D. Other Point Sources Outside of Impaired Waters

In addition to sources described in the above section, there are additional sewage treatment plants in the Peconic Study Area that discharge to estuarine waters outside of the impaired waters: the Sag Harbor Sewage Treatment Plant and the Shelter Island Heights Sewage Treatment Plant. As noted previously, the Villages of Sag Harbor and North Haven, the Towns of Brookhaven, Riverhead, and Southampton, the New York State Department of Transportation, and Suffolk County stormwater facilities are currently regulated under the EPA's Phase II Stormwater Program. While other municipalities within the Peconic study area (the Towns of Shelter Island, Southold, and East Hampton) are not currently covered by the Phase II regulations, they may be designated by the New York State Department of Environmental Conservation for such coverage during the second Phase II permit cycle (2008-2013). In addition, the Brookhaven National Laboratory STP, which discharges to the freshwater Peconic River is addressed as a boundary/tributary load, as is the Plum Island STP which discharges to Gardiners Bay. While the former Naval Weapon Industrial Reserve Plant (previously operated by the Grumman Corporation) in Calverton, NY also has an STP that discharges to a branch of the freshwater Peconic River, the operators have submitted engineering reports to upgrade and build a new facility discharging to groundwater outside of the Peconic Estuary study area.

V. TMDL Development

This section provides a description of the data inputs to the modeling process and ultimately the TMDL, including ambient data, nutrient loading data, and uncertainties associated with current and projected future nutrient loads.

A. Available Ambient Data

Data from the SCDHS's water quality monitoring efforts as well as data from PEP funded studies and reports were used to calibrate and validate the Peconic Estuary EFDC (Environmental Fluid Dynamics Code) three-dimensional hydrodynamic and water quality model by Tetra-Tech, Inc. The SCDHS, in part through the Peconic Estuary Program, conducts an extensive water quality sampling program in the Peconic Estuary and its watershed.

1. Routine Water Quality Monitoring Program

While the SCDHS began limited surface water quality sampling in 1976, the number of stations and samples taken in the Peconics increased through the years. Currently, monitoring is conducted every other week at 32 stations throughout the year; two surface water quality monitoring stations are located in the waters for which the nitrogen this TMDL is being developed. Water samples are tested for a suite of nitrogen components (NH3, NO2+NO3, Urea, TN, TDN), phosphorus components (TP, TDP, ortho-phosphate), carbon components (TOC, DOC), silicate (SiO3), total suspended solids (TSS), chlorophyll-a (Total and < 10 μm), coliform bacteria (Total and Fecal), and Brown Tide (*Aureococcus*). At each station, secchi depth, temperature, dissolved oxygen, salinity, and the extinction of photosynthetically active radiation at incremental

depths are measured. See Figure IV.1 and Figure V.1 for additional information on the SCDHS surface water quality monitoring program sampling locations.

2. Peconic Estuary Stream and Point Source Sampling Program

The SCDHS monitors 28 Peconic Estuary System stream and point source stations on a monthly to quarterly basis, as time permits. Eight monitoring stations are located in the waters for which the nitrogen TMDL is being developed, including sites at the Peconic River, Meetinghouse Creek, Sawmill Creek, Terrys Creek, the Crescent Duck Farm in the Meetinghouse Creek Watershed, and the Riverhead Sewage Treatment Plant. These stations are sampled for a suite of metals and organic compounds.

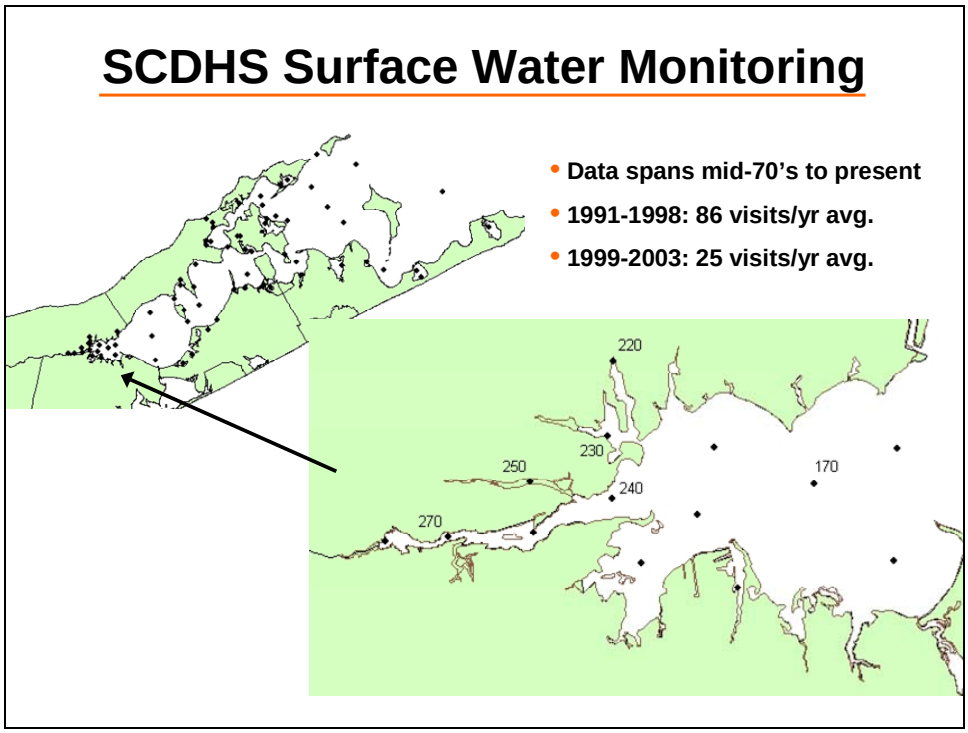


Figure V.1: Peconic Estuary Program Routine Marine Monitoring Stations

3. Continuous Water Quality Monitoring

For the summer and fall of 2002, continuous monitoring devices (Yellow Springs Instruments (YSI)) were deployed in the tidal portion of the Peconic River (at the Route 105 Bridge), western Flanders Bay (southwest of Buoy G"9"), and eastern Flanders Bay (approximately mid-way between SCDHS station 170 at Buoy R "9" and Red Cedar Point) by the SCDHS. The devices measure and record dissolved oxygen levels, temperature, and conductivity (to calculate salinity) every 15 minutes.

4. Groundwater Quality Monitoring Program

The SCDHS maintains a network of wells throughout the county to monitor the quality and quantity of the groundwater supply, and conduct studies and investigations of the county's hydrology. Groundwater measurement reports are periodically produced. The focus of groundwater monitoring has been on human induced loadings such as: fertilizers and pesticides use at agricultural operations, golf courses and residences; septic systems;

and chemicals (petroleum, solvents, and degreasers). In eastern Suffolk County, agricultural chemicals are the primary contaminant of concern.

B. Nutrient Loading Data

1. Overview

Nutrient loads are classified into several categories, based on geographic origin, source type, and whether it is of natural or human origin.

With regard to geographic origin, in-basin nutrient load contributions for this TMDL originating within the northwest portion of the Peconic watershed include: stormwater runoff, the Riverhead Sewage Treatment Plant and Atlantis Marine World discharges, nutrient flux from the sediments, groundwater enriched by agricultural and non-agricultural sources, and wet and dry atmospheric deposition. Although the origin of atmospheric nitrogen may be many hundreds of miles away, it is presently included in the geographic category where it is deposited. Nutrient loads from all other sources, i.e., beyond the in-basin boundaries, are considered imported loads or out-of-basin loads, and include the loadings from the freshwater portion of the Peconic River and estuarine transport from outside the Peconic Estuary System.

Nitrogen loads by source type are categorized as nonpoint and point. While the Peconic Estuary, on a regional basis, is dominated by nonpoint source impacts, there are point source discharges, including the Riverhead Sewage Treatment Plant and Atlantis Marine World which discharge to an impaired water (the Lower Peconic River), and the Sag Harbor and Shelter Island Heights STPs. The Towns of Riverhead and Southampton are both regulated under the EPA's Phase II Stormwater Program, as are the New York State Department of Transportation and the Suffolk County stormwater facilities within these towns, along with the Villages of Sag Harbor and North Haven. Further, the Town of Brookhaven is also regulated under the Phase II Stormwater Program, though stormwater from the Town of Brookhaven enters and contributes only to non-tidal Peconic River upstream of the impaired segment and is included in tributary loads. Other stormwater inputs are not currently regulated as point sources and are considered nonpoint sources. Nonpoint sources also include diffuse sources (*e.g.*, nitrogen-enriched groundwater resulting from septic systems and residual fertilizers, sediment flux, and wet and dry atmospheric deposition.

Nitrogen sources can be further subdivided into a pre- and post-colonial (*i.e.*, enriched) load. The pre-colonial or pastoral load is an estimate of the amount of nitrogen that was delivered to the estuary before European settlers colonized the area. The pre-colonial condition estimates what the natural load might have been. Human-caused loads include wastewater treatment facility outflows and nonpoint source groundwater flows from residential septic systems and residual fertilizers.

Nitrogen loads are presented as daily loads estimated for an average flow year. These loads, therefore, differ somewhat from the time variable nitrogen loads specific to the time period used in the Peconic Estuary EFDC Model employed to develop this TMDL.

Oxidizable carbon loads were also estimated for the water segments using the same categories and approach that was used for nitrogen. Carbon is of interest because it contributes to low dissolved oxygen levels in the Peconic Estuary. While nitrogen plays the dominant role in causing hypoxia, the oxidation of carbon loads is also responsible for oxygen consumption. Because source management to remove nitrogen will also remove some of the total organic carbon (TOC) load, both nitrogen and carbon reductions are considered in quantifying the potential dissolved oxygen improvements. Since the carbon reductions are incidental to the management of nitrogen, no targets for TOC reduction have been established.

2. Development of Nutrient Loading Factors

This TMDL and the nutrient loading factors that support it are based on both the extensive and detailed data bases on land uses and groundwater quality, and on the relationship between them. This involved looking at existing land uses, trends and build-out potential based on the zoning for the over 58,000 parcels of land in the Peconic Estuary Program Study Area. Special attention and consideration was given to farmland because of farmland preservation programs and also to open space acquisition because of the very significant funding that the five east end towns, the county and state along with private land trust organizations (The Nature Conservancy and the Peconic Land Trust) have assembled to acquire open space. Golf courses were addressed separately, as was developable land within the boundaries of the sewer districts. Recent work to estimate environmental implications associated with vegetative preservation requirements (i.e., clearing restrictions) and clustering requirements also factored into this analysis.

a. Existing Land Use Data

Existing land uses were categorized at the individual tax map parcel level using a standardized methodology showing 13 general land use category attributes based on assessor code data and residential density criteria. This data was then verified via field inspection, aerial photo interpretation, Real Property Tax Service Agency property data and owners list files, etc. and also manual corrections as necessary. This effort involved resolving complications such as:

- When more than one land use was found to occur on a single parcel, the primary use was determined and assigned to that parcel. Primary use was based on the relative intensity of use in comparison with the other use(s) in question. Consideration was also given to the areal extent of the use on the parcel.
- Dedicated common areas on tax map parcels in condominium/townhouse projects were classified as recreation and open space, since such areas are not available for development in the future.
- Agricultural lands that had reverted to old field habitat due to non-agricultural use were classified as vacant. Actively cultivated lands and those recently left fallow were classified as agriculture.
- All publicly owned parks and conservation lands, whether actively or passively used, were classified as recreation and open space
- The existing zoning designation of a parcel was not a factor in how that parcel was classified as to existing land use.

Given the extensive level of effort devoted to the PEP land use inventory, the Suffolk County Planning Department that prepared the inventory is confident that the incidence of errors (either judgment error (i.e., assigning the wrong classification category to a particular parcel or attribute error (i.e., the wrong classification is assigned a parcel in the GIS data base)) is very low. This work does, however, represent a static or "snapshot" view of land and does not reflect incremental changes that have occurred as a result of more recent development and open space acquisition activities. This work is documented in "Peconic Estuary Program Existing Land Use Inventory" (Suffolk County Department of Planning, January 1997).

b. Land Use Change Trends

A subsequent and related report is entitled "Peconic Estuary Program Land Use Change Analysis" (Suffolk County Department of Planning March 1998). The findings of this report included that nearly 10,500 acres of land and over 9,850 parcels in the PEP study area were converted to developed uses in the 19 year period of record studied (1976 to 1995). This amounts to a conversion rate of about 550 acres per year. By far, the greatest amount of change involved conversion to residential uses. The over 9,400 acres of additional residential development accounted for 89.9% of the total acreage change and the vast majority of the parcels (98.6%) undergoing a change in use. The report also documented 46,112 acres of residential zoned land, 650 acres of commercial zoned land and 5,136 acres of industrial zoned land available for development in the PEP watershed, for a total of 51,898 acres. This report also cited the key environmental issue for the Peconic Estuary and its watershed is how and when this available land will be utilized in the future.

c. Projections Associated with Land Available for Development

A third related report, the "Peconic Estuary Program Land Available for Development" (Suffolk County Department of Planning, April 1998), was prepared to help answer the first of two related questions of special significance to the PEP:

1) How *can* the PEP watershed be developed in the future
2) How *will* the PEP watershed be developed in the future?

The answer to the first question is a function of how land has been used in the past, what proportion of the land is available for development in the future, and the uses that are allowed on this available land as dictated by existing zoning regulations. The report answered the question of how the study area could be used in the future given the constraints of existing zoning and various assumptions. The data and information gathered anticipated the future use of assisting in quantifying pollutant loadings and the modeling of nitrogen management alternatives by the PEP, as well as the evaluation of potential land use, zoning, pollution abatement and habitat protection recommendations impacting the Peconic Estuary.

