Chapter 4

Existing and Future Conditions in Eastham

CHAPTER 4

EXISTING AND FUTURE CONDITIONS IN EASTHAM

4.1 INTRODUCTION

This chapter provides a description of the Town of Eastham, and a summary of its natural resources, physical characteristics, land use, wastewater flows and nitrogen loadings. The natural resources and physical characteristics are defined by the Town's topography, geology, soils, groundwater, fresh and marine surface-water resources, protected natural areas and cultural areas. Each of these existing and future conditions has been identified through review of Town documents and records, review of available MEP documents and data, Cape Cod Commission maps and data, and evaluations made by the project team.

4.2 WATERSHED DELINEATIONS

The water resource areas for this project are illustrated in Figure 4-1. The Rock Harbor Creek Watershed delineation is the only watershed in Eastham delineated by MEP through a Technical Report at the time this report was prepared. Figure 4-1 illustrates other watershed boundaries in Eastham as delineated by the work of the Cape Cod Commission and USGS. It is expected that the Nauset Town Cove Recharge and Wellfleet Harbor Recharge areas will be modified slightly from current Cape Cod Commission watersheds as MEP Technical Reports are developed (June 2009 and June 2011, respectively). The Freshwater Ponds System Watershed delineation is based on the aggregation of several individual pond delineations developed by the UMass SMAST Coastal Systems Group and the Cape Cod Commission in their December 2008 draft report on Eastham freshwater ponds, and estimates to include Bridge Pond and Widow Harding Pond. This aggregation is also based on the 2004 map prepared by the USGS entitled "Ground-water Recharge Areas and Travel times to Pumped Wells, Ponds, Streams, and Coastal Water Bodies, Cape Cod, Massachusetts" (Scientific Investigations Map I-2857).

Marine Recharge Areas:

- Rock Harbor Creek Watershed
- Nauset-Town Cove Recharge Area
- Wellfleet Harbor Recharge Area
- Herring River Recharge Area
- Boat Meadow River Recharge Area
- Atlantic Ocean Recharge Area
- Cape Cod Bay Recharge Area

Freshwater Recharge Area:

- Freshwater Pond System Watershed

It is noted from the overlay of the freshwater pond watersheds and the marine and ocean watersheds that Herring Pond, Widow Harding Pond, Bridge Pond, Great Pond, Deborah's Pond, Depot Pond, and Jemima Pond drain to the west and the Cape Cod Bay. Mill/Muddy Pond, Long Pond, Minister's Pond, Schoolhouse Pond, and Moll's Pond drain to the east and the Atlantic Ocean. The MEP Technical Report on the Nauset Estuary may modify the western boundary of that estuary based on more detailed watershed delineation work.

4.3 NATURAL RESOURCES, PHYSICAL CHARACTERISTICS

A. Embayment Water Quality.

1. **Introduction.** Currently the predominant issue associated with wastewater planning on Cape Cod is the marine water quality impacts from the nitrogen in wastewater discharges. Nitrogen is typically the limiting nutrient in marine waters, which means that the other essential nutrients for plant growth (e.g., phosphorus, potassium, etc.) are in sufficient supply, and the addition of nitrogen to marine water will produce a corresponding growth of algae. Algae are the suspended and attached plant material that can foul the water, making it unattractive for swimming, fishing, and boating. The algae will typically settle to the bottom of the embayment, smothering shellfish resources and, through decay, deplete oxygen in the water. The oxygen depletion can cause unpleasant odors and produce fish kills.

The excessive nitrogen loading originates from several sources, including wastewater, roof and road runoff, lawn and agricultural fertilizers, atmospheric deposition, and nitrogen recycling from the sediments on the floor of the estuary (benthic flux). On Cape Cod, wastewater from on-site systems is typically the largest nitrogen source in the watershed.

As stated in the MEP reports, overall indication of biological health and determination of site-specific nitrogen thresholds for an embayment requires integration of key habitat parameters such as infauna and eelgrass, sediment characteristics, and nutrient related water quality information, particularly dissolved oxygen (DO) and chlorophyll a.

a. **Infaunal Communities (Benthic Organisms).** These organisms are defined as aquatic animals that live within the bottom substratum rather than on the surface. These organisms are an important indicator to the overall health of an embayment, especially in areas that do not support eelgrass beds. For example, a healthy habitat area would present low organic matter loading and high DO where a stressed habitat area would present high organic matter loading and low DO. The basic concept is that certain species or species assemblages reflect the quality of the habitat in which they live. Benthic animal species from sediment samples are identified and ranked as to their association with nutrient related stresses, such as organic matter loading, anoxia, and dissolved sulfide. The analysis is based upon life-history information and animal-sediment relationships (Howes, B.L., et al. 2004).

