Chapter 5

Existing and Future Conditions in the Town of Barnstable

CHAPTER 5

EXISTING AND FUTURE CONDITIONS IN THE TOWN OF BARNSTABLE

5.1 INTRODUCTION

This chapter provides a description of the existing and future conditions in the Town of Barnstable with respect to land use, water consumption, nutrient loading, and wastewater generation. Embayment water quality, groundwater hydrology and quality, ponds and lakes, and other natural and physical characteristics, as well as protected cultural areas, and population and demographics within Barnstable are discussed.

Existing and future conditions are analyzed on a Town-wide scale as well as on a village and watershed level to provide a detailed understanding to develop the wastewater and nutrient management needs of the Town.

5.2 PLANNING AREA AND COMPONENT DELINEATIONS

As discussed in Chapter 1, the Project Planning Area is the Town of Barnstable but there are several water-resource and nutrient-management issues that extend beyond the town borders and must be considered. Figure 1-1 illustrates the planning area and several of these water resource areas that extend beyond the town boundaries.

The planning area contains several watershed areas to the following main marine estuaries that have (or will have) nutrient limits:

- Popponesset Bay
- Rushy Marsh (No formal nitrogen TMDL limits are expected to be developed for this water body due to its small size and history of shoaling.)
- Three Bay System
- Centerville River System
- Halls Creek

- Lewis Bay
- Barnstable Harbor

All of these watersheds except the Rushy Marsh, Centerville River System, and Halls Creek watersheds extend beyond the town boundaries into the neighboring towns as illustrated on Figure 1-1. Coordination with these neighboring towns is needed to develop a successful plan to meet the nitrogen limits for these estuaries.

Figure 1-1 also illustrates the public water supply Zones of Contribution (ZOC) areas. These areas include Zone II areas and are the areas that may provide groundwater to public water supply wells. Several of these ZOC areas extend across town borders.

The Town of Barnstable is also unique due to the Village structure and delineation within the town itself. Figure 1-1 illustrates the Town's seven villages: Barnstable, West Barnstable, Cotuit, Marstons Mills, Osterville, Centerville and Hyannis, all of which have their distinct character.

These areas, and their overlapping nature, are considered in this chapter.

5.3 TOWN GOALS WITH RESPECT TO WASTEWATER AND NUTRIENT MANAGEMENT

Chapter 1 of this report references the vision statement and comprehensive plan goals of the Town of Barnstable as outlined in the Barnstable Comprehensive Plan (BCP).

In summary, this project will work within the guidelines of this vision and their goals, and strive to meet the following Town specific goals outlined in the BCP pertaining to wastewater and nutrient management:

- Growth shall be located in areas where infrastructure capacity is in place or has the ability to absorb development impacts through concurrently planned expansion. Redevelopment of existing developed areas is the preferred form of development (Goal 1.1).
- Manage residential development and redevelopment to protect sensitive embayments and drinking water supply, offset growth incentives in the Growth Incentive Zones

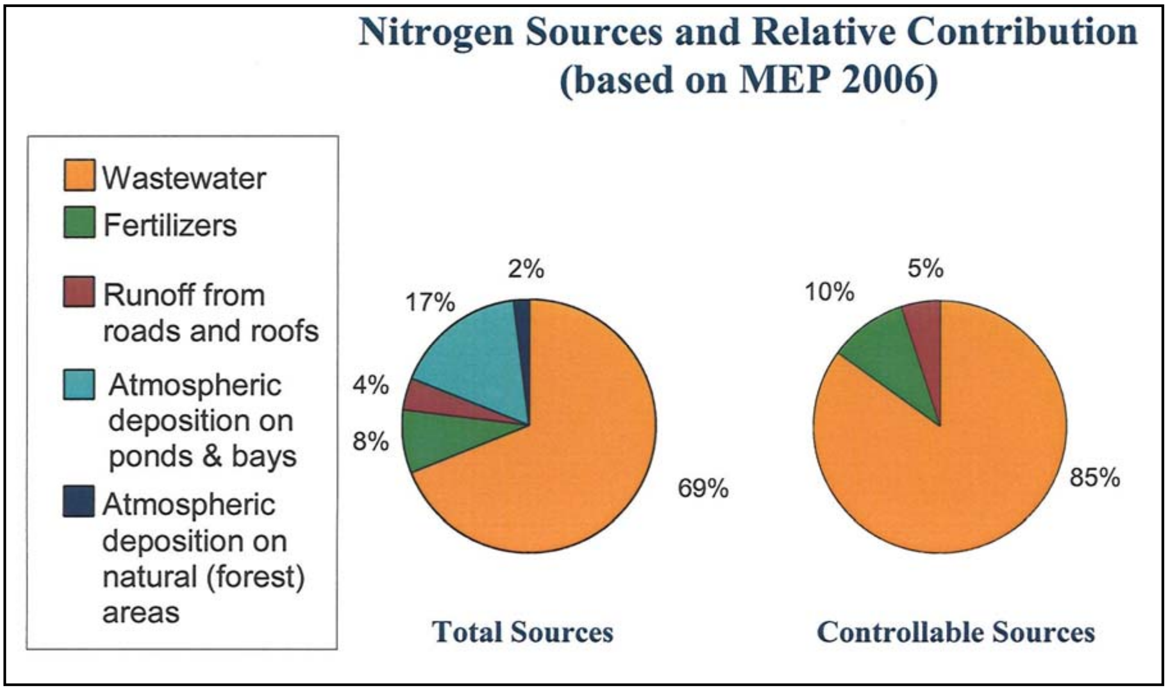
(GIZ) and densely developed residential areas, manage traffic circulation, preserve open lands, agricultural lands and cultural, historic and scenic landscapes (Goal 1.6).

- Minimize wastewater contamination of water resources from private or public wastewater management systems to improve drinking water quality, with the ultimate goal of achieving an untreated water supply, and to improve the ecological integrity of streams, ponds and coastal embayments using all available data including MEP data (Goal 2.6.1).
- Encourage, in coordination with the Wastewater Facilities Plan, the use of public and private wastewater treatment facilities in appropriate areas where they will provide environmental or other public benefits (Goal 2.6.2).
- Encourage the use of innovative or alternative wastewater treatment technologies to achieve higher quality effluent discharge to better protect natural resources, especially water resources with the ultimate goal of achieving an untreated water supply and ecological integrity of streams, ponds and coastal embayments (Goal 2.6.3).
- Provide adequate wastewater treatment facilities to meet community need while protecting the quality and quantity of our sole source aquifer (Goal 4.3.1).
- Provide infrastructure required for growth centers and redevelopment areas (Goal 3.5).

5.4 EMBAYMENT WATER QUALITY RELATED TO NITROGEN IMPACTS AND MEP REPORT FINDINGS

One of the largest issue associated with wastewater and nutrient management planning on Cape Cod is the marine water quality impacts from the nitrogen in wastewater (particularly septic system) 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. As documented in the Massachusetts Estuaries Project (MEP) Technical Reports, the excessive nitrogen loading to the Town’s embayments is damaging these water resources and could impact property values and ultimately the tourist and summer home economy of many portions of Barnstable.

The excessive nitrogen loading originates from several sources, including roof and road runoff, lawn and agricultural fertilizers, and atmospheric deposition. On Cape Cod, wastewater from on-site systems is the largest nitrogen source in the watershed. The illustration below depicts the typical sources and relative quantity of nitrogen to the estuaries:



The pie chart on the left illustrates the relative quantity of all the sources, or "Total Sources," while the chart on the right illustrates the relative quantity of the sources that could be controlled in the future, also called "Controllable Sources." Although it is not feasible to effect a change on the nitrogen that infiltrates from atmospheric deposition, we can control the nitrogen loadings from the other sources. The wastewater source represents 69 percent of the "Total Sources" and 85 percent of the "Controllable Sources" depicted above. Collecting and treating the wastewater provides the best chance of solving this problem.

The estuary depicted in these charts is the Three Bay System, and the chart and preceeding paragraph of text is from the Guidance Document prepared by Three Bay Preservation Inc. entitled "Understanding Nitrogen Pollution and Wastewater Management at Three Bays and Cape Cod". Each estuary will have unique percentages for its nitrogen sources; but they tend to be similar to the percentages presented above.

Chapter 1 (Section 1.2.B) of this Needs Assessment Report provided detailed background on the development of nitrogen limits and Total Maximum Daily Limits (TMDL) for the group of 89 estuaries in Southeastern Massachusetts, of which five have large watersheds in Barnstable. The TMDLs are developed through the following steps:

1. The Massachusetts Estuaries Project develops threshold nitrogen concentrations for the estuaries and nitrogen loading limits for the watersheds to these esturies. These evaluations and nitrogen limits are documented in a Technical Report for each estuary.
2. Massachusetts Department of Environmental Protection (MassDEP) reviews the Technical Report for each estuary and then develops a TMDL Report for it. The TMDL Report is submitted to USEPA for their review and approval.
3. USEPA reviews the TMDL Report for compliance with respect to the Federal Clean Water Act and, if acceptable, issues a TMDL for the estuary.

As discussed in Chapter 1, final Technical Reports have been issued for Popponesset Bay, Rushy Marsh, Three Bays System, and Centerville River System. TMDL Reports and USEPA TMDLs have been issued for all of these except Rushy Marsh, and a TMDL Report and formal nitrogen limit is not expected for Rushy Marsh due to its small size and history of shoaling. A draft Technical Report has been issued for Lewis Bay. No reports have been issued for Barnstable Harbor.

As stated in the MEP reports, overall indication of biological health and determination of site-specific nitrogen thresholds for an estuary 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. These characteristics are briefly described below.

- **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).

- **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 believed to be from high nitrogen concentrations, the production of algae that results from the high nitrogen concentrations, and the subsequent shading of the eelgrass (Howes, B.L., et al. 2004).
- **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 occur rarely. 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).

Evaluation of these characteristics by the MEP has developed an understanding of the health of the embayments and the amount of nitrogen that needs to be removed to remediate current nitrogen impacts as discussed below.

A. **Popponesset Bay Estuary.** The Popponesset Bay Estuary is classified overall as having high quality within the Popoonesset Bay Central Basin, significant impairment within the upper areas of Popponesset Bay, including Shoestring and Ockway Bays and significant impairment to degraded embayments within the Mashpee River. Within the Popponesset Bay System, wastewater from on-site septic systems represents 66 percent of the overall nitrogen load and 82 percent of the local controllable nitrogen load.

The local controllable load represents nitrogen sources that could be potentially regulated by municipalities, therefore local controllable loads do not include nitrogen loading from water body surface areas and “natural” surfaces.