The methodology employed in the report was used to identify, map and quantify the land available for development in the PEP land use study area at the tax map scale using the PEP existing land use maps, municipal zoning maps and GIS coverages of zoning data, farmland preservation data, easement information, etc. Land available for development is

defined in this report as vacant land or land that has not yet been developed to the maximum extent as permitted by municipal zoning law. Vacant parcels, agriculturally used property with intact development rights, residentially developed property capable of further residential subdivision according to zoning and a select group of "special case" properties that are not included in any of the above categories were considered as land available for development. The methodology used for land available for development assumes that every parcel so designated will be residentially, commercially or industrially developed to the fullest extent according to town or village zoning regulations. In all cases, the projected use of a parcel available for development was determined by the existing zoning classification for that particular parcel. Designating a parcel of land available for development does not connote that the parcel should necessarily be developed. It simply states that under current zoning regulations that the parcel can be developed or the existing use occurring on the parcel can be intensified. Current zoning serves as a blueprint for the type and intensity of future development one can expect within a municipality and it is used as a planning tool to assist in the identification, mapping, and quantification of the land available for development within the study area.

Land available for residential, commercial and industrial development was inventoried. The acreage and potential number of dwelling units were calculated and special consideration was given in the case of the re-development of large parcels of developed property where changes in use are likely to occur over the near term. This report documented nearly 52,000 acres (40%) of the upland acreage in the PEP study area are still available for development, and that development of residentially zoned available land under current zoning conditions has the potential for the creation of over 27,000 new dwelling units. In 1990 over 39,000 dwelling units existed in the PEP study area. Maximization of residential development according to existing zoning could result in a total of more than 66,000 dwelling units – a 69% increase in the number of dwelling units than existed in the study area in 1990. Findings were also presented for commercial and industrially zoned lands.

d. Critical Lands Protection

The "Peconic Estuary Program Critical Lands Protection Plan" (2004) identified and prioritized land available for development in the Peconic Watershed's five eastern towns for protection. As of 2001, a little more than 22% of the land was still available for development (including both vacant land as well as land that is developed but could still be subdivided under current zoning). Agricultural lands were not included in the critical lands analysis as they are being dealt with in a separate forum. The most widely used land protection tool is full fee acquisition from willing sellers. While the Community Preservation Fund (CPF), utilizing a real estate transfer fee assessed upon the buyer, is the most successful land protection program on Long Island, raising over $169 million through January 2004, it is not sufficient to keep up with the rate of development and the loss of critical landscapes, let alone the overall inventory of land that could be developed. Future CPF revenues, while still significant, could purchase less than 10% of these lands, perhaps 1800 acres. Fortunately, other programs, primary at the county and state (and potentially Federal) level can help to bridge some of the gap, together with programs of

private land trust organizations and private citizens to reach perhaps a 15% acquisition threshold of available land.

The PEP Critical Lands Protection Strategy work group also recommended an expansion of the existing land use/vegetation preservation requirements in the Towns of Southampton and East Hampton and encouraged the adoption of similar land use regulations in other towns. Large amounts of land can be effectively protected without having to expend funds to actually acquire the properties, through clearing restrictions, clustering requirements, rezoning, overlay districts, easements, purchase of development rights, and overall sustainable land use practices. It is estimated that the implementation of vegetation preservation requirements (i.e., clearing restrictions) alone would protect an additional 3,183 acres in the five east end towns; acquiring an equivalent amount of land would cost an estimated $382 million. Vegetation preservation requirements can help to significantly reduce the amount of property that will be planted in turf grass at both the time of development and in the future, significantly reducing likely fertilizer inputs, among other benefits. These figures were calculated using the land available for development, assuming CPF purchase of some lands, and not considering lands already in a town overlay district already requiring vegetation preservation.

e. Land Use Trends Projections for Future Loads

Because so much of the watershed could be developed and there is corresponding likelihood for nitrogen loads (and especially nonpoint source loads) to increase, a TMDL that did not take into account future development are likely to be unsuccessful in achieving water quality standards in the short-term or ensuring that they will continue to be attained in the long-term. For this reason, it was necessary to specify a likely reasonable build-out scenario. Based on the above narratives and for the purpose of developing this TMDL, the main elements of this reasonable cumulative full build-out scenario, which will also be referred to in the practical load reduction scenario, are as follows:

- 50% of the remaining farmland is preserved
- 15% of the vacant land is protected, increased to 30% in the watersheds of the impaired waters
- 15% of subdividable land is protected, increased to 30% in the watersheds of the impaired waters
- The rest of agricultural, vacant and further subdividable land is developed with clustering and vegetation preservation requirements, with even more aggressive land use controls in the watersheds of the impaired waters

f. Groundwater Quality Assumptions for Calculating Loads

Groundwater inputs are especially significant for modeling the Peconic Estuary for the current baseline condition as well as projecting what may happen in the future in response to changing land uses. Once existing or future land uses were determined or projected, associated nutrient loadings also needed to be determined or projected. For the purpose of this TMDL, average nitrogen concentrations in the groundwater management zones ranged from 0.65 mg/L in the high quality freshwater Peconic River corridor

(where there is significant protected open space and vacant land, relatively little agriculture and some sewering) to 9 mg/L in north fork zones where is a significant amount of agriculture.

- Nitrogen levels in groundwater in agricultural areas were estimated at a concentration of 13 mg/L; best management practices were estimated to be able to reduce the concentration in groundwater by 25% to 9.75 mg/L, or if aggressively managed in the watersheds of the impaired waters, by 50%.

- Nitrogen levels in groundwater in non-agricultural existing developed areas were estimated at a concentration of 6 mg/L; best management practices were estimated to be able to reduce the concentration in groundwater by 25% to 4.5 mg/L, or if aggressively managed in the watersheds of the impaired waters, by 33%.

- Nitrogen levels in groundwater in golf courses areas were estimated at a concentration of 3.58 mg/L; best management practices were estimated to be able to reduce the concentration in groundwater by 25% to 2.69 mg/L, or if aggressively managed in the watersheds of the impaired waters, by 50%.

- Nitrogen levels in groundwater from vacant and subdividable lands that are developed residentially with vegetation preservation requirements and other land use controls and best management practices were estimated at 3.75 mg/L; additional best management practices in the watersheds of the impaired waters were estimated to be able to reduce the concentration in groundwater to 3 mg/L.

- Nitrogen levels in groundwater in areas of open space and vacant lands were estimated at 1 mg/L.

- Nitrogen levels in groundwater in developed areas of sewer districts were estimated at 2 mg/L. This includes a portion of the land area in the Village of Greenport which is sewered, though the Greenport STP discharges outside of the Peconic Estuary (to the Long Island Sound).

- The above nitrogen levels in groundwater were assumed to be further reduced by 0.2 mg/L in response to the implementation of Federal Clean Air Act requirements (i.e., less nitrogen being deposited on the watershed landscape will lead to improved groundwater quality).

g. Tributary Inflows

In the western Estuary, there are 8 tributary inflows included in the model as distinct loads. These 8 tributaries (along with the location of the Riverhead Sewage Treatment Plant outfall) are depicted in Figure V.4

Table V.1: Summary of Relevant Permit Requirements, Limitations and Discharge Monitoring Data for the Sag Harbor, Shelter Island Heights and Riverhead Sewage Treatment Plants

Riverhead STP ---------- Parameter	Permit Conditions	Discharge Monitoring Data		
		Summer Average (06/'05 to 09/'05)	1 Yr Average (03/'05 to 02/'06)	4 Yr Average (04/'02 to 02/'06)
Flow (MGD)	1.3	0.79 (min=0.766; max=0.808) 0.79 (winter average, 11/05 to 01/06)	0.81 (min=0.697; max=1.146)	0.79 (min=0.66; max=1.044)
Total Nitrogen (lbs/day)	170	71. (min=43.; max=133)	61. (min=43.; max=133)	70. (min=23.; max=141.)
Total Nitrogen concentration (mg/L) (back-calculated)	no reporting requirement	10.8	9.0	10.7
Sag Harbor STP ---------- Parameter	Permit Conditions	Discharge Monitoring Data		
		Summer Average (06/'05 to 09/'05)	1 Yr Average (03/'05 to 02/'06)	4 Yr Average (04/'02 to 02/'06)
Flow (MGD)	0.25	0.13 (min=0.11; max=0.14) 0.06 (winter average, 11/05 to 01/06)	0.094 (min=0.06; max=0.138)	0.094 (min=0.059; max=0.14)
Total Nitrogen (lbs/day) (back-calculated)	no reporting requirement	5.5 lbs/day	4.4 lbs/day	4.8 lbs/day
Total Nitrogen concentration (mg/L)	8	2.5 (min.=2, max-3.1), 5.2 (2003) 6.6 (winter average, 11/05 to 01/06)	5.6 (min.=2, max=9.3)	6.17 (min=1.8, max=18.6)
Shelter Island Heights STP ---------- Parameter	Permit Conditions	Discharge Monitoring Data		
		Summer Average (06/'05 to 09/'05)	1 Yr Average (03/'05 to 02/'06)	4 Yr Average (04/'02 to 02/'06)
Flow (MGD)	0.053	0.032 (min=0.025, max=0.038) 0.014 (winter average, 11/05 to 01/06)	0.021 (min=0.011; max=0.038)	0.021 (min=0.008; max=0.042)
Total Nitrogen (lbs/day) (back-calculated)	no reporting requirement	5.2	2.1	1.7
Total Nitrogen concentration (mg/L)	reporting only	19.5 mg/l, (min=5.2, max=27.4) 11.3 (winter average, 11/05 to 01/06)	12.2 mg/l (min.=5.1 max=27.4)	10.2 mg/l (min=3.8, max=27.4)

h. Point Sources/Sewage Treatment Plants
See table V.1 for a summary of relevant permit requirements, limitations and discharge monitoring data for the Sag Harbor, Shelter Island Heights and Riverhead Sewage Treatment Plants. A discussion of the Atlantis Marine World (the Riverhead Aquarium) follows.

***i.* The Sag Harbor and Shelter Island Heights STPs**
For the baseline scenario, the nitrogen loads from the Sag Harbor and Shelter Island Heights sewage treatment plants were determined by extending the existing effluent quality (i.e., 6.2 mg/L and 10.2 mg/L, respectively) for their permitted flows (0.25 and 0.053 MGD, respectively) or 13. lbs TN/day and 4.5 lbs. TN/day. The nitrogen load assigned to the Sag Harbor STP treatment plant was determined using the current permit effluent discharge concentration (8 mg/L) and the permitted flow (0.25 MGD), resulting in a calculated load of 17 lbs. TN/day. Similarly, the nitrogen load assigned to the Shelter Island Heights STP was determined by extending the existing effluent quality (10.2 mg/L) to the permitted flow (0.053 MGD), resulting in a calculated load of 5.0 lbs. TN/day.

***ii.* Riverhead Sewage Treatment Plant - Overview**
At the Riverhead Sewage Treatment Plant, the current nitrogen load being discharged, based on existing effluent quality and flows, is 70 lbs. of TN/day. For baseline model runs however, the load is 130 lbs./day which was statistically related to the estimated daily average daily loading associated with a monthly average of 170 lbs. per day for a 24-hr composite sample at a sampling frequency of one sample per week. For loads in the future, the assigned load is 40 lbs. TN/day from May 1 to September 30 and 130 lbs. TN/day rest of year. From October 1 to April 30, the load is based on the permitted flow and existing treatment. From May-September, the target load can be achieved by reducing the flow based on a beneficial effluent reuse project that will divert a portion of the flow from discharge to the nutrient sensitive Tidal Peconic River, with the balance of the flow receiving optimization of existing treatment. This is described in additional detail in the section that follows.

***iii.* Riverhead Sewage Treatment Plant – Expanded Discussion**
The Riverhead Sewage Treatment Plant presented some special challenges in this analysis due to the location of its outfall in the poorly flushed and already nutrient enriched Tidal Peconic River. State water quality standards for dissolved oxygen are not currently achieved in the area in the proximity of the outfall. The DO sag occurs in spite of the fact that there is already an advanced wastewater treatment system in place for nutrient removal and that the facility is discharging well below its permitted maximum flow and permitted nitrogen load. Numerous modeling scenarios investigating a variety of point and nonpoint source load reductions demonstrated that it is necessary to reduce this particular point source load, particularly during the critical warm weather months, in order to achieve water quality standards for dissolved oxygen.

The current SPDES permit for this facility authorizes a permitted flow of up to 1.3 million gallons per day and a maximum nitrogen loading of 170 lbs. TN/day (expressed

as a monthly average based on a 24 hour composite sample and a sampling frequency of once per week). The permit does not specify concentration limits for nitrogen. If the maximum nitrogen load was discharged at the maximum permitted flow, it would translate to 15.7 mg/L.

At the present time, the Riverhead STP flow is 0.79 MGD and discharges at an average of 10.7 mg/L; this translates to a daily loading of 70 lbs. of TN/day. The discharge load and effluent quality data are based on actual STP monitoring data from April 2002 through February 2006. If the Riverhead STP was to maintain this existing effluent quality at its permitted flow of 1.3 MGD, the nitrogen load would be 116 lbs. TN/day. Additional advanced treatment technology could achieve an effluent quality of 5 mg/L; this will be referred to as the "limit of technology" for the STP. Effluent at this limit of technology would discharge 33 lbs. TN/day at the current flow or 54 lbs. TN/day at the permitted flow.

There is currently a funded project in place through which a portion of the Riverhead STP effluent flow will be beneficially reused to irrigate the adjacent county golf course during the warm weather months (May through September), thereby lessening the impact from the direct discharge to the stressed Tidal Peconic River. Both the current and maximum permitted flows from the STP exceed the projected irrigation needs at the golf course, which has been calculated to be 0.35 MGD. This project, when implemented will use the reclaimed water and reduce the direct loading of a portion of the discharged nitrogen load during the critical warm weather months.

At the permitted flow, with the existing effluent quality, and effluent diversion for beneficial reuse, the calculated load during the warm weather months would be 86 lbs. TN/day. At the current flow with the existing effluent quality, and effluent diversion for beneficial reuse, the calculated load during the warm weather months would be 40 lbs. TN/day.