b. **Eelgrass Distribution.** Eelgrass distribution studies were conducted by the MassDEP Eelgrass Mapping Program and used by the MEP technical team. These studies incorporate surveys at different intervals and historical data from aerial photographs. The primary use of the data is to indicate if eelgrass currently and/or previously exists (existed) in a basin and if large-scale system-wide shifts have occurred. The loss of eelgrass is expected to be from high water column nitrogen concentrations, the production of algae that results from high water column nitrogen concentrations, and the subsequent shading of the eelgrass (Howes, B.L., et al. 2004).

c. **Water Quality.** Dissolved oxygen levels near atmospheric equilibrium are important for maintaining healthy animal and plant communities. Short-duration oxygen depletions can significantly affect communities even if they rarely occur. DO levels in temperate embayments vary seasonally, due to changes in oxygen solubility,

which varies inversely with temperature. Conversely, biological processes that consume oxygen from the water column vary directly with temperature, explaining why the lowest levels of oxygen are found in the summer in southeastern Massachusetts embayments when the biological respiration rates are greatest (Howes, B.L., et al 2004).

2. **Evaluation of Nitrogen Sensitivity and Habitat Health.**

a. **Rock Harbor Estuary.** The Rock Harbor estuary is classified overall as having a healthy upper salt marsh and a significantly impaired lower harbor basin. The upper salt marsh is very similar in structure, communities, and total nitrogen levels to high quality upper marsh reaches of adjacent Namskaket and Little Namskaket salt marsh systems (Howes, B.L. et al. 2007). According to MEP, the upper reach of this estuary is a typical New England salt marsh with a large central tidal creek, while the lower reach is an artificial "embayment," created from the lower portion of the central creek as a harbor. Table 4-1 represents Table VIII-1 from the Rock Harbor Technical Report and summarizes the habitat based on embayment water quality and various health indicators. This table is a very brief summary and the full MEP Technical Report can be referenced for a full description.

Evaluations completed by the MEP have identified a nitrogen limit of 2.35 kg/day for Rock Harbor to restore suitable water quality for an estuary and habitat of this type. As part of their evaluations they have indicated in their report the amount of wastewater nitrogen that is currently entering the watershed (and estuary) through septic systems and have identified the quantity to be removed to meet the limit under one scenario. Their findings indicate approximately 79 percent of the existing wastewater nitrogen loading to the watershed needs to be removed to remediate the impacted water quality in the lower portion of the watershed. Their evaluations indicate that nitrogen originates from the following sources at the following percents:

- Wastewater (83 percent)
- Fertilizers (five percent)
- Impervious Surfaces (five percent)
- Water Body Surface Area (three percent)
- "Natural" Surfaces (three percent)

- From WWTF (one percent; includes partial load from the Community of Jesus WWTF)

Of the overall load listed above, the following nitrogen inputs represent the local control load, which are the nitrogen sources that could potentially be under regulatory control (Howes, B.L. et al. 2007):

- Wastewater (88 percent)
- Fertilizers (six percent)
- Impervious Surfaces (five percent)
- From WWTF (one percent; includes partial load from the Community of Jesus WWTF)

The Water Body Surface Area (three percent) and "Natural" Surfaces (three percent) loads cannot be controlled locally, thus the remaining nitrogen sources above; Wastewater, Fertilizers, Impervious Surfaces, and From WWTF contain higher percentages than the overall nitrogen load sources initially discussed.

b. **Nauset-Town Cove Estuary.** Nauset-Town Cove Estuary nitrogen limits are currently being developed by the MEP and are expected to be released by July 2009. A preliminary estimate of the wastewater nitrogen that needs to be removed from this watershed was made by the Town of Orleans CWMP Project based on preliminary discussions with MEP staff. That estimate indicates that 55 percent of the existing wastewater nitrogen needs to be removed to meet the proposed limit. It is unknown if that removal rate applies to the entire watershed or just to the Town Cove portion of the watershed. The current assumption is that 55 percent of the existing wastewater nitrogen loading needs to be recharged but this value may change in the future.

c. **Wellfleet Harbor Estuary.** The northwestern portion of Eastham contains a watershed to the outer reaches of Wellfleet Harbor; and the MEP plans to develop a nitrogen limit for this estuary in the next two or three years. Due to the large tidal flushing of the harbor and Eastham's portion of the watershed being located at the extreme southern limit of the overall watershed; the percentage of wastewater nitrogen removal is not expected to be as high as for Rock Harbor and Nauset Estuary. No estimate can be reasonably made at this time due to the early stages of

the MEP evaluations. This finding is expected to change in the future after study by the MEP.

