Appendix B:

ALTERNATIVES SCREENING REPORT

Forge River Watershed Sewer Project

Mastic-Shirley Proposed Sewer District

Town of Brookhaven, New York

FEMA-DR-4085-NY HMGP

Sixth Revision: November 28, 2016

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EXECUTIVE SUMMARY

The Forge River Watershed Sewer Project proposes decommissioning on-site wastewater treatment and disposal systems (OSWS) in the project area and connecting the parcels to a new sewer collection system that would flow to a new advanced wastewater treatment facility (AWTF). The project area consists of three areas identified as Phases I to III, which contain 3,662 parcels in total. This report identifies and screens several alternatives for improving wastewater treatment in the project area to determine a reasonable range of alternatives warranting more detailed analysis in the draft environmental assessment (EA)/environmental impact statement (EIS).

Existing Conditions

Forge River is located in the hamlets of Mastic and Shirley in the Town of Brookhaven. The OSWS providing sanitary wastewater disposal in the project area are partially outdated and failing. Failing OSWS cause untreated effluent to be released into the surrounding soil. These failures can be caused by hydraulic overloading and flooding. Many of the OSWS in the project area failed during Hurricane Sandy and will continue to be subject to failures during future storm events. Failing systems result in impacts on human health during floods and contribute to high nutrient loading to Forge River and Great South Bay.

Screening Approach

A screening approach was developed to evaluate a range of alternatives for improving wastewater treatment in the project area and to identify those alternatives that are feasible and meet the purpose and need of the project. Section 404 of the Robert T. Stafford Relief and Emergency Assistance Act of 1974 (42 United States Code 5170c), as amended, authorizes the Federal Emergency Management Agency (FEMA) to provide funding to eligible grant applicants for activities that reduce or eliminate risks to life and property from hazards and their effects. The primary purpose of the proposed action is to mitigate short-term, repetitive, adverse impacts on human life and property associated with OSWS failures in the Forge River watershed in Suffolk County, New York, caused by natural hazards. The secondary purpose is to mitigate long-term, adverse impacts associated with such failures on surface waters and coastal wetlands that reduce the ability of these waters and wetlands to provide natural protection against storm surge. Five criteria were used during screening:

- *Treatment performance (removal of total nitrogen):* This criterion relates to the mitigation of OSWS failure-related nitrogen impacts on surface waters and coastal wetlands and the resultant impact on their storm surge coastal flood risk protection capacity. The target for groundwater nitrogen concentrations for Suffolk County Groundwater Management Zone VI is 6 milligrams per liter (mg/L). The improvement in water quality provides long-term benefits through improved wetland health that contributes to a reduction in coastal flood risk.
- *Performance during flood events:* This criterion relates to the ability of an alternative to reduce or avoid short-term, repetitive, adverse impacts on human life and property associated with OSWS failures during and after flood events. Alternatives that perform best are those that are able to remain fully functional during and after flood events without a loss of treatment performance and avoid impacts on human health from flooded treatment systems.

- *Performance under projected sea level rise and climate change conditions:* This criterion evaluates the ability of an alternative to maintain full performance in the face of sea level rise and other climatic changes.
- *Acquisition of land (with appropriate dimensions and compatible land use):* For an alternative to be feasible, it must be constructible within a reasonable footprint on a site and within an area that is compatible with the use of the property for the proposed type of wastewater treatment.
- *Costs:* This criterion estimates order-of-magnitude costs for construction as well as for operation and maintenance (O&M) and the feasibility of an alternative in light of cost considerations for various industry practices.

Screening Summary and Recommendations

The screening approach was applied to five action alternatives. Following is summary of the evaluation for each alternative:

- *Action Alternative A (Replacing existing OSWS with Innovative/Alternative [I/A] OSWS):* This alternative generally would not mitigate short-term, repetitive, adverse impacts on human life and property associated with OSWS failures caused by natural hazards such as rising groundwater levels and overland flooding that result from precipitation and/or tidal and surge conditions (i.e., the alternative generally would not meet the primary purpose of the project). A rising sea level would further reduce the performance of I/A OSWS and increase the human health risk because more OSWS would leak during flood events. However, newer systems assessed during the County's ongoing demonstration project may include I/A OSWS set up above ground with less risk of flooding. Action Alternative A would achieve an effluent quality of at least 19 mg/L for total nitrogen, which would be an improvement from existing conditions (conventional OSWS achieve only about 40 mg/L). The target of a nitrogen concentration in the groundwater of 6 mg/L would be achieved in parts of the project area, and the nitrogen loading of Forge River would be substantially reduced (improved) from current conditions. Therefore, this alternative would meet the secondary purpose of the project, but not to the same extent as other action alternatives discussed below. In addition, the nitrogen reduction performance of these systems would be affected by flood events and sea level rise. I/A OSWS can operate effectively with reduced separation to groundwater, but the system still requires an unsaturated zone of soil to hydraulically function. A flood event would increase the elevation of the groundwater table and could cause flowing floodwaters, both of which would impact the functionality of OSWS. Compared to a centralized treatment system, construction costs would be substantially lower than the costs for a centralized system (less than half), while O&M costs would be in the same range. Therefore, Action Alternative A is recommended for further analysis in the draft EA/EIS, although this alternative does not achieve the same level of nitrogen reduction as centralized treatment system alternatives. The analysis shall be based on the latest available I/A OSWS technology, which may also meet part of the primary purpose of the project.
- *Action Alternative B (Low pressure and gravity sewer collection system with membrane bioreactor [MBR] or Sequencing Batch Reactor [SBR] facility):* This alternative would mitigate short-term, repetitive, adverse impacts on human life and property associated with OSWS failures caused by natural hazards such as rising groundwater levels and overland

flooding that result from precipitation and/or tidal and surge conditions (i.e., the alternative would meet the primary purpose of the project). Potential impacts on human health as a result of surcharged failed leaching fields would largely be eliminated with a centralized treatment facility. Rising sea levels would not reduce the performance of the AWTF because the proposed location of the AWTF is at a sufficiently high surface elevation, and National Oceanic and Atmospheric Administration (NOAA) sea level rise projections (NOAA, 2016) do not indicate inundation of the site. The facility would be protected from stormwater flooding by appropriate site drainage systems. Under rising sea levels, this alternative would therefore continue to eliminate the existing human health risk as a result of OSWS that leak during flood events. This alternative would provide the highest level of nitrogen removal from the effluent, expected to result in groundwater nitrogen concentrations below the target of 6 mg/L throughout large portions of the project area (i.e., the alternative would also meet the secondary purpose of the project). Construction costs for any centralized facility would be substantially higher than for I/A OSWS (Action Alternative A), but O&M costs would be similar. Action Alternative B is recommended for further analysis in the draft EA/EIS.

- *Action Alternative C (Different wastewater treatment technology):* The modified Ludzack-Ettinger (MLE) is a different form of treatment processes. Other than the treatment technology and cost, Action Alternative C is identical to Action Alternative B. Action Alternative C performs the same as Alternative B in terms of mitigating human health and property impacts and the effects of sea level rise. Thus, Action Alternative C would meet the primary purpose of the project. However, under this alternative, the nitrogen concentration in the effluent would be 100–233 percent higher than for the MBR or SBR processes. Thus, the alternative would not meet the secondary purpose of the project to the same extent as Action Alternative B. Total construction costs for a centralized system with MLE processes would be slightly lower (less than 3 percent) than for a system with the MBR or SBR process (Action Alternative B). In summary, Action Alternative C would result in lower benefits at similar costs compared to Action Alternative B. Therefore, Action Alternative C is not recommended for further analysis in the draft EA/EIS.
- *Action Alternative D (Different collection system infrastructure):* This action alternative is similar to Action Alternative B and would perform the same as Action Alternative B in terms of mitigating human health, property impacts, the effects of sea level rise, and effluent quality. Thus, the alternative would meet the primary and secondary purposes of the project similar to Action Alternative B. However, vacuum sewers can be operationally challenging to maintain and prone to vacuum leaks or blockage from grease build-up; these challenges could occasionally affect the secondary purpose of the project. O&M costs for this alternative would be slightly higher than for the combination of gravity and low pressure sewers under Action Alternative B. While Action Alternative D would generally meet the purpose and need to a similar extent as Action Alternative B, the alternative would not result in greater benefits and would result in less reliable operations at slightly greater cost. Therefore, Action Alternative D is not recommended for further analysis in the draft EA/EIS.
- *Action Alternative E (Alternative location[s] for AWTF):* Nine different sites were identified and evaluated for a wastewater treatment facility as part of various feasibility studies between 1999 and 2014. Review of the studies indicated that the Brookhaven

Calabro Airport site is the only feasible location for the AWTF. This site is part of Action Alternatives A to D. The site is close to the project area, thereby enabling efficient connectivity to the sewer network. The site acreage is adequate to accommodate the treatment facility and associated treatment area for all four phases of the sewer network. The site's depth to the groundwater table of 30 to 40 feet provides the necessary distance for feasible operation of the AWTF. Other sites considered during the various feasibility studies were screened out because they either had insufficient depths to the groundwater table, were located too close to residential neighborhoods, had unsuitable site dimensions, or were located too far from the area to be sewered.

In summary, Action Alternative A (replacing existing OSWS with I/A OSWS) and Action Alternative B (low pressure and gravity sewer collection system with MBR or SBR facility) are recommended as the appropriate alternatives for analysis in the draft EA/EIS.

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ABBREVIATIONS AND ACRONYMS

AWTF	Advanced Wastewater Treatment Facility
CR	County Road
EA	environmental assessment
EIS	environmental impact statement
FAST	Fixed Activated Sludge Treatment
FEMA	Federal Emergency Management Agency
gpd	gallon(s) per day
HMGP	Hazard Mitigation Grant Program
I/A	innovative/alternative
lbs/day	pound(s) per day
MBR	membrane bioreactor (a wastewater treatment process)
MGD	million gallons per day
mg/L	milligram(s) per liter
MLE	modified Ludzack-Ettinger (a wastewater treatment process)
MSL	mean sea level
NCA	National Climate Assessment
NOAA	National Oceanic and Atmospheric Administration
O&M	operation and maintenance
OSWS	on-site wastewater treatment and disposal system(s)
Project	Forge River Watershed Sewer Project
SBR	sequencing batch reactor (a wastewater treatment process)
SCDHS	Suffolk County Department of Health Services
SCDPW	Suffolk County Department of Public Works
SEQRA	State Environmental Quality Review Act
SFE	single family equivalent
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
yr	year

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1.0 INTRODUCTION

1.1 Background

The Forge River Watershed Sewer Project proposes decommissioning on-site wastewater treatment and disposal systems (OSWS) in the project area and connecting the parcels to a new sewer collection system that would flow to a new advanced wastewater treatment facility (AWTF). The project area was initially identified as "Phase I/II" (2,094 parcels) and included properties on the north and south sides of County Road (CR) 80 (Montauk Highway) between William Floyd Parkway and Forge River (**Figure 1-1**). This portion of the project is funded and is undergoing design. This alternatives screening report also includes "Phase III" (1,568 parcels), which consists primarily of residential areas along Forge River to the south of the Phase I/II area. Unless a particular phase is specified, the term "project area" applies to the combined Phase I to III area.

This report identifies and screens several alternatives for improving wastewater treatment in the project area to determine a reasonable range of alternatives warranting more detailed analysis in the draft EA/EIS; screening results are summarized in a matrix (**Attachment 1**). Phases I/II and III are screened separately, because Phases I/II are anticipated to be implemented before Phase III. The screening process concludes with a recommendation regarding which alternatives to advance for further analysis in the draft EA/EIS.

Public comments were received during scoping for a potential future phase of the overall project ("Phase IV"). This phase will be considered in the assessment of cumulative impacts in the draft EA/EIS. Phase IV includes the Village of Mastic Beach (south of Neighborhood Road) and Smith Point in the Hamlet of Shirley. This phase is discussed briefly in **Attachment 2**.

1.2 Existing Conditions

The project area is affected by heavy storms that can lead to flooding and inundation from surging ocean water (**Figure 1-2**). About 90 percent of the Phase I/II area is located within the Forge River watershed, and the remaining 10 percent of the area is located within the Carmans River watershed to the west. The entire Phase III area is located within the Forge River watershed.

The density of OSWS in the project area is high compared to many other parts of the Forge River watershed (**Figure 1-3**). About 96 percent of the current total nitrogen load from effluent discharged to the groundwater in the Phase I/II area is contributed by residential sources, with the remainder contributed by commercial and institutional sources (CDM Smith, 2015). The relative contribution from residential sources is likely even higher in the Phase III area. Ground surface elevations in the project area range from about 50 feet to 0 feet above mean sea level (MSL). Depth to groundwater ranges from 40 feet to less than 5 feet below the land surface (USGS, 2016) (**Figure 1-4**). Groundwater in much of the Phase I/II and III areas takes two years or less to flow to Forge River (CDM Smith, 2014).

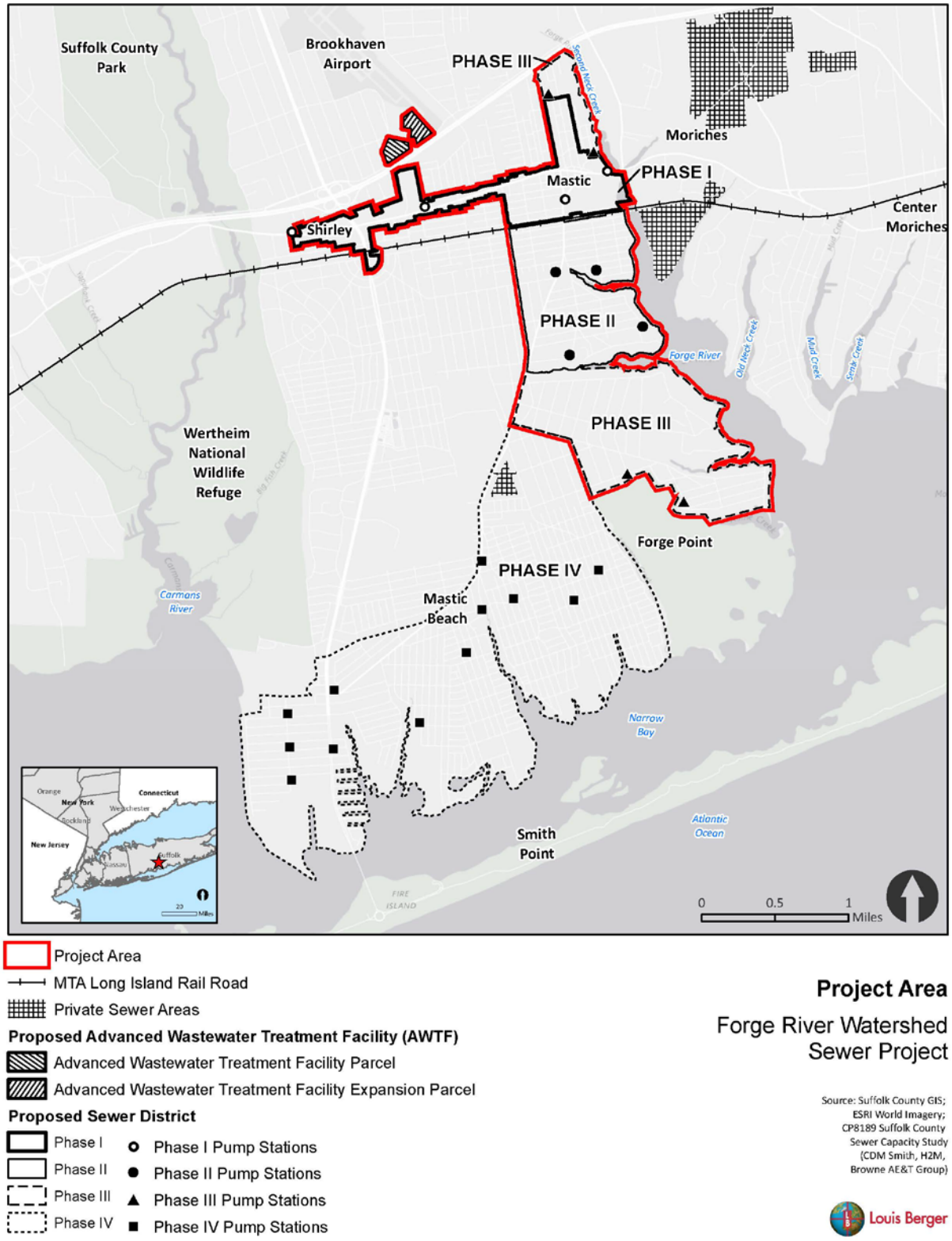
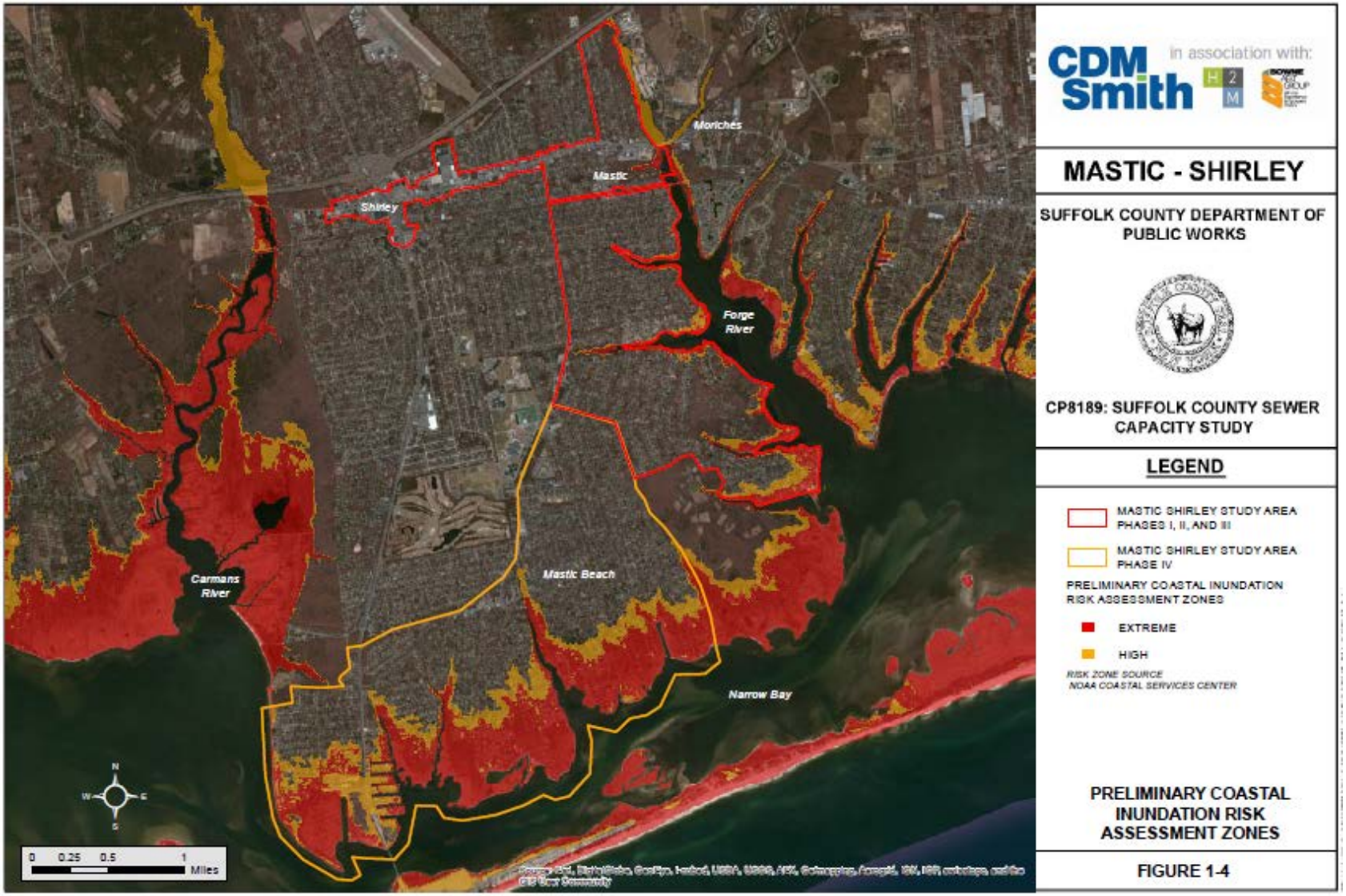


Figure 1-1. Forge River Watershed Sewer Project Area



Source: CDM Smith, 2014

Figure 1-2. Coastal Inundation Risk Assessment Zone (Preliminary)

