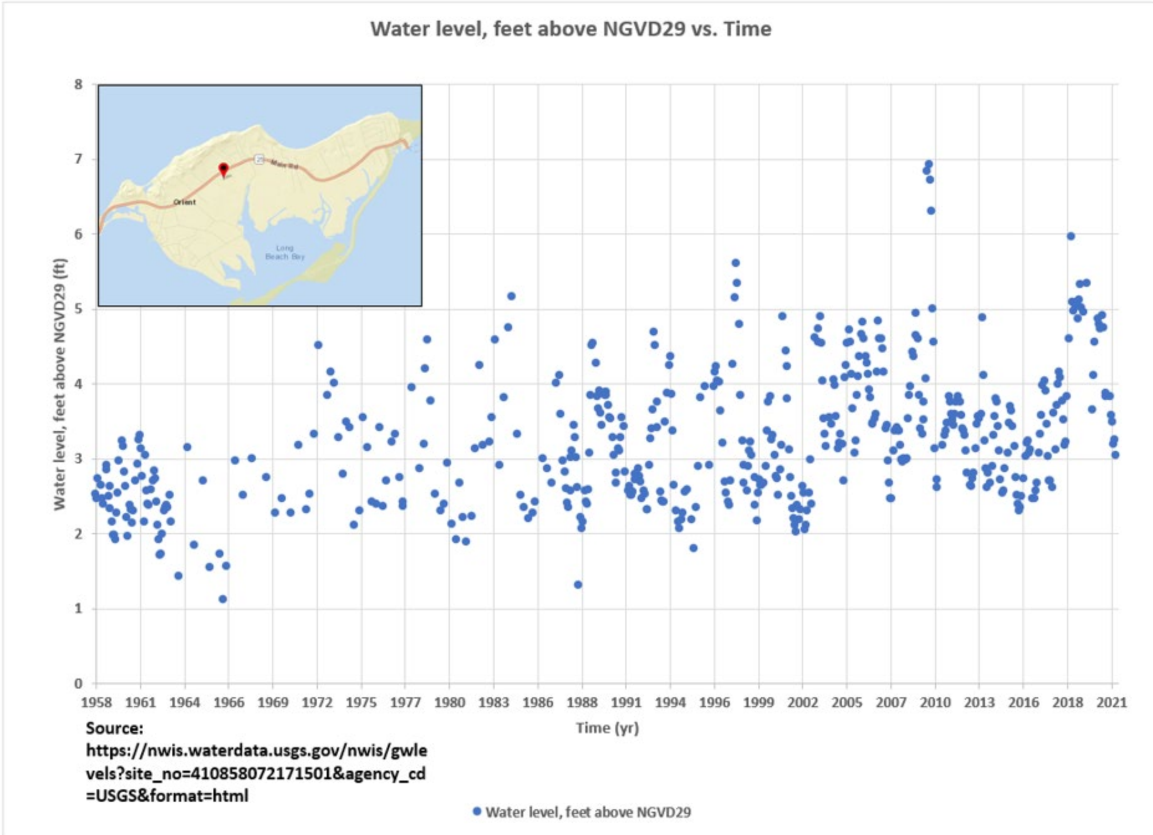


Figure 2-7 Groundwater Elevations Measured in Orient Have Not Declined Over the Past 60 Years

Notes:

1. NGVD29 is the National Geodetic Vertical Datum of 1929, which was the national standard reference datum for elevations, also referred to as Mean Sea Level of 1929. While it has been the basis for defining ground and flood elevations, it has been replaced by the North American Vertical Datum of 1988, NAVD 88.
2. The lowest water levels were observed during the historic 1962-1966 drought that occurred in the northeastern United States.

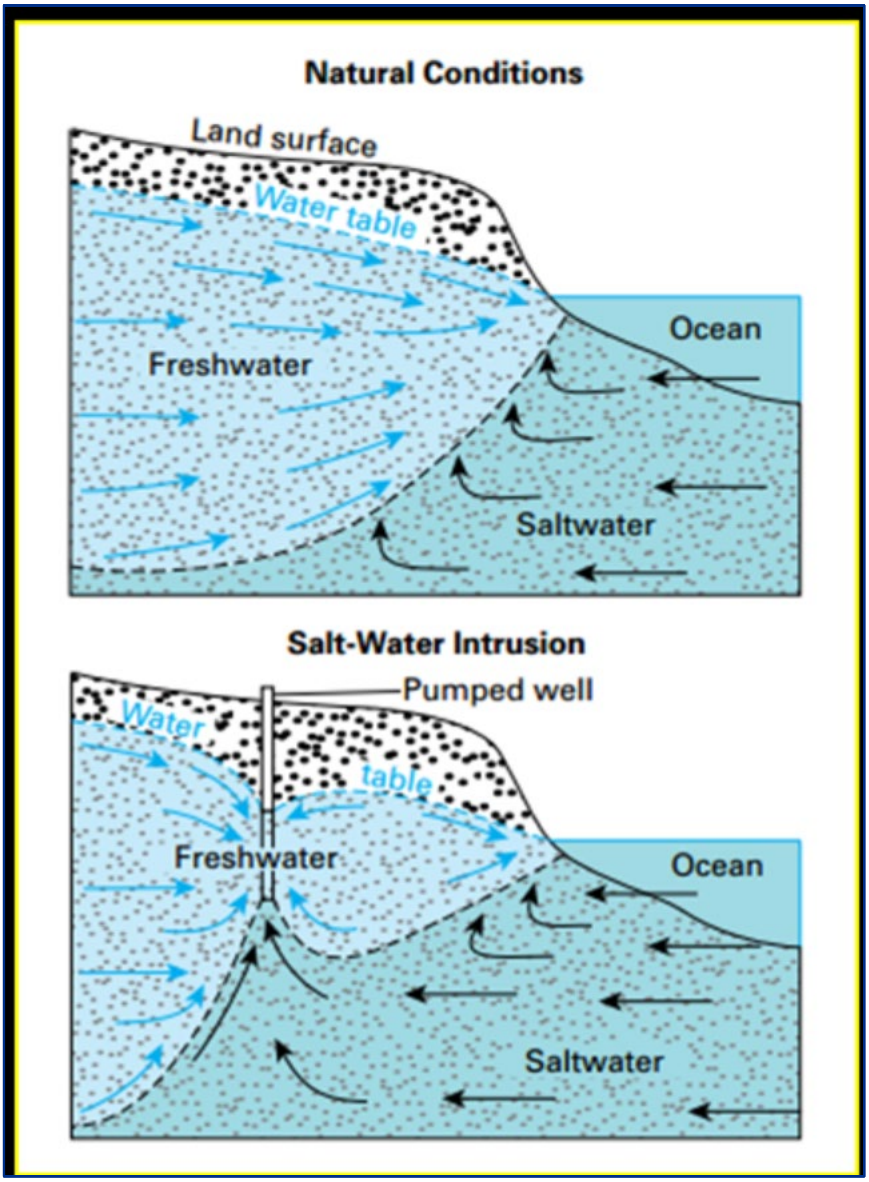


Figure 2-8 Conceptual Illustration of Salt Water Intrusion Shows How Water Supply Pumping Can Contribute to Salt Water Intrusion from the Coast and Salt Water Upconing from Beneath
Source: USGS, New York Water Science Center Public Domain

2.1.2 Groundwater Quality

Because recharging precipitation can carry contaminants introduced at or below the ground surface down to the aquifer, groundwater quality in Orient, as in other parts of Long Island may be impacted by human activities. Through the years, contaminants of concern have included nitrogen from on-site wastewater treatment systems and fertilizers, pesticides, including Temik (also known as Aldicarb) from agricultural areas, volatile organic compounds such as the gasoline additive MTBE, and recently identified contaminants of emerging concern such as Per- and Polyfluorinated Substances (PFAS). In addition, chlorides may affect the quality of wells impacted by salt water, and pathogen indicators such as fecal coliform may be a potential concern where the aquifer is shallow and susceptible to contamination from on-

site wastewater disposal. Decades of study of Suffolk County groundwater quality have confirmed that various upgradient land use types have the potential to introduce different types of contaminants to the groundwater.

EPA has established mandatory water quality standards for drinking water contaminants; these enforceable standards, or maximum contaminant levels (MCLs) are established to protect the public from consuming drinking water containing contaminants that pose a risk to human health. An MCL is the maximum allowable amount of a contaminant that can exist in drinking water delivered to a consumer. USEPA also establishes Maximum Contaminant Level Goals (MCLGs) for contaminants, based on the maximum concentration at which no known or anticipated adverse health effect would occur, including a margin of safety. New York State Department of Health (NYSDOH) also establishes drinking water criteria that may be more stringent than USEPA's and New York State Department of Environmental Conservation (NYSDEC) has established ambient groundwater standards to protect fresh groundwater use as a source of potable water supply.

EPA has also established secondary, non-mandatory water quality standards for over a dozen additional contaminants that provide guidelines to assist public water suppliers manage their drinking water for aesthetic considerations, such as taste, color, and odor. These contaminants include parameters such as color and iron among others that are not considered to pose risks to human health.

Concentrations of contaminants in concern in Orient have been compared to contaminant-specific MCLs to assess existing groundwater quality.

Community supply wells (public water systems that provide water to the same people on a year-round basis) are monitored and tested for these regulated water quality parameters on a regular basis. Suffolk County Water Authority (SCWA) routinely tests both raw (untreated) water and treated water in their distribution systems for approximately 300 parameters, about 100 more than are required by regulations. Because community supply wells are sampled consistently over the years, comparison of measured concentrations of contaminants of concern over time at the same set of wells can be used to identify water quality trends at the same locations and depths within the groundwater system.

Water quality data characterizing private wells serving individual residents in Orient is not as readily available. Suffolk County Department of Health Services (SCDHS) analyzes samples from private wells at individual homeowner request, and no longer divulges sample locations due to privacy concerns. Because water quality data is not available from the same sets of wells and/or locations over time, comparison of analytical results collected through the years at different locations is not statistically meaningful.

Instead, a qualitative review of groundwater quality over time was completed based on review of water quality testing of private wells available from SCDHS from 1997 to 2021. Through the years, contaminants including nitrogen, pesticides, pathogen indicators such as coliform, and contaminants of emerging concern have been reported.

Results of previous studies relating upgradient land use types to the potential for contaminants of concern to be observed in downgradient water quality (e.g., Suffolk County Comprehensive Water Resources Management Plans, 1983 and 2015, Long Island Source Water Assessment Program, 2003) were used to assess the potential for potential contamination of private wells in Orient. Based on the primarily unsewered residential, agricultural, and undeveloped land uses that are prevalent in Orient, the contaminants of concern that could be anticipated to be present in wells screened in the shallow upper glacial aquifer include nitrogen, pesticides, pathogen indicators and emerging contaminants of concern. The potential for chloride contamination in coastal areas and from saltwater upconing is also considered.

The results of water quality analyses from private supply wells for contaminants of potential concern in Orient are summarized below.

2.1.2.1 Nitrogen

Predevelopment concentrations of nitrate in Suffolk County's upper glacial aquifer were less than 1 milligram per liter (mg/L), but the nitrogen introduced to groundwater by on-site sanitary wastewater disposal and application of fertilizers to agricultural land, residential lawns and golf courses has significantly increased nitrogen concentrations in groundwater throughout Suffolk County and in Orient.

The MCL for nitrate has been established at 10 mg/L, based on the potential for infants who consume excessive nitrate to cause methemoglobinemia (blue baby syndrome) National Primary Drinking Water Regulations | US EPA and https://www.health.ny.gov/statistics/environmental/public_health_tracking/about_pages/drinking_water/about_dw . More recent studies have explored the relationship between nitrate in drinking water and increased potential for colorectal cancer and thyroid disease (Drinking Water Nitrate and Human Health: An Updated Review - PMC).

As part of the Long Island Nitrogen Action Plan (LINAP), SCDHS, in collaboration with a wide variety of stakeholders, recently completed a Subwatersheds Wastewater Plan (SWP) to identify the sources of nitrogen to Suffolk County waters, to characterize the water quality and ecological sensitivity to the nitrogen, and to provide a strategy to address nitrogen from wastewater sources. Working closely together with the SWP Nitrogen Loading Model Focus Area Work Group comprised of technical specialists, parcel-specific nitrogen loads were developed based upon SCDEDP land use mappings (2016). Considering all 191 subwatersheds that were evaluated, on a County-wide basis, 63.6 percent of the nitrogen load to groundwater was contributed by on-site wastewater disposal, 26.9 percent of the nitrogen load to groundwater was contributed by fertilizer, 4.4 percent was derived from atmospheric deposition to the subwatersheds, 3.9 percent was from pets, and 1.2 percent was contributed by treated sewage treatment plant effluent discharging to groundwater as shown by **Figure 2-9.**

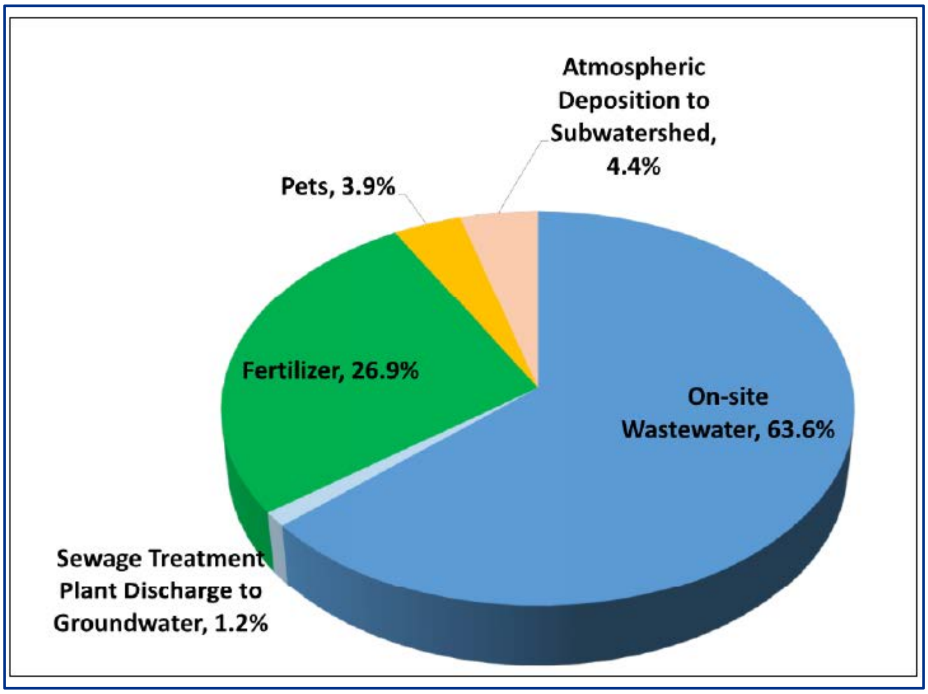


Figure 2-9 Nitrogen from Wastewater and Fertilizer are the Largest Components of Nitrogen Loading to Groundwater on a County-wide Basis (191 Subwatersheds, Suffolk County Subwatersheds Wastewater Plan, 2020)

Nitrogen from wastewater is the most significant source of nitrogen from groundwater to Suffolk County's subwatersheds and is also the most significant source of nitrogen from groundwater baseflow to eastern Long Island Sound, the Peconic Estuary and to Orient Harbor, while fertilizer was the most significant source of nitrogen to Hallock/Long Beach Bay, as described later in Section 2.1.2.

Nitrogen loading to groundwater from these sources through the years has resulted in increasing nitrogen levels in groundwater. The comparison of nitrogen concentrations in the same sets of community supply wells documented in the 2015 Comp Plan showed an increasing trend in nitrogen concentrations in the same set of 175 upper glacial community supply wells from 2.63 mg/L in 1987 to 3.69 mg/L in 2013.

Although a similar trend analysis cannot be completed for the private wells characterizing Orient, historical nitrogen concentrations in private supply wells in Orient from 1997 through 2006, and from 2007 through 2013 (two data sets provided by SCDHS) are shown by **Figures 2-10** and **2-11**. The data does not show a general trend in nitrogen concentrations between the two time periods, it does illustrate the highly variable and site-specific nature of the observed nitrate concentrations.

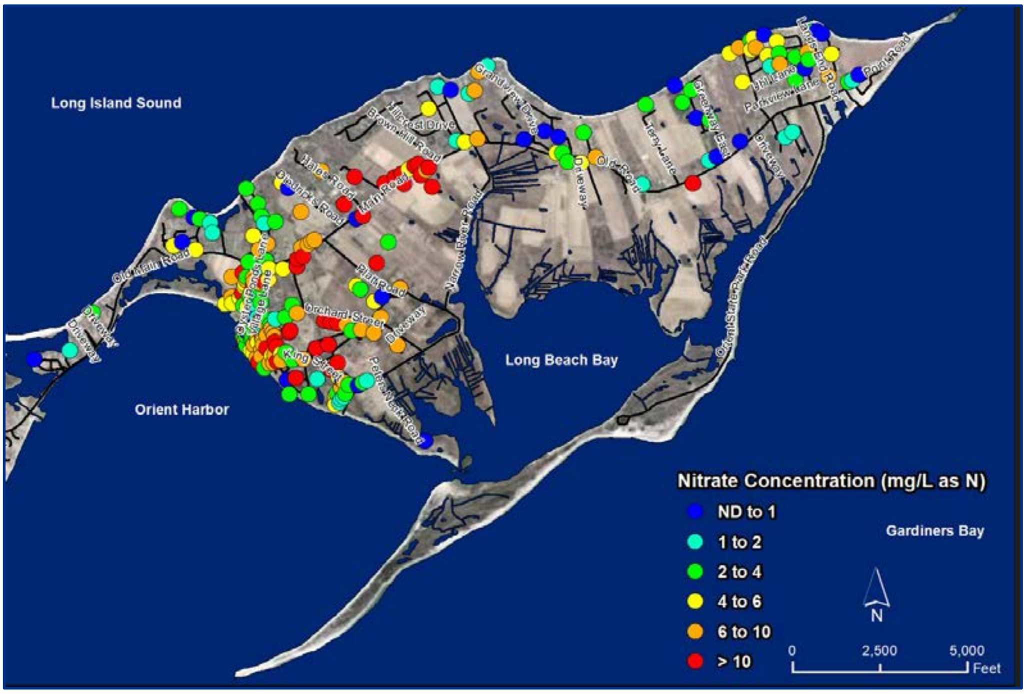


Figure 2-10 Nitrogen Concentrations in Private Wells from 1997 through 2006 Vary from < 1 mg/L to Exceedances of the 10 mg/L Drinking Water Standard
(Note: These locations are not precise and do not identify a specific property.)

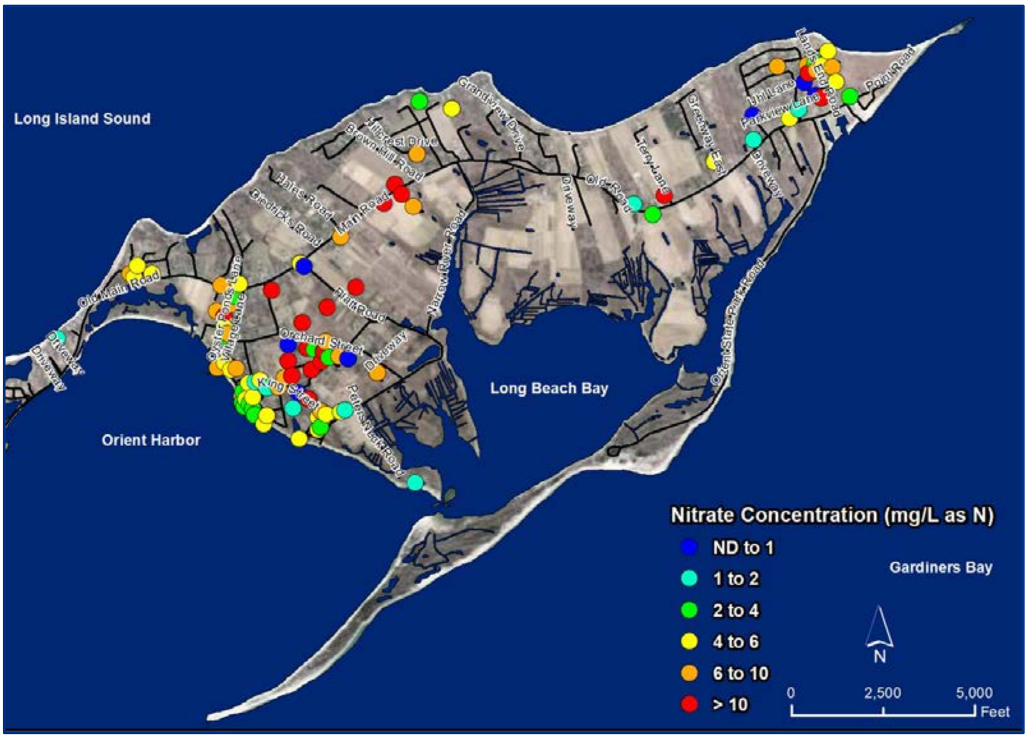


Figure 2-11 Nitrogen Concentrations in Private Wells from 2007 through 2013 Vary from < 1 mg/L to Exceedances of the 10 mg/L Drinking Water Standard (Note: These locations are not precise and do not identify a specific property.)

The dark blue dots represent nitrate levels of less than 1mg/L, essentially background levels. Blue-green dots represent very low nitrogen concentrations between 1 and 2 mg/L, and green dots show areas where nitrate concentrations are between 2 and 4 mg/L and have been impacted by human activity. Locations where nitrate concentrations are between 4 and 6 are shown in yellow; locations where nitrate concentrations are above the 6 mg/L target for Groundwater Management Zone IV, but less than the 10 mg/L MCL are shown in orange. Locations where nitrate concentrations exceeded the 10 mg/L MCL are shown in red.

More recent data provided by SCDHS revealed that 18 percent of the 137 private well samples analyzed between 2014 and 2021 exceeded the 10 mg/L MCL and 54 percent exceeded the 6 mg/L concentration identified by SCDHS as the not-to-exceed concentration in Groundwater Management Zone IV where Orient is located (Suffolk County Sanitary Code, Article 6). In fact, the arithmetic average of nitrate concentrations detected between 2014 and 2021 was 6.2 mg/L.

The estimated nitrogen loads were introduced to the County's groundwater models to estimate the nitrogen concentrations that would result if the nitrogen loads remained constant for 200 years. The simulated concentrations were compared to nitrogen concentrations measured in shallow community supply wells to confirm the model's ability to represent resulting nitrogen concentrations. Model-simulated nitrogen concentrations in Orient are shown by **Figure 2-12**; measured nitrogen concentrations in non-community supply wells are also shown for comparison. Areas shown in blue represent simulated nitrogen concentrations in the upper glacial aquifer that are less than 1 mg/L, areas shown in turquoise and green represent concentrations between 1 and 4 mg/L. Areas shaded yellow represent areas where the simulated nitrogen concentration is between 4 and 6 mg/L, areas shown in orange represent areas where the simulated nitrogen concentration is between 6 and 10 mg/L and areas shown in red are areas where the nitrogen concentration can exceed 10 mg/L if fertilization and on-site wastewater management remain constant.

Both the model projections and the limited private well data provided by SCDHS illustrate that nitrate is currently a contaminant of concern in Orient.

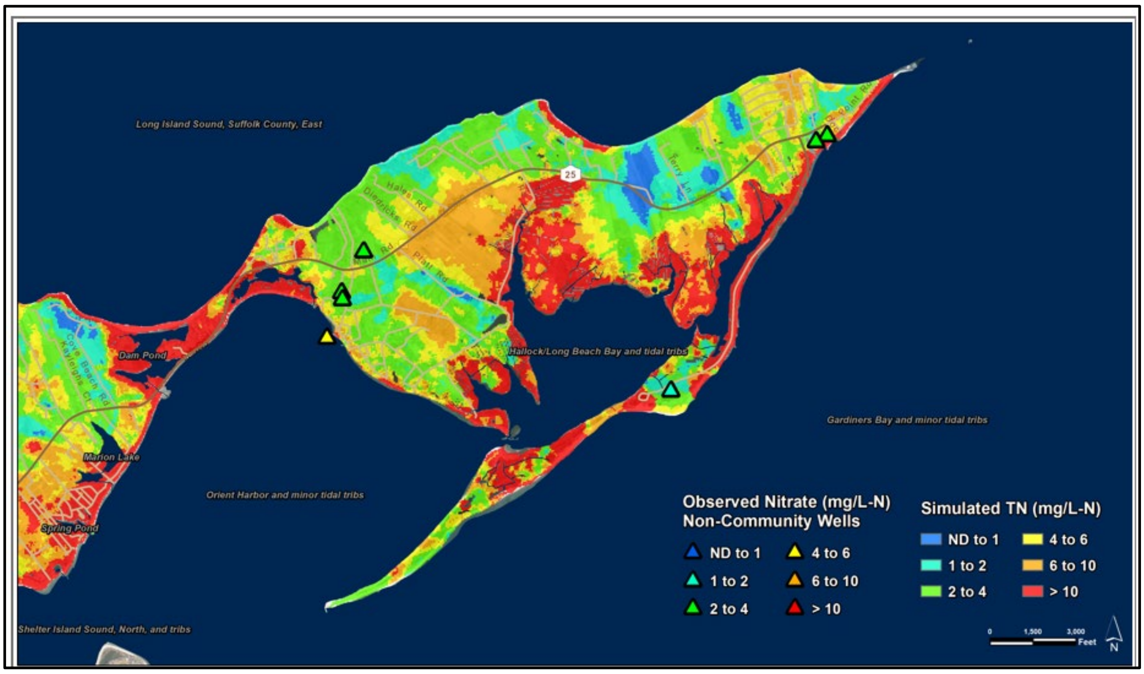


Figure 2-12 Simulated Nitrogen Concentrations Remain Low in Parts of Orient and Exceed the Drinking Water Standard in Others, Based Upon Existing Conditions of Wastewater Management and Fertilization
(Source: Suffolk County SWP, 2020. Please note that the high projected concentrations along the barrier beach are an artifact of the model discretization that did not focus on the limited fresh water found in narrow barrier beaches, rather than actual anticipated nitrate concentrations greater than 10 mg/L).

A similar evaluation was performed to assess the impact of potential build-out projections on nitrogen concentrations in the aquifer. Future projected parcel-specific nitrogen loads were developed based on Suffolk County Department of Economic Development and Planning's build-out projections. These projections were based on development potential based on the more stringent of Suffolk County Sanitary Code Article 6 density restrictions or local zoning for all vacant parcels without development restrictions, agricultural parcels without development restrictions and subdividable low density residential parcels. In Orient, based on the County's build-out projections, it was estimated that up to 329 new residences could be constructed. The projected future nitrogen loads were introduced to the County's groundwater models to estimate the nitrogen concentrations that would result if the nitrogen loads remained constant for 200 years. Estimated future nitrogen concentrations in Orient are shown by **Figure 2-13.**

Consistent with **Figure 2-12,** areas shown in blue represent simulated nitrogen concentrations in the upper glacial aquifer that are less than 1 mg/L, areas shown in turquoise and green represent concentrations between 1 and 4 mg/L. Areas shaded yellow represent areas where the simulated nitrogen concentration is between 4 and 6 mg/L, areas shown in orange represent areas where the simulated nitrogen concentration is between 6 and 10 mg/L and areas shown in red are areas where the nitrogen concentration can exceed 10 mg/L if fertilization and on-site wastewater management remain constant.

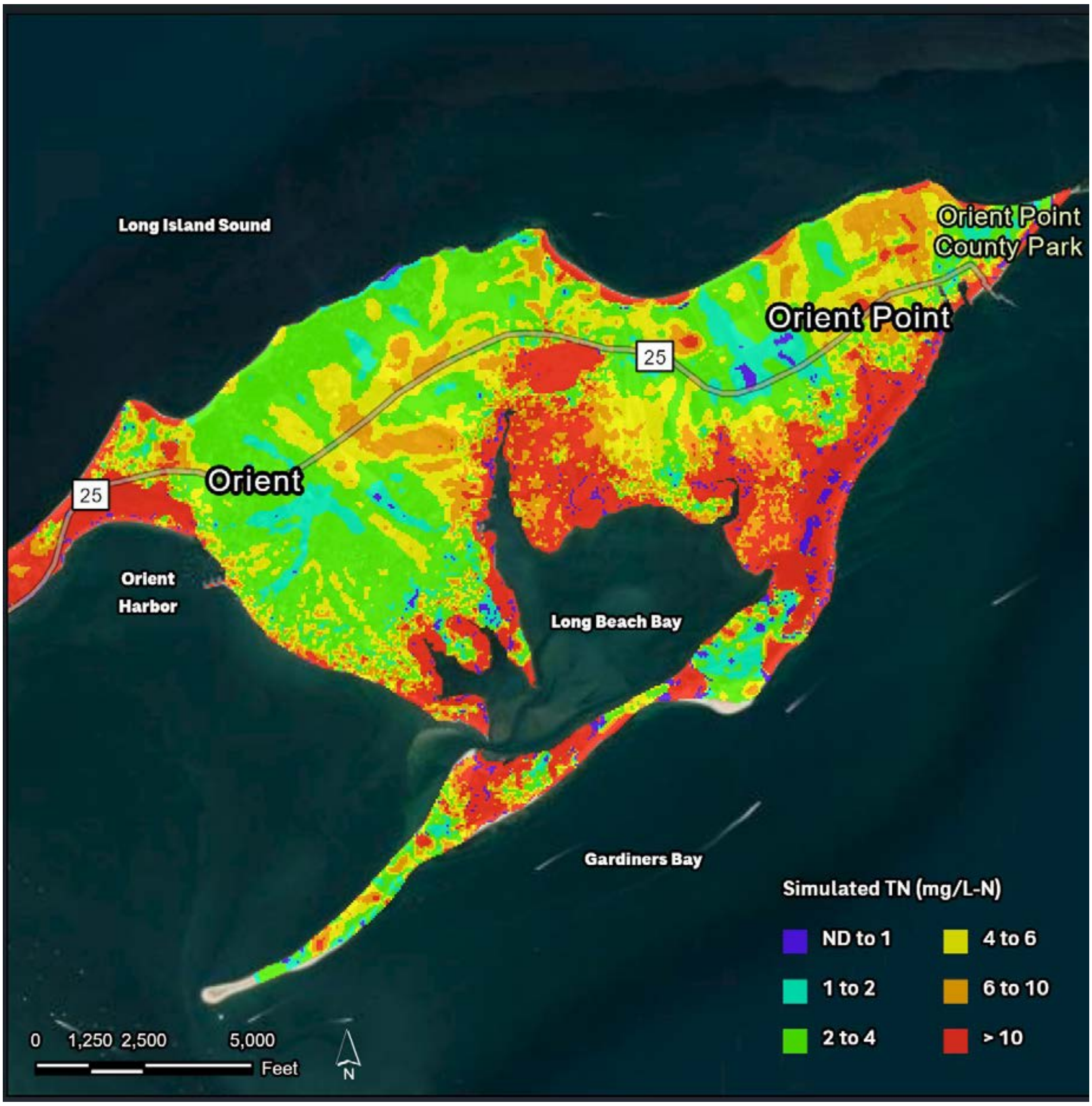


Figure 2-13 Simulated Nitrogen Concentrations Based Upon Projected Future Conditions of Wastewater Management and Fertilization (Source: Suffolk County Subwatersheds Wastewater Plan, 2020.
(Please note that the high projected concentrations along the barrier beach are an artifact of the model discretization that did not focus on the limited fresh water found in narrow barrier beaches, rather than actual anticipated nitrate concentrations greater than 10mg/L).

In general, simulated nitrogen concentrations in areas north of Main Road and areas east of Narrow River where new residences would be built on currently vacant parcels are simulated to increase by up to 2 mg/L and in some areas north of Hallocks Bay by up to 6 mg/L. In areas where residences may be built on existing agricultural areas, nitrogen concentrations are simulated to decline by up to 6 mg/L.

Model projections indicate that nitrate will continue to be a contaminant of concern in parts of Orient in the future.

2.1.2.2 Chlorides

New York State Department of Health has established a drinking water standard of 250 mg/L for chlorides; this is based on taste, rather than health considerations. High chloride concentrations can also corrode plumbing which can reduce the life of plumbing, hot water heaters and appliances, (Salt and Drinking Water) and Annual Water Quality Report Table. High chloride levels in potable supply wells can result as salt water is pulled laterally into wells in coastal areas or from salt water upconing when salt water is pulled up and into a pumping well. While water quality data obtained from SCDHS shows that coastal non-community wells (Cross Sound Ferry and Orient State Park) and two private wells in Orient have exceeded the 250 mg/L secondary MCL for chlorides since 2014. Recent data from the SCDHS survey in Orient Village showed that chloride levels in seven wells of the 178 tested exceeded the 250 mg/L criteria with chloride levels ranging from 289 to 616 mg/L. Anecdotal information suggests that increasing chloride concentrations are being observed, both in coastal and inland areas, where pumps may be deployed at shallower depths.

Chloride contamination from salt water intrusion and upconing are anticipated to be of increasing concern in the future as sea level rises; please see Section 2.1.3.

2.1.2.3 Pesticides and Herbicides

Pesticide contamination in Suffolk County has been primarily associated with agricultural land use, although residential, commercial and institutional lawn care may also introduce pesticides and herbicides to groundwater. It is important to note that the presence of agriculture does not always mean that pesticide contamination will result; previous assessments of Suffolk County groundwater quality have also shown that pesticides are not always detected in wellfields downgradient of agricultural land.

Contaminant-specific MCLs have not been established for most pesticides and pesticide degradation products. Instead, NYSDOH typically regulates pesticides as Unspecified Organic Contaminants (UOCs), with a drinking water criterion of 50 parts per billion or ug/L. The sum of all pesticides and their breakdown products may not exceed 100 ug/L in drinking water. Health-impacts of pesticides and herbicides in drinking water are product-specific and include a wide range of potential impacts including anemia, cancer, kidney, intestinal, liver and reproductive system impacts and more. Pesticide and herbicide-specific impacts may be found at National Primary Drinking Water Regulations | US EPA and Annual Water Quality Report Table.

It is also important to recognize that only a small percentage of pesticides are tested for, and that other pesticides or their degradates that are not analyzed may be present in groundwater. SCDHS has been on the forefront of pesticide monitoring, including development of analytical methods to analyze for carbamate pesticides including aldicarb and the herbicide dacthal and its breakdown products (e.g., TCPA). The County has implemented several intensive pesticides monitoring programs over the past fifty years, when aldicarb (Temik) was detected in several private wells in eastern Suffolk County. SCDHS collected and

analyzed samples from more than 8,000 private wells during the initial monitoring events, focusing on additional carbamate pesticides (e.g., carbofuran, oxyamyl, methomyl), soil fumigants (1,2 Dichloropropane, EDB) and the herbicide dacthal that was known to be widely-applied to agricultural areas.

The 2015 Comprehensive Water Resources Management Plan described how public and private well data compiled for selected pesticides from 1980 through 2014 showed that some agricultural pesticide chemicals may persist in groundwater for decades, and that pesticide degradates have been detected more frequently and at higher concentrations than some of the parent compounds. The Plan also described how crop type significantly impacted the type and concentration of pesticides observed in downgradient groundwater and described historical detections of alachlor, metolachlor and parent pesticides or metabolites/degradates of aldicarb and metabolites of dacthal in private wells in Orient.

Given the surrounding land uses and the shallow nature of Orient's groundwater supply, the continued actual and potential presence of pesticides in Orient's groundwater remains a concern. As pesticide and herbicide applications are increasingly regulated, and farmers continue to work with the Farm Bureau, Cornell Cooperative Extension and Suffolk County on agricultural stewardship and integrated pest management, it is anticipated that pesticide concentrations in groundwater will decline in the future.

2.1.2.4 Pathogen Indicators

Pathogens, including bacteria, viruses and protozoa can be a direct and immediate threat to human health, causing disease by consumption of contaminated water, recreational contact or ingestion of contaminated shellfish. Fecal wastes of humans and animals are the source of most common waterborne pathogens in the United States (USEPA). Pathogens can cause a of gastrointestinal illnesses with symptoms that include diarrhea, cramps, nausea, or other symptoms (National Primary Drinking Water Regulations | US EPA). In Orient, on-site wastewater treatment systems are likely to be the primary source of pathogens introduced to groundwater. Rather than measure the waterborne pathogens themselves, fecal indicator bacteria (FIB), such as fecal coliform, E. Coli and enterococcus are monitored. These FIB identify the possible presence of pathogens associated with fecal waste.