d. **Herring and Boat Meadow Rivers.** These two marine water bodies are not planned to be evaluated for nitrogen limits by the MEP and minimal work has been completed to characterize their sensitivity to existing nitrogen loadings. It is believed that the MEP would characterize them as salt-marsh dominated tidal creeks that nearly empty during low tide similar to the Namskaket and Little Namskaket Creek Systems in Orleans and Brewster. These two later systems in Orleans and Brewster have been evaluated by the MEP and determined not to be impacted by nitrogen loading.

e. **Cape Cod Bay and Atlantic Ocean Recharge Areas.** Two large areas of Eastham recharge their groundwater (and nitrogen loadings) directly to Cape Cod Bay and the Atlantic Ocean. There are no nitrogen limits for these marine waters and none are planned at this time. It is believed that these two large water bodies are not currently impaired by nitrogen loadings.

3. **Summary of Wastewater Nitrogen Removal Needed.** The only estuary in Eastham that has a nitrogen limit developed (in draft form) is Rock Harbor, and a large portion of the lower watershed extends into the Town of Orleans. Approximately 79 percent of the existing nitrogen loading needs to be removed to meet this limit as illustrated on Figure 4-1.

The MEP is nearly complete with the nitrogen limit development for the Nauset-Town Cove Estuary and an estimate of 55 percent wastewater nitrogen removal has been adopted by the Orleans Wastewater Planning Study and has been adopted for the Eastham project as well. This removal rate is illustrated on Figure 4-1.

The other marine waters around Eastham do not have nitrogen limits and are not believed to be severely impacted by current nitrogen loading from septic systems. This finding may change in the future; but for now the existing wastewater nitrogen load that needs to be removed is shown as not available (N/A) on Figure 4-1 and is considered for this project to be low or zero.

B. **Freshwater Pond Resources, Water Quality, and Evaluation of Phosphorus Sensitivity.** The Cape Cod Commission is currently evaluating the phosphorus sensitivity and habitat health of the following freshwater ponds in Eastham:

- Great Pond
- Herring Pond
- Mill/Muddy Pond
- Depot Pond
- Ministers Pond

These evaluations are scheduled to be finalized in mid 2009 but draft findings were released to the Town in December 2008. This Interim Needs Assessment and Alternatives Screening Analysis Report summarizes some of the main findings of the December 2008 draft report with the caveat that the findings may change in the future.

Four out of the five ponds listed above are classified as "great ponds" with the exception being Mill/Muddy Pond. A great pond is defined by the MassDEP as any pond or lake of ten or more acres. Six other smaller freshwater ponds in Eastham are listed as follows (some of which are privately owned):

- Molls Pond
- Widow Harding Pond
- Jemima Pond
- Bridge Pond
- Baker's Pond
- Deborah's Pond

Freshwater ponds are typically affected by excessive phosphorus discharges in their watersheds because phosphorus is the limiting nutrient for these water bodies. This means that the other essential nutrients for plant growth (e.g. nitrogen, potassium, etc.) are in sufficient supply, and the addition of phosphorus to these waters will produce a corresponding growth of algae. This is similar for marine waters except that in marine waters, nitrogen is the limiting nutrient. Algae are the suspended and attached plant material that can foul the water, making it unattractive for swimming, fishing, and boating. The algae will typically settle to the bottom of the ponds, and through natural decay process, deplete oxygen source in the water.

Similar to nitrogen in marine watersheds, the phosphorus originates from several sources including: septic systems, roof and road run-off, lawn and agricultural fertilizers, atmospheric deposition, and phosphorus recycling from the sediments on the bottom of the ponds. The largest source of phosphorus to the watershed is from on-site septic systems.

Unlike nitrogen, phosphorus is not very soluble in the groundwater system and it will not travel at the same velocity as the groundwater. The phosphorus tends to adsorb to sand and clay particles until all of the adsorption sites are saturated, at which time it will dissolve again and move with the groundwater to the next area of clean soils and adsorption sites. This process will continue until the phosphorus emerges in a pond and stimulates the growth of algae.

Phosphorus plumes from septic systems have been documented to move at approximately 1 meter/year (Robertson et al, 1998). This is considerably slower than the typical movement of groundwater (and nitrogen) on Cape Cod which is typically idealized at 1 foot per day (Cape Cod Commission, 2006) or 110 meters per year.

Research by USGS (McCobb et al, Investigation Report 02-4306, 2003) indicates there is complex soil chemistry and loading factors that determine the phosphorus plume travel velocities. The transport of phosphorus to ponds can take many (greater than 100) years. Watershed evaluations at the Great Sand Lakes in Harwich (Stearns & Wheler, LLC, June 2007) indicates that the phosphorus discharged to that watershed over 50 years ago (when the watershed near the pond was first developed) may (just now) be arriving at the ponds and causing increased algae blooms.