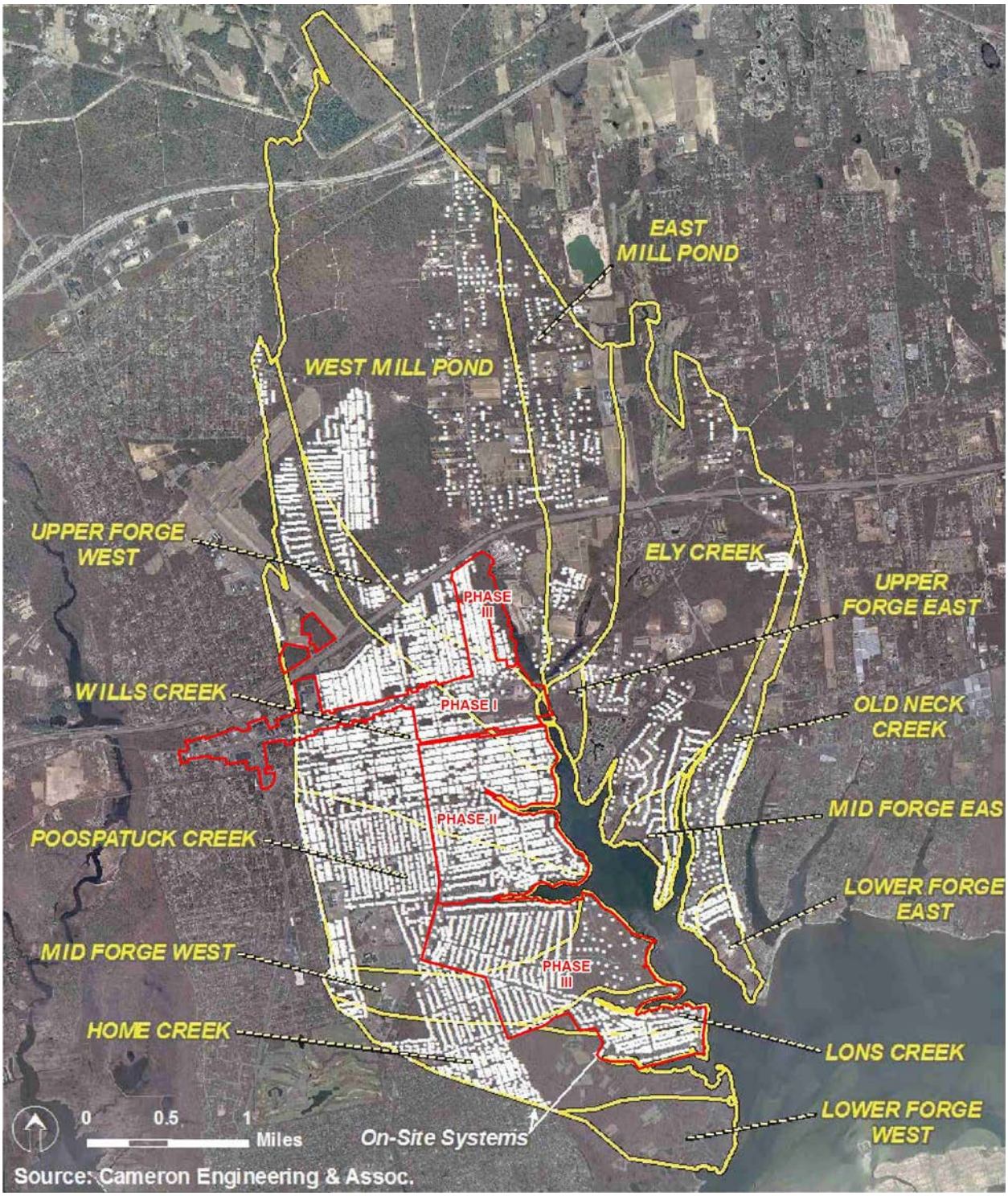
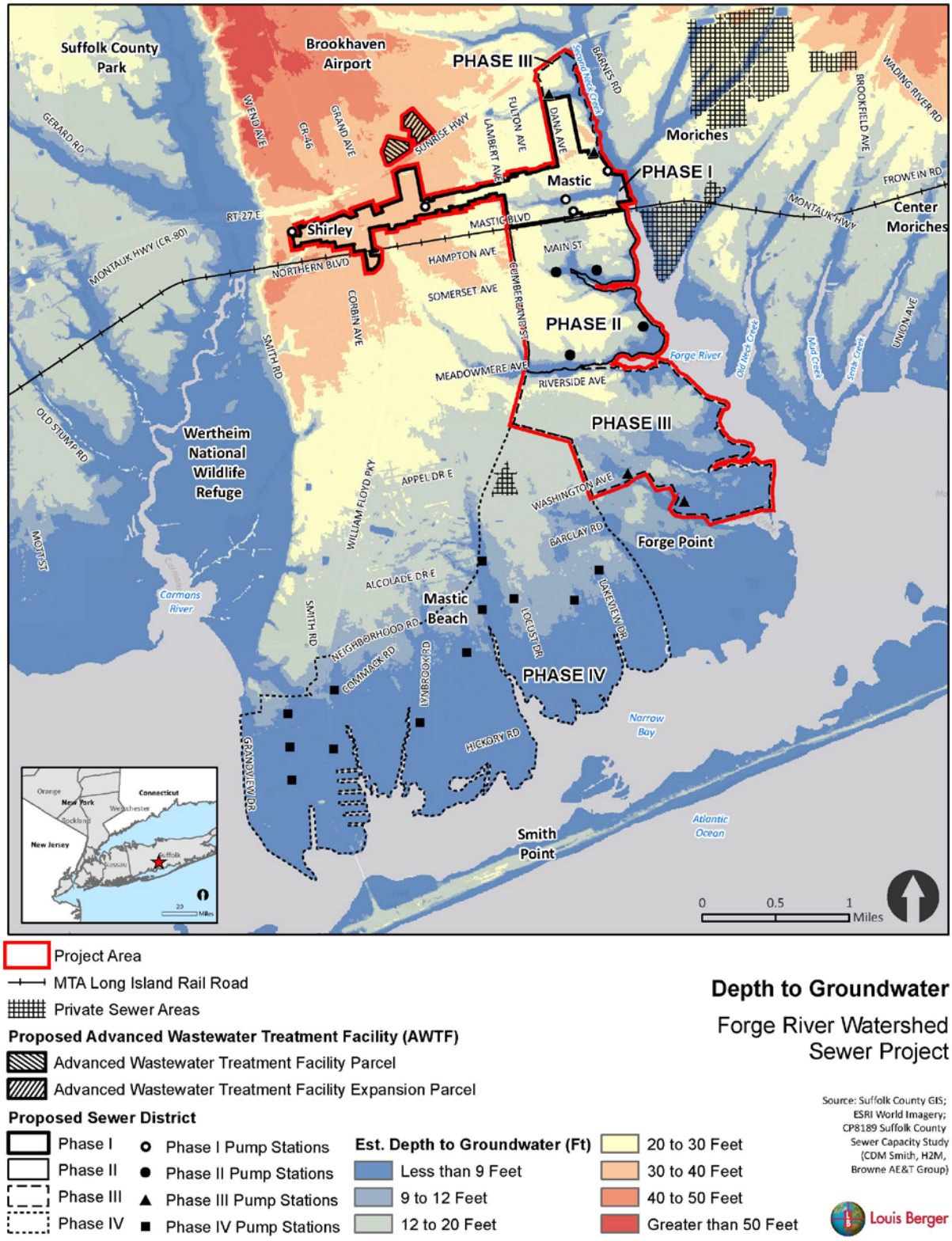


Figure 1-3. Septic Systems and Subwatersheds within the Forge River Watershed



Project Area
MTA Long Island Rail Road
Private Sewer Areas

Proposed Advanced Wastewater Treatment Facility (AWTF)

Advanced Wastewater Treatment Facility Parcel
Advanced Wastewater Treatment Facility Expansion Parcel

Proposed Sewer District

Phase I
Phase II
Phase III
Phase IV

Phase I Pump Stations
Phase II Pump Stations
Phase III Pump Stations
Phase IV Pump Stations

Est. Depth to Groundwater (Ft)

Less than 9 Feet
9 to 12 Feet
12 to 20 Feet
20 to 30 Feet
30 to 40 Feet
40 to 50 Feet
Greater than 50 Feet

Depth to Groundwater

Forge River Watershed Sewer Project

Source: Suffolk County GIS; ESRI World Imagery; CP8189 Suffolk County Sewer Capacity Study (CDM Smith, H2M, Browne AE&T Group)

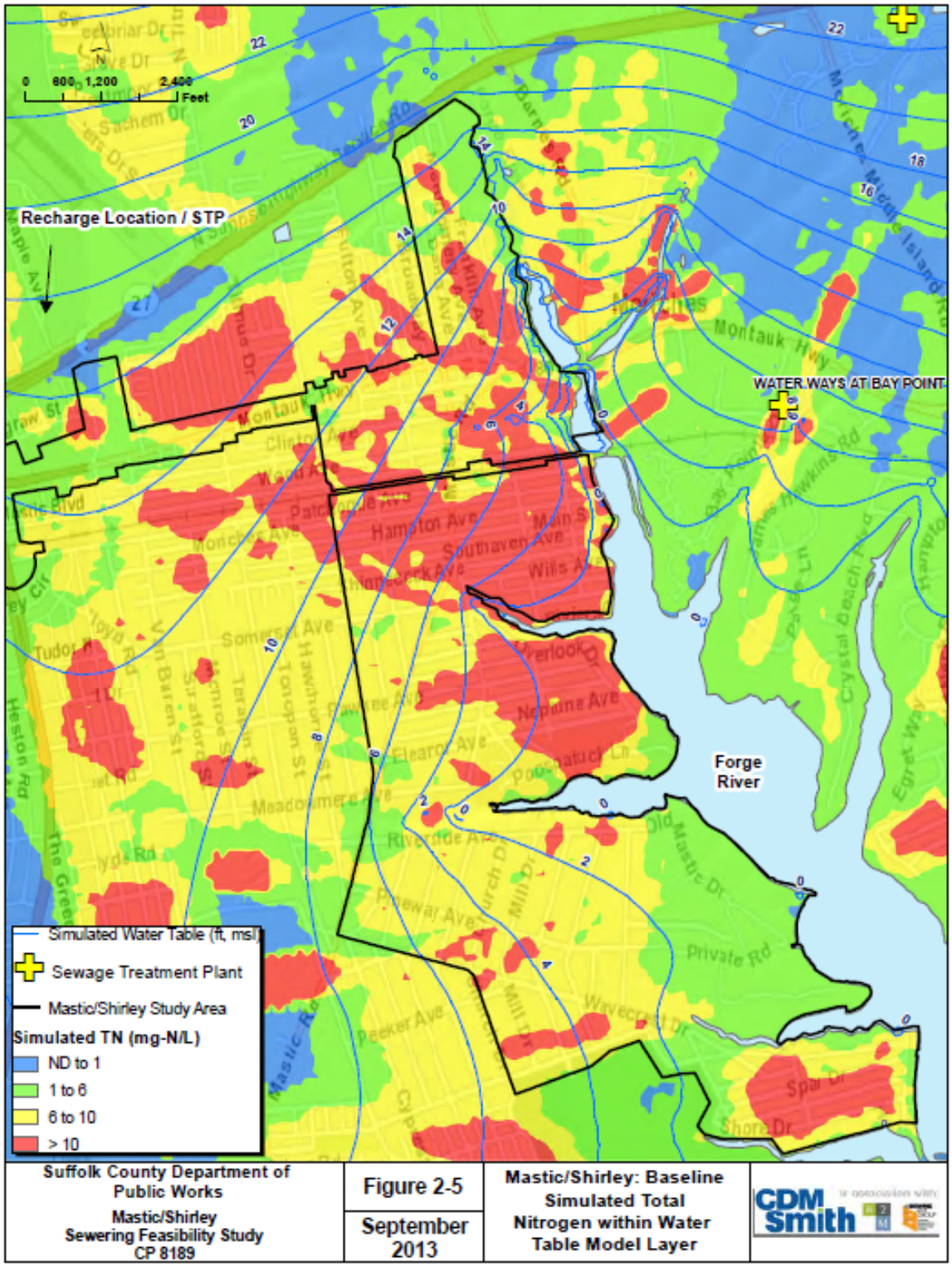
Louis Berger

Figure 1-4. Depth to Groundwater

OSWS failures occur when systems are flooded by heavy rainfall or are submerged in shallow groundwater that rises during storm events and reduces system capacity and/or inhibits or eliminates system treatment or disposal capability, as described below:

- *Capacity failure* occurs when tidal inundation of the land surface saturates soils above and around the systems causing water to enter the systems or when groundwater rises into the cesspool or leaching pools, reducing system hydraulic capacity. Capacity failure manifests itself by slow-draining domestic plumbing or backup of wastewater into the homes or basements of buildings served by the systems.
- *Treatment and disposal failure* occurs when groundwater or flood waters inundate the systems or soils immediately beneath the systems, disrupting the biological treatment activity in the systems. A 2-foot vertical separation between the bottom of the cesspool or leaching pool and the water table is necessary for decomposition of organic compounds, biodegradation of detergents, and die-off of bacteria and viruses. For an extended period of months to years following system failures caused by inundation, nutrients (e.g., nitrogen) and pathogens are discharged unabated to groundwater and potentially to nearby surface waterbodies (i.e., Forge River and Great South Bay). Rising groundwater tables and floodwaters can also result in flotation of tanks unless they are properly anchored in the ground.

OSWS are a significant source of nitrogen loading in Forge River because nitrogen leaches out of the OSWS into groundwater and the nitrogen-rich groundwater then flows subsurface toward these estuaries. Total nitrogen concentrations in the groundwater are currently higher than 10 milligrams per liter (mg/L) in a large portion of the project area (**Figure 1-5**) and do not meet Suffolk County's target for the area of 6 mg/L.



Source: CDM Smith, 2014.

Figure 1-5. Modeled Total Nitrogen Concentrations in Shallow Groundwater under Existing Conditions for the Phase I/II and III Areas

2.0 SCREENING APPROACH

A screening approach was developed to evaluate a range of alternatives for improving wastewater treatment in the project area and to identify those alternatives that are feasible and meet the purpose and need of the project.

2.1 Purpose and Need

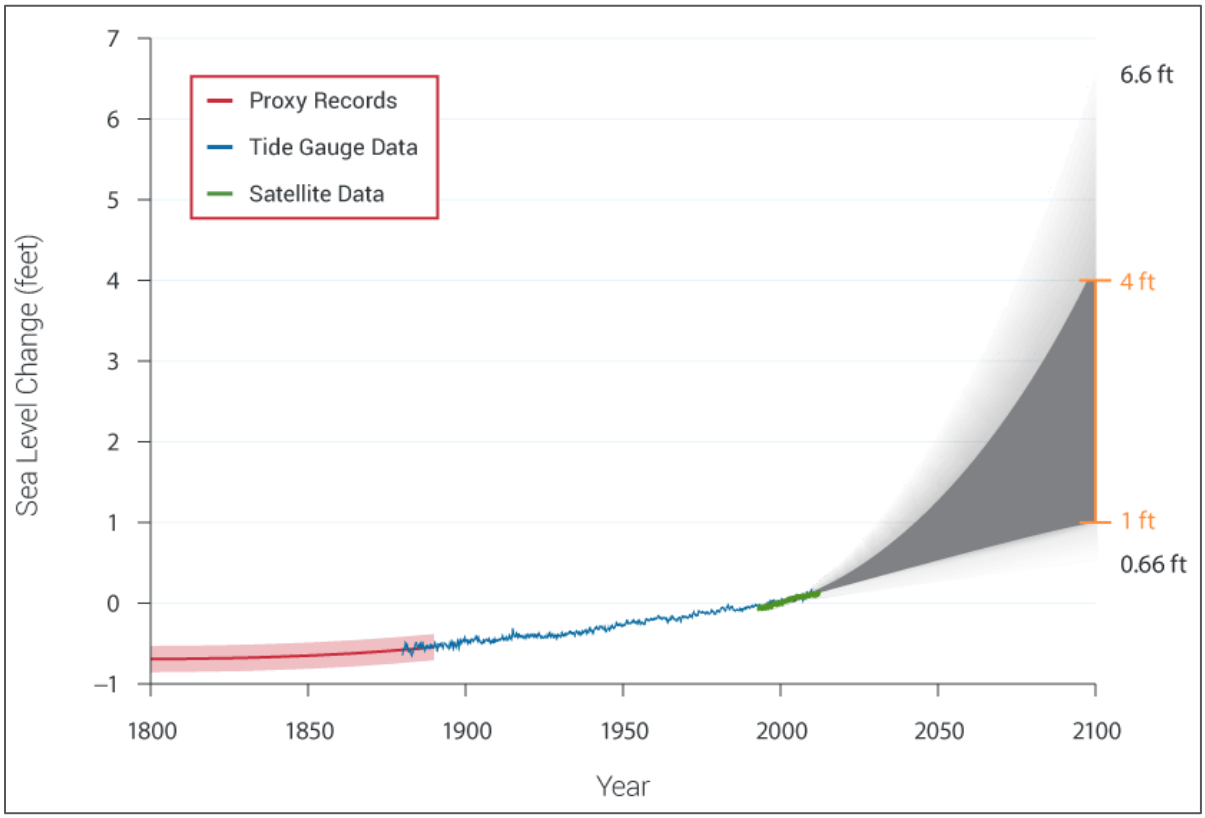
Section 404 of the Robert T. Stafford Relief and Emergency Assistance Act of 1974 (42 USC 5170c), as amended, authorizes FEMA to provide funding to eligible grant applicants for activities that reduce or eliminate risks to life and property from hazards and their effects. The primary purpose of the proposed action is to mitigate short-term and repetitive, adverse impacts on human life and property associated with OSWS failures in the Forge River watershed in Suffolk County, New York, caused by natural hazards. The secondary purpose is to mitigate long-term, adverse impacts associated with such failures on surface waters and coastal wetlands that reduce the ability of these waters and wetlands to provide natural protection against storm surge. The project is needed because OSWS in the project area are susceptible to both capacity failure and treatment and disposal failure during floods and heavy rain events.

2.2 Criteria

Based on the purpose and need for the project, the following five screening criteria were identified:

- *Treatment performance (removal of total nitrogen):* This criterion relates to the mitigation of OSWS failure-related nitrogen impacts on surface waters and coastal wetlands and the resultant impact on their storm surge coastal flood risk protection capacity. In the 1970s, Suffolk County studied the effect of buildings on the groundwater (Suffolk County, 2015). To limit nitrogen concentrations in the groundwater, groundwater management zones were established, based on differences in hydrogeology and groundwater quality. In 1981, these zones were added under Article 6 to the Suffolk County Sanitary Code. The Mastic-Shirley project area is located within Groundwater Management Zone VI (CDM Smith, 2014). The targeted nitrogen concentration in the groundwater within this zone is 6 mg/L, as stated above (Suffolk County, 2015). Therefore, this criterion evaluates the performance of alternatives relative to this target. Alternatives that perform best are those that meet or exceed this target, i.e., that result in the lowest total nitrogen discharge to groundwater (in mg/L). Alternatives with the lowest nitrogen discharge to groundwater provide the highest benefit to water quality in Forge River. The improvement in water quality provides long-term benefits through improved wetland health that contributes to a reduction in coastal flood risk.
- *Performance during flood events:* This criterion relates to the ability of an alternative to reduce or avoid short-term and repetitive, adverse impacts on human life and property associated with OSWS failures during and after flood events. Alternatives that perform best are those that are able to remain fully functional during and after flood events without a loss of treatment performance and avoid impacts to human health from flooded treatment systems.
- *Performance under projected sea level rise and climate change conditions:* Projections for sea level rise vary. The National Climate Assessment (NCA) projects a rise in sea level of 1 to 4 feet by 2100 (**Figure 2-1**) (NCA, 2014). NCA (2014) also provides a wider range of

0.66 foot to 6.6 feet that incorporates uncertainty about how glaciers and ice sheets would react to the warming ocean, the warming atmosphere, and changing winds and currents. Sea level rise inundates low-lying properties more frequently and raises the groundwater table in coastal areas permanently. In addition, more extreme storm events may occur as a result of climate change, resulting in more frequent and intense coastal surges and precipitation events (NCA, 2014). With the increase in groundwater levels, both on an event basis and on a permanent basis, OSWS are expected to fail more frequently. This criterion evaluates the ability of an alternative to maintain full performance in the face of these future conditions. Alternatives that perform best are those that are able to remain fully functional as groundwater levels rise both permanently and during and after a storm event in a future increasingly affected by climate change and sea level rise. The draft EA/EIS will assume a project life of up to 60 years (i.e., up to year 2082 with a start date of 2022). The expected sea level rise by 2080 would range between about 0.8 and 3 feet.



Source: NCA, 2014

Figure 2-1. Past and Projected Changes in Sea Level

- *Acquisition of land (with appropriate dimensions and compatible land use):* For an alternative to be feasible, it must be constructible within a reasonable footprint on a site and within an area that is compatible with the use of the property for the proposed type of wastewater treatment. Alternatives that require acquisition of an unusually large land area

or are not compatible with site or area land uses are considered poorly performing or infeasible.

- *Costs:* This criterion estimates order-of-magnitude costs for construction as well as for operation and maintenance (O&M) and the feasibility of an alternative in light of cost considerations for various industry practices. The criterion is applied to ascertain whether any alternatives would result in disproportionally or unusually high costs that would render the alternative infeasible. Costs for the 2,094 parcels within the Phase I/II area were calculated using 2,893 "single family equivalent (SFE) parcels." The use of SFEs accounts for more densely populated parcels and commercial lots and is consistent with the approach used by CDM Smith (2014; 2015). For the Phase III area, SFEs were not available; the number of parcels (i.e., 1,568) was used for calculations because this area contains few commercial properties (approximately 1 percent). Cost estimates were not adjusted for inflation for this screening analysis.

2.3 Screened Alternatives

Over the past decades, a wide range of alternatives has been evaluated to address the issues associated with the impacts of OSWS in Suffolk County and in the project area in particular. These alternatives include technology alternatives, variations and options thereof that were previously evaluated with similar project conditions, and alternatives suggested during the public scoping period for the draft EA/EIS.

The screening criteria above were applied to the following alternatives:

- **On-site Wastewater Treatment and Disposal Systems**
  - Action Alternative A: Replacing existing OSWS with innovative/alternative (I/A) OSWS
- **Centralized Treatment**
  - Action Alternative B: Low pressure and gravity sewer collection system with membrane bioreactor (MBR) or sequencing batch reactor (SBR) facility
  - Action Alternative C: Different wastewater treatment technology: Modified Ludzack-Ettinger (MLE) process
  - Action Alternative D: Different collection system infrastructure
  - Action Alternative E: Alternative location(s) for AWTF

These alternatives are discussed in Section 3. There are no environmental constraints that would render any of these alternatives entirely impracticable.

3.0 SCREENING ANALYSIS

This section describes the alternatives considered to meet the purpose and need of the project. This screening level of analysis allows alternatives to be compared to determine the action alternatives to be assessed in the draft EA/EIS. The analyses of potential long-term impacts will evaluate conditions with and without the proposed action and alternatives during the foreseeable design life of the proposed action and alternatives. As stated above, results of the screening analysis are summarized in a matrix (**Attachment 1**).

3.1 Action Alterative A: On-site Treatment and Disposal – Replacing Existing OSWS with I/A OSWS

This alternative would replace failing cesspools and septic systems in the project area with modern I/A OSWS. In 2014, Suffolk County began a demonstration project for I/A OSWS and, by fall 2016, plans to implement a program permitting the use of I/A OSWS (SCDPW, personal communication, 2016). Several systems are currently being tested. The effluent from these systems shall contain no more than 19 mg/L total nitrogen (Suffolk County, 2014) because this is the limit for effluent from residential dwellings in Massachusetts where the system was originally tested and which serves as a reference for efficacy (H2M, 2013).

3.1.1 Technical Aspects

As examples for this screening analysis, two I/A OSWS studied by H2M (2013) would achieve the desired nitrogen treatment based on effluent concentrations in Suffolk County—the BioMicrobics MicroFAST® system and Lombardo Associates Nitrex™ system (see **Attachment 3** for technical details of these systems). The Nitrex™ system is comparatively expensive for practical implementation. Therefore, the remaining discussion focuses primarily on the MicroFAST® treatment system.

The MicroFAST® system is a fixed activated sludge treatment, an aerobic method that injects air into wastewater to sustain suspended and attached microbial populations. Biological organisms allow nitrification to take place; an anoxic chamber allows for subsequent denitrification (USEPA, 2004). Flow through the system depends on gravity. Effluent from the house enters a septic tank where solids settle before the liquid flows into the second chamber where air is continuously blown into the module through an external blower. Some of the liquid is then airlifted back to the original anoxic tank where denitrification takes place. Treated effluent is released to a soil absorption system/leaching field (or drain field) (USEPA, 2004).

Before preparing the draft EA/EIS, the status of the ongoing demonstration program will be reviewed with the Suffolk County Department of Public Works (SCDPW) to integrate the latest findings in the analysis. As appropriate, that review will include "closed water systems," recommended for consideration during the project's public scoping meeting on January 26, 2016.

3.1.2 Screening Results – Phase I/II Area

Applying the screening criteria to Action Alternative A yields the following for the Phase I/II area:

- *Treatment performance:* For the H2M (2013) study, effluent samples were taken from MicroFAST® systems installed at two residential properties in Massachusetts. The technology was pre-engineered to meet the design requirement of at least 19 mg/L total nitrogen, the limit for effluent from residential dwellings in Massachusetts (H2M, 2013).