B. **Rushy Marsh.** The Rushy Marsh Pond Estuary is classified overall as having severe degradation in both the channel and main basin as provided in the MEP Technical Report. Historically, Rushy Marsh was connected to Nantucket Sound through an inlet and once the inlet closed, a culvert was constructed to connect the marsh with the Sound. Within Rushy Marsh, wastewater from on-site septic systems represents 54 percent of the overall nitrogen load and 89 percent of the local controllable nitrogen load. MEP determined however, that removal of the entire nitrogen load would still result in an estuarine system that is significantly impaired, and this is due to restricted tidal flushing. There are currently no plans to issue a TMDL for this estuary and plans to remediate the water quality include opening the inlet through an improved culvert design. Once the outlet is reopened, monitoring will continue to verify improvements to water quality.

C. **Three Bays Estuary.** The Three Bays Estuary is classified overall as having moderate impairment in Cotuit Bay and West Bay, moderate to significant impairment in the lower portion of North Bay, significant impairment to severe degradation is Prince Cove and the upper portion of North Bay and severe degradation in Warrens Cove. Within the Three Bays System overall, wastewater from on-site septic systems represents 69 percent of the overall nitrogen load and 85 percent of the local controllable nitrogen load.

D. **Centerville River Estuary.** The Centerville River Estuary is classified overall as having healthy habitat conditions in the upper reaches of the Centerville River and in Bumps River, healthy to moderately impaired in the mid reaches of the Centerville River and healthy to significantly impaired in the lower reaches of the Centerville River. Scudder Bay is classified as having moderate impairment and East Bay as having moderate to significant impairment. Within the Centerville River System overall, wastewater from on-site septic systems represents 80 percent of the overall nitrogen load and 87 percent of the local controllable nitrogen load.

E. **Halls Creek Estuary.** Halls Creek was evaluated as part of the MEPs work on Lewis Bay and is classified overall as having healthy habitat conditions. Because Halls Creek is classified as a salt marsh and not an embayment; its salt marsh structure does not support eelgrass and has a high tolerance to nitrogen inputs. The present condition of Halls Creek is below the nitrogen threshold for this system, meaning the nitrogen threshold is not currently being exceeded. Within the system overall, wastewater from on-site septic systems represents 62 percent of the overall nitrogen load and 66 percent of the local controllable nitrogen load; the recharge from the Hyannis WPCF represents 10 percent of the overall nitrogen load and 10 percent of the local controllable nitrogen load.

F. **Lewis Bay Estuary.** The Lewis Bay Estuary is classified overall as having moderate impairment in Mill Creek and Hyannis Inner Harbor, and significant impairment in Uncle Roberts Cove and the Lewis Bay main basin. Within the Lewis Bay System overall, wastewater from on-site septic systems represents 55 percent of the overall nitrogen load and 63 percent of the local controllable nitrogen load. The load from on-site septic systems is lower for this estuary because a portion of the watershed is currently sewered. Within the Lewis Bay System overall, the WWTF represents 20 percent of the overall nitrogen load and 22 percent of the local controllable nitrogen load.

G. **Summary of Wastewater Nitrogen Load Reductions to Meet TMDLs.** Figure 5-1 summarizes the loading reductions that would be necessary to achieve the TMDL by reducing existing on-site subsurface wastewater disposal system loads, and ignoring the other sources of nitrogen. This figure and the resulting removals for each watershed is based on detailed water quality modeling completed by the Massachusetts Estuaries Project. As part of their modeling evaluations summarized in their Technical Report, they evaluated the septic system nitrogen removals needed to meet the TMDL on a sub-watershed by sub-watershed basis. They used judgment on which sub-watersheds to target for nitrogen removal and which ones to leave as they are. The judgment appears to be based on the nitrogen sensitivity of the individual sub-estuary and if the sub-watershed to that sub-estuary provides natural nitrogen attenuation. The judgment also appears to be based on the level of tidal flushing that individual sub-estuaries receive. Information on more detailed sub-watershed removals suggested by the Massachusetts Estuaries Project is attached in Appendix 5-4.

It is noted that this model to remove only septic tank effluent from selected sub-watersheds is only one of many possible ways to meet the TMDLs. It is recognized that there was some judgment applied to select these sub-watersheds.

Additional development and land use has occurred in Barnstable since the MEP evaluations were completed and development will continue as allowed by zoning and other land use requirements.

The MEP also conducted a buildout analysis for each of the estuarine watershed areas to understand how the nitrogen source would increase at the buildout condition. As the nitrogen load from the various sources increases over time, and the nitrogen limit (TMDL) remains the same; therefore a higher percentage of wastewater nitrogen removal must be considered as part of wastewater and nutrient management planning for the future and Appendix 5-4 also contains an estimate of the loading reductions that would be necessary to achieve the TMDL by reducing future on-site subsurface wastewater disposal system loads, ignoring all other sources of nitrogen. These values were developed by incorporating MEP's buildout analysis into their landuse model for each of the estuaries.

5.5 GROUNDWATER HYDROLOGY AND QUALITY

The groundwater in Barnstable provides drinking water supplies and recharges the ponds, wetlands, and coastal estuaries. All groundwater in Barnstable is supplied by the Sagamore Lens which is shared by the Towns of Bourne, Sandwich, Falmouth, Mashpee and Yarmouth and the groundwater resources on Cape Cod as a whole are classified as a sole-source aquifer by USEPA.

A. **Flow Direction and Elevation.** Generally, the groundwater system (Sagamore Lens) is at its highest elevation in the mid section of the Town. Groundwater flows in a northerly direction towards Barnstable Harbor and in a southerly direction into Nantucket Sound. Figure 5-3 illustrates the generalized groundwater contours and elevations (based on evaluations completed for the 2007 WWFP) and indicates the direction of flow.

B. **Public Water Supplies.** As discussed in Chapter 4, the Town DPW operates the Hyannis Water System which supplies public water supply to properties in the Village of Hyannis. Three water/fire districts provide public water supply to other portions of Barnstable listed below:

- Barnstable Fire District Water Department provides water supply to the Village of Barnstable.
- The Centerville-Osterville-Marstons Mills (C-O-MM) Fire District Water Department provides water supply to those three villages.
- The Cotuit Fire District Water Department provides water supply to that village.

The West Barnstable Fire District has a Water Commission but does not currently have any Water Supply infrastructure.

According to the Town's LCP, the water suppliers own and maintain 443 miles of mains, 16 interconnections between the water suppliers in Barnstable and abutting town districts/water departments, 41 wells and 10 storage tanks. Over 2 billion gallons of water per year is pumped; and, combined, the suppliers own approximately 1,233 acres of watershed property. Figure 5-3 illustrates the Zones of Contribution (Zone I and II areas) to the public water supplies in the Town of Barnstable.

Public water supply systems have testing requirements for inorganic, volatile organic, and synthetic organic compounds, turbidity, disinfectants/disinfection byproducts, bacteria and radionuclides depending on a system's MassDEP approved plan. MassDEP also has a list of drinking water guidelines for chemicals that do not have maximum contaminant levels (MCLs) or maximum residual disinfectant levels (MRDLs).

Annually, public water supply systems must deliver to their customers a Consumer Confidence Report (CCR) which is an annual report on drinking water quality in their community. Reports are due every July 1 for the previous calendar year. The reports are mandated by the federal Safe Drinking Water Act and MassDEP is the state agency authorized to implement and enforce the CCR rule. The CCR summarizes concentrations of regulated and unregulated contaminants that were detected in the water supply during the previous year. Systems are not required to report on contaminants that were not detected. If a detected contaminant exceeds the standard or MCL, MassDEP is notified and the public water system must notify their consumers about the potential health effects and what they must do until the problem is solved. Community water systems are defined as public water systems that have at least fifteen service connections or regularly serve at least 25 year-round residents.

Because water systems are not required to report on contaminants that were not detected in the water supply, the exact water quality parameters that are included in the reports vary by system. In general, water quality parameters reported in annual CCRs for groundwater systems include microbial constituents (total coliform and fecal coliform or E. Coli), regulated inorganic contaminants (arsenic, barium, nitrate, nitrite, perchlorate, alpha emitters), and regulated volatile organic compounds (chlorine, cis 1,2-dichloroethylene, total trihalomethanes, haloacetic acids, trichloroethylene, tetrachloroethylene). Lead and copper are reported based on 90th percentile concentrations and number of samples exceeding the action level, according to the Lead and Copper Rule. In addition, utilities may report monitoring results for currently unregulated contaminants which have been detected, such as sodium, sulfate, chloroform, methyl-tert-butyl-ethter (MTBE), and dichlorofluoromethane.

Table 5-1 summarizes the water quality parameters reported in the CCRs prepared by the Barnstable Fire District Water Department, C-O-MM Fire District Water Department, and the Cotuit Fire District Water Department.

(continued)

TABLE 5-1

SUMMARY OF CONSUMER CONFIDENCE REPORT (CCR) DATA FOR LOCAL WATER DEPARTMENTS

REGULATED CONTAMINANTS	MAXIMUM CONTAMINANT LEVEL (MCL)	MCL GOAL (MCLG)	BARNSTABLE FIRE DISTRICT WATER DEPARTMENT(1)	C-O-MM FIRE DISTRICT WATER DEPARTMENT(2)	COTUIT FIRE DISTRICT WATER DEPARTMENT(3)
			Range of Detections	**Range of Detections**	**Range of Detections**
Nitrate (ppm)	10	10	0.47 – 0.71	Not detected – 5.0	1.4 – 2.7
Alpha emitters (pCi/L)	15	0	Not reported	0.9	0 – 0.9
Radium	5	None	Not reported	Not reported	0 – 0.9
Lead and Copper	**Action Level (AL)**	**MCLG**	**90th Percentile / Samples Above the AL**	**90th Percentile / Samples Above the AL**	**90th Percentile / Samples Above the AL**
Lead (ppb)	15	15	7.7 / 1 site above AL	6 / 0 out of 45	2 / 0 out of 10
Copper (ppm)	1.3	1.3	0.79 / 2 sites above AL	0.820 / 0 out of 45	0.48 / 0 out of 10
Microbiological Contaminants	**MCL**	**MCL Goal**	**Range of Detections**	**Range of Detections**	**Range of Detections**
Turbidity (NTU)	Treatment Technique	None	Not detected – 1.0	Not reported	Not reported
Unregulated Contaminants	**Secondary MCL**	**Office of Research Standards Guideline**	**Range of Detections**	**Range of Detections**	**Range of Detections**
Chloroform (ppm)	--	60	0.88 – 2.9	Not detected – 2.3	Not detected – 1.1
Sodium (ppm)	--	20	13 – 24	5.2 – 31	8.9 – 19
Sulfate (ppm)	250	--	Not detected – 9.6	5.1 – 11	5.2 – 8.4
MTBE (ppm)	20 - 40	70	Not reported	Not detected – 0.27	Not reported

Notes:
(1) Data provided in the Barnstable Fire District Water Department's 2009 Consumer Confidence Report.
(2) Data provided in the C-O-MM Fire District Water Department's 2009 Consumer Confidence Report.
(3) Data provided in the Cotuit Fire District Water Department's 2009 Consumer Confidence Report.