The draft report (December 2008) on the ponds by the UMass SMAST Coastal Systems Group and Cape Cod Commission indicates that all of the ponds investigated (with the exception of Jemima and Mill/Muddy Ponds) fail to meet the minimum dissolved oxygen thresholds set by the state. Also, all of the ponds fail to meet the dissolved phosphorus thresholds set by the Cape Cod Commission for “healthy” ponds. This report goes on to identify additional sampling, analysis, and environmental studies that could be completed to further detail the current impacts to pond water quality.

It is noted that the consolidated watershed to Eastham's ponds is dominated by dense residential development (Figure 4-1). It is believed that significant phosphorus loads have already entered the watershed and are now emerging into the ponds and causing the water quality problems.

The phosphorus plumes will continue to move as long as additional phosphorus is discharged to the watershed. Recent science indicates that the entire wastewater phosphorus load (100 percent) needs to be removed to stop the plume movement. An alternative management practice would be to periodically tie up (chemically precipitate) the phosphorus that is already in the ponds to the bottom of the ponds with the use of alum addition as was recently completed on Long Pond in Harwich and Brewster, and several years ago at Hamblin Pond in Barnstable. These alternative management concepts will be reviewed later in this report.

For now, we suspect that 100 percent of the wastewater phosphorus needs to be removed (shown on Figure 4-1) as a long-term management approach pending the final evaluations by the Cape Cod Commission.

C. **Topography.** In general, the topography in Eastham and in this area of Cape Cod is relatively flat (sea level) with a high point of seventy feet along its northeastern coastline. There are no major rivers or hills, but numerous surface water areas including creeks, wetlands, marshes, estuaries and ponds.

D. **Geology/Soils.** The Town of Eastham is primarily comprised of "outwash plain and ice-contact deposits" in addition to areas identified as "marsh deposits" according to the Geologic Map of Barnstable County.

According to the Barnstable County Soil Survey, Eastham contains approximately 21 specific soil types. These soils can be further classified based on topography and thickness of the soil layers. The predominant soil types within the Town of Eastham are Carver, Ipswich-Pawcatuck-Matunuck and Hooksan-Beaches-Dune Land. The Carver soils are "nearly level to steep, very deep, excessively drained, sandy soils formed in glacial outwash and ice-contact deposits; on outwash plains and kames." The Ipswich-Pawcatuck-Matunuck soils are "nearly level, very deep, very poorly drained peats formed in marine organic and sandy deposits; in areas sheltered from ocean waves along coastal shorelines and adjacent to bodies of brackish water." The Hooksan-Beaches-Dune Land soils are "nearly level to steep, drained, sandy soils formed in windblown deposits; along coastal shorelines."

E. **Groundwater.** The groundwater in Eastham provides drinking water supplies and recharges the ponds, wetlands, and coastal estuaries. The groundwater resources on Cape Cod are classified as a sole-source aquifer by USEPA.

1. **Flow Direction and Elevation.** Eastham is essentially the sole user and major beneficiary of the Nauset Lens of the Lower Cape aquifer. The Town sits above the Nauset Lens. Groundwater flows in both a westerly and easterly direction and eventually drains into Cape Cod Bay (westerly) and the Atlantic Ocean (easterly). Figure 4-2 illustrates the generalized groundwater contours and elevations and indicates the direction of flow. In general, groundwater flow is perpendicular to the lens's contour lines.

2. **Public Drinking Water Supplies.** The Town of Eastham's drinking water supplies consist almost entirely of private wells. Only a few properties near the Orleans town line are connected to the Orleans public water supply. Figure 4-2 also illustrates the proposed water supply sites and evaluated water supply sites as identified by Environmental Partners Group for the Town of Eastham. A well site screening matrix was developed identifying potential water supply well sites for the Town of Eastham and the factors influencing the ranking. See Table 11-1 for this matrix and Chapter 11 for additional discussion.

3. **Protected Areas.** The Town of Eastham's Local Comprehensive Plan discusses the zoning districts set forth by the Town which allows for the protection of the Town's water resources. A Seashore District was developed to further the preservation of the Cape Cod National Seashore in accordance with the purposes of the Act of Congress. A Water Resources Protection District and Wellfield Protection District were accepted at Annual Town Meeting, May 3, 1989 to protect the public health by preventing the contamination of the ground and surface water resources.

Figure 4-2 illustrates the several Interim Wellhead Protection Areas (IWPAs) in the Town. An IWPA is defined as a one-half mile radius measured from the proposed well or wellfield for sources whose approved pumping rate is 100,000 gpd or greater. For wells or wellfields that pump less than 100,000 gpd, the IWPA radius is proportional to the approved pumping rate which is typically calculated according to the following equation: IWPA (radius in feet) = (32 x pumping rate in gallons per minute) + 400. A default IWPA radius or an IWPA radius otherwise computed and determined by MassDEP is often applied to transient non-community and non-

transient non-community wells when there is no metered rate of withdrawal or no approved pumping rate. Complete information can be found in the Massachusetts Drinking Water Regulations of 310 CMR 22.