Sampling indicated the system met the design requirements; effluent consistently tested at less than 19 mg/L. Based on these results and additional manufacturer information, the system could be capable of meeting the limit of 19 mg/L required by the Suffolk County Department of Health Services (SCDHS) for the I/A OSWS demonstration project. If I/A OSWS are adequately adapted to conditions in Suffolk County, they would provide a significant improvement in treatment performance compared to a conventional OSWS, removing potentially at least 75 percent of the total nitrogen in the effluent (based on an effluent nitrogen concentration of 19 mg/L). However, effective oversight of O&M for I/A OSWS would be essential to ensure that treatment goals are met. I/A OSWS that are not regularly inspected and only occasionally monitored would not achieve treatment objectives (Heufelder et al., 2008). System reliability also is subject to availability of electrical power, and sustained power outages could adversely affect the system operation.

Extrapolated from data in CDM Smith (2014), an effluent nitrogen concentration of 19 mg/L from installed I/A OSWS would discharge a total load of approximately 138 pounds per day (lbs/day) to the groundwater from all the parcels in the Phase I/II area. Model data are not available to determine the resulting total nitrogen concentrations in the groundwater resulting from this nitrogen load. The discharged nitrogen load would mix with the groundwater that slowly migrates from high elevations on Long Island toward the coast. Groundwater is largely recharged by precipitation (rain and melting snow), which contains very low nitrogen concentrations. After mixing of the effluent discharge from I/A OSWS with the groundwater, the resulting total nitrogen concentration in the groundwater would be lower than under existing conditions with conventional OSWS; however, parts of the Phase I/II area would not be expected to meet the target of 6 mg/L.

- *Performance during flood events:* Although I/A OSWS such as the MicroFAST® system can generally operate in areas with shallower groundwater tables compared to conventional OSWS, I/A OSWS also face risks from floods because of similar or more complex components (e.g., control and electrical panels and external blowers that could be damaged during a flood). The capacity of the drain field would be diminished under mounded water table conditions, and the effluent would flood at the surface, creating human health and environmental concerns, similar to conventional OSWS. Inundation flooding can damage septic systems that are not properly designed to prevent flotation. Erosive velocities during storm events also can expose portions of the I/A OSWS. In addition, I/A OSWS require operation of aerators and/or pumps to provide treatment. Electrical power may need to be switched off during flood events to prevent electrical shock, thereby preventing a portion of the system from functioning and achieving its intended effectiveness.
- *Performance during sea level rise and climate change conditions:* **Figure 3-1** shows the effect of sea level rise on the position of the shoreline with sea level rise of up to 4 feet. Loss of land in the Phase I/II area would be comparatively limited. **Figure 3-2** shows that a rise in sea level by 2.8 feet between 2014 and 2100 (NCA, 2014) would cause the groundwater table to rise by up to 3 feet. A higher groundwater table would decrease the thickness of unsaturated soil below any OSWS, decreasing the extent of nitrogen reduction by soil bacteria or roots before nitrogen is released into the estuary. Therefore, similar to conventional OSWS, an I/A OSWS like the MicroFAST® system would also be susceptible to sea level rise. However, I/A OSWS would still provide effective nitrogen removal under increased water table conditions because the primary nitrogen removal

mechanism is within the treatment train with less reliance on the bacterial layer at the base of the disposal field for nitrogen reduction. Therefore, I/A OSWS would perform better than the conventional OSWS.

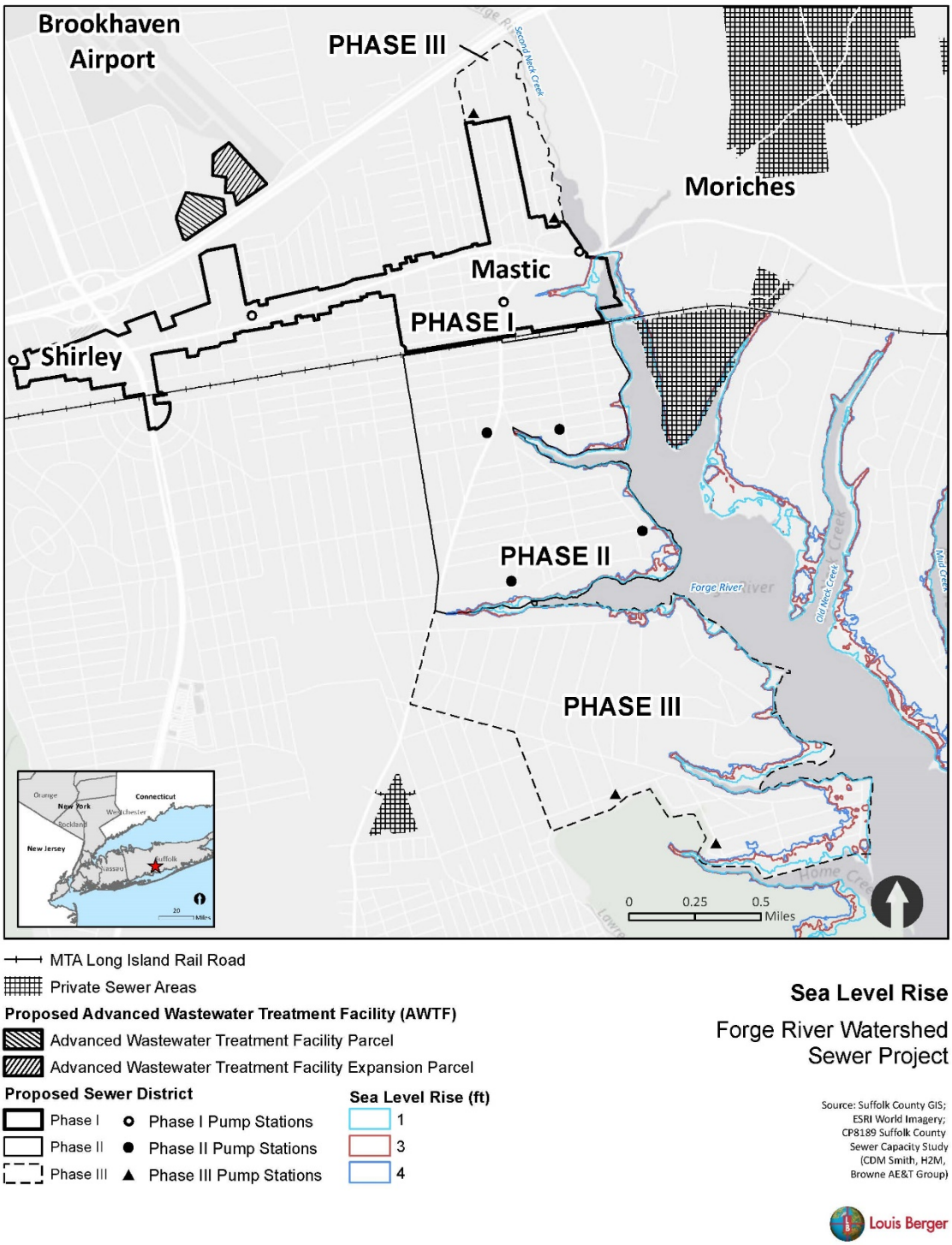
- *Acquisition of land:* OSWS design standards set by SCDHS require systems to be located on the same parcel as the building to be serviced and owned by the individual applicants (SCDHS, 1995; 2009). Thus, no public lands would need to be acquired under Action Alternative A.
- *Costs:* Because of the complexity of the technology involved, capital costs for I/A OSWS are generally much higher than a conventional OSWS. For example, capital costs for the MicroFAST® system would be $25,000; costs for the Nitrex™ system would be $41,500 (H2M, 2013) (**Table 3-1**). Using the costs for the MicroFAST® system as an example, replacement of all conventional OSWS in the Phase I/II area (using SFE) with I/A OSWS would require approximately $72 million (**Table 3-2**).

  O&M costs for I/A OSWS also would be higher than for conventional OSWS given the larger number of components of I/A OSWS. Based on data from other jurisdictions with a developed market of advanced treatment systems, annual O&M costs for typical I/A OSWS are between $200 and $500 (SCDPW, personal communication, 2016) (**Table 3-1**). Accordingly, annual O&M for the Phase I/II area would require $500,000 to $1.4 million (**Table 3-2**).

3.1.3 Screening Results – Phase III Area

Applying the screening criteria to Action Alternative A yields the following for the Phase III area:

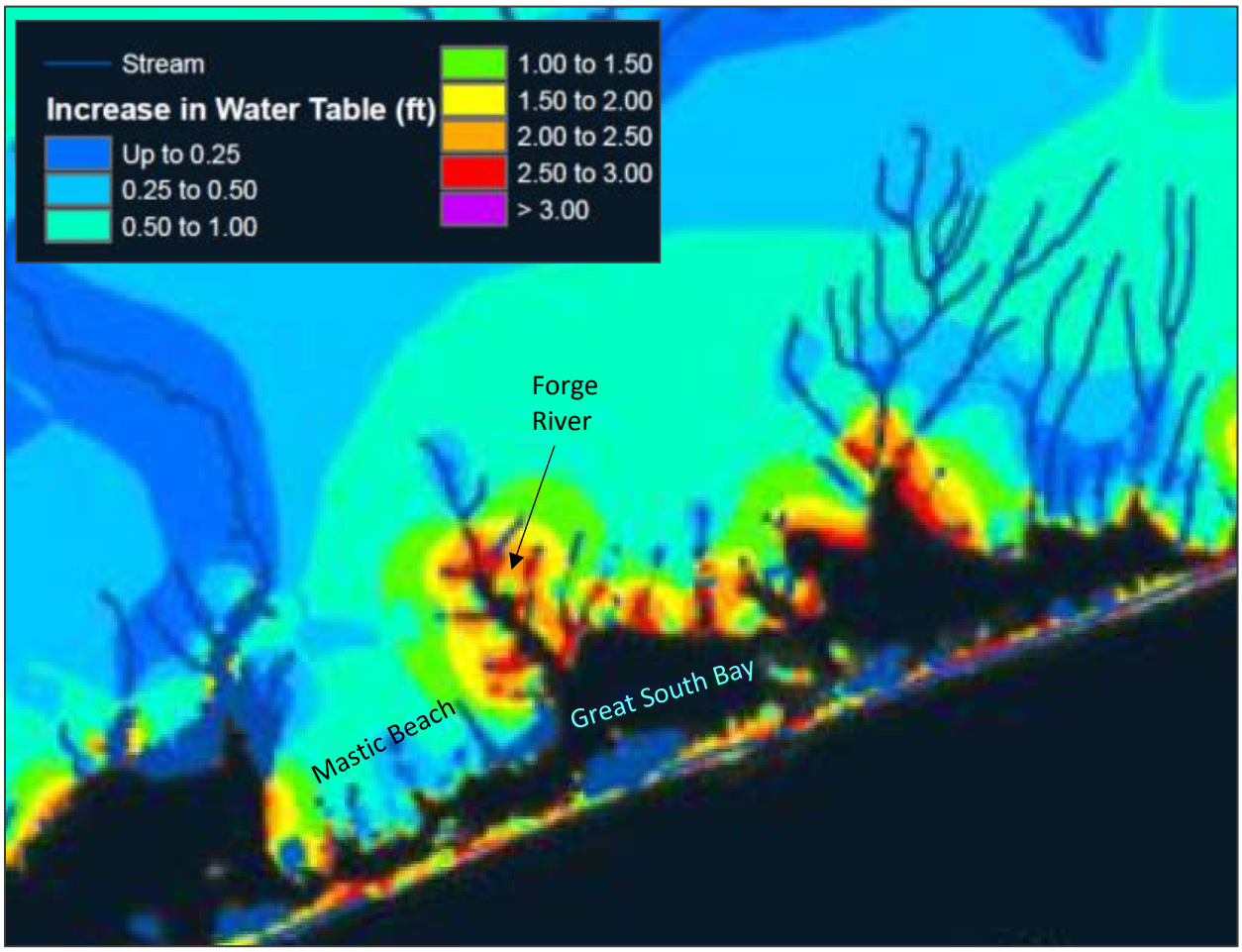
- *Treatment performance:* An effluent nitrogen concentration of 19 mg/L from installed I/A OSWS would discharge a load of approximately 84 lbs/day to the groundwater from all the parcels in the Phase III area (extrapolated from data in CDM Smith, 2014). After mixing of the effluent discharge from I/A OSWS with the groundwater, the resulting total nitrogen concentration in the groundwater would be lower than under existing conditions with conventional OSWS, and a larger portion of the Phase III area than is the case presently would meet the target of 6 mg/L. The densely populated southeastern corner of the Phase III area, however, likely would not meet the target.
- *Performance during flood events:* Performance in the Phase III area would be slightly worse than in the Phase I/II area because a larger proportion of the Phase III area has shallow depths to groundwater (**Figure 1-4**) and is thus more susceptible to flooding impacts (particularly in the southeastern corner of the area).
- *Performance during sea level rise conditions:* Performance during sea level rise conditions also would be slightly worse than in the Phase I/II area because of the overall shallower depths to groundwater.
- *Acquisition of land:* No land acquisition would be required.
- *Costs:* Using a cost of $25,000 per I/A OSWS for each of the 1,568 parcels, replacement of all conventional systems with I/A OSWS would require approximately $39 million (**Table 3-2**). Annual O&M would require between $300,000 and $800,000.



Source: NOAA, 2016.

Note, the 3-foot contour is shown in red for easier comparison of this figure with Figure 3-2.

Figure 3-1. Shoreline with Projected Sea Level Rise



Source: CDM Smith, as published in Suffolk County, 2015

Figure 3-2. Projected Increase in the Groundwater Table between 2014 and 2100 as a Result of a 2.8-foot Sea Level Rise

Table 3-1. Unit Costs for Construction and Installation of Conventional OSWS and two Examples of I/A OSWS in Residential Applications

		I/A OSWS (per unit)	I/A OSWS (per unit)
Cost Component	**Conventional Septic System (per unit)**	**BioMicrobics MicroFAST®**	**Lombardo Associates, Inc. – Nitrex™**
Permitting and regulatory requirements	$650	$5,000	$7,500
Treatment components (including ancillary equipment and contractor markup)	$3,700	$7,000	$19,500
Construction and installation	$730	$13,000	$14,500
TOTAL	$5,080	$25,000	$41,500
Annual O&M costs	$160	Typical I/A OSWS based on data from other jurisdictions with a developed market of I/A OSWS, O&M costs for typical I/A OSWS are between $200 and $500, including electrical costs (SCDPW, personal communication, 2016).	Typical I/A OSWS based on data from other jurisdictions with a developed market of I/A OSWS, O&M costs for typical I/A OSWS are between $200 and $500, including electrical costs (SCDPW, personal communication, 2016).

Source: SCDHS, 2013

Table 3-2. Costs for Construction and Annual Operation and Maintenance of Alternatives *(Order-of-magnitude Analysis)*

Alternatives[1]	Capital Costs* Phase I/II [2]	Capital Costs* Phase III	Capital Costs* Total	Annual O&M Costs* Phase I/II	Annual O&M Costs* Phase III	Annual O&M Costs* Total
Action Alternative A: Replacing all existing OSWS in project area with I/A OSWS[2,3]	$72	$39	**$111**	$0.5–$1.4	$0.3–$0.8	**$0.8–$2.2**
Action Alternative B: Low pressure and gravity sewer collection system with MBR facility[5]	$188	$106	**$294**	$1.1	$0.6	**$1.7**
Action Alternative B: Low pressure and gravity sewer collection system with SBR facility[6]	$185	$104	**$289**	$1.1	$0.6	**$1.7**
Action Alternative C: Different wastewater treatment technology using MLE process[6]	$183	$103	**$286**	$1.1	$0.6	**$1.7**
Action Alternative D: Different collection system infrastructure using vacuum sewers[7]	$188	$106	**$294**	$1.1	$0.66	**$1.76**

* in millions, estimate

[1] Action Alternative E (different locations for AWTF) was not considered because it only addresses one component of a complete centralized treatment system.

[2] Costs for the 2,094 parcels are applied to 2,893 SFE parcels in the Phase I/II area; for the Phase III area, the actual number of parcels was used.

[3] Capital costs: Assumes a one-time replacement of all conventional OSWS with an I/A OSWS costing $25,000. O&M: Assumes annual costs of $200 to $500 for typical I/A OSWS based on data from other jurisdictions with developed markets (SCDPW, personal communication, 2016), and includes electrical costs.

[5] Sources: Capital costs: Phase I/II, CDM Smith, 2015; Phase III, CDM Smith, 2013. O&M: See text for method of calculation.

[6] Capital costs: See text for method of calculation for Phase I/II. For Phase III, the percent difference between MBR and MLE (2.5%) and MBR and SBR (1.5%) was used for estimation. O&M: Costs were based on $1.71 per gallon per day (gpd) (CDM Smith, 2014). Thus, the costs for each phase were calculated based on applying the following factors: $1.71/gpd, 225 gpd per parcel, and number of parcels. O&M costs are anticipated to be the same as for Alternative B.

[7] Construction costs of vacuum sewers are expected to be approximately 10 to 15 percent higher than costs of low pressure sewers. Costs for low pressure sewers represent a relatively small percentage of the overall construction costs. Therefore, the overall capital costs for Action Alternative D are considered similar to Action Alternative B.

3.2 Action Alterative B: Centralized Treatment – Low Pressure and Gravity Sewer Collection System with Membrane Bioreactor or Sequencing Batch Reactor Facility

3.2.1 Technical Aspects

Action Alternative B would include a collection system with a combination of gravity sewers and low pressure sewers, a conveyance system consisting of multiple pump stations, and an AWTF. The wastewater or sanitary flow from the entire project area is projected to be approximately 3.2 million gallons per day (MGD) for the complete project area (CDM Smith, 2013; 2014). This flow includes approximately 1.0 MGD from the Phase I/II area and 0.4 MGD from the Phase III area. Following is a description of each component, based on information provided by CDM Smith (2014; 2015):

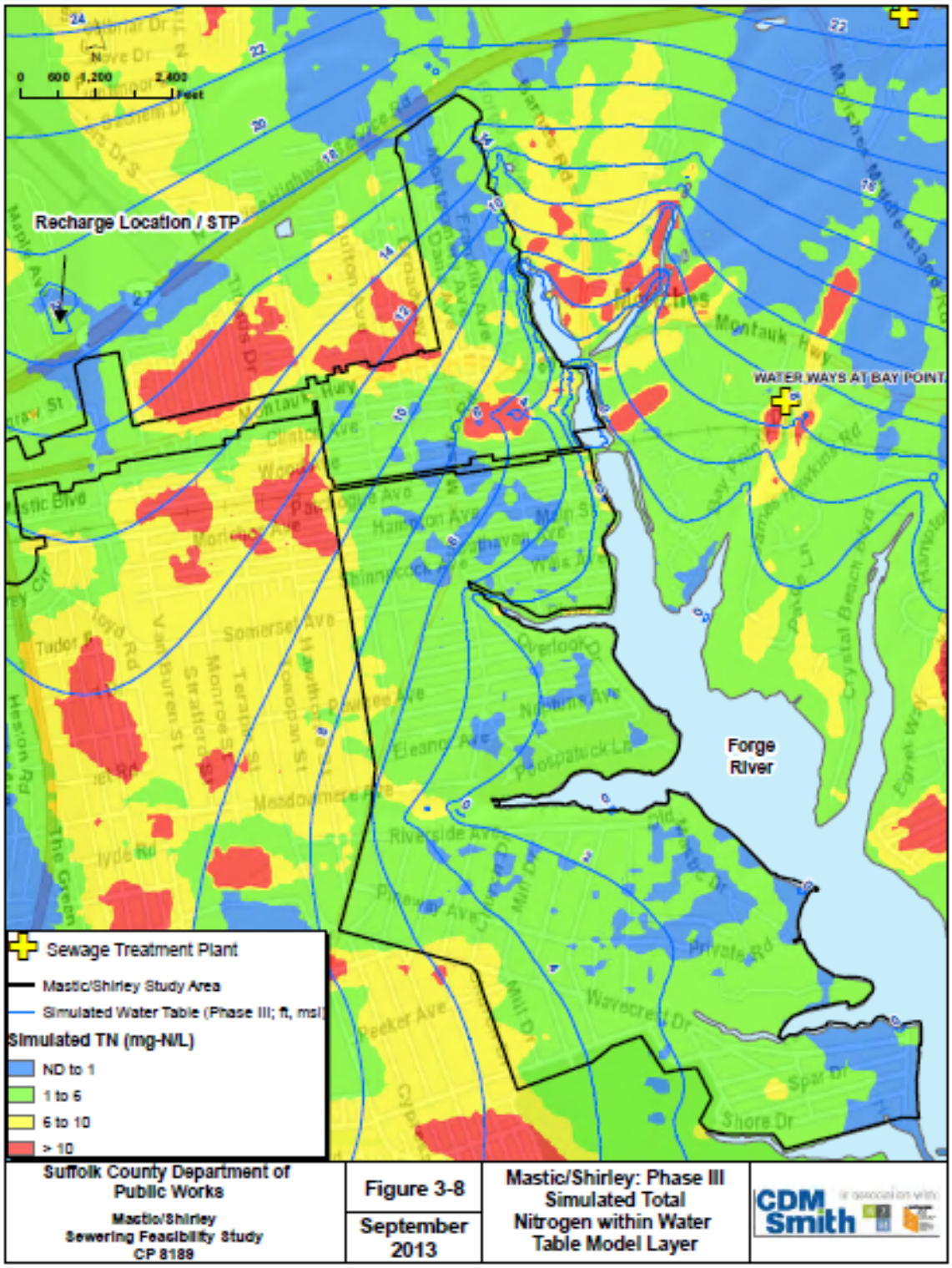
- *Collection – Gravity sewers:* Gravity sewers would be used in areas where the pipe installation can follow the natural inclines of the terrain to allow for natural flow to a pump station or treatment facility. The gradient must be steep enough to allow for self-cleaning flow inside the pipes. The main gravity sewer line usually runs the length of a street with lateral connections to adjacent properties.
- *Collection – Low pressure sewers:* Low pressure sewers would be used in relatively flat areas where the groundwater table is shallow, generally at a depth of 10 feet or less along Forge River and its tributaries, and along Great South Bay (see **Figure 1-4**). Therefore, low pressure sewers would be used in a small portion in the Phase I/II area and in the eastern half of the Phase III area. Each property in the collection area would be required to operate and maintain an on-site grinder pump.
- *Conveyance – Pump stations:* A total of 12 pump stations would be located throughout the project area, including eight pumps in the Phase I/II area and four pumps in the Phase III area. One of the pump stations would serve as an influent pump station to the AWTF.
- *Treatment – Advanced Wastewater Treatment Facility:* The sewer network would be connected to the AWTF via an influent pump station. Wastewater would be processed at the AWTF using either the MBR process or the SBR process, and effluent would be disposed after treatment through subsurface leaching pools.
    - *MBR Process:* Flow from pump stations would be discharged directly to influent screening equipment at the headworks, which would remove grit, large solids, and debris. Thereafter, wastewater would flow through various tanks and basins for treatment. Finally, effluent would enter parallel downstream membrane reactors to remove solids remaining in the process before being discharged to the leaching pools.
    - *SBR Process:* The SBR process is a suspended growth type activated sludge treatment process. The SBR process would involve pre-anoxic denitrification and combine anoxic conditions, aeration, and clarification within one common basin, eliminating the need to recycle process flow between tanks and optimizing the overall nitrogen removal efficiency (CDM Smith, 2014). The entire biological process would occur in one tank.