C. **Water Quality.**

1. **Sampling at Hyannis WPCF.** A groundwater monitoring program was established for the Hyannis WPCF and was evaluated and summarized in the Town's 2007 WWFP. Several wells are sampled on a monthly basis and data since December 2004 was reviewed. The groundwater samples were analyzed for pH, specific conductance, ammonia, nitrate, chloride, copper, iron, manganese, sodium and sulfate. Once per year, the samples are also analyzed for potassium, volatile organics and total trihalomethanes. Although there have been fluctuations in the levels of individual constituents during this period of time there have been no dramatic changes in water quality and no alarming trends.

During this period of monthly testing, it had also been noted that there have been no detections of copper above the detectable limits. This is probably due to the corrosion control programs initiated by the water suppliers.

As discussed in Chapter 4; the Hyannis WPCF is operating very well and meeting its permit limits. As discussed in Chapter 3, Regulatory Issues, revised regulations may also include new limitations on total organic carbon (TOC) concentrations for treated waters recharged to Zone II areas. These new TOC limitations are intended to provide increased protection of groundwater supplies, limiting both the amount of naturally occurring organic carbon introduced to the groundwater as well as synthetic forms of organic carbon that may be present in treated water. Further, because many contaminants of emerging concern (CECs) including endocrine disrupting compounds (EDCs), pharmaceuticals, and personal care products (PPCPs) are organic in nature, reductions in total organic carbon are expected to generate similar reductions in concentrations of CECs introduced to groundwater through reductions in total carbon concentrations. As discussed in Chapter 4, Existing Wastewater and Water Infrastructure, the Hyannis WPCF does not have a current TOC limit and this parameter is not currently monitored. Several TOC samples have been collected and analyzed since October 2009, and based on data collected to-date, the average TOC concentration in the treated water was 7.1 mg/L.

2. **Sampling at Marstons Mills WWTF.** Sampling is required at the Marstons Mills WWTF as a result of their groundwater permit. Six groundwater monitoring wells are sampled for the parameters and at the frequency shown in Table 5-2.

TABLE 5-2

MONITORING WELL SAMPLING AT MARSTONS MILLS WWTF

PARAMETER	FREQUENCY OF ANALYSIS
Static Water Level	Monthly
pH	Monthly
Total Nitrogen (NO_2+NO_3+TKN)	Quarterly
Nitrate-Nitrogen	Quarterly
Nitrite-Nitrogen	Quarterly
Total Kjeldahl Nitrogen	Quarterly
Total Phosphorus (as P)	Quarterly
Orthophosphate (as P)	Quarterly
Volatile Organic Compounds	Annually

In addition, routine monitoring includes UV intensity, influent biological oxygen demand (BOD), influent and effluent total solids (TS), effluent total suspended solids (TSS), and effluent coliform.

3. **Sampling at Barnstable Solid Waste Division Site.** Groundwater monitoring for the Landfill has been performed since 1981. In all, there are 38 groundwater-monitoring wells in and around the Barnstable Landfill, including the three public supply wells operated by the Centerville Osterville Marston Mills (C-O-MM) Water Department. Based on historical results and MassDEP requirements, 33 of these wells are typically sampled on a semi-annual basis as part of the Landfill-monitoring program.

Water samples are analyzed for general chemistry parameters, volatile organics (VOCs), filtered metals, and field parameters. The general chemistry parameters analyzed include alkalinity, chloride, sulfate, and total dissolved solids (TDS). Filtered metals include arsenic (As), barium

(Ba), iron (Fe), manganese (Mn), and lead (Pb). Field parameters (pH, temperature, dissolved oxygen (DO), and conductivity) are measured in the field at each sample location.

The overall frequency of detection of organic compounds in the Landfill's monitoring array continues to be fairly low. In all, the data for organic compounds indicates only subtle groundwater impacts from the Landfill, with no indication of a significant change in groundwater quality over time. Likewise, the inorganic data indicate that water quality is largely constant over time in the monitoring well array. The groundwater analytical results over the last several years are very stable and do not vary from one sampling round to the next.

In the future, this site may be considered as a potential location for a new WWTF or treated water recharge site. As such, the nitrogen species of ammonium, nitrate, and total nitrogen should be added to the groundwater monitoring program to establish a recent baseline assessment.

4. **Water Supply Sampling**. Water supply sampling in the Town of Barnstable is done by each water supplier according to their MassDEP approved plan. As discussed above, annual reports are distributed to water supply customers annually outlining water quality sampling results.

Water quality as it relates to embayment water quality is discussed above in Section 5.4 and water quality as it related to ponds and lakes is discussed in the following section.

5.6 PONDS AND LAKES

The fresh surface water resources in the Town of Barnstable are numerous and consist of lakes, ponds, rivers, wetlands, and vernal pools. A brief discussion of these water bodies follows.

A. **Lakes and Ponds.** There are 11 great ponds within the Town of Barnstable as defined by the MassDEP as any pond or lake of 10 or more acres. The following great ponds are illustrated on Figure 5-3.

- Garretts Pond

- Hamblin Pond
- Hathaway Pond (lower portion)
- Long Pond
- Lovell's Pond
- Middle Pond
- Mystic Lake
- Round Pond
- Rushy Marsh Pond (originally tidal)
- Shubael Pond
- Wequaquet Lake (including Bearse Pond)

According to the CCC Pond and Lake Atlas, there are 184 ponds in Barnstable totaling 1,892 acres. The atlas serves as a status report on the Cape Cod Pond and Lake Stewardship (PALS) program and reviews water quality data collected by volunteers during the 2001 PALS snapshot in order to gain Cape Cod specific nutrient indicators of pond impacts. Of the 184 ponds located within the Town of Barnstable, 38 ponds were sampled and of those 38, 28 were considered impacted by the CCC for chlorophyll a and total nitrogen and 21 were considered impacted for total phosphorus.

As part of this CWMP process, a pond water quality evaluation was completed, and an action plan to manage the ponds was developed. The report by EcoLogic LLC and Stearns & Wheler is attached as Appendix 5-1 and is entitled "Action Plan for the Barnstable Ponds", December 2009. This report builds on the data summary and analysis completed by the Cape Cod Commission as reported in the following recent reports:

- "Barnstable Ponds: Current Status, Available Data, and Recommendations for Future Activities, Final Report", CCC, July 2008.
- "Lake Wequaquet Water Quality Assessment, draft Final Report", CCC, October 2008.
- "First Order Assessment of the Indian Ponds (Mystic Lake, Middle Pond, and Hamblin Pond), Final Report", CCC, March 2006.

The Action Plan Report is a very detailed technical report that provides further water quality evaluation, identifies and considers various alternatives for protection and restoration of the Barnstable Ponds, and presents a detailed summary of existing conditions, recommended actions, and priorities for managing the ponds. The following Table 5-3 is a repeat of Table 11 in the Action Plan Report (in Appendix 5-1) and summarizes these key findings, priority, and recommendations. The ponds are grouped according to their depth.

(continued)

TABLE 5-3

POND SUMMARY OF EXISTING CONDITIONS, MANAGEMENT PRIORITY, AND RECOMMENDED ACTIONS (1)

POND	PRIORITY (2) (LOW-MODERATE-HIGH-PROTECT)	FINDINGS (3) (TROPHIC STATES: O, M, E, H)	RECOMMENDED ACTIONS (4)
Ultra-Shallow			
Aunt Bett's	Low	M; Limited public access	Education, watershed BMP
Bog	Low	M; Impacted/at risk	Education, watershed BMP
Dunn's	Moderate	E; Impacted	Education, watershed BMP
Fawcett's	Low	M; Impacted/at risk; potential for increased residential development	Education, watershed BMP; guide future development to minimize nutrient export
Hathaway (South)	Protect	O; Unimpacted	Low impact recreational use & education in protected watershed
Little Parker	High	H; Impacted; does not support desired uses	Watershed BMPs; mitigate symptoms to improve aesthetics and recreational use: hand-pulling, benthic barriers
Little/Stony	Moderate	E; Impacted/at risk	Education, watershed BMP
Lumbert	Low	M; Private; Impacted/at risk	Education, watershed BMP
Mary Dunn	Low	O; Impacted/at risk	Education, watershed BMP
Mill (MM)	Protect	O; Impacted; Conservation area	Low impact recreational use & education in protected watershed
Mill (WB)	Moderate	E; Impacted	Education, watershed BMP
Red Lily (North, South)	Low	O; Impacted/at risk; Limited public access	Education, watershed BMP
Shallow			
Bearse	Moderate	M; Impacted/at risk; fanwort; potential for increased residential development	Macrophyte survey, strategies to control exotics; consider reducing density of future development

POND	PRIORITY (2) (LOW-MODERATE-HIGH-PROTECT)	FINDINGS (3) (TROPHIC STATES: O, M, E, H)	RECOMMENDED ACTIONS (4)
Coleman	Low	M; Impacted	Mitigate symptoms of eutrophication in recreational areas (benthic mats, hand harvesting); watershed BMPs
Eagle	Protect	E; At risk; watershed in land trust	Consider hand pulling emergent vegetation to improve shoreline access; maintain trails and prevent erosion
Elizabeth	Moderate	E; Impacted; Limited public access	BMPs, control stormwater on roadways
Garrett's	Low	O; At risk; limited public access	Education, watershed BMPs
Hinckley	High	E; Impacted	Stormwater management, septic inspections
Joshua	High	O; At risk; Town beach, natural vegetation; reference pond indicative of pristine conditions	Priority for protection, education, BMPs
Long (C'Ville)	High	E; Impacted; Town beach, highly developed; Does not support desired uses	Stormwater management, septic inspections, mitigating measures to improve recreational use: benthic mats, hand-pulling
Long (MM)	Moderate	E; Impacted; Conservation area; moderately protected	Education, watershed BMPs
Muddy	Moderate	E; Impacted/at risk	Education, watershed BMPs
No Bottom	Low	M; Impacted	Education, watershed BMPs
Parker	Moderate	E; Impacted	Education, watershed BMPs
Round (MM)	Moderate	E; Impacted/at risk; Private	Education, watershed BMPs
Schoolhouse	High	H; Impacted; does not support desired uses	
Shallow	Moderate	M; Impacted/at risk; vegetated shoreline; potential for increased residential development	Controls on future density and/or BMPs to minimize phosphorus migration to pond from surface runoff and groundwater