A regulation issued by the Eastham Board of Health was enacted to protect environmentally sensitive areas including areas near marshlands, surface waters, tidal flats, etc. The regulation severely restricts the issuance of variances from septage disposal regulations in these locations.

4. **Quality.** The Town of Eastham has long considered the implementation of a town-wide municipal drinking water system and has completed a Municipal Water Distribution System Master Plan dated on May 2006. However, funding to initiate the master plan has failed at Town Meeting.

Long-term nitrate sampling data has been summarized and was presented during Special Town Meeting on October 1, 2007 indicating a decline in drinking water quality. Figure 4-3 illustrates that nitrate levels above 5 mg/L increased from 1984 to 2001 and that favorable nitrate levels (below 2 mg/L) have steadily declined. The Federal/State maximum contaminant level (MCL) for nitrate is 10 mg/L. As a result, the Cape Cod Commission has set a groundwater planning limit of 5 mg/L total nitrogen to protect drinking water supplies and other water resources.

Figure 4-4 compares the nitrate levels in Eastham from 2001 to 2008. This figure further identifies an increase in nitrate levels at various concentration ranges specifically for 5 – 10 mg/L, and above 10 mg/L as well as a decrease in nitrate levels with concentrations below 2 mg/L. Figure 4-5 displays the results of the Eastham Water Survey Program conducted from fiscal years 2003 to 2005. All three figures illustrate why drinking water quality is a growing concern for the Town of Eastham.

F. **Fresh Surface Water Resources.** The fresh surface waters in the Town of Eastham consist of ponds, wetlands, and vernal pools. A discussion on the ponds was summarized in Section B of this chapter. A brief discussion of the other fresh-water bodies follows:

1. **Wetlands.** Wetlands in Eastham include both freshwater wetland and salt marsh vegetation. A Wetlands Protection Act was adopted by the Town of Eastham by Annual Town Meeting on May 3, 1999. The purpose of this bylaw is to "protect the foreshore and wetlands of the Town of Eastham by controlling activities deemed to have a significant effect on wetland

values including, but not limited to, the following: public or private water supply groundwater, flood control, erosion control, storm damage, water pollution, fisheries, shellfish, wildlife and recreation."

Wetlands are valuable for flood protection, nutrient uptake and release, wildlife habitat and propagation, groundwater recharge, and open space for recreation and scenic beauty. The Wetlands Protection Act is administered and enforced by MassDEP's Wetlands Program. The Wetlands Protection Act imposes restriction on the removal, filling, dredging, or alteration of any designated wetland. The wetland delineations within the planning area are shown on Figure 4-6.

2. **Vernal Pools.** Vernal pools are temporary bodies of freshwater that provide critical habitat for a number of vertebrate and invertebrate wildlife species. Approximately 12 vernal pools have been identified by the Natural Heritage & Endangered Species Program in the Town of Eastham. The vernal pools located within the town are shown on Figure 4-6. The majority of the vernal pools are located in the Atlantic Ocean Recharge and Nauset-Town Cove Recharge Areas of Eastham.

G. **Floodplains and Velocity Zones.** Floodplains are nature's way of buffering land areas from excessive storm events because they act to dissipate the wind and wave action generated during these storms. V-Zones are designated by FEMA and are defined as areas susceptible to 100-year coastal flooding with high velocity wave action.

Also designated by FEMA, A-Zones are areas where flooding is predicted to occur once every 100 years. This flooding occurs with minimal associated wave action, and these areas are typically located landward of the V-Zones, typically in salt marshes and low elevation areas of Eastham. The surface elevations in these areas typically lie below 10 feet mean sea level. The flood zones are illustrated in Figure 4-7.

H. **Protected Natural and Cultural Areas.**

1. **Areas of Critical Environmental Concern (ACECs).** Inner Cape Cod Bay located in Brewster, Eastham and Orleans was designated in 1985 as an ACEC and includes 2,600 acres. Wellfleet Harbor located in Eastham, Truro and Wellfleet was designated in 1989 as an ACEC and includes 12,480 acres. Both ACECs are identified on Figure 4-6.

2. **District of Critical Planning Concern.** There are no Districts of Critical Planning Concern located in the Town of Eastham.