If the effluent quality is improved to the limit of technology (5 mg/L), at the permitted flow and with effluent diversion for beneficial reuse, the calculated load would be 40 lbs. TN/day. At the limit of technology, the current flow and effluent diversion for beneficial reuse, the calculated load would be 18 lbs. TN/day.

The baseline scenario in the analysis that follows is based on a year-round load from the Riverhead STP of 130 lbs. TN/day. Based upon the various modeling scenarios designed to achieve state water quality standards for dissolved oxygen now and in the future (in combination with other point and nonpoint source load reductions) this TMDL is based on a discharge of 130 lbs. TN/day during the cold weather months and 40 lbs. TN/day during the warm weather months. These loads are achievable at the existing flow, continuing existing effluent quality and effluent diversion for beneficial reuse. It can alternatively be achieved for the permitted flow, at limit of technology treatment and effluent diversion for beneficial reuse.
The information in the preceding paragraphs for the Riverhead Sewage Treatment Plant is summarized in Table V.2.

Table V.2: Riverhead STP Flows, Effluent Concentrations and Nitrogen Loads Associated with Various Discharge Scenarios

Scenario Summary Description	Average Daily STP Flow (MGD)	Average Daily Effluent Concentration (mg/L)	Average Daily Nitrogen Loading (lbs./day)
Current flow at existing effluent quality	0.79	10.7	70
Permitted flow at existing effluent quality	1.3	10.7	116
Permitted flow at existing effluent quality with effluent diversion for reuse	0.95	10.7	86
Permitted flow with limit of technology effluent quality	1.3	5.0	54
Permitted flow with limit of technology effluent quality and effluent diversion for reuse	0.95	5.0	40
Current flow at existing effluent quality and effluent diversion for reuse	0.44	10.7	40
Current flow with limit of technology effluent quality	0.79	5.0	33
Current flow with limit of technology effluent quality and effluent diversion for reuse	0.44	5.0	18

Notes to Table V.2
(1) The current 4 year average from April 2002 through February 2006 flow, discharge load and effluent quality are 0.79 MGD; 70. lbs. TN/day; and 10.7 mg TN/L, respectively. All other values in this table are calculated values.
(2) Anticipated diversion for beneficial effluent reuse, irrigating the adjacent Indian Island County Golf Course, is 0.35 MGD from May 1 through September 30.
(3) The current permit allows a discharge of 1.3 MGD and 170 lbs. TN/day; there is no expressed concentration limit for nitrogen.

iv. Atlantis Marine World (the Riverhead Aquarium)

The Atlantis Marine World facility discharges to the tidal Peconic River, just west of the Riverhead STP. The permitted flow is 0.0081 MGD; there is no nitrogen loading or concentration limit in the current permit. The load assigned to this facility is 4 lb. TN/day; while this assignment is based on a limited data set from discharge monitoring reports, a limit is necessary due to the location of the discharge in the nutrient sensitive tidal Peconic River,

i. Wet and Dry Atmospheric Deposition

The Peconic Estuary Program model documentation presents atmospheric deposition rates (pre implementation of Clean Air Act Amendments) and includes wet and dry deposition of organic and inorganic nitrogen, and translates to approximately 21 kilograms per hectare (18.7 lbs./acre). Wet and dry atmospheric deposition loads are estimated to be reduced by 31.3% in response to the implementation of the Clean Air Act. This results in a direct reduction to the surface waters loads; groundwater TN contributions are projected to be reduced by 0.2 mg/L in response to the improved atmospheric deposition quality (also described/included above under "Groundwater Quality Assumptions for Calculating Loads").

j. Stormwater Runoff

Stormwater runoff loading is treated as a point source in the model. In response to mitigation, a 15% reduction in stormwater N load is attributed to Peconic River and

Flanders Bay and a 10% reduction to east of Flanders Bay. Note that current stormwater TN loading estimates for the Peconic River and Flanders Bay is 30 lb TN/day and east of Flanders Bay is 100 lb TN/day. The stormwater loading is apportioned to each shoreline model grid cell.

Stormwater discharges from the separate storm sewer systems operated by the Villages of Sag Harbor and North Haven, the Towns of Riverhead, Southampton and Brookhaven, the New York State Department of Transportation, and Suffolk County stormwater facilities are regulated under the EPA's Phase II Stormwater Program. As of March 2003, these municipal entities were required to obtain NPDES permit coverage and to begin implementing comprehensive stormwater management programs designed to reduce and prevent the impacts of their discharges of contaminated stormwater on surface waters. Complete implementation of first permit cycle (2003-2008) municipal Phase II stormwater management programs is mandated by January 2008, at which time the second Phase II permit cycle (2008-2013) will begin. The points of discharge, or outfalls, from regulated municipal separate storm sewer systems are considered point sources to the Peconic Estuary. Other stormwater inputs are not currently regulated as point sources and are managed as nonpoint sources, but this will be reviewed in the future and may result in additional areas subject to municipal stormwater permits.

The stated stormwater load originates from municipal separate stormwater systems as well as from flows from rural and developed areas, including stormwater that directly and indirectly enters watercourses. The stated reductions of 10 % and 15% percent were determined (based upon best professional judgment) to be maximum that could be reasonably achieved.

k. Other Point Sources

In addition to the point sources described above, there are other point sources within the Peconic Estuary watershed: the Brookhaven National Laboratory, the former Naval Weapon Industrial Reserve Plant, and Plum Island STPs. The PEP model accounts for the Brookhaven National Laboratory STP discharge as a boundary load in the tributary load attributed to the Peconic River, which is expressed as a loading allocation (LA) within these TMDLs. The BNL discharge does not discharge to estuarine waters or directly to an impaired segment. The Plum Island STP discharges to an extremely well mixed area at the eastern boundary of the system and its impact on the Peconic Estuary System is considered de minimus due to its location. While the former Naval Weapon Industrial Reserve Plant (previously operated by the Grumman Corporation) in Calverton, NY has an STP that discharges to a branch of the Peconic River, the operators have submitted engineering reports to upgrade and build a new facility discharging outside of the Peconic Estuary study area. Additional discussion of these discharges is provided in the implementation section of this report.

3. Summary of Baseline Nutrient Loads and Uncertainties

In the average estimated baseline year, 5,357,364 pounds of nitrogen enters the Peconic Estuary, consisting of: 3,015,041 pounds (56%) from atmospheric deposition; 2,175,031 pounds (41%) from groundwater, 66,242 pounds (1%) from the Peconic River and seven

western tidal creeks, 53,689 pounds (1%) from three sewage treatment plants, and 47,361 pounds (1%) from stormwater. It should also be noted that the model integrates stormwater into river flows. Actual loadings will vary from year to year depending on the amount and intensity of rainfall and meteorological conditions that affect water circulation and fluxes. Land development trends in the future and how humans contribute nitrogen to the landscape and to groundwater (principally from on-site disposal systems, agricultural operations, and lawn care and landscaping) will also affect nitrogen load increases or decreases. Future work may improve estimates of land based contributions and atmospheric deposition rates.

Estuaries, by their very nature, are complex and are in a constant state of change. The twice daily flooding and ebbing tides mix ocean water with freshwater from rivers, creeks, and groundwater to form a rich cradle of life. Likewise, the watershed surrounding the estuary also changes: homes are built on open space; some land is preserved in its natural state for the benefit of humans and wildlife; farmland is tilled or is left to lie fallow; an individual makes a decision about whether to apply fertilizers. The cumulative effects of natural events and human actions (or inaction) will ultimately influence the Peconics, its watershed, and everything in them. While areas with low levels of dissolved oxygen continue to exist, total nitrogen concentrations throughout the main stem of the estuary seem to be decreasing. Decreases in nitrogen concentrations in the western Peconic Estuary may possibly be due to decreases in loadings to the system, increased uptake in the food web, or some combination of these two mechanisms (and perhaps others). Decreases in loadings may be attributed to the Riverhead Sewage Treatment Plant tertiary treatment upgrade completed in May 2001and decreases in the nitrogen load contributed from the freshwater portion of the Peconic River (a marked decrease in nitrogen concentrations from the freshwater portion of the Peconic River has been seen in the past 20 years). Changes in subregional land uses and agricultural practices also may have an impact on nitrogen concentrations in groundwater (e.g., conversion of agricultural land to residential uses, and row crops to vineyards (vineyards being less heavily fertilized)). It should be noted that the roles macroalgae, sediment nutrient flux, and filter feeders play in affecting the surface water concentrations of nitrogen are believed to be significant. Ambient total nitrogen water quality levels should not be considered the only indicator of eutrophication stress. Further study is warranted to better understand where excess nitrogen is going and why DO conditions are not improving.

The tables and pie charts that follow depict nitrogen sources for the three impaired waterbody segments and for the other waters in the Peconic Estuary System, as well as a summary of the entire system by waterbody and by nitrogen source.

Table V.3: Baseline Nitrogen Load Summary for Segment 1701-259, Lower Peconic River and Tidal Tributaries

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	2,590.
Groundwater	115,672.
Little River	2,181.
Peconic River	40,146.
Stormwater	3,140.
Riverhead STP	47,353.
Total*	211,072.

*May not add due to rounding

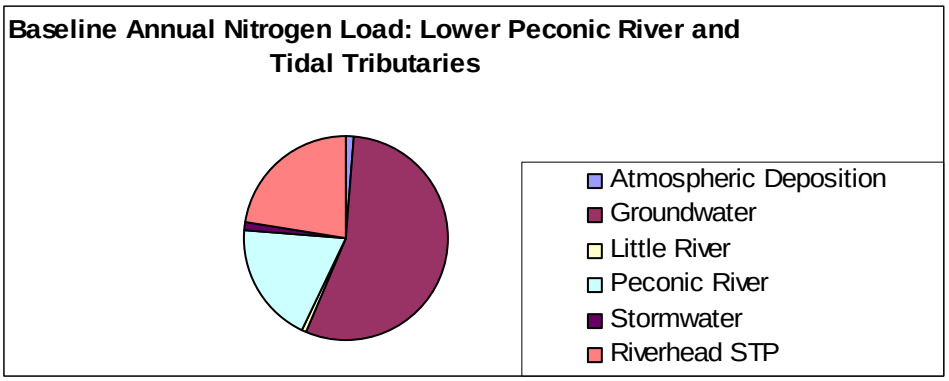


Table V.4: Baseline Nitrogen Load Summary for Segment 1701-254, Western Flanders Bay and Lower Sawmill Creek

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	2,724.
Groundwater	26,539.
Sawmill Creek	2,181.
Stormwater	1,919.
Total*	33,363.

*May not add due to rounding

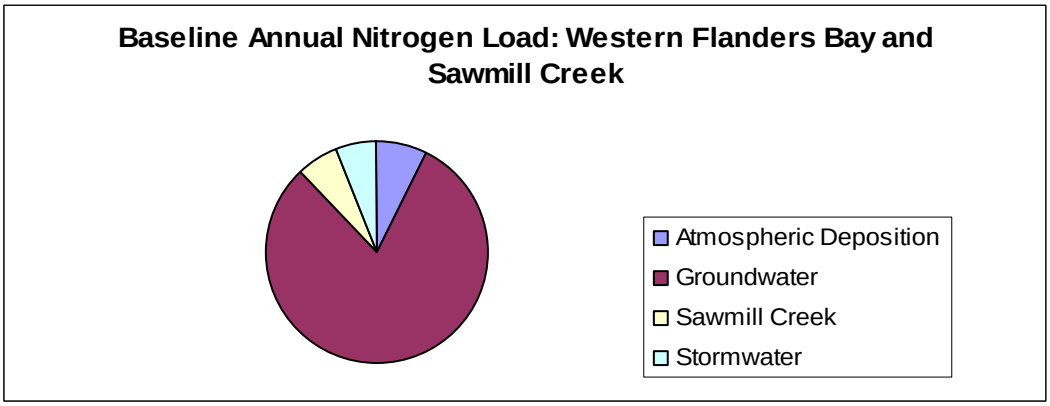


Table V.5: Baseline Nitrogen Load Summary for Segment 1701-256, Meetinghouse Creek and Terrys Creeks and Tributaries

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	1,508.
Groundwater	77,387.
Terrys Creek	1,589.
Meetinghouse Creek	17,021.
Stormwater	2,328.
Total*	99,838.

* May not add due to rounding

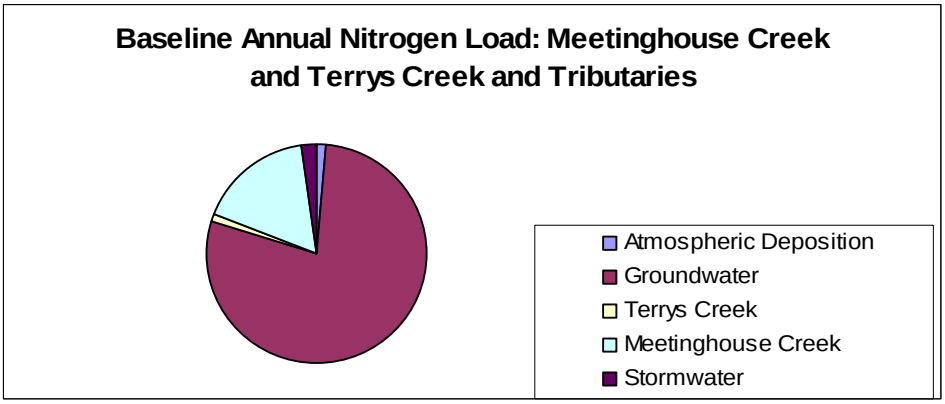


Table V.6: Baseline Nitrogen Load Summary for Flanders Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	46,490.
Groundwater	176,811.
Hubbard Creek	1,733.
Mill Creek	940.
Birch Creek	452.
Stormwater	3,541.
Total*	229,966.