Pathogen transport is influenced by precipitation and organism-specific characteristics. Organism survival is influenced by a variety of factors including moisture, temperature and sunlight. Pathogen removal from onsite wastewater treatment systems occurs primarily when the microorganisms die as they are sorbed to sediments in the unsaturated zone, which is typically an inhospitable habitat for pathogens that originate within the human body.

Twenty-three samples collected from private wells and analyzed for pathogen indicators between 2014 and 2022 exceeded drinking water criteria for coliform; this sample set includes multiple positive detections of pathogen indicators from thirteen monitoring points. These detections indicate that some locations in Orient may be at risk of direct contamination from onsite wastewater disposal systems. As sea level rises, contamination by pathogen indicators is likely to be of increased significance downgradient of developed coastal areas as further described in Section 2.3.

2.1.2.5 Contaminants of Emerging Concern

USEPA and New York State continue to identify new contaminants of concern; that is contaminants with impacts to human health that may be found in drinking water. The process by which USEPA identifies contaminants with potential human health impacts that may be found in drinking water may be found here: SDWA Evaluation and Rulemaking Process | US EPA.

The Safe Drinking Water Act requires EPA to regulate contaminants that may be found in public water supplies when regulation can improve public health protection. Every five years, EPA publishes a Contaminant Candidate List (CCL) of currently unregulated contaminants that may be detected in public water systems. After monitoring and evaluation, EPA determines whether or not these contaminants should be regulated, based upon:

- Whether the contaminant may have adverse health effects;
- Whether the contaminant is found (or likely to be found) in public water systems at concentrations of concern and
- Whether there is a meaningful opportunity to reduce health risks by regulation.

Drinking water standards have recently been established for one group of chemicals that is of particular importance to Orient based upon their detection in Orient groundwater and private wells; that is PFAS, or per- and polyfluoroalkyl substances.

2.1.2.5.1 Per- and Polyfluoroalkyl substances (PFAS)

Per- and Polyfluoroalkyl substances (PFAS) are a group of approximately 15,000 manufactured compounds that have been used in industry and in consumer products since the 1940s (https://www.niehs.nih.gov/health/topics/agents/pfc, https://www.epa.gov/pfas/pfas-explained). Perfluorooctanoic acid (PFOA) and Perfluorooctane Sulfonate (PFOS) are two of the most widely used and studied PFAS compounds. PFAS have been used to make fluoropolymer coatings and products that resist heat, oil, stains, grease and water. They are found in firefighting foams, in manufacturing facilities and in a wide variety of products including water-repellent clothing, furniture, adhesives, paints and varnishes, food packaging (e.g., fast food containers, microwave popcorn bags, candy wrappers, etc.), non-stick cookware, electrical wire insulation and in some personal care products, including shampoos, dental floss and cosmetics.

Because the carbon-fluorine bond is one of the strongest, PFAS do not degrade easily. The persistence of PFAS compounds allows them to remain in the environment over time. USEPA and the Agency for Toxic Substances and Disease Registry (ATSDR, How PFAS Impacts Your Health | PFAS and Your Health | ATSDR) report that exposure to specific PFAS compounds above certain levels can cause:

- Increased cholesterol levels and risk of obesity;
- Reduced ability of immune systems to fight infections and lower antibody response to some vaccines;

- Changes in liver enzymes;
- Reproductive impacts including reduced fertility and hypertension and preeclampsia in pregnant women;
- Developmental effects in children including low birth weight, bone variations or behavioral issues, and
- Increased risk of some cancers (prostate, kidney and testicular cancers were cited).

Recognizing the potential health related impacts of very low concentrations of PFAS, New York State was among the first states in the nation to regulate PFAS in drinking water, establishing the New York State MCL for PFOS and PFOA at 10 parts per trillion (ppt) or 10 nanograms/liter (ng/L) in 2020. (EPA has since established even lower limits of 4 ppt for PFOS and PFOA and 10 ppt for PFHxS, PFNA, HFPO-DA – also known as GenX Chemicals; public supplies must comply with these MCLs within five years; New York State is working to establish drinking water standards for up to 23 PFAS.)

2.1.2.5.2 PFAS in Orient

After PFAS compounds were detected in several private wells in Orient, SCDHS initiated a private well survey in October 2022. The private well survey area was expanded sequentially in January 2023, September 2023 and September 2024 to ultimately include the study area shown in **Figure 2-14**. There are an estimated 247 private wells in the expanded study area, serving 243 properties. Throughout this period, SCDHS conducted multiple rounds of outreach to provide additional opportunities for private well sampling.

As of March 2025, SCDHS has sampled 194 of the wells in the survey area (50 residences either did not respond to the SCDHS offer to sample their well, or they declined to have the well sampled, or the home is currently vacant/unoccupied. Three sampling requests were pending at the time of report preparation.)

The results of the private well survey revealed that:

- Water from 93 wells[(1)] exceeded the NYS MCL for PFOS or PFOA (the highest combined PFOS/PFOA concentration was 3,350 ppt);
- PFOS or PFOA was detected below the NYS MCL in 92 wells, and
- Neither PFOS nor PFOA was detected in nine of the wells.

The Orient Fire Department has been identified as the potential source of the observed PFAS contamination. New York State Department of Environmental Conservation has identified the Orient Fire Department as a Class P site (152273), that is a potential State Superfund site. The Fire Department will conduct an environmental investigation with NYSDEC oversight to confirm and assess the potential source, the extent of contamination and the need for remediation.

(1) Includes one well on a property that had a PFOS MCL exceedance in a sample the owner had analyzed by a private laboratory.

Figure 2-14 Orient Private Well Survey Area (Source: SCDHS, March 2025)

To date, NYSDEC has provided filtration systems or bottled water for households in the SCDHS survey area with concentrations of PFOS or PFOA above the state standard of 10 ppt.

SCDHS initiated two smaller surveys in in 2024 in Orient Point. The source of PFAS in this area is unknown, but is likely to be localized. It should be noted that PFAS is present in many household products which can make their way into the aquifer. (See Section 3.3.3 for tips on best practices.)

2.1.2.6 Groundwater Quality

Orient's shallow aquifer is highly vulnerable to contamination by overlying land uses, including contaminants introduced by onsite wastewater treatment systems, particularly in densely developed areas. Both available water quality data and predictive modeling indicate that developed areas of the community are susceptible to high concentrations of nitrate. Eighteen percent of the private wells tested between 2014 and 2021 exceeded the 10 mg/L standard for drinking water and the average concentration of all wells exceeded the 6 mg/L threshold established for Groundwater Management Zone IV by the Suffolk County Sanitary Code. Elevated nitrogen from on-site disposal of sanitary wastewater may be considered a surrogate for other contaminants of concern that are contained in sanitary wastewater. While more limited data is available to characterize other contaminants of emerging concern, recent detections of PFAS compounds are alarming and show.

Orient's shallow aquifer system is vulnerable from contamination from human activities such as discharge of sanitary wastewater, spills, and application of fertilizers, pesticides and herbicides. The presence of PFAS compounds in multiple private wells that appears to have resulted from a release at one facility underscores the susceptibility of Orient's aquifer to contamination. All within the community should be aware that the products they choose to use may impact drinking water quality. Continued monitoring of the resource is important. Chloride contamination in wells located near the coast will be of increasing concern as sea level continues to rise.

2.1.3 Climate Change

Climate change, and the impacts of climate change are being studied by scientists throughout the world. NYSDEC identifies a variety of effects of climate change that are impacting communities (including Orient) and ecosystems throughout the state and, in fact, the world (Climate Change Effects and Impacts - NYS Dept. of Environmental Conservation). Three of the many predicted effects of climate change in particular may have an impact on Orient's water resources; these are sea level rise, increased precipitation and increased temperature. In recent years, it has become apparent that climate change is not a future problem, but a current problem. Sea levels will continue to rise in response to the warming that has already occurred. Sea level rise is anticipated to have the most significant impact on Orient's aquifer and potable supply, and the potential future impacts of sea level rise on Orient's groundwater resource are described here.

The New York State Community Risk and Resiliency Act (CRRA) required to adopt science-based projections of sea level rise to guide decision making, including permitting, regulations and funding. The groundwater modeling evaluations summarized below rely on the high-

medium projections that were developed in 2016 and are shown in **Table 2-5**. The North Fork groundwater model was used to estimate the impact of predicted sea level rise on Orient's groundwater quantity and quality, based on average monthly rates of precipitation, recharge and water supply pumping and the New York State High-Medium projection of sea level rise (e.g., an increase of sea level elevation of 21 inches by the 2050s and 47 inches by 2100) which was consistent with the National Oceanic and Atmospheric Administration (NOAA)'s 2022 intermediate projection.

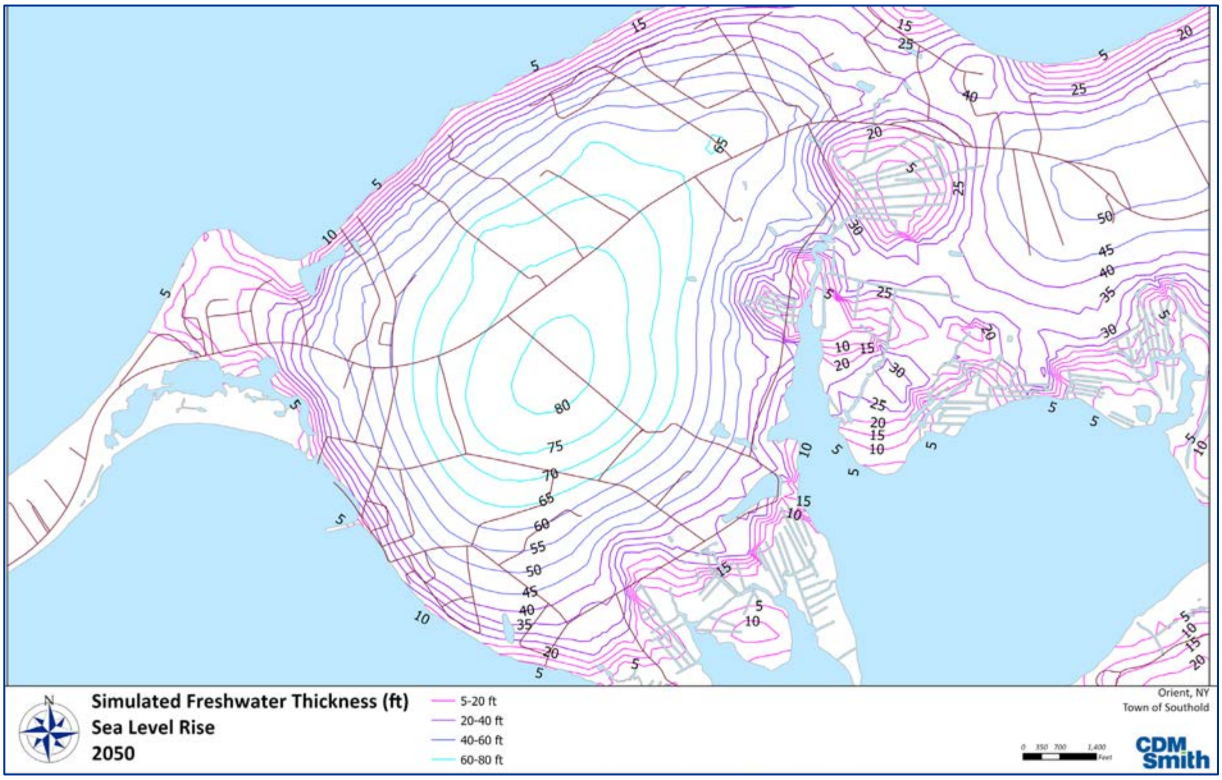
Table 2-5 Sea Level is Projected to Rise by 21 Inches by 2050 and 47 Inches by 2100 (Inches, Relative to 2000-2004 Baseline, 6 NYCRR Part 490)

(c) Long Island Region

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection
2020s	2 inches	4 inches	6 inches	8 inches	10 inches
2050s	8 inches	11 inches	16 inches	21 inches	30 inches
2080s	13 inches	18 inches	29 inches	39 inches	58 inches
2100	15 inches	21 inches	34 inches	47 inches	72 inches

Sea level rise is one of the most significant threats to Orient's water supply, both in terms of future impacts to water quantity and water quality, particularly in coastal areas. Sea level rise is likely to impact Orient's aquifer and the reliability of the potable supply in several ways:

- Predicted sea level rise will result in salt water contamination of coastal wells and may result in salt water upconing at inland wells. As sea level rises, the maximum thickness of Orient's fresh water aquifer is anticipated to decline by up to five feet by 2050 and by up to ten feet by 2100 as shown on **Figures 2-15** and **2-16**, respectively.
- **Figure 2-17,** a west to east cross section through Orient illustrates the impact of sea level rise on aquifer thickness. The blue line shows the simulated interface between fresh groundwater and the underlying salt water during predevelopment conditions; that is, before water was removed from the aquifer for consumption and agricultural irrigation. The yellow line shows the approximate current interface location. The red line shows how the salt water is predicted to move higher up into the fresh groundwater based on projected sea level rise in 2100, resulting in reduced aquifer thickness. The predicted reduction in aquifer thickness varies depending on a number of factors, but is anticipated to exceed twenty feet in the vicinity of Narrow River.
- Overall, the fresh water stored in the aquifer is projected to decline by up to 20 percent, as shown on **Figure 2-18**; this will impact the quantity of potable supply available to future residents.



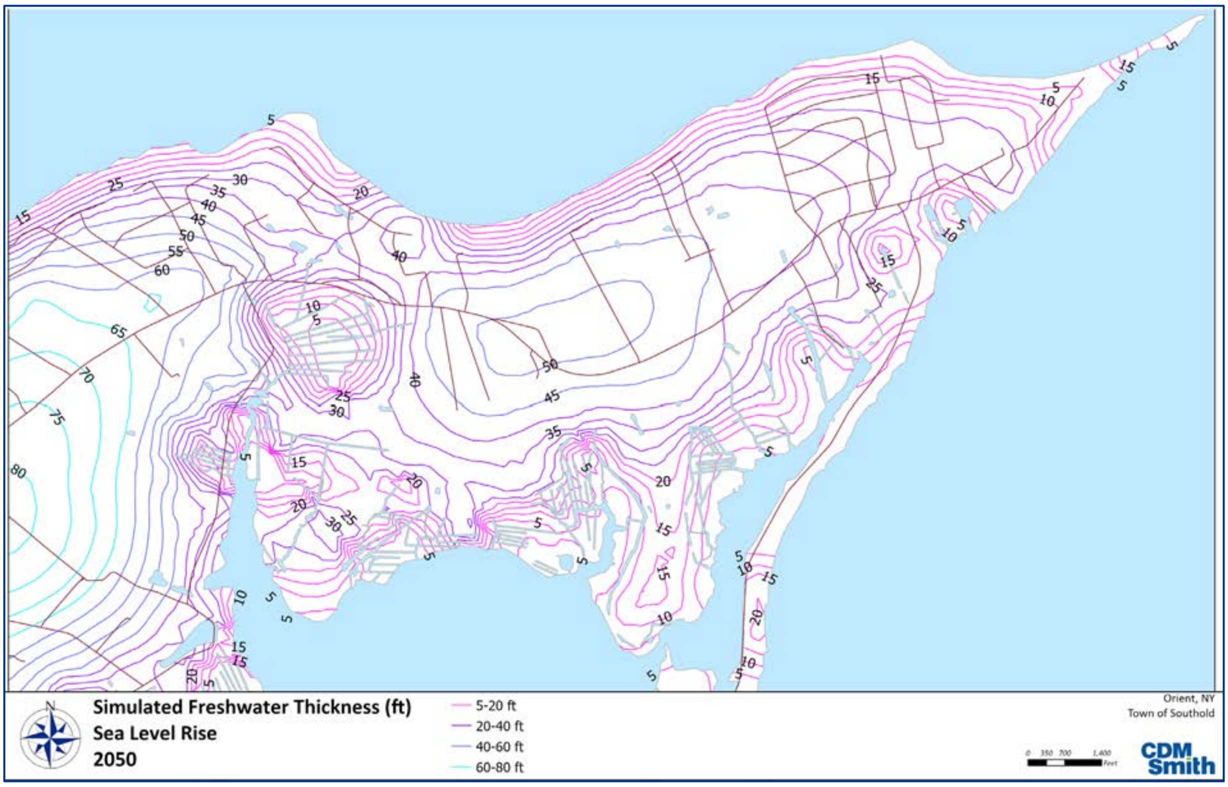


Figure 2-15a and 2-15b The Thickness of Some Areas of Orient's Freshwater Aquifer is Simulated to Be Reduced by 2050 as a Result of Projected Sea Level Rise

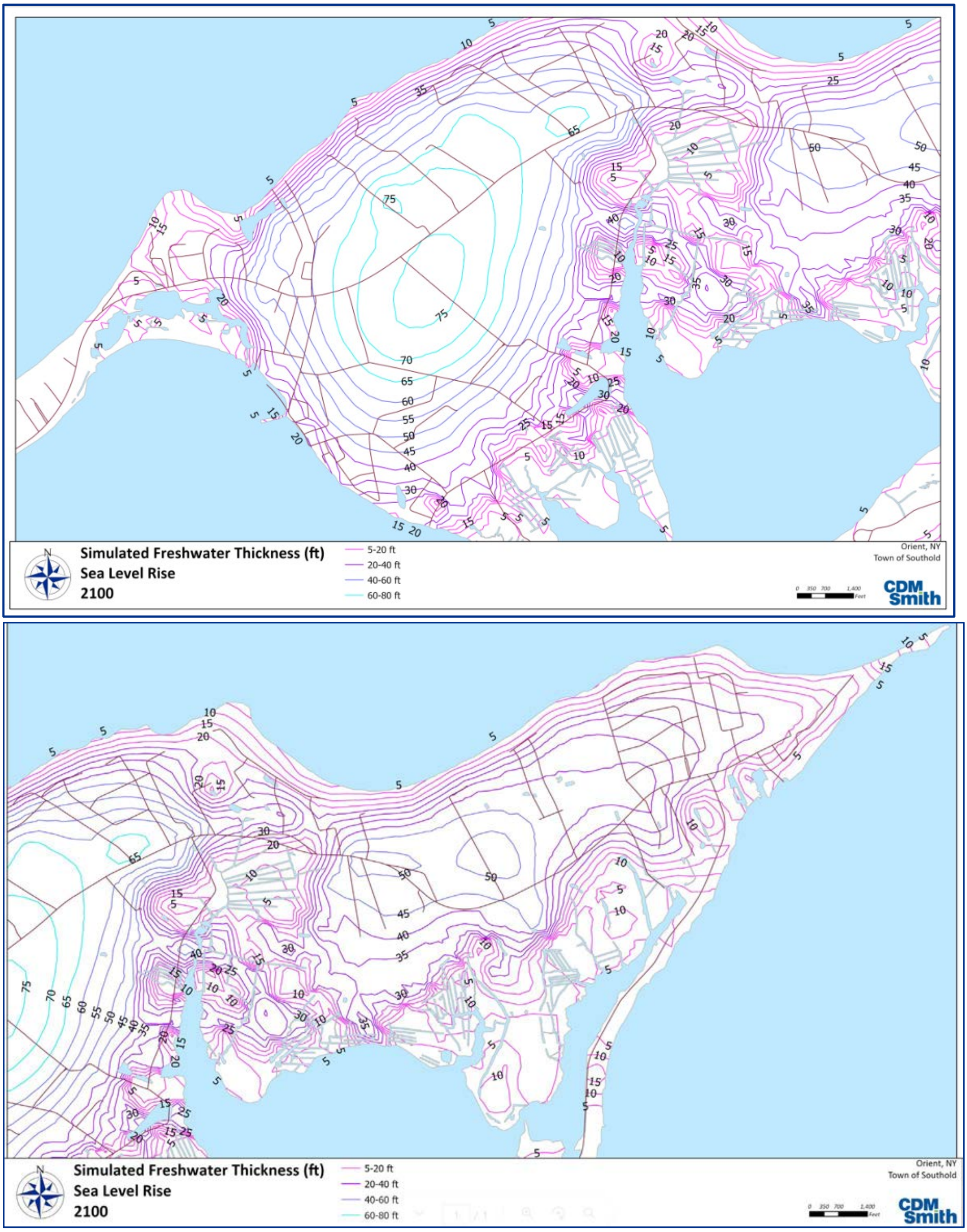


Figure 2-16a and 2-16b The Thickness of Some Areas of Orient's Freshwater Aquifer is Simulated to be Reduced by 2100 as a Result of Projected Sea Level Rise

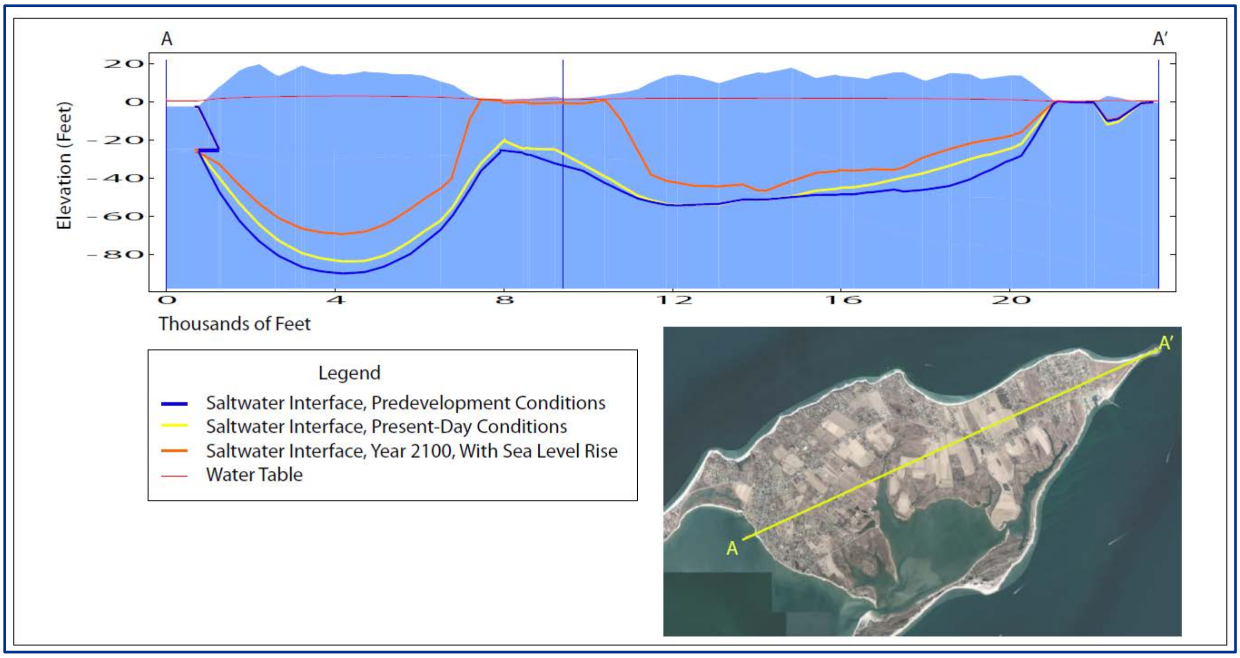


Figure 2-17 Cross Section Shows the Reduction in Orient's Aquifer Thickness Resulting from Predicted Sea Level Rise

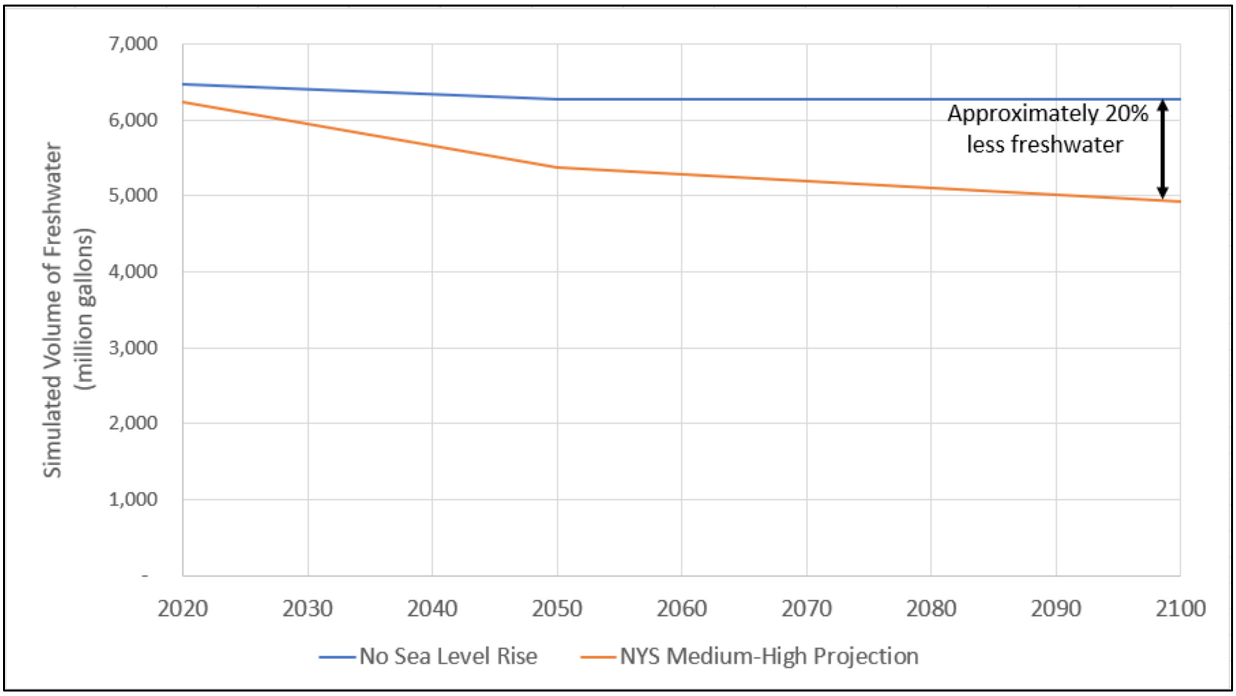


Figure 2-18 Available Fresh Groundwater is Predicted to Decline by Approximately 20% by 2100 as a Result of Sea Level Rise

- The impacts of sea level rise on Orient on Orient's water supply will have significant localized impacts in coastal areas. **Figure 2-19** highlights the areas of Orient where the freshwater aquifer is both already limited and is projected to be reduced even further by 2100 as sea level rises. **Figure 2-19a** shows the freshwater thickness in 2020, which can be compared to the predicted freshwater thickness in 2100, shown in **Figure 2-19b**. In **Figure 2-19c**, the areas where there is predicted to be a significant reduction in freshwater thickness and the freshwater thickness is less than 40 feet are outlined in yellow. The freshwater thickness at each parcel is indicated by the color-coded markers as follows:
  - Freshwater thickness less than 10 feet are tagged with light blue symbols;
  - Freshwater thicknesses between 10 and 20 feet are tagged with green symbols;
  - Freshwater thicknesses between 20 and 30 feet are tagged with red symbols;
  - Freshwater thicknesses between 30 and 40 feet are tagged with purple symbols, and
  - Greater than 40 foot freshwater thicknesses are symbolized in white.

Figure 2-19a Freshwater Thickness at Private Wells on Properties, 2020

Figure 2-19b Freshwater Thickness at Private Wells on Properties, 2100

Figure 2-19c Areas of Projected Significant Impacts from Sea Level Rise, 2100
Note: The figures show structures in addition to houses on some properties.

- Projected changes in freshwater thickness as a result of sea level rise are summarized in **Figure 2-20**, which shows the projected number of buildings in each depth-to-salt water interface interval through 2100 (note that this total is primarily homes and commercial establishments, but may include ancillary structures such as garages and barns in some cases). Together, the figures show that private wells located in the Village and the eastern most part of Orient will be most vulnerable to rising seas.

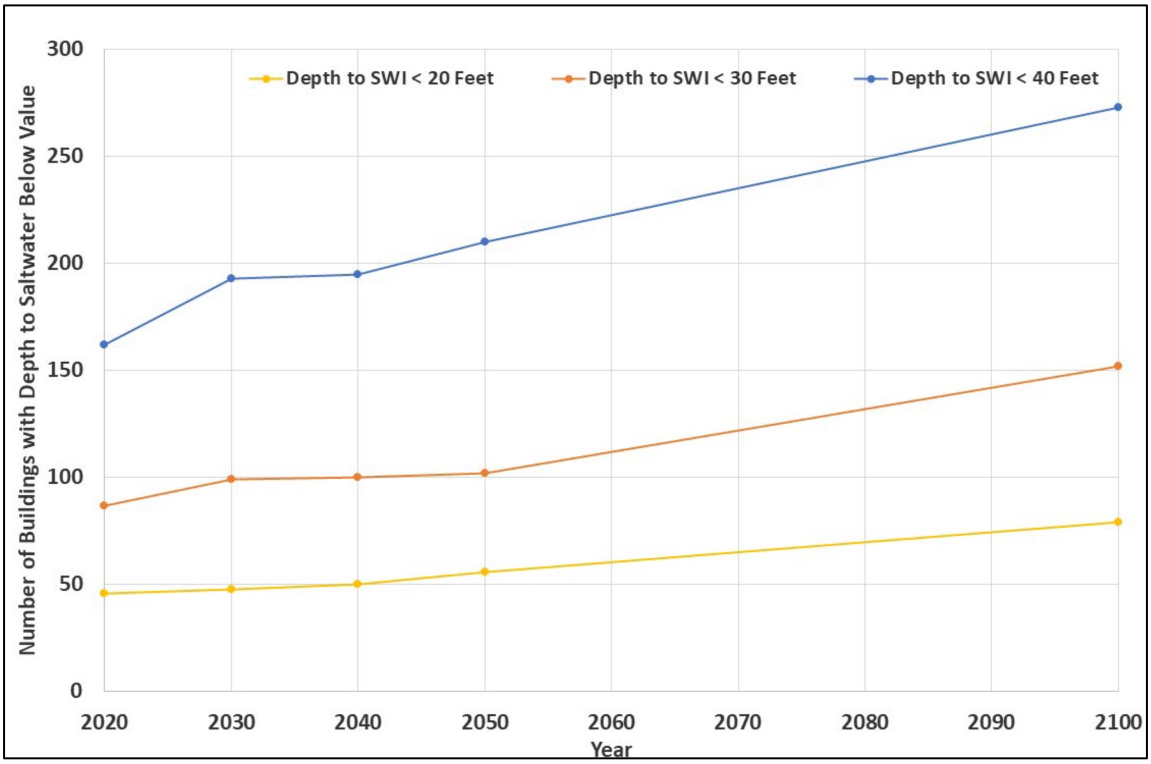


Figure 2-20 Sea Level Rise is Projected to Increase the Number of Buildings with Shallow Depths to the Salt Water Interface (and Reduced Fresh Aquifer Thickness)

- Sea level rise is predicted to result in an elevated water table, particularly in coastal areas. This increase in water table elevation will be heightened during high tides and will be exacerbated by more frequent intense storm events (according to the NYSDEC, the northeastern part of country experienced an over 70 percent increase in heavy precipitation from 1958 to 2010). The impacts of sea level rise are already being observed in coastal communities such as Orient. Several on-line mappers depict the projected impacts of sea level rise exacerbated flooding. **Figures 2-21** and **2-22** illustrate projected inundated areas in Orient in 2050 and 2100 based on the North American Oceanic and Atmospheric Administration (NOAA) mapper ([Sea Level Rise and Coastal Flooding Impacts (noaa.gov)]).

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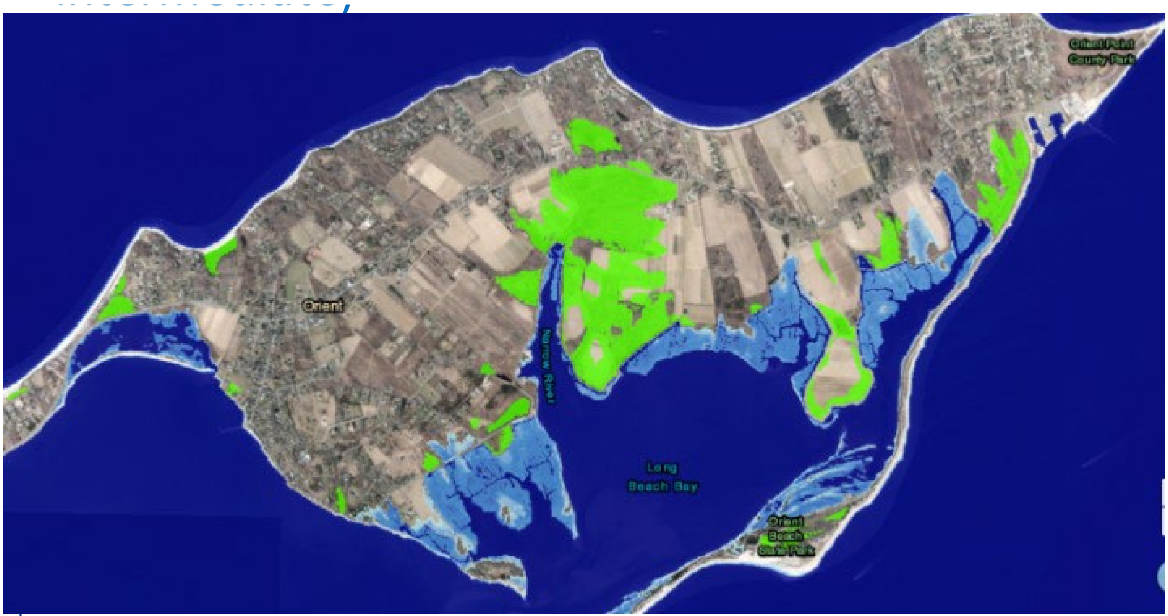


Figure 2-21 Predicted Inundation from High-Intermediate Sea Level Rise Projections, 2050

Source: NOAA Sea Level Rise and Coastal Flooding Impacts (noaa.gov) Flooded areas are shown in light blue (connected to surface waters) and green (not directly connected to a surface water, e.g., flooding may result from an elevated water table).

Figure 2-22 Predicted Inundation from High-Intermediate Sea Level Rise Projections, 2100

Source: NOAA Sea Level Rise and Coastal Flooding Impacts (noaa.gov) Flooded areas are shown in light blue (connected to surface waters) and green (not directly connected to a surface water; the green areas are predicted to become "blue areas" by 2100 as sea level elevation continues to increase from 2050).

- Sea level rise may impact the quality of both groundwater and downgradient surface water. Suffolk County Standards for On-Site Wastewater Disposal Systems require a minimum three-foot separation distance between the bottom of a septic system leaching pool and the highest recorded water table to provide adequate treatment in the unsaturated zone prior to wastewater discharge to groundwater (please see **Figure 2-34**). This typically translates to a minimum depth of 9 feet to the high-water table for a single-family household with four or fewer bedrooms. If the unsaturated zone is reduced or eliminated as the water table rises, a direct conduit between sanitary wastewater containing pathogen indicators and other contaminants of concern, and the groundwater is created, increasing the risk of groundwater that does not meet drinking water quality criteria. This is of concern in coastal areas where increasing intensity of storm events overwhelms the storm drainage system, resulting in saturated soils and standing water that may also impact septic system effectiveness.

It is important to acknowledge that our understanding of climate change and projections of sea level rise continues to evolve as more research and modeling studies are completed. As more data is collected, the understanding of the causes of sea level rise (e.g., thermal expansion, glacial ice melt, etc.) and how these processes will impact changes in sea level in the future improves. Advances in this science and in modeling result in improved projections of future sea level rise. The evolving study of climate change and resulting updated projections of impacts underscore the importance of monitoring the changes in sea level rise projections, particularly for coastal communities such as Orient.

Sea level rise represents one of the most significant threats to Orient's water supply, in terms of future impacts to both water quantity and water quality, particularly in coastal areas.

2.2 Surface Water

2.2.1 Existing and Future Surface Water Quality

While changes in groundwater quality are not readily discernible to the eye, Orient residents have directly observed changes in the surrounding surface waters. Through the years, they have observed declines in finfish, shellfish and eelgrass beds in Orient Harbor, Hallock Bay and Long Island Sound. In the following pages, existing data characterizing levels of nitrogen, oxygen, pathogen indicators and temperature measured in Orient's surface waters are compared to accepted standards for healthy surface waters.