Removed solids would either be returned to the biological process or be pumped to a sludge holding tank for thickening before disposal at the Bergen Point Water Control Facility. A site under consideration for the AWTF is located at the Brookhaven Calabro Airport.

3.2.2 Screening Results – Phase I/II Area

Applying the screening criteria to Action Alternative B yields the following for the Phase I/II area:

- *Treatment performance:* The MBR process would produce a total nitrogen concentration in the effluent of between 3 and 5 mg/L, commonly described as the "limit of technology" for nitrogen removal. Assuming the selection of MBR technology, this alternative would reduce the nitrogen load discharged to the groundwater from the Phase I/II area from 166 lbs/day (currently) to 36 lbs/day (using an MBR effluent concentration of 5 mg/L during modeling) (CDM Smith, 2014). Total nitrogen concentrations in groundwater would decrease from currently greater than 10 mg/L in large parts of the Phase I/II area (**Figure 1-5**) to below the target of 6 mg/L in most of the area (**Figure 3-3**). Model results show that only a few small areas in mostly the northeastern part of the Phase I/II area would have groundwater nitrogen concentrations that would continue to exceed 6 mg/L; this may be due to the higher nutrient loading from OSWS located to the northwest of the Phase I/II area. The SBR process has been documented to achieve the limit of technology. Model data for the resulting total nitrogen concentration in groundwater do not exist. However, considering the modeling results for the MBR and SBR process, most of the Phase I/II area also would achieve the nitrogen concentration target of 6 mg/L in the groundwater.
- *Performance during flood events:* The AWTF would be located 60 feet above MSL, which is outside the flood zone for the Mastic-Shirley area (CDM Smith, 2014). A substantial portion of the proposed sewer collection infrastructure would be located within the floodplain. Pump stations located in the floodplain are expected to be constructed of flood-resistant building materials equipped with submersible pumps to minimize damage and disruption of service during flood events. Flooding could have a temporary impact on the sanitary collection system. Gravity sewers within flooded areas would likely surcharge, and grinder pumps within low pressure collection areas would be impacted by power outages. These operational impacts should be short-term, unless a storm event caused structural damage to roadways.
- *Performance during sea level rise and climate change conditions:* The system would be designed to withstand the forecasted sea level rise. As noted above, because the AWTF would be located at an elevation of 60 feet above MSL, it should be protected from sea level rise projected for 2100 (**Figure 2-1**). On-site grinder pumps would be located on or near the right-of-way for each parcel. Each grinder pump would be sealed in a watertight pit so it could be submerged. All electrical and vent pipes associated with the grinder pumps would be installed at a height higher than the base flood elevation (100-year storm elevation plus 5 feet, Hurricane Sandy inundation plus 4 feet, or 500-year storm elevation, whichever is the most restrictive).



Source: CDM Smith, 2014

Figure 3-3. Modeled Total Nitrogen Concentrations in Shallow Groundwater after Implementing Action Alternative B with MBR for the Phase I/II and III Areas

- *Acquisition of land:* Public land would be used for the AWTF and the eight pump stations. The area under consideration for the AWTF comprises approximately 30.7 acres of non-contiguous vacant/undeveloped land southwest of the Brookhaven Calabro Airport. Based on preliminary engineering of an AWTF with MBR treatment, the facility for treating Phase I/II wastewater volumes could be accommodated in the western parcel (13.7 acres), which would include buildings, road access, and leaching pools. Each of the proposed eight pump station sites throughout the Phase I/II area would occupy approximately 2,500 square feet (for a total of approximately 0.5 acre). Thus, the total area of land that would need to be acquired for centralized wastewater treatment of the Phase I/II area under Action Alternative B would be approximately 14.2 acres. The primary advantage of the SBR process is that multiple treatment processes take place in a single tank. AWTFs with SBR have a larger footprint compared to MBR facilities (USEPA, 2007a), but the overall footprint is estimated to be less than 1 percent larger than the footprint for an AWTF with MBR treatment; thus, the SBR treatment option would be expected to fit in the 13.7-acre parcel for the AWTF.
- *Costs:* Total estimated capital cost to establish the sewer district would be $188 million (**Table 3-2**). This includes $177 million for construction/engineering costs for the collection, conveyance, and treatment system and $11 million for grinder stations, abandonment of existing systems, and connection to the new system. The unit cost for a residential grinder pump station would be $4,500; the unit cost for a commercial grinder pump station would be $9,000. Costs for abandoning existing septic systems and connecting to the new conveyance system would be $2,500 for residential properties connecting to gravity sewers, $6,000 for residential properties connecting to low pressure sewers, and $9,000 for a commercial property connecting to the central system (CDM Smith, 2015). The total estimated construction costs for a centralized wastewater treatment system with SBR technology are estimated to be only approximately 1.5 percent lower than a system with MBR technology (i.e., $185 million).

  O&M include utility and chemical costs and staff salaries. Based on other sewer district operations, the annual cost would be approximately $1.71 per gallon per day (gpd). Annual costs incurred by residential properties would range from $385 for a single-family residence to $1,200 for a three-family residence. Annual costs for commercial properties would range from $2,000 to $11,000 depending on the type of retail facility. Properties serviced by low pressure sewers would have to pay for O&M of grinder pump stations that would range from an annual cost of $275 for residential properties to $1,700 for commercial properties (CDM Smith, 2015). For the entire Phase I/II area, estimated annual O&M would require $1.1 million (**Table 3-2**). The SBR process is operationally less intensive than the MBR process, but the SBR treatment process would include the same associated system costs for staff salaries, electricity, chemicals, and sludge disposal. Therefore, it is reasonable to assume that the margin of difference would be comparatively small with respect to total O&M costs.

3.2.3 Screening Results – Phase III Area

Applying the screening criteria to Action Alternative B yields the following for the Phase III area:

- *Treatment performance:* If the MBR treatment option is selected, the nitrogen load from the Phase III area would be reduced from about 78 lbs/day to 22 lbs/day (based on an

effluent concentration of 5 mg/L and extrapolating data from CDM Smith, 2014). Total nitrogen concentrations in the groundwater would decrease from the current concentration of 6 mg/L or more in over two thirds of the Phase III area (**Figure 1-5**) to below the target of 6 mg/L in nearly the entire area (**Figure 3-3**). If the SBR treatment option is selected, a lower nitrogen load would be discharged to the groundwater compared to existing conditions.

- *Performance during flood events:* Performance during flood events would be limited to a short-term temporary impact on the sanitary collection system, similar to the Phase I/II area.
- *Performance during sea level rise and climate change conditions:* Impacts are generally not expected, similar to the Phase I/II area. Service could be disrupted in areas served by low pressure sewers if there was a loss of power.
- *Acquisition of land:* The land needed for leaching the additional effluent volume of 0.4 MGD could be accommodated within the 17-acre expansion area for the AWTF, roughly estimated to require 20 percent of that additional land. In addition, land would be required for two pumping stations in the Phase III area.
- *Costs:* CDM Smith (2013) estimated costs for Phase III as $106 million (including costs for abandoning existing septic systems and connecting to the new conveyance system). Constructing the sewer network and pump stations in the Phase III area and expanding the AWTF to accommodate the additional wastewater would cost approximately the same regardless of selection of either the MBR or SBR process. Annual O&M for the entire Phase III area are estimated to be $600,000.

3.3 Action Alterative C: Centralized Treatment – Different Wastewater Treatment Technology

Action Alternative C would employ a different suspended growth type activated sludge process for nitrogen removal at a potentially lower cost. The MLE process was considered.

3.3.1 Technical Aspects

The Modified Ludzack-Ettinger (MLE) process would treat the same volume of sanitary wastewater but may result in higher total effluent nitrogen concentrations. The MLE process is a suspended growth type activated sludge treatment process used for nitrogen removal. This process requires an oxygen-deficient pre-anoxic zone for denitrification followed by an oxygen-rich aeration zone for nitrification and a secondary clarifier for sludge removal. Flow into the pre-anoxic zone comprises screened treatment plant influent and recycled process flow from the downstream aeration zone and secondary clarifier (CDM Smith, 2014). According to CDM Smith (2013), the primary advantage of this equipment is the operational energy savings realized over time.

3.3.2 Screening Results – Phase I/II Area

Applying the screening criteria to Action Alternative C yields the following for the Phase I/II area:

- *Treatment performance:* The MLE process would treat the same volume of sanitary wastewater as described under Action Alternative B, but would result in higher total nitrogen concentrations in the effluent: 10 mg/L (CDM Smith, 2014). Using mean values

for the MLE process, this implies that the total nitrogen loads discharged to the groundwater would be 100–233 percent higher for the MLE process compared to the MBR or SBR processes. Specifically, the total nitrogen load discharged to the groundwater would be 72 lbs/day for the MLE process, compared to the 22 to 36 lbs/day for the MBR process or 29 to 43 lbs/day for the SBR process (based on data extrapolated from CDM Smith [2014]). Model data for the resulting total nitrogen concentration in groundwater do not exist. However, considering the modeling results for the MBR process (**Figure 3-3**, which is based on a total nitrogen concentration in the effluent of 5 mg/L), the portion of Phase I/II area that would achieve the target of 6 mg/L nitrogen in the groundwater with an MLE process would be smaller. In summary, the MLE process does not perform as well as the MBR or SBR processes.

- *Performance during flood events:* Performance during flood events would be the same as described for Action Alternative B.
- *Performance during sea level rise and climate change conditions:* Performance during sea level rise and climate change conditions would be the same as described for Action Alternative B.
- *Acquisition of land:* The footprint for an MLE facility would be larger than for both MBR and SBR facilities, given that secondary clarification would be required, and the fact that an MLE process typically operates at lower mixed liquor suspended solids concentrations than an MBR process, necessitating the use of larger tanks. The increase in additional footprint is limited only to the area specific to secondary treatment. The areas required for site access, preliminary treatment, administration, and subsurface disposal remain constant for all three technologies. The basis of design for the subsurface leaching area is the hydraulic capacity of the treatment facility and infiltration capacity of the soils. Overall, the footprint for Action Alternative C is estimated to be less than 1 percent larger than the footprint for Action Alternative B; thus, Action Alternative C would be expected to fit in the 13.7-acre parcel for the AWTF.
- *Costs:* USEPA (2007b) compared costs for small new biological nutrient removal treatment facilities that treated up to 100,000 gpd. The construction cost of an MLE facility was $1.16 million. Based on cost information provided in USEPA (2007a), MLE facility costs would be up to approximately 25 percent lower than MBR or SBR facility costs. Considering the different components of these facilities (tanks, building, electrical, plumbing, piping, valves, instrumentation and controls, subsurface disposal pools), the total costs for a centralized system with MLE technology are estimated to be only approximately up to 2.5 percent lower than for an MBR or SBR technology (i.e., $183 million) (**Table 3-2**).

  With regard to O&M costs, all three wastewater treatment processes include the same associated system costs for staff salaries, electricity, chemicals, and sludge disposal. Therefore, it is reasonable to assume that the margin of difference would be comparatively small with respect to total O&M costs for any centralized treatment alternative (**Table 3-2**).

3.3.3 Screening Results – Phase III Area

Applying the screening criteria to Action Alternative C yields the following for the Phase III area:

- *Treatment performance:* As for the Phase I/II area, an MLE facility would lower the nitrogen load discharged to the groundwater compared to existing conditions. However, an MLE facility is not as effective as MBR or SBR facilities in removing nitrogen from wastewater prior to discharge to the groundwater.
- *Performance during flood events:* Performance during flood events would be the same as described for Action Alternative B.
- *Performance during sea level rise and climate change conditions:* Performance during sea level rise and climate change conditions would be the same as described for Action Alternative B.
- *Acquisition of land:* Acquisition of land would be the same as described for Action Alternative B.
- *Costs:* Costs for construction would be up to 2.5lower for an MLE compared to an MBR or SBR facility, using the approach described under Phase I/II above. Although the technologies are somewhat less expensive to install, constructing the sewer network and pump stations in the Phase III area and expanding the AWTF to accommodate the additional wastewater would cost approximately the same as under Action Alternative B. O&M costs would also be in the same range as those described for Action Alternative B.

3.4 Action Alterative D: Centralized Treatment – Different Collection System Infrastructure

Rather than the combination of gravity and low pressure sewers considered for Action Alternative B, this alternative would construct another type of collection system infrastructure throughout the same project area, which would consist of a combination of gravity and vacuum sewers. Action Alternative D would service the same number of parcels as Action Alternative B.

3.4.1 Technical Aspects

Vacuum sewers are another type of collection system that may be used in areas where gravity sewers are not an option. As such, they can be considered an alternative to the low pressure sewers described in Action Alternative B.

Vacuum sewers were assessed by CDM Smith (2014) and subsequently dismissed due to relatively high O&M costs and a lack of local operator experience. It is acknowledged that vacuum sewers were recommended for high water table areas in the Proposed Mastic-Shirley Sewer District (Henderson and Bodwell, 1999). However, Henderson and Bodwell (1999) did not provide an explanation why vacuum sewers, rather than low pressure sewers, were considered. The findings of the study were not implemented.

Vacuum sewers rely on a pressure differential to convey wastewater from individual properties to the treatment facility. The pressure differential is created by a vacuum pump located at a centralized pump station. The pump is connected to an enclosed collection tank that is directly connected to the collection system pipes. Wastewater from individual properties first flows into an on-site storage tank. Once it reaches a particular level in the tank, a pneumatic valve opens, and the induced vacuum suction causes wastewater to flow into the collection system piping and to the

enclosed collection tank at the pump station. It is then conveyed to the treatment facility via dry pit sewage pumps and force mains (CDM Smith, 2014).

Vacuum sewers would only be considered as a potential replacement of the collection system in areas proposed for the low pressure sewers. They would not replace the gravity sewers and/or the larger pump stations. Vacuum sewers are only effective in relatively flat areas with less than 10 feet of static head. The technology has not experienced widespread use; therefore, it is generally unknown to both utility contractors and operators. The applications to date have been for generally smaller service areas in newer developments.

There are a few local vacuum sewer installations in New England (Plum Island and Provincetown, Massachusetts). The system in Plum Island has experienced significant operational issues because of frozen valve chambers and air vents (Cape Cod Times, 2009; Newburyport DPS, 2015). Vacuum sewers also are more susceptible to blockages from overloading of the system with solids and/or grease.

3.4.2 Screening Results – Phase I/II Area

Applying the screening criteria to Action Alternative D yields the following for the Phase I/II area:

- *Treatment performance:* The type of collection system would not affect the treatment performance; thus, the performance would be the same as described for Action Alternative B.
- *Performance during flood events:* Assuming proper installation, including backup power generation, the effects would be the same as described for Action Alternative B.
- *Performance during sea level rise and climate change conditions:* Performance during sea level rise and climate change would be the same as described for Action Alternative B.
- *Acquisition of land:* Similar to Action Alternative B, the combination of gravity and vacuum sewers would require open-cut excavation for the entire length of roads where the pipe installation would occur. However, the small grinder pump stations at individual properties connected to the low pressure system would be replaced with fewer, but slightly larger, centralized pump stations for every cluster of houses connected to the vacuum pump system. These pump stations would have to be located on land available for public use. Overall, the land requirement would not be significantly different to that of Action Alternative B. Compared with low pressure sewers, Action Alternative D would rely less on locating equipment on individual parcels. However, easements may be required because of the challenges in siting a number of valve chambers within a utility right-of-way.
- *Costs:* The capital cost of a vacuum system would be higher than for a low pressure system. The higher capital costs are associated with the vacuum pumps, associated piping, and system controls and the need for an enclosed collection tank (CDM Smith, 2014). Construction costs of vacuum sewers are expected to be approximately 10 to 15 percent higher than costs of low pressure sewers. However, costs for low pressure sewers in the Phase I/II area represent a relatively small percentage of the overall construction costs. Therefore, the overall capital costs for Action Alternative D are considered similar to Action Alternative B (**Table 3-2**).

  The primary disadvantage of the technology is its long-term operational costs and substantial operational challenges. Higher O&M costs would result from the vacuum

equipment necessary to operate the collection system and address grease build-up within the individual on-site storage tanks. Grease could impede the proper operation of the pneumatic valves and cause potential blockage. In addition, vacuum leaks could directly result in failure of the collection system to convey wastewater to the central vacuum station (CDM Smith, 2014). O&M costs for a centralized system with vacuum sewers are not available, although the long-term O&M costs are expected to approach a 15 to 20 percent premium for this type of technology. However, given the comparatively small portion of the Phase I/II area that would require vacuum sewers, overall O&M costs for Action Alternative D are considered similar to Action Alternative B (**Table 3-2**).

3.4.3 Screening Results – Phase III Area

The screening criteria for Action Alternative D apply for Phase III in the same way they do for Phase I/II. The only exception is O&M costs. Vacuum sewers are required for a larger portion of the Phase III area than for the Phase I/II area. Therefore, overall O&M costs for Action Alternative D for the Phase III area are roughly estimated to be 10 percent higher than for Action Alternative B (**Table 3-2**).

3.5 Action Alterative E: Centralized Treatment – Alternative Location(s) for AWTF

This alternative would use the same MBR process as described under Action Alternative B but would use an alternative site to locate the AWTF and leaching area. Several screening analyses have been performed since 1999 that investigated a sewer district for the Mastic-Shirley area. While each of these studies had differing project objectives with varying study areas, they do reflect siting criteria associated with selection of a feasible site for an AWTF. The feasibility of an AWTF location is directly related to the proximity to the area being sewered. Locating an AWTF farther from the service area increases the cost of construction, energy cost of pumping, and land disturbance. Also, availability and active site development is dynamic, causing formerly available/feasible sites to be no longer available and/or feasible. A summary of past AWTF site location screening studies is provided below.

- **Henderson and Bodwell (1999):** This site screening analysis was performed as part of a feasibility study to create the Mastic-Shirley Sewer District in connection with the redevelopment of downtown Mastic. The study investigated six sites and reached the following conclusions:

  a) *William Floyd Estate:* The site is located in Mastic Beach, south of Washington Avenue. The groundwater table was considered to be too close to the surface for leaching fields and the site is owned by the U.S. Government (National Park Service).

  b) *Golf course complex (east/south of William Floyd Parkway):* The site was considered too close to newly installed public water wells and too close to existing residential homes. (Depth to groundwater at the site is less than 12 feet, also limiting its feasibility for subsurface leaching.)

  c) *Brookhaven Calabro Airport - Site 1 (South of ballfield):* At the time, the site was the future site for a planned development (Brookhaven Trans-Tech facility).

  d) *Brookhaven Calabro Airport - Site 2 (Intersection east and south of the two runways):* This site was considered too close to a concentration of existing homes and therefore was eliminated from further consideration for a wastewater treatment plant.

e) *Brookhaven Calabro Airport - Site 3 (Moriches Middle Island Road northeast of airport):* This site was considered relatively removed from existing developments that could be affected by a treatment facility and proximate to potential future developments in the area around the airport.

f) *New York DOT (southwest corner of Sunrise Highway and Titmus Drive):* The site, located at the southwestern corner of Sunrise Highway and Titmus Drive, was considered too small (long and narrow) and too close to existing homes and therefore was eliminated from further consideration.

The Henderson and Bodwell (1999) report selected alternative (e), Moriches Middle Island Road northeast of airport (airport site 3), for locating a wastewater treatment facility. Airport site 1 (alternative c) was considered for future development at the time and therefore was excluded in that study.

- **Henderson and Bodwell (2004) and SCDPW (2009):** The 2004 study conducted an additional site screening analysis for a wastewater treatment facility. The study was prepared in support of a proposed new sewer district for the CR 80 Shirley-Mastic corridor (including an area to the west of Carmans River), the Brookhaven Calabro Airport, and a proposed retirement community development on approximately 150 acres (NPV, 2009). SCDPW's selection process (2009), directed by Suffolk County resolution 1439-2008, started with six different locations for a wastewater treatment facility. Evaluation criteria included a candidate site's vicinity to residential communities, depth to groundwater, public well locations, soil recharge capabilities, site availability, accessibility, future use of adjacent properties, ability to accommodate expansion, and topography. After evaluating the initial list of six sites, three sites were assessed further:
    - *AVR Site*: This site was located near the Long Island Expressway and was primarily dismissed because of the distance (4 miles) from the master pump station. The long distance would require a long force main and result in higher construction costs and higher energy operating costs.
    - *Miles Development:* This site was located to the north of Sunrise Highway and west of Weeks Avenue. It was dismissed because of on-going development and proximity to new residential homes. As part of the Miles Development project, a 50-acre parcel was deeded to the town for the purposes of conservation. Parcel usage for a treatment plant would require a revision to the deed restriction. The site was dismissed because the parcel was considered too narrow (width of approximately 600 feet) for siting the disposal field and incompatible for use as a treatment plant.
    - *Brookhaven Airport, south of ballfield:* This site was recommended because of its proximity to the master pump station. It would be the least expensive to operate, but would be far enough from homeowners that it would not be a potential nuisance.
- **CDM Smith (2014):** After the initial evaluation, two potential locations for a wastewater treatment facility were considered more closely: an area at the Brookhaven Calabro Airport and an area on the "Links at Shirley Golf Course." The resolution from 2009 was used as a basis of the selection process. However, because the study area and design flow in the 2014 feasibility study had progressed since the 1999 study, sites too remote from the

treatment location were eliminated from further consideration. Characteristics of the sites that were advanced in the 2014 study for further consideration are as follows:

- *Links at Shirley Golf Course:* The golf course site is located in the southern part of Shirley to the east of the William Floyd Parkway. The site was eventually eliminated as an alternative because of much higher costs associated with constructing a force main from the master pump station. At the end of 2009, the Links at Shirley Golf Course was sold for private residential development. After the property was rezoned and subdivided, the developer dedicated 98 acres of the property as open space to the Town of Brookhaven for active recreational purposes (CDM Smith, 2014). Furthermore, the site has a comparatively shallow depth of only 12 feet to groundwater, which limits its treatment potential (**Figure 1-4**). In addition, the site is located outside of the Forge River watershed; groundwater would flow either to Great South Bay in the south and/or to Carmans River in the west (through the Wertheim National Wildlife Refuge).
- *Brookhaven Airport, south of ballfield:* Unlike the golf course site discussed above, the airport site is located close to the master pump station and would require a relatively short force main, resulting in lower construction costs. Furthermore, the area available at the site was determined to provide adequate space to accommodate wastewater from the Phase I to IV areas, including space for the treatment plant tanks and equipment, subsurface leaching pools, and buffers between adjacent properties as required by SCDPW and SCDHS. The airport site is located at approximately 60 feet above MSL, which is located outside of the future flood zone projected for the Mastic-Shirley area. The depth to groundwater at the site is between 30 and 40 feet (**Figure 1-4**).