POND	PRIORITY [2] (LOW-MODERATE-HIGH-PROTECT)	FINDINGS [3] (TROPHIC STATES: O, M, E, H)	RECOMMENDED ACTIONS [4]
Deep			
Crystal	Low	M; Impacted	Education, watershed BMPs
Hamblin	High	O; At risk; Town Beach, conservation land; alum-treated; potential for increased residential development	Monitor for effectiveness of alum treatment; controls on future density and/or BMPs to minimize phosphorus migration to pond from surface runoff and groundwater
Hathaway (North)	High	O; At risk; Town beach, mix of conservation land and development	Continue acquisition of hydrologically important parcels in watershed
Lovell's	High	M; Impacted; Town beach closed; blue-green algal bloom; does not support desired uses	Priority for monitoring deep water phosphorus levels and N/P ratio; consider nutrient inactivation
Micah	Protect	O; At risk; Undeveloped, reference pond	Priority for monitoring deep water phosphorus levels
Middle	Protect	O; At risk; Public access, very clear	Priority for monitoring deep water phosphorus levels; consider acquisition of key parcels to control density
Mystic	High	M; Impacted/at risk; Public access, endangered mussels; permit phase for alum application; potential for increased residential development	Priority for alum treatment program; guide future development to minimize surface runoff and groundwater nutrient input
Neck	Moderate	O; Impacted/at risk;	Period monitoring to detect symptoms of degradation; watershed BMPs;
Shubael	High	O; Impacted; Town beach, exceptionally clear water potential for increased residential development	Priority for monitoring deep water phosphorus levels; septic inspections; guide future development to minimize nutrient input from surface runoff and groundwater seepage

POND	PRIORITY [2] (LOW-MODERATE-HIGH-PROTECT)	FINDINGS [3] (TROPHIC STATES: O, M, E, H)	RECOMMENDED ACTIONS [4]
Wequaquet	High	M; Impacted; Town beach, potential for future residential and commercial growth	Priority for monitoring deep water phosphorus levels; septic inspection; consider density controls on future development

Notes:
(1) This table is from "Action Plan for the Barnstable Ponds", December 2009, EcoLogic LLC and Stearns & Wheler GHD and summarizes the key findings and recommendations of that report.
(2) Higher priority assigned to ponds with town beach and/or public access.
(3) Trophic states: O – Oligotrophic; M – Mesotrophic; E – Eutrophic; H –Hypereutrophic. Definition of these trophic states and the ways that limnologists quantify these parameters is provided in the Barnstable Action Plan Report in Appendix 5-1 starting on page 6 and summarized in Table 3.
(4) These recommendations are described in Appendix B of the Action Plan Report.
BMP- Best Management Practices

The findings of the Action Plan Report go beyond a typical Needs Assessment evaluation and provide detailed recommendations that can be implemented as the full CWMP project proceeds. These recommendations will be incorporated into the Final CWMP report with updates.

B. **Wetlands.** Wetlands are identified as both fresh and salt water. The Town has conservation regulations and ordinances in place which regulate activities within the 100 foot buffer zone of a resource area. Resource areas include a surface water body, vegetation or unvegetated wetland, any land under said waters, and any land subject to flooding or inundation by groundwater, surface water, tidal action or coastal storm flowage.

Wetlands result from both salt water and fresh water and 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 Town are shown on Figures 5-3 and 5-4.

C. **Vernal Pools.** Vernal pools are temporary bodies of freshwater that provide critical habitat for a number of vertebrate and invertebrate wildlife species. Certified vernal pools and potential vernal pools have been identified by the Natural Heritage & Endangered Species Program in the Town of Barnstable and are shown on Figure 5-4.

5.7 BATHING BEACH RESOURCES

An important resource to the Town of Barnstable is its bathing beaches which attract residents and tourists alike. The beach sites which fall under the Town's Recreation Division include the following saltwater and freshwater beaches:

Marine Public Beaches:

- Covells
- Craigville
- Dowses
- Kalmus Beach
- Loop Beach
- Millway Beach
- Sea Street Beach (also known as Keyes Beach)
- Veteran's Beach

Freshwater Public Beaches:

- Hamblin's Pond Beach
- Joshua's Pond Beach
- Lake Wequaquet Beach
- Lovells Pond

All other ponds, beaches and ways to water in the Town fall under the jurisdiction of the Department of Marine & Environmental Affairs including Sandy Neck Beach or the Harbor Master.

Water quality bacteria monitoring is performed by the Barnstable County Board of Health and Environment in collaboration with the Barnstable Health Department, which test pubic and semi-public beaches weekly for indicator organisms during the summer bathing season (June to August). Sampling is performed for 26 public marine beaches and 15 public freshwater beaches for the presence of the indicator organism Enterococcus bacteria; in addition to 14 semi-public marine and freshwater beaches. The state bacterial standard for Enterococcus is 104 cfu/100mL (colony forming unit per milliliter) and levels above that cause public bathing beach closures to insure the safety of public health.

Table 5-4 displays the occurence of bathing beach closures due to elevated levels of bacteria over the past three years according to the data supplied by the Town of Barnstable Coastal Health Resource Coordinator. From the data below it appears the most closures occurred during this time period in the villages of Cotuit and Hyannis. Exceedances of the bacterial health standard were not all experienced after a storm event; exceedances after a storm event are typically indicative of stormwater runoff causing the elevated bacteria levels.

TABLE 5-4

SUMMARY OF BATHING BEACH CLOSURES BY VILLAGE (2007-2009)

SAMPLE DATE	BEACH	VILLAGE	RESULT(1) ON FIRST TEST	RESULT(1) ON RETEST	DATE REOPENED	STORM EVENT(2)
06/23/09	Bone Hill Rd	Barnstable	>400	242	06/25/2009	Yes
08/04/09	Hathaway Pond	Barnstable	240	8	08/05/2009	Yes
06/23/09	Indian Trail	Barnstable	154	202	06/25/2009	Yes
07/09/07	Millway	Barnstable	>400	2	07/10/2007	Yes
06/23/09	Millway	Barnstable	>400	>400	06/25/2009	Yes
06/23/09	Scudder Lane	Barnstable	>400	>400	06/26/2009	Yes
08/27/07	Covells	Centerville	256	<2	08/28/2007	No
06/30/08	Covells	Centerville	268	26	07/03/2008	Yes
06/30/08	Craigville	Centerville	130	48	07/03/2008	Yes
07/23/07	Fifth Ave	Centerville	334	<2	07/24/2007	Yes
08/27/07	Fifth Ave	Centerville	168	2	08/28/2007	No
06/16/08	Shallow Pond	Centerville	280	52	06/18/2008	Yes
08/11/08	Cordwood Rd	Cotuit	188	12	08/13/2008	Yes
08/18/08	Cotuit Bay Shore (semi-public)	Cotuit	116	<2	08/19/2008	No
06/23/09	Cotuit Bay Shores	Cotuit	110	74	06/24/2009	Yes
07/30/07	Crockers Neck	Cotuit	248	2	07/31/2007	Yes

SAMPLE DATE	BEACH	VILLAGE	RESULT[1] ON FIRST TEST	RESULT[1] ON RETEST	DATE REOPENED	STORM EVENT[2]
07/21/09	Crocker's Neck	Cotuit	184	10	07/22/2009	No
07/28/09	Crocker's Neck	Cotuit	132	<2	07/29/2009	No
08/04/09	Crocker's Neck	Cotuit	310	4	08/06/2009	Yes
08/18/09	Crocker's Neck	Cotuit	>400	<2	08/19/2009	No
08/25/09	Crocker's Neck	Cotuit	206	344	08/27/2009	No
06/02/09	Cross St	Cotuit	108	2	06/03/2009	No
08/11/08	Little River Rd	Cotuit	154	22	08/13/2008	Yes
08/06/07	Loop	Cotuit	134	6	08/07/2007	No
06/04/07	Oregon	Cotuit	238	<2	06/05/2007	Yes
08/11/08	Oregon	Cotuit	220	4	08/13/2008	Yes
07/28/09	Oregon	Cotuit	114	<2	07/29/2009	No
06/16/08	Ropes	Cotuit	>400	66	06/18/2008	Yes
06/30/08	Ropes	Cotuit	106	72	07/03/2008	Yes
08/11/08	Ropes	Cotuit	>400	20	08/13/2008	Yes
06/23/09	Ropes	Cotuit	110	14	06/24/2009	Yes
06/16/08	Estey Ave	Hyannis	156	<2	06/18/2008	Yes
06/30/08	Kalmus (Ocean)	Hyannis	374	40	07/02/2008	Yes
05/31/08	Kalmus (Yacht)	Hyannis	>400	8	06/03/2008	N/A
06/04/07	Kennedy Memorial	Hyannis	>400	4	06/05/2007	Yes
07/09/07	Keyes	Hyannis	124	2	07/10/2007	Yes
05/21/08	Keyes	Hyannis	236	6	05/23/2008	N/A
06/16/08	Keyes	Hyannis	>400	28	06/18/2008	Yes
07/21/08	Keyes	Hyannis	126	2	07/23/2008	Yes
07/28/08	Keyes	Hyannis	164	2	07/30/2008	Yes
08/18/08	Keyes	Hyannis	212	2	08/19/2008	No
06/04/07	Veteran's	Hyannis	>400	4	06/05/2007	Yes
05/31/08	Veteran's	Hyannis	118	6	06/03/2008	N/A
06/04/07	East (Town) Eugenia Fortes	Hyannisport	>400	2	06/05/2007	Yes
08/11/08	East (Town) Eugenia Fortes	Hyannisport	156	16	08/13/2008	Yes
06/18/07	Hamblins Pond	Marstons Mills	560	220	06/19/2007	Yes
06/25/07	Hamblins Pond	Marstons Mills	640	12	06/26/2007	No

SAMPLE DATE	BEACH	VILLAGE	RESULT(1) ON FIRST TEST	RESULT(1) ON RETEST	DATE REOPENED	STORM EVENT(2)
07/28/08	Middle Pond	Marstons Mills	740	16	07/30/2008	Yes
06/04/07	Prince Cove	Marstons Mills	>400	50	06/05/2007	Yes
06/30/09	Regency Drive Homeowners	Marstons Mills	496	32	07/01/2009	Yes
07/21/08	Garrett Pond	West Barnstable	444	<4	07/23/2008	Yes
06/23/09	Sandy Neck	West Barnstable	106	42	06/24/2009	Yes

Note:

1. Results are in units of Enterococci Colony Forming Units (CFU) per 100 milliliter.
2. N/A in the "Storm Event" column means sampling was done during the pre-season.

5.8 SHELLFISH RESOURCES

The Town of Barnstable has many shellfish resource areas and commercial fisherman rely on productive and healthy shellfish beds for their livelihoods. Shellfish resources are also important recreationally.