2.2.1.1 Overview of Available Water Quality Data and Water Quality Standards and Water Quality Data

Orient is bordered by two estuaries of national significance, the Long Island Sound (LIS) and the Peconic Estuary. The water quality and ecosystems of both estuaries have been studied extensively for decades. Data, investigations, research and water quality modeling, along with work towards implementation of the Long Island Sound Comprehensive Conservation and Management Plans may be found for the LIS at https://longislandsoundstudy.net/ and for the Peconic Estuary Program at https://www.peconicestuary.org/. These extensive repositories of information characterizing the estuaries and their embayments and harbors are not summarized here.

Both estuaries provide important habitats to a variety of marine life including shellfish, finfish, and submerged aquatic vegetation. The estuary programs have evaluated how water quality affects these resources, and the impacts of contaminants introduced by both point and nonpoint sources on water quality and marine life. A point source of contamination is a readily identifiable source such as a pipe or outfall from a factory or wastewater treatment plant. Non-point sources of contamination are released over a wider area; examples include nitrogen from fertilizer that is carried to a surface water by stormwater runoff or nitrogen from septic system discharges to groundwater that travels to surface water discharge. Both estuary programs have demonstrated that nutrients (particularly nitrogen) and pathogens have been responsible for water quality impairments. In western Long Island Sound and in Peconic Estuary embayments west of Orient, reduced oxygen levels and increased algal blooms have been largely attributed to high nitrogen loads discharged to the surface waters.

New York State has established water quality standards for surface waters of the state; in fact, the state program was established in the 1950s, well before the 1972 federal Clean Water Act. New York State Department of Environmental Conservation (NYSDEC) has classified New York surface waters based on their best usage, identifying four fresh water and five marine water classifications of best use, and has established ambient water quality standards defining the maximum allowable levels of contaminants that may be present in order to protect the waters' best uses. Orient's marine surface waters are designated as Class SA (saline) waters, the highest marine water classification. The best usages of SA waters are "shellfishing for market purposes, primary and secondary contact recreation and fishing. These waters shall be suitable for fish, shellfish and wildlife propagation and survival" (6CRR-NY 701.10 NY-CRR).

Surface waters are characterized by many physical and chemical attributes that affect water quality and the ecological resources that may inhabit the waters. While water samples are analyzed for many parameters that characterize surface water quality, this evaluation of Orient's surface waters focuses on the key indicators of dissolved oxygen, nitrogen and fecal coliform. Data characterizing these parameters were compared to their respective New York State water quality standards as described further below. Although no numerical standard exists for water temperature, increased temperature, indicative of the impacts of climate change, is also briefly presented here because it impacts compliance with the dissolved oxygen standard, and because it is believed to be one of the factors impacting a variety of important ecological resources such as eelgrass. Several different government agencies monitor surface water quality in Orient. Suffolk County Department of Health Services (SCDHS) is responsible for monitoring and protecting the environment and ecological resources of the County. The SCDHS Office of Ecology has monitored water quality in the County's surface waters, including the Long Island Sound and the Peconic Estuary and their harbors and embayments for decades. Water quality data has been collected from a monitoring station in Orient Harbor (station 060115, shown on **Figure 2-23**) and from stations 60330 in and 060331 in Hallock/Long Beach (also shown on **Figure 2-23**) from 2007 through 2021. In addition, a federal agency, the United States Geological Survey (USGS) has monitored water quality parameters at Station 1304200 in Orient Harbor since 2012 at the end of the Orient Wharf (Orient Yacht Club) shown on **Figure 2-23**.

Figure 2-23 SCDHS Monitors Water Quality at Station 060115 in Orient Harbor and at Stations 060330 and 060331 in Hallock Bay and the USGS Monitors Water Quality at Station 1304200 in Orient Harbor

While the water quality of Long Island Sound is monitored extensively, none of the established monitoring stations are near Orient (a map of the monitoring locations may be found at: https://ctdeep.maps.arcgis.com/apps/webappviewer/index.html?id=f3fb1bb862fc4781ab2561f348bc3d0c).

2.2.1.1.1 Dissolved Oxygen

Dissolved oxygen is a key water quality indicator. Aquatic organisms require sufficient dissolved oxygen to survive and to thrive. Low dissolved oxygen concentrations can result in water quality impairments that can stress or kill aquatic life. NYSDEC has established the dissolved oxygen standard for Class SA waters at 4.8 mg/L, with allowable excursions to not less than 3.0 mg/L for certain periods of time (NYS 6 NY-CRR 703.3). The average daily dissolved oxygen concentration at any point in the water body should not be less than 4.8 mg/L. Recognizing that marine organisms can tolerate concentrations 4.8 mg/L for short periods of time, dissolved oxygen concentrations of no less than 3 mg/L are permitted for limited durations (New York State TOGS 1.1.6 - Interpretation of Marine Dissolved Oxygen Standard provides further explanation of the standard and its interpretation.)

It is important to understand that the concentration of dissolved oxygen (e.g., the amount of oxygen that the water can hold) is temperature dependent. The dissolved oxygen standard recognizes that the concentration of dissolved oxygen in a water body varies as a result of temperature and algal productivity; dissolved oxygen levels are observed to vary both seasonally and daily. Dissolved oxygen concentrations are typically higher during cold weather months than warm summer months because colder water can hold more oxygen than warm water. Dissolved oxygen levels are typically higher during the day than overnight because algae add oxygen to the water as they photosynthesize during daylight hours and remove oxygen from the water as a result of respiration during the night. Dissolved oxygen levels near the top of stratified deep water bodies are typically higher than dissolved oxygen levels near the bottom because water bodies are re-aerated from the overlying atmosphere.

Surface waters with strong currents that are reaerated and well mixed may have higher dissolved oxygen levels than slower moving or stratified water bodies. Because of these factors, it is a challenge to characterize this highly variable water quality parameter by a single value.

The SCDHS Office of Ecology monitors dissolved oxygen on a monthly basis at two depths at Station 060115 in Orient Harbor and at two stations in Hallock/Long Beach Bay. Based on the data collected from 2016 through February 2022, only one measurement of 4.5 mg/L, collected in August 2019 in Orient Harbor, was lower than the 4.8 mg/L criterion. No samples collected from Station 060330 (Hallock Bay) contravened the 4.8 mg/L criterion and no samples from either Orient Harbor or Hallock/Long Beach Bay were lower than the 3.0 mg/L acute criterion.

SCDHS Office of Ecology collects and analyzes grab samples of surface waters throughout the year that were compiled and evaluated as part of Suffolk County's Subwatersheds Wastewater Plan (SWP). The tenth percentile of dissolved oxygen concentrations was used to characterize the quality of the Suffolk County surface waters evaluated during the SWP. The tenth percentile of dissolved oxygen concentrations measured in Orient Harbor and Hallock/Long Beach Bay from 2007 through 2016 were 6.10 mg/L and 6.7 mg/L respectively; both of which are well above the New York State dissolved oxygen criterion of 4.8 mg/L.

The USGS has deployed a continuous monitor at Station 1304200 in Orient Harbor which provides an assessment of the natural variability of dissolved oxygen concentrations in the water body. **Figure 2-24** shows the continuous record of measured dissolved oxygen values from 2012 when the monitor was deployed through December 2022. The data show how dissolved oxygen concentrations increase as the water temperature decreases and the saturation value increases (e.g., the colder water can hold more oxygen), and how the dissolved oxygen concentrations decrease as the water warms in the spring and summer.

The USGS continuous data record also illustrates the diurnal variability in the dissolved oxygen values as a result of algal photosynthesis and respiration. **Figure 2-25** shows a snapshot of the data from February 2024 through January 2025 which illustrates both the seasonal and the diurnal variations in dissolved oxygen concentration resulting from algal photosynthesis and respiration. The continuous record of dissolved oxygen concentrations in Orient Harbor does show warm weather excursions below the 4.8 mg/L criterion, and no excursions below the 3 mg/L acute criterion.

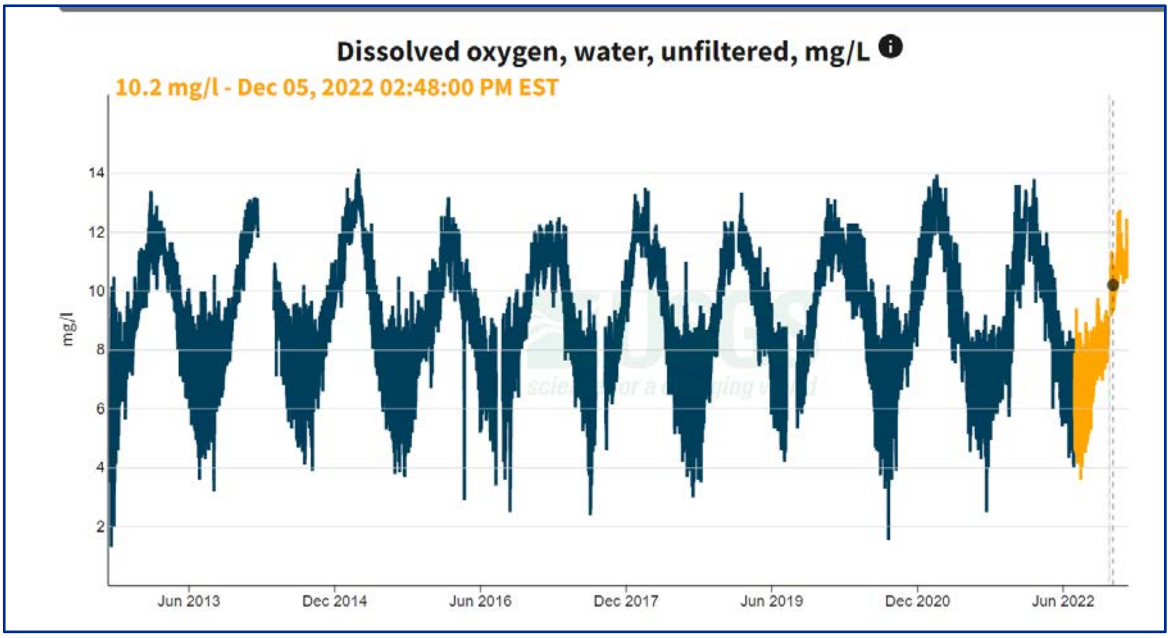


Figure 2-24 Dissolved Oxygen Concentrations in Orient Harbor (USGS Station 1304200) Show General Compliance with Water Quality Standards from 2012-2022
(Source: USGS https://waterdata.usgs.gov/monitoring-location/01304200)

Oxygen in Orient Harbor, 2024-2025

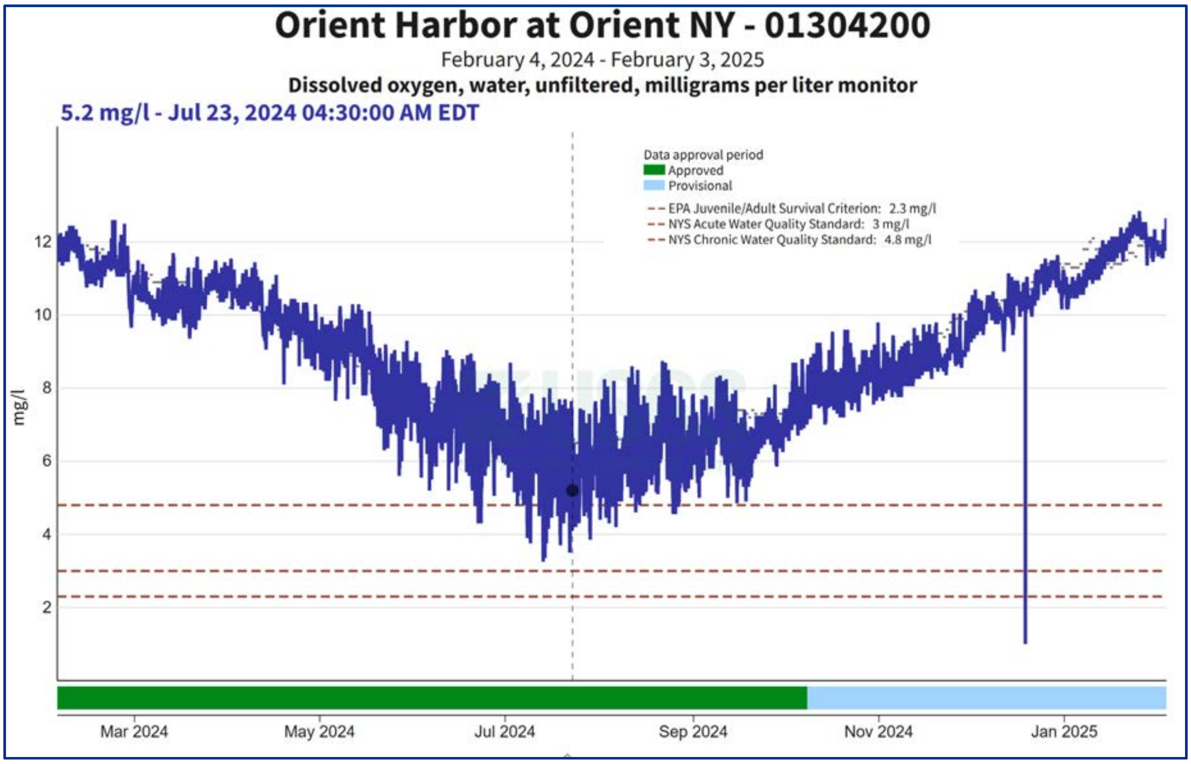


Figure 2-25 Dissolved Oxygen Levels in Orient Harbor Measured at the USGS Monitoring Station from 2024-2025 Demonstrate Both Typical Seasonal Variations and Demonstrate Daily Variability during the Summer Months Caused by Algal Photosynthesis and Respiration
(Source: USGS https://waterdata.usgs.gov/monitoring-location/01304200)

These data show that dissolved oxygen levels in Orient's marine waters are currently in compliance with applicable water quality criteria and are sufficient to support the area's ecological resources.

However, future dissolved oxygen concentrations will be impacted both by the discharge of oxygen demanding materials (nitrogen in particular as described in Section 2.2.1.2 below) to surface waters and by increasing water temperatures (please see Section 2.2.1.4). Reduction of oxygen-demanding contaminants may be accomplished by local action. Both estuary programs have been working to reduce nitrogen loads to the Sound and the Peconic Estuary, and Suffolk County, in partnership with NYDSEC and many others, is implementing the SWP to reduce loadings of nitrogen to ground and surface waters, which should result in a benefit to dissolved oxygen concentrations.

As described above, as water temperature increases, the amount of oxygen that the water can hold decreases. Because increased water temperature as a result of climate change is an issue of a global scale, it cannot be managed or controlled on a local scale. This makes it even more important to control point and non-point sources of contamination.

2.2.1.2 Nitrogen

Surface waters require nutrients, including nitrogen, to support healthy ecosystems. Although nitrogen is an essential nutrient for both plants and aquatic organisms, too much nitrogen can negatively impact surface water quality in a variety of ways:

- High levels of nitrogen support the growth of increased algal populations. While algal photosynthesis contributes oxygen to the water during the day, algal populations consume dissolved oxygen from the water as they respire, and additional oxygen is also used as the organisms die and decompose. Dissolved oxygen levels may decline so low that aquatic life cannot survive in the "dead zones" that result. Hypoxia occurs when dissolved oxygen concentrations are reduced to less than 3 mg/L (Extent of Hypoxia - Long Island Sound Study).
- Increased nitrogen has also been correlated with increases in harmful algal blooms (HABs) that have occurred in area surface waters in recent years. HABs have a detrimental effect on ecosystems and can be a direct health hazard to human and animal life. Certain HAB species create toxins that bioaccumulate in shellfish.
- Excessive algal growth, including growth of macroalgae, can reduce the amount of sunlight that can penetrate the water column; this shading reduces the ability of submerged aquatic vegetation (SAV) such as eel grass (*Zostera marina*), to photosynthesize and thrive.
- Both low dissolved oxygen and reduced SAV can impact marine habitats that support finfish and shellfish populations.
- Excess nitrogen can over-fertilize wetland vegetation, weakening root systems and reducing their resilience to wave action.

The direct link between anthropogenic nitrogen loading (e.g., caused by humans) and water quality and ecosystem impacts is well documented globally, nationally and locally. Both the Long Island Sound Study and Peconic Estuary Program have identified addressing excessive nitrogen loading as a top priority.

2.2.1.2.1 Subwatersheds Wastewater Plan and Nitrogen Loads to Surface Waters

In 2015, NYSDEC developed the Long Island Nitrogen Action Plan (LINAP) in recognition of and response to Long Island's nitrogen pollution crisis. As part of LINAP implementation, Suffolk County's SWP evaluated 191 subwatersheds which encompass all Suffolk County estuaries and streams and 14 fresh or coastal ponds that stakeholders identified as priority water bodies.

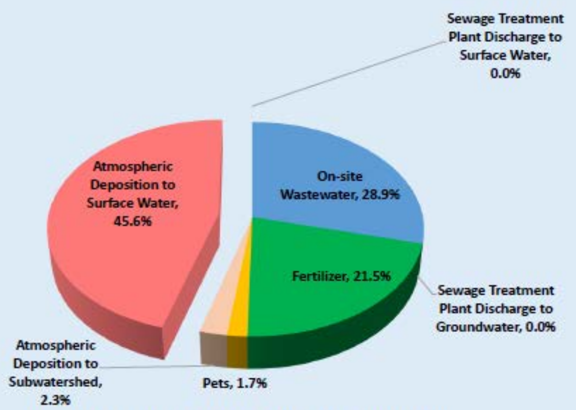
As part of LINAP implementation, the SWP evaluated nitrogen contributed to 191 of Suffolk County's surface waters from:

- Sanitary wastewater discharged from sewage treatment plants and from on-site wastewater treatment systems,

- Fertilizer application,
- Atmospheric deposition (transfer of pollutants in the air to the earth's surface), and
- Pets

Summaries of nitrogen loading and water quality data in Orient Harbor and Hallock/Long Beach, the two subwatersheds in Orient that were evaluated as part of the SWP, are included as **Figures 2-26** and **2-27**, respectively**.** (The Long Island Sound, East subwatershed includes the area of Long Island Sound that borders Orient; nitrogen contained in atmospheric deposition directly to the Sound contributed the greatest portion of the nitrogen load to the subwatershed at 71.8 percent. Nitrogen from fertilizer contributed 12.6 percent of the nitrogen load, nitrogen from on-site wastewater disposal contributed 10.7 percent, sewage treatment plant discharges directly to the Sound contributed 2.7 percent, atmospheric deposition to the subwatershed 1.6 percent, and nitrogen contained in pet waste contributed only 0.6 percent.)

Orient Harbor and minor Tidal Tribs Nitrogen Load Sources
PWL ID: 1701-0168



Nitrogen Source	Nitrogen Load (lbs/day)	% Contribution
Groundwater Sources		
On-site Wastewater	21.8	28.9%
Sewage Treatment Plant Discharge to Groundwater	0.0	0.0%
Fertilizer	16.2	21.5%
Pets	1.3	1.7%
Atmospheric Deposition to Subwatershed	1.7	2.3%
Surface Water Sources		
Atmospheric Deposition to Surface Water	34.3	45.6%
Sewage Treatment Plant Discharge to Surface Water	0.0	0.0%
Total N Load (without Hyporheic Zone Attenuation)	**75.3**	**100%**

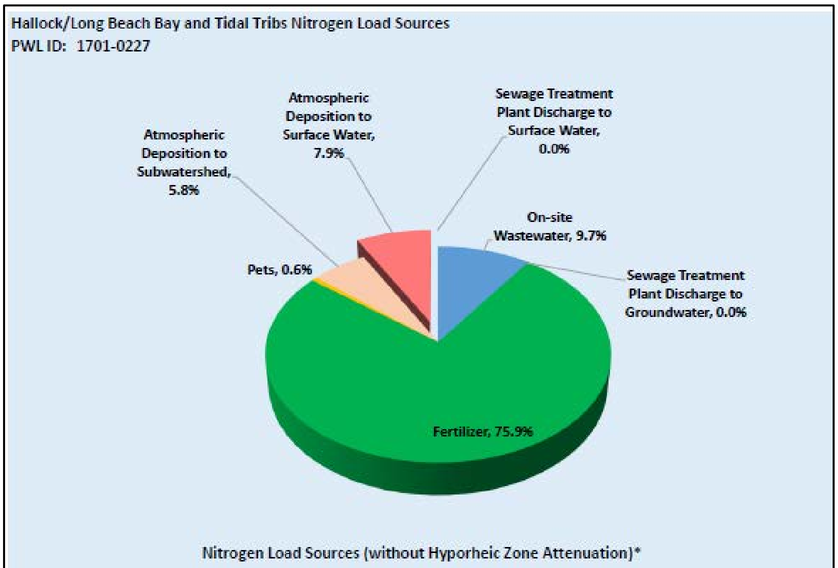
*Attenuation reduces the nitrogen load from groundwater baseflow as it travels through the hyporheic zone to surface water discharge. The hyporheic zone reduces the total nitrogen load from groundwater sources to 31 lbs/day

Figure 2-26 Nitrogen from Atmospheric Deposition is the Largest Component of the Estimated Nitrogen Load to Orient Harbor

Figure 2-26 shows that direct atmospheric deposition (including nitrogen in precipitation) to Orient Harbor is the most significant source of nitrogen loading to the water body, contributing

over 45 percent of the load. Nitrogen from on-site wastewater disposal is estimated to contribute 28.9 percent of the load, followed by nitrogen from fertilizer at 21.5 percent. Nitrogen from atmospheric deposition to the watershed (e.g., nitrogen in the atmosphere, including nitrogen in precipitation that falls on the land surrounding Orient Harbor, recharges the aquifer and travels with the groundwater that discharges to Orient Harbor) contributed 2.3 percent of the total nitrogen load to the water body, while nitrogen from pet waste was estimated to contribute 1.7 percent.

Figure 2-27 shows that the largest component of nitrogen load to Hallock/Long Beach Bay and its tidal tributaries was fertilizer, which contributed over 75 percent of the total nitrogen load. Nitrogen from on-site wastewater disposal contributed 9.7 percent of the load, followed by 7.9 percent from direct atmospheric deposition to the surface water, 5.8 percent from atmospheric deposition to the subwatershed and 0.6 percent from pet waste.



Nitrogen Source	Nitrogen Load (lbs/day)	% Contribution
Groundwater Sources		
On-site Wastewater	9.6	9.7%
Sewage Treatment Plant Discharge to Groundwater	0.0	0.0%
Fertilizer	74.9	75.9%
Pets	0.6	0.6%
Atmospheric Deposition to Subwatershed	5.8	5.8%
Surface Water Sources		
Atmospheric Deposition to Surface Water	7.8	7.9%
Sewage Treatment Plant Discharge to Surface Water	0.0	0.0%
Total N Load (without Hyporheic Zone Attenuation)	**98.7**	**100%**

*Attenuation reduces the nitrogen load from groundwater baseflow as it travels through the hyporheic zone to surface water discharge. The hyporheic zone reduces the total nitrogen load from groundwater sources to 90.7 lbs/day

Figure 2-27 Fertilizer is the Largest Component of the Estimated Nitrogen Loads to Hallock/Long Beach Bay and Tidal Tributaries

In contrast to Orient's two subwatersheds, nitrogen discharged from on-site wastewater systems is the greatest component of nitrogen loading to Suffolk County's surface waters, accounting for over 47 percent of the total nitrogen load as shown by **Figure 2-28**. For this reason, Suffolk County's Reclaim Our Water Initiative focuses on replacing the 365,000 cesspools and conventional septic systems with wastewater treatment technologies that remove nitrogen.

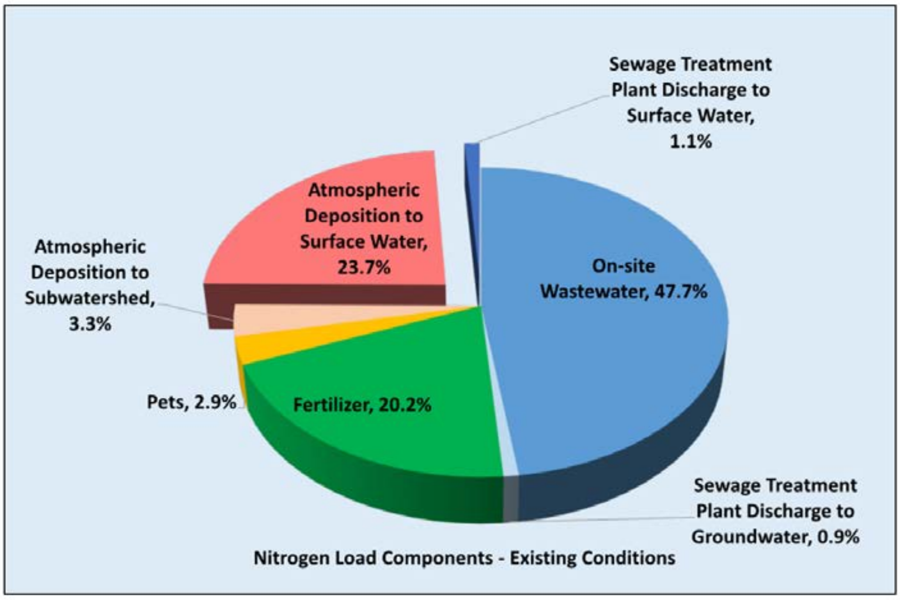


Figure 2-28 Nitrogen from On-site Wastewater Systems is the Largest Source of Nitrogen to Suffolk County Surface Waters (Source: Subwatersheds Wastewater Plan, SCDHS, 2020).

2.2.1.2.2 Nitrogen Concentrations in Orient Surface Waters

To date, neither the EPA nor NYSDEC have established numeric water quality standards for nitrogen in marine waters. Instead, the New York State narrative water quality standard for nitrogen is "*None in amounts that result in the growths of algae, weeds and slimes that will impair the waters for their best usages*." Recognizing that establishment of a numerical standard is a challenge because the amount of nitrogen a water body can assimilate depends on a variety of site-specific factors including water depth, flow through the water body and the resulting flushing time, temperature, etc., no single nitrogen criterion exists to define how much nitrogen is too much in a marine water body. Nevertheless, some reported reference values may be used to provide a framework for comparison. For example, the Long Island Comprehensive Waste Treatment Management Plan (1978), also known as the 208 Plan reported that total nitrogen concentrations in all Long Island bays periodically exceed 0.4 mg/L and that if nitrogen concentrations remain below 0.4 mg/L abnormally high fluctuations in dissolved oxygen resulting from algal blooms would not be expected. The 208 Plan also reports that algal blooms occasionally occur in all Long Island bays. The LINAP referenced the 1978 208 Study which identified a total nitrogen concentration of 0.35 to 0.40 mg/L as an indicator of the overall status of the water body.

Similar to dissolved oxygen, SCDHS Office of Ecology has collected and analyzed grab samples from Orient Harbor and Hallock Bay to characterize concentrations of both total nitrogen and nitrate species including nitrate and ammonia. The continuous monitor deployed by the USGS also measured nitrogen concentrations from August 2012 through June 2020.

During the development of the SWP and guided by the Ecological Endpoints Focus Area Work Group established by SCDHS, the 90th percentile of all grab samples of nitrogen collected over the past ten years was used to characterize total nitrogen in each water body. (The Ecological Endpoints Focus Area Work Group was comprised of subject matter experts from USEPA, NYSDEC, the Long Island Sound Study, the Peconic Estuary Program, the South Shore Estuary Reserve, Stony Brook School of Marine and Atmospheric Sciences, the Nature Conservancy and the University of Massachusetts, to provide technical input and guidance to the SWP program.) The 90th percentile of measured nitrogen was used in lieu of the maximum measured concentration to avoid biasing the evaluation with anomalously high values that are not representative of typically observed conditions. The 90th percentile nitrogen concentration in Orient Harbor from 2007 through 2016 was 0.31 mg/L and the 90th percentile nitrogen concentration in Hallock/Long Beach Bay was just slightly higher at 0.35 mg/L. Average concentrations of total nitrogen are significantly lower in both water bodies. The 90th percentile of total nitrogen in Orient Harbor in more recent data collected from 2016 through February 2022 was 0.33 mg/L (average 0.22 mg/L) and in Hallock/Long Beach Bay was 0.35 mg/L (average 0.23 mg/L).

Nitrate (the main nitrogenous compound utilized by primary producers in marine waters that is required for photosynthesis) that the USGS monitors continuously in Orient Harbor is shown on **Figure 2-29**. The data shows that nitrogen levels normally fluctuate around low levels (e.g., lower than 0.15 mg/L) with several short-term excursions exceeding 0.40 mg/L during the eight year period shown.

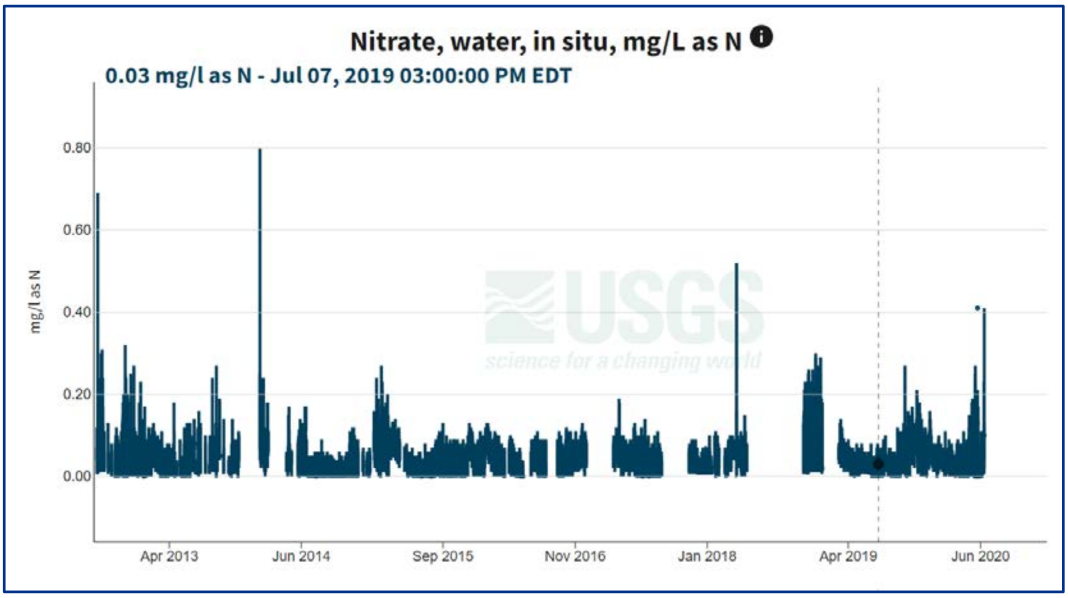


Figure 2-29 Concentrations in Orient Harbor Measured by the UGSS from 2012 through 2020 (Source: USGS https://waterdata.usgs.gov/monitoring-location/01304200) are Generally Low

Nitrogen loading to Orient's coastal waters is relatively low; eastern Long Island Sound, Orient Harbor and Hallock Bay are well flushed (e.g., it takes a very short time to flush nitrogen and other contaminant loads out of these embayments to the ocean) and the resulting nitrogen concentrations in Orient's waters are low compared to in-water nitrogen concentrations

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thoughout Suffolk County coastal waters and are less than the 0.40 mg/L threshold identified in the 208 Plan.

Without intervention (e.g., implementation of wastewater management and/or fertilizer management), nitrogen concentrations in Orient's surface waters are anticipated to decrease following the trends projected for area groundwater. As described in Section 2.1.2.1 above, based on Suffolk County Department of Economic Development and Planning's official build-out projections, simulated nitrogen concentrations in areas north of Main Road and areas east of Narrow River and north of Long Beach Bay where new residences could be built on currently vacant parcels are projected to increase. East of Narrow River where residences could be built on existing agricultural areas, nitrogen concentrations are simulated to decrease. Overall, and considering the projected reduction in nitrogen contributed by atmospheric deposition (USEPA unpublished model results shared with SCDHS showed reductions of nitrogen from atmospheric deposition are resulting from implementation of air pollution control regulations), the overall nitrogen load to Hallock/Long Beach Bay is projected to decline by four percent and to Orient Harbor and its tidal tributaries, by six percent. Reduction in nitrogen loading to these marine water bodies would be expected to result in similar modest declines in nitrogen concentrations. The projected future nitrogen loads to Orient Harbor and Hallock/Long Beach Bay are summarized in **Table 2-6**.

Table 2-6 Projected Future Nitrogen Loads to Orient Surface Waters Are Predicted to Decline Slightly

Subwatershed	Existing Conditions (lbs./day)	Projected Future Build-out (lbs./day)	% Change
Orient Harbor and tidal tributaries	75.3	70.4	-6.4%
Hallock/Long Beach Bay and tidal tributaries	98.7	94.8	-4.0%

While nitrogen concentrations in Orient Harbor and Hallock/Long Beach Bay are currently consistent with acceptable levels identified historically and in the Suffolk County SWP, it would be prudent to continue to limit nitrogen loading to these surface waters as other stresses, including projected temperature increases associated with climate change may reduce levels of dissolved oxygen.

2.2.1.3 Pathogen Indicators

USEPA has developed water quality criteria to protect people from exposure to disease-causing organisms such as bacteria and viruses that may be present in contaminated surface waters. These criteria were developed to "protect primary contact recreation, including swimming, bathing, surfing, water skiing, tubing, water play by children, and similar water contact activities where a high degree of bodily contact with the water, immersion and ingestion are likely" (2012 recreational water quality criteria (RWQC) recommendations). Exposure to disease-causing microorganisms in contaminated surface waters can occur when people swim, participate in other water-based recreational activities or consume shellfish.

In Suffolk County, the most significant sources of pathogens are usually stormwater runoff or avian populations, although discharges from boats and discharges from septic systems in areas with a high groundwater table have also been identified as contaminant sources to some waters.

Coastal surface waters are routinely monitored to confirm that they are safe for swimming and contact recreation and for shellfishing. Because it is not practical or even possible to monitor for each potential disease-causing organism that exists, coliform, enterococcus and e. Coli are the three bacteria that are monitored and regulated as indicators of potential pathogen contamination. These pathogen indicators are found in the intestinal tracts of humans and other animals and can identify the potential presence of fecal contamination and associated potential disease-causing organisms.

New York State water quality regulations establish criteria for total coliform, fecal coliform and enterococcus for Class SA coastal recreation waters. Historically, the health of recreational marine waters was based on comparison to a fecal coliform criterion of 200 MPN/100 mL. Studies finding that the presence of enterococcus was more highly correlated with incidences of gastrointestinal illness than fecal coliform led to the establishment of enterococcus as the preferred pathogen indicator in marine waters.

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New York State water quality criteria for Class SA coastal recreational waters for enterococcus states that the geometric mean of samples collected during any consecutive 30-day period may not exceed 35 MPN/100 mL and no more than 10 percent of the samples during the same 30-day period may exceed 130 MPN/100 mL.

In accordance with New York State Department of Health (NYSDOH) regulations, SCDHS Office of Ecology conducts a bathing beach water quality monitoring program from May through September. Consistent with the USEPA RWQC recommendations and the requirements of the New York State Sanitary Code, samples are analyzed for enterococci as the pathogen indicator organism for marine beaches, and E. coli as the pathogen indicator organism for freshwater beaches. Orient State Park Beach is monitored on a weekly basis from Memorial Day through Labor Day. Review of weekly data from 2019 through 2022 identified three excursions above the NYSDOH single-sample limit of 104 MPN/100 mL (https://ny.healthinspections.us/nybeaches/); weekly enterococcus levels ranged from 0 to 48 in 2022. Monitoring results may also be found here: Coastal Beach Water Quality.

In addition to SCDHS monitoring of recreational waters, NYSDEC monitors the pathogen indicator fecal coliform to manage shellfish harvest areas. This monitoring program is conducted year-round to protect human health from impacts resulting from consumption of contaminated shellfish. Shellfish harvesting restrictions vary seasonally due to changes in seasonal conditions, including potential sources of contamination (e.g., boating), temperature, precipitation, sunlight intensity, etc. that can cause elevated levels of coliform bacteria.

Based on water quality monitoring and historical experience, NYSDEC may close shellfish beds based on a regulatory closure or a temporary closure.