3. **Critical Wildlife and Plant Habitat.** There are several regions the Town of Eastham that have been identified as estimated habitats of rare species and wildlife by the Massachusetts Division of Fisheries, Natural Heritage and Endangered Species Program (NHESP). Figure 4-6 shows areas where NHESP Certified vernal pools are located as well as NHESP estimated rare wildlife habitat areas. Figure 4-6 also illustrates areas designated as wetlands by the MassDEP.

4. **Town Conservation Lands.** The Town of Eastham has several areas protected as open space. The Cape Cod National Seashore along Eastham's eastern boundary provides more than 3,000 acres (approximately one-third) of the Town. The National Seashore is a favorite destination spot and provides miles of beaches, swimming, nature trails, bicycling, horseback riding, fishing and hunting. The park is operated by the National Park Service. Eastham has over 485 acres of town-owned open space holdings, some of which are historic areas. These areas provide a variety of outdoor experiences to both visitors and residents. In addition, the Town owns 64 acres of land known as The Roach Property. This property was evaluated as a potential site for water supply but was later ranked as unfavorable due to its distance from the proposed limited water system, and its potential impact on Hatch's Creek. Groundwater modeling by the USGS concluded that pumping of the Roach Property at 380 gallons per minute would affect streamflow at Hatch's Creek located north of the proposed well site. Development of the Roach Property for a limited municipal water supply of less than 70 gallons per minute would require further groundwater modeling to assess the potential affects on Hatch's Creek (Environmental Partners Group, May 2006).

The Eastham Conservation Foundation, which is a private, nonprofit land trust established to promote the interests of the Town and its inhabitants, and to assist in the preservation and maintenance of various natural resources. The Eastham Conservation Foundation was founded in 1978 and to date has protected 270 acres of land of which 214 acres are owned and 56 acres are under easement and protected by conservation restrictions (Compact of Cape Cod Conservation Trusts, Inc., 2008). Of the 214 acres, 76 percent of that area is considered wetlands. The conservation restrictions place limits on the future development of a parcel of

land thereby retaining it in a natural or open condition. An organization, such as the Eastham Conservation Foundation (or Massachusetts Audubon Society) generally holds the restriction.

5. **Protected Cultural Areas.** The Town of Eastham is made up of many significant historic sites, landscapes and buildings. Eastham's Atlantic coastline is preserved by the presence of the Cape Cod National Seashore. The bayside has pleasant summer homes, various Town landings and beaches, and Rock Harbor Marina in the south. The Town's settlement pattern has traditionally been dispersed and focused primarily on agricultural and maritime pursuits.

The Town of Eastham has many historic sites, identified in several documents. The Heritage Preservation/Community Character section of the Eastham Local Comprehensive Plan provides the most complete listing of existing historic sites and districts. Figure 4-2 shows the historic districts and sites within the Town. According to the National Register of Historic Places at the time this report was developed, Eastham has 5 districts which each include several properties:

1. Collins Cottages Historic District
2. Eastham Center Historic District
3. Fort Hill Rural Historic District
4. Nauset Archeological District
5. Old Town Center Historic District

The individually listed properties exclusive of the districts are:

1. The Beacon (Nauset Light)
2. Bridge Road Cemetery
3. Cove Burying Ground
4. Nauset Beach Light
5. Edward Penniman House and Barn
6. Three Sisters of Nauset (Twin Lights)

4.4 TOWN LAND USE

A. **Existing Land Use.** As part of the Local Comprehensive Plan, the Town of Eastham developed Town-wide land use statistics. The area of Eastham is approximately 9,130 acres in

size, with approximately 46 percent (or 4,145 acres) zoned residential. The Town of Eastham (including the portion of the Cape Cod National Seashore located within Eastham) is currently 52 percent developed and seven percent undeveloped by land area. The Cape Cod National Seashore makes up approximately 33 percent of the Town while roads and water bodies make up the balance of the Town (approximately eight percent). Eastham, like other towns on Cape Cod has experienced significant growth over the past few decades; in 1960 only four percent of the Town was developed residentially.

This land use data is illustrated for the Town of Eastham in Figure 4-8 and includes Commercial, Forest, Industrial, Mining, Open Land, Pasture, Residential, Salt Wetland, Urban Open, Waste Disposal, Water, Water Based Recreation, Freshwater Wetland and Woody Perennial as the land use codes.