The Town's Natural Resource Division is responsible for the protection and enhancement of the town's natural resources, enforcement of various laws relating to fish and game, marine and recreational use, land management and environmental laws. The division also provides protection and enhancement of the town's shellfish resources.

Management by the Town's Natural Resource Division includes the following:

- Managing and performing shellfish propagation projects for select species of economically and recreationally important shellfish.
- Assisting the Massachusetts Division of Marine Fisheries with constant water quality monitoring of local classified areas and instituting management protocols for the areas. Water quality testing and shellfishery management by the state are mandated by the Federal Food and Drug Administration's National Shellfish Sanitation Program for areas used for the public consumption of shellfish. Assessing coastal zone projects and performing surveys and reports for such projects. Performing shellfish surveys for resource management purposes.
- Formulating, integrating, disseminating and maintaining shellfishery management information for the general public.

- Interacting with federal, state and local authorities, agencies and groups regarding shellfish management, regulatory, enforcement, educational and private shellfish aquaculture issues.
- Report, grant and contract writing as well as comprehensive review studies including GIS/GPS mapping.

Shellfish resources within the Town of Barnstable are illustrated on Figure 5-5. Designated shellfish resources are categorized by the Division of Marine Fisheries (DMF) as follows:

- *Approved* – Open for harvest of shellfish for direct human consumption subject to local rules and state regulations.
- *Conditionally Approved* – During the time area is approved it is open for harvest of shellfish for direct human consumption subject to local rules and state regulations.
- *Conditionally Restricted* – During the time area is restricted it is only open for the harvest of shellfish with depuration subject to local rules and state regulations.
- *Management Closure* – Closed for harvest of shellfish. Not enough testing has been done in the area to determine whether it is fit for shellfish harvest or not.
- *Prohibited* – Closed for harvest of shellfish.
- *Restricted* – Open for harvest of shellfish with depuration subject to local rules and state regulations or for the relay of shellfish.

Figure 5-5 is a large scale view of the resource areas and in many cases there are many designations within one area. For additional site specific shellfish information, access the Town of Barnstable, Natural Resource Division's website at: http://www.town.barnstable.ma.us/MarineEnvironmental/Shellfishing. Click on "Shellfish Area Maps" to search for specific resource areas within the Town.

Figure 5-5 also illustrates the anadromous fish presence within the Town, shellfish suitability areas, shellfish sampling stations and presence within the lobster harvest zone. The "anadromous fish presence" GIS-layer includes known coastal anadromous fish spawning habitat and runs within the Town of Barnstable. The "shellfish suitability areas" GIS-layer comprises habitats suitable for ten species of shellfish along the coast of Massachusetts, the ten species represented are:

- American Oyster

- Bay Scallop
- Blue Mussell
- European Oyster
- Ocean Quahog
- Quahog
- Razor Clam
- Sea Scallop
- Soft-shelled Clam
- Surf Clam

The shellfish sampling stations shown on Figure 5-5 range from sites for collecting water quality and shellfish samples, to monitoring marine biotoxins such as Paralytic Shellfish Poison (PSP) or as it is commonly referred to “Red Tide”, to locations of marines and mooring fields; several sampling stations are located in and around the Town of Barnstable as indicated on Figure 5-5. The Town of Barnstable is also located within the “lobster harvest zone.”

5.9 ADDITIONAL NATURAL RESOURCES AND PHYSICAL CHARACTERISTICS

A. **Topography, Geology and Soils.** The topography of the Town of Barnstable is illustrated in Figure 5-6 and the geology of the Town is illustrated in Figure 5-7. The topography of the Town ranges from 0 to 266 feet, with the highest elevation being within the area of Route 6.

Figure 5-7 illustrates the Town’s soils as being primarily of the following classifications, although several classifications exist:

- *Barnstable Outwash Plain Deposits* – Mostly gravelly sand with some pebble and small boulders. North part of the deposits includes some clay till, clayey silt, and large boulders. Some areas may be underlain by silt and clay.
- *Mashpee Pitted-Plain Deposits* – Mostly gravelly sand with some pebble and small boulders.
- *Sandwich Moraine Deposits* – A veneer of sandy to silty till from 3 - 25 feet thick underlain by stratified sand and gravel.
- *Glacial Lake Deposits* – Deposits associated with the proglacial lake in Cape Cod Bay. Mostly a discontinuous veneer of clay and silt over ice-contact deposits composed of gravelly sand, gravel, till and large boulders.

- *Marsh & Swamp Deposits* – Mostly decaying marine marsh plants mixed varying amounts of sand, silt and clay. Underlain by glacial, marine, and freshwater deposits, capped by live marine marsh plants.
- *Dune Deposits* – Mostly sand derived from beach deposits, deposited by wind action to form dunes.

Refer to Figure 5-7 for additional classifications and for geologic classification areas.

Figure 5-8 was developed to illustrate the soil classifications within the Town of Barnstable. The soil classifications displayed on this figure can be found in the Barnstable County Soil Survey (U.S. Department of Agriculture (USDA), 1993). The predominant soil types in the Town of Barnstable are as follows with their USDA description:

- *Ipswich-Pawcatuck-Matunuck* – very deep, level, very poorly drained soils; are in tidal areas that are subject to daily inundation by salt water.
- *Hooksan Series* – very deep, excessively drained soils on vegetated sand dunes adjacent to beaches along the coast.
- *Enfield Series* – very deep, well drained soils on outwash plains.
- *Carver Series* – very deep, excessively drained soils on outwash plains, on moraines, and in areas of glacial lake deposits; slopes range from 0 to 35 percent.
- *Plymouth Series* – very deep, excessively drained soils on moraines and outwash plains and in areas of glacial lake deposits; slopes range from 0 to 35 percent.

As shown on Figure 5-8, many defined classifications of soils exist within the Town of Barnstable.

B. **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

Barnstable. The surface elevations in these areas typically lie below 10 feet mean sea level. The flood zones throughout the Town are illustrated in Figure 5-9.

C. **Critical Wildlife and Plant Habitat.** There are several regions within the Town of Barnstable that have been identified as combined habitats of rare species and wildlife by the Massachusetts Division of Fisheries, Natural Heritage and Endangered Species Program (NHESP). The combined habitat layers is a combination of seven NHESP layers including; Priority Habitats of Rare Species, Estimated Habitats of Rare Wildlife, BioMap Core Habitat, BioMap Supporting Natural Landscape, Living Waters Core Habitats, Living Waters Critical Supporting Watersheds and Natural Communities. Figure 5-4 also illustrates combined resource areas where wetlands and NHESP habitat layers overlap.

D. **Protected Natural Areas.** The following includes a summary of Areas of Critical Environmental Concern, Districts of Critical Planning Concern, Town Conservation Lands and Open Space.

1. **Areas of Critical Environmental Concern (ACECs).** With 90 percent located within the Town of Barnstable, the Sandy Neck Barrier Beach System was designated an ACEC in 1978. The ACEC boundary generally follows the 100-year floodplain elevation on the landward side and mean low water on the seaward side of Barnstable Harbor as shown on Figure 5-4. Sandy Neck is one of the largest barrier beach systems in New England and extends eastward approximately seven miles and shelters Barnstable Harbor and the extensive salt marsh habitat. The Code of the Town of Barnstable has ordinances including Chapter 177, Sandy Neck and Chapter 601, Sandy Neck Beach.

2. **District of Critical Planning Concern (DCPC).** The Town of Barnstable has three designated Districts of Critical Planning Concern (DCPCs), the Pond Village DCPC and the Craigville Beach/Centerville Village Center DCPC which is shown on Figure 5-4 and the Barnstable DCPC which encompasses the entire Town of Barnstable and is not shown on Figure 5-4. The Town of Barnstable is also located within one nominated county-wide DCPC known as the Ocean Management Planning DCPC.

The Barnstable DCPC was designated in February 2001 throughout the entire town to address the rate of residential growth and subsequently the Growth Management Ordinance was adopted to manage residential development.

The Pond Village DCPC was designated in January 2006 for the Pond Village area of Barnstable Village to protect freshwater pond quality, a portion of Barnstable Harbor and the historic and scenic character of a 115-acre area north of Route 6A near Barnstable village. This DCPC also resulted in a two-acre minimum lot size for this area.

The Craigville Beach/Centerville Village Center DCPC includes the Centerville Village Center area which includes an existing business zoning district, other non-residential parcels, and residential parcels including the Main Street National Register Historic District. The Village DCPC has two purposes: an economic resource district and a cultural, historic, and architectural resource district. The Craigville Beach area of the DCPC includes a barrier beach along Nantucket Sound, an estuary system behind it, and freshwater ponds. It encompasses many summer homes and cottages, a portion of which is recognized within a National Register Historic District. The DCPC has five purposes: a natural and ecological resource district; a cultural, historic, and architectural resource district; a hazard district; a wastewater management district; and a waterfront management district. The Town is (2010) working on implementing regulations for the Craigville Beach area.

On December 16, 2009, the Barnstable County Commissioners nominated the Ocean Management Planning DCPC in anticipation of the final Massachusetts Ocean Management Plan. The nominated DCPC includes all the ocean waters and land below and air above within Barnstable County, starting from a line drawn 0.3 nautical miles seaward from mean high water and extending three nautical miles from MHW, or the state jurisdictional boundary, whichever is farther. This DCPC area includes 576,745 acres.

3. **Town Conservation Lands and Open Space.** The 2005 Final Open Space and Recreation Plan (an update is expected in 2010) developed for the Town of Barnstable, incorporates the goals of protecting natural resources, conserving open space and providing a varied recreation program.

According to this plan, the Town's existing open space and recreation lands are both privately and publicly owned. "Most of the privately owned conservation lands are designated as state Chapter 61 properties, restricted by conservation easements or in the form of unprotected quasi public recreation lands such as those on school fields and golf courses. Publicly owned open space and recreation lands are more numerous. There are a total of 6,304 acres owned and managed by the Town of Barnstable Conservation Division. An additional 894 acres is listed as Open Space acquired with Land Bank funds equaling a total of 7,198 acres of municipally owned conservation land. By contrast, there are only 111 acres owned and managed by the Town of Barnstable Recreation Division. This amounts to 1.5 percent of the Conservation total of 7,198 acres." (2005 Open Space and Recreation Plan).

Protected open space is associated with the following groups; Town Conservation, Town Land Bank, Town CPA Open Space, State Owned Protected Land, Fire District with Conservation Restriction, Barnstable Land Trust, Mary Barton Conservation, Massachusetts Audubon Society, The Nature Conservancy, Orenda Wildlife Land Trust, Three Bays Preservation, Inc., Compact of Cape Cod Conservation Trusts, Trustees of Reservations, and Private Land with Conservation Restriction and is shown on Figure 5-10, Open Space Map. Recreational land use areas can be seen in Figure 5-11, Land Use Map.