NYSDEC has defined each as follows:

- *“Regulatory closures are based on the water quality analysis of a specific area. Changes in regulatory classifications are based on year-round water quality monitoring to ensure that the harvest areas meet the stringent requirements for the safe harvest of shellfish for food consumption.*

- *Temporary closures can occur when an area that is normally open experiences sudden, short-term degradation in water quality. This could be the result of excessive amounts of storm water run-off or the presence of harmful algal blooms or biotoxins in the water or shellfish.”*

Shellfish closure data obtained from the NYSDEC identified locations within water bodies where unsanitary conditions trigger advisories for shellfish consumption. Temporary shellfish closures may also be implemented as precautionary measures when predicted conditions threaten water quality (e.g., holidays when there are increased numbers of boaters increase the possibility of sanitary waste being disposed, anticipated storm event). After the temporary event that caused the poor water quality is over and the water quality has improved, a shellfish area may be reopened to harvest.

Figure 2-30, from the NYSDEC on-line mapper, shows the water in Hallock Bay in red, as a regulatory closure, and the locations of temporary closures in seasonally uncertified (May 1 through October 31) waters in blue. NYSDEC advises that generally, all the enclosed bays, harbors and creeks within Southold (as well as other east end towns), are designated as uncertified following rainfalls of more than three inches. Based on the results of sampling, east end embayments may re-open after four or five days if water sampling demonstrates acceptable water quality. However, on a case-by-case basis some areas may remain closed for longer periods.

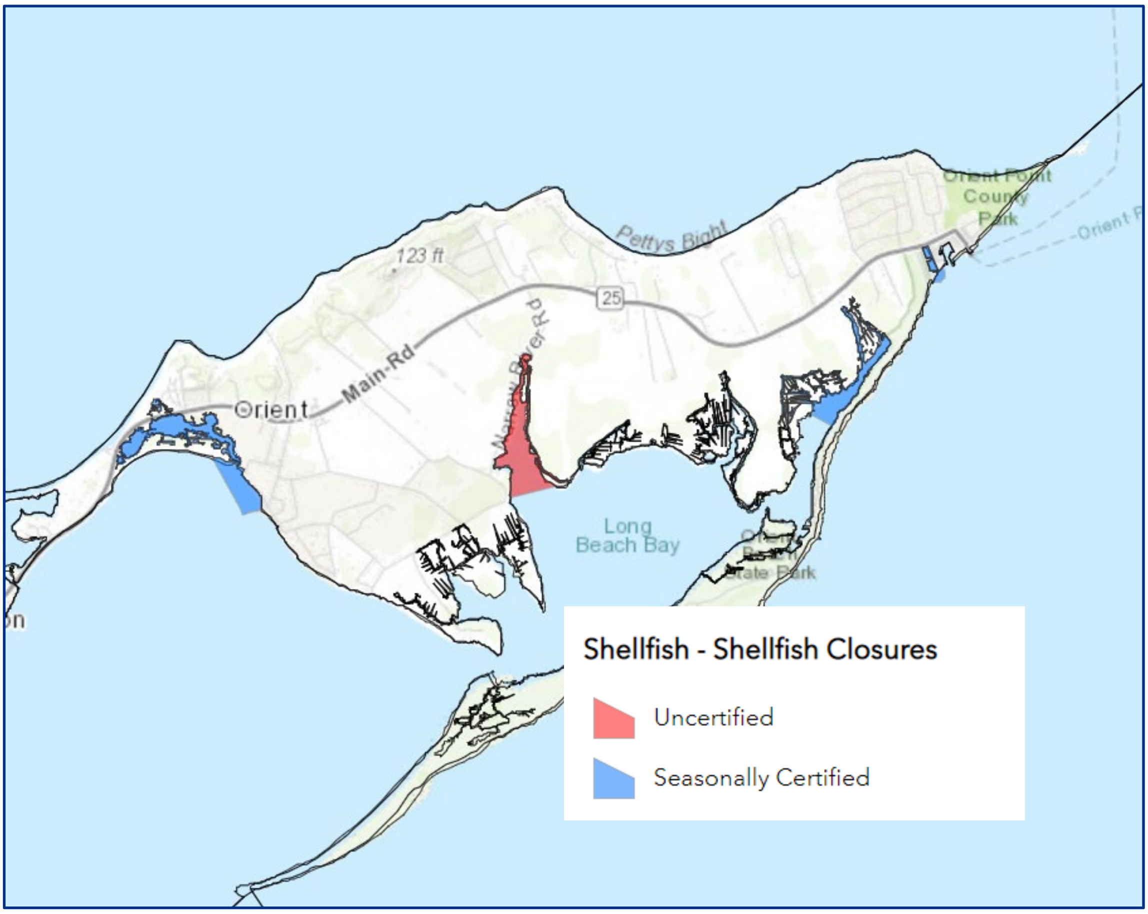

Figure 2-30 Uncertified Shellfishing Waters and Seasonally Certified Shellfishing Waters
Source:https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=d98abc91849f4ccf8c38dbb70f8a0042 updated January 6, 2023

A review of fecal coliform samples collected by SCDHS from 2014 through 2022 shows that fecal coliform levels were all well below applicable criteria in Orient Harbor and Hallock Bay as shown by **Figures 2-31** and **2-32**. Fecal coliform levels exceeded regulatory limits in Narrow River as shown on **Figure 2-33.**

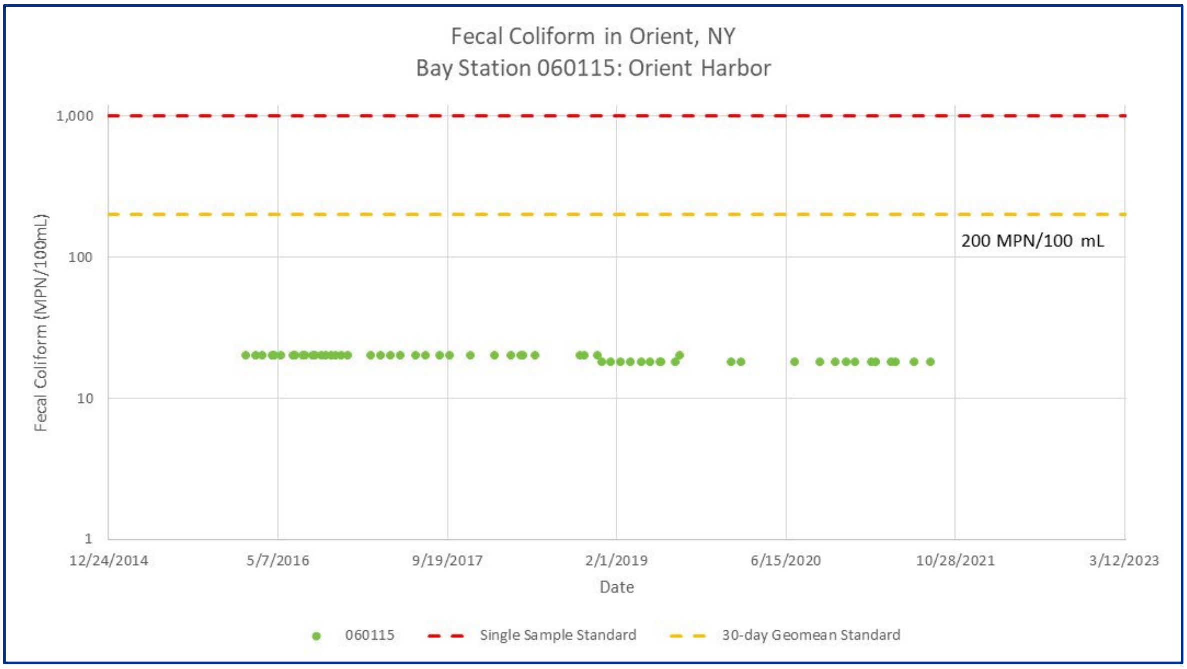

Figure 2-31 Fecal Coliform Levels in Orient Harbor, New York Comply with NYSDEC Limits (Source: SCDHS)

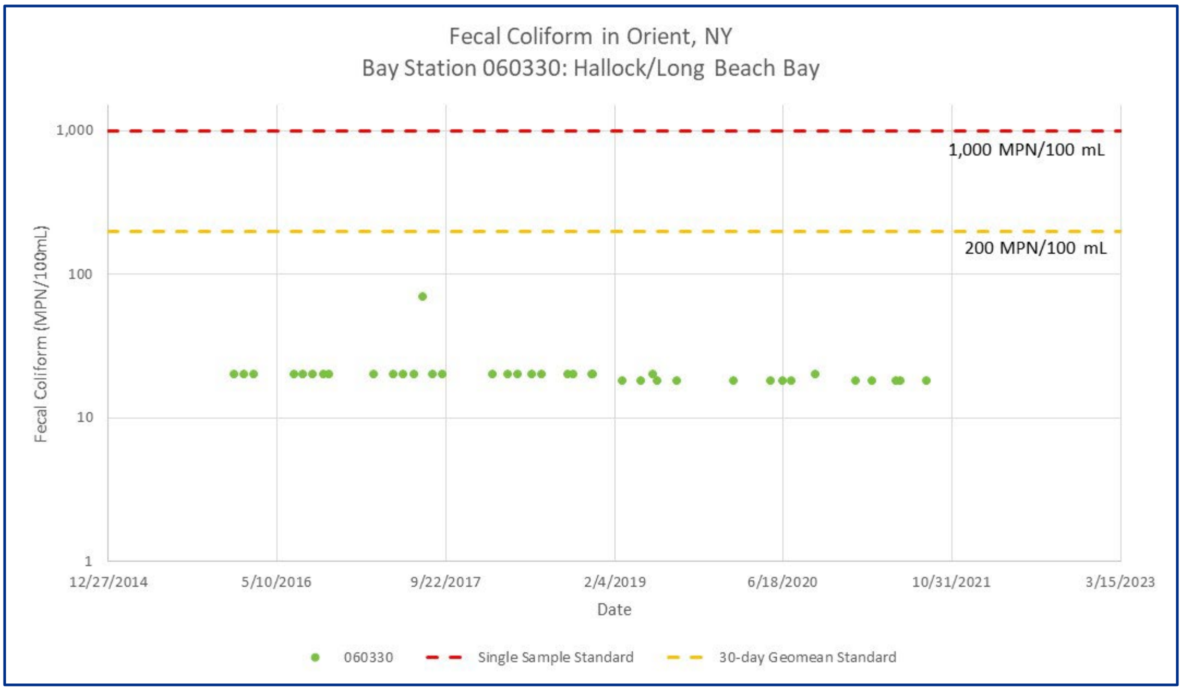

Figure 2-32 Fecal Coliform Levels in Hallock/Long Beach Bay, New York Comply with NYSDEC Limits (Source: SCDHS)

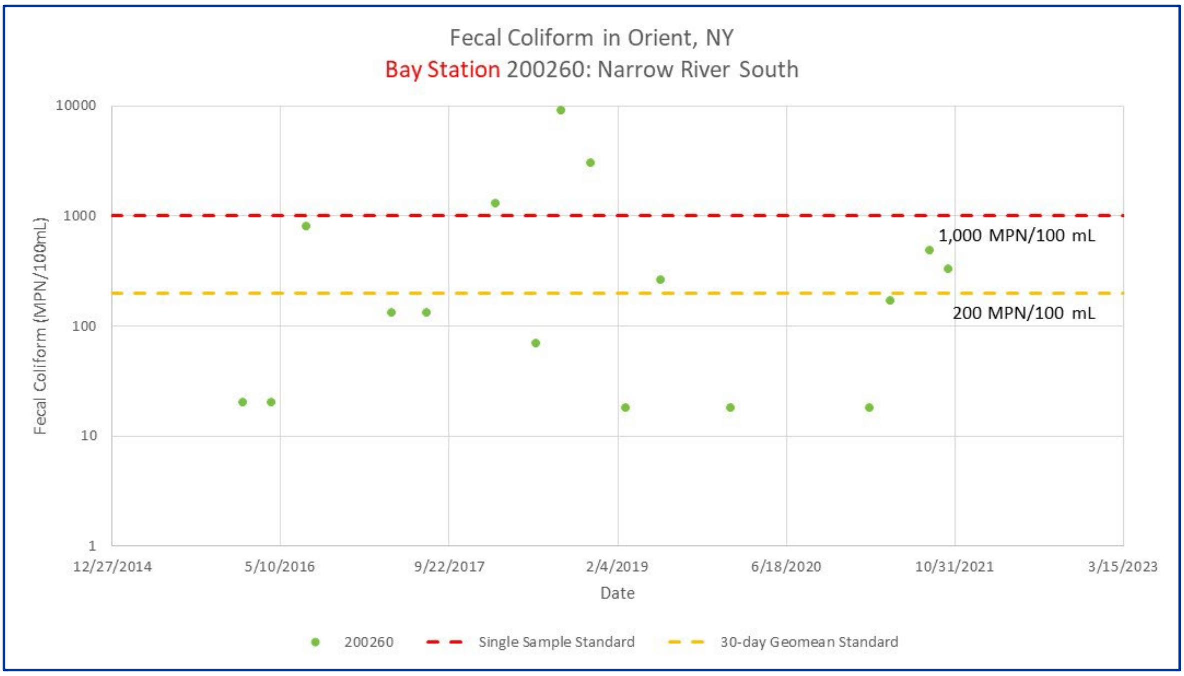

Figure 2-33 Fecal Coliform Levels in Narrow River, Orient, New York Have Historically Exceeded NYSDEC Limits (Source: SCDHS)

As mentioned above, pathogen sources include human waste and animal and bird waste. Human waste may reach surface waters as a direct discharge from boats, or may travel from on-site septic systems to surface water discharge in areas where there is inadequate distance between the leaching system and the groundwater table. Animal and bird waste may be conveyed to surface waters via storm water runoff, and bird waste may be deposited directly into a surface water. The first step in developing a response to reduce pathogen contamination is to identify the source(s) of the observed contamination so appropriate management actions can be identified and implemented.

Climate change is anticipated to have the highest potential to influence future pathogen levels in Orient's surface waters. As described in Section 2.1.3 above, as the elevation of the groundwater table increases with sea level rise, sanitary wastewater discharges from near-shore septic systems in the low-lying coastal areas of Orient may have a direct conduit through groundwater to coastal waters, introducing pathogen loads directly to the surface water bodies. Similarly, the predicted more frequent intense storm events may more efficiently carry the animal and bird waste into surrounding surface waters, resulting in short-term increases in pathogen indicator concentrations after storm events. **Figure 2-34** provides an illustrative example of how a higher water table elevation may allow a direct discharge of wastewater containing pathogens to groundwater and surface water resulting in greater pathogen contamination in the future.


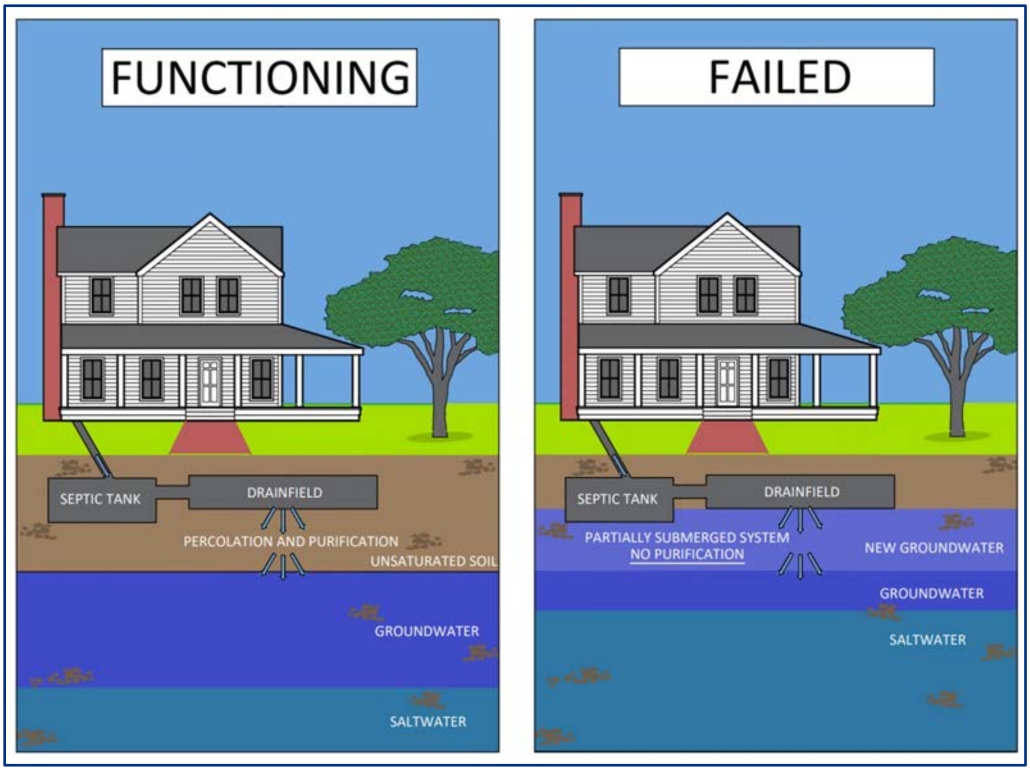

Figure 2-34 As Sea Level Rise Increases the Elevation of the Groundwater Table, Pathogens from Sanitary Wastewater May be Discharged Directly to Groundwater and Nearby Surface Waters, Source: Barbara Friedman

2.2.1.4 Temperature

Increased water temperatures can have a significant impact on both water quality and on marine life. Some impacts of increased water temperature include:

- **Impacts on dissolved oxygen**: As water temperature increases, the saturation value of oxygen is reduced; that is, less oxygen can be dissolved in the water body and therefore less oxygen is available to support marine species.
- **Impacts on algal growth**: Increased water temperatures increase the rate of growth of algal populations; accelerated growth can contribute to unwanted algal blooms.
- **Impacts on the type of species** that can thrive in local waters.

Increasing water temperatures are being documented locally. For example, the Long Island Sound program reports that the temperature in Long Island Sound has risen approximately 2.8 degrees F since the 1970s (please see **Figure 2-35** for water temperature since 1990), and that the temperature increases are most pronounced in the spring. They have concluded that the observed change has led to longer optimal growing seasons for warm water species (e.g., fluke) and a shorter growing season for cold-water species such as winter flounder.

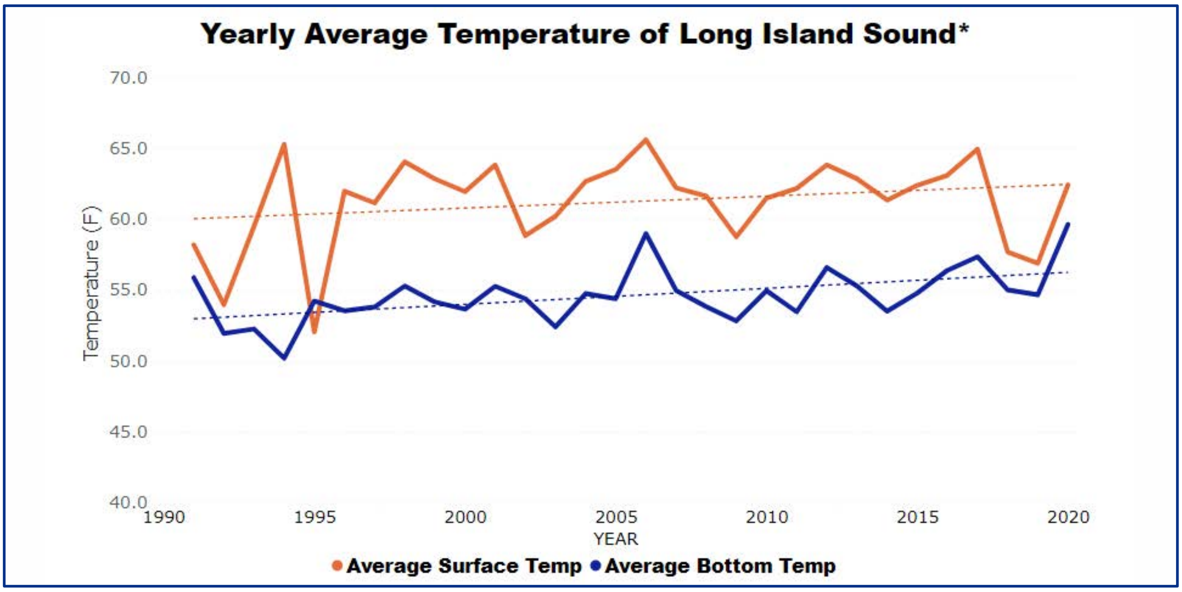

Figure 2-35 Annual Average Water Temperature of Long Island Sound Is Increasing
Source: CT State Council on Environmental Quality https://portal.ct.gov/CEQ/AR-20-Gold/2020-CEQ-Annual-Report

Figure 2-36, which provides a continuous record of water temperature measured by the USGS in Orient Harbor since 2012 illustrates the seasonal variation in water temperature from a low of approximately 30° F during the winter months to peaks of approximately 80° F during the summer months. This relatively short-term record is not long enough to document long-term temperature trends.

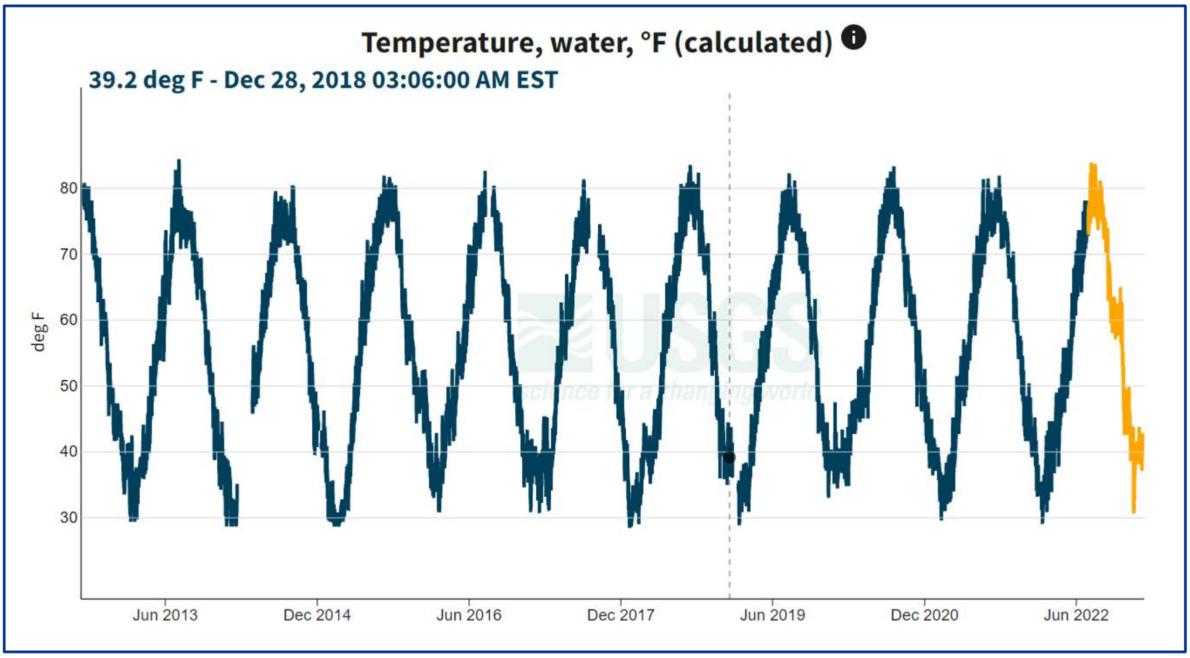

Figure 2-36 Water Temperature Data in Orient Harbor Shows that Temperature Varies Approximately 30 Degrees (Source: USGS)

Water temperatures are projected to increase by between 4°F and 8°F over the next century and extreme temperature events are predicted to occur more frequently (Peconic Estuary Partnership; https://www.peconicestuary.org/projects/resilient-communities-prepared-for-climate-change-2/). There are a number of potential impacts of increasing temperature on marine ecosystems. As described above, the saturation value of dissolved oxygen decreases with increased temperature, meaning that less oxygen may be available for use by aquatic organisms as temperatures increase. Studies indicate that valued resources including eelgrass and lobsters prefer cooler temperatures (Peconic Estuary Program, Long Island Sound Study, et al).

Research reported by the Long Island Sound Study concluded that American lobsters cannot maintain their metabolisms in water temperatures that remain above 20° C (68°F) for long periods of time, which is the case in Orient Harbor during warm weather months as shown by **Figure 2-36**. Conversely, some of the algal populations that comprise HABs thrive as waters warm (Climate Change and Harmful Algal Blooms | US EPA). Projections also indicate that water temperatures will warm earlier in the season, enabling warm-water species to migrate into the Sound earlier in the year and remain longer in the fall (LISS Ecosystem Targets and Supporting Indicators - Long Island Sound Study).

2.2.2 Surface Water Quality Summary

Overall, measurements of dissolved oxygen, nitrogen and pathogen indicators from Suffolk County and the USGS show that Orient Harbor and Hallock Bay are generally in compliance with the water quality standards for New York States's highest class of marine surface waters.

2.2.2.1 Suffolk County Subwatershed Wastewater Plan (SWP) Evaluations of Orient Subwatersheds

As part of development of the SWP, Suffolk County (in collaboration with the Ecological Endpoints Work Group) identified characteristics of Suffolk County surface waters with ideal water quality. Orient's marine surface waters generally exhibited this water quality which included:

- Dissolved oxygen levels greater than NYSDEC's chronic water quality standard of a daily average of 4.8 mg/L in 90 percent of all samples;
- Chlorophyll-*a* levels less than 5.5 µg/L in 90 percent of all samples collected, OR average blooming season chlorophyll-*a* levels less than 5.5 µg/L (Chlorophyll-*a* is a measure of algal biomass and indicator of primary productivity);
- Water clarity (as measured by secchi depth) greater than two meters (6.56 feet) during the blooming season for protection of eelgrass;
- No HABs with primarily health impacts during the past ten years, and
- A maximum of one HAB with primarily environmental impacts in the past ten years.

Dissolved oxygen levels were described above. New York State has not promulgated water quality standards for secchi depth, chlorophyll-*a* or HABs, but all are monitored by SCDHS.

Water clarity allows light penetration, which is important for aesthetic value, for primary productivity and for thriving SAV, including eel grass. While there are a number of factors that affect water clarity, nitrogen can play a significant role when excess nitrogen spurs the growth of phytoplankton that significantly reduce light penetration. Secchi depth is measured by lowering an 8-inch diameter disk with alternating black and white quadrants into the water body until it can no longer be seen; this depth is the secchi depth. Greater secchi depths indicate increased water clarity (but it should also be noted that secchi depth may be limited to the depth of a sampling location).

Based on available water quality data collected over a ten-year period, the quality of Hallock/Long Beach Bay was consistent with the ecological endpoints used to identify ideal water quality, and Hallock/Long Beach Bay was selected as a reference water body for the SWP. This may be attributed in large part to the relatively low nitrogen loads and well flushed nature of the embayment due to its proximity to Gardiners Bay, Block Island Sound and the Atlantic Ocean. Because two occurrences of HABs were reported in Orient Harbor over the past ten years, it did not achieve every ecological endpoint associated with ideal water quality. Nevertheless, due to its otherwise excellent water quality, it was also identified as a reference water body for dissolved oxygen.

As part of the SWP, nitrogen loading to and water quality characterizing Suffolk County's surface waters were evaluated to assess the need for nitrogen load reduction to improve surface water quality. The watersheds were ranked as follows:

- Priority Rank 1 – generally moderate to severe water quality impacts, subwatersheds typically had the highest nitrogen loads and/or may be poorly flushed;
- Priority Rank 2 – generally minor to moderate water quality impacts, waters in this category may have moderate to high nitrogen loads and/or may be poorly flushed;
- Priority Rank 3 – generally minor water quality impacts, low to moderate nitrogen loads and/or may be poorly flushed
- Priority Rank 4 – generally minor or no known water quality impacts, low nitrogen loads and/or well flushed

Table 2-7 below summarizes the average characteristics of the subwatersheds with each priority ranking designation, along with Orient Harbor and Hallock/Long Beach Bay for comparison. With the exception of the two incidences of HABs observed in Orient Harbor (rust tide, Cochlodinium polykrikoides, a HAB with environmental impacts whose presence in Orient Harbor was documented in 2011), the comparison shows that both Orient Harbor and Hallock/Long Beach Bay exhibit low nitrogen loads and excellent water quality.

Table 2-7 Suffolk County Subwatershed Wastewater Plan Priorities for Nitrogen Reduction

Subwatershed/ Subwatershed Priority Rank	Calculated Nitrogen Load (pounds/ cubic meter/yr)	Total Nitrogen 90th percentile over 10 years) (mg/L)	Dissolved Oxygen 10th percentile over 10 years (mg/L)	HABs Number of blooms in ten years	Chl-*a* 90th percentile over 10 years (ug/L)	Clarity Average Secchi Depth over 10 years (feet)
Priority Rank 1	0.070	1.36	4.60	5	29.1	4.1
Priority Rank 2	0.030	0.80	6.11	3	21.8	5.5
Priority Rank 3	0.013	0.74	5.81	1	9.4	6.1
Priority Rank 4	0.008	0.39	6.52	0	6.1	7.4
Orient Harbor	0.00088	0.30	6.10	2	6.5	9.4
Hallock/Long Beach Bay	0.001	0.35	6.70	0	4.6	6.4

Figures 2-37 and **2-38**, subwatershed-specific score-cards for Orient Harbor and Hallock/Long Beach Bay developed as part of the SWP, include mappings of the groundwater contributing areas, nitrogen load sources and a chart characterizing subwatershed water quality with respect to water quality of the 191 Suffolk County water bodies that were evaluated. In each figure, the left/blue end of the chart is the 'best' observed value of each parameter considered, while the right/red end of the chart is the worst. For example, desirable water quality would include a low nitrogen load, low nitrogen concentration, no harmful algal blooms and low flushing or residence time, high dissolved oxygen concentration and high secchi depth. Both Orient Harbor and Hallock/Long Beach score cards visually illustrate the low nitrogen loads, nitrogen concentrations and chlorophyll-a levels associated with desirable water quality. Representative dissolved oxygen concentrations exceed the established water quality standards, and secchi depth in both water bodies is greater than the minimum depth of 6.56 feet.

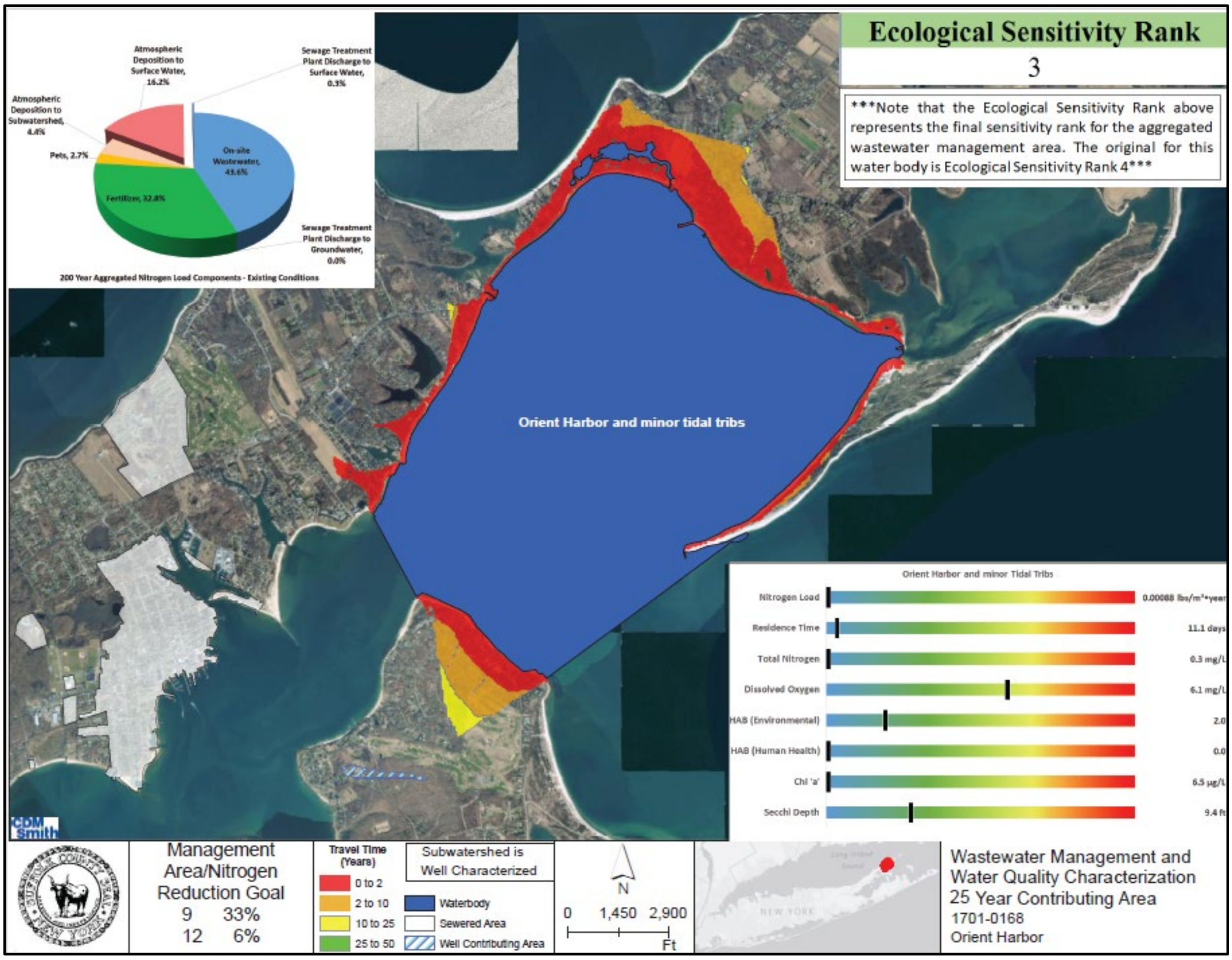

Figure 2-37 Characteristics of Orient Harbor Nitrogen Loads and Water Quality (Source: Suffolk County Subwatersheds Wastewater Plan)

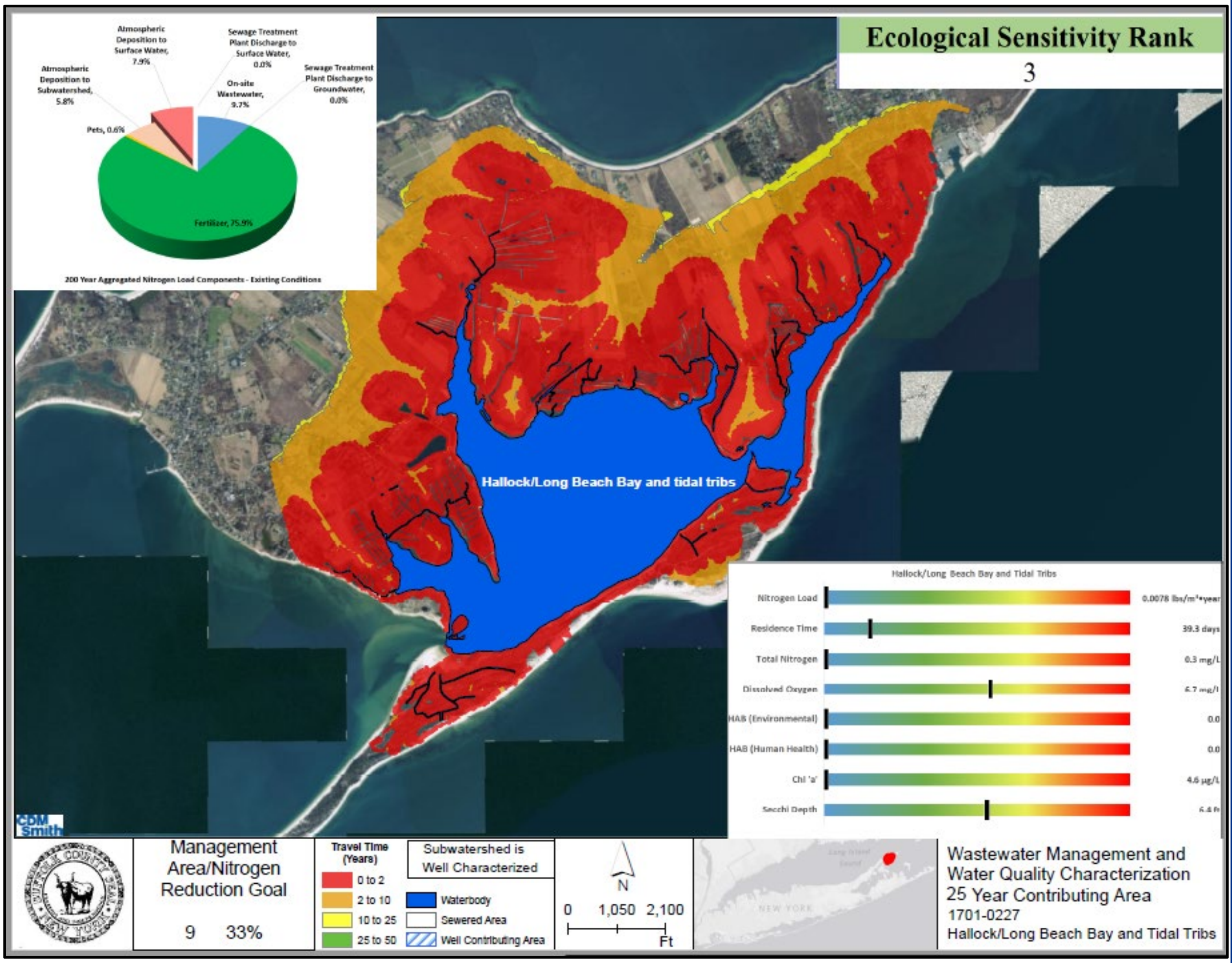

Figure 2-38 Characteristics of Hallock/Long Beach Bay and Tidal Tribs Nitrogen Loads and Water Quality (Source: Suffolk County Subwatershed Wastewater Plan)

2.2.2.2 Key Ecological Resources

In addition to the parameters discussed above, a myriad of other factors impact the viability of marine resources that are important to Orient, including submerged aquatic vegetation, finfish and shellfish. These factors include a wide variety of physical and water quality characteristics including wave action, substrate characteristics (e.g., gravel, sand, fine-grained sediments), nutrients (e.g., silica), pesticides, contaminants of emerging concern, pH and disease. In addition, as characteristics such as temperature or salinity change, the resulting conditions may sometimes provide ideal conditions for predators.