In summary, several sites previously screened in various studies were deemed not feasible because of significant concerns related to site size, depth to groundwater, proximity to homes, availability, and distance to public drinking wells. Two other screened sites could be feasible, but are located at a considerable distance from the current project area, which is now focused much farther to the south without any other contributing areas in the north. These two sites are the AVR site, located approximately 4 miles to the north of the current project area, and the Moriches Middle Island Road site, located approximately 2 miles to the north of the current project area. The remaining site, located at the southern end of the Brookhaven Calabro Airport, south of ballfield, is located close to the current project area (less than 0.5 mile) and is considered the only feasible site for the treatment plant.

4.0 SUMMARY AND RECOMMENDATIONS

The primary purpose of the project is to mitigate short-term, repetitive, adverse impacts on human life and property associated with OSWS failures caused by natural hazards. The secondary purpose is to mitigate long-term, adverse impacts associated with such failures on surface waters and coastal wetlands that reduce the ability of these waters and wetlands to provide natural protection against storm surge. Following is summary of the evaluation for each alternative:

- *Action Alternative A (Replacing existing OSWS with Innovative/Alternative [I/A] OSWS):* This alternative generally would not mitigate short-term, repetitive, adverse impacts on human life and property associated with OSWS failures caused by natural hazards such as rising groundwater levels and overland flooding that result from precipitation and/or tidal and surge conditions (i.e., the alternative generally would not meet the primary purpose of the project). A rising sea level would further reduce the performance of I/A OSWS and increase the human health risk because more OSWS would leak during flood events. However, newer systems assessed during the County's ongoing demonstration project may include I/A OSWS set up above ground with less risk of flooding. Action Alternative A would achieve an effluent quality of at least 19 mg/L for total nitrogen, which would be an improvement from existing conditions (conventional OSWS achieve only about 40 mg/L). The target of a nitrogen concentration in the groundwater of 6 mg/L would be achieved in parts of the project area, and the nitrogen loading of Forge River would be substantially reduced (improved) from current conditions. Therefore, this alternative would meet the secondary purpose of the project, but not to the same extent as other action alternatives discussed below. In addition, the nitrogen reduction performance of these systems would be affected by flood events and sea level rise. I/A OSWS can operate effectively with reduced separation to groundwater, but the system still requires an unsaturated zone of soil to hydraulically function. A flood event would increase the elevation of the groundwater table and could cause flowing floodwaters, both of which would impact the functionality of OSWS. Compared to a centralized treatment system, construction costs would be substantially lower than the costs for a centralized system (less than half), while O&M costs would be in the same range. Therefore, Action Alternative A is recommended for further analysis in the draft EA/EIS, although this alternative does not achieve the same level of nitrogen reduction as centralized treatment system alternatives. The analysis shall be based on the latest available I/A OSWS technology, which may also meet part of the primary purpose of the project.
- *Action Alternative B (Low pressure and gravity sewer collection system with membrane bioreactor [MBR] or sequencing batch reactor [SBR] facility):* This alternative would mitigate short-term, repetitive, adverse impacts on human life and property associated with OSWS failures caused by natural hazards such as rising groundwater levels and overland flooding that result from precipitation and/or tidal and surge conditions (i.e., the alternative would meet the primary purpose of the project). Potential impacts on human health as a result of surcharged failed leaching fields would largely be eliminated with a centralized treatment facility. Rising sea levels would not reduce the performance of the AWTF because the proposed location of the AWTF is at a sufficiently high surface elevation, and National Oceanic and Atmospheric Administration (NOAA) sea level rise projections (NOAA, 2016) do not indicate inundation of the site. The facility would be protected from

stormwater flooding by appropriate site drainage systems. Under rising sea levels, this alternative would therefore continue to eliminate the existing human health risk as a result of OSWS that leak during flood events. This alternative would provide the highest level of nitrogen removal from the effluent, expected to result in groundwater nitrogen concentrations below the target of 6 mg/L throughout large portions of the project area (i.e., the alternative would also meet the secondary purpose of the project). Construction costs for any centralized facility would be substantially higher than for I/A OSWS (Action Alternative A), but O&M costs would be similar. Action Alternative B is recommended for further analysis in the draft EA/EIS.

- *Action Alternative C (Different wastewater treatment technology):* The modified Ludzack-Ettinger (MLE) is a different form of treatment process. Other than the treatment technology and cost, Action Alternative C is identical to Action Alternative B. Action Alternative C performs the same as Alternative B in terms of mitigating human health and property impacts and the effects of sea level rise. Thus, Action Alternative C would meet the primary purpose of the project. However, under this alternative, the nitrogen concentration in the effluent would be 100–233 percent higher than for the MBR or SBR processes. Thus, the alternative would not meet the secondary purpose of the project to the same extent as Action Alternative B. Total construction costs for a centralized system with MLE processes would be slightly lower (less than 3 percent) than for a system with the MBR or SBR process (Action Alternative B). In summary, Action Alternative C would result in lower benefits at similar costs compared to Action Alternative B. Therefore, Action Alternative C is not recommended for further analysis in the draft EA/EIS.
- *Action Alternative D (Different collection system infrastructure):* This action alternative is similar to Action Alternative B and would perform the same as Action Alternative B in terms of mitigating human health, property impacts, the effects of sea level rise, and effluent quality. Thus, the alternative would meet the primary and secondary purposes of the project similar to Action Alternative B. However, vacuum sewers can be operationally challenging to maintain and prone to vacuum leaks or blockage from grease build-up; these challenges could occasionally affect the secondary purpose of the project. O&M costs for this alternative would be slightly higher than for the combination of gravity and low pressure sewers under Action Alternative B. While Action Alternative D would generally meet the purpose and need to a similar extent as Action Alternative B, the alternative would not result in greater benefits and would result in less reliable operations at slightly greater cost. Therefore, Action Alternative D is not recommended for further analysis in the draft EA/EIS.
- *Action Alternative E (Alternative location[s] for AWTF):* Nine different sites were identified and evaluated for a wastewater treatment facility as part of various feasibility studies between 1999 and 2014. Review of the studies indicated that the Brookhaven Calabro Airport site is the only feasible location for the AWTF. This site is part of Action Alternatives A to D. The site is close to the project area, thereby enabling efficient connectivity to the sewer network. The site acreage is adequate to accommodate the treatment facility and associated treatment area for all four phases of the sewer network. The site's depth to the groundwater table of 30 to 40 feet provides the necessary distance for feasible operation of the AWTF. Other sites considered during the various feasibility studies were screened out because they either had insufficient depths to the groundwater

table, were located too close to residential neighborhoods, had unsuitable site dimensions, or were located too far from the area to be sewered.

In summary, Action Alternative A (replacing existing OSWS with I/A OSWS) and Action Alternative B (low pressure and gravity sewer collection system with MBR or SBR facility) are recommended as the appropriate alternatives for analysis in the draft EA/EIS.

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ATTACHMENT 1: ALTERNATIVES SCREENING MATRIX

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Forge River Watershed Sewer Project: Alternatives Screening Matrix for Phases I to III Areas

Screening Criteria	Action Alternative A: Replacing Existing OSWS with I/A OSWS	Action Alternative B: Low Pressure and Gravity Sewer Collection System with (a) MBR Facility	Action Alternative B: Low Pressure and Gravity Sewer Collection System with (b) SBR Facility	Action Alternative C: Different Wastewater Treatment Technology: Ludzack-Ettinger (MLE) Process	Action Alternative D: Different Collection System Infrastructure: Vacuum Sewers in same Project Area [1]
Report Section	4.2	4.3	4.4	4.4	4.5
Treatment performance	Effluent TN of at least 19 mg/L using I/A OSWS. Groundwater TN concentration target of 6 mg/L expected to be met in parts of the project area.	Effluent TN of 3-5 mg/L (limit of technology). Groundwater TN concentration target of 6 mg/L met in almost entire project area.	Effluent TN of 3-5 mg/L (limit of technology). Goundwater TN concentration target of 6 mg/L met in almost entire project area.	Effluent TN of 10 mg/L. Groundwater TN concentration target of 6 mg/L expected to be met in parts of the project area.	Effluent TN of 3-5 mg/L (limit of technology). Groundwater TN concentration target of 6 mg/L met in almost entire project area.
Performance during flood events	IA OSWS would hydraulically fail in flooded areas due to elevated water table. Risks to human health remain.	AWTF located above flood zone. Pump stations designed to withstand floods. Risks to human health could occur during events with power failure.	AWTF located above flood zone. Pump stations designed to withstand floods. Risks to human health could occur during events with power failure.	AWTF located above flood zone. Pump stations designed to withstand floods. Risks to human health could occur during events with power failure.	AWTF located above flood zone. Pump stations designed to withstand floods. Risks to human health could occur during events with power failure.
Performance under projected sea level rise and climate change conditions	Increased rate of failure as separation to water table decreases with rising sea levels.	Treatment system and AWTF can be designed to operate under projected sea level rise.	Treatment system and AWTF can be designed to operate under projected sea level rise.	Treatment system and AWTF can be designed to operate under projected sea level rise.	Treatment system and AWTF can be designed to operate under projected sea level rise.
Acquisition of land	None needed. Installation limited to individual parcels.	Public land for AWTF and pump stations. Some parcels require grinder pumps.	Public land for AWTF and pump stations. Slightly (<5%) more space needed due to larger AWTF. Some parcels require grinder pumps.	Public land for AWTF and pump stations. Slightly (<5%) more space needed due to larger AWTF. Some parcels require grinder pumps.	Those parcels in the project area serviced by vacuum sewers require storage tanks. Also, potentially more space would be needed for pump stations.
Costs *(Phases I-III) (order-of-magnitude estimates)* a. Capital costs	I/A OSWS cost for project area: $111 million	Total costs for system: $294 million	Total costs for system: $289 million	Total costs for system: $286 million	Total costs for system: $294 million
Costs *(Phases I-III) (order-of-magnitude estimates)* b. O&M costs	$0.8 - $2.2 million/yr (based on $200 to $500/yr per system)	$1.7 million/yr	Expected to be similar to MBR system ($1.7 million/yr)	Expected to be similar to MBR system ($1.7 million/yr)	$1.76 million/yr; higher costs due to operational challenges of vacuum systems.

[1] Other components of the system are the same as under Action Alternative B.

Note: Action Alternative E (Alternative Location[s] for AWTF) is not included in this matrix because the only feasible site is the Brookhaven Calabro airport site which is included in Action Alternatives B to D.

Key:

	1 - Meets screening criterion best
	2
	3
	4 - Meets screening criterion least

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ATTACHMENT 2: CONSIDERATIONS FOR WASTEWATER TREATMENT FOR PHASE IV

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Attachment 2:

CONSIDERATIONS FOR WASTEWATER TREATMENT FOR PHASE IV

In consideration of the extensive damage caused by Hurricane Sandy in the Village of Mastic Beach and at Smith Point in the Hamlet of Shirley, and stakeholder input received during the New York Rising Community Reconstruction planning process, the project area (i.e., Phases I, II and III) was considered for expansion in March 2014. Specifically, the expanded area (referred to as Phase IV) would include the densely developed residential area south of Neighborhood Road from the Carmans River on the west, and the area south and east of Commack and Mastic Roads to Great South Bay on the south (see **Figure 1-1** for the location of the Phase IV area). The draft Environmental Assessment and Environmental Impact Statement (EA/EIS) provides a detailed analysis of Phases I, II and III identified in the Draft Mastic-Shirley Feasibility Study (CDM Smith, 2013[1]) and utilizes the considerable amount of information developed for those phases. Phase IV has not yet been analyzed to a similar level of detail and definition of Phase IV has not yet advanced to a degree that a detailed analysis can be conducted. In consideration of this, Phase IV is considered only in the cumulative impact analysis of the draft EA/EIS. If warranted, a separate environmental review may be conducted in the future when the specifics of Phase IV would become defined in greater detail.

Following is a summary of baseline information and aspects associated with the Phase IV area as relevant for future wastewater treatment in this area.

- *Area description:* The Phase IV area covers approximately 1,900 acres and contains approximately 6,000 parcels (CDM Smith, 2014). Greater than 60 percent of the Phase IV area is residential and greater than 35 percent of the area is currently recreation, open space or vacant. Only 1 percent of the area land use is commercial.
- *Watershed:* The Phase IV area is located mostly in the watershed of Narrow Bay to the south of Mastic Beach and Bellport Bay to the west. Both bays are hydrologically connected and part of Great South Bay. Only the northeastern corner of the Phase IV area is part of the Forge River watershed.
- *Flooding:* Topographic elevations of much of the Phase IV area are less than 20 feet above sea level; elevations in the southern portion of the Phase IV area are less than 10 feet. As a result, the area has a high risk of inundation from coastal surges. Figure 1-3 shows that the southern portion of the Phase IV area would be flooded during a high-risk event (i.e., major coastal storm or hurricane).
- *Depth to groundwater:* Due to the low topographic elevations of the area and proximity to the bay, depths to groundwater are less than 9 feet in a large portion of the Phase IV area (see **Figure 1-4**).
- *Sea level rise:* Rising sea levels of 3 or 4 feet by year 2100 would result in a loss of approximately the southern one third of the Phase 4 area (see **Figure 3-1**).

[1] References listed in Attachment 1 are included in Section 5 (References) of the main report.

- *Wetlands:* The Phase IV area has a broad band of coastal wetlands bordering Narrow Bay, including New York State Department of Environmental Conservation and National Wetlands Inventory wetlands.

A number of issues should be considered in a future assessment for wastewater treatment of the Phase IV area. It is important to note that the list is based on an initial assessment.

- *Engineering analysis:* Although the Phase IV area was included in the *Feasibility Study Map and Plan for Mastic Shirley* by CDM Smith (2014), the primary focus of the feasibility study were the Phases I - III areas. For example, modeled information on the total nitrogen concentrations in the groundwater after implementing wastewater treatment are available for the Phases I - III areas, but not for the Phase IV area. The subsequent "*Forge River Nitrogen Reduction Report"* by CDM Smith (2015) focused on the Phase I/II area only.

- *Environmental baseline information:* The watershed management plan by Cameron Engineering (2012) entitled *Forge River Watershed Management Plan* provides extensive background information on the natural and socioeconomic environment that is relevant as a background document for the draft EA/EIS for Phases I - III. A similar assessment has not been performed for the Phase IV area.

- *Watershed discharge*: Groundwater in the Phase IV area discharges to Narrow Bay. Should wastewater be collected from the approximately 6,000 parcels within the Phase IV area and treated at the Advanced Wastewater Treatment Facility (AWTF) proposed to be sited at the Brookhaven Calabro Airport, the treated effluent would be released into the Forge River watershed via groundwater discharge. Currently, the total nitrogen load from wastewater treatment by conventional onsite wastewater treatment systems (OSWS) entering the groundwater in the Phases I - III areas is 244 pounds/day (lbs/day) (CDM Smith, 2014). After implementing centralized wastewater treatment for the Phases I - III area, the total nitrogen load entering the groundwater would be 58 lbs/day (based on the membrane bioreactor [MBR] process, and an effluent concentration of 5 mg/L total nitrogen). If the treated wastewater effluent from the Phase IV area was added, the total nitrogen concentration in the treated effluent would be 134 lbs/day, still considerably less than the current discharge but more than doubling the load from the Phases I - III areas only. This added load would decrease the environmental benefit to Forge River achieved through a centralized treatment system for the Phases I - III areas and would be evaluated to determine if this outcome would be environmentally desirable, considering that Forge River has been identified as the "most eutrophic estuary in the county" in the *"Comprehensive Watershed Management Plan"* (Suffolk County, 2015). As noted above, a hybrid approach whereby only a portion of the Phase IV area would be connected to the AWTF and the remainder of the Phase IV area would be serviced by OSWS would reduce the contribution of the Phase IV area to the Forge River watershed. The effects of nitrogen loading from the Phase IV area on the Great South Bay (to which both Forge River and Narrow Bay connect) may vary accordingly.

- *Climate change considerations:* A large portion of the Phase IV area is at risk for inundation from flood surges. Sea level rise could permanently flood a portion of the Phase IV area. The State of New York is offering a program to purchase homes damaged by Hurricane Sandy under the premise that they will be demolished and the vacant properties then would be restored to their natural state, including wetlands. The increase of

ecologically healthy wetland systems along Narrow Bay will contribute to the reduction of flooding and erosion impacts resulting from storm surges. A wider coastal wetland zone will also improve the gradual adjustment of ecosystems in the coastal area to the effects of sea level rise. Considering these factors, and considering the high cost of implementing a centralized treatment network and other related facilities, a combination of centralized treatment and innovative/alternative (I/A) OSWS (or other alternative technologies) in selected areas might be a more cost-effective and environmentally preferable approach than centralized sewer service only.

In summary, while it is very likely that improved wastewater treatment in Phase IV would have important benefits to the water quality of Great South Bay, the specific approach to be chosen for the Phase IV area will require additional analysis and evaluation in preparation for eventual implementation.

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ATTACHMENT 3:
ALTERNATIVE ON-SITE SEWAGE DISPOSAL SYSTEMS, TASK IX - SUMMARY REPORT

Prepared for Suffolk County, New York, Department of Health Services,

Office of Wastewater Management

Prepared by H2M, February 2013

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SUFFOLK COUNTY, NEW YORK
DEPARTMENT OF HEALTH SERVICES
OFFICE OF WASTEWATER MANAGEMENT

ALTERNATIVE ON-SITE SEWAGE DISPOSAL SYSTEMS

TASK IX–SUMMARY REPORT

H2M Project No.: SCHS 09-01

Draft: August 2012

Final: February 2013

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EXECUTIVE SUMMARY

The Suffolk County Department of Health Services (SCDHS) retained the services of Holzmacher, McLendon and Murrell, P.C. (H2M) to determine the feasibility of instituting alternative on-site wastewater treatment systems into decentralized sewered communities or in single family residential properties that could better manage total nitrogen discharged to groundwater. The project objective, as stated in the County's Request for Proposal, is to investigate the performance, installation and design costs, economic benefits, and operation and maintenance requirements for alternative on-site sewage disposal systems for projects generating a flow less than 30,000 gpd. The investigation was broken down into two different treatment categories. The first category was defined as single-family residential dwellings with flows from 300 to 1,000 gallons per day (GPD); the second category was defined as other than single-family comprised of commercial, industrial, or high-density residential properties, with flows from 1,000 GPD to 30,000 GPD. For the purposes of this report, the first flow category will be referred to as residential applications, while the second flow category will be referred to as commercial applications.

The investigation was broken down into the following nine (9) tasks composed of reports and progress meetings with the Department.

- Task I, III, V, VI – Progress meetings to discuss previously submitted Task Reports
- Task II – Review of Standards, Codes, and Regulations for On-Site System Technologies
- Task IV A and B – Selection, Sampling, and Evaluation of AOSSDS
- Task IV C – System Assessment and Acceptance using SCDHS Requirements
- Task VI – Cost and Benefit Analysis
- Task VIII – Evaluations of Conditions and Restrictions Under Which AOSSDS are Permitted for use in Massachusetts, Rhode Island, New Jersey, and Maryland
- Task IX – Study Summary, Findings and Recommendations

Overall study conclusions and recommendations for the individual residential applications:

- The Nitrex™ System was the only on-site treatment system that consistently met the 10 mg/l total nitrogen discharge requirement.
- Suffolk County currently utilizes the practice of limiting the building density in order to protect both the drinking and surface water supplies in addition to conventional sanitary systems.
- At this point in time, further study and modeling are necessary to determine if additional nitrogen controls are required and to what extent. This companion study is currently in the planning stage.
- There are numerous policy concerns with the proposed use of treatment systems for individual residences. These deal not only with potential public health nuisances, but also with various

social and economic concerns that transcend the purview of Department of Environmental Quality (DEQ) – especially since the goal is generally surface water protection, rather than strictly public health and drinking water.

- Ultimately, once DEQ is able to provide facts grounded in science, issues can be fully vetted by policymakers in an informed manner to support a reasoned and systematic regional approach to treatment on individual residences, with the goal of garnering public support and implementation funding.

Overall study conclusion and recommendations for commercial projects:

- The Nitrex™ System, Aqua Point – Bioclere®, WesTech's STM-Aerotors™, and BESST technologies were added to the list of technologies that the Department would approve.
- Cromaglass, SBR, and MBR technologies are currently approvable technologies.
- For larger communal systems (i.e. commercial property or small housing clusters), the owners could propose to install an alternative system as a demonstration system providing that the project is within the sanitary density permitted under Article 6 of the Suffolk County Sanitary Code and that the proposed system is in conformance with separation distances as specified in Appendix A of the Commercial Standards.

1. Summary of Task II Report

The purpose of the Task II report was to review alternative on-site sewage disposal system (AOSSDS) technologies that could potentially be implemented in place of current on site treatment systems if approved by the Suffolk County Department of Health Services (SCDHS). The investigation was broken down into two different treatment categories as specified by SCDHS. The first category was defined as single-family residential dwellings with flows from 300 to 1,000 gallons per day (GPD); the second category was defined as other than single-family comprised of commercial, industrial, or high-density residential properties, with flows from 1,000 GPD to 30,000 GPD. For the purposes of this report, the first flow category will be referred to as residential applications, while the second flow category will be referred to as commercial applications.

Over 60 websites were used to construct a list of viable technologies capable of consistently achieving a total nitrogen (TN) effluent concentration 10 mg/L or less. The information obtained from the research was in the form of standards, regulations, codes, product brochures, operations manuals, case study reports, research papers, demonstration project studies, college reports, testing data, and technical drawings and specifications. The sources that provided relevant and valuable information for alternative on-site treatment systems were:

- New York State Department of Health
- National Sanitation Foundation (NSF) 245 Standards for nitrogen removal
- State of New Jersey Pinelands Commission
- Washington State Department of Health
- Nitrogen removal of three alternate septic systems technologies and a conventional system – Massachusetts Alternative Septic System Test Center, September 2002
- Performance of innovative alternative on-site septic systems for the removal of Nitrogen in Barnstable County, Massachusetts 1999-2007
- University of Rhode Island/State of Rhode Island
- USEPA Onsite Wastewater Treatment Systems Manual

The researched and the information gathered during Task II - Review of Standards, Codes and Regulations for On-site System Technologies was submitted to the Department for review, concluding Task II.

2. TASK III MEETING

Following the research performed in Task II, a follow-up meeting (a.k.a. Task III) between the SCDHS and H2M took place to discuss the alternate on-site sewage treatment technologies that would be evaluated in Task IV.

A database of approximately 60 alternative technologies was presented, containing information on the technology, manufacturer, type of installation, and treatment capabilities. Eighteen (18) of these technologies were then selected to be evaluated as part of Task IV, where fourteen (14) systems were recommended for use in residential applications and nine (9) systems in commercial applications. Thirteen (13) manufacturers (process vendors) are responsible for the 18 technologies. The Task IV report provides a comprehensive investigation at the selection, sampling, and evaluation of the technologies that deserve further consideration for achieving the TN discharge requirement of 10 mg/L.