B. **Town Zoning.** The Town of Eastham is divided into eight major zoning districts: District A - Residential, District B - Marina, District C - Industrial, District D - Retail Sales/Service, District E - Limited Commercial, District F - Seashore, District G - Water Resource Protection and District H - Wellfield Protection and is illustrated on Figure 4-9. Town of Eastham zoning district bylaws can be generalized as follows:

Districts A and E:

- 0.92-acre zoning for single family
- 1.8-acre zoning for two-family

Districts B, C, D and E:

- No business structure on lot less than 40,000 square feet

District F:

- 3.0-acre zoning for any dwelling

District G:

- 3.0-acre zoning for single family

- 6.0-acre zoning for two-family

District H:

- An open space area designed to protect the public health by preventing the contamination of the ground and surface water resources in a test wellfield area demonstrated to be capable of providing a portion of the potential public water supply for the Town of Eastham as accepted at Annual Town Meeting.
- Uses are limited to: 1) Construction, operation, and maintenance of municipal water supply wells; 2) Protection of soil, water, plants and wildlife, and other natural features and values; 3) Passive recreation and; 4) Ocean Beach subject to Site Plan – Special Permit.

4.5 WASTEWATER FLOWS AND LOADINGS

A. **Information on Failing Systems.** As discussed previously in Chapter 2, an Eastham Board of Health Database (extracts of water quality/septic data and nitrate data) was provided by the Eastham Board of Health to Stearns & Wheler. The database includes water quality data, septic data and nitrate data. Upon discussion with the Board of Health, a record is created within the Board of Health database when a permit is issued. In order to determine whether a septic system failure occurred at a property from the Board of Health database information, a comparison would need to be done against the Town Assessor's database to determine if the record created was due to a property transfer inspection. When records exist in the Board of Health database that do not match with Assessor's inspection records, assumptions can be made that a septic system failure was the reason for the inspection. A suggestion may be to include an additional field in the Board of Health database so that a timely comparison would not be necessary. This database could be a very useful tool for the Town to monitor septic system failures and to determine if property-type trends exist.

B. **Existing Average Annual Wastewater Flows and Wastewater Nitrogen Loadings.** The existing average annual wastewater flow estimates are based on the work and methodology of the MEP for the Rock Harbor estuary. The value used in the MEP Rock Harbor Embayment Technical Report for existing developed residential parcels without water accounts is 142 gpd. In order to develop wastewater flow estimates, a value of 0.9 is used to calculate wastewater flows from water use. The methodology includes the following steps:

- The number of parcels (frequency) are grouped by state land use code.
- For single-family residential, a water value of 142 gpd and a wastewater value of 128 gpd (142 gpd x 0.9) is then assigned and connected to the parcel data to determine a flow estimate based on state land use codes. Adjustments are then made to parcel assignments based on state land use codes.

The wastewater nitrogen loadings to the groundwater system associated with these existing flows were developed by MEP based on an average nitrogen concentration of 26.25 mg/L, which assumes a nitrogen removal in the septic tank, in the leaching system, and in the soils beneath the leaking system to the top of the aquifer. Properties with an advanced (I/A) septic system were not calculated differently in terms of nitrogen concentrations because only 78 properties out of a total 6,606 (about one percent) exist in Eastham. In general, properties with an advanced (I/A) septic system are assumed to achieve an effluent concentration of 19 mg/L total nitrogen.

The wastewater flows and loadings for each of the major watershed areas in Eastham are summarized in Table 4-2.

C. **Seasonal Variations for the Wastewater Flows.** Eastham, like many towns on Cape Cod experiences a significant population surge in the summer months due to tourism and the residence of second home owners. As the population increases so does the water demand and thus wastewater flows. The Town of Eastham has a population of approximately 5,450 according to 2000 U.S. Census Bureau data. The Municipal Water Distribution System Master Plan prepared for the Town of Eastham in May 2006 states that it can be assumed that a cape community such as Eastham has a 4:1 increase in population in the summer as compared to the winter. This ratio was developed from population data collected from the Towns of Orleans and Provincetown, two nearby towns with public water consumption data. The report states that despite the surge in population, the water consumption does not quadruple. The average summer to average annual demand ratio is Provincetown is 1.6:1 and the average summer to average annual demand ratio in Orleans is 1.82:1. The ratio for the Town of Orleans is used for the purpose of this report due to the similarity in community structure (residential and commercial). The annual population of Eastham also most similarly resembles Orleans at 6,340 as compared to Provincetown at 3,430. A summary of annual and seasonal wastewater flows are summarized below in Table 4-3.

D. **Buildout.** Figure 4-10 illustrates the Town's buildout potential in each major watershed area based on available vacant properties and the current (2008) allowable Town zoning. A total of 555 additional buildout properties were identified during this analysis in GIS. Assumptions for buildout were based on suggested MEP values, water demand estimates using Title 5 flow developed in the Eastham Municipal Water Distribution System Master Plan, and the Town of Eastham zoning regulations (as discussed previously in this chapter). Assumptions for buildout from the MEP as it pertains to residential, commercial and industrial properties are derived from Table IV-1 in the Rock Harbor Embayment Technical Report; 142 gpd for existing developed residential parcels without water accounts, 98 gpd per 1,000 square feet of building, and 16 gpd per 1,000 square feet of building, respectively. Water demand estimates using Title 5 flow were applied to commercial land use codes where motels, inns, an athletic club, restaurants etc. are located and exempt property/charitable organizations land use codes where housing authority, churches, schools etc. are located. A summary of the methodology is as follows:

1. **Buildout Assignments Based on Land Use Codes:**

- Single-Family Residential (101) – Lots with square footage larger than current zoning were assigned buildout values by dividing existing area by current zoning. The buildout number represents an additional property.