*May not add due to rounding

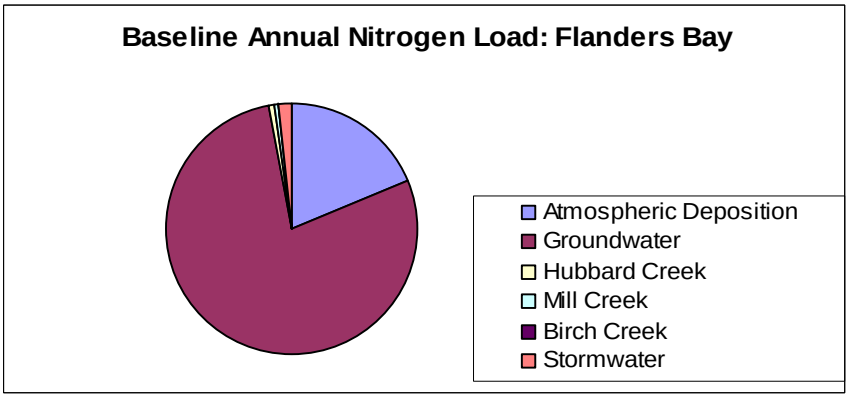


Table V.7: Baseline Nitrogen Load Summary for Great Peconic Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	379,951.
Groundwater	309,881.
Stormwater	3,252.
Total*	693,081.

*May not add due to rounding

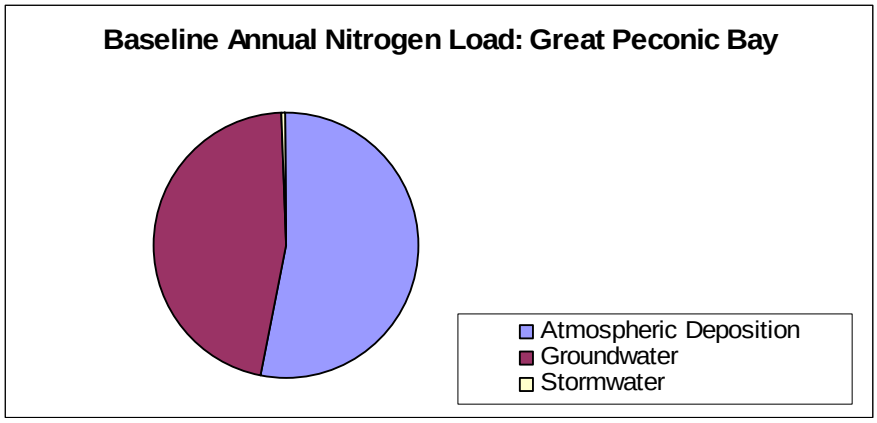


Table V.8: Baseline Nitrogen Load Summary for Little Peconic Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	251,440.
Groundwater	327,139.
Stormwater	5,990.
Total*	584,565.

* May not add due to rounding

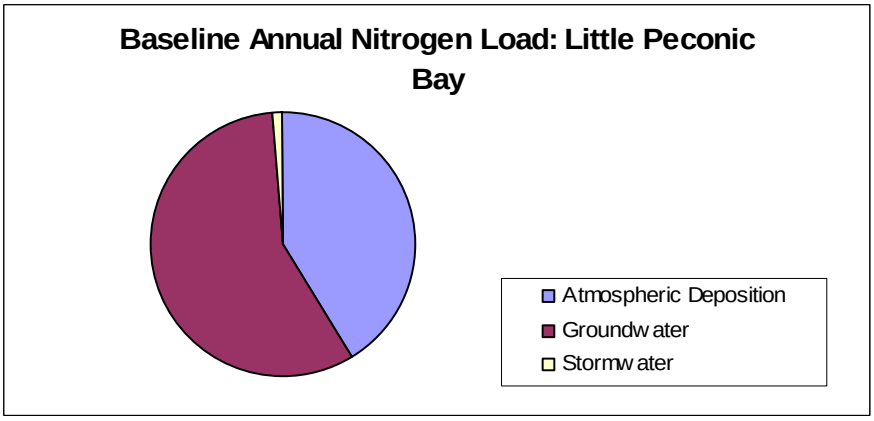


Table V.9: Baseline Nitrogen Load Summary for Shelter Island Sound

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	438,292.
Groundwater	645,275.
Sag Harbor STP	4,690.
Shelter Island Heights STP	1,646.
Stormwater	18,983.
Total*	1,108,888.

*May not add due to rounding

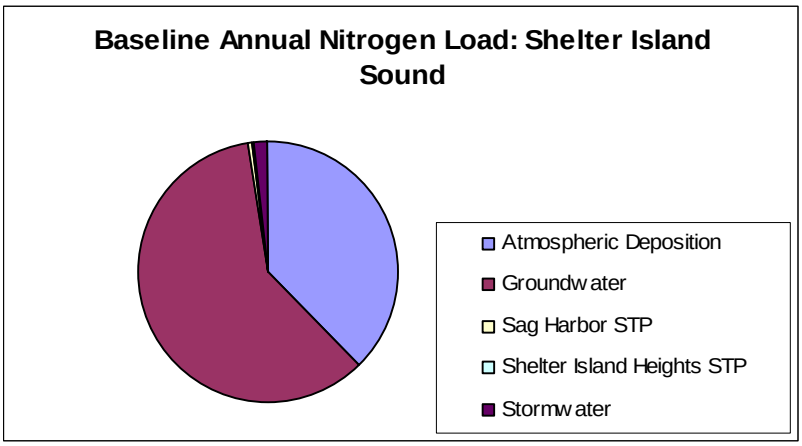


Table V.10: Baseline Nitrogen Load Summary for Gardiners Bay

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	1,892,048.
Groundwater	496,327.
Stormwater	8,207.
Total*	2,396,587

*May not add due to rounding

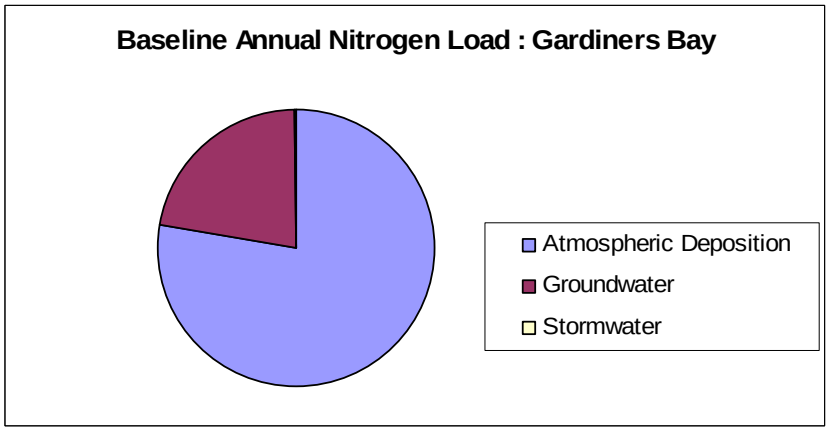


Table V.11: Baseline Systemwide Summary

Nitrogen Source	Total Annual Load TN (lbs)
Lower Peconic River and tidal tributaries	211,072.
Western Flanders Bay and Sawmill Creek	33,363.
Meetinghouse and Terrys Creeks and Tributaries	99,838.
Flanders Bay	229,966.
Great Peconic Bay	693,081.
Little Peconic Bay	584,565.
Shelter Island Sound	1,108,888.
Gardiners Bay	2,396,587.
Total*	5,357,359.

*May not add due to rounding

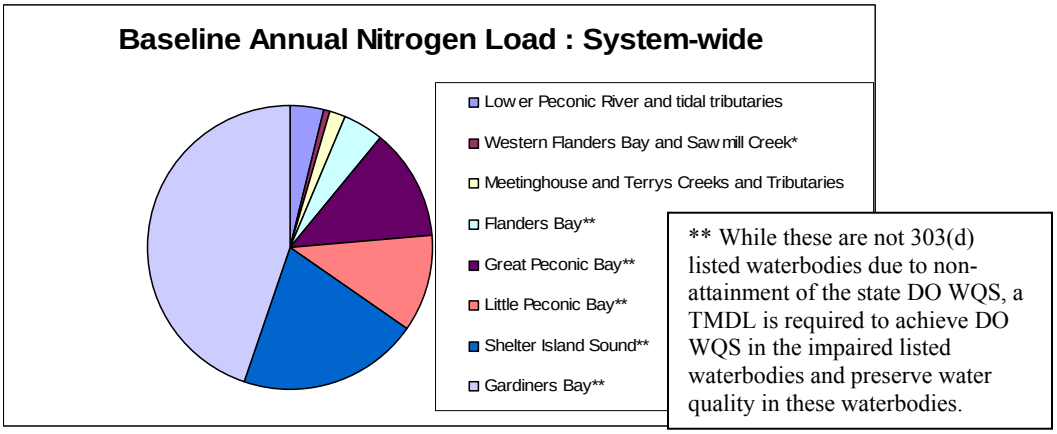
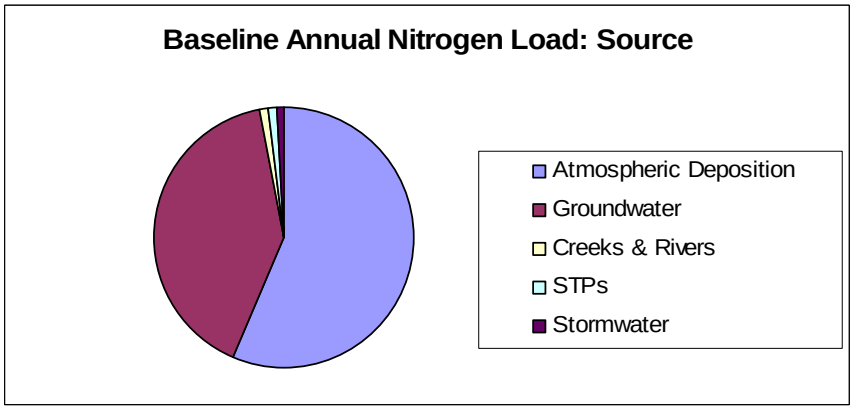


Table V.12: Baseline Systemwide Summary by Source

Nitrogen Source	Total Annual Load TN (lbs)
Atmospheric Deposition	3,015,041.
Groundwater	2,175,031.
Creeks & Rivers	66,242.
STPs	53,689.
Stormwater	47,361.
Total*	5,357,364.

*May not add due to rounding



C. Water Quality Model

Under the Peconic Estuary Program, the SCDHS, EPA, and the DEC sponsored the development of a three-dimensional, time-variable hydrodynamic and water quality model called the Environmental Fluid Dynamics Code or EFDC (Hamrick, 1992). EFDC is a public domain, open source, surface water modeling system, which includes hydrodynamic, sediment and contaminant, and water quality modules fully integrated in a single source code implementation. The kinetic processes included in the EFDC water quality model are derived from the CE-QUAL-ICM water quality model (Cerco and Cole, 1993, 1994) as described in Park et al. (1995). The water quality model also included a sediment flux processes submodel. The model incorporated advanced physical, biological, and chemical kinetics that relate nutrients to phytoplankton dynamics and DO. The model was used to help understand nutrient and oxygen dynamics in the Peconic Estuary System and to evaluate alternative nutrient management options for improving water quality.

The model used for the Peconic Nitrogen TMDL built upon the PEP model by including a much more detailed grid in the western bays in order to provide adequate resolution for resolving water quality issues in the three listed waterbodies (i.e., the Lower Peconic River and Tidal Tributaries, Western Flanders Bay and Lower Sawmill Creek, and Meetinghouse Creek, Terrys Creek and Tributaries). The vertical resolution of the model was increased from two layers in the PEP study to four layers in the TMDL effort. Also, kinetic rates in the sediment flux submodel were updated based on information from a sediment accretion study funded under PEP (Cochran et al., 2000) as well as from published data (DiToro, 2001).

The EFDC model was calibrated using an eight-year period from October 1, 1988 to September 30, 1996. The model was verified using a six-year period from October 1, 1996 to September 30, 2002. Details of the calibration and verification are documented in the hydrodynamic and water quality model reports (Tetra Tech, 2000, 2005). The 14-year period covered by the calibration and verification included all seasons of the year as well as extreme wet and dry years. Tributary loadings were determined using time-variable river flow measured at the Peconic River USGS gauge (01304500) and observed water quality data. Meteorological, hydrological, and tidal forcing conditions that influence external boundary conditions and internal circulation within the estuary have been considered and are included in the model. The EFDC model reproduced both the temporal and spatial trends in observed data and successfully simulated the 1988-2002 conditions.

Although data records indicate that the occurrence of low DO takes place from May through September, nitrogen loadings throughout the year contribute to the pool of nitrogen available for uptake by phytoplankton and for distribution to bottom sediments. The model indicated that the Riverhead STP warranted special attention to seasonal management of nitrogen due to the location of its outfall in relation to the critical DO sag point in tidal Peconic River.

A review of the biweekly monitoring data collected by SCDHS indicated that the October 2000 to September 2002 time frame was the most severe period in terms of DO observations below the New York State water quality standard of 5 mg/L. Based on this review, the period October 1, 2000 to September 30, 2002 was selected as the critical period for the TMDL model runs. Because 2000-2002 was a severe period, average year conditions would predict better water quality conditions. Thus, by using the severe conditions of 2000-2002 as the TMDL modeling period, a conservative level of nitrogen reduction is identified, thereby providing a margin of safety (MOS) for average years.

1. Water Quality Model Projections

The EFDC model was run under a range of alternative nutrient management loading scenarios to simulate the effect on DO concentrations, especially in the listed waterbodies. Of particular importance were simulations of "baseline" and "pastoral" conditions. The baseline condition consisted of existing nutrient loadings corresponding to the 2000-2002 modeling period, and provided important information on the dynamics of oxygen in western Peconic Estuary and the causes for its depression. The pastoral condition included loadings of nutrients estimated for a pristine, forested watershed that presumably existed before colonial settlement of the region. This condition provided insight into what oxygen levels may have been before intensive human uses in the Peconic Estuary watershed.