The following are lists Barnstable's major conservation and recreation areas according to the Open Space and Recreation Plan:

- Hathaways Pond Conservation area – 60 acres in Hyannis
- Crocker Neck Conservation Area – 97 acres in Cotuit
- Whelan Conservation Area – 12.9 acres in Centerville
- Long Pond Conservation Area – 37 acres in Cotuit
- Sandy Neck Barrier Beach Ecosystem – 6 miles long and 0.5 miles wide along the northern Cape Cod Bay coast of Barnstable.
- West Barnstable Conservation Area – 1,114 acres in West Barnstable
- Old Jail Lane Conservation Area – 180 acres in Barnstable Village

5.10 PROTECTED CULTURAL AREAS

There are several areas in the Town of Barnstable that have historic importance, scenic and archaeological significance as discussed in this section.

The Town of Barnstable has two designated local historic districts; the Old Kings Highway Local Historic District and the Hyannis Main Street Waterfront Historic District. These areas include many contributing historical structures. Figure 5-12 reflects these local historic districts. The Town of Barnstable also has a Historical Commission which was established to assist the

Town in the preservation and protection of historical buildings and settings; in addition each village has a historical society except for Hyannis, in which the Civic Association acts as the historical society.

As shown on Figure 5-12, the National Register Historic Districts within the Town of Barnstable are as follows:

- Old Kings Highway National Historic District
- Sandy Neck Cultural Resources District
- Barnstable Harbor Historic District
- Hyannis Road Historic District
- West Barnstable Historic District
- Santuit Historic District
- Cotuit Historic District
- Wianno Historic District
- Centerville Historic District
- Craigville Historic District
- Hyannisport Historic District
- Kennedy Compound National Historic Landmark
- Municipal Group Historic District
- Pleasant Street School Street Historic District

5.11 POPULATION AND DEMOGRAPHICS

According to the 2009 Town Annual Report, the year round population in the Town of Barnstable is approximately 50,000 with the seasonal population increasing to approximately 145,500 during the summer months.

According to 2000 U.S. Census data, residents aged 65 and over comprises 20.1 percent of the Town's population, and the median age of residents within the Town was 42.3. In 1980 the median age was 36.4 and in 1990 was 38.1 years of age. This median age statistic implies the Town has an aging population. Consequently, the average household size continues to decrease in the Town of Barnstable; in 1980 the average household size was 2.57, in 1990 it was 2.47 and in 2000 it was 2.38. According to the Town's BCP, those residents between the ages of 55 and

64 comprised an additional 10.6 percent of the population with the single fastest growing sector being the 45 – 54 age group that at 15 percent has increased 46 percent since the 1990 census.

With respect to race, according to 2000 U.S. Census data, 91.9 percent of the Town of Barnstable is white, 2.7 percent is black or African American, and 2.3 percent is two or more races. Social characteristics of the Town include 90.4 percent of the population having a high school diploma or higher and 32.2 percent having a Bachelor's degree or higher. Foreign born residents make up 6.9 percent of the population and 8.9 percent of the population speak a language other than English at home. 19.7 percent of the Town population has disability status.

According to the Executive Office of Labor and Workforce Development, the unemployment rate in the Town of Barnstable during 2009 was as low as 7.0 in July of 2009 and as high as 10.2 in January of 2009 with a yearly average of 8.3. The unemployment rate during December 2009 in the Town of Barnstable was 9.5, just above the state wide rate of 9.4. This is an increase from the average unemployment rate in 2008 of 5.1. These rates are not seasonally adjusted for population. The 2000 U.S. Census also shows 76.2 percent of housing units being owner-occupied and 23.8 percent of housing units being renter-occupied.

5.12 LAND USE AND EVALUATIONS TO QUANTIFY WATER CONSUMPTION AND WASTEWATER FLOWS

A. **Introduction.** Understanding the current and future land use in Town as well as the associated water consumption and wastewater generation is critical to developing a CWMP. Extensive evaluations have been completed to evaluate existing land use, water consumption and wastewater generation rates; projected estimates of the future land use, water consumption and wastewater generation at the buildout condition; and to summarize this information on a Town-wide, village-wide, and watershed basis. This information has also been developed on a parcel by parcel basis in the Town's Geographic Information System (GIS) so that it can be summarized for any geographic area in Town.

The parcel by parcel buildout evaluations were completed through a Town Land Use and Projected Buildout Working Group comprised of the following individuals:

i. Dale Saad, DPW and CWMP Project Manager
ii. Jo Anne Miller Buntich, Growth Management Department Director

iii. Jackie Etsten, Principal Planner
iv. Jim Benoit, GIS Coordinator
v. Nathan Weeks, P.E., Stearns & Wheler Project Manager
vi. Jessica Janney, Stearns & Wheler Project Engineer

Over several months this group worked to develop this data in the Towns GIS where it can be used for this project as well as for future planning, implementation, and monitoring projects.

Appendix 5-3 provides a summary of how the buildout data was developed.

B. **Existing Land Use.** Figure 5-11 illustrates the town-wide existing land use grouped into the following categories according to the land use code assigned to each parcel by the Town's Tax Assessing Department.

- Residential – defined with land use codes starting with 1
- Commercial – defined with land use codes starting with 3 and 4; also includes industrial uses
- Mixed Use – defined with land use codes starting with 0
- Agricultural – defined with land use codes starting with 6 and 7
- Recreational – defined with land use codes starting with 8
- Tax Exempt – defined with land use codes starting with 9

Table 5-5 summarizes the existing land use by village and watershed in Barnstable. A detailed listing of the land use codes used to develop this summary is attached in Appendix 5-2.

(continued)

TABLE 5-5

LAND USE SUMMARY PER VILLAGE AND MARINE WATERSHED [1]

VILLAGE	EXISTING PARCEL EVALUATION BY VILLAGE						
	Residential	**Commercial**	**Recreational**	**Agricultural**	**Tax Exempt**	**Mixed Use**	**Total**
Cotuit	2,284	25	1	4	126	17	2,457
Osterville	2,580	78	0	1	91	21	2,771
Marstons Mills	3,836	52	0	11	168	19	4,086
Centerville	5,890	57	0	6	185	15	6,153
Hyannis	5,878	781	0	0	363	109	7,131
Barnstable	1,901	161	1	6	309	16	2,394
West Barnstable	1,414	36	3	4	334	27	1,818
Total	23,783	1,190	5	32	1,576	224	26,810
MARINE WATERSHED	**EXISTING PARCEL EVALUATION BY MARINE WATERSHED**						
	Residential	**Commercial**	**Recreational**	**Agricultural**	**Tax Exempt**	**Mixed Use**	**Total**
Popponesset Bay	771	13	0	0	29	8	821
Three Bays	5,224	129	1	13	237	38	5,642
Centerville River	7,683	69	0	5	259	20	8,036
Halls Creek	2,219	43	0	0	57	10	2,329
Lewis Bay	3,148	759	0	0	317	97	4,321
Barnstable Harbor	3,743	164	4	11	642	43	4,607
Rushy Marsh Pond	15	0	0	0	3	0	18
Uncategorized[2]	980	13	0	3	32	8	1,036
Total	23,783	1,190	5	32	1,576	224	26,810

Notes:
(1) Land use data taken from FY2010 Assessor’s Database. This summary does not include individual condominium units which are summarized to a single parcel per condominium complex. This table summarizes a GIS query and the counts are not rounded.
(2) This includes all parcels not within the MEP watersheds listed.

This summary provides the ability to characterize the existing land use in broad terms for the Town, but it has limitations with respect to quantifying future land use, water consumption, and wastewater generation due to the following observations:

- There are wide variations in the land use within each group.

- Residential properties can have one dwelling unit per parcel or several dwelling units.
- Commercial properties can have varying amounts of building square footage.
- Mixed Use and Tax Exempt properties can have combinations of dwelling units, commercial area, institutional uses such as schools and churches, and conservation land.
- Many properties, particularly in West Barnstable, are not served by public water systems; therefore it is difficult to empirically estimate their water consumption and wastewater generation.

Based on these observations it was determined that the number of existing and future dwelling units needed to be quantified as well as the existing and future commercial square footage to obtain a more fundamental and concise measure of land use.

C. **Existing and Future Dwelling Units and Non-Residential Building Square Footage.** All parcels in Town were evaluated by the number of dwelling units and the non-residential building square footage that they contain. This existing land use information was readily available in the Town's Assessing Database and is summarized on Table 5-6 for the villages and marine watersheds.

(continued)

TABLE 5-6

EXISTING DWELLING UNIT AND NON-RESIDENTIAL BUILDING SQUARE FOOTAGE EVALUATION BY VILLAGE AND MARINE WATERSHED

VILLAGE	EXISTING PARCEL EVALUATION BY VILLAGE	
	Total Existing Residential Dwelling Units	**Total Existing Non-Residential Sq. Ft.**
Cotuit	2,229	157,157
Osterville	2,784	731,585
Marstons Mills	3,744	755,175
Centerville	5,809	667,892
Hyannis	8,803	9,207,263
Barnstable	1,823	2,473,418
West Barnstable	1,238	535,421
Total	26,430	14,527,911
MARINE WATERSHED	**EXISTING PARCEL EVALUATION BY MARINE WATERSHED**	
	Total Existing Residential Dwelling Units	**Total Existing Non-Residential Sq. Ft.**
Popponesset Bay	754	70,513
Three Bays	5,307	1,083,805
Centerville River	7,726	1,640,270
Halls Creek	2,478	442,303
Lewis Bay	5,554	8,878,019
Barnstable Harbor	3,612	2,261,552
Rushy Marsh Pond	8	0
Uncategorized[2]	991	151,449
Total	26,430	14,527,911

Notes:
(1) This table summarizes a GIS query and the counts are not rounded.
(2) This includes all parcels not within the MEP watersheds listed.

A buildout analysis was then completed to estimate future dwelling units and commercial square footage in the future conditions as allowed by current zoning. This was completed by the Land Use and Projected Buildout Working Group with the following additional considerations:

- Parcels with known conservation restrictions were not included in the buildout analysis.
- Buildout potential for each parcel was based on current zoning regulations and considered vacant buildable lots as well as currently developed properties that could be further subdivided to add additional residences or commercial space.
- Predicted growth centers (i.e. Hyannis Growth Incentive Zone (GIZ)) were analyzed at buildout.
- The Working Group used professional judgment for mixed use parcels and "ultimate" buildout for the GIZ.

These estimates were then entered into the Town's GIS database. Table 5-7 summarizes the estimated quantity of dwelling units and non-residential building square footage per village and per watershed that could occur at the buildout conditions. It also estimates the percent of buildout for each of the geographic areas. This table indicates that there is significant additional development that can occur in portions of Barnstable as allowed by current zoning.