- Residential Developable and Potentially Developable (130 & 131) – Lots with square footage larger than current zoning were assigned additional buildout values by dividing existing area by current zoning. The buildout number represents an additional property.

- Commercially Developable and Potentially Developable (390 & 391) – Lots with square footage larger than current zoning were assigned buildout values by dividing existing area by current zoning. The buildout number represents an additional property.

- Other Land Use Codes – Were assigned buildout values according to assumptions made in the Municipal Water Distribution System Master Plan (water demand estimates using Title 5 flow).

2. **Buildout Assignments Based on Location and Town Feedback.** As a separate deliverable to the Draft report, a technical memorandum and accompanying GIS maps were provided to the Town for review and comment. The buildout typically needs to represent an approximation of future conditions. Therefore, the approach of using current zoning and state class codes to identify initial buildout was used. Once this was developed, a review was made and buildout values (numbers of additional future properties) were adjusted based on their proximity to wetlands, flood plains, and other sensitive receptors (conservation restrictions) that might impact the potential development of a property.

The proposed buildout was presented to the Town for feedback and comment so that the future wastewater flows could be adjusted and presented. Feedback was received by various Town departments resulting in revised buildout and future flows for this Final Report.

E. **Future Wastewater Flows and Nitrogen Wastewater Loadings.** The development of future wastewater flows in the Town is dependent on the zoning regulations and how that applies to the area of a parcel; the parcel's buildout potential. However, typical buildout assumptions based on current zoning may change in certain areas to allow Chapter 40B developments that may exceed the current zoning requirements. Future flows are developed based on the buildout approach as identified previously in this chapter.

A future residential wastewater flow of 128 gpd per residential property is estimated for the Town of Eastham. This flow corresponds with the MEP's buildout wastewater flow for the Rock Harbor Embayment Technical Report.

Determining the basis for nitrogen loading development for projected buildout consists of identifying developable and potentially developable properties by state land use code and then comparing these identified properties with the Town Assessor. Properties classified as "undevelopable" (e.g., codes 132, 392 and 442) were not assigned any development at buildout. Commercially developable properties were not subdivided. Commercial properties were assigned a wastewater value of 98 gpd/1,000 square feet of building and industrial properties were assigned a wastewater value of 16 gpd/1,000 square feet of building to remain consistent with the MEP methodology.

The estimated future wastewater flows and loadings for the Town of Eastham are summarized in Table 4-4.

F. **Estimated Wastewater Flows to be Treated at a Community/Municipal Facility.** The wastewater removal percentages indicated in Figure 4-1 are high in certain areas, specifically the Rock Harbor Estuary (for nitrogen) and the Freshwater Pond System (for phosphorus) and could only be attained in an enhanced nitrogen/phosphorus removal facility that would have the ability to recharge the treated water in a less sensitive area. When these removal percentages are applied to the existing wastewater flows in these watershed areas the following flows are estimated as shown in Table 4-5 below. As discussed further in Chapter 14, I/A systems which achieve a nitrogen effluent of 10 mg/L may aid in TMDL compliance in the Nauset-Town Cove Estuary.

When wastewater treatment facilities are designed, an allowance for I/I must be estimated for the time when the collection systems age and groundwater or surface waters will seep into the system. An infiltration rate of 500 gpd per inch mile of gravity pipe is recommended by the TR-16 Guide. This needs to be determined once the wastewater collection system has been quantified with a preliminary design. A recent preliminary design for a similar Cape Town indicates the I/I contributes 30 percent additional flow to the average annual wastewater flow for areas of moderate residential density. The 30 percent increase to the 0.21 mgd flow would indicate a total average annual flow of 0.27 mgd. This flow estimate represents a preliminary municipal/community size facility to treat the wastewater nitrogen (phosphorus) that needs to be removed to meet the existing/potential TMDLs. This flow estimate does not include buildout which would increase flows to be treated. Table 4-6 discusses the wastewater flows to be treated with buildout flows included.

In addition, a larger flow is expected to be needed once the return nitrogen loading (the 3 mg/L total nitrogen in the treated water) is calculated. If 50 percent nitrogen attenuation is obtained in the watershed due to recharged flow through freshwater resources, approximately four percent more wastewater flow will need to be collected and treated.