One of the advanced features of the EFDC model is the sediment processes submodel, which provides dynamic simulation of benthic nutrient fluxes and sediment oxygen demand in response to variations in external loading of organic material to the system. Model tests indicated that the sediment requires about six years to reach a new dynamic equilibrium in response to a reduction in nutrient loading to the model. Therefore, each of the alternative model simulations, including the baseline and pastoral scenarios, was run for a total of six years. In other words, the two-year simulation period (October 1, 2000 to September 30, 2002) was repeated three times with the water column and sediment conditions at the end of each run being input as initial conditions for the beginning of the next two-year run. It is important to remember that the model predicts that there will be a six-year lag time between the implementation of nutrient controls and the corresponding full response of improvements to water quality in the Estuary.

Interpretation of the monitoring data as well as the results of the water quality model led to the following conclusions:

- The monitoring data and modeling results both indicate that nitrogen, not phosphorus, is the limiting nutrient for phytoplankton growth in the western Peconic Estuary.

- The model reproduced the principal interactions among density-driven circulation, nutrient inputs, sediment nutrient flux processes, and phytoplankton abundance on an annual cycle. The spatial and temporal distributions of dissolved oxygen were also reproduced on both an annual cycle and a daily cycle in the critical western region of Peconic Estuary.

- Sediment fluxes of nutrients and sediment oxygen demand are especially important in the shallow waters of the western Estuary. The model adequately reproduced the temporal and spatial distribution of sediment flux rates that were measured in the Estuary.

- Hypoxia is defined as a reduced oxygen concentration in a water body that may lead to stressful or fatal conditions for aquatic organisms. Hypoxic conditions for the TMDLs are considered as DO concentrations less than 3.0 mg/L, which is the acute DO criterion in the proposed New York water quality standard. The extent of hypoxia was estimated by using the model results to calculate a volume-day unit of measure (acre-feet-days) for each of the three impaired waters (see Table V.3).

- The chief regulators of DO concentrations in the Estuary are related to biological activity. While nitrogen is essential to a productive ecosystem, too much nitrogen fuels the excessive growth of aquatic plants, including phytoplankton and macroalgae that may, through night-time respiration and ultimate decomposition (including accumulations in bottom sediments), result in low dissolved oxygen levels in the water column. Night-time respiration of plants in combination with other routes of oxygen demand (especially sediment oxygen demand) can cause short-term DO depressions in the early morning hours (diurnal dissolved oxygen variation).

- In Table V.3, the column labeled "Worst Case Scenario" shows the hypoxic volume-days assuming DO is less than 3.0 mg/L at all locations and all times. The hypoxic volume-days total for baseline conditions is about 2% of the worst-case scenario total. However, this is somewhat misleading because hypoxic conditions may only need to exist for a short period of time (e.g., one or two hours) to be fatal to some aquatic organisms.

- For pastoral conditions, the DO concentration in all waters is greater than the 3.0 mg/L hypoxic threshold at all times.

The pastoral scenario is sensitive to the methods used to estimate loadings to the Peconic Estuary. The elimination of point source loads from sewage treatment plants in the Peconic Estuary is straightforward. However, pastoral estimates are not as easily made for nutrient loads from natural forested areas in the watershed and groundwater underflow loads. For this TMDL analysis, atmospheric deposition during pastoral times was estimated to be 31.3% less than present day levels, which only represents the projected improvement that will occur with implementation of Clean Air Act pollution controls. The rationale behind this assumption is that air quality in pastoral times should have been at least as good as the projected quality due to Clean Air Act improvements.

Ultimately, the full achievement of designated uses and water quality standards will be the result of actions on several fronts, including the preservation of open space and

ensuring that where future development does occur, it results in lower loading rates of nitrogen to groundwater than current existing development practices. Existing sources of nitrogen need to be reduced, including from wet and dry atmospheric deposition, agricultural operations, stormwater (both regulated/permitted flows and flows not currently subject to regulation/permitting), residential lawn care and gardens, golf courses and turf in other commercial and institutional settings. Loadings from sewage treatment plants and other point sources must also be managed. Based on the modeling effort, implementation of this TMDL (including mechanical aeration where and if necessary) will achieve New York State Water Quality Standards for dissolved oxygen, including the diurnal DO variation that has been discussed previously.

Table V.3: Hypoxic Volume-Days in 303(d) Impaired Waters of Western Peconic Estuary

Waterbody ID	Waterbody Name	Hypoxic Volume-Days (ac-ft-days)				
		Worst Case Scenario	Baseline Condition	Practical Load Reduction Scenario	PLR plus Mechanical Aeration	Pastoral Condition
1701-0259	Tidal Peconic River and tributaries	313,697.	12,036.	192.	0.00	0.00
1701-0254	Sawmill Creek and Western Flanders Bay	303,510	1,891	1.50	0.00	0.00
1701-0256	Meetinghouse Creek and Terrys Creek	130,039	1,175.	5.09	0.00	0.00
	Total	747,246	15,102	199.	0.00	0.00
		Percent Reduction from Baseline Condition				
1701-0259	Tidal Peconic River and tributaries	-	0.00%	98.40%	100.00%	100.00%
1701-0254	Sawmill Creek and Western Flanders Bay	-	0.00%	99.92%	100.00%	100.00%
1701-0256	Meetinghouse Creek and Terrys Creek	-	0.00%	99.57%	100.00%	100.00%
	Total	-	0.00%	98.68%	100.00%	100.00%

2. Development of Nitrogen Reduction Plans

The EFDC model of Peconic Bay was used to simulate the effects of reducing nitrogen loading on DO concentrations in the estuary. Of particular interest were the "practical load reduction" (PLR) scenario and the "PLR plus mechanical aeration" scenario. The PLR scenario included nutrient loading at projected growth and reductions described above in V.B.2, Nutrient Loading Factors, for controllable sources within the Peconic Estuary watershed. In the western portion of Peconic Estuary, aside from the regulated MS4s, there is one STP (Riverhead) and eight tributary inflows included in the model (see Figure V.4 and Tables V.4 and V.5). The small Atlantis Marine World facility also discharges to the tidal Peconic River. There are a number of groundwater management zones for which nitrogen concentrations were estimated (see Figures V.3 and V.5 and Table V.6). Monthly-varying groundwater flows into the Peconic Estuary were estimated from a study by the USGS (Schubert, 1998). Estimated reductions in groundwater nitrogen loads were based on management measures placed on land uses within the groundwater management zones.

Table V.4: SPDES Permit Limits for Peconic Estuary Sewage Treatment Plants

Facility SPDES ID	Baseline Condition		Practical Load Reduction Scenario (Oct-Apr)		Practical Load Reduction Scenario (May-Sep)	
	Flow (mgd)	TN (lb/day)	Flow (mgd)	TN lb/day)	Flow (mgd)	TN (lb/day)
Riverhead NY0020061	1.300	130	1.300	130	0.950	40
Sag Harbor NY0028908	0.250	13	0.250	17	0.250	17
Shelter Island NY0021814	0.053	4.5	0.053	5	0.053	5

Note: there were no STP discharges in the pastoral scenario

Table V.5: Tributary TN concentrations for the baseline, pastoral, and practical load reduction scenarios

Tributary	Flow ratio to Peconic River USGS gage	TN Concentration (mg/L)		
		Baseline Condition	Pastoral Scenario	Practical Load Reduction Scenario
Peconic River	1.0160	0.65	0.3	0.38
Meetinghouse Creek	0.0957	7.00	0.3	4.19
Hubbard Creek	0.0439	0.65	0.3	0.38
Mill Creek	0.0238	0.65	0.3	0.38
Birch Creek	0.0114	0.65	0.3	0.38
Terrys Creek	0.0290	0.65	0.3	0.38
Sawmill Creek	0.0402	0.65	0.3	0.38
Little River	0.0552	0.65	0.3	0.38

Table V.6: Groundwater TN concentrations for the baseline, pastoral, and practical load reduction scenarios

Groundwater Management Zone	Area (acres)	Baseline Condition (mg/L)	Pastoral Scenario (mg/L)	Practical Load Reduction Scenario (mg/L)
Montauk (MONT)	8,515	4.00	0.3	3.06
Gardiners Bay South (GB-S)	15,998	4.00	0.3	3.04
Little Peconic South (LP-S)	15,090	4.00	0.3	2.89
Great Peconic South (GP-S)	10,001	4.00	0.3	3.11
South Fork Inland (SF-I)	3,177	3.00	0.3	2.54
South Fork Central (SF-C)	1,777	3.00	0.3	2.27
North Fork Central (NF-C)	1,798	8.00	0.3	4.37
North Fork Inland (NF-I)	1,409	8.00	0.3	3.89
Peconic River East (PR-E)	6,884	5.00	0.3	2.95
Great Peconic North (GP-N)	7,011	9.00	0.3	5.23
Little Peconic North (LP-N)	9,357	9.00	0.3	5.91
Gardiners Bay North (GB-N)	3,202	9.00	0.3	5.21
Shelter Island (SHE)	7,173	3.00	0.3	2.26
Meetinghouse Creek (MC)	1,236	9.00	0.3	4.19

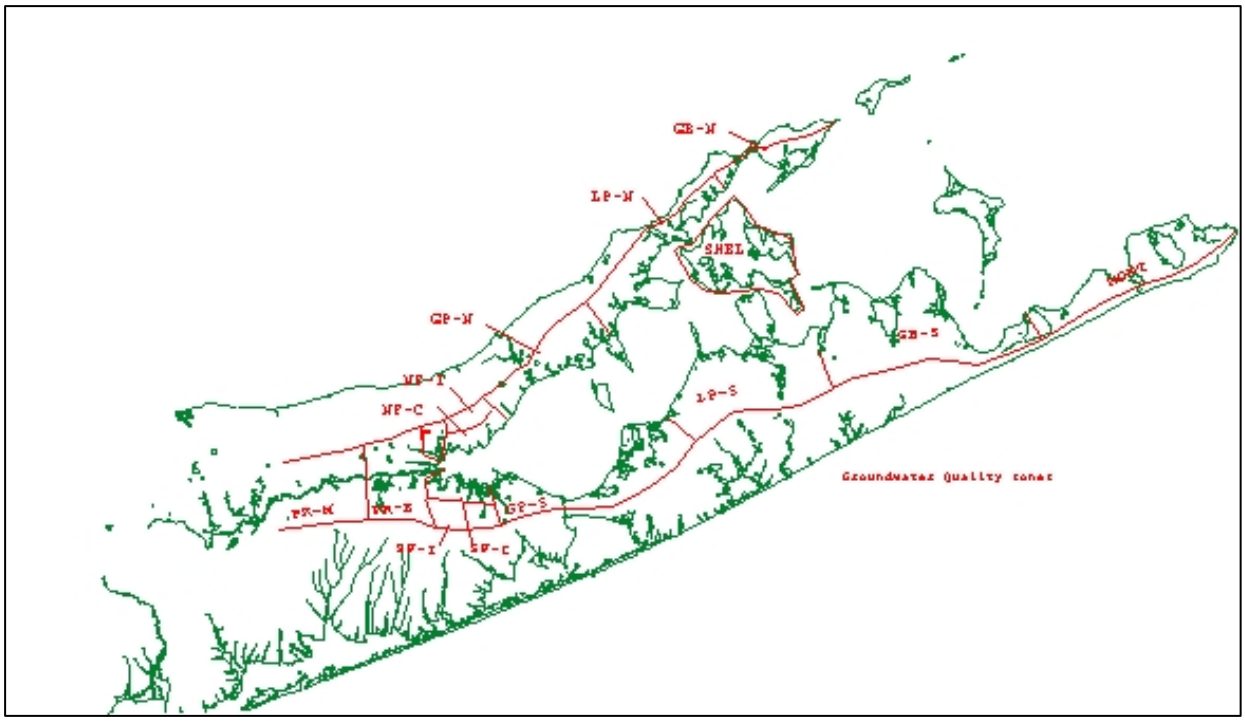


Figure V.3: Peconic Estuary Study Area Groundwater Management Zones

The practical load reduction scenario includes the reasonable cumulative full build-out scenario [50% of remaining farmland is preserved; 15% of vacant land is protected (30% in Meetinghouse Creek (MC) and Peconic River–East (PR-E) groundwater management zones); 15% of subdividable land is protected (30% in MC and PR-E); rest of agricultural, vacant and further subdividable land is developed with clustering and vegetation preservation requirements (i.e., clearing restrictions)]. This scenario also includes:

1) A 25% total nitrogen (TN) reduction from all protected agricultural parcels (50% reduction in the MC and PR-E groundwater management zones)
2) A 25% TN reduction from golf course parcels (50% reduction in MC and PR-E)
3) A 25% TN reduction from existing development (non-agricultural) parcels (33% reduction in MC and PR-E)
4) A 37.5% TN reduction from the existing agricultural land, vacant land, and further subdividable land that is then developed with clustering and vegetation preservation requirements (50% reduction in MC and PR-E)
5) A 31.3% TN reduction in atmospheric deposition and groundwater TN contributions reduced by 0.2 mg/L in response to the improved atmospheric deposition quality
6) Currently permitted effluent quality extended to permitted flow for Sag Harbor Sewage Treatment Plant (*i.e.*, 8 mg TN/liter) permitted flow of 0.25 million gallons per day (MGD))
7) Existing effluent quality extended to permitted flow for Shelter Island Heights Sewage Treatment Plant (*i.e.*, 10.2 mg TN/liter based on 4-yr average of DEC discharge monitoring records from April 2002 to February 2006 and permitted flow of 0.053 MGD)

8) At Riverhead Sewage Treatment Plant, the load is 40 lb TN/day from May 1 to September 30 and 130 lb TN/day rest of year. From May-September, a flow of 0.95 MGD will be employed to reflect permitted flow conditions (1.3 MGD) less the effluent projected to be used irrigating the adjacent golf course (0.35 MGD). From October 1 to April 30, a flow of 1.3 MGD will be employed.
9) At Atlantis Marine World, this 0.0081 MGD design flow facility is assigned a load of 4 lbs. TN/day.
10) Stormwater runoff loading is treated as a point source in the model. In response to mitigation, a 15% reduction in stormwater N load is attributed to Peconic River and Flanders Bay and a 10% reduction to east of Flanders Bay. Note that current stormwater TN loading for the Peconic River and Flanders Bay is 30 lb TN/day and east of Flanders Bay is 100 lb TN/day. The stormwater loading is apportioned to each shoreline model grid cell.