A summary of the procedure used to develop the buildout estimates is included in Appendix 5-3.

(continued)

TABLE 5-7

DWELLING UNIT AND NON-RESIDENTIAL BUILDING SQUARE FOOTAGE EVALUATION BY VILLAGE AND MARINE WATERSHED AT BUILDOUT (1)

VILLAGE	BUILDOUT EVALUATION BY VILLAGE			
	Total Residential Dwelling Units at Buildout		Total Non-Residential Sq. Ft. at Buildout	
	Number	Percentage of Existing Numbers	Number	Percentage of Existing Numbers
Cotuit	2,634	118%	296,493	189%
Osterville	3,353	120%	1,638,393	224%
Marstons Mills	4,657	124%	1,495,468	198%
Centerville	6,246	108%	1,133,867	170%
Hyannis	11,897	135%	28,836,804	313%
Barnstable	3,703	203%	8,688,829	351%
West Barnstable	2,051	166%	1,176,707	220%
Total	34,541	131%	43,266,560	298%
MARINE WATERSHED	**BUILDOUT EVALUATION BY MARINE WATERSHED**			
	Total Residential Dwelling Units at Buildout		**Total Non-Residential Sq. Ft. at Buildout**	
	Number	**Percentage of Existing Numbers**	**Number**	**Percentage of Existing Numbers**
Popponesset Bay	994	132%	175,194	248%
Three Bays	6,609	125%	2,377,124	219%
Centerville River	8,326	108%	2,316,220	141%
Halls Creek	2,808	113%	757,645	171%
Lewis Bay	8,490	153%	30,698,013	346%
Barnstable Harbor	6,138	170%	6,415,391	284%
Rushy Marsh Pond	10	125%	0	0%
Uncategorized(2)	1,166	118%	526,973	348%
Total	34,541	131%	43,266,560	298%

Notes:
(1) Buildout data based on FY2007 Assessor's maps/data.
(2) This includes all parcels not within the MEP watersheds listed.

It is important to note that buildout could be construed as a speculative term, meaning that judgment is placed based on conditions that may or may not exist. As an example, zoning can change in the future; some land use types such as 40B developments/affordable housing projects and other special cases can find exemptions from zoning. However, the work completed presents a reasonable estimate of buildout for planning purposes based on the current Town zoning and accepted land use judgment.

This evaluation provides a perspective on the buildout conditions but it is still limited because not all of these dwelling units and commercial properties have public water supply; therefore, water consumption and wastewater generation cannot be estimated directly from this data.

D. **Estimates of Existing and Future Buildout Water Consumption and Wastewater Generation.** Existing water consumption per dwelling unit and per 1,000 sf non-residential space was developed by identifying the parcels with public water supply that only had dwelling units and only had non-residential square footage; and then identifying the number of dwelling units and non-residential square footage for those properties. This evaluation is summarized in Table 5-8.

Also existing wastewater generation per dwelling unit and per 1,000 sf non-residential space was then developed by multiplying the water consumption values by 90 percent to estimate the quantity of water consumption that actually becomes wastewater (the remaining 10 percent is assumed to be a measure of non-potable uses such as irrigation, outdoor showers, car washing, etc.). This factor is consistent with the calculations made by the MEP. Table 5-8 also summarized these wastewater generation estimates.

This water consumption evaluation methodology using dwelling units and 1,000 non-residential sq ft building area differs slightly from the evaluation methodology used by the MEP as part of their watershed evaluations. They developed typical water consumption for “all developed residential parcels” that had public water supplies, and then used this value (specific for each watershed) to estimate water consumption (and nitrogen loading) at properties with no public water supplies and for buildout projections at vacant properties. The use of dwelling units and 1,000 non-residential sf is believed to be a more precise measure of land use and water consumption, and makes best use of the Town’s GIS database. Also the Town GIS utilized more up to date water consumption data. As a check of the MEP water consumption methodology, the water consumption data was queried by the Town GIS Department for all residential parcels with public water consumption. Table 5-9 summarizes the water consumption for the residential parcels in the marine watershed areas using the two methodologies along with the water consumption value per dwelling unit developed earlier.

(continued)

TABLE 5-8
WATER CONSUMPTION AND WASTEWATER GENERATION CALCULATION SUMMARY BY VILLAGE AND MARINE WATERSHED

MARINE WATERSHED	DWELLING UNIT EVALUATION					COMMERCIAL BUILDING SQUARE FOOTAGE (Sq. Ft.) EVALUATION				
	Number of Residential Parcels with Public Water and Dwelling Units (but No Commercial Sq. Ft.)	Water Consumption(1) (Gal/Day) for these Parcels	Number of Dwelling Units (DU) for these Parcels	Estimated Water Consumption per DU (Gal/DU)	Estimated Wastewater Generation(2) per DU (Gal/DU)	Number of Commercial Parcels with Public Water and Commercial Sq. Ft. (but No Dwelling Units)	Water Consumption(1) (Gal/Day) for these Parcels	Commercial Sq. Ft. for these Parcels	Estimated Water Consumption per Commercial Area (Gal/1,000 Sq. Ft.)	Estimated Wastewater Generation(2) per Commercial Area (Gal/1,000 Sq. Ft.)
Popponesset Bay	683	129,535	707	183	165	16	5,399	61,762	87	79
Three Bays	4,398	1,055,211	4,887	216	194	136	54,230	984,490	55	50
Centerville River	6,996	1,279,501	7,567	169	152	82	77,086	1,585,654	49	44
Halls Creek	2,071	445,625	2,468	181	163	43	74,820	408,160	183	165
Lewis Bay	2,990	804,161	5,353	150	135	621	625,657	8,314,797	75	68
Barnstable Harbor	2,054	467,916	2,357	199	179	102	105,052	1,652,510	64	57
Rushy Marsh Pond	6	2,044	8	255	230	0	0	0	0	0
Uncategorized	797	200,688	942	213	192	17	18,896	142,411	133	119
Totals/Averages	19,995	4,384,681	24,289	181	176	1,017	961,140	13,149,784	73	66

VILLAGE	DWELLING UNIT EVALUATION					COMMERCIAL BUILDING SQUARE FOOTAGE (Sq. Ft.) EVALUATION				
	Number of Residential Parcels with Public Water and Dwelling Units (but No Commercial Sq. Ft.)	Water Consumption(1) (Gal/Day) for these Parcels	Number of Dwelling Units (DU) for these Parcels	Estimated Water Consumption per DU (Gal/DU)	Estimated Wastewater Generation(2) per DU (Gal/DU)	Number of Commercial Parcels with Public Water and Commercial Sq. Ft. (but No Dwelling Units)	Water Consumption(1) (Gal/Day) for these Parcels	Commercial Sq. Ft. for these Parcels	Estimated Water Consumption per Commercial Area (Gal/1,000 Sq. Ft.)	Estimated Wastewater Generation(2) per Commercial Area (Gal/1,000 Sq. Ft.)
Cotuit	1,990	413,242	2,122	195	175	39	11,004	137,117	80	72
Osterville	2,335	639,547	2,743	233	210	86	44,659	664,015	67	61
Marstons Mills	3,138	624,491	3,317	188	169	51	28,181	722,310	39	35
Centerville	5,308	951,033	5,677	168	151	60	56,272	622,619	90	81
Hyannis	5,524	1,377,622	8,598	160	144	664	715,937	8,632,661	83	75
Barnstable	1,561	347,711	1,687	206	186	107	91,575	2,005,393	46	41
West Barnstable	139	31,036	145	214	193	10	13,514	365,669	37	33
Totals/Averages	19,995	4,384,681	24,289	181	175	1,017	961,140	13,149,784	73	66

Notes:

(1) Water consumption data is from the following time periods:
- Barnstable Water District: October 2006 - September 2008 (2 years)
- C-O-MM Water District: January 2008 - December 2009 (2 years)
- Cotuit Water District: October 2006 - September 2009 (3 years)
- Hyannis Water District: April 2006 - March 2009 (3 years)

(2) Based on 90% of water consumption assuming 10% of water consumption used for non-potable uses such as irrigation, outdoor showers, car washing, etc.

TABLE 5-9

AVERAGE EXISTING RESIDENTIAL WATER CONSUMPTION PER RESIDENTIAL PARCEL

WATERSHED	TOWN WATER DATA AND METHODOLOGY (GPD)(1)	MEP WATER DATA AND METHODOLOGY (GPD)(2)
Popponesset Bay	189	154
Three Bays	240	227
Centerville River	182	204
Halls Creek	214	175
Lewis Bay	255	175
Barnstable Harbor	228	N/A
Uncategorized(3)	252	N/A
Average	217	184

Notes:

(1) Based on water consumption data from the following years:
- Barnstable Water District: October 2006 – September 2008 (2 years)
- C-O-MM Water District: January 2008 – December 2009 (2 years)
- Cotuit Water District: October 2006 – September 2009 (3 years)
- Hyannis Water District: April 2006 – March 2009 (3 years)

(2) Based on water consumption data from the following years:
- 2000 for the Towns of Barnstable and Sandwich and 2001 for the Town of Mashpee (Popponesset Bay)
- 2004 for the Town of Barnstable, 2001 for the Town of Mashpee and 2000 for the Town of Sandwich (Three Bays)
- 2004 for the Town of Barnstable (Centerville River)
- 2004 for the Towns of Barnstable and Yarmouth (Lewis Bay/Halls Creek)
- 2004 for the Town of Barnstable (Rushy Marsh Pond)

This includes all parcels not within the MEP watersheds listed.

Comparison of the two methodologies illustrates similar findings of water use and wastewater generation, though the Town data analysis indicates an 18 percent higher water consumption. This could be due to more recent data or a more accurate GIS.

When the water consumption and wastewater generation rates for the future dwelling units and commercial space with units of gallons per day per dwelling unit (gpd/DU) and gallons per day per 1,000 square feet of commercial space (gpd/1000sf) respectively and applied to the buildout projections for the village and marine watersheds; the future flows for the Town become more apparent. These flows are summarized in Tables 5-10, 5-11, and 5-12 for the residential, non-residential, and total land uses respectively.