While it is beyond the scope of this report to discuss each resource and potential stress in detail, a brief overview of relevant information and useful resources is included in **Table 2-8**.

Table 2-8 Overview of Ecological Resources

Background & Status	Potential Stressors	References
Eel Grass		
Seagrasses, including eel grass, provide essential habitat and nursery areas for locally important fish and shellfish species and play a significant role in carbon and nutrient cycling. They also stabilize bottom sediments and act as wave and storm surge barriers by reducing wave energy and amplitude, reducing water velocity and protecting coastal communities from storm surge. Eel grass [once ubiquitous along the eastern shore of Orient Harbor] has largely disappeared. Beds monitored by CCE at Orient Point (Gardiner's Bay side) have declined from 62 acres to 13 acres (2004 to 2019). Please see **Figure 2-39.** In 2019, CCE reported that light penetration and temperature at the Orient monitoring station were suitable for eelgrass and the eelgrass meadow has been migrating inshore towards shallower water. They attributed the loss in eelgrass acreage to erosion from storm-related wave action. Cornell Cooperative Extension's attempts at replanting eel grass in Hallock Bay were abandoned in 2012, with the failures to thrive attributed to a muddy (rather than sandy) bottom, and warm temperatures during summer months.	▪ Historically, "Wasting Disease" caused by the pathogen Labyrinthula zosterae was responsible for the decimating the eelgrass beds along the Atlantic Cost of North America. ▪ More recently, increased water temperatures (Cornell reports that the optimal water temperature is between 50- and 77-degrees F) ▪ Reduced water clarity ▪ Wave action ▪ Boating	▪ Peconic Estuary Partnership ▪ Peconic Estuary Program ▪ Cornell Cooperative Extension ▪ Cornell Cooperative Extension | Eelgrass Restoration and Monitoring ▪ Report of the New York State Seagrass Task Force: Recommendations to the Governor ▪ https://longislandsoundstudy.net/ecosystem-target-indicators/eelgrass-extent/

Table OP-3. Trend analysis of the estimated area of the Orient Point meadow as determined from aerial photographs from 2000 to 2019.

Year	Estimated Area
2000	*7.59 acres (3.07 hect.)
2004	62.24 acres (25.19 hect.)
2007	55.80 acres (22.58 hect.)
2010	31.39 acres (12.70 hect.)
2012	17.18 acres (6.95 hect.)
2013	16.40 acres (6.64 hect.)
2014	21.60 acres (8.74 hect.)
2015	19.40 acres (7.85 hect.)
2016	17.40 acres (7.04 hect.)
2017	14.70 acres (5.95 hect.)
2018	10.8 acres (4.37 hect.)
2019	13.1 acres (5.30 hect.)

*Area of meadow was significantly underestimated in aerial survey.

Figure 2-39 Eel Grass Decline at Orient Point and Location of Eel Grass Monitoring Stations Source: Cornell Cooperative Extension/Christopher Pickerell and Stephen Schott

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Background & Status	Potential Stressors	References
Oysters		
Until the 1820s, oysters were abundant in local bays (hence, Orient's original name, Oysterponds) and were readily harvested from shallow near-shore waters. **Figure 2-40** summarizes the decline in oyster production in the Long Island Sound since 1990.	Overfishing depleted the wild oyster population by 1870 Seeded populations were impacted by pollution, disease, predation by starfish, oyster drills and crabs and weather in the 1950's	John Holzapfel, Hunting the Blue-Eyed Bay Scallop https://oysterpondshistoricalsociety.org/recent-events Long Island Sound Study https://longislandsoundstudy.net/ecosystem-target-indicators/shellfish-harvested/

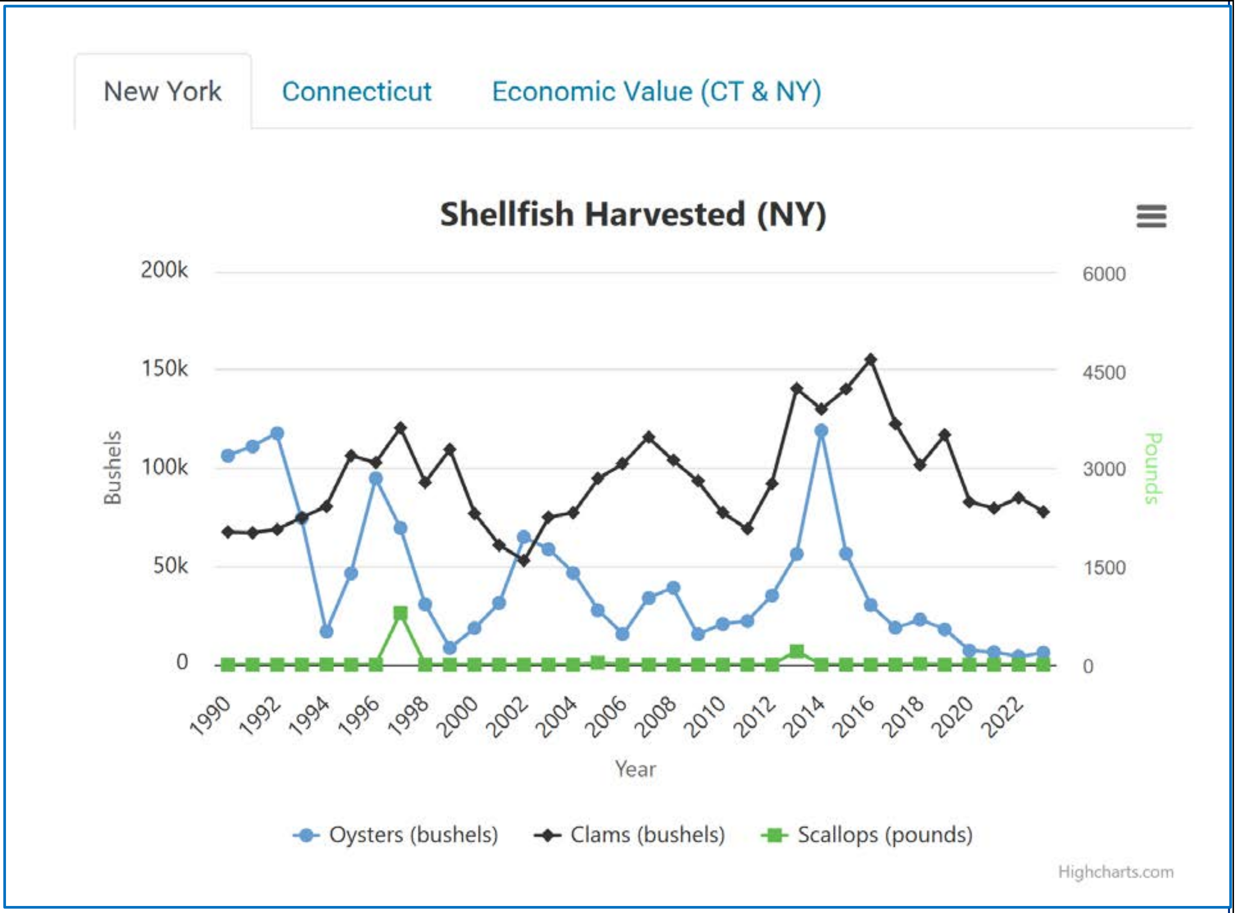
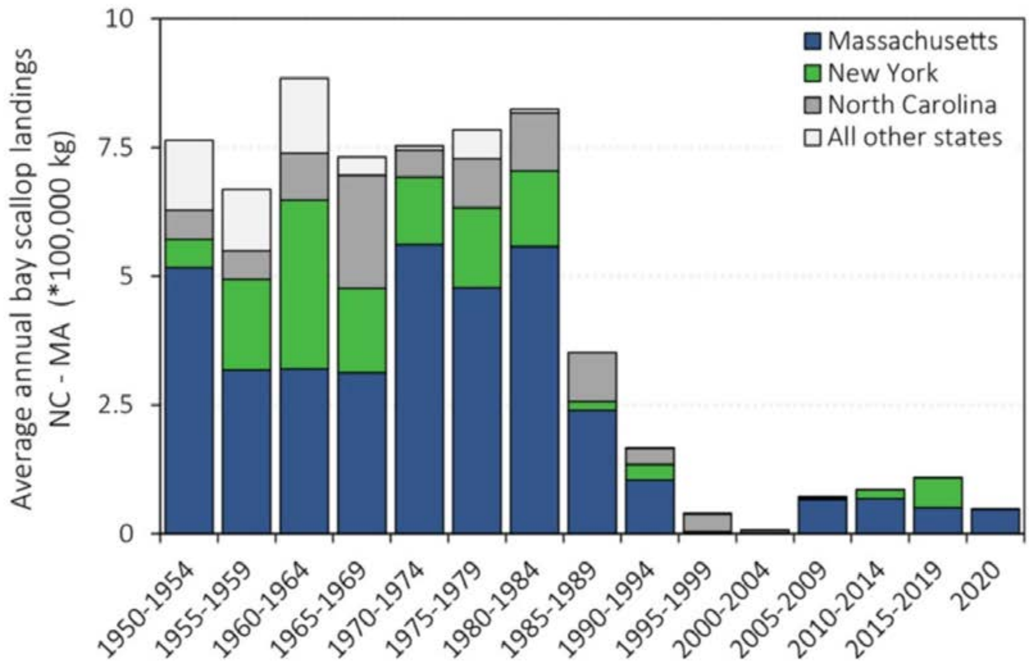


Figure 2-40 Oyster and Scallop Harvests Have Declined in Long Island Sound/New York
Source: Shellfish Harvested - Long Island Sound Study

Background & Status	Potential Stressors	References
Scallops		
Thriving population before being wiped out by brown tide in 1985 Scallop populations have since been restored several times, each time to decline again as a result of brown tide and other factors. Higher temperatures are believed to be a significant factor contributing to their mortality. While efforts to reseed scallops continue, they have been impacted by a variety of factors. The decline in scallop landings on the east coast is shown by **Figure 2-41**.	▪ Brown tide ▪ Increasing water temperature ▪ Low dissolved oxygen levels ▪ Newly discovered bay scallop parasite ▪ Potential predation (cownose rays, a primarily southern species that is known to prey on adult shellfish)	https://ccesuffolk.org/marine/aquaculture/scallop-program/scallop-program-overview-and-results https://onlinelibrary.wiley.com/doi/epdf/10.1111/gcb.16575 Shellfish Harvested - Long Island Sound Study Marine Shellfish - NYSDEC



Since 2019, almost none of the bay scallops in Long Island have reached a harvest-ready age. [Credit: Tettelbach et al.]

Figure 2-41 Scallop Landings on the East Coast Have Declined
Source: Long Island's scallops are dying out. Scientists are hunting for answers. - Scienceline % %

Background & Status	Potential Stressors	References
Lobsters		
Lobsters were found more in the deeper, cooler waters of the Long Island Sound than the shallower, sandy bottomed Peconic. Data collected by the Long Island Sound Study shown in **Figure 2-42** shows a precipitous decline in lobster abundance since the turn of the century.	▪ Increased summer water temperatures (American lobsters cannot maintain their metabolisms in waters above 20°C for long periods of time.) ▪ Greater abundance of warm water species (e.g., black sea bass) that prey on lobster	Lobster Abundance - Long Island Sound Study

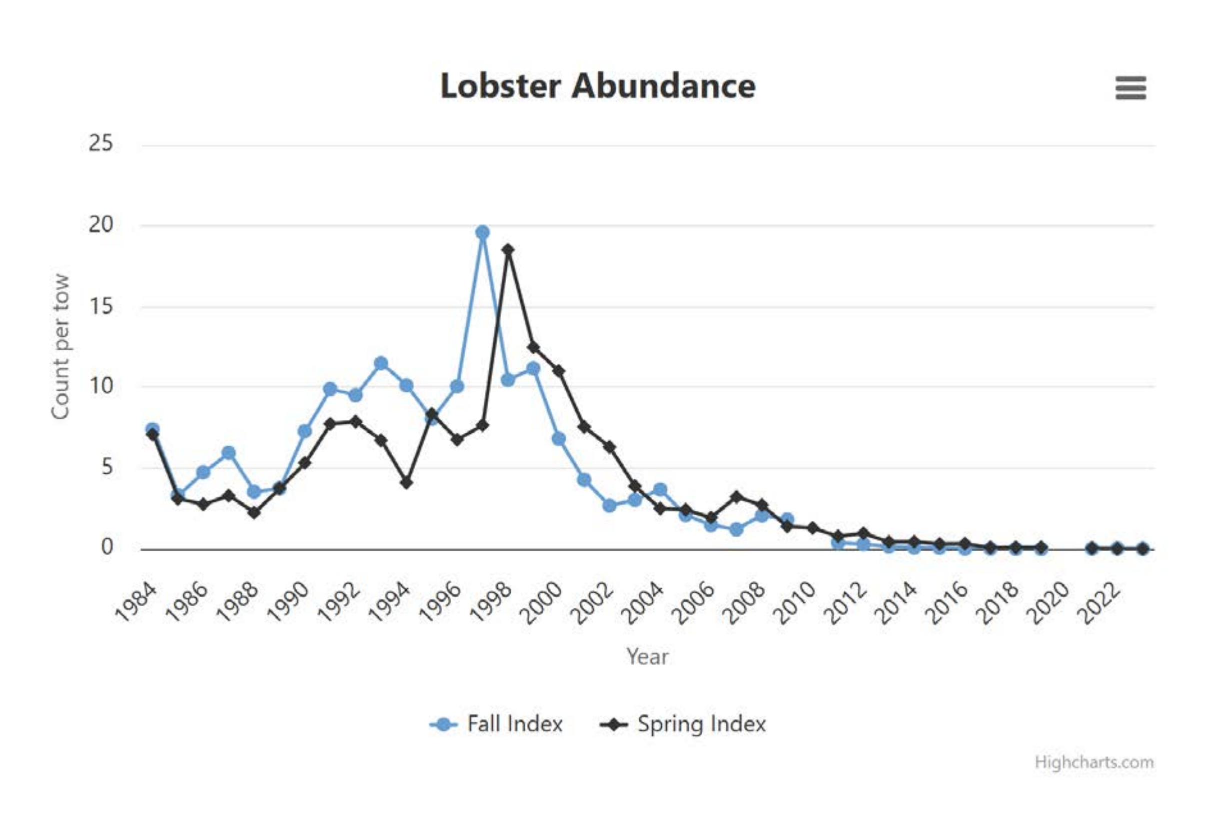


Figure 2-42 Declining Lobster Abundance in Long Island Sound (Source: Lobster Abundance - Long Island Sound Study)

Background & Status	Potential Stressors	References
Horseshoe Crabs		
Horseshoe crabs are harvested for bait. Their abundance is considered to be an indicator of the health and productivity of the shallow intertidal environment. Their eggs provide food for shorebirds and their larvae and juveniles provide food for fish. Horseshoe crab populations in Peconic Bay have declined through the past three decades. **Figure 2-43** shows the decline in horseshoe crab abundance in the Long Island Sound.	Loss of habitat and illegal harvesting including use as bait for conch and eel fishing	Horseshoe Crab Abundance - Long Island Sound Study Cornell Cooperative Extension, NYSDEC, Stony Brook SoMAS: New York Horseshoe Crab Monitoring Network (nyhorseshoecrab.org) Save Horseshoe Crabs in New York Harbor — Save Coastal Wildlife

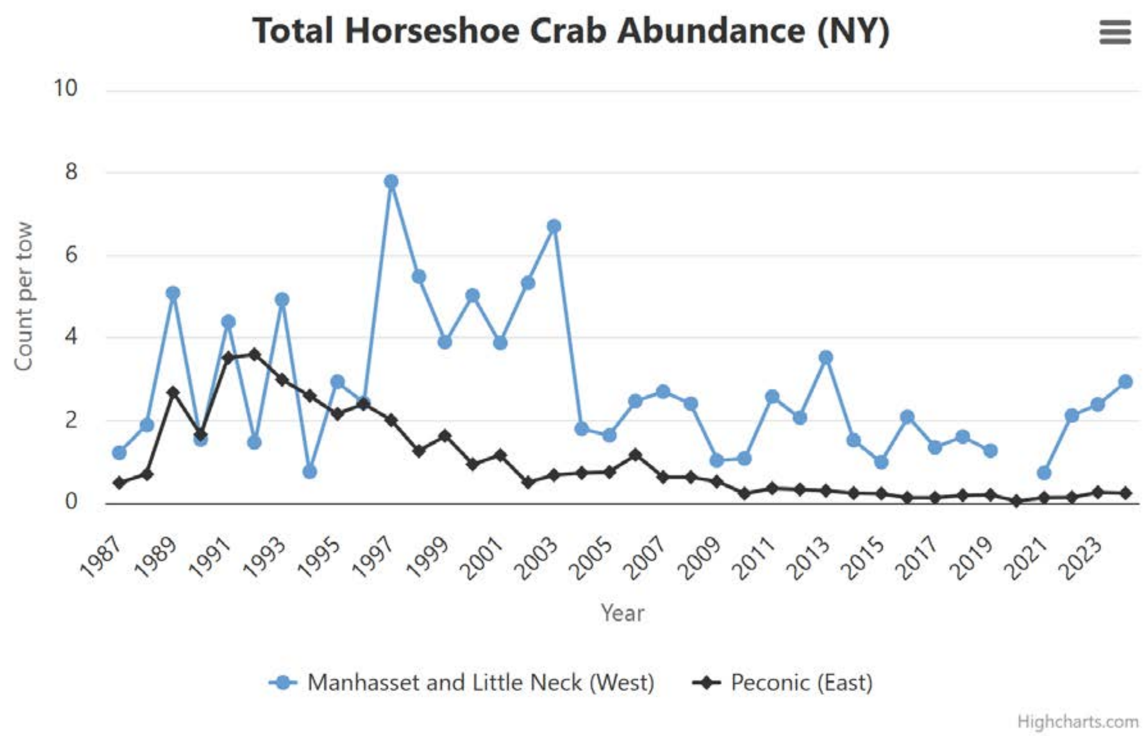


Figure 2-43 Declining Abundance of Horseshoe Crabs Source: Horseshoe Crab Abundance - Long Island Sound Study

2.2.3 Looking Ahead at Future Surface Water Quality

Existing surface water quality in the marine surface waters surrounding Orient is currently very good. However, data confirm that Orient residents' anecdotal impressions of declining populations of key local species including eelgrass, scallops and horseshoe crabs are correct. Available data characterizing key water quality indicators dissolved oxygen and nitrogen in Orient Harbor and Hallocks Bay show that hypoxia (low oxygen concentrations) and eutrophication (overabundance of nutrients) are not the primary drivers of these declines.

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Instead, the declines likely result from a variety of factors including overfishing, disease, and increased water temperature.

Continued increased water temperature is one predicted impact of climate change. Both the Long Island Sound Study and the Peconic Estuary Partnership are monitoring the anticipated continued impacts of climate change on water quality and the estuaries' ecological resources. The Long Island Sound Study Climate Change and Sentinel Monitoring - Long Island Sound Study is being implemented to collect the data needed to identify and facilitate management decisions, mitigation and adaptation responses to address impacts to water quality and ecosystems. Peconic Estuary's 2020 updated Comprehensive Conservation and Management Plan identifies climate change as one of the most significant threats to the Peconic Estuary (https://www.peconicestuary.org/projects/resilient-communities-prepared-for-climate-change-2/).

Climate change is anticipated to continue to cause changes to water quality and Orient's marine resources. As described above, increased water temperatures resulting from climate change may contribute to the increased occurrence, distribution and duration of HAB events. Increased HABs reduce light penetration which further impacts SAV such as eelgrass that depend on adequate light.

Climate change may also become a factor contributing to increased pathogen levels in Orient's surface waters, both because the increased groundwater table resulting from sea level rise may allow septic tank effluent to travel directly from the groundwater to surface water discharge, and because the predicted more frequent intense storm events may wash animal and bird waste into surrounding surface waters after storm events.

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Section 3
Alternative Solutions

Despite Orient's limited fresh groundwater resources, the quantity is sufficient for current and future projected community needs. Groundwater quality impacts that have been observed in some areas of the community are currently being addressed by home treatment systems such as filtration. Available data shows that surface water quality is generally good, although impacts from climate change, such as the warming of surface waters, are being observed.

Due to the impacts on groundwater and surface water resources, climate change, which the Orient community cannot control, has been identified as the most significant issue facing Orient. Certain areas of Orient, particularly coastal areas, are more vulnerable to sea level rise-induced salt water intrusion than others. Coastal wells are likely to be impacted, particularly during the summer months, and high pumpage from inland wells may also cause salt water upconing. At some point in the future, rising sea level is projected to cause Orient's aquifer to become shallower, resulting in extensive salt water intrusion to residential wells, particularly at waterfront properties. Monitoring and reporting will be required so the community is alerted to begin the years-long process of obtaining public water. The increased water table elevation caused by sea level rise will also threaten the efficacy of septic systems and cesspools, which may also increase groundwater and surface water contamination.

The primary issue identified for evaluation was Orient's groundwater supply, with the understanding that improved groundwater quality would also result in improved surface water quality. With an increasing number of houses and ongoing threat of contamination, Orient residents must protect their groundwater more vigilantly than they have in the past. Noting that discharges from conventional onsite wastewater treatment systems (OWTS) have the potential to impact both groundwater and surface water quality, potential solutions to manage sanitary wastewater were also considered.

Alternative solutions to address Orient's potable water supply and wastewater management were identified, discussed with Orient Association (OA), and evaluated. Members of the Orient community have long held very strong and contrasting opinions on alternative water resources management solutions that have been proposed in the past. An approach utilizing a decision support tool to evaluate water resource management alternatives and identify recommended solutions was implemented as described in the following pages, however, the OA Water Committee ultimately determined that further consideration and discussion of the alternatives amongst the broader Orient community would be a more appropriate path forward.

Overall recommendations include:

- In the near term, residents should implement supply well testing, water conservation, utilize home treatment systems as appropriate, and consider the best practices identified in Section 3. 3.1 below;
- Continue to collect and analyze groundwater samples from monitoring wells to identify water quality impairments;
- Use groundwater table monitoring data collected by the United States Geological Survey (USGS) and Suffolk County Department of Health Services (SCDHS) Office of Water Resources and work with SCDHS and the Suffolk County Water Authority (SCWA) to develop a plan for a reliable long term water supply.

The following pages identify the water supply and wastewater management alternatives that were identified, describe the initial evaluation process that was implemented, and summarize the potential actions that Orient may consider to address water supply and wastewater management in the years ahead.

3.1 Identification of Alternative Solutions

A range of alternative solutions to address Orient's drinking water supply and wastewater management was identified for evaluation. The solutions that were formally evaluated are identified below; additional potential solutions that were subsequently discussed are also noted.

3.1.1 Water Supply Options

Five alternatives were considered to provide Orient with a reliable supply of drinking water that achieves water quality standards:

- No Action (Existing Conditions) – Private wells continue to be impacted by contaminants of concern, sea level rise or salt water upconing. Some, although not all, Orient residents have addressed water quality concerns by having their wells tested and installing individual home treatment systems. Therefore, no action for purposes of this discussion is identified as existing conditions, which includes some residences that have implemented treatment to remove contaminants of concern from their water supply and others who have not.
- Individual Home Treatment Systems –Individual home treatment systems include a variety of options such as filtration that are installed to address one or more specific contaminants of concern such as PFAS. This alternative should be combined with regular water quality testing. Home treatment systems may include:
  - Point-of-Use (POU) systems which provide treatment at one household faucet, and
  - Point-of-Entry (POE) systems which provide treatment to all water used by the household.

- Suffolk County Water Authority Supply to Village – This public water supply alternative includes SCWA construction of a pipeline that would carry water from the aquifer west of Orient to serve residences and businesses located in the Village that are impacted by PFAS.
- SCWA Supply to Orient –The second public water supply alternative would have SCWA construct a pipeline carrying water from the aquifer west of Orient to serve any Orient residences and businesses who wish to connect to public water supply.
- New Village Supply - Orient would establish an independent Orient Water Authority to supply potable water to the community.

The OA Water Committee also proposed the potential that wells located further inland where the freshwater aquifer is thicker could provide water to multiple homes where the fresh water supply was threatened by salt water intrusion, salt water upconing or contamination. This alternative was not considered further as it is not permitted by the County's Sanitary Code.

3.1.2 Wastewater Management Options

Three wastewater management alternatives were identified for evaluation:

- No Action – No action would be the continued use of cesspools and conventional septic systems that are not designed for removal of nitrogen and potentially other contaminants of concern.
- Individual Innovative/Alternative On-site Wastewater Systems (I/A OWTS) – Individual homeowners would replace their existing conventional on-site wastewater disposal systems with I/A OWTS systems that are designed to remove nitrogen. I/A OWTS technologies are also being evaluated for removal of additional contaminants of concern; some have proven to be very effective.
- Centralized wastewater treatment - Orient would plan, design, construct, operate and maintain a sanitary sewer system and wastewater treatment plant to collect and treat sanitary wastewater from the community.

A fourth alternative, siting a larger I/A OWTS or I/A OWTS cluster that could serve multiple households at an inland location where the depth to groundwater was sufficient to provide adequate treatment of the sanitary wastewater was subsequently identified during discussion with the OA Water Committee. While there is currently no regulatory mechanism to implement a clustered I/A OWTS system in Suffolk County, SCDHS has recognized that this may be a viable alternative for Orient and other coastal communities that should be explored further.

3.2 Alternative Evaluation Process

There are many different approaches that may be used to evaluate alternative solutions. As previously noted, members of the Orient community have long held very strong and disparate opinions on potential alternative water resources management solutions so it was important

to identify an approach that would enable direct stakeholder participation in an organized and objective evaluation process.

Initially, the OA Water Committee participated in an exercise using a decision support tool to objectively identify the water resources solution(s) that best achieved their goals and objectives and would be recommended for implementation. While this approach provided the organized and objective process that was initially planned, the OA Water Committee identified the need to conduct broader community outreach and further consider the advantages and disadvantages of each alternative before a solution could be recommended and implemented. The decision support tool used for the evaluation, EVAMIX, the priorities of the OA Water Committee representatives who participated in the evaluation, and the evaluation approach are provided in **Appendix B**.

3.2.1 Evaluation Criteria

Each of the potential water supply and wastewater management options was evaluated based on ten criteria that are summarized in **Table 3-1** below.

Table 3-1 Criteria Used to Evaluate Potential Water Resource Management Options

Criterion	Description
Protection of human health	Prevents/reduces human exposure to contaminants of concern
Reliability	Dependability, effectiveness
Resiliency	Ability to withstand changing conditions (including climate change, emerging contaminants of concern)
Impact on surface water resources	Effect on surface waters and ecosystems (e.g., does it reduce contaminants discharging to surface waters?)
Implementation complexity (regulatory requirements, permitting)	Ability/ease of legally implementing the alternative (considers number of approvals and permits required considering federal, state, county, town, etc.)
Siting requirements/construction disturbance	Need for land/space within the community
Impact on development potential	Perceived ability of the alternative to encourage additional development within the community
Capital cost	Initial cost per household to maintain and operate the alternative
Operations and maintenance costs	Annual cost per household to operate and maintain the alternative
Implementation schedule	Number of years before alternative can be implemented and operational

The advantages and disadvantages of each potential water supply and wastewater management option based on these criteria are summarized in Section 3.3, below.

3.2.2 Additional Input and Considerations

After review of the decision support tool results and further discussion, the OA Water Committee both sought additional input and identified additional options for consideration, as described below.

3.2.2.1 Water Supply Considerations

Recognizing that wider community input would be beneficial to the decision-making process, the OA Water Committee developed and distributed a survey to community members to enable incorporation of additional water supply quality, practices and opinions into the evaluation. The survey results are included in **Appendix C**.

The results of one key question, e.g., whether SCWA should be asked to provide public supply to Orient, underscore the community's divided opinions. As shown on **Figure 3-1,** almost 40 percent of the 124 respondents would not want SCWA water, over 35 percent of the respondents would like to connect to the public water supply and 25 of the respondents were undecided or needed additional information to decide.

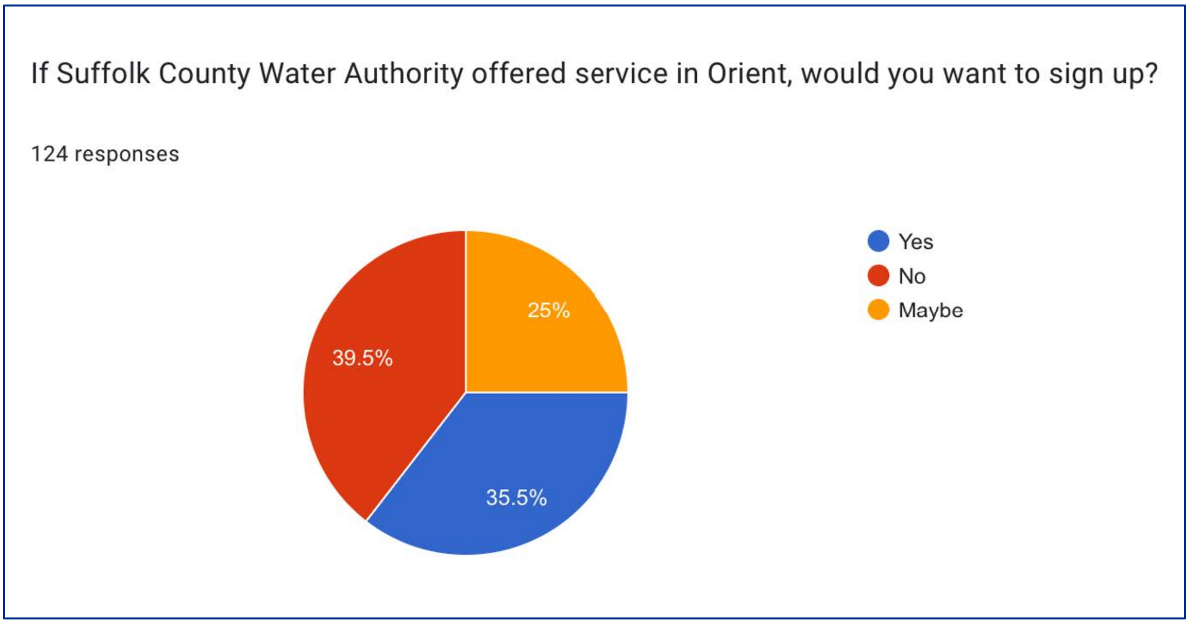

Figure 3-1 Results of OA Survey Question

3.2.2.2 Wastewater Management Considerations

Recognizing that the higher water table resulting from sea level rise would cause challenges for siting I/A OWTS on small waterfront properties, the OA Water Committee proposed a fourth alternative; siting a larger I/A OWTS or I/A OWTS cluster that could serve multiple households at an inland location where the depth to groundwater was sufficient to provide adequate treatment of the sanitary wastewater. This solution would address the potential resiliency issues associated with traditional on-site septic systems and potentially with I/A OWTS as sea level rise impacts the water table and reduces the thickness of the unsaturated zone that is necessary to attenuate pathogens that may be present in wastewater.

While there is currently no regulatory mechanism to implement a clustered I/A OWTS system in Suffolk County, SCDHS has recognized that this may be a viable and necessary alternative for Orient and other coastal communities in the future that should be explored further. As part of the Suffolk County Subwatersheds Wastewater Plan (SWP), several pilot area evaluations

were completed that began to identify the complexity of implementing small clustered systems and recommendations to streamline and simplify the process. The permitting, approval(s) to construct, and the long-term management for sewering/clustering of existing parcels to a new common treatment system typically involve a complicated process that can involve multi-jurisdictional review of construction plans, the need for sewer agency agreements, the potential need for creation of a District, and additional significant financial burden associated with multiple permit fees and financial assurance requirements. While the process assures project quality control and provides a mechanism for long-term management of the system, it is not a viable and cost-effective approach for smaller clustering projects, particularly for existing homeowners or business owners who wish to provide advanced wastewater treatment but do not have the required space or financial means to do so.

For example, all new wastewater proposals that involve the connection of multiple property owners to a common treatment plant require the execution of a sewer agency agreement with the Suffolk County Department of Public Works (SCDPW) to establish a long-term mechanism for the continued administrative and financial obligations associated with the operation of the system, in the event that the property owners fail to maintain the system properly due to financial or other reasons. Projects requiring sewer agency agreements ultimately must meet both SCDHS and SCDPW design and construction standards, must obtain construction permits from both agencies (including the payment of associated permit fees for both agencies), and may require financial assurance for both agencies. While this process has proven largely successful, the additional financial and administrative burden is not practical or realistic for smaller projects that might benefit from a clustering approach using Appendix A wastewater treatment systems or I/A OWTS; particularly for small residential clustering projects.

SCDHS has determined that the identification of alternatives to streamline and facilitate the use of clustering in Suffolk County is a critical component of the overall wastewater management strategy. Clustering provides an attractive wastewater management option where the use of I/A OWTS or connection to existing sewer districts is not feasible. Discussions with SCDHS indicated that Suffolk County's progress towards establishment of a Countywide Wastewater Management District may ultimately provide the ability to establish a stable and recurring revenue source and streamline approvals, oversight, and funding options for "clustered" systems in Suffolk County.

3.3 Consideration and Implementation of Alternatives

Additional information that may be useful to OA as they consider important decisions about the future is provided in the following pages.

3.3.1 Water Supply Alternatives Considerations

Recognizing that factors such as climate change and actual and potential contamination of the limited aquifer system will require some action if Orient residents are to continue to have access to a potable supply, OA recognizes that some decision will be needed. The water supply of some residents will be affected long before others. However, based on the wide variation of conclusions and strong opinions on the topic of water supply, the OA Water Committee determined that further community consideration was warranted. To support further

discussions with the larger community, **Table 3-2** summarizes the advantages and disadvantages (actual and perceived) of each of the alternatives evaluated.