The practical load reduction plus mechanical aeration scenario is identical to the practical load reduction scenario described above except that mechanical aeration is added to specific locations in the impaired waters to bring the dissolved oxygen levels into compliance with the both existing and proposed New York water quality standards. Model results indicated that about 7,180 lb/day of oxygen will need to be added to the impaired waters during critical summer months (May 1 to September 30) to attain the existing DO standard of 5.0 mg/L. The estimated cost of mechanical aeration to attain the existing DO standard is up to $2,300,000 for initial capital expenses and up to $189,000 for annual operating costs. To attain the proposed DO standard, 980 lb/day of DO will need to be added during the summer period. The estimated cost of mechanical aeration to attain the proposed DO standard is up to $330,000 for initial capital expenses and up to $27,000 for annual operating costs.

Using the EFDC model simulations, the following improvements to water quality in the 303(d) impaired waters were projected for the practical load reduction scenario and practical load reduction plus mechanical aeration scenario:

- For the practical load reduction scenario, the total hypoxia measured in volume-days is reduced by more than 98% from the baseline condition (see Table V.1).

- For the practical load reduction scenario with mechanical aeration, the DO concentrations in all waters are above the hypoxic threshold at all times, therefore hypoxia is reduced by 100% from the baseline condition.

As a result of these analyses, this TMDL includes overall nitrogen reduction targets of 34.3% for the winter period (October 1 to April 30) and 43.4% for the summer period (May 1 to September 30) from loads associated with the cumulative full build-out scenario without load reductions. Even greater reductions would be required in a worst case cumulative full build-out scenario (i.e., less vacant and further subdividable land is protected, vacant and further subdividable land that is developed is developed without clustering requirements or vegetation preservation requirements (clearing restrictions).

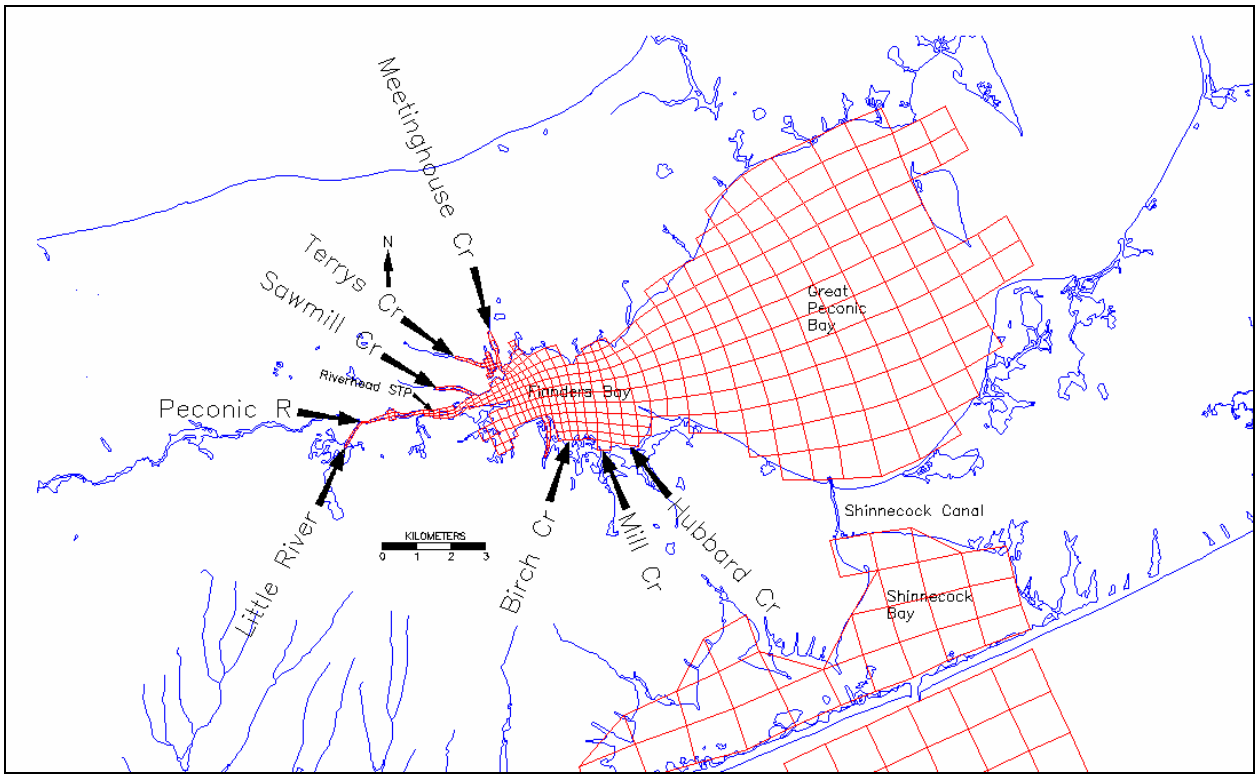


Figure V.4: Locations of tributary and STP inflows in western Peconic Estuary

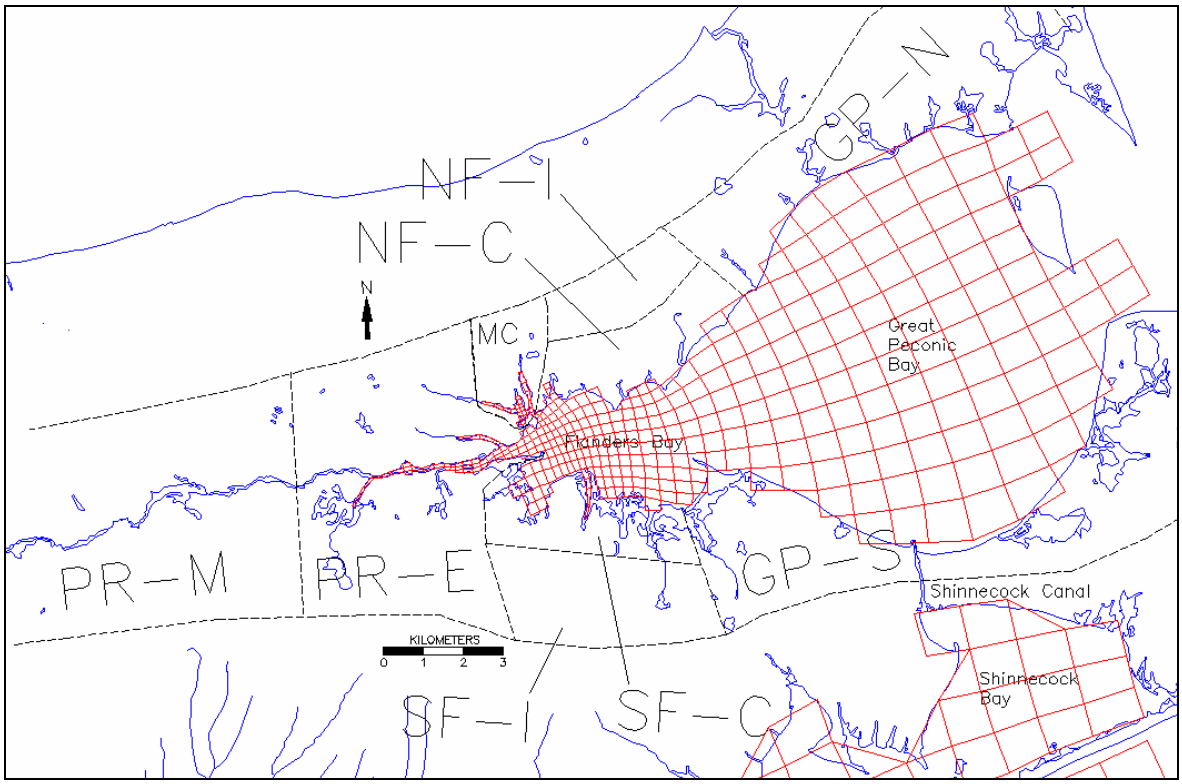


Figure V.5: Locations of groundwater management zones in western Peconic Estuary

VI. TMDL/WLAs/LAs for Nitrogen

This section describes the total maximum daily load, wasteload allocations and loading allocations for the Peconic Estuary to address impairments due to non-attainment of the state water quality standards for dissolved oxygen, discussion and details on the allocation of loads, mechanical aeration, margin of safety, critical conditions, seasonal variations, and an overall summary.

Section 303(d) of the Clean Water Act requires the establishment of TMDLs that will result in attainment of water quality standards. As the term implies, TMDLs are typically expressed as maximum daily loads. However, as specified in 40 CFR 130.2(I), TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measures. As discussed in Section V.C. of this document, nitrogen loadings throughout the year contribute to the pool of nitrogen available in the Peconic Estuary for uptake by phytoplankton. Also, the magnitude of the range of daily dissolved oxygen concentration is dependent on the abundance of phytoplankton as well as the strength of sediment oxygen demand, which leads to depressed DO levels in the pre-dawn and early morning hours. The hypoxia resulting from the decay of phytoplankton is due to both long-term nitrogen loadings and daily or short-term nitrogen-oxygen dynamics. Therefore, the Peconic Estuary nitrogen TMDL is expressed in terms of both a daily average nitrogen load and a daily maximum nitrogen load based on model simulations of the October 2000 to September 2002 period. In addition, the TMDL is further categorized into seasonal loads for a summer period (May 1 to September 30), which is the critical season for hypoxia, and a winter period (October 1 to April 30).

For the three 303(d) listed impaired waters, the practical-load-reduction (PLR) scenario targets a nitrogen reduction of 37.5% for the winter period (October 1 to April 30) and 42.3% for the summer period (May 1 to September 30). Although the PLR scenario is predicted to greatly reduce hypoxia and minimize impacts on aquatic life, there were some areas of the western Peconic Estuary that continued to experience DO concentrations below both the existing and proposed water quality standards for a short period of time, though the PLR scenario meets the proposed DO standard in one of the two model years. It is however necessary for this TMDL to identify additional actions for achieving water quality standards, namely, the use of mechanical aeration in those areas experiencing contraventions of the DO standards. This TMDL is expressed as the sum of the PLR nitrogen targets, the addition of oxygen via mechanical aeration, and an implicit margin of safety. Model predictions indicated that mechanical aeration was not necessary to achieve DO water quality standards during the winter period.

TMDL (winter) = 37.5% nitrogen reduction from all sources + margin of safety

TMDL (summer) = 42.3% nitrogen reduction from all sources + oxygen from mechanical aeration + margin of safety

The pollutant reductions and resultant DO improvements from each of these components are identified in sections A through C that follow. Implementation of management actions, measures, practices and controls lead to the specified loads not being exceeded

are predicted to result in attainment of water quality standards in each of the three impaired waters of western the Peconic Estuary. The water quality model was used to assess the degree to which mechanical aeration could provide the remaining improvement in DO needed to achieve water quality standards. The margin of safety provided in the analysis is discussed in Section C.

A. Allocation of Sources

Seasonal nitrogen loads categorized by source for the three impaired 303(d) waterbodies (see Figure VI.1), as well as Flanders Bay, Great Peconic Bay, Little Peconic Bay, Shelter Island Sound and Gardiners Bay for the baseline and TMDL scenarios, are summarized in Tables VI.1 through VI.8. The summer daily average load was calculated during the May 1 to September 30 periods of the 2-year model simulation. The summer maximum daily load is the largest of the daily loads during the May 1 to September 30 periods of the 2-year simulation. The winter daily average load was calculated during the October 1 to April 30 periods of the 2-year model simulation.

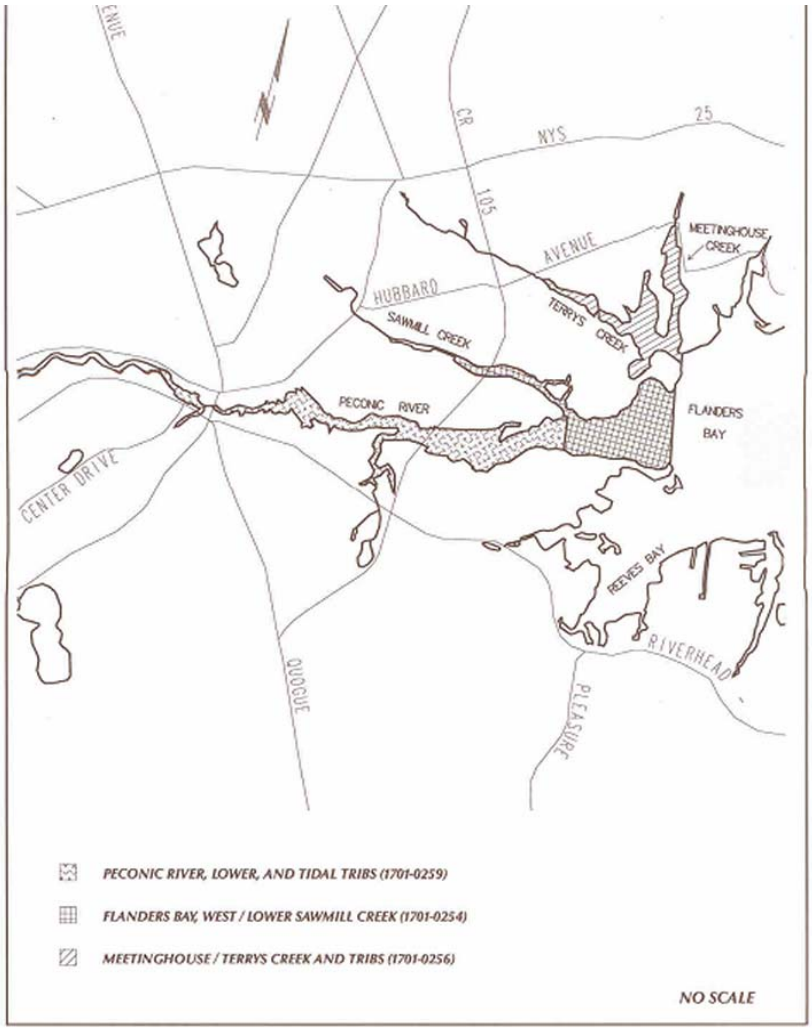


Figure VI.1: Locations of waterbodies on 303(d) list impaired for nitrogen and low DO

The winter maximum daily load is the largest of the daily values during the October 1 to April 30 periods of the two-year simulation. The locations of the tributary inflows to the water quality model were shown previously in Figure V.4. The groundwater management zones used to develop nitrogen loads for the water quality model were shown in Figures V.3 and V.5. A description of the practical-load-reduction (PLR) scenario was provided in Section V.C.2.