3. SUMMARY OF TASK IV REPORT

The Task IV portion of the study was divided into three subtasks, A, B, and C. In Task IV A and B the evaluation, selection, and sampling of the previously selected alternative on-site treatment systems technologies was undertaken. Following Task IV A and B, an assessment of the ability of the selected alternative OSSDS to meet the design and operations criteria established by SCDHS was discussed in Task IV C.

3.1 TASK IV A – EVALUATION AND SELECTION

This portion of the study included the selection of alternative on-site treatment systems that can consistently achieve total nitrogen concentrations below 10 mg/L. Technologies were selected based on USEPA regulations for discharge to drinking water, Suffolk County requirements, New York State requirements, and the requirements for NSF 245 certification. The information provided for each system was obtained from the manufacturers for both single-family residential applications and commercial applications.

Residential

Fourteen (14) systems were selected and evaluated utilizing the following:

- List of all available models and sizes for each selected technology
- Location of installations, date of installations, and type of development
- Any available operating data for each installed system
- Capacity range of the system
- Technical drawings
- Operation and maintenance instructions.

At the conclusion of this evaluation, two (2) systems were selected for Task IV (B), BioMicrobics' MicroFAST® and Lombardo Associate's Nitrex™.

Commercial

Nine (9) commercial systems were selected and evaluated utilizing the following:

- List of all available models and sizes for each selected technology
- Location of installations, date of installations, and type of development

- Any available operating data for each installed system
- Capacity range of the system
- Technical drawings
- Operation and maintenance instructions.

At the conclusion of this evaluation, four (4) systems were selected for Task IV (B), BioMicrobics' MicroFAST®, Aqua Point's Bioclere®, WesTech's STM-Aerotor™ and Lombardo Associate's Nitrex™.

3.2 TASK IV (B) – SAMPLING

Sampling of full scale and on-line installations was then undertaken. The sites to be sampled were determined based on operating data and recommendations from the system manufacturers. The manufacturers were given every opportunity to select their best operating facilities.

These systems were sampled by Camp Dresser McKee (CDM) consulting engineers as a subconsultant to H2M. CDM has numerous offices throughout the USA. Since many of the sampling sites were scattered throughout the USA, H2M subcontracted the sampling portion to CDM. H2M's Wastewater Engineering Division coordinated the sampling for each site with the Woodbury, New York office of CDM and H2M Labs of Melville, New York. CDM's Woodbury project manager enlisted the staff performing the actual sampling. The staff performing the sampling are engineers or technicians who are trained in sampling techniques. H2M Labs shipped empty sample bottles and coolers to the CDM staff performing the actual field sampling. The collected samples were packed in ice and shipped overnight back to H2M Labs.

The parameters considered for each grab sample included TKN, TN, nitrates, nitrites, BOD, TSS, pH, and wastewater temperature. Wastewater temperature and pH were taken at the site. H2M Labs analyzed the samples for the remaining parameters. A characterization of the influent data was undertaken to assess the wastewater strength and to judge if the data was representative for expected parameters. The typical characteristics of untreated domestic wastewater are industry recognized, as described by numerous resources, and were used to categorize the strength of the sampled influent wastewater.

3.3 FIELD SAMPLING RESULTS

This section summarizes the field sampling results for the technologies chosen for further consideration in both flow categories.

3.3.1 BioMicrobics - MicroFAST® System for Residential Applications

The MicroFAST® sites sampled were chosen from the list provided by Bio-Microbics of current and operational installations. The two (2) sites selected are single-family residential dwellings located in Eastham, MA capable of handling a daily average flow of 440 gpd. Both these systems were designed based on the following typical residential strength influent wastewater characteristics and effluent regulations set in Massachusetts:

Constituents	Influent	Effluent
BOD (mg/L)	250	30
TSS (mg/L)	250	30
TN (mg/L)	60	19

A summary of the sampling results is shown in Table 1. The classification of the influent characteristics from the wastewater of both residences is very weak wastewater, meaning that the BOD/TSS/TN ratio is below 110/120/20 mg/L. The waste therefore, does not have the required nutrients to maintain a healthy population of microorganism. From the results presented the system is not able to nitrify or denitrify the wastewater in an efficient manner. However, the effluent TN concentrations of the four (4) sampling days met the design requirement of 19 mg/L effluent limit set in Massachusetts for residential dwellings. The design of the MicroFAST® technology is pre-engineered specific to the effluent design requirements and application of the system.

Table 1. Field Sampling Results for the MicroFAST® System

	Site	Sampling	Influent Concentration (mg/L)				Effluent Concentrations (mg/L)			
		Date	Alkalinity	CBOD	TSS	TKN	Nitrate-Nitrite	Ammonia	TKN	TN
1.	Campground Rd Eastham, MA	10/31/2011	111	17	38	15.6	13.4	0.14	0.17	13.6
		11/03/2011	130	46	60	20.3	14.0	0.17	0.85	14.8
2.	Bayview Rd Eastham, MA	10/31/2011	96	17	10	1.81	3.19	0.10	1.78	5.0
		11/03/2011	94	20	13	0.76	2.17	0.10	1.16	3.3

A schematic of a typical MicroFAST® residential installation is shown in Figure 1. As part of a residential installation in Suffolk County, a conventional septic tank will be required prior to the two-compartment septic tank that the MicroFAST® insert is placed.

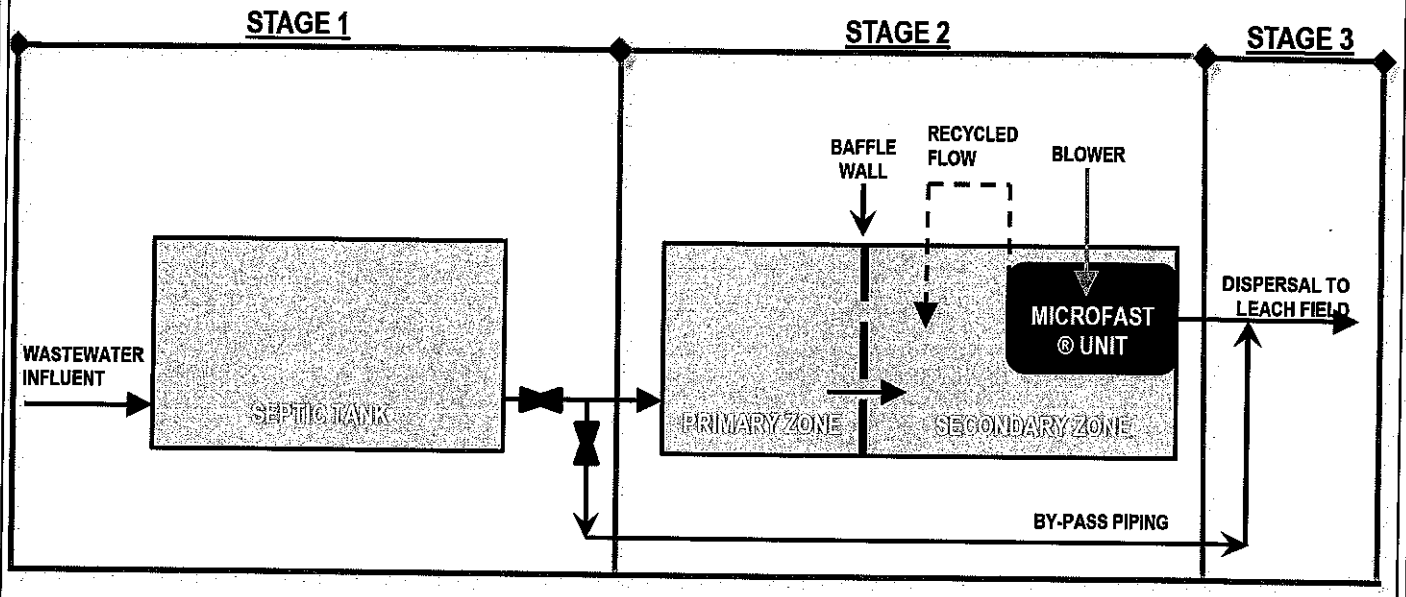

Figure 1 – Typical MicroFAST® Residential Installation Schematic in Suffolk County

3.3.2 Lombardo Associates – Nitrex™ System in Residential Applications

The two (2) Nitrex™ selected sites were single-family residences located in Harvard, MA and Leonard, MD using the Waterloo Biofilter® and the Advantex® nitrifying processes, respectively. The following raw and septic effluent wastewater characteristics were used for the design of the system:

Constituents	Raw Wastewater Influent	Septic Effluent
BOD (mg/L)	250	150
TSS (mg/L)	210	90
TN (mg/L)	70	70

A summary of the sampling results are shown in Table 2. All four samples obtained an effluent total nitrogen concentration below the required limit of 10 mg/L.

Table 2. Field Sampling Results for the NitrexTM System

	Site Location	System Setup	Sampling Date	Influent Concentration (mg/L)		Effluent Concentration (mg/L)			
				Alkalinity	TKN	Nitrate-Nitrite	Ammonia	TKN	TN
1.	Harvard, MA	Waterloo Biofilter® + Nitrex™ Filter	9/19/2011	492	118	0.81	0.17	1.34	2.15
			9/22/2011	540	102	0.10	0.36	1.40	1.40
2.	Leonard, MD	Advantex® + Nitrex™ Filter	9/22/2011	223	15	0.10	0.76	2.25	2.30
			9/29/2011	308	48	0.10	0.75	3.68	3.68

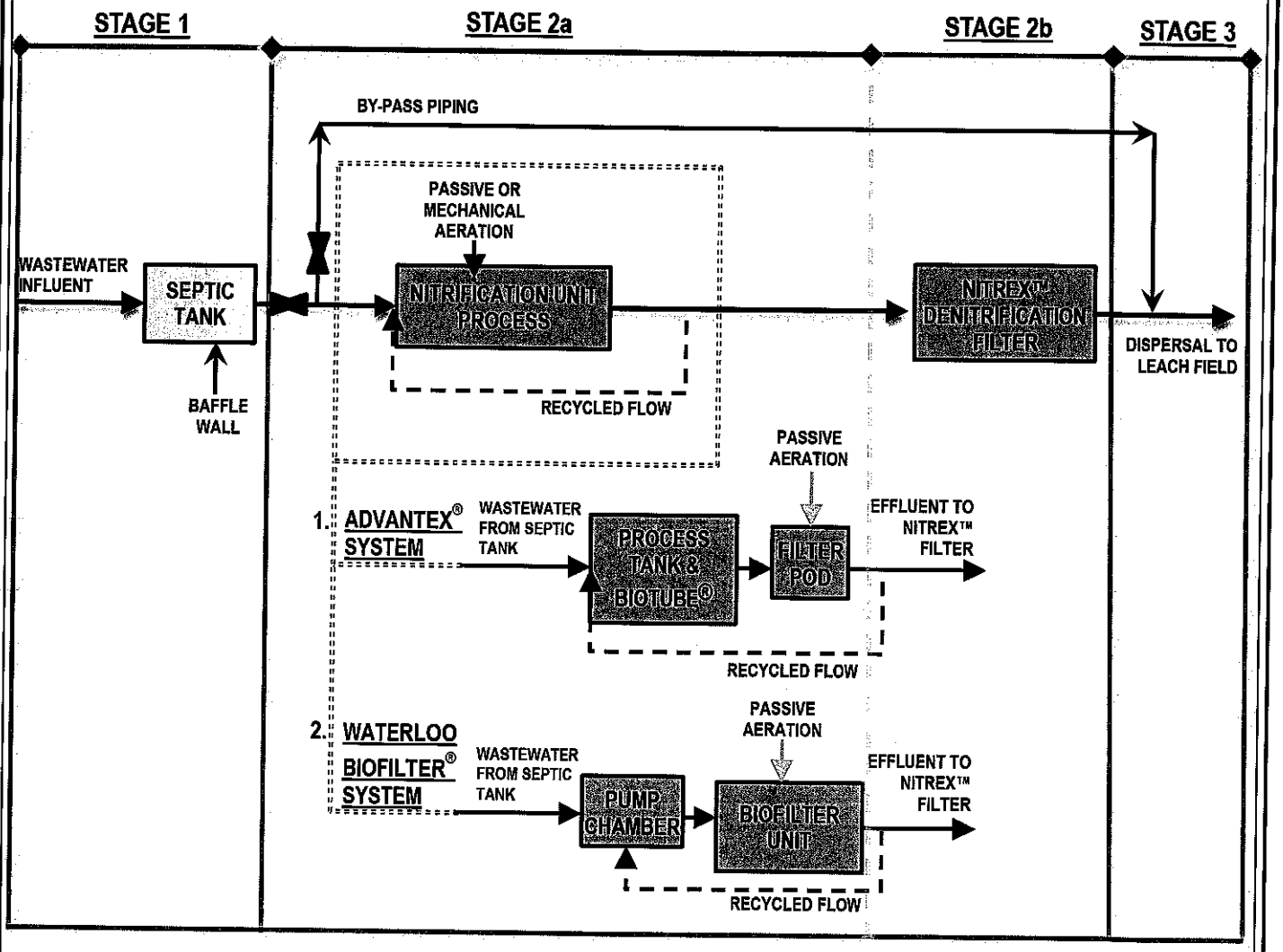

Figure 2 – Typical Nitrex™ System Residential Installation Schematic in Suffolk County

As shown in Figure 2 schematic, the Nitrex™ Denitrification Filter (Stage 2b) must be used as part of an integrated two (2) part system, referred to as the Nitrex™ system. The two (2) nitrifying systems (Stage 2a) that have proven to treat wastewater to total nitrogen levels below the discharge limit of 10 mg/L in residential installations are the Orenco Systems' Advantex® system and Waterloo Biofilter, Inc.'s Waterloo Biofilter® system. A residential installation shall include a conventional septic tank, the nitrifying system approved by SCDHS, the Nitrex™ Denitrification Filter tank, and a leaching field.

3.3.3 Aqua Point – Bioclere® System for Commercial Applications

The two selected Bioclere® sites sampled were the Patriots Square Shopping Center in Dennis, MA and the Wise Living Housing Community in Orleans, MA. Both these systems were designed based on the following influent and effluent wastewater characteristics:

	Patriot Square Center		Wise Living Housing	
Constituents	**Influent**	**Effluent**	**Influent**	**Effluent**
BOD (mg/L)	600	30	250	30
TSS (mg/L)	250	30	250	30
TN (mg/L)	75	10	45	10

The influent and effluent results from the two days of field sampling are shown in Table 3. Both systems had total nitrogen effluent concentrations below the required limit of 10 mg/L, with the exception of the first sample obtained from the Patriots Square Shopping Center. This is possibly due to the weak influent wastewater concentration entering the system, affecting the nitrification and denitrification process. The lab results of the remaining samples show the ability of the Bioclere® system to treat wastewater to the desired concentrations.

Table 3. Field Sampling Results for the Commercial Bioclere® System

	Site Location	Sampling Date	Influent Concentration (mg/L)				Effluent Concentration (mg/L)			
			Alkalinity	CBOD	TSS	TKN	Nitrite	Ammonia	TKN	TN
1.	Patriots Square Shopping Center, Dennis, MA	10/312011	316	51	94	56	3.58	0.73	7.36	10.90
		11/03/2011	342	133	120	64	0.12	0.10	6.28	6.40
2.	Wise Living Housing Community, Orleans, MA	10/31/2011	173	98	1300	24	0.14	0.17	8.43	8.57
		11/03/2011	173	133	600	29	1.40	0.99	6.38	7.78

The Bioclere® system used in commercial applications has proven to treat wastewater to the required design effluent requirements. The submitted performance data and the lab results from the field sampling show the capability of this system in reducing total nitrogen concentration to 10 mg/L or less. H2M recommends this process be considered as an alternate on-site wastewater treatment system to be implemented in Suffolk County in commercial applications to treat flows between 1,000 to 30,000 gpd.

A typical Bioclere® commercial installation in Suffolk County would comprise of the process components shown in Figure 3. The duplicity of the tanks will be based on the design characteristics. Stage 1 shall include a septic tank followed by a pre-equalization tank. If alkalinity adjustments are required, then the feed system will pump the chemical to this stage. In the Stage 2 portion, the pre-equalization effluent will be pumped to a Bioclere® unit. Pumps within the unit will recycle and pump the effluent to the next Bioclere® unit in the treatment train. The treated wastewater from each Bioclere® unit accumulates in the anoxic tank where it will then be pumped to an anoxic Membrane Bed Biological

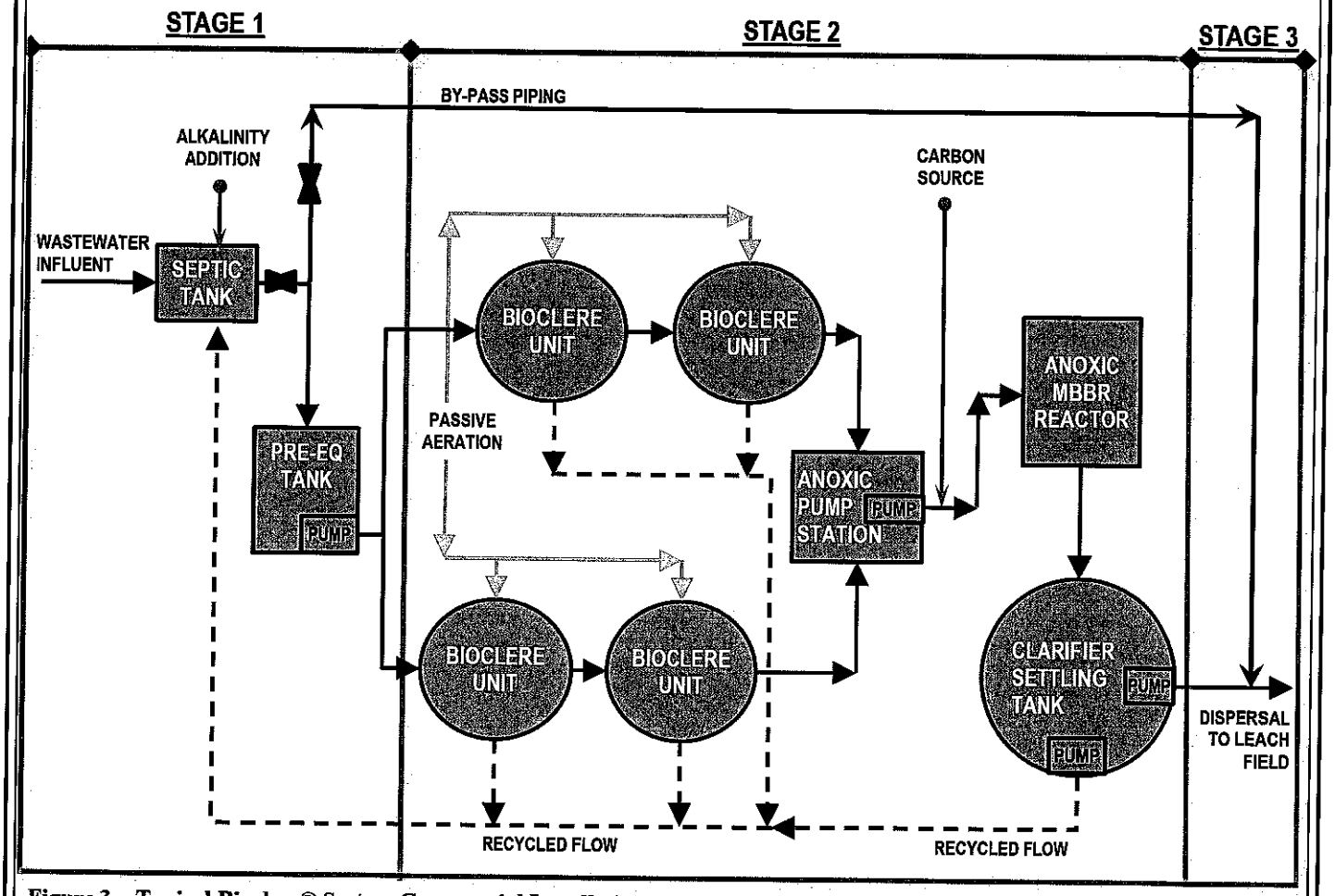

Figure 3 – Typical Bioclere® System Commercial Installation Schematic in Suffolk County

Reactor (MBBR). The addition of a carbon source will be utilized at this point. The effluent is then conveyed to a final clarifier settling tank where additional BOD removal occurs. The treated effluent is pumped to the leaching fields on site (Stage 3 portion of process).

3.3.4 BioMicrobics - MicroFAST® System for Commercial Applications

The two commercial MicroFAST® selected sites are residential developments located in Stillwater, MN, the Audubon and Miller Farms developments. These systems were designed based on the following influent and effluent wastewater characteristics:

Constituents	Influent	Effluent
BOD (mg/L)	250	10
TSS (mg/L)	250	10
TN (mg/L)	60	10

The influent grab samples were obtained from the sampling port of the septic tank and the effluent grab samples were taken from the inlet to the dosing chambers in both installations. A summary of the results from the two days of field sampling are shown in Table 4. The Miller Farms development shows an effluent total nitrogen concentration below the required limit of 10 mg/L. On the other hand, the Audubon site has a slightly higher effluent total nitrogen concentration. Upon review of the influent and effluent results, it has been identified that the system is not denitrifying the wastewater well at the Audubon site. This could be a result of the low strength influent wastewater, affecting the biology of the system.

Table 4. Field Sampling Results for the MicroFAST®, NitriFAST®, AND ABC®-N Systems

	Site Location	Sampling Date	Influent Concentration (mg/L)				Effluent Concentration (mg/L)			
			Alkalinity	CBOD	TSS	TKN	Nitrate-Nitrite	Ammonia	TKN	TN
1.	Audubon Development, Stillwater, MN	11/18/2011	416	134	74	62.2	13.4	0.17	0.29	13.7
		11/15/2011	419	281	123	75.5	12.4	0.11	0.61	13.0
2.	Miller Farms Development, Stillwater, MN	11/18/2011	442	306	328	103.0	6.62	0.16	0.75	7.4
		11/15/2011	410	215	132	62.9	4.55	0.10	0.94	5.5

The manufacturer information provided and lab results indicate the system is capable of treating wastewater and reaching effluent total nitrogen concentrations below the required limit of 10 mg/L. We

recommend the MicroFAST® system be further investigated on an installation in the same climate as Suffolk County. A pilot study in a residential or commercial installation in Suffolk County would provide a better representation of the ability of the system to denitrify.

The commercial installation will have a septic tank and a pre-equalization tank as part of the Stage 1 portion of the process. The effluent will be pumped to the two compartment concrete tank containing the MicroFAST® insert. As part of a commercial installation a concrete tank containing the NitriFAST® insert followed by an additional concrete tank containing the ABC®-N insert will be required to be installed following the MicroFAST® system. A schematic of a typical MicroFAST® commercial installation is shown in Figure 4, and a factory unit insert shown in Figure 5.