Table 3-2 Summary of Water Supply Alternative Advantages and Disadvantages

Alternative	Advantages	Disadvantages	Comments
No Action	Residents retain complete independence Straightforward installation in many areas of the community Perceived deterrent to increased development No additional expenses for existing wells	Shallow private wells continue to be vulnerable to contamination from a variety of potential contaminants Many wells will face increased vulnerability to salt water intrusion and to salt water upconing	This option poses the greatest risk to human health - while some residents will implement a home treatment system, others will consume water that does not meet drinking water standards for one or more contaminants. Over time, an increasing number of wells will be lost to salt-water intrusion or salt water upconing. No action may be sustainable for some residents, but it will not provide safe drinking water for many residents in the years ahead.
Home Treatment Systems	Homeowners retain complete independence Straightforward installation for most residences Perceived deterrent to increased development Provides increased protection of health if properly maintained Rapid implementation possible	A wide variety of treatment systems are available and capable of removing different contaminants – a home treatment system may provide a false sense of security if not all contaminants of concern are removed. Technology-specific capital and operation costs may also be significant Wells remain vulnerable to salt water intrusion and/or upconing Homeowner must conscientiously maintain the treatment system	Homeowners should continue to have their water quality monitored to be confident that water quality is acceptable. Homeowners should implement best practices to avoid contamination (Section 3.3.3) and continue to conserve water, especially in near shore locations vulnerable to salt water intrusion. While costs for home treatment systems vary widely based on factors such as the types of contaminants to be removed, installation of home treatment systems for all private wells would cost on the order of $1,000,000. Home treatment systems must also be maintained; costs to operate and maintain the systems also vary widely based on the type of system installed; an annual operation and maintenance cost of $1,500/year was used for planning purposes. Home treatment systems may be installed quickly, as indicated by water quality monitoring results. Reverse osmosis (RO) is one type of home treatment system that could be considered to remove salt from brackish or salty water. While RO can successfully

Alternative	Advantages	Disadvantages	Comments
			remove chlorides and other contaminants of concern such as nitrates, there are some significant disadvantages that must be considered, including high power requirements, the need for a water storage tank, and because the RO process typically generates about five gallons of wastewater for each gallon of clean water provided (https://www.epa.gov/watersense/point-use-reverse-osmosis-systems). RO systems with USEPA's WaterSense label must generate no more than 2.3 gallons of wastewater for each gallon of clean water produced, but this still means that the resident would need to pump over three times as much water as they need, which could exacerbate salt water intrusion and also increase the load on the septic system.
SCWA Supply to Village or to Orient	Water quality is routinely monitored so that delivered water achieves water quality criteria Provides long-term reliability as new contaminants are identified and regulated, as SCWA provides appropriate treatment as needed Provides long-term resiliency as private wells are impacted by salt water Consistent with SCDHS recommendations and the Suffolk County Sanitary Code	Loss of independence Perceived to encourage development Years-long implementation schedule Capital cost (please see comments) Construction disturbances while distribution system is built Provision of public supply to the Village alone does not provide the same benefits to the entire Orient community	SCWA is committed to working with communities to provide water to those who want access to the reliable supply and has expressed a willingness to discuss the possibility with members of the Orient community. A preliminary planning level cost to supply water to the Village would approach $7M and to supply water to all of Orient is approximately $9M. While the capital cost to plan, design and construct a pipeline to convey water to Orient, a distribution system and connect homes to the distribution system is significant, SCWA has been very successful in obtaining funding and grants to either reduce costs to residents, or in some recent cases, completely pay for the supply (there is no guarantee how much longer the funding opportunities and grants will be available in the future.) SCWA estimates the average annual cost of water per household is $557. While this is higher than the no action alternative, it is less costly than the cost to operate and maintain some home treatment systems. Planning, permitting, design and construction is estimated to take approximately 5 to 6 years.
Orient Water Authority	Residents retain independence	Challenging – and potentially impossible to site	Besides the technical challenges of finding one or more locations where the aquifer is adequate to reliably supply

Alternative	Advantages	Disadvantages	Comments
	High level of human health protection as delivered water would be treated to comply with drinking water standards	wells that are capable of providing water to the entire community Unsustainable due to climate change Most costly alternative to implement and to operate and maintain Anticipated implementation schedule (planning, permitting, design, construction) at least a decade Perceived to enable increased development Construction disturbance as wells, treatment plant, and distribution system are built	fresh water to the community, there are administrative challenges associated with establishing a new water authority. Due to the limited aquifer thickness, this is not a viable option as intensive pumping from a limited number of wells is not sustainable. In addition to constructing the physical wells, treatment plant and distribution system, an administrative framework to manage, operate and maintain, monitor, report to the regulatory authorities, respond to water main breaks and other incidences and invoice customers for the delivered water would also need to be established. A very preliminary planning level cost to plan, design and construct a new supply is on the order of $15,000,000. A preliminary estimate of annual costs per household is approximately $2500. It is estimated that it would take at least eight years to establish a new Water Authority, plan, permit, design, construct and begin operation of a new public water supply system.

3.3.2 Wastewater Management Alternatives Considerations

Recognizing the inevitability of climate change and the impact that sanitary wastewater discharges can have on both groundwater and surface water quality, wastewater management will require some action. Existing on-site wastewater treatment systems in coastal areas will be impacted by sea level rise long before systems located further inland. To support further discussions with the larger community, **Table 3-3** summarizes the advantages and disadvantages (actual and perceived) of each of the alternatives evaluated.

Table 3-3 Summary of Wastewater Management Alternative Advantages and Disadvantages

Alternative	Advantages	Disadvantages	Comments
No Action	Homeowners retain complete independence No permitting or construction	Not designed to remove nitrogen, so does not improve groundwater or surface water quality	While there are no capital costs associated with the no action alternative, an annual operation and maintenance cost of septic tank pumpage would cost about $500/household.

Alternative	Advantages	Disadvantages	Comments
	disturbance is involved Swiftest implementation and lowest capital cost	Will not function in the future in areas impacted by sea level rise	
I/A OWTS	Homeowners retain complete independence Straightforward permitting and installation and implementation at most residences Grants are readily available to offset capital costs Provides increased protection of health if properly maintained Reduces nitrogen discharged to the environment, improving groundwater and surface water quality Rapid implementation possible May be designed and constructed above the water table to delay the impacts of sea level rise in coastal areas	Operation (electricity) and maintenance costs higher than for conventional septic systems Homeowners must maintain the systems May be challenging to implement in coastal areas	I/A OWTS may be sited, designed and installed within about 6 months. While capital costs vary depending on the system selected and property characteristics; the total estimated cost for installation throughout Orient is approximately $7.5M. Suffolk County has estimated annual operation and maintenance costs as $1,500/household. It would be prudent to anticipate the impacts of sea level rise and an elevated groundwater table by incorporating a greater than required separation distance between the bottom of the on-site system and the seasonal high water table.
Centralized wastewater treatment system	Provides the highest level of wastewater treatment, removing other contaminants of concern in addition to nitrogen	Loss of independence Perceived to encourage development Anticipated decade-long	In addition to an administrative framework to manage, operate and maintain, monitor, report to the regulatory authorities and respond to blockages and other incidences and invoice customers would also need to be established. A preliminary planning level cost to plan, permit, design and construct

Alternative	Advantages	Disadvantages	Comments
	Reduces nitrogen discharged to the environment, improving groundwater and surface water quality Provides increased protection of health Can be designed to be resilient	implementation schedule Planning, siting a plant and permitting a discharge will be challenging Most costly to implement and to operate and maintain Construction disturbances as conveyance system (piping and potentially pump stations) and treatment plant are built	a wastewater collection and treatment system is on the order of $56M; it is anticipated that it would take about a decade to establish a wastewater treatment authority, site a treatment facility, plan, permit, design and construct they system. Annual costs per household are estimated as approximately $3000.

3.3.3 Water Supply, Groundwater Protection and Wastewater Management Planning

Given the vulnerability of the Orient aquifer that provides the only source of the community's potable supply, planning for a long term solution should be considered. While it is clear that sea level is rising and that sea level rise will impact Orient's groundwater supply, researchers continue to develop alternative projections of the rate and magnitude of sea level rise in the coming decades; NYSDEC's recently updated proposed sea level rise projections significantly increase the projected sea level rise for the low and low-medium projections as summarized on **Table 3-4**.

Table 3-4 Proposed Changes to Sea Level Rise Projections for the Long Island Region

(c) Long Island Region

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection	Rapid Ice Melt Projection
2030s	7 inches	8 inches	10 inches	12 inches	14 inches	NA
2050s	13 inches	15 inches	18 inches	21 inches	25 inches	NA
2080s	23 inches	26 inches	32 inches	41 inches	48 inches	83 inches
2100	27 inches	32 inches	39 inches	54 inches	69 inches	114 inches
2150	42 inches	50 inches	63 inches	94 inches	185 inches	NA

Source: NYSDEC Part 490 Express Terms 2024 (ny.gov)

Combined with potential water quality impacts as new and emerging contaminants are found in groundwater, it will be prudent for Orient to begin to identify a sustainable and reliable source of fresh water for the community, with the understanding that implementation may take some time.

Thoughtful stewardship of the groundwater system will also continue to be important – both to protect the community's water supply and because the groundwater discharge to the coastal waters impacts surface water quality.

Actions that the community should implement immediately include:

- Each resident/business owner should have their water tested, and testing should be repeated annually at a minimum. SCDHS will test private well water and private laboratories will also provide this service. SCDHS currently provides private well testing for a fee of $100, although this fee may be waived based on income limits. A description of the private well testing program, including directions on how to apply for well sampling may be found here: https://www.suffolkcountyny.gov/Departments/Health-Services/Environmental-Quality/Water-Resources/Private-Well-Water-Testing-Program. Specifically request that PFAS analyses be included.

- In accordance with Article 4 of the Suffolk County Sanitary Code and the County's water supply goals and recommendations articulated in the Comprehensive Water Resources Management Plan, CDM Smith advises that development of an agreement with SCWA to provide water to Orient is the most reliable and protective long-term solution for the community. CDM Smith advises that it would be prudent to contact SCWA to begin a

conversation about the potential to work together to provide water to those who need it and those who would like the security of the public supply. Because SCWA would need to obtain the water to provide to Orient, seek and hopefully obtain funding, and plan, permit, design and construct the infrastructure, implementation of this alternative will take years, so the community should not wait until a water supply crisis is imminent.

- Continue to communicate with SCDHS and NYSDEC on PFAS detections in groundwater and remediation of the contamination identified at the Orient Fire Department and implement agency guidance with respect to testing, monitoring and treatment of private well water.

- Use water wisely and conserve supply, especially during the growing season when demand is high and recharge is low and over-pumping can accelerate salt water intrusion or upconing:

  - Limit irrigation and irrigated landscaped areas by reducing turfed area, installing smart irrigation systems that do not irrigate when it is has rained, plant native plant species that require less water, consider installing a rain garden. Information on responsibly maintaining lawns and implementing rain gardens may be found at Healthy Lawns, Clean Water (suffolkcountyny.gov) https://healthlawns.suffolkcountyny.gov/lawn/watering.htm and Microsoft Word - countyRain Gardens[1][1].doc, respectively.

  - Install (and use) a pool cover to reduce the need to replace water lost to evaporation. Pool covers can reduce the amount of make-up water required by 30-50 percent; chemical consumption is also reduced by 35 to 60 percent: https://www.energy.gov/energysaver/swimming-pool-covers

  - Consider use of water saving fixtures, such as EPA Watersense fixtures that may be found here: https://www.epa.gov/watersense/watersense-products and fix leaks immediately.

- Recognizing that the farm community also has a need for an adequate supply of fresh water to irrigate their crops, encourage voluntary implementation of agricultural stewardship and best management practices identified by the National Resources Conservation Service, including providing assistance in securing available funding. Farmers are important environmental stewards and preservation of farmland will continue to maintain groundwater recharge that might be lost to stormwater runoff if it is developed.

- Be aware that everything that is washed down a household drain or is applied to your property may reach and contaminate groundwater.

- Choose cleaning, household and personal care products wisely; particularly avoiding those that contain 1,4-dioxane and PFAS:

  - Refer to EPA https://www.epa.gov/saferchoice/products to identify safer cleaners, household and personal products. Many other resources are available, including The Spruce https://www.thespruce.com/the-best-septic-safe-household-cleaning-products-4175069

  - Fabrics with stain/waterproof repellent coatings, such as Teflon, Scotchgard, Stainmaster, Polartec, or Gore-Tex can contain PFAS chemicals. They are found on pan coatings, sails, fast-food wrappers, pizza boxes, some watch bands and even Oral-B glide floss and in gelcoats, paints, varnish, sealants and solvents. Choose personal care products without "PTFE" or "FLUORO" Ingredients. Check "performance" fabric specifications when purchasing furniture.

  - 1,4-Dioxane is a by-product that is present in many cosmetics, shampoos, detergents, liquid soaps and cleaning products. New York State has established a maximum allowable concentration of 1 part per million of 1,4-dioxane in household cleaning and personal care products by December 31, 2023, and a maximum allowable concentration of 10 parts per million in cosmetics by December 31, 2022. However, companies who have been unable to achieve these concentrations by the December 31, 2023 deadline may obtain waivers for up to two additional years provided they provide proof that they have implemented actions to reduce the 1,4 dioxane concentration but have still not achieved the limit. The current list of waivers may be found here: https://www.dec.ny.gov/fs/projects/waivers/1-4DApprovedWaivers.xlsx

- Properly dispose of pharmaceuticals and hazardous products. Do not wash them down the drain or flush them down the toilet. Use available programs to dispose of products containing hazardous materials (e.g., oils and fuels, paints and solvents, pesticides, and cleaning products) and pharmaceuticals. The Southold Transfer Station accepts hazardous materials four times each year as described at http://www.southoldtownny.gov/149/Hazardous-Waste. ELIH pharmacy and CVS will accept unused pharmaceuticals for proper disposal.

- Harmful bacteria may contaminate private wells if contaminated runoff enters the well through a cracked well casing or damaged wellhead. Wells may be protected from damage from mowers or vehicles if they are surrounded by rocks or flowerbeds.

- Limit the use of fertilizer, herbicides, pesticides and fungicides. Remember that Suffolk County does not allow fertilizer use between November 1 and April; additional information is available at: https://healthylawns.suffolkcountyny.gov/. Additional information is available from the Peconic Estuary Partnership: Pesticides Near the Bay – Peconic Estuary Partnership.

- If spraying your property for ticks or other pests, do not allow application after a heavy rain event or during windy conditions.

- Clean up pet waste to reduce potential impacts from nutrients and bacteria that may be washed into groundwater or a nearby surface water.

- As Suffolk County voters have approved establishment of the Suffolk County Wastewater Management District, work with SCDHS, Division of Wastewater Quality, Bureau of I/A OWTS to explore, advance and fund clustered I/A OWTS to treat sanitary wastewater from coastal residences and avoid contaminating groundwater and adjacent surface water bodies.

- Consider replacing existing septic systems with I/A OWTS to reduce nitrogen discharges; Suffolk County's I/A OWTS program, including grant applications and approved technologies may be found here: https://reclaimourwater.info/Septic-Improvement-Program. I/A OWTS implementation costs range from approximately $15,000 to over $50,000 in challenging locations such as Fire Island; Suffolk County reports the average cost of I/A OWTS installation is $25,000, not including engineering and design costs. Grants of up to $10,000 each are currently available from both Suffolk County and New York State to significantly reduce the cost. Cost information for Suffolk County approved I/A OWTS technologies may be found here: https://reclaimourwater.info/Portals/23/pdfs/4-bedroom_Vendor_Ranking_Document_rev_05-10-2024.pdf

- Maintain existing septic systems and avoid using strong chemicals and products that will harm the bacteria in the septic tank, such as drain cleaners, solvents, paint, paint thinners, motor oil, antifreeze, pesticides, etc. New York State provides additional guidance on septic system use and maintenance: https://www.health.ny.gov/publications/3208/#:~:text=Septic%20Tank%20Maintenance,out%20the%20tank%20when%20necessary.

- Finally, keep apprised of re-seeding (e.g., eelgrass, clams, scallops) and shellfish aquaculture projects and provide support as appropriate: Shellfish Aquaculture Lease Program ; Cornell Cooperative Extension | SPAT Program.

3.3.4 Other Resources

The list of potential water resource protection actions provided above is not exhaustive, but does include a range of applicable responses to the need to protect and preserve limited water resources. Many area agencies and programs have already compiled recommendations to protect water resources; additional resources are identified here:

https://www.peconicestuary.org/projects/resilient-communities-prepared-for-climate-change-2/

https://longislandsoundstudy.net/educational_resource/

https://www.peconicestuary.org/what-you-can-do/education-and-outreach-programs/

https://www.peconicestuary.org/what-you-can-do/create-a-peconic-friendly-yard/

https://www.peconicestuary.org/pep-reduction-bmp/

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Section 4
Monitoring and Reporting

Monitoring programs are developed and implemented to collect the specific information necessary to guide informed decisions. Data characterizing groundwater quality, fresh groundwater needs, sea level rise and surface water quality will all be useful to Orient. In addition to collection and analysis of private well water quality samples, Orient may obtain information from a variety of on-going programs and resources. It is anticipated that Orient can obtain useful information from existing monitoring programs, potentially supplemented by targeted monitoring at key locations.

4.1 Recommended Monitoring

Reliable data collection, analysis and evaluation is a significant undertaking. The following types of data and information would be useful to continue to improve the understanding of Orient's water resources and to guide water resource management:

- Groundwater and drinking water quality;
- Groundwater elevation;
- Surface water quality;
- Research (including a variety of topics such as climate change and resiliency, ecological resources, water and wastewater treatment technologies, etc.) and
- Grants and programs available to fund and support citizen science, community education and implementation of water resource protection activities.

Due to the commitment of resources required, it is anticipated that it will be most advantageous for Orient to work with existing agencies who conduct ground and surface water quality monitoring, including Suffolk County Department of Health Services (SCDHS) Offices of Water Resources and Ecology, New York State Department of Environmental Conservation (NYSDEC), Long Island Sound and Peconic Estuary Programs, the United States Geological Survey (USGS), and Cornell Cooperative Extension Marine Sciences to track climate change, groundwater elevation and groundwater quality and surface water quality data at established monitoring stations and to potentially site new locations as needed. Established groundwater and surface water monitoring stations are illustrated on **Figure 4-1**.

Orient Association can take ownership of encouraging residents to have their private well tested to characterize drinking water quality and compiling and sharing this water quality information, coordinating with existing agencies to collect water resources data characterizing Orient, monitoring research completed by others, and taking advantage of water resources protection programs and funding opportunities.

Figure 4-1 Existing Monitoring Well and Surface Water Monitoring Stations

Establishment, maintenance and sampling of monitoring locations, laboratory analyses, database management and data evaluation will be consistent and reliable when completed by the agencies who conduct monitoring programs under Quality Approved Project Plans (QAPPs) to help to ensure that the data quality objectives are achieved. In general, it is recommended that Orient's monitoring program build upon existing established monitoring programs to provide the historical perspective that helps to identify and evaluate changing conditions.

4.2 Drinking Water/Groundwater

As described in Section 2.1, Orient's drinking water supply is completely dependent on the ability of the shallow aquifer system to provide an adequate quantity of fresh water that complies with drinking water criteria. The following types of monitoring would provide Orient with valuable information:

- Groundwater quality monitoring will provide the data needed to either confirm that groundwater meets drinking water standards, or if contamination is found, to identify the type of treatment that should be implemented.

- Groundwater quantity monitoring can build upon measurements of the elevation of the groundwater table at the same monitoring point over time to assess changes in aquifer storage and available fresh water.

- A combination of groundwater quality monitoring and water table monitoring, potentially combined with focused monitoring of the fresh water/salt water interface may be used to monitor salt water intrusion.

4.2.1 Drinking Water/Groundwater Quality

Monitoring groundwater quality is of critical importance to confirm that Orient residents are drinking water that complies with drinking water criteria. The best and most direct approach to monitor Orient's groundwater quality is for Orient residents to have their water regularly tested by SCDHS.

SCDHS offers a comprehensive and economical private well testing program. For a nominal fee of $100, Suffolk County Public Health Sanitarians who are trained in proper procedures to collect and transport potable water samples will collect samples from private well and transport the samples to the Suffolk County Public and Environmental Health Laboratory (PEHL), who analyzes the samples for a wide range of parameters including pathogen indicators, inorganic chemicals, volatile organic compounds, petroleum products and certain pesticides. If contamination is found and the water does not comply with drinking water standards, the Department will suggest some possible remedies depending on the type and number of contaminants detected. More information on the program, including a link to the application for testing may be found here:

https://www.suffolkcountyny.gov/Departments/Health-Services/Environmental-Quality/Water-Resources/Private-Well-Water-Testing-Program

Of course, at any time, Orient residents and business owners can also contract with a private laboratory to collect and analyze private well or groundwater samples. The cost to analyze a sample for the full suite of parameters evaluated by SCDHS is typically well over $1,000.

SCDHS also currently monitors groundwater quality at a network of shallow monitoring wells installed to investigate PFAS contamination. As part of their County-wide groundwater monitoring network, the SCDHS has installed a cluster of three permanent monitoring wells on Tabor Road. These wells will be sampled periodically for a full range of water quality parameters and will be used to evaluate general groundwater quality trends.

The water quality data characterizing private Orient wells can also be compiled and used to help to track movement of the salt water interface. Salt water intrusion and/or upconing may be identified over time by reviewing changes in chloride concentrations. Ambient chloride levels in groundwater are typically very low. Observation of increasing chloride levels in one or more private wells in an area before they approach the drinking water criteria of 250 parts per million would be one indication that salt water is beginning to impact the aquifer.

4.2.2 Groundwater Quantity

As described in Section 2, declining groundwater levels and/or increasing concentrations of salt in wells may both be indicators that the aquifer is being stressed.

Both USGS and SCDHS monitor the water table at wells in Orient. The USGS has deployed a continuous meter to monitor water levels at S-16787. Orient residents can access and review this data via the USGS website at any time: https://nwis.waterdata.usgs.gov/ny/nwis/gwlevels/?site_no=410858072171501.

SCDHS monitors the elevation of the water table at two water table monitoring wells in Orient; S-5562 and S-22660. Public Health Sanitarians measure the depth to water at these wells annually at the same time of year, usually in March. Collection of water levels at the same monitoring points through the years enables the Office of Water Resources to develop a long-term period of record of water levels at these wells. A subset of Suffolk County's water table mapping data may be accessed via their website: https://gis.suffolkcountyny.gov/portal/apps/webappviewer/index.html?id=831e3f1e35484fd7a2efe6e5312b3ea5. Additional information may be obtained directly from the Office of Water Resources.

4.3 Surface Water

Surface water quality is monitored to assess compliance with surface water quality standards to protect human health as well as aquatic ecosystems. Water quality in the Long Island Sound and Peconic Estuary is well characterized by existing surface water monitoring programs. As described in Section 2.2.1, surface water quality in local Orient surface waters including Orient Harbor, Narrow River and Hallock/Long Beach Bay is currently monitored by SCDHS Office of Ecology, who collect and analyze samples for a wide variety of water quality criteria including dissolved oxygen, temperature, salinity, chlorophyll-*a*, coliform and the nutrients nitrogen and phosphorus on a monthly basis throughout the year. Surface water quality monitoring locations are illustrated on **Figure 4-1**. Orient residents can access the data from these stations, which characterize the quality of Orient's marine surface waters via this link: https://gis.suffolkcountyny.gov/portal/home/group.html?id=41d8d15a5d7542d896aea4003379e0f2#overview.

In addition, the USGS maintains a continuous water quality sonde measuring temperature, dissolved oxygen, salinity, nitrogen, pH and turbidity on the Orient Wharf, at the Orient Yacht Club. The continuous data from the USGS water quality sonde may be accessed here: https://waterdata.usgs.gov/monitoring-location/01304200,

SCDHS Office of Ecology monitors enterococcus on a weekly basis from June through the first weekend in September at Orient Beach State Park on behalf of the New York State Parks Department; this data is used to assess whether the water at the beach meets the standards required for contact recreation such as swimming. This data is typically accessible during the bathing season at: https://gis.suffolkcountyny.gov/portal/home/item.html?id=e3b344ff82b74762b625cacaa3e9621a.

4.4 Climate Change

A variety of potential climate change indicators have been identified and discussed in Section 2.1.3.

The most obvious, and most critical from an Orient infrastructure perspective is sea level rise. As described in Section 4.2, monitoring the impacts of sea level rise on the groundwater table to assess potential salt water intrusion and wastewater management impacts may be assessed using existing monitoring points combined with new data where possible.

For example, the USGS continuous sonde at the Orient Wharf has measured sea level elevation on a continuous basis since 2012. While this does not provide an extensive historical record, the continuous reliable data will enable Orient to track local sea level rise impacts on nearly a real-time basis. The data is available here: Orient Harbor at Orient NY - USGS Water Data for the Nation or https://waterdata.usgs.gov/monitoring-location/01304200/#parameterCode=00003&period=P7D&showMedian=true .

This information will provide the basis for actual measured changes in sea level rise. Historical long-term trends in sea level elevation can be tracked by following the National Oceanic and Atmospheric Administration's Montauk Station at: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8510560 .

Partnering with the USGS and potentially SCDHS to map and track the salt water interface would be the most effective and efficient option for OA to consider. USGS is currently working with NYSDEC to study the Long Island aquifer system (https://www.usgs.gov/centers/new-york-water-science-center/science/groundwater-sustainability-long-island-aquifer-system) and has expressed a willingness to help evaluate salt water intrusion in Orient provided that sufficient resources can be obtained.

The USGS conducts long term monitoring of groundwater elevation and quality and surface water elevation and quality. The USGS also conducts a wide variety of studies, including characterization of hydrogeology and mapping the location and movement of the salt water/fresh water interface. There are multiple approaches that may be implemented to map and monitor the salt water/fresh water interface, including installation of monitoring wells and collection and analysis of water quality samples, downhole geophysical monitoring and geophysical investigation. Discussion of various geophysical investigation techniques may be found here: https://www.epa.gov/environmental-geophysics/surface-geophysical-methods.

The USGS and others have successfully implemented surficial geophysical studies to map the location of salt water interfaces on Long Island, including a study performed in Orient. Of most particular relevance to Orient are the Time Domain Electromagnetic (TDEM) investigation of salt water intrusion on nearby Shelter Island. https://www.usgs.gov/data/time-domain-electromagnetic-soundings-estimate-extent-saltwater-intrusion-shelter-island-new. This non-intrusive technique is an alternative that OA may work with USGS to consider as it may provide more cost-effective mapping of the interface over a larger area. **Figure 4-2** illustrates the locations of USGS TDEM investigations on Long Island, including an investigation in Orient.

Long Island TDEM survey locations

By New York Water Science Center AUGUST 8, 2024

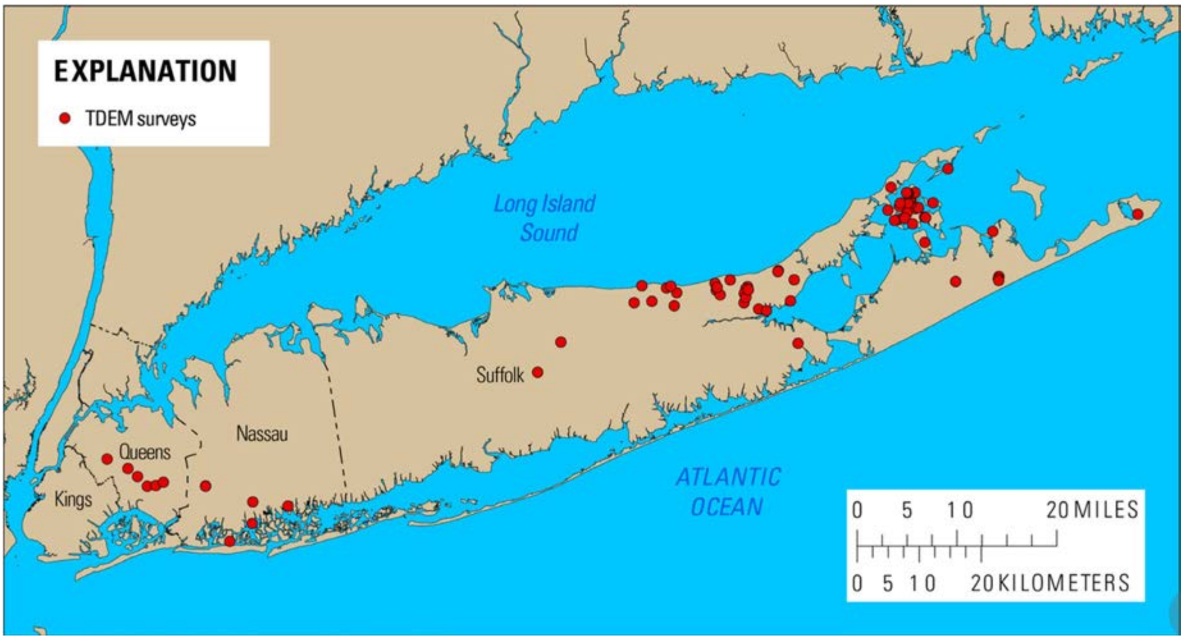

Figure 4-2 Locations of USGS TDEM Investigations on Long Island

Taken together with the long term trends in groundwater elevation documented by SCDHS Office of Water Resources and documenting changes in chloride levels reported at private wells from year to year, OA will have a cost-effective multi-pronged approach to track salt water intrusion and changes to the salt water interface.

4.5 Research, Grants and Community-based Programs

As described above, hands-on groundwater and surface water monitoring can be reliably accomplished by partnering with agencies such as SCDHS, NYSDEC and USGS. Depending on Orient interests and priorities, OA may wish to review and evaluate other information and relevant research, studies and advances to better understand their resource and potential water resources protection and management options.

Information describing drinking water quality regulations, surface water quality and habitats and advances in understanding climate change, the relationships between water quality and ecology and best practices are available from a wide variety of resources. Research is conducted on Suffolk County's water resources by federal, state and local agencies, by non-profits and research institutions. Grants and funding opportunities for research and for implementation of potential solutions to water resources issues are also available.

Perhaps on an annual basis, OA may select areas or topics of interest for the OA Water Committee to study. As areas of particular interest are identified, or educational, water resource protection or water resource management activities are identified, funding may be sought to support the community's initiative.

Potential resources for information, data and grant and funding opportunities to begin are provided below. The lists below are not exhaustive compilations, but provide an initial starting point for OA to monitor topics of interest and relevance and to seek and access funding for water resource management and protection.

4.5.1 Resources

Long Island Nitrogen Action Plan (LINAP) - NYSDEC (sign up to receive frequent newsletters reporting on new studies, programs and opportunities)

https://longislandsoundstudy.net/

https://www.peconicestuary.org/

https://longislandsoundstudy.net/research-monitoring/sentinel-monitoring/

https://www.peconicestuary.org/projects/resilient-communities-prepared-for-climate-change-2/

https://longislandsoundstudy.net/research-monitoring/sentinel-monitoring/sentinel-monitoring-for-climate-change-research-projects/

https://www.usgs.gov/centers/new-york-water-science-center/science/groundwater-sustainability-long-island-aquifer-system

https://dec.ny.gov/environmental-protection/climate-change

https://ccesuffolk.org/marine

https://sealevelrise.org/states/new-york/

https://www.stonybrook.edu/commcms/cleanwater/about/index.php

https://suffolkstormwater.com/

https://ccrun.climate.columbia.edu/

https://www.nature.org/en-us/about-us/where-we-work/united-states/new-york/stories-in-new-york/long-island-water-quality/

4.5.2 Funding

The following sites are useful in identifying available funding programs and grant opportunities:

Funding Finder Tool - NYSDEC

Water Quality Improvement Project (WQIP) Program - NYSDEC

Non-Agricultural Nonpoint Source Planning And MS4 Mapping Grant (NPG) - NYSDEC

Long Island Sound Futures Fund | NFWF

https://www.lisresilience.org/funding-database/

https://seagrant.sunysb.edu/proposals/

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Cornell Cooperative Extension. https://ccesuffolk.org/marine

Cornell Cooperative Extension: Shellfish Aquaculture Lease Program ; Cornell Cooperative Extension | SPAT Program.