River loads include some regulated stormwater discharge from MS4s, and the requirement for 15 % reduction applies to the MS4s discharging to these rivers. Also, the stormwater load estimates includes some unregulated stormwater from private property to surface water that were not separated out in the model analysis. Both the MS4 loads to the rivers and the overestimation in the stormwater (WLA) are minimal and tend to balance each other out.

Consistent with the recommendations in EPA's November 15, 2006 memo, "Establishing TMDL "Daily" Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5015, (April 25, 2006) and Implications for NPDES Permits," the TMDL/WLAs/LAs have also been expressed as daily loads. As noted in the guidance, "EPA does not believe that the Friends of the Earth decision requires any changes to EPA´s existing policy and guidance describing how a TMDL´s wasteload allocations are implemented in NPDES permits." Water quality-based effluent limits (WQBELs) in NPDES permits that implement wasteload allocations in approved TMDLs must be “consistent with the assumptions and requirements of any available wasteload allocation for the discharge” 122.44(d)(1)(vii)(B). These provisions do not require that effluent limits in NPDES permits be expressed in a form that is identical to the form in which the wasteload allocation for the discharge is expressed in a TMDL. The permit writer has the flexibility to express the effluent limitation using a time frame appropriate to the water body, pollutant, and the applicable water quality standard. In addition, allocations based on monthly, seasonal or annual timeframes may be used to guide management measures and implementation efforts because they are related to the overall loading capacity of the waterbody, while the daily expressions represent day to day snapshots of the total loading capacity based on ambient conditions.

In presenting the daily average and maximum daily stormwater loads, the baseline and TMDL values as presented in Tables V1.1 through V1.8 are the same. This simplification is reflective of the way stormwater nitrogen loads are provided as an input to the model (the stormwater loading is apportioned to each shoreline model grid cell), that stormwater presents a relatively small contribution in relation to the sources (especially groundwater, and particularly to co-occurring wet weather inputs associated with groundwater and wet atmospheric deposition), and the relatively even and diffuse distribution of stormwater inputs (either as discrete conveyances or as diffuse overland flow) across the Estuary and its shoreline. Future efforts could potentially result in more refined apportionments and precision regarding daily average and maximum daily stormwater loads than can presently be derived and appear as part of this TMDL.

Similarly, the model runs were simplified by using constant seasonal loadings for point sources. The model runs have shown that the dissolved oxygen response integrates nitrogen loading over a period of days. The hypoxia resulting from night time respiration and the decay of phytoplankton is due to both long-term nitrogen loadings and daily or short-term nitrogen-oxygen dynamics. Thus imposition of a daily maximum load for the Riverhead STP is not critical, and the warm weather 40 lbs/day limit for the Riverhead STP may be incorporated into the SPDES permit as a monthly average.

Table VI.1: Nitrogen load summary for segment 1701-259, Lower Peconic River and Tidal Tributaries

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	6.47	97.68	4.44	67.1	31.3%	31.3%
Groundwater (LA)	318.	331.	184	191.	42.2%	42.3%
Little River (LA)	5.87	18.92	3.43	11.07	41.5%	41.5%
Peconic River (LA)	108.	348.	63.16	204.	41.5%	41.5%
Stormwater (WLA)	9	9	7	7	15.0%	15.0%
Riverhead STP (WLA)	130.	130.	130.	130**.	0.0%	0.0%
Atlantis Marine World (WLA)	***	***	4	4		
Total*	577.	934.	396.	614.	31.4%	34.3%
Sum of October 1 to April 30 WLAs*	1396	139	141	141		
	May 1 to September 30					
Atmospheric Deposition (LA)	7.96	152.	5.48	104.	31.3%	31.3%
Groundwater (LA)	315.	331.	182.	191.	42.2%	42.3%
Little River (LA)	6.12	13.90	3.59	8.14	41.5%	41.5%
Peconic River (LA)	113.	256.	65.89	150.	41.5%	41.5%
Stormwater (WLA)	9	9	7	7	15.0%	15.0%
Riverhead STP (WLA)	130.	130.	40.	40**.	69.5%	69.5%
Atlantis Marine World (WLA)	***	***	4	4		
Total*	580.	891.	308.	504.	47.0%	43.4%
Sum of May 1 to September 30 WLAs*	139	139	51	51		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** As noted in the text, this daily maximum will not be used as the basis for permit limits.
*** The discharge from Atlantis Marine World was not included in the baseline analysis.

Table VI.2: Nitrogen load summary for segment 1701-254, Western Flanders Bay and Lower Sawmill Creek

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	6.80	103.	4.66	70.62	31.3%	31.3%
Groundwater (LA)	72.82	75.77	42.72	44.46	41.3%	41.3%
Sawmill Creek (LA)	5.87	18.92	3.43	11.07	41.5%	41.5%
Stormwater (WLA)	5.26	5.26	4.47	4.47	15.0%	15.0%
Total*	90.75	203.	55.29	131.	39.1%	35.6%
Sum of October 1 to April 30 WLAs*	5.26	5.26	4.47	4.47		
	May 1 to September 30					
Atmospheric Deposition (LA)	8.38	160.	5.76	110.	31.3%	31.3%
Groundwater (LA)	72.56	75.77	42.55	44.46	41.3%	41.3%
Sawmill Creek (LA)	6.12	13.90	3.59	8.14	41.5%	41.5%
Stormwater (WLA)	5.26	5.26	4.47	4.47	15.0%	15.0%
Total*	92.31	255.	56.36	167.	38.9%	34.5%
Sum of May 1 to September 30 WLAs*	5.26	5.26	4.47	4.47		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.

Table VI.3: Nitrogen load summary for segment 1701-256, Meetinghouse Creek and Terrys Creek and Tributaries

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	3.76	56.96	2.60	39.14	31.3%	31.3%
Groundwater (LA)	213.	221.	99.40	103.	53.3%	53.3%
Terrys Creek (LA)	3.08	9.94	1.80	5.81	41.6%	41.5%
Meetinghouse Creek (LA)	45.80	148.	27.41	88.42	40.2%	40.1%
Stormwater (WLA)	6.38	6.38	5.41	5.41	15.0%	15.0%
Total*	272.	442.	137.	242.	49.7%	45.2%
Sum of October 1 to April 30 WLAs*	6.38	6.38	5.41	5.41		
	May 1 to September 30					
Atmospheric Deposition (LA)	4.64	88.61	3.19	60.87	31.3%	31.3%
Groundwater (LA)	211.	221.	98.56	103.	53.3%	53.3%
Terrys Creek (LA)	6.12	13.90	3.59	8.14	41.5%	41.5%
Meetinghouse Creek (LA)	47.78	109.	28.6	64.97	40.1%	40.1%
Stormwater (WLA)	6.38	6.38	5.41	5.41	15.0%	15.0%
Total*	228.	330.	139.	243.	51.5%	46.1%
Sum of May 1 to September 30 WLAs*	6.38	6.38	5.41	5.41		

Note: LA denotes load allocation; WLA denotes wasteload allocation

*** May not add up due to rounding.**

Table VI.4: Nitrogen load summary for Flanders Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	116.	1755.	79.75	1206.	31.3%	31.3%
Groundwater (LA)	486.	506.	297.	309.	38.9%	38.9%
Hubbard Creek (LA)	4.66	15.05	2.73	8.8	41.6%	41.5%
Mill Creek (LA)	2.53	8.16	1.47	4.77	41.6%	41.5%
Birch Creek (LA)	1.21	3.91	0.70	2.29	41.6%	41.5%
Stormwater (WLA)	9.70	9.70	8.25	8.25	15.0%	15.0%
Total*	620.	2298.	390.	1539.	37.2%	33.0%
Sum of October 1 to April 30 WLAs*	9.70	9.70	8.25	8.25		
	May 1 to September 30					
Atmospheric Deposition (LA)	143.	2730.	98.25	1876.	31.3%	31.3%
Groundwater (LA)	482.	505.	294.	307.	38.9%	38.9%
Hubbard Creek (LA)	4.86	11.07	2.84	6.47	41.5%	41.5%
Mill Creek (LA)	2.64	6.01	1.54	3.50	41.6%	41.6%
Birch Creek (LA)	1.28	2.88	0.75	1.67	41.6%	41.5%
Stormwater (WLA)	9.70	9.70	8.25	8.25	15.0%	15.0%
Total*	644.	3265.	406.	2204.	36.9%	32.5%
Sum of May 1 to September 30 WLAs*	9.70	9.70	8.25	8.25		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

Table VI.5: Nitrogen load summary for Great Peconic Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	949	14342.	652.	9853.	31.3%	31.3%
Groundwater (LA)	833.	1098.	531.	689.	36.3%	37.3%
Stormwater (WLA)	9	9	8	8	10.0%	10.0%
Total*	1791.	15449.	1191.	10550	33.5%	31.7%
Sum of October 1 to April 30 WLAs*	9	8.9	8	8		
	May 1 to September 30					
Atmospheric Deposition (LA)	1169.	22313.	803.	15329.	31.3%	31.3%
Groundwater (LA)	871.	1088.	554.	684.	36.4%	37.1%
Stormwater (WLA)	9	9	8	8	10.0%	10.0%
Total*	2049.	23410.	1365.	16021.	33.4%	31.6%
Sum of May 1 to September 30 WLAs*	9	9	8	8		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

Table VI.6: Nitrogen load summary for Little Peconic Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	628.	9491.	431.	6520.	31.3%	31.3%
Groundwater (LA)	873.	1191.	589.	793.	32.5%	33.4%
Stormwater (WLA)	16.41	16.41	14.76	14.76	10.0%	10.0%
Total*	1517.	10698.	1035.	7328.	31.8%	31.5%
Sum of October 1 to April 30 WLAs*	16	16	15	15		
	May 1 to September 30					
Atmospheric Deposition (LA)	774.	14766.	531.	10144.	31.3%	31.3%
Groundwater (LA)	929.	1188.	626.	793.	32.6%	33.2%
Stormwater (WLA)	16	16	15	15	10.0%	10.0%
Total*	1719.	15971.	1172.	10952.	31.8%	31.4%
Sum of May 1 to September 30 WLAs*	16	16	15	15.76		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

Table VI.7: Nitrogen load summary for Shelter Island Sound**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	1094.	16544.	752.	11366.	31.3%	31.3%
Groundwater (LA)	1733.	2276.	1205.	1567	30.2%	30.9%
Sag Harbor STP (WLA)	13	13.	17	17***	0.0%****	0.0%****
Shelter Island Heights STP (WLA)	4.5	4.5	5	5***	0.0%****	0.0%****
Stormwater (WLA)	52	52	46	46	10.0%	10.0%
Total*	2897.	18890.	2026.	13002.	30.1%	31.2%
Sum of October 1 to April 30 WLAs*	69	69	69	69		
	May 1 to September 30					
Atmospheric Deposition (LA)	1348.	25740.	926.	17683.	31.3%	31.3%
Groundwater (LA)	1816.	2267.	1260	1562.	30.3%	30.9%
Sag Harbor STP (WLA)	13	13	17	17***	0.0%****	0.0%****
Shelter Island Heights STP (WLA)	4.5	4.5	5	5***	0.0%****	0.0%****
Stormwater (WLA)	52	52	47	472	10.0%	10.0%
Total*	3234.	28076.	2255.	19314.	30.2%	31.2%
Sum of May 1 to September 30 WLAs*	69	69	69	69		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.
*** As noted in the text, this daily maximum will not be used as the basis for permit limits.
**** The TMDL reflects current or proposed permit requirements; the baseline represents current discharge characteristics for these facilities.

Table VI.8: Nitrogen load summary for Gardiners Bay**

Source	Baseline		TMDL		Percent Reduction	
	Daily Avg.	Max. Daily	Daily Avg.	Max. Daily		
	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	TN (lbs./day)	Daily Avg.	Max. Daily
	October 1 to April 30					
Atmospheric Deposition (LA)	4724.	71420.	3245.	49066.	31.3%	31.3%
Groundwater (LA)	1330.	1607.	958.	1141.	28.0%	29.0%
Stormwater (WLA)	22	22	20	20	10.0%	10.0%
Total*	6076.	73050.	4223.	50227.	30.5%	31.2%
Sum of October 1 to April 30 WLAs*	22.	22	20	20.		
	May 1 to September 30					
Atmospheric Deposition (LA)	5821.	111113.	3999.	76335.	31.3%	31.3%
Groundwater (LA)	1401.	1636.	1009.	1165.	28.0%	28.8%
Stormwater (WLA)	22	22	20	204	10.0%	10.0%
Total*	7244.	112772.	5028.	77521.	30.6%	31.3%
Sum of May 1 to September 30 WLAs*	22	22	20	20		

Note: LA denotes load allocation; WLA denotes wasteload allocation.
* May not add up due to rounding.
** While this is not a 303(d) listed waterbody due to non-attainment of the state DO WQS, this TMDL is required to achieve DO WQS in the impaired listed waterbodies and preserve water quality in this waterbody.

B. Mechanical Aeration

The use of non-treatment alternatives may be considered as a method of achieving water quality standards when technology-based treatments are not sufficient to achieve standards [40 CFR 125.3(f)]. Such techniques must be the preferred environmental and economic method of achieving standards after consideration of alternatives such as advanced waste treatment and other technologies.