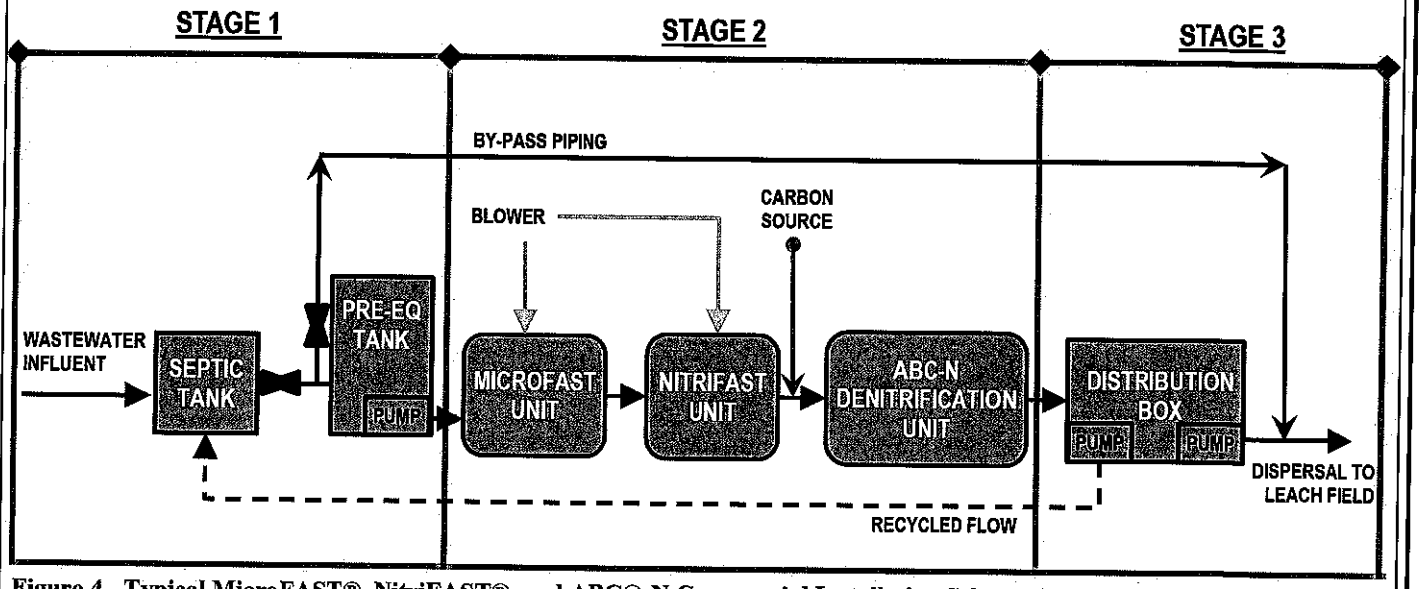

Figure 4 – Typical MicroFAST®, NitriFAST®, and ABC®-N Commercial Installation Schematic in Suffolk County

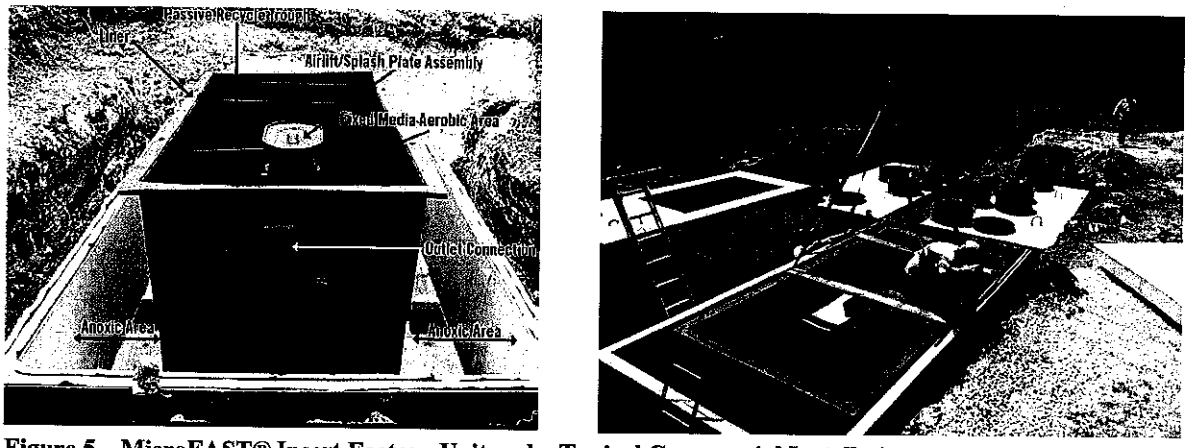

Figure 5 – MicroFAST® Insert Factory Unit and a Typical Commercial Installation

3.3.5 Lombardo Associates – Nitrex™ System in Commercial Applications

Three (3) commercial installations were chosen to be sampled to represent the Nitrex system, each using the three (3) different Stage 2 nitrifying processes. The first installation is the Bracket Landing residential community in Eastham, MA using the SeptiTech® system capable of treating 10,000 gpd. The second installation treats the Main Street Villages residential community in Mashpee, MA using the Waterloo Biofilter® system capable of treating 5,225 gpd. The final installation sampled was a shopping plaza located in Malibu, CA using the Advantex® system capable of treating 16,000 gpd. The following influent wastewater characteristics were used to design the treatment systems in Massachusetts and California:

Constituents	MA Raw Wastewater Influent	MA Septic Effluent	CA Raw Wastewater Influent	CA Septic Effluent
BOD (mg/L)	250	150	800	410
TSS (mg/L)	210	90	225	150
TN (mg/L)	70	70	80	80

A summary of the sampling results are of the three (3) systems is shown in Table 5. All samples obtained resulted in effluent total nitrogen concentrations below the required limit of 10 mg/L.

Table 5. Field Sampling Results for the Nitrex System

	Site Location	System Setup	Sampling Date	Influent Concentration (mg/L)		Effluent Concentration (mg/L)			
				Alkalinity	TKN	Nitrate-Nitrite	Ammonia	TKN	TN
1.	Eastham, MA	SeptiTech® + Nitrex™ Filter	9/19/2011	117	28	0.10	0.14	1.54	1.54
			9/22/2011	57	18	0.10	0.23	1.37	1.37
2.	Mashpee, MA	Waterloo Biofilter® + Nitrex™ Filter	9/19/2011	167	41	0.10	0.58	1.56	1.56
			9/22/2011	160	64	0.10	0.16	1.57	1.57
3.	Malibu, CA	Advantex® + Nitrex™ Filter	9/22/2011	370	94	0.68	0.80	1.06	1.74
			9/29/2011	322	69	0.67	0.14	0.91	1.58

The Nitrex™ system used in commercial applications has proven to treat wastewater to total nitrogen levels well below the discharge limit of 10 mg/L. The submitted performance data and the lab results

from the field sampling show the ability of this system to denitrify regardless of the nitrifying treatment process. As shown in Figure 6 schematic, the Nitrex™ Denitrification Filter (Stage 2b) must be used as part of an integrated two (2) part system, referred to as the Nitrex™ system.

The three (3) nitrifying systems that have proven to treat wastewater to total nitrogen levels below the discharge limit of 10 mg/L, in commercial applications, are the Orenco Systems' Advantex® system, Waterloo Biofilter, Inc.'s Waterloo Biofilter® system, and SeptiTech's SeptiTech® system. All three nitrifying systems contain a storage space which serves as the pre-equalization tank. Wastewater from the septic gravity flows to this processor tank/pump chamber and is then pumped to the aerobic portion of the process. The treated effluent gravity flows to the Nitrex™ Denitrification Filter, then to the leaching fields. The final installation of these systems shall comply with the requirements set forth by SCDHS.

A schematic of a typical NitrexTM system for a commercial installation in Suffolk County is shown in Figure 6.

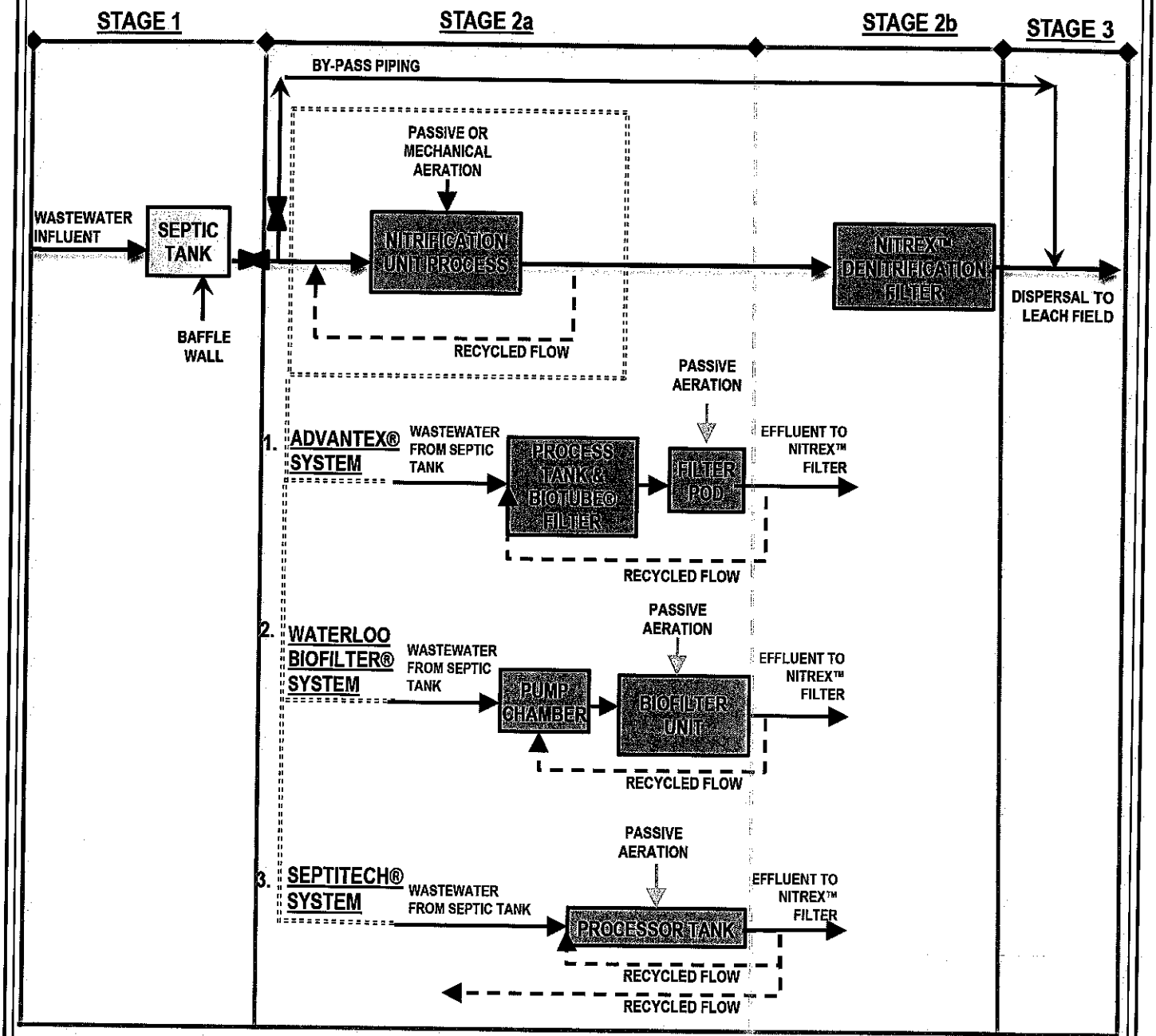

Figure 6 – Typical Nitrex™ System Commercial Installation Schematic in Suffolk County

3.3.6 WesTech – STM-Aerotor™ System Commercial Applications

The STM-Aerotor™ system has been installed in three different locations in Suffolk County, treating wastewater flows between 1,000 and 30,000 gpd. All three systems are meeting the effluent total nitrogen concentration of less than 10 mg/L. The Department is aware of the performance at these installations, and therefore, the sampling of these systems was not necessary. The WesTech STM-Aerotor™ system should be considered as an alternate on-site wastewater treatment system in Suffolk County for commercial applications.

WesTech, Inc. provides a packaged STM-Aerotor™ treatment system for commercial installations treating wastewater flows from 1,000 to 30,000 gpd. The Stage 1 portion of a typical system installation for a commercial application shall include a septic tank followed by a pre-equalization tank. The effluent will then be pumped to the Stage 2 portion of the process consisting of the process tank with the Aerotors followed by a conical clarifier structure. The settled sludge is pumped to the septic tank and the overflow effluent flows to the distribution box where it is pumped to the leaching fields (Stage 3). Refer to Figure 7 for a schematic of an installation in Suffolk County

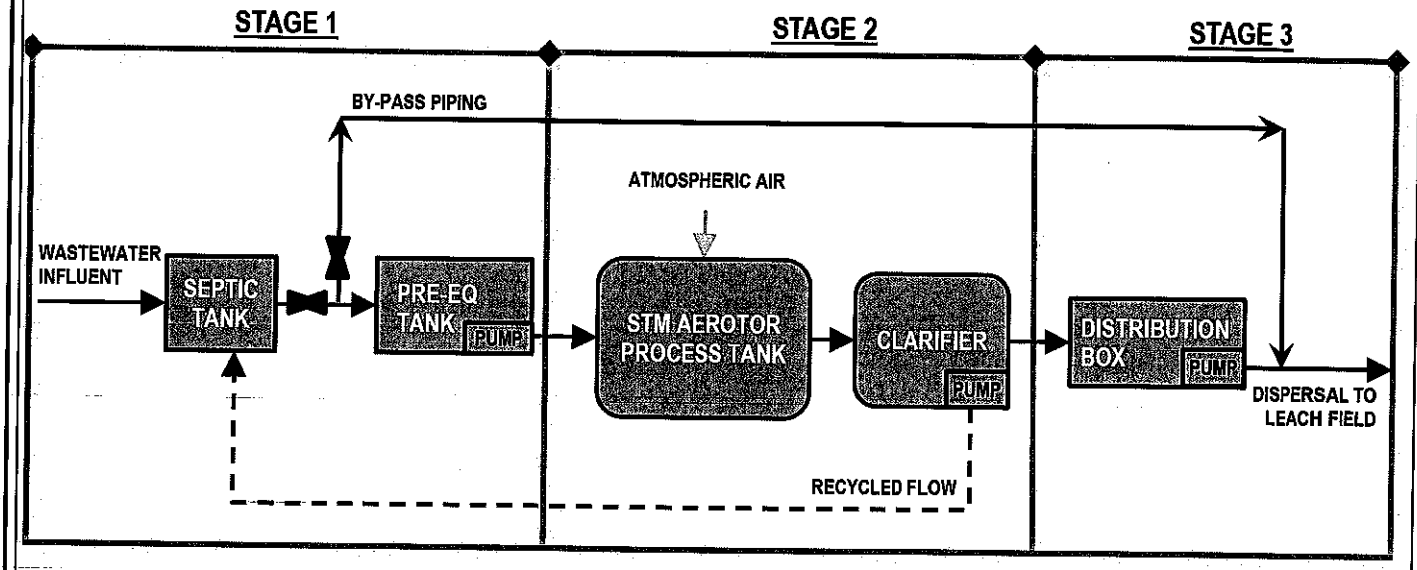

Figure 7 – Typical STM-Aerotor™ System Commercial Installation Schematic in Suffolk County

3.4 TASK IV C – SYSTEM ASSESSMENT AND ACCEPTANCE USING SCDHS REQUIREMENTS

Following the Task IV (A) evaluation and Task IV (B) selection of the alternative on-site treatment systems from each flow category, a thorough assessment of each technology was undertaken. The purpose of Task IV(C) is to assess the ability of the selected alternative OSSDS to meet the design and operations criteria that have been established by the Suffolk County Department of Health Services (SCDHS).

The recommended standards for the approval of plans and construction of sewage disposal systems in Suffolk County have been developed using the "Ten State Standards" as a reference. For single-family dwellings, SCDHS standards for the design and construction of a conventional on-site treatment system can be found in the November 13, 1995 edition of "Approval of Plans and Construction – Sewage Disposal Systems for Single-Family Residences". For commercial installations, standards can be found in the July 15, 2008 edition of "Standards for Approval of Plans and Construction for Sewage Disposal Systems for Other than Single-Family Residences". These regulations were used as the basis in establishing the necessary criteria for the approval and acceptance of the alternative OSSDS. The evaluation on each system was based on the following eight (8) categories:

- the equipment provided by the manufacturer
- material of construction
- ease of operation and system requirements for controlling the biological process
- short term maintenance requirements
- long term maintenance requirements
- installation details
- emergency power, duplicity and by-pass enhancements
- supplementary unit processes

The preliminary set of guidelines was then presented to SCDHS for their review. After evaluation, it was decided that both residential and commercial systems to be installed in Suffolk County shall comply with the approved set of requirements. The design and all the materials used during the construction of the alternative OSSDS shall be approved by the SCDHS prior to installation.

The requirements were established to provide a reliable, easy to operate, easy to maintain system that would consistently achieve levels of treatment to less than 10 mg/L of Total Nitrogen.

4. TASK V MEETING

The Task V meeting took place following the Task IV selection, sampling, and evaluation of the recommended alternative OSSDS technologies. As discussed during the meeting, H2M proceeded would proceed with the Task VI cost and benefit analysis portion of the study for the systems selected in both flow categories.

In addition the Department decided, as part of Task VIII, to investigate and evaluate the conditions and restrictions under which alternative on-site treatment systems are permitted for use in four (4) specific states. The states under consideration include Massachusetts, Rhode Island, New Jersey, and Maryland. The following restrictions and items were to be evaluated:

1. Buffer distance requirements
2. Minimum lot size requirements
3. Operator service contract requirements
4. Engineer of record requirements
5. Sampling, testing and reporting
6. Effluent requirements for installed systems

5. SUMMARY OF TASK VI REPORT

The purpose of Task VI is to develop estimates of costs for the design, construction, installation, and operation and maintenance (O&M) of the selected Alternative On-Site Sewage Disposal Systems (OSSDS) meeting the criteria discussed in the Task IV (C) Report. Suffolk County has been in the forefront of protecting its groundwater and shoreline aquatic water resources. The current planning efforts and monitoring began with the Long Island Comprehensive Wastewater Treatment Management Study (commonly referred to as the 208 Study). The relationship between land use and the well-being of the aquifer system was established in these early studies and led to development of nitrogen loading as a suitable surrogate controller for these land-use related impacts to the groundwater. The three major sources of nitrogen contributions in groundwater include atmospheric deposition, fertilizer use, and sanitary wastewater. As a result, Suffolk County Department of Health Services (SCDHS) adopted Article VI of the Suffolk County Sanitary Code which established Population Density Equivalents for the various Suffolk County Groundwater Management Zones. Atmospheric deposition and fertilizer applications are not controllable and are outside of SCDHS' jurisdiction, and would remain unaffected.

The selected alternative OSSDS systems are expected to reduce influent nitrogen concentrations from wastewater by 87% as opposed to a 50% reduction in a conventional septic system, refer to Table 6. The 75 mg/L influent and 40 mg/L effluent total nitrogen concentrations resulting in a 50% reduction have been observed by various authors and have been documented in literature. In implementing an alternative OSSDS the effluent total nitrogen requirement will be enforced to be maintained at 10 mg/L, yielding an 87% reduction. The 30 mg/L total nitrogen difference results in 0.075 lbs. of additional TN removed in a typical residential household producing wastewater flows of 300 gpd.

Table 6. Total Nitrogen Reductions in Residential Applications

Type of System	Influent Concentration (mg/L)	Effluent Concentration (mg/L)	Reduction (%)
Conventional Article VI Septic System	75	40	50%
Alternate OSSDS System	75	10	87%

5.1 Cost Opinion

The costs opinions for residential and commercial applications were based on quotes obtained from local contractors, suppliers, and the alternate system manufacturers. The costs were based on typical system configurations as previously established in Task IV (C). The cost estimate is applicable to alternative OSSDS installed in new construction residences or developments with standard soil and groundwater conditions. Properly functioning OSSDS are a viable option for public health and environmental protection in developed communities which lack centralized wastewater collection and treatment. An operation and maintenance contract is essential and is considered a necessary requirement to assure the proper functionality of the OSSDS. These costs consist of pumping and hauling of sludge, inspection and influent and effluent sampling by an certified operator, and electrical usage.

5.2 Cost Opinion for Residential Applications

The costs associated with the construction and installation of alternate OSSDS in residential applications were based on a typical residential configuration for the recommended on-site treatment system to be potentially used in residential applications, treating wastewater flows of 300 to 1,000 gpd. These costs are indicated in Table 7, providing a summary of the three (3) cost components that would be considered during the design, construction, and installation of the alternative on-site system. In residential applications the cost associated with the design, construction and installation of the two recommended alternate OSSDS is $25,000 for the MicroFAST® and $41,500 for the NitrexTM system. Comparatively, a conventional Article VI OSSDS would cost $5,080.

Table 7. Construction and Installation Costs of Alternative OSSDS in Residential Applications

Cost Component	BioMicrobics - MicroFAST®	Lombardo Associates, Inc. - Nitrex™	Conventional Septic System
Permitting and Regulatory Requirements	$5,000	$7,500	$650
Treatment Components (Including Ancillary Equipment and Contractor Markup)	$7,000	$19,500	$3,700
Construction and Installation	$13,000	$14,500	$730
TOTAL	**$25,000**	**$41,500**	**$5,080**
Annual O & M	$1,700	$1,400	$160

5.3 Impact to New Homeowners

Figures 9 and 10 show a representation of the difference between the installation of a conventional Article VI OSSDS and alternative OSSDS for a new construction residence. The nitrogen sources from

atmospheric deposition and fertilizer cannot be controlled by SCDHS and remain as constants in both illustrations. The wastewater nitrogen source is the only variable that is effected by the installation of an OSSDS system. A conventional OSSDS installation yields a 50% TN reduction and an alternative OSSDS yields an 87% reduction, as shown in Figure 9 and 10, respectively.

The figures also show the value that would be added to a new home in either scenario. The following assumptions are taken into account to calculate the future and present worth for each system:

- a typical 30 year mortgage payment plan
- an average interest rate of 3.950%

The present worth for a conventional system would be approximately $10,160. The present worth for the lowest costing alternative system would be approximately $50,000. A homeowner would have to pay an additional $222.86 a month ($260.30 – $37.44) if an alternative OSSDS is required to be installed. This amount consists of the monthly payment towards the principal and compounded interest of the OSSDS system and monthly O&M.