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http://longislandsoundstudy.net/ecosystem-target-indicators/lis-hypoxia/

http://longislandsoundstudy.net/ecosystem-target-indicators/duration-of-hypoxia/

http://longislandsoundstudy.net/ecosystem-target-indicators/eelgrass-extent/

Lobster Abundance - Long Island Sound Study

Horseshoe Crab Abundance - Long Island Sound Study

Climate Change and Sentinel Monitoring - Long Island Sound Study

LISS Ecosystem Targets and Supporting Indicators - Long Island Sound Study

https://longislandsoundstudy.net/ecoysystem-target-indicators/shellfish-harvested/

Shellfish Harvested - Long Island Sound Study

https://ccesuffolk.org/marine/aquaculture/scallop-program/scallop-program-overview-and-results

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http://www.dec.ny.gov/docs/water_pdf/linapfertilizer.pdf

Long Island Pesticide Pollution Prevention Strategy - NYS Dept. of Environmental Conservation

http://www.dec.ny.gov/regulations/103877.html

http://www.dec.ny.gov/docs/water_pdf/linapfertilizer.pdf

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TOGS 1.1.6 - Interpretation of Marine Dissolved Oxygen Standard

https://nysdec.maps.arcgis.com/apps/webappviewer/index.html?id=d98abc91849f4ccf8c38dbb70f8a0042 updated January 6, 2023

Part 490 Express Terms 2024 (ny.gov)

Funding Finder Tool - NYSDEC

Water Quality Improvement Project (WQIP) Program - NYSDEC

Non-Agricultural Nonpoint Source Planning And MS4 Mapping Grant (NPG) - NYSDEC

Climate Change Effects and Impacts - NYS Dept. of Environmental Conservation

https://dec.ny.gov/environmental-protection/climate-change

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New York State Department of Health: Coastal Beach Water Quality

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CDM Smith

Appendix A
Private Well Water Supply Pumping Estimates

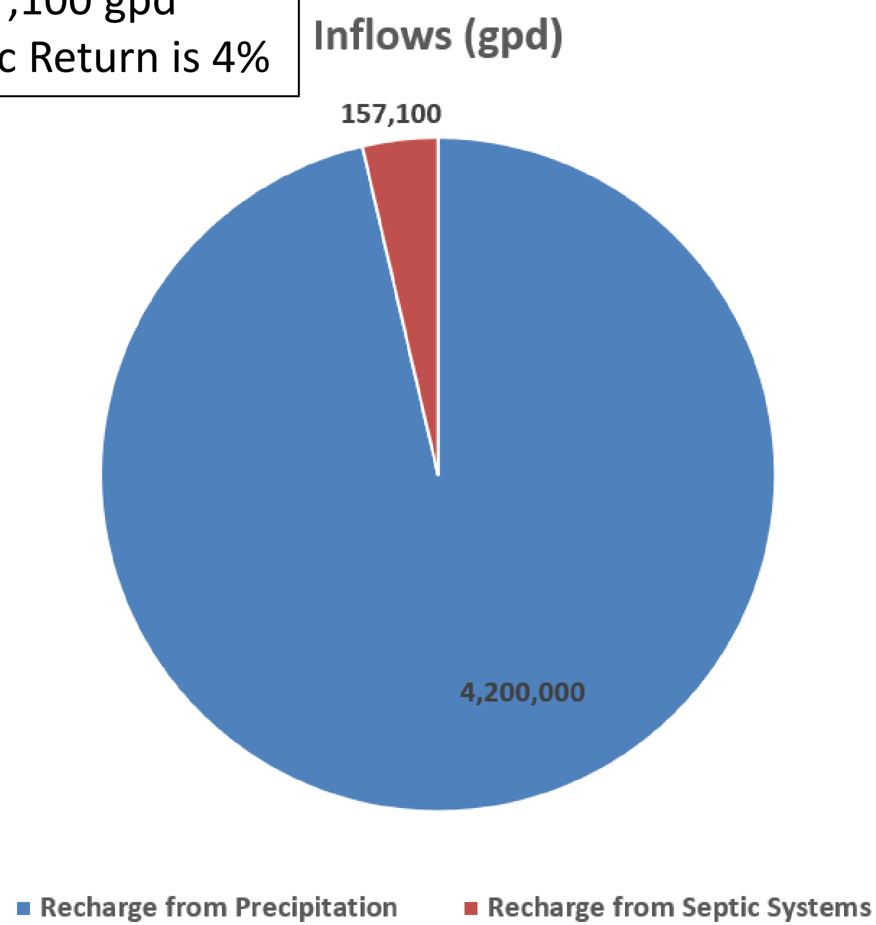
CDM Smith

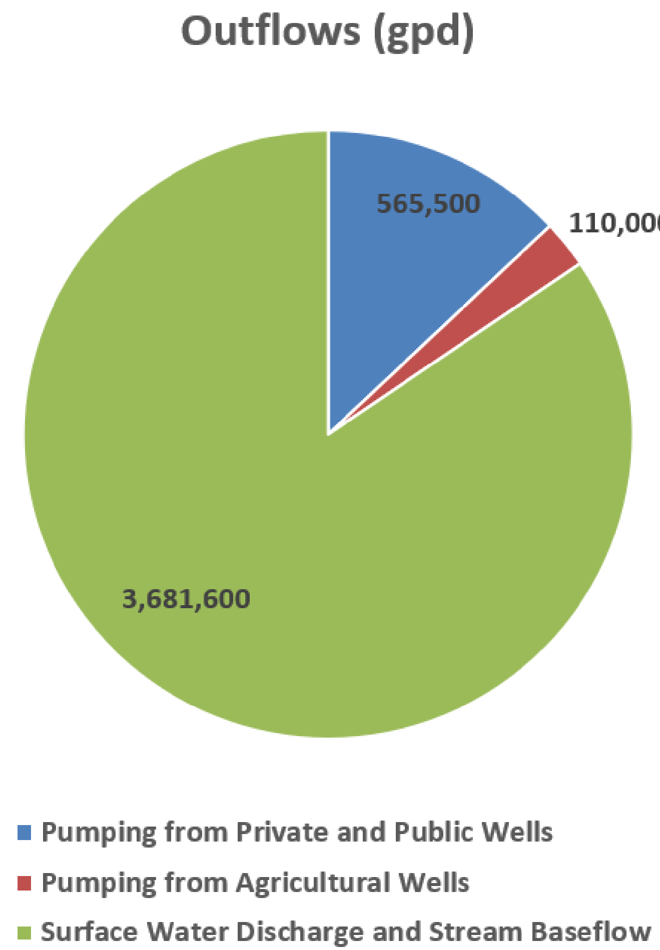
Water Budget

Current (2020) Water Budget

Total Inflow of 4,357,100 gpd
Septic Return is 4%

Pumping is 15% of Recharge





Water Budget

- Water Supply Pumpage
  - Potable Supply (Public and Private)
    - Annual Average of 557,000 gpd (Monthly range of 77,000 to 1,700,000 gpd)
  - Non-Community
    - Cross Sound Ferry: 3,000 gpd
    - Oysterpond Elementary School: 995 gpd
    - Orient Country Store: 995 gpd
    - Orient Beach State Park: 2,000 gpd
    - Orient by the Sea: 500 gpd
    - Orient Ice Cream Parlor: 500 gpd
    - Orient Yacht Club: 500 gpd
    - Total: 8,490 gpd
  - **Total Annual Average: 565,500 gpd**

Water Budget

- Agricultural Pumpage
  - **Annual average of 110,000 gpd based on reported and estimated data from seven wells**
  - 220,000 gpd in summer, 0 gpd in winter

Water Budget

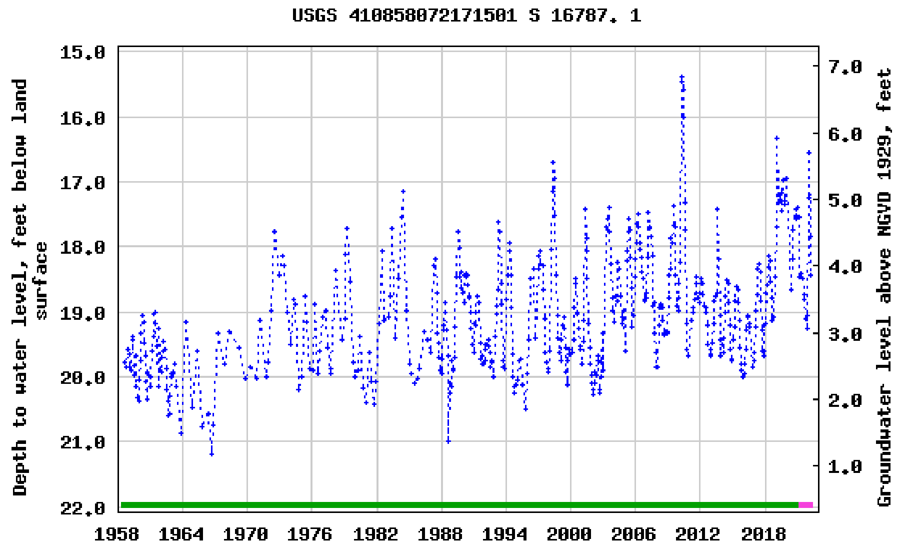
- Recharge from Precipitation
  - **Annual average of 4,200,000 gpd**
  - Varies from 10,800,000 gpd in January to 72,000 gpd in September
- Recharge from Septic Systems (aka Return Flow)
  - **Annual average of 157,100 gpd**
  - Varies seasonally from 66,000 gpd to 312,000 gpd

Water Budget

- Surface Water Discharge and Stream Baseflow
  - **Annual average of 3,650,000 gpd**

Water Budget Summary

- Water level data suggest conditions are stable to rising
- Water budget is based on historic data
  - Water supply pumping
    - Biased high (conservative)
  - Agricultural pumping
    - Incomplete
  - Precipitation recharge
    - Climate change may cause increased rainfall in the future

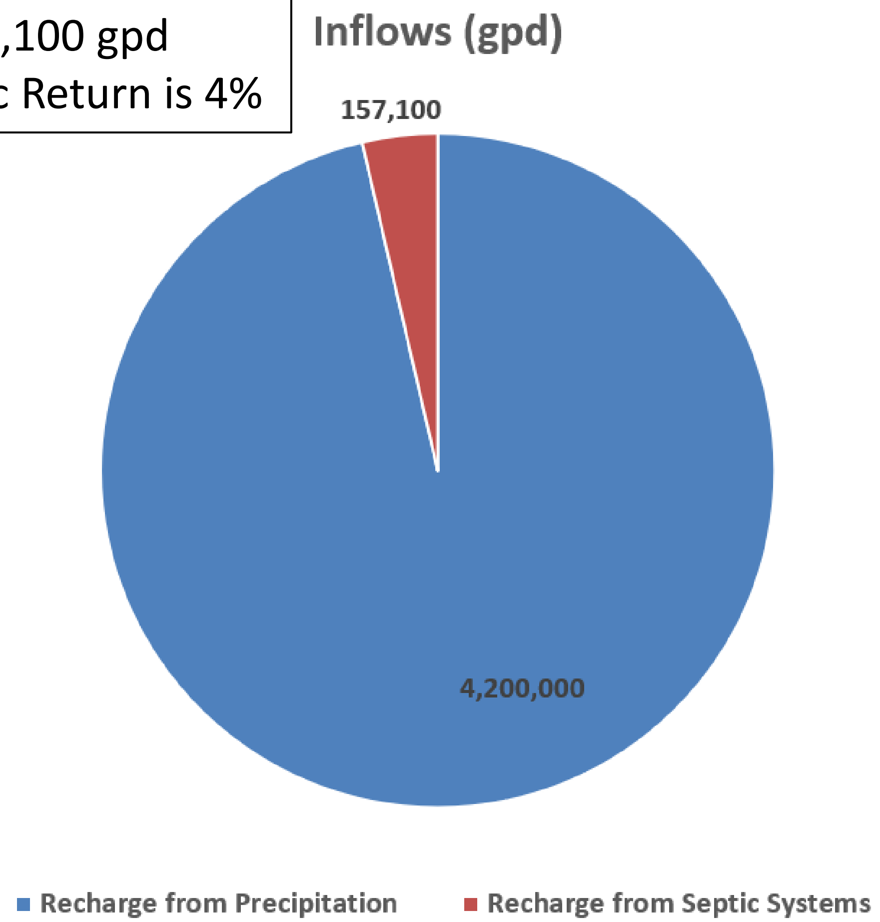


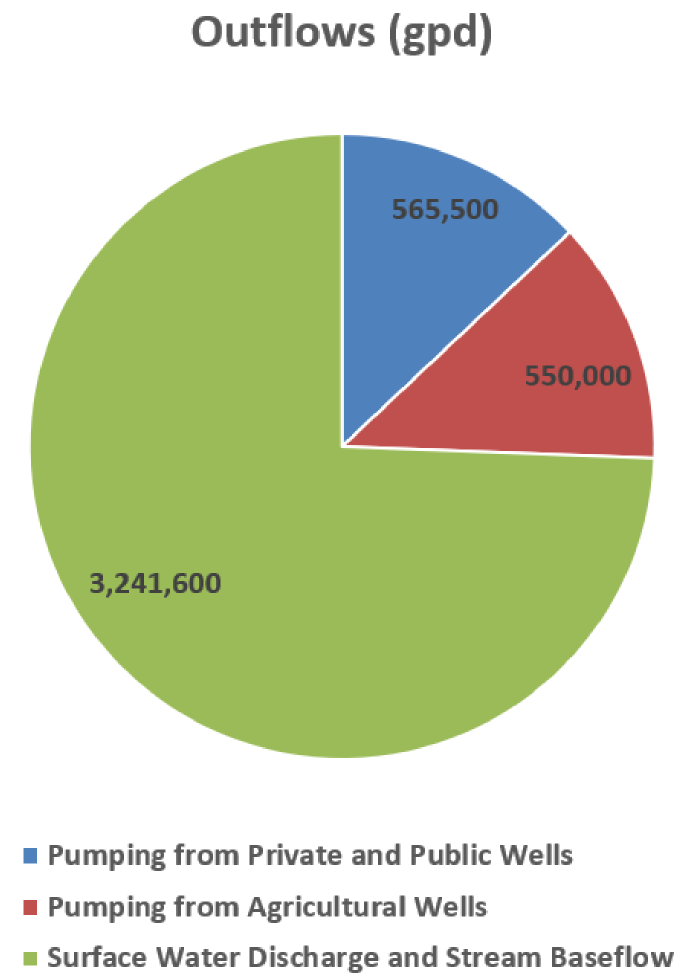
Inflows	Outflows
Precipitation Recharge 4,200,000 gpd	Water Supply Pumping 565,500 gpd
Septic System Recharge 157,100 gpd	Agricultural Pumping 110,000 gpd
	Surface Water Discharge 3,681,600 gpd
Total In/Out 4,357,100 gpd	

Current Worst Case Water Budget
Maximum Agricultural Pumping

Pumping is 25% of Recharge

Total Inflow of 4,357,100 gpd
Septic Return is 4%

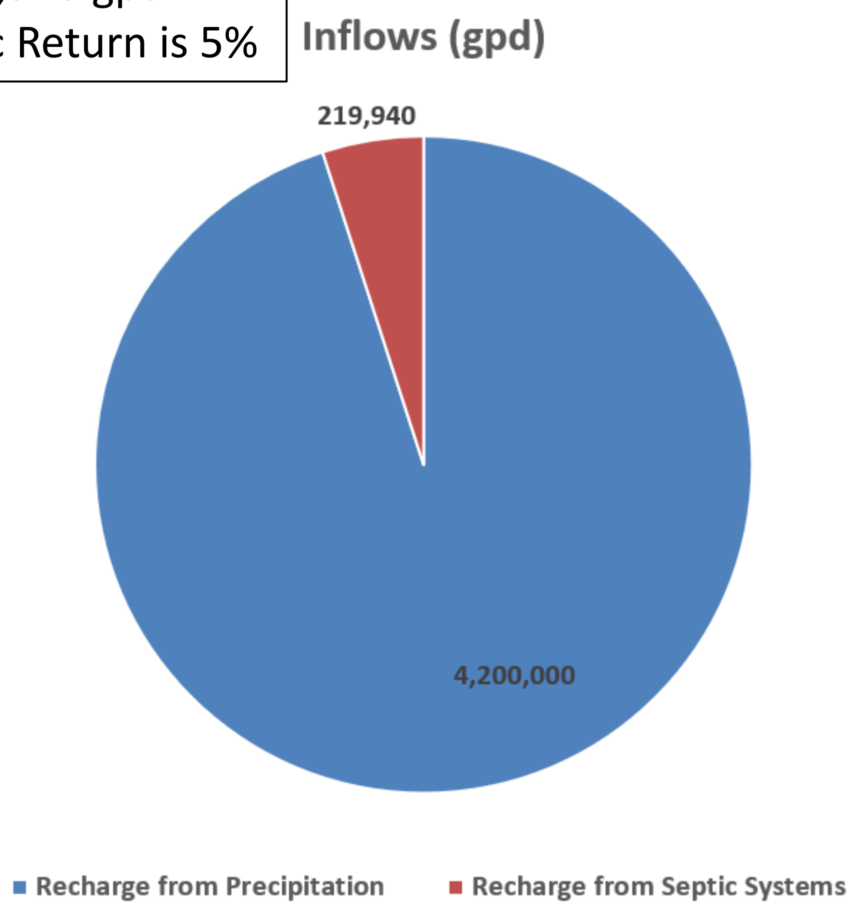


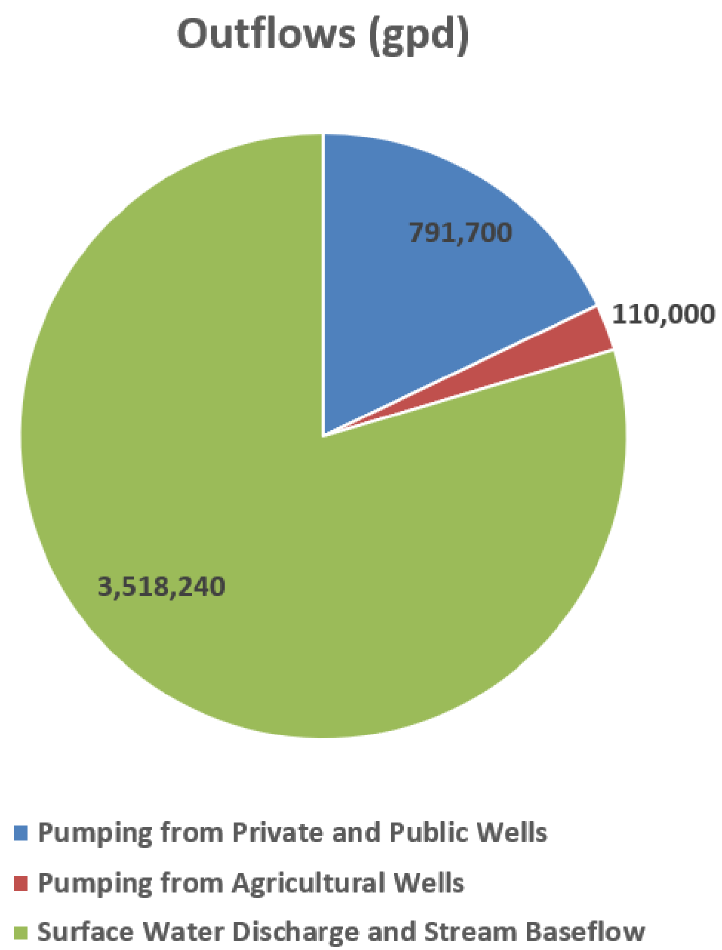


Water Budget, With Full Potential Buildout

Total Inflow of 4,419,940 gpd
Septic Return is 5%

Pumping is 20% of Recharge





Private Wells Pumping Assumptions

Private Wells Pumping

Month	Residents	Pumped (gpd)	Recharged via Septic (gpd)	% Pumpage Returned	Net Water Removed (gpd)
January	800	86,326	73,377	85%	12,949
February	800	81,116	68,949	85%	12,167
March	800	77,395	65,786	85%	11,609
April	800	97,488	82,865	85%	14,623
May	1,673	426,492	153,585	36%	272,907
June	2,586	1,018,866	237,385	23%	781,481
July	3,400	1,703,163	312,075	18%	1,391,088
August	3,400	1,693,674	312,075	18%	1,381,599
September	2,553	992,574	234,302	24%	758,272
October	1,484	335,446	136,209	41%	199,237
November	800	93,023	79,070	85%	13,953
December	800	82,977	705,30	85%	12,447
Average	**1,658**	**557,378**	**152,183**	**30%**	**405,194**

Assumptions and Steps in the Calculation

- Assumptions
  - Winter Population: 800 people
  - People per household in the winter: 2.15
  - “24 households served by Browns Hills wells” - SCWA
  - “Majority are year-round residents” – SCWA
  - Peak summer population: 3,400 people
  - 85% of pumped water is returned via septic systems in November-April

Assumptions and Steps in the Calculation

- Winter Calculation
  - Average January Brown Hills Pumping of 5,575 gpd / 24 households = 232 gpd/household
  - 232 gpd/household / 2.15 people/household = 107.907 gpd/person in January
  - 107.907 gpd/person * 800 people = 86,326 gpd pumped in January in Orient
  - 86,326 gpd * 85% = 73,377 gpd returned to the groundwater in January in Orient
  - Net Removed = 86,326 gpd – 73,377 gpd = 12,949 gpd in January in Orient
  - Same steps used for February, March, April, November and December
    - Browns Hills pumping varies by month (though it is relatively consistent) so the net removed varies by month as well

Private Wells Pumping

Month	Residents	Pumped (gpd)	Recharged via Septic (gpd)	% Pumpage Returned	Net Water Removed (gpd)
January	800	86,326	73,377	85%	12,949
February	800	81,116	68,949	85%	12,167
March	800	77,395	65,786	85%	11,609
April	800	97,488	82,865	85%	14,623
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October	1,484	335,446	136,209	41%	199,237
November	800	93,023	79,070	85%	13,953
December	800	82,977	705,30	85%	12,447
Average	**1,658**	**557,378**	**152,183**	**30%**	**405,194**

Assumptions and Steps in the Calculation

- Summer Calculation
  - Brown Hills pumping varies by month, but number of households does not
  - Taking the average Brown Hills monthly pumping and dividing by 24 you get

Month	Browns Hills Pumping per Household (gpd)
January	232
February	218
March	208
April	262
May	548
June	847
July	1077
August	1071
September	836
October	486
November	250
December	223

Assumptions and Steps in the Calculation

- Summer Calculation
  - **Assuming that the Brown Hills residents are year-round**, divide these pumping per household values by 2.15 people/household

Month	Browns Hills Pumping per Household (gpd)	Browns Hills People per Household	Browns Hills Pumping per Person (gpd)
January	232	2.15	108
February	218	2.15	101
March	208	2.15	97
April	262	2.15	122
May	548	2.15	255
June	847	2.15	394
July	1077	2.15	501
August	1071	2.15	498
September	836	2.15	389
October	486	2.15	226
November	250	2.15	116
December	223	2.15	104

Assumptions and Steps in the Calculation

- Summer Calculation
  - Scale the number of May-October residents in each month based on Brown Hills Pumping, assuming a range between 800 and 3,400 people

Month	Browns Hills Pumping per Household (gpd)	Browns Hills People per Household	Browns Hills Pumping per Person (gpd)	Orient Residents
January	232	2.15	108	800
February	218	2.15	101	800
March	208	2.15	97	800
April	262	2.15	122	800
May	548	2.15	255	1673
June	847	2.15	394	2586
July	1077	2.15	501	3400
August	1071	2.15	498	3400
September	836	2.15	389	2553
October	486	2.15	226	1484
November	250	2.15	116	800
December	223	2.15	104	800

Assumptions and Steps in the Calculation

- Summer Calculation
  - Multiply the pumping per person by Orient residents

Month	Browns Hills Pumping per Person (gpd)	Orient Residents	Orient Pumping (gpd)
January	108	800	86,326
February	101	800	81,116
March	97	800	77,395
April	122	800	97,488
May	255	1673	426,492
June	394	2586	1,018,866
July	501	3400	1,703,163
August	498	3400	1,693,674
September	389	2553	992,574
October	226	1484	335,446
November	116	800	93,023
December	104	800	82,977

Assumptions and Steps in the Calculation

- Summer Calculation
  - Calculate a return flow per person for winter months (pumping per person * 85%)

Month	Browns Hills Pumping per Person (gpd)	Orient Residents	Orient Pumping (gpd)	Return Flow per Person (gpd Winter)
January	108	800	86,326	91.7
February	101	800	81,116	86.2
March	97	800	77,395	82.2
April	122	800	97,488	103.6
May	255	1673	426,492	-
June	394	2586	1,018,866	-
July	501	3400	1,703,163	-
August	498	3400	1,693,674	-
September	389	2553	992,574	-
October	226	1484	335,446	-
November	116	800	93,023	98.8
December	104	800	82,977	88.1

Assumptions and Steps in the Calculation

- Summer Calculation
  - Use the average return flow per person in November-April for the summer months

Month	Browns Hills Pumping per Person (gpd)	Orient Residents	Orient Pumping (gpd)	Return Flow per Person (gpd Winter)
January	108	800	86,326	91.7
February	101	800	81,116	86.2
March	97	800	77,395	82.2
April	122	800	97,488	103.6
May	255	1673	426,492	91.8
June	394	2586	1,018,866	91.8
July	501	3400	1,703,163	91.8
August	498	3400	1,693,674	91.8
September	389	2553	992,574	91.8
October	226	1484	335,446	91.8
November	116	800	93,023	98.8
December	104	800	82,977	88.1

Assumptions and Steps in the Calculation

- Summer Calculation
  - Multiply return flow per person by the Orient residents

Month	Orient Residents	Orient Pumping (gpd)	Return Flow per Person (gpd Winter)	Return Flow (gpd)
January	800	86,326	91.7	73,377
February	800	81,116	86.2	68,949
March	800	77,395	82.2	65,786
April	800	97,488	103.6	82,865
May	1673	426,492	91.8	153,585
June	2586	1,018,866	91.8	237,385
July	3400	1,703,163	91.8	312,075
August	3400	1,693,674	91.8	312,075
September	2553	992,574	91.8	234,302
October	1484	335,446	91.8	136,209
November	800	93,023	98.8	79,070
December	800	82,977	88.1	70,530

Assumptions and Steps in the Calculation

- Summer Calculation
  - From here you can calculate the % returned and net removed for each month

Month	Orient Pumping (gpd)	Return Flow (gpd)	% Pumpage Returned	Net Water Removed (gpd)
January	86,326	73,377	85%	12,949
February	81,116	68,949	85%	12,167
March	77,395	65,786	85%	11,609
April	97,488	82,865	85%	14,623
May	426,492	153,585	36%	272,907
June	1,018,866	237,385	23%	781,481
July	1,703,163	312,075	18%	1,391,088
August	1,693,674	312,075	18%	1,381,599
September	992,574	234,302	24%	758,272
October	335,446	136,209	41%	199,237
November	93,023	79,070	85%	13,953
December	82,977	70,530	85%	12,447

Private Wells Pumping

Month	Residents	Pumped (gpd)	Recharged via Septic (gpd)	% Pumpage Returned	Net Water Removed (gpd)
January	800	86,326	73,377	85%	12,949
February	800	81,116	68,949	85%	12,167
March	800	77,395	65,786	85%	11,609
April	800	97,488	82,865	85%	14,623
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November	800	93,023	79,070	85%	13,953
December	800	82,977	705,30	85%	12,447
Average	**1,658**	**557,378**	**152,183**	**30%**	**405,194**

Agricultural Pumping

- Agricultural Pumpage
  - **Annual average of 110,000 gpd based on reported and estimated data from seven wells**
  - 220,000 gpd in summer, 0 gpd in winter

  - This average annual value equates to a rate of 567 gpd/acre over 194 acres
  - If that rate is expanded to all of the remaining farmland in Orient, the average annual pumping would increase to 550,000 gpd, or an additional 440,000 gpd
  - However, this would likely be a conservative estimate as some acreage is not active and some produce crops requiring less water

Appendix B
Water Resources Management Alternatives Decision Support Tool Evaluation

1.1 Water Resources Management Alternative Evaluation Using a Decision Support Tool

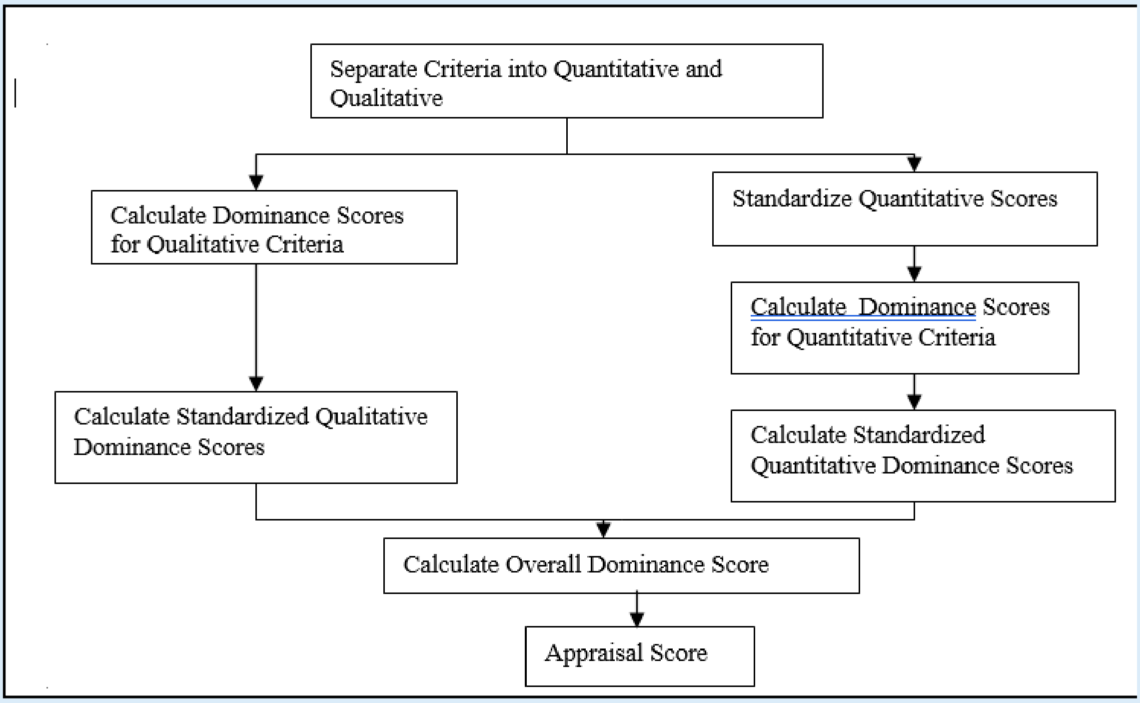
The water resource management solutions were evaluated impartially using a decision support tool to mathematically assess how well the alternative solutions achieved the objectives of providing a safe and reliable water supply and protecting surface water quality. Use of a decision support tool enabled identification of the alternative solution(s) that would best satisfy the evaluation criteria that were identified, as well as ranking of the alternative solutions.

EVAMIX, a mathematically sophisticated decision support tool, was used to help guide the process of comparing each alternative to the other alternatives. As background, EVAMIX was originally developed in the 1980s at Delft in the Netherlands by Dr. Henk Voogd and Dr. Mark Maimone. EVAMIX is a matrix based, multi-criteria evaluation program that allows use of both quantitative (cardinal) and qualitative (ordinal) criteria. As suggested, quantitative criteria are those that can be described by a number (e.g., annual cost, years to implement) while qualitative criteria are those that cannot be readily described by a number (e.g., reliability). Whether a criterion is defined as quantitative or qualitative depends on the ability to assign a numerical value and the reliability of the quantitative data available within the timeframe of the evaluation. Criteria that cannot be reliably and quickly quantified were described qualitatively. Each criterion is identified as N (numerical, or quantitative) or Q (qualitative).

The algorithm behind EVAMIX maintains the essential characteristics of quantitative and qualitative criteria yet is designed to eventually combine the results into a single appraisal score for each alternative. This unique feature of the program provides the ability to make use of all available data, whether it is quantitative or qualitative. EVAMIX has been successfully applied both internationally and in the United States and internationally and in the United States, including planning projects in Suffolk County, Nassau County, New York City and Westchester County and the results have been upheld in the New York courts, because the evaluation was completed in a rigorous, open and technically sound process.

The figure below shows conceptually how EVAMIX handles both quantitative (also called cardinal) and qualitative (also called ordinal) data. In the first step, the evaluation matrix is split into two sub-matrices, one with only quantitative criteria, and one with only qualitative criteria. Next, the priority of each criterion is assigned to one of two vectors. Using the scores and weights, dominance scores representing the degree to which one alternative is better than another are calculated for each pair of alternatives for each criterion. These scores are calculated separately for the qualitative and quantitative data respectively. For the quantitative criteria, the difference in the values assigned to each alternative is preserved in the equations to reflect that one alternative may be significantly better than another. For the qualitative criteria, only the fact that one alternative is better than another is identified but the degree of difference is not included in the equations. In this way, EVAMIX treats qualitative criteria correctly by only recognizing the order of preference, not the degree of preference.

After the dominance scores are calculated (one for each possible alternative pair for each of the criteria), they must be standardized in such a way that the relative value of the scores for both quantitative and qualitative criteria can be recombined without distorting the calculations. There are several mathematical techniques to accomplish this. After the scores are standardized, they are recombined, using the weighting matrix to assign relative importance to the overall dominance score. Finally, a single score, representing the overall worth of an alternative relative to the other alternatives considered is developed. This score establishes the final ranking of alternatives from best to worst, or most important to least important.



EVAMIX Flow Chart

1.2 Evaluation Criteria

Each of the potential water supply and wastewater management alternatives was evaluated based on ten criteria. These criteria are briefly described in **Table 1** below. **Table 1** also identifies whether each criterion was characterized quantitatively or numerically (N) or qualitatively (Q) during this evaluation.

Table 1 Criteria Used to Evaluate Potential Resource Management Alternatives

Criterion	Type	Description
Protection of human health	Q	Prevents/reduces human exposure to contaminants of concern
Reliability	Q	Dependability, effectiveness
Resiliency	Q	Ability to withstand changing conditions (including climate change, emerging contaminants of concern)
Impact on surface water resources	Q	Effect on surface waters and ecosystems (e.g., does it reduce contaminants discharging to surface waters?)
Implementation complexity (regulatory requirements, permitting)	Q	Ability/ease of legally implementing the alternative (considers number of approvals and permits required considering federal, state, county, town, etc.)
Siting requirements/construction disturbance	Q	Need for land/space within the community
Impact on development potential	Q	Perceived ability of the alternative to encourage additional development within the community
Capital cost	N	Initial cost per household to maintain and operate the alternative
Operations and maintenance costs	N	Annual cost per household to operate and maintain the alternative
Implementation schedule	N	Number of years before alternative is implemented

The purpose of using the decision support tool to evaluate the alternatives was that the results directly reflect the stated priorities of the community. Recognizing that there was likely to be a diversity of opinion regarding the relative importance of each of these criteria, each member of the OA committee was asked to consider how important each criterion was to them based upon their own priorities, experience and perspectives. The evaluation incorporates the relative importance of each of these criteria by assigning "weights" ranging from 0 to 100 percent to each criterion, with the total of all of the weights or percentages equaling 100 percent. OA was also asked to identify any evaluation criteria that were not included in Table 3-1 that should be included in the evaluation. The percentages or weights proposed by each of the four OA committee members who participated in the evaluation are summarized in **Table 2**.

Table 2 illustrates the diversity of OA opinions regarding what is most important, and underscores the challenges of identifying an alternative that responds to all stakeholder perspectives. Nevertheless, there were also significant areas of agreement as all OA four respondents identified protection of human health, impact on surface water resources and annual operation and maintenance costs as priorities. The practical aspects of alternative implementation including satisfying regulatory requirements, construction disturbance and the time that it would take to implement the solution were assigned very low priorities by two

of the respondents and were not even considered to be a factor in the decision making process by the others.

Table 2 Diversity of Criterion Importance Identified by Participating OA Members

	OA 1	OA 2	OA 3	OA 4
Criterion	**Weight**	**Weight**	**Weight**	**Weight**
Protection of human health	15%	20%	40%	40%
Reliability	5%	20%	5%	
Resiliency	10%	25%	40%	
Impact on surface water resources	5%	15%	5%	30%
Implementation (regulatory requirements, permitting)	5%	5%		
Siting requirements/construction disturbance	10%	2%		
Impact on development potential	15%	4%		20%
Capital cost	15%	5%	5%	
Operations & Maintenance cost	15%	2%	5%	10%
Implementation schedule	5%	2%		
Total Priority Weight	**100%**	**100%**	**100%**	**100%**

Note: The sum of the criteria weights must be 100 percent.

Using the decision support tool EVAMIX, the alternative water supply and wastewater management solutions were evaluated based upon the priorities identified by the OA committee. The EVAMIX model was run five times for each evaluation. The first run provided the results if all of the evaluation criteria were equally important (e.g., each was assigned a weight of 10 percent) and provided a baseline assessment. The remaining four runs identified the alternative that best satisfied each participating OA member's objectives and priorities based on their criteria weights. Assigning different criteria weights (indicating importance) allowed the sensitivity of the results to varying viewpoints to be considered. Sometimes, even with very different viewpoints/priorities, the 'best' alternative is most highly rated by all.

1.3 Water Supply Alternatives Evaluation

Table 3 characterizes each alternative's score for each criterion. The example shown below in **Table 3** and **Figure 1** illustrates the ranking of the alternative water supply alternatives if all criteria were assumed to be of equal importance; that is each is weighted at 10 percent. Provision of SCWA to the community was the highest ranked alternative, primarily because it was the most effective solution in terms of protection of human health, resiliency, reliability and annual cost to the homeowner. Disadvantages to provision of SCWA water included the perception that it could enable increased development within the community, and the

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approximately six year implementation schedule. Under this scenario, establishment of a new Orient water supply was ranked the lowest, due in large part to the difficulty of siting new wells capable of providing an adequate supply for the community, the challenges of planning, siting, designing and constructing a new water treatment plant to provide a potable supply meeting drinking water standards, the high estimated capital and operation and maintenance costs and the implementation schedule, anticipated to be a minimum of eight years.

Table 3 Water Supply Alternative Evaluation Assuming All Criteria Are Equally Important

Calc Criteria	Criteria	Protection of Human Health	Resiliency	Reliability	Impact on Surface Water Resources	Implementation (Regulatory/Permitting)	Siting Construction Disturbance	Impact on Development Potential	Capital Cost	O&M Cost	Implementation Schedule (Years)
Type	**Q,+N,-N**	Q	Q	Q	Q	Q	Q	Q	-N	-N	-N
Weight	0<wt<1	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Alternatives Up to 99	No Action	1	1	1	2	5	5	3	$1	$520	0.01
	SCWA Water	5	3	5	5	2	2	1	$9,000,000	$220	6
	SCWA Water in Village	4	3	4	4	3	3	1	$6,840,000	$1,295	5
	Homeowner Systems	3	2	2	3	5	4	3	$1,000,000	$1,500	1
	New Orient Supply	3	2	3	4	1	1	2	$15,000,000	$2,500	8

Note: For mathematical calculation reasons, a higher score must consistently be the better score for all criteria. Therefore, for criteria such as capital cost, operation and maintenance costs and schedule when higher values are worse, they are multiplied by -1 so that the higher number (e.g., 1 year to implement an alternative is better than 8 years to implement an alternative; so, -1 is a higher number than -8.)