As demonstrated by this TMDL, the practical load reductions and technology-based treatment requirements are not sufficient to *fully* achieve DO standards in all locations of the Peconic Estuary. Therefore, this TMDL identifies the use of a non-treatment alternative (mechanical aeration) to achieve the DO water quality standards. In order to achieve the existing DO water quality standard of 5.0 mg/L, a total of 3,280 kg/day (7,181 lb/day) of oxygen was distributed to the bottom layer at various grid cells in the water quality model (see Table VI.9). To attain the proposed DO standard, 445 kg/day (980 lb/day) of oxygen was added by mechanical aeration to the grid cells listed in Table VI.10. For the modeling simulation, oxygen was added at a continuous rate from May 1 to September 30, and was turned off for the remainder of the year. Note that the aeration was not needed for one of the two modeled years to meet the proposed standard.

Table VI.9: Location and magnitude of DO added to achieve the existing water quality standard

1701-0259		1701-0254		1701-0256		(not on 303(d) list)	
Tidal Peconic River and tributaries		Sawmill Creek and Flanders Bay West		Terrys Creek and Meetinghouse Creek		Western Flanders Bay	
Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)
[12,17]	70	[27,20]	40	[26,27]	10	[32,19]	30
[12,18]	60	[27,21]	60	[27,27]	20	[32,20]	30
[12,19]	20	[27,22]	30	[28,27]	20	[32,21]	30
[12,23]	50	[27,23]	20	[29,24]	10	[33,16]	80
[13,23]	50	[27,24]	30	[29,27]	10	[33,17]	70
[14,23]	40	[27,25]	20	[30,24]	10	[33,18]	60
[15,22]	20	[28,20]	40	[30,25]	30	[33,19]	30
[15,23]	30	[28,21]	60	[30,26]	20	[33,20]	30
[15,24]	30	[29,19]	40	[30,27]	30	[33,21]	40
[16,23]	20	[29,20]	40	[30,28]	10	[33,22]	30
[17,23]	50	[29,21]	40	[31,25]		[33,23]	30
[18,23]	70	[30,19]	10	[31,26]	30	[34,18]	30
[19,22]	50	[30,20]	40	[31,27]	30	[34,19]	30
[19,23]	30	[30,21]	40	[31,28]	20	[34,20]	20
[20,22]	40	[30,22]	30	[31,29]	10	[35,18]	20
[20,23]	30	[31,19]	10	[31,30]	30	[35,19]	30
[21,21]	40	[31,20]	30	[32,26]	30	[35,20]	20
[21,22]	40	[31,21]	30	[33,24]	40	[36,17]	20
[21,23]	30	[31,22]	40	[33,25]	40	[36,18]	30
[22,21]	40			[33,26]	30	[36,19]	20
[22,23]	40			[33,27]	30	[37,18]	30
[23,21]	40			[33,28]	40	[38,18]	30
[23,22]	30			[33,29]	70	[39,18]	20
[23,23]	40			[33,30]	20		
[24,21]	30						
[24,22]	50						
[25,21]	40						
[25,22]	50						
[26,20]	40						
[26,21]	40						
[26,22]	50						
Subtotal	1,260	Subtotal	650	Subtotal	590	Subtotal	760
Total	3,260						

Table VI.10: Location and magnitude of DO added to attain the proposed water quality standard

1701-0259		1701-0254		1701-0256		(not on 303(d) list)	
Tidal Peconic River and tributaries		Sawmill Creek and Flanders Bay West		Terrys Creek and Meetinghouse Creek		Western Flanders Bay	
Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)	Grid Cell	DO (kg/day)
[12,17]	55	[27,20]		[26,27]		[32,19]	
[12,18]	55	[27,21]		[27,27]		[32,20]	
[12,19]	15	[27,22]		[28,27]	5	[32,21]	
[12,23]	25	[27,23]		[29,24]		[33,16]	
[13,23]	30	[27,24]	5	[29,27]		[33,17]	
[14,23]	15	[27,25]		[30,24]		[33,18]	
[15,22]	10	[28,20]		[30,25]		[33,19]	
[15,23]	5	[28,21]		[30,26]		[33,20]	
[15,24]	10	[29,19]		[30,27]		[33,21]	
[16,23]	10	[29,20]		[30,28]		[33,22]	
[17,23]	10	[29,21]		[31,25]		[33,23]	
[18,23]	25	[30,19]		[31,26]		[34,18]	
[19,22]	15	[30,20]		[31,27]		[34,19]	
[19,23]	10	[30,21]		[31,28]		[34,20]	
[20,22]	10	[30,22]		[31,29]	5	[35,18]	
[20,23]	10	[31,19]		[31,30]	15	[35,19]	
[21,21]	10	[31,20]		[32,26]		[35,20]	
[21,22]	10	[31,21]		[33,24]		[36,17]	
[21,23]	10	[31,22]		[33,25]		[36,18]	
[22,21]	10			[33,26]		[36,19]	
[22,23]	10			[33,27]		[37,18]	
[23,21]	10			[33,28]	10	[38,18]	
[23,22]	10			[33,29]	10	[39,18]	
[23,23]	5			[33,30]	5		
[24,21]	5						
[24,22]							
[25,21]							
[25,22]							
[26,20]							
[26,21]							
[26,22]							
Subtotal	390	Subtotal	5	Subtotal	50	Subtotal	0
Total	445						

C. Margin of Safety

A TMDL must include a margin of safety (MOS) to account for lack of knowledge concerning the relationship between pollutant loads and water quality. EPA guidance explains that the MOS may be incorporated into the conservative assumptions used in the analysis (an implicit MOS) or it may be expressed in loading set aside as a separate component of the TMDL (an explicit MOS). An implicit MOS is used in this TMDL through conservative assumptions in the analysis such as using the critical 2000 - 2002 period as the baseline condition and assuming the Riverhead STP continuously discharges both flow and load at fully permitted levels for the TMDL scenario.

An important component in the implicit MOS assumption was the use of 2000-2002 as the baseline period. This time period was the most severe period of hypoxia on record based on analysis of monitoring data from 1988 to 2002. Model simulations of reduced nitrogen predicted water quality conditions that would result from the same physical conditions that existed during the 2000-2002 period. Thus, it can be expected that average year conditions would see even better improvements in water quality conditions given the same nitrogen reductions. In other words, since the baseline period used the severe conditions that existed in 2000-2002, a margin of safety (MOS) is provided for average years.

Another implicit MOS assumption was the use of continuous flow and load discharges for the Riverhead STP throughout the simulation period. It is unlikely this facility would discharge at its maximum allowable load continuously for the entire two-year period. The water quality model simulations predicted the amount of nitrogen that would need to be reduced from the Riverhead STP discharging continuously at maximum permitted load. This provides a margin of safety for the more typical condition where the Riverhead STP discharges at less than maximum permitted load.

D. Critical Conditions

Hypoxia in western Peconic Estuary typically occurs from mid-May through September. Minimum hourly DO concentrations simulated by the EFDC water quality model during the summer hypoxic period were used in this TMDL as the basis to assess actions necessary to attain water quality standards. The alternative management scenarios were run for a 24-month period beginning on 10/1/2000 and ending on 9/30/2002, which corresponds to hydrologic water years 2001 and 2002. This critical period was chosen based on the analysis of water quality sampling data within the three listed waterbodies having dissolved oxygen concentrations less than the existing 5.0 mg/L water quality standard. (see Table VI.11).

E. Seasonal Variations

Accounting for seasonal variations in pollutant loading and water quality is an important factor in the TMDL analyses. This requires including seasonal variations in the modeling analysis, identifying a critical period for achieving water quality standards, and basing the TMDLs on the critical conditions. As discussed in Section V.C, the water quality model was calibrated and validated using ambient monitoring data over a 14-year period from

Table VI.11 Inventory of DO samples below water quality criteria in 303(d) waters of Peconic Estuary

Year	Number of DO samples less than 5.0 mg/L
1989	14
1995	51
1996	136
1997	100
1998	40
1999	29
2000	19
2001	21
2002	20*

* Continuous monitoring devices deployed in the tidal Peconic River during the summer and fall of 2002 documented water quality conditions every 15 minutes and resulted in thousands of data points where the DO level was less than 5.0 mg/L. These continuous monitoring device data are not reflected in this table, however, due to difficulties in comparing these results to the routine water quality monitoring data set.

October 1988 to September 2002. This period covers all seasons of the year as well as actual extreme hydrological and meteorological conditions. Tributary loads, groundwater loads, and sewage treatment plant loads were included in based on available time-variable data. Water year 2001 was relatively wet followed by a relatively dry water year 2002, which is important to satisfy the seasonality aspect of the Peconic Estuary nitrogen TMDL. The hydrograph of freshwater inflow from the Peconic River during the 24-month simulation period is shown in Figure VI.2.

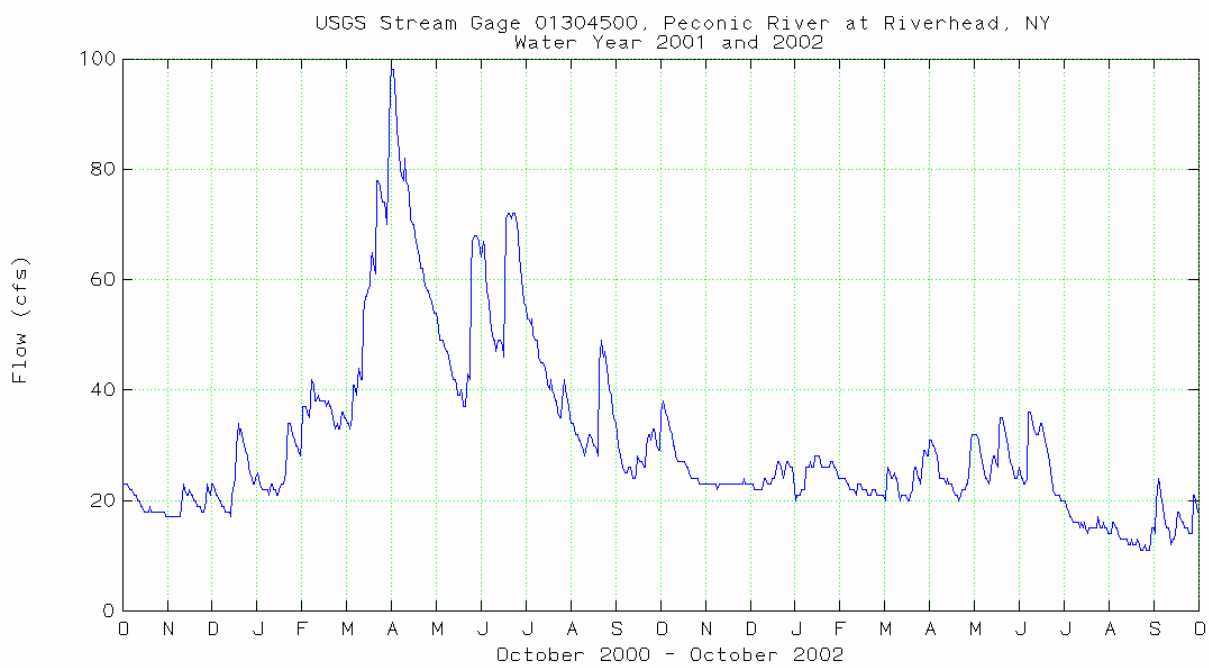


Figure VI.2: Streamflow at Peconic River USGS gage for model simulation period

F. Summary

Based on the modeling results, the New York State DO water quality standards in the western Peconic Estuary would be attained through implementation of the nutrient reduction and mechanical aeration actions outlined in this TMDL. Improvements in the hourly minimum DO from nitrogen management would result in an addition of 2.36 mg/L of DO above the baseline condition at the critical grid cell in tidal Peconic River. Mechanical aeration would improve the hourly minimum DO at the critical grid cell by an additional 2.64 mg/L. The critical grid cell [18,23] is located about 0.23 miles west of the Riverhead STP discharge. The incremental improvement in DO at the critical grid cell for the cumulative impact of each of five management alternatives is shown in Table VI.12. The two largest incremental improvements in DO among the nitrogen management alternatives result from implementation of land use management measures, actions, practices and controls to reduce groundwater nitrogen loads and from practical load reduction controls on the Riverhead STP. Despite significant gains due to applying the PLR controls, mechanical aeration is still required to attain the existing water quality standard for DO of 5.0 mg/L as well as the proposed water quality standards.

Table VI.12: Incremental improvements in DO at critical grid cell [18,23] in tidal Peconic River

Run ID	Cumulative Management Action for Reducing Nitrogen	Lowest Daily Average DO		Lowest Hourly Minimum DO	
		DO (mg/L)	Incremental Improvement In DO (mg/L)	DO (mg/L)	Incremental Improvement In DO (mg/L)
01g	Baseline condition	1.496	-	0.003	-
15h1	Atmospheric deposition reduced by 31.3%	1.649	0.153	0.034	0.031
15h2	Groundwater loads improved to PLR	2.575	0.926	1.156	1.122
15h3	Stormwater and Tributaries improved to PLR	2.787	0.212	1.586	0.043
15h	Riverhead STP improved to PLR	3.423	0.636	2.363	0.777
15i	Mechanical aeration	6.175	2.752	5.005	2.642

VII. Implementation

This section describes programs and actions that are in place that directly or indirectly impact nitrogen loads or the impacts nitrogen has on the Peconic Estuary, including those waters impaired due to low dissolved oxygen. Further, it describes enhancements to those programs and other new or related initiatives that could be put in place to further reduce the nitrogen load or otherwise reduce that impact that excess nitrogen has on the Peconic System. The Peconic Estuary Program seeks to have this TMDL fully implemented within 15 years from approval, based upon current expectations for full build-out and land acquisition programs, development and implementation of education and outreach programs, full participation in the agricultural stewardship/agricultural environmental management program, and other necessary efforts. Full implementation of this TMDL is expected to result in water quality standards for dissolved oxygen being met where they are not currently attained and ensure continued compliance where these standards are presently achieved.