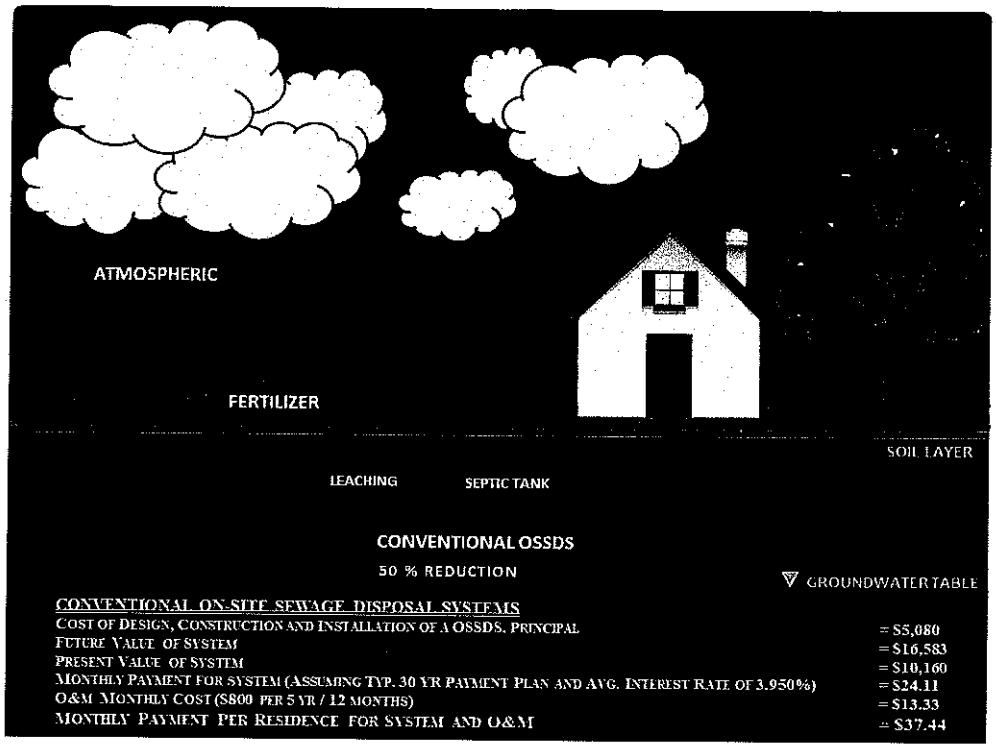

Figure 8 – Total Nitrogen Contributions Using Conventional Article VI Standards

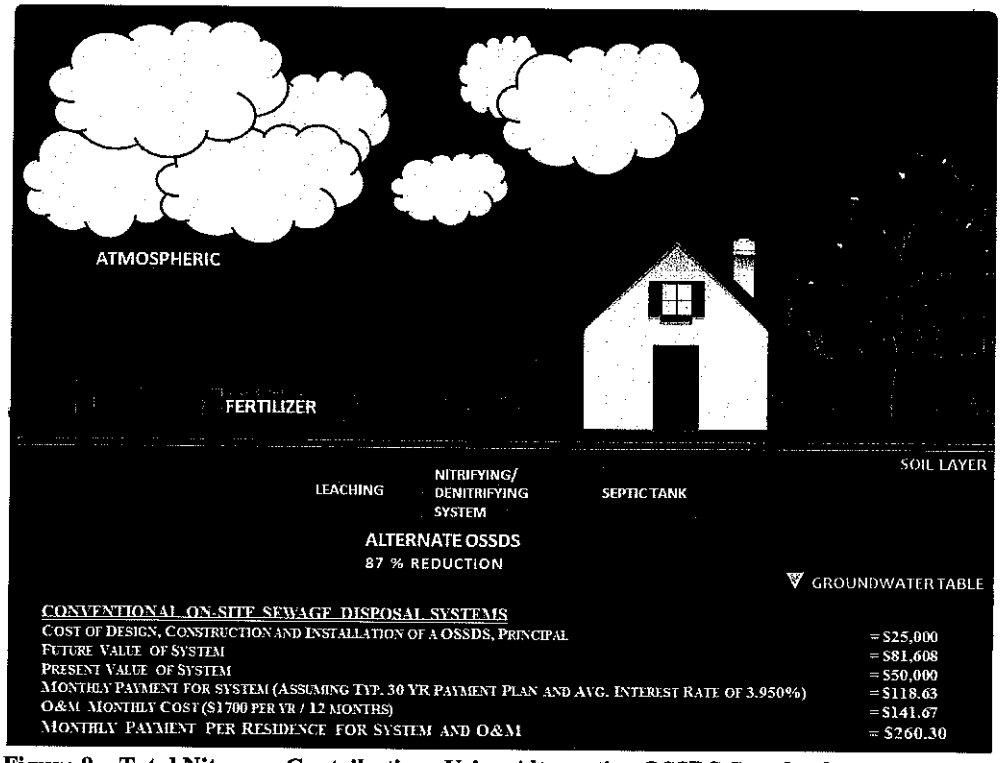

Figure 9 – Total Nitrogen Contributions Using Alternative OSSDS Standards

5.4 Cost Opinion for Commercial Applications

The costs associated with the construction and installation of the recommended alternative OSSDS in commercial applications are summarized in Figure 10. The cost estimate for the commercial systems was broken down into three design flow criteria including 1) 5,000 gpd, 2) 15,000 gpd, and 3) 30,000 gpd to better represent the construction and installation of each system. The cost estimate applies to alternative OSSDS installed in new residential developments with acceptable site and groundwater conditions. Grease traps were not included in the analysis, but will be required in food preparation applications.

The initial costs of the systems recommended for commercial applications are relatively high, with a unit price range of $64-$116 per gpd for a 5,000 gpd system. As the design flow increases the costs level off to a unit price in the range of $36-50 per gpd for a 30,000 gpd system.

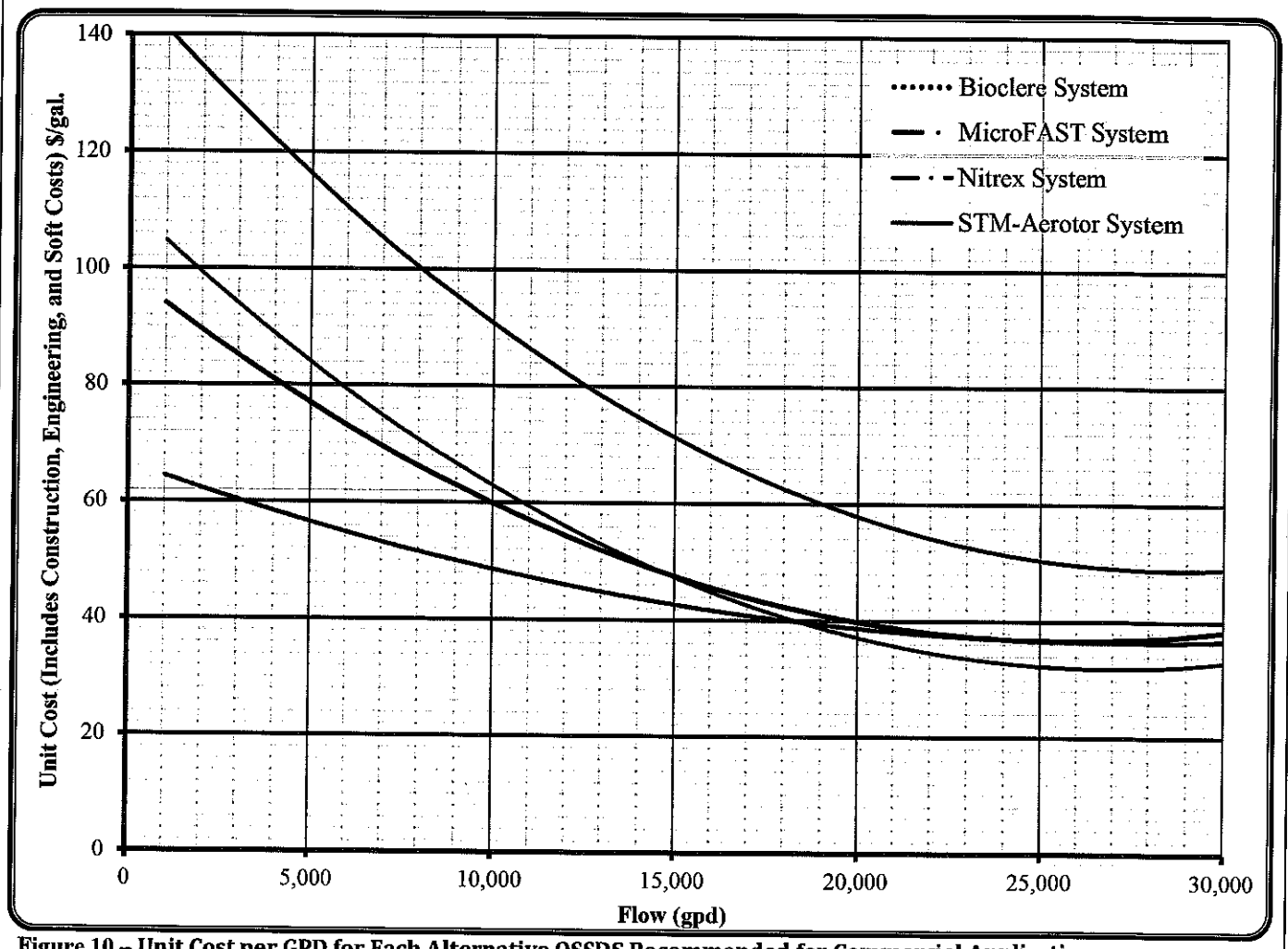

Figure 10 – Unit Cost per GPD for Each Alternative OSSDS Recommended for Commercial Applications

5.5 Economic Benefits

5.5.1 Residential Properties

At the current time, it is difficult to truly calculate the economic benefit which will be derived from the installation of alternative OSSDS on residential properties because the environmental benefit has yet to be determined. Without quantifying the environmental benefits (protection of drinking water, maintenance of quality beaches, fishing, tourism, etc.) and translating these quality of life issues to economic benefits (housing prices, salary rates, etc.), the cost of Alternative OSSDS will be greater than the perceived economic benefits when based solely on septic system costs.

5.5.2 Commercial Properties

For commercial properties, the economic analysis can be more fully derived because of the fact that the installation of an Alternative OSSDS allows a commercial property to build over the current Health Department density restrictions providing that the sanitary treatment system meets the applicable discharge standards. The economic benefit gained from the additional square footage or restaurants seats can, under certain conditions, offset the cost of the treatment system and make the project viable.

6. SUMMARY OF TASK VIII

As part of Task VIII, SCDHS decided to investigate and evaluate the conditions and restrictions under which alternative on-site treatment systems are permitted for use in four (4) specific states. The states under consideration include Massachusetts, Rhode Island, New Jersey, and Maryland. A description of the approval process and regulations set in each state is described in this report. The restrictions and items evaluated are listed below. An overview of the findings from each state is combined in Table 8.

- Buffer distance requirements
- Minimum lot size requirements
- Operator service contract requirements
- Engineer of record requirements
- Sampling, testing and reporting
- Effluent requirements for installed systems

7. TASK IX – CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS AND RECOMMENDATIONS FOR ALTERNATIVE OSSDS SYSTEMS

The purpose of the study was to evaluate systems that can significantly reduce nitrogen, as compared with conventional subsurface systems consisting of septic tanks and leaching pools. A majority of the County is not served by public sewers. Conventional subsurface systems are the main method of sewage disposal used by residential and commercial facilities in Suffolk County. These systems provide limited nitrogen reduction and discharge effluent into the ground. The amount of nitrogen discharge is of particular concern to the residents of Suffolk County as the County's aquifer is the sole source of drinking water and also provides the base flow to most streams, harbors and other coastal waters in the County.

The study topic was split into two categories – the benefit of the application of Alternative OSSDS systems for a) the residential properties and b) the commercial properties in Suffolk County. Various technologies were evaluated to assess their ability to consistently meet the NYSDEC's requirement of 10 mg/l of nitrogen limit in the effluent. The Ten State Standards and the County's regulations for construction of sewage disposal systems for single-family residences as well as for commercial facilities were used to establish the study criteria for evaluation of the systems. Initially a total of eighteen (18) technologies were selected for evaluation. Thirteen (13) manufacturers (process vendors) are responsible for the 18 technologies. The study findings and recommendations are discussed in separate sections below.

7.2 ALTERNATIVE OSSDS SYSTEMS FOR INDIVIDUAL RESIDENCES

The study commenced with an extensive web-search and search of other sources to obtain information on advanced sanitary systems for residential purposes. After completion of this preliminary step, fourteen (14) residential systems were chosen for evaluations. Based on the findings, the study criteria, and the manufacturers' availability and willingness to participate in the study, two (2) systems were selected for sampling and analyses: BioMicrobics' MicroFAST ® system and Lombardo Associates' Nitrex™ System.

As indicated in the Task IV C report, from the perspective of system performance, the analyses reports for Nitrex™ System revealed that it can consistently meet the required nitrogen limitation of 10 mg/l in the effluent; however, the installation cost is very expensive. Therefore, from an affordability standpoint and in light of the following discussions, selection of this system as an outcome of the study is not practicable at this time.

Long Island is a unique place considering the connection between groundwater and surface waters. Nitrogen that is discharged from the sanitary systems mixes with nitrogen from other sources such as fertilizers, atmospheric deposition and surface runoff before it reaches the Island's groundwater table and eventually feeds the surface waters. While control of nitrogen discharge into the ground is possible through restricted use of fertilizers and treatment of sewage within the limits of the technologies, a substantial portion of the total nitrogen discharge occurs naturally and beyond anybody's control.

Suffolk County currently utilizes the practice of limiting building density through Article VI of the County's Sanitary Code in order to protect both drinking and surface water supplies in addition to the conventional sewage disposal systems that have been widely used throughout the County for more than three decades now. Monitoring programs have confirmed that Article VI limitations on development where sewers are not available have restrained the wastewater contribution to nitrogen loading to groundwater to levels within the recommendations of the 208 Study.

As developed in the Task Report, the application of the selected Alternative OSSDS systems for wastewater disposal would reduce potential nitrogen contribution from the wastewater component of future developments. However, the economic costs for this incremental reduction would be substantial. The advantages of this nitrogen loading reduction becomes less significant when compared to the magnitude of the existing nitrogen contribution from the estimated 423,525 existing wastewater systems, and the continued, significant contribution from existing and future turf fertilizer application. The worth of incremental reductions from the relatively small number of future OSSDS residential developments should be considered in light of this fact.

The alternative systems themselves, by design, have significant operational shortcomings associated with their non-passive design, and impose operational needs which constitute significant O&M challenges. From the 1977 on site denitrification pilot study, the Department recognized passive operation to be a highly desirable design feature of on-site disposal system design advancements, and the selected systems cannot meet this desirable objective. As a result, the need to provide a piped bypass of major nitrification and denitrification components of the selected alternative residential OSSDS for use in the event of power and/or pump failures poses potential operational problems related to inadvertent or deliberate actions by the homeowner.

Incorporating biological treatment processes, the single family OSSDS' ability to endure upset due to changes in wastewater quality has not been adequately evaluated, and the small subset of long term operational data does not provide significant insight into this issue. This is a concern that has been voiced recently in the light of continued revelations about effects of pharmaceuticals and personal care products

on aquatic systems. These concerns may range from occasional major upsets from disposal of unused prescriptive medications and even over the counter antibiotic products, to impacts from more frequent use of household disinfectants, waste paints and solvents, or laundry oxidant products. It is apparent that the RME mechanism, whether municipal or private in its formulation, must incorporate a substantial education and training component for affected residents.

As a capital expenditure requirement, the alternative system would constitute a significant increase in residential construction cost, and the necessary O&M for continued operation and replacement of critical components represents a significant ongoing financial burden. Given the relatively small percentage of additional wastewater nitrogen increase that total build out represents, this overall cost is difficult to justify as fair and is not regarded to be an equitable distribution of what should be a shared environmental burden.

In light of the discussions in the preceding paragraphs, it is apparent that the County cannot rely on individual homeowners' maintenance contracts to ensure proper operation and maintenance of these systems, but rather, it is envisioned that a formal management district or agency would need to be created for this purpose. In addition, new standards would need to be adopted that address the requirements for emergency power or by-pass process control and maintenance, separation distances, odors, operating expenses, etc. However, the Department could most likely take cues from other municipalities with existing operational programs when addressing issues of this kind.

There are numerous policy concerns with the proposed use of treatment systems for individual residences. These deal not only with potential public health nuisances, but also with various social and economic concerns that transcend the purview of DEQ – especially since the goal is generally surface water protection, rather than strictly public health and drinking water. At this point in time, it is evident that further study and modeling are necessary to determine if additional nitrogen controls are required and to what extent. What levels of nitrogen improvements to groundwater are attainable under various scenarios, with what impact to surface waters? Where does it makes sense to sewer or treat with onsite sanitary systems? What are the costs and benefits of these solutions and how do we finance them? The Department has to address the issue of the management of such a large scale program, as most areas have on the order of several hundred systems; The County could need upgrading of several hundred thousand systems. Therefore, application of Alternative sewage treatment system to individual residences does not appear to be a viable solution at this point in time.

7.3 ALTERNATIVE OSSDS SYSTEMS FOR COMMERCIAL USE

The study commenced with an extensive web-search and search of other sources was conducted to obtain information on advanced sanitary systems for commercial purposes. After completion of the preliminary reasearch step, nine (9) commercial technologies were chosen for evaluations. Based on the findings, the study criteria, and the manufacturers' availability and willingness to participate in the study, the following four (4) systems selected for sampling and analyses - Aqua Point's Bioclere® System, BioMicrobics' MicroFAST® System, Lombardo Associates' Nitrex™ System and WesTech's STM- Aerator™. As indicated in the Task IV C report, all the systems with the exception of BioMicrobics' MicroFAST® System qualified for recommendation for commercial use as an outcome of the study.

A total of four technologies were selected for evaluation and sampling analyses for commercial use - Compared to residential applications, the utilization of alternative OSSDS systems in commercial applications presents fewer and more manageable operational issues. The selected alternative OSSDS technologies should be considered appropriate to be allowed for those new facilities requiring discharge permits with nitrogen limitations. Furthermore, the selected systems may also be considered as satisfactory disposal method for new developments which could meet Article VI equivalent density requirements. Such facilities could incorporate conventional OSSDS with design flow up to 15,000 gpd without limits on nitrogen discharge as long as the Article VI equivalent density (one equivalent Dwelling Unit per acre or two DUs per acre, depending on the Groundwater Management Zone location) is met. The sanitary wastes from commercial facilities represent a concentrated point source of greater significance of local-impact than a single family home. Therefore even when the regional Article VI nitrogen requirements are being met such discharges may be of greater significance. Applications of the selected alternative OSSDS systems may be of value if local receptors such as surface waters, wetlands or shallow sources of drinking water are in proximity. It should be pointed out that the alternative OSSDS application is intended to reduced nitrogen loading and not intended to obviate the need for restricting the setback distances more than what is currently required by Department standards.

Responsible Management Entities and their regulation are likely to face fewer problems than the residential OSSDS component of future development. First, mechanisms for enforceable permitting for discharges greater than 1,000 gpd currently exist though the SPDES permit program, allowing a viable process for sustainable RME creation, and provision of technical and financial management capacity as well as promoting periodic departmental review and inspection through permit conditions. Many commercial applications also incorporate facilities under separate state or county Departmental operational permits (food service establishments, nursing homes, day care) which also impose certain operating conditions calling for due care and diligence in handling and disposal of sanitary waste.

The Department currently operates a management program for overseeing performance of the existing treatment plants that have been operating in Suffolk County for several decades now. The Department has prevailing rules and regulations that are exercised through this program. The projected number of commercial OSSDS appears to be manageable for the Departmental permitting, oversight, independent monitoring and regulatory control.

The non-passive nature of the Alternative OSSDS systems does not appear to become an operational issue during power outages as the Department always requires a standby emergency power system adequately sized to satisfy the power requirements of a treatment system as part of the system design. Permit conditions may also require cessation of operations of a commercial facility without the provision of a standby emergency power system during such an event.

In addition to the accepted technologies such as Wes Tech, Cromaglass and BESST already in operation in Suffolk County, the choice range for alternative technologies is expanded with the selection of Nitrex and Aqua Point's Bioclere system through the study. The OSSDS facilities that predate the departmental standards and are currently deteriorating and/or failing, facilities with operational failure that are in close proximity to water bodies or rising water table, etc. may be replaced by any of these accepted technologies.

Table 8. Requirements Set By Approving Authority for the Installation of Innovative/Alternative On-Site Treatment Systems in Massachusetts, Rhode Island, New Jersey, and Maryland

REQUIREMENTS	I. MASSACHUSETTS	II. RHODE ISLAND	III. NEW JERSEY	IV. MARYLAND
	Barnstable County Department of Health and Environment	Department of Environmental Management	Pinelands Commission	Anne Arundel County Department of Health
EFFLUENT REQUIREMENTS				
Biochemical Oxygen Demand (BOD)	30 mg/L	30 mg/L	30 mg/L	30 mg/L
Total Suspended solids (TSS)	30 mg/L	30 mg/L	30 mg/L	30 mg/L
Total Nitrogen (TN)	25 mg/L (19 mg/L in Nitrogen Sensitive Areas)	19 mg/L and 50% removal	14 mg/L	50% removal
SEPARATION DISTANCE				
Minimum Horizontal Separation (from septic tank)				
Property line	10 ft.	10 ft.	5 ft.	10 ft.
Private well	50 ft.	75 ft.	50 ft.	50 ft.
Public Water Supply	50 ft.	200 ft.	50 ft.	100 ft.
Wetland	100 ft.	200 ft.	300 ft.	-
Minimum Horizontal Separation (from soil absorption system)				
Property line	10 ft.	10 ft.	10 ft.	10 ft.
Private well	100 ft.	100 ft.	100 ft.	100 ft.
Public Water Supply	50-100 ft.*	200 ft.	150 ft.	100 ft.
Wetland	100 ft.	200 ft.	300 ft.	-
Vertical Separation (depth to groundwater)	4-5 ft.	4 ft.	4-5 ft.	4 ft.
DESIGN REQUIREMENTS				
Minimum Lot Size	Max effluent loading rate 0.15 gpd/sq. ft.	Min lot size of 2 ac for a conventional septic system (≥ 1/6 ac lot for an alternate system)	3.2 ac lot for a conventional septic system (≥ 1 ac lot for an alternate system)	Minimum lot size of 10,000 sq. ft. or 1/4 ac
Minimum Design Flow	330 gpd (440 gpd/ac in Nitrogen Sensitive Areas)	345 gpd	350 gpd	250 gpd
OPERATIONS AND MAINTENANCE REQUIREMENTS				
Operations & Maintenance Contract	O&M contract required for the life of each installed I/A system.	Annual O&M contract required as stated in the certification letters issued by the Department of Environmental Managements for each alternate system.	O&M contract required for first five (5) years of piloting program.	O&M contract required for first five (5) years of installation paid for by BRF grant. Property owners within Critical Area are required to maintain a O&M contract at their expense. Property owners outside this zone are recommended to maintain a contract.
System Monitoring	Monitoring of system per approval letter specific to each technology.	Three (3) residential systems are required to be monitored for a minimum of two (2) years for each technology. Commercial systems 2,000 gpd and greater are required to be monitored quarterly as required in the issued permit.	Sampling performed on a quarterly bases for the first three (3) years of piloting program on effluent samples only.	Quarterly effluent samples for the first five (5) years of installation under the O&M contract. No additional sampling required.

*DEPENDING ON THE ZONE THE RESIDENCE IS LOCATED