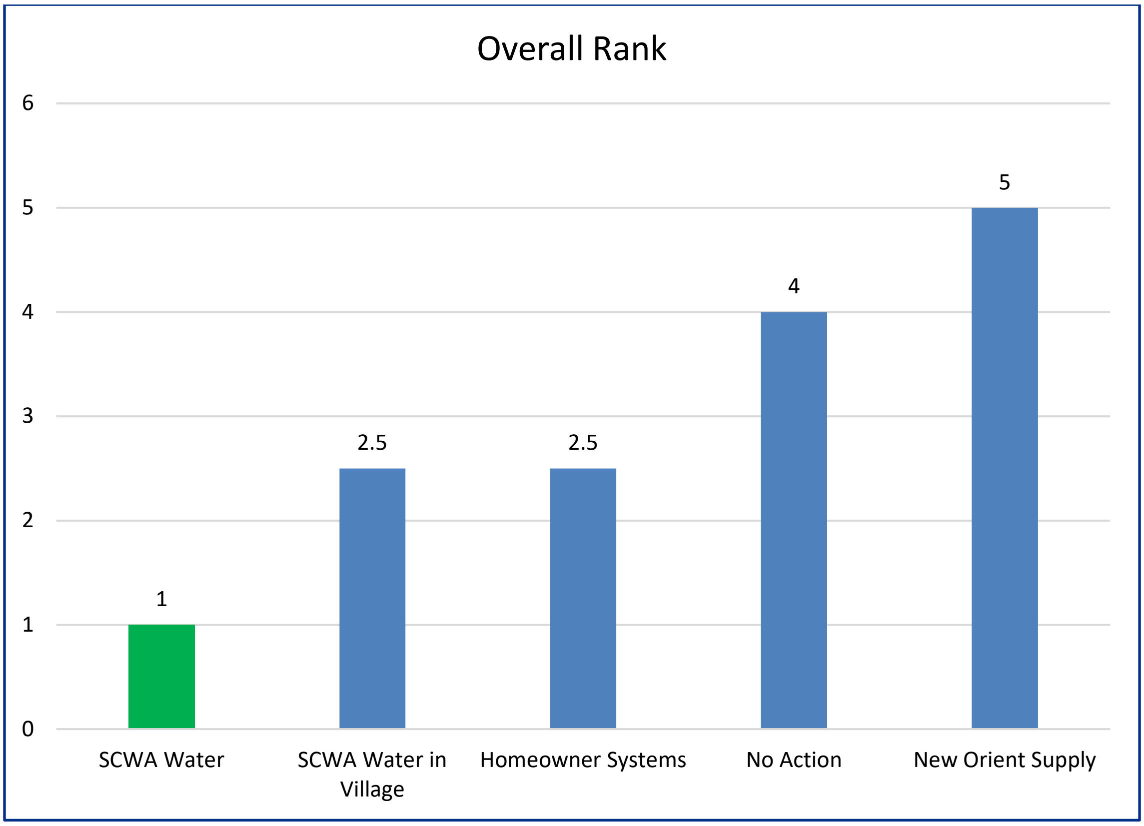

Figure 1 Water Supply Alternative Ranking with All Criterion Equally Important

As shown in **Table 2**, members of the OA community did not believe that the evaluation criteria were equally important. Protection of human health was the highest priority for all four of the OA committee members who provided input. The decision support tool evaluation results based on OA committee member 1 priorities are shown on **Figure 2**. Based upon OA Member 1's prioritization of protection of human health, impact on development potential, and capital and operation and maintenance costs, provision of SCWA water to the community was the highest ranked alternative, and establishment of a new Orient supply was the lowest ranked alternative.

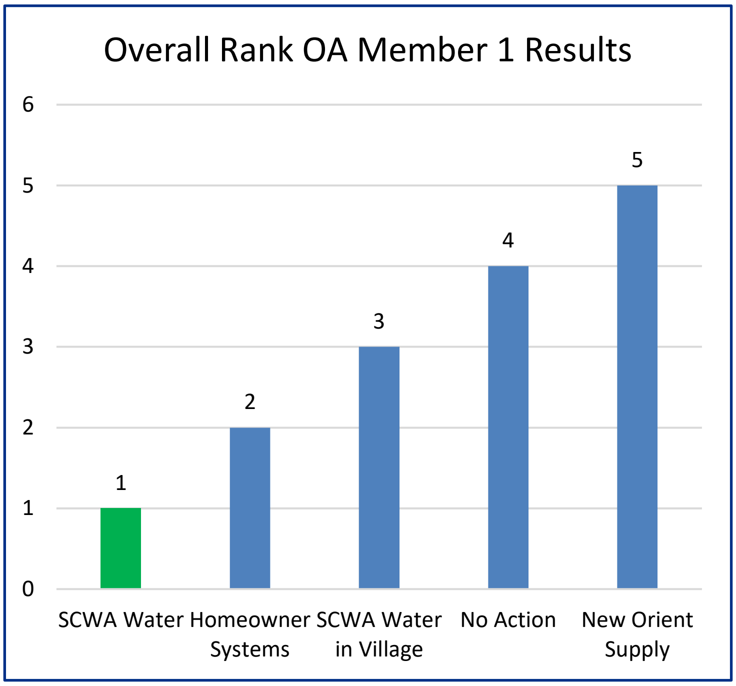

Figure 2 Water Supply Alternatives Based on OA Member 1 Priorities

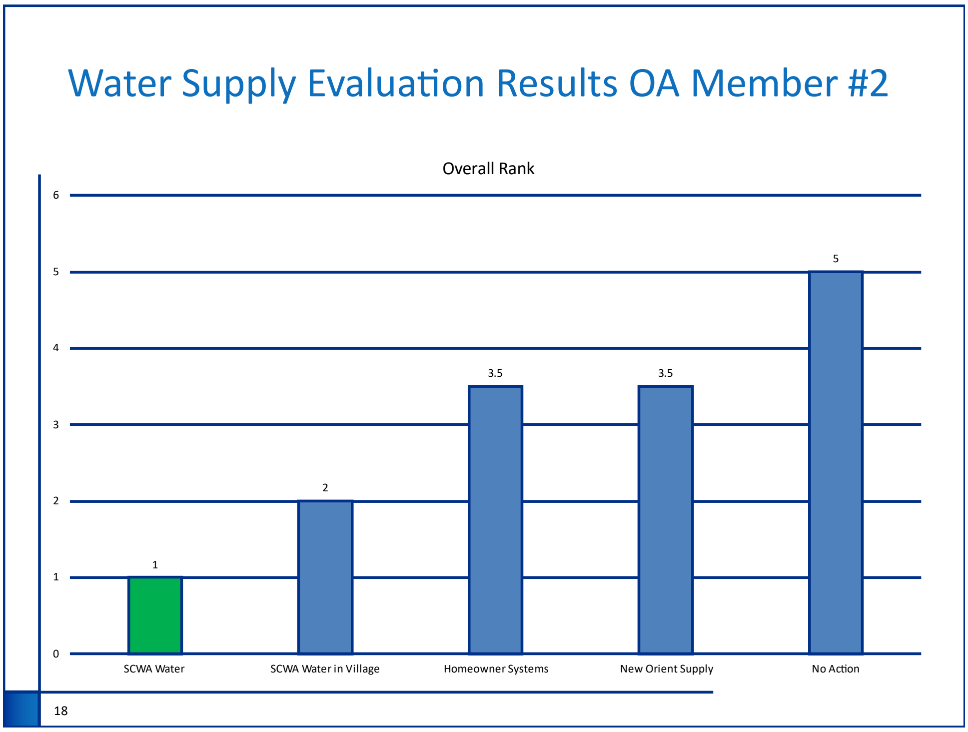

Figure 3 Water Supply Alternatives Based on OA Member 2 Priorities

Based on OA Member 2's priorities of protection of human health and resiliency, provision of SCWA water to the community was the highest ranked solution. No action was the lowest ranked alternative, as shown by **Figure 3.**

OA Member 3 identified protection of human health and resiliency as their highest priorities. Provision of SCWA water to the community was the highest ranked solution to achieve those objectives. No action, which may not always provide a potable supply achieving water quality criteria and is not sustainable for the future for many members of the community was the lowest ranked alternative as shown by **Figure 4**.

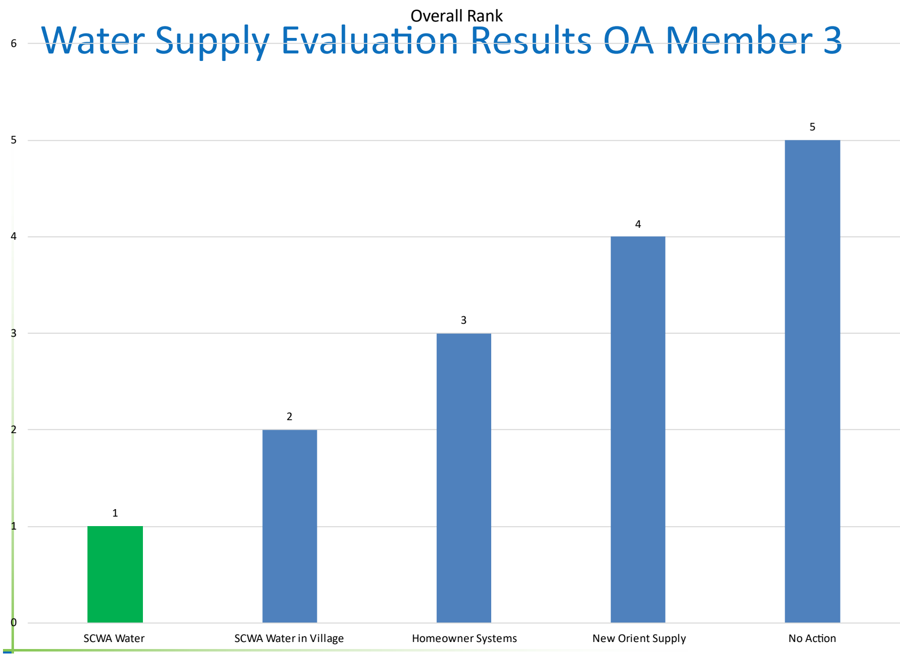

Figure 4 Water Supply Alternatives Based on OA Member 3 Priorities

Based on OA Member 4's priorities of human health protection, impact on surface water and potential impacts on development, provision of SCWA water to the community was the highest ranked solution. No action, which may not provide a potable supply achieving water quality criteria and is not sustainable for the future for many members of the community was the lowest ranked alternative as shown by **Figure 5**.

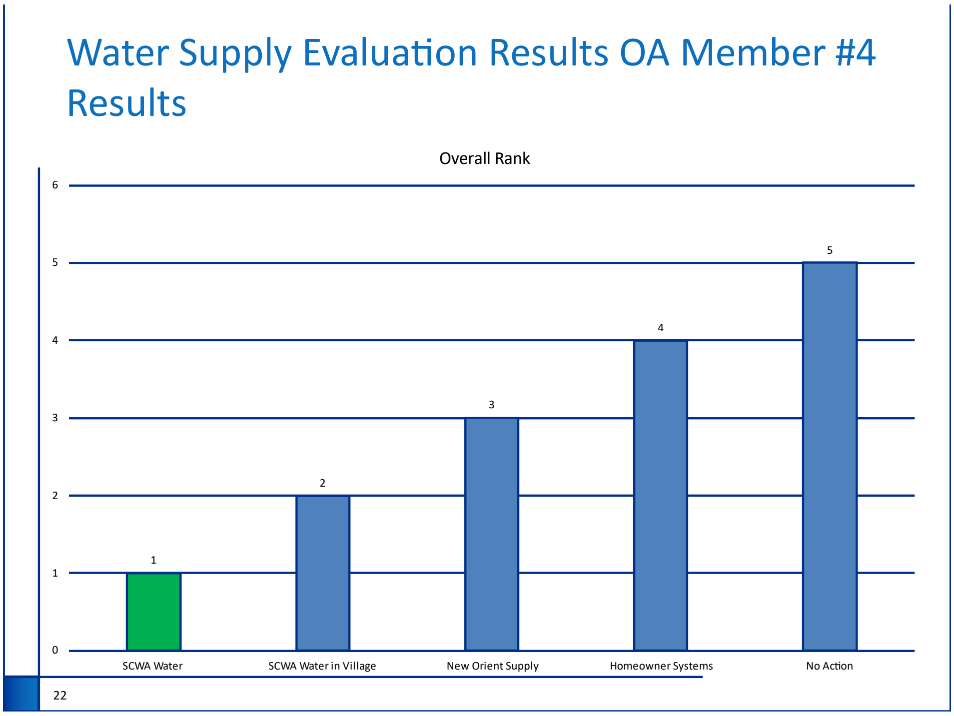

Figure 5 Water Supply Alternatives Based on OA Member 4 Priorities

Because provision of SCWA most reliably achieves Orient's desire to have a dependable source of high quality drinking water, it was the alternative that most successfully achieved the objectives identified by all four OA committee members . Provision of SCWA supply to the vulnerable homes within the Village was ranked second, based on three of the OA member priorities, and homeowner systems was ranked second based on one of the OA member priorities. The results of all evaluations were unanimous in concluding that No Action was the lowest ranked solution.

It should be noted that while the objective alternative evaluation process identified provision of SCWA water to the community as the solution that best responded to the priorities identified by the OA members, the community may still choose to implement another alternative.

1.4 Wastewater Management

Table 4 characterizes each wastewater management alternative's score for each criterion. The example shown below in **Table 4** and **Figure 6** illustrates the ranking of the alternative wastewater management solutions if all criteria were assumed to be of equal importance; and each is weighted at 10 percent.

Table 4 Wastewater Management Alternative Evaluation Assuming All Criteria Are Equally Important

Calc / Randomize Values / Randomize Weights		Protection of Human Health	Resiliency	Reliability	Impact on Surface Water Resources	Implementation (Regulatory/Permitting)	Siting Construction Disturbance	Impact on Development Potential	Capital Cost	O&M Cost	Implementation Schedule (Years)
Criteria	Criteria										
Type	Q,+N,-N	Q	Q	Q	Q	Q	Q	Q	-N	-N	-N
Weight	0<wt<1	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Alternatives Up to 99	No Action	1	1	1	1	3	3	3	0	500.0	0.01
	IA OWTS	2	2	3	3	2	2	3	7,500,000	1,200.0	0.5
	Centralized Treatment	3	3	3	3	1	1	1	56,000,000	3,000.0	10

Note: For mathematical calculation reasons, a higher score must consistently be the better score for all criteria. Therefore, for criteria such as capital cost, operation and maintenance costs and schedule when higher values are worse, they are multiplied by -1 so that the higher number is properly incorporated into the evaluation.

Community-wide implementation of I/A OWTS was the highest ranked alternative, primarily because it balanced positive impact on surface water quality, reliability and annual cost to the homeowner, is quick to implement and does not encourage additional development. I/A OWTS operation is reliable, and a properly designed and sited I/A OWTS will provide some protection of human health at a reasonable cost. The no action alternative was the lowest ranked alternative. Although conventional on-site septic systems are the least expensive and easiest to implement wastewater management alternative, they are not designed to remove nitrogen and they do not improve surface water quality.

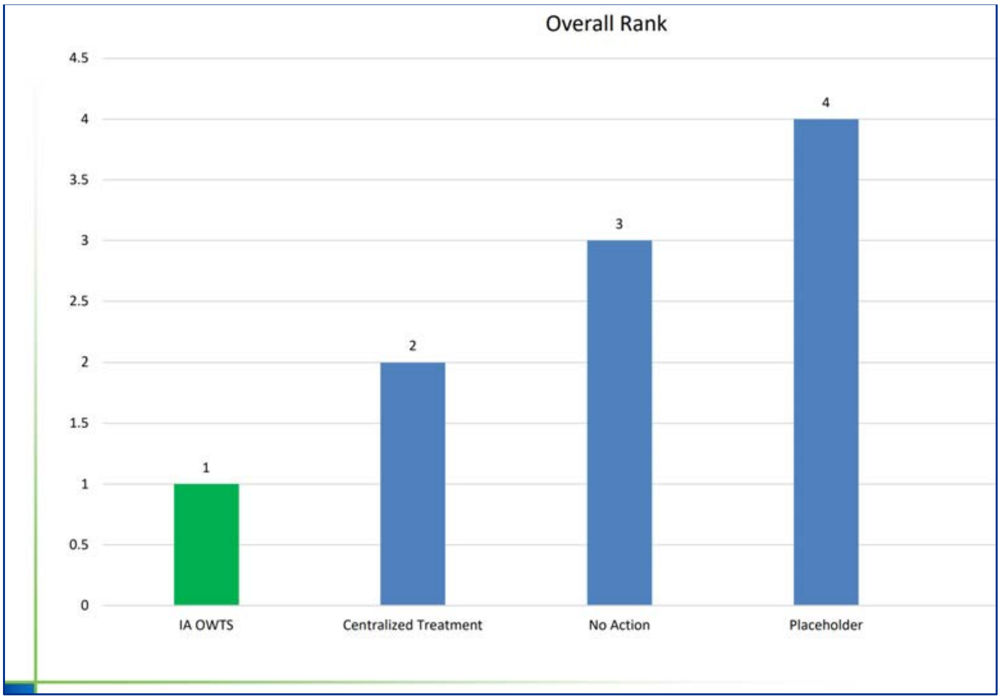

Figure 6 Wastewater Management Alternative Ranking with All Criterion Equally Important
Note: Space was left for evaluation of a fourth alternative solution; as none were identified, the results show the unranked placeholder as last.

As shown in **Table 2**, members of the OA community did not believe that the evaluation criteria were equally important. Protection of human health was the highest priority for all four of the OA committee members who provided input. The decision support tool evaluation of wastewater management alternatives based on OA committee Member 1 priorities are shown on **Figure 7**. Based upon OA Member 1's prioritization of protection of human health, impact on development potential, and capital and operation and maintenance costs, implementation of I/A OWTS would be the highest ranked alternative, and centralized wastewater treatment would be lowest ranked.

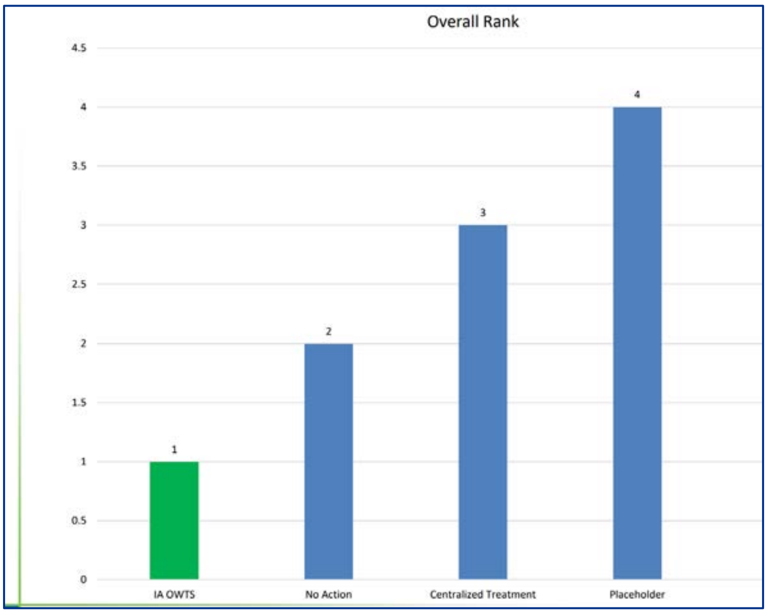

Figure 7 Wastewater Management Alternative Rankings Based on OA Member 1 Priorities

Based on OA Member 2's priorities of protection of human health and resiliency, implementation of a centralized wastewater treatment plant would be the highest ranked solution. No action, which does not provide human health benefits and is not resilient would be the lowest ranked alternative as shown by **Figure 8.**

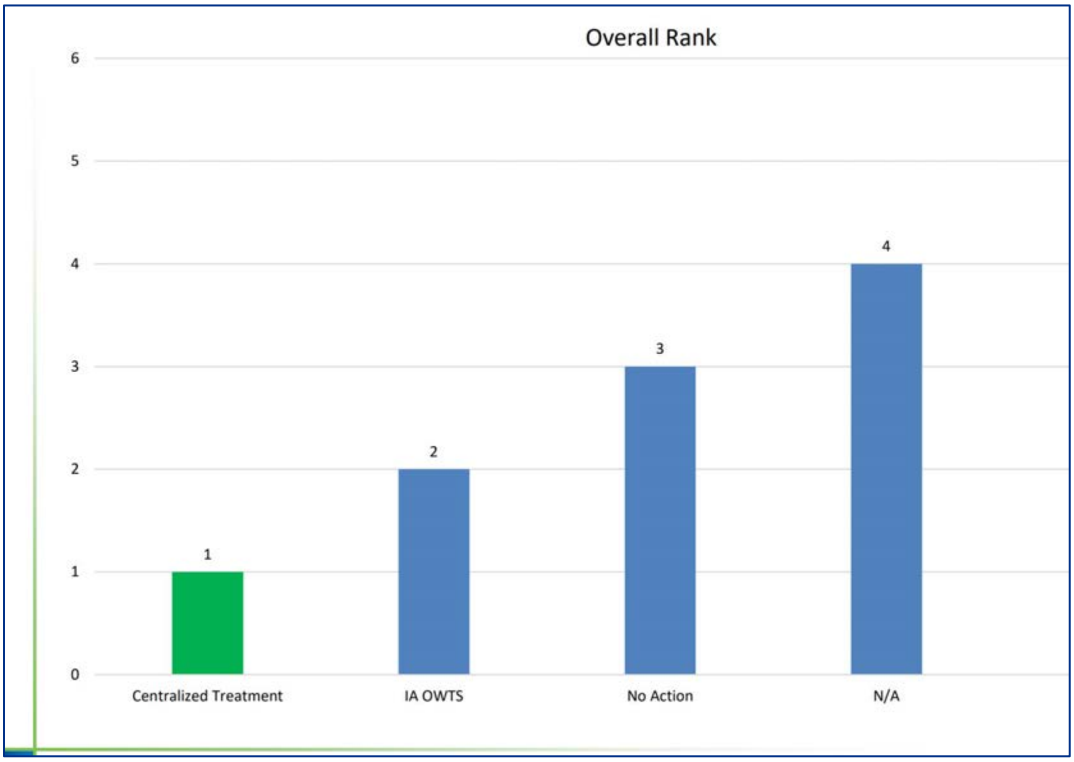

Figure 8 Wastewater Management Alternative Ranking Based on OA Member 2 Priorities
Note: Space was left for evaluation of a fourth alternative solution; as none were identified, the results show the unranked placeholder as last.

Similar to OA Member 2, based on OA Member 3's highest priorities of human health protection and resiliency, implementation of a centralized wastewater treatment plant for the Orient community would be the highest ranked wastewater management solution. No action, which does not provide significant surface water quality benefits and is not sustainable in the future for many members of the community was the lowest ranked alternative as shown by **Figure 9**.

Based on OA Member 4's priorities of human health protection, impact on surface water and potential impacts on development, community-wide implementation of I/A OWTS was the highest ranked solution. No action, which does not significantly improve public health or the surface water quality and is not sustainable for the future for many members of the community was the lowest ranked alternative as shown by **Figure 10**.

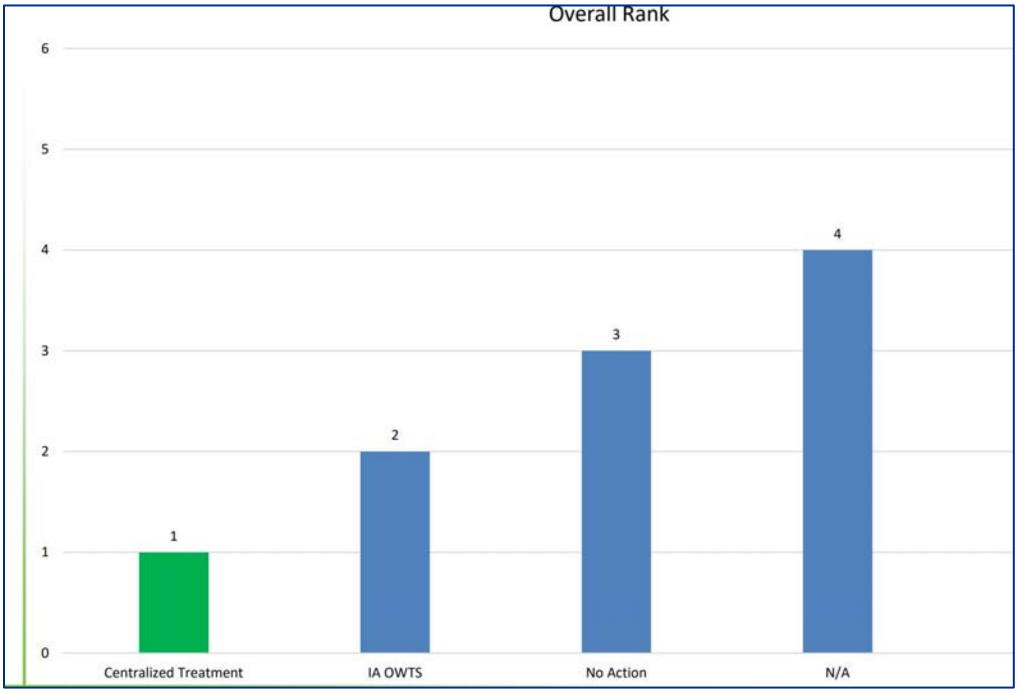

Figure 9 Wastewater Management Alternative Ranking Based on OA Member 3 Priorities
Note: Space was left for evaluation of a fourth alternative solution; as none were identified, the results show the unranked placeholder as last.

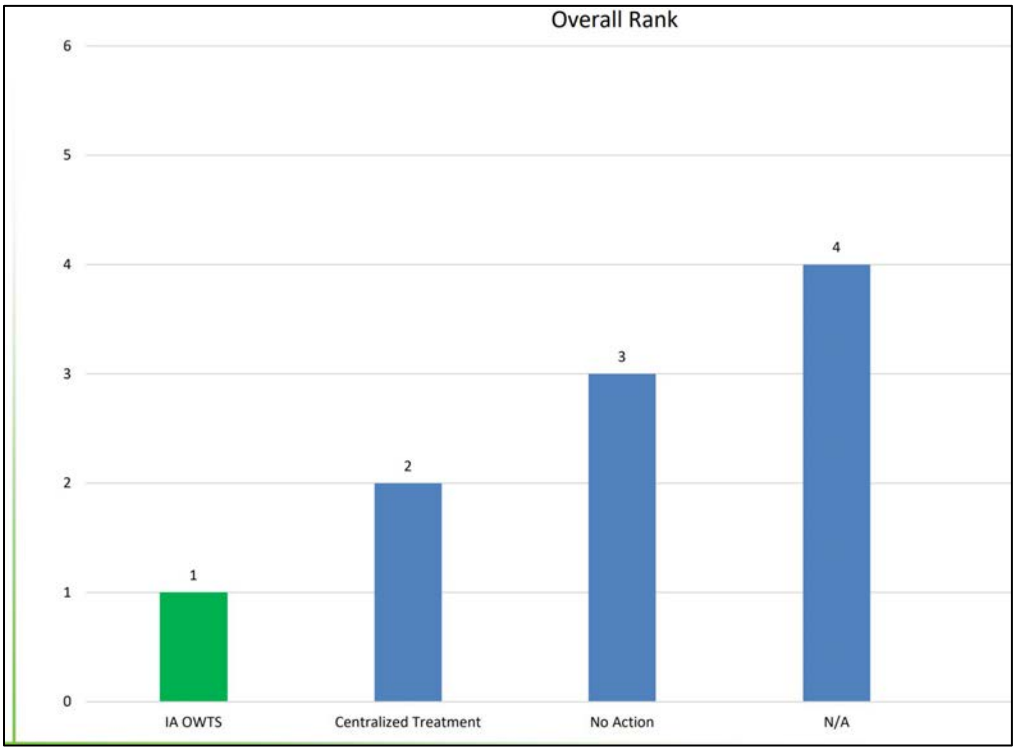

Figure 10 Wastewater Management Alternative Ranking Based on OA Member 4 Priorities
Note: Space was left for evaluation of a fourth alternative solution; as none were identified, the results show the unranked placeholder as last.

The results of the evaluation clearly show the commitment of OA to protect ground and water resources by providing wastewater treatment, either by I/A OWTS or by a centralized wastewater treatment system. No action was the lowest ranked alternative solution based on the priorities of three of the four OA members.

Appendix C
Orient Association Water Resources Survey Results

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ORIENT WATER RECOMMENDATIONS SURVEY RESULTS

When is the last time you had your water tested?

124 responses

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Do you filter your drinking water?

123 responses

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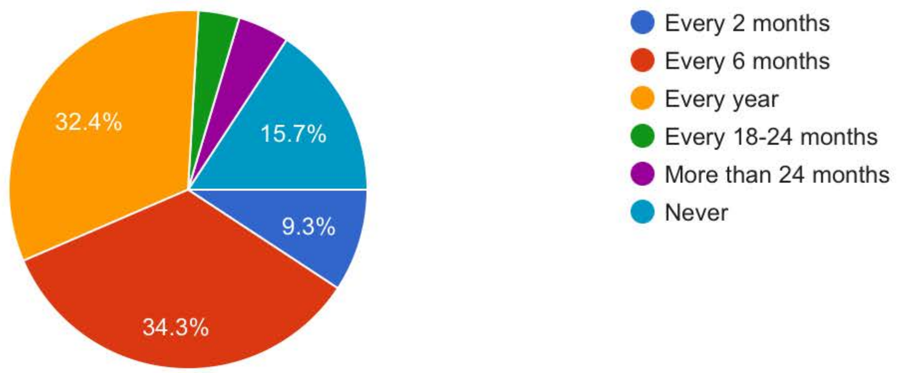
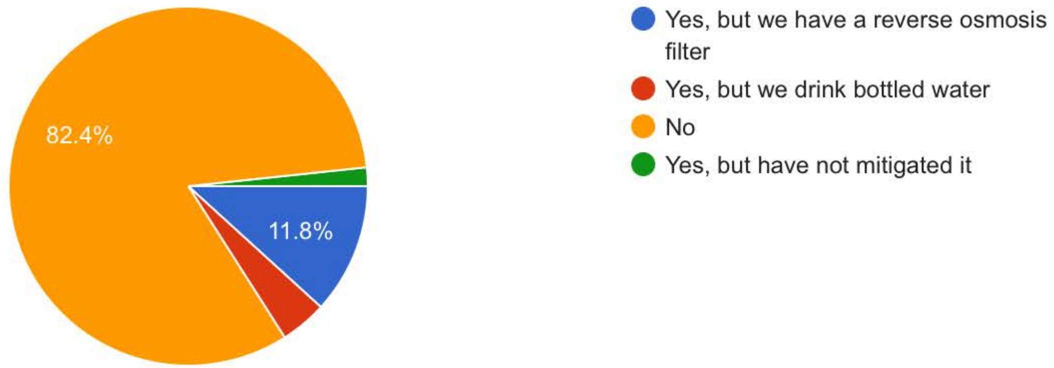
How often do you have your filter system maintained?

108 responses



Have you ever had high concentrations of salt in your well water?

119 responses



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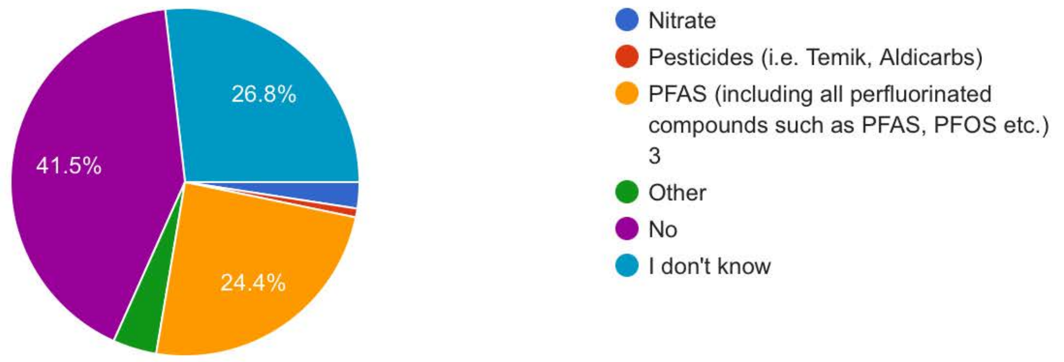
Do you have high concentrations (above the maximum contamination level) of other contaminants in your well water?

123 responses



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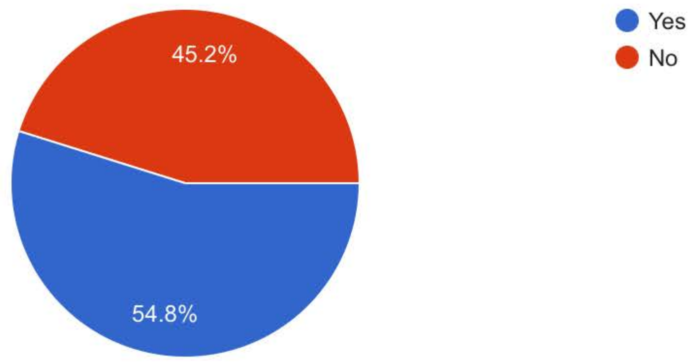
Do you have a generator that runs your well pump during power outages?

124 responses



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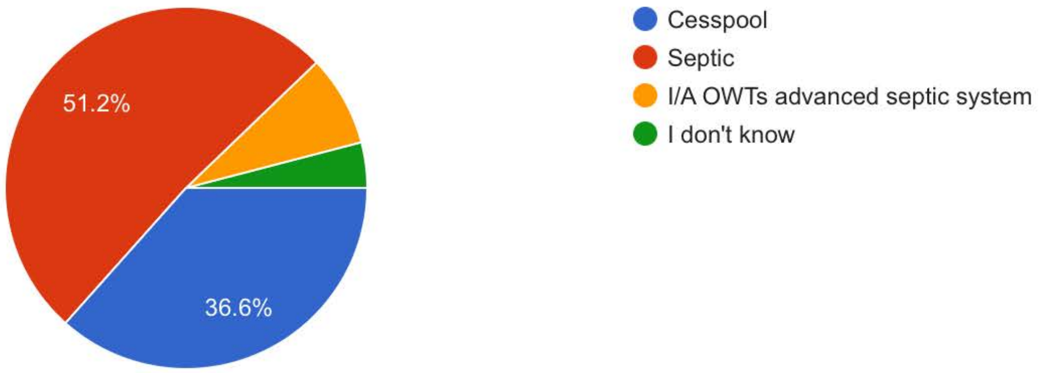
What kind of wastewater system do you have?

123 responses



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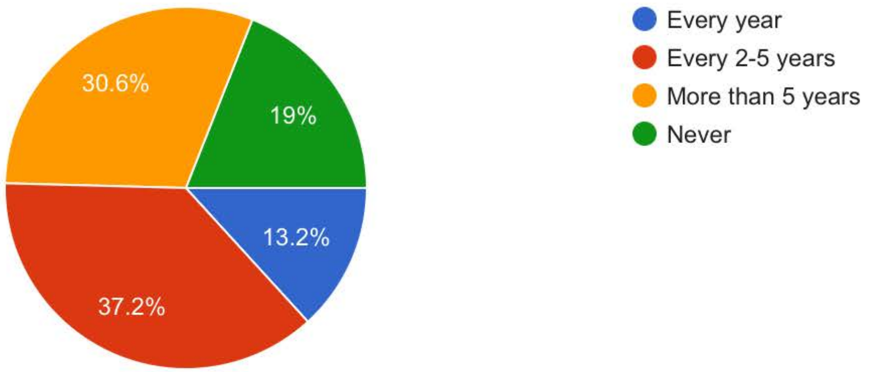
How often do you maintain your wastewater system?

121 responses



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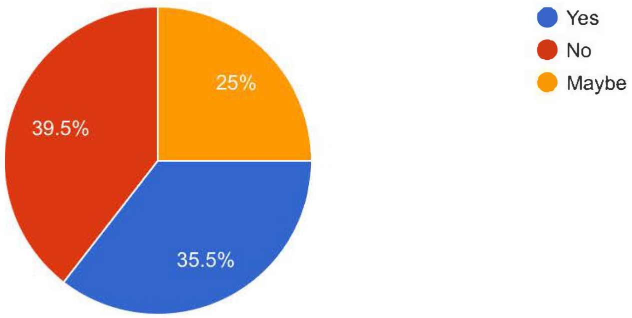
If Suffolk County Water Authority offered service in Orient, would you want to sign up?

124 responses



Comments:

38 responses

Keep SCWA out of Orient, Freddie Wachenberg was right!

We have never experienced problems with our well. The water is "hard" but otherwise fine. We have a filter on the water as it enters the reservoir tank and that filter is changed periodically.

Brita filter pitcher

We get our drinking water from the municipal water station in Greenport for 50 cents a gallon. Had salt in water for a year after Superstorm Sandy.

PFaS seems to be concentrated around the Village and we are not impacted. That said I have long term concerns about salt water intrusion and pot ability of our well water. Muni water and tough code limiting development around Oriwnt would be the best of both worlds...

If filtration can be installed, no reason to have Suffolk water provide service. Especially if they have plans to draw water from artesian wells beneath orient and use up Island.