TABLE 5-10

RESIDENTIAL WATER CONSUMPTION AND WASTEWATER GENERATION AT BUILDOUT BY VILLAGE AND MARINE WATERSHED[1]

VILLAGE	RESIDENTIAL EVALUATION BY VILLAGE			
	Total Residential Dwelling Units at Buildout	**Average Water Consumption per Dwelling Unit (gal/day)**	**Future Residential Water Flow (mgd)**	**Future Residential Wastewater Flow (mgd)**
Cotuit	2,634	209	0.55	0.50
Osterville	3,353	258	0.86	0.77
Marstons Mills	4,657	203	0.94	0.85
Centerville	6,246	179	1.12	1.01
Hyannis	11,897	160	1.91	1.72
Barnstable	3,703	206	0.76	0.68
West Barnstable	2,051	232	0.48	0.43
Total	34,541	189	6.5	5.9
WATERSHED	**RESIDENTIAL EVALUATION BY WATERSHED**			
	Total Residential Dwelling Units at Buildout	**Average Water Consumption per Dwelling Unit (gal/day)**	**Future Residential Water Flow (mgd)**	**Future Commercial Wastewater Flow (mgd)**
Popponesset Bay	994	197	0.20	0.18
Three Bays	6,609	235	1.55	1.40
Centerville River	8,326	180	1.50	1.35
Lewis Bay	11,425	160	1.83	1.65
Barnstable Harbor	6,012	202	1.22	1.10
Rushy Marsh Pond	10	277	0.00	0.00
Uncategorized[2]	1,165	234	0.27	0.24
Totals	34,541	189	6.5	5.9

Notes:
(1) All flows are in million gallons per day (mgd) and are annual averages.
(2) This includes all parcels not within the MEP watersheds listed

TABLE 5-11

NON-RESIDENTIAL WATER CONSUMPTION AND WASTEWATER GENERATION AT BUILDOUT BY VILLAGE AND MARINE WATERSHED[(1)]

VILLAGE	NON-RESIDENTIAL EVALUATION BY VILLAGE			
	Total Non-Residential SF at Buildout	Average Water Consumption per 1,000 SF of Non-Residential Use (gal/day)	Future Non-Residential Water Flow (mgd)	Future Non-Residential Wastewater Flow (mgd)
Cotuit	296,493	84	0.02	0.018
Osterville	1,638,393	76	0.12	0.108
Marstons Mills	1,495,468	40	0.06	0.054
Centerville	1,133,867	96	0.11	0.099
Hyannis	28,836,804	83	2.39	2.151
Barnstable	8,688,829	46	0.40	0.36
West Barnstable	1,176,707	40	0.05	0.045
Total	43,266,560	74	3.20	2.88
WATERSHED	**NON-RESIDENTIAL EVALUATION BY WATERSHED**			
	Total Non-Residential SF at Buildout	**Average Water Consumption per 1,000 SF of Non-Residential Use (gal/day)**	**Future Non-Residential Water Flow (mgd)**	**Future Non-Residential Wastewater Flow (mgd)**
Popponesset Bay	175,194	95	0.02	0.02
Three Bays	2,377,124	60	0.14	0.13
Centerville River	2,316,220	52	0.12	0.11
Lewis Bay	31,946,417	79	2.52	2.27
Barnstable Harbor	5,924,632	70	0.42	0.38
Uncategorized[(2)]	526,973	141	0.07	0.06
Totals	43,266,560	74	3.20	2.88

Notes:
(1) All flows are in million gallons per day (mgd) and are annual averages.
(2) This includes all parcels not within the MEP watersheds listed

TABLE 5-12

DAILY FUTURE WASTEWATER FLOWS BY VILLAGE AND MARINE WATERSHED[1]

VILLAGE	FUTURE RESIDENTIAL WASTEWATER FLOW (MGD)	FUTURE NON-RESIDENTIAL WASTEWATER FLOW (MGD)	TOTAL AVERAGE ANNUAL WASTEWATER FLOW (MGD)
Cotuit	0.50	0.02	0.51
Osterville	0.77	0.11	0.89
Marstons Mills	0.85	0.05	0.90
Centerville	1.10	0.10	1.11
Hyannis	1.7	2.15	3.9
Barnstable	0.68	0.36	1.0
West Barnstable	0.43	0.05	0.47
Total	5.9	2.9	8.8
WATERSHED	**FUTURE RESIDENTIAL WASTEWATER FLOW (MGD)**	**FUTURE NON-RESIDENTIAL WASTEWATER FLOW (MGD)**	**TOTAL AVERAGE ANNUAL WASTEWATER FLOW (MGD)**
Popponesset Bay	0.18	0.02	0.19
Three Bays	1.4	0.13	1.5
Centerville River	1.4	0.11	1.5
Lewis Bay	1.7	2.3	3.9
Barnstable Harbor	1.1	0.38	1.5
Rushy Marsh Pond	0.00	0.00	0.00
Uncategorized[2]	0.24	0.06	0.32
Total	5.9	2.9	8.8

Notes:
(1) All flows are in million gallons per day (mgd) and are annual averages.
(2) This includes all parcels not within the MEP watersheds listed

E. **Buildout Projections for the Area Served by the Hyannis WPCF Collection System and Planned Sewer Expansion.** The buildout potential of the properties served by the Hyannis WPCF Collection System (illustrated in Figure 4-9) was evaluated and is summarized in Table 5-13 by watershed.

TABLE 5-13

SUMMARY OF EXISTING AND BUILDOUT WATER CONSUMPTION AND WASTEWATER GENERATION FOR THE CURRENT WPCF

WATERSHED AREA	EXISTING WATER CONSUMPTION (MGD)	EXISTING WASTEWATER GENERATION (MGD)	ADDITIONAL LAND USE AND FLOWS			
			DWELLING UNITS	NON-RESIDENTIAL AREA (1,000SF)	WATER CONSUMPTION FLOW (MGD)	WASTEWATER GENERATION FLOW (MGD)
Barnstable Harbor	0.16	0.14	95	553	0.05	0.04
Centerville River	0.05	0.05	3	62	0.004	0.003
Halls Creek	0.22	0.20	100	269	0.07	0.06
Lewis Bay	1.1	0.99	2,121	12,647	1.26	1.14
Total	1.5	1.3			1.4.	1.3

Note:
(1) All flows are in million gallons per day (mgd) and are annual averages.

Significant additional land use and growth is possible in the Hyannis area as allowed by the Growth Incentive Zone (GIZ). The Massachusetts Estuaries Project recognized the growth potential in their Technical Report (page 46) for Lewis Bay and presented a similar additional wastewater flow value of 1.25 mgd.

Several planned sewer extensions will provide additional flow to the Hyannis WPCF as summarized in Table 5-14.

TABLE 5-14

SUMMARY OF EXISTING AND BUILDOUT WATER CONSUMPTION AND WASTEWATER GENERATION FOR THE PLANNED SEWER EXTENSIONS[6] AS ILLUSTRATED IN FIGURE 2-1

WASTEWATER AOC AND SEWER EXTENSION AREA[1]	EXISTING WATER CONSUMPTION (MGD) FROM:		FUTURE LANDUSE AND WATER CONSUMPTION IN TOTAL AOC AREAS			FUTURE WASTEWATER GENERATION (MGD)[6]		
	Total AOC Area	Parcels Currently Connected to Hyannis WPCF	Number of Dwelling Units (DU)	Commercial Area (1,000 sf)	Water Consumption Flow (mgd)[2][6]	Total AOC Area[3]	Total Additional Wastewater Flow for Total Area[4]	Additional Flow for Planned Sewer Area[5]
Bearses Way	0.21	0.07	1.129	1,870	0.34	0.31	0.24	0.12
Water Supply ZOC's								
- BWMEL 1A	0.02	0	166	1,314	0.13	0.11	0.11	0.01
- BWMEL 1B	0.03	0.03	51	1,044	0.09	0.08	0.05	0.00
- BWST 1	0.58	0.26	3,158	1,424	0.67	0.61	0.37	0.02
- CO 7	0.13	0.02	868	514	0.19	0.17	0.16	0.01
CCCC	0.004	0	125	625	0.07	0.06	0.06	0.06
CE1	0.03	0	181	62	0.04	0.03	0.03	0.03
CE2	0.02	0.001	176	53	0.04	0.03	0.03	0.03
CE4	0.13	0	1,011	201	0.20	0.18	0.18	0.18
H1	0.06	0.02	289	132	0.08	0.07	0.07	0.05
H3	0.04	0	263	1	0.05	0.04	0.04	0.04
Totals[6]	1.3	0.40	7,517	7,240	1.9	1.7	1.7	0.55

Notes:
(1) Planned as part of 2007 WWFP.
(2) Based on 180 gal/DU and 73 gal/1000sf commercial area which are Town-wide averages.
(3) Based on 90% of water consumption becoming wastewater flow.
(4) Flow from the total planned area minus the existing flow from that area.
(5) The following AOC areas are only planned for partial sewering (see Table 2-3).
- Bearses Way at 50% of area.
- Water Supply ZOC's at 5% of area.
(6) These estimates are made for overlapping areas and are subject to change as the CWMP proceeds. The flow estimates are in million gallons per day (mgd) and are annual averages. These estimates do not include Infiltration/Inflow (I/I) that could occur in the future collection system.

When these future flows (at buildout) to the Hyannis WPCF are summed with other additional flows as listed on Table 2-3, a projected average annual flow of 3.8 mgd is indicated with an estimated maximum month flow of 5.5 as summarized on Table 5-15.

TABLE 5-15

SUMMARY OF PROJECTED FLOWS TO THE HYANNIS WPCF AT THE BUILDOUT CONDITION

FLOW SOURCES	PROJECTED FLOWS AT BUILDOUT (MGD)	
	Maximum Month(1)	Average Annual
Existing flow from existing collection system	1.94	1.46
Additional flow from buildout along existing collection system	2.2	1.3
Additional flow from AOC's(3)	0.73	0.55
- Bearses Way(2)		0.12
- BWMEL 1A(2)		0.01
- BWMEL 1B(2)		0.00
- BWST 1(2)		0.02
- CO 7(2)		0.01
- CCCC		0.06
- CE1		0.03
- CE2		0.03
- CE4		0.18
- H1		0.05
- H3		0.04
Allowance for I/I at the AOC's(4)	0.04	0.03
Allowance for potential expansion and additional infilling from Table 2-3		
- Independence Park	0.13	0.10
- Gravel Pit Development	0.10	0.07
- North of Kids Hill Road	0.40	0.3
Total	5.5	3.8

Notes:
(1) Maximum month flows are estimated using the current maximum month to average annual peaking factors (observed in Table 4-1) for all of the listed sources except the allowances for Independence Park, the Gravel Pit Development, and potential development North of Kids Hill Road which are carried over from Table 2-3 as developed in the 2007 WWFP.
(2) These flows do not represent the total flow that could come from these areas. Smaller portions of these areas were recommended in the 2007 WWFP as discussed in Chapters 2 and 5.
(3) Illustrated in Figure 2-1.
(4) Estimated at 6% of wastewater flow (section 4.3D).

It is noted that the summary in Table 5-14 does not include an allowance for future I/I. MassDEP requires planning for the additional flows that can come from I/I. Chapter 4, section 4.3 describes the analysis of the I/I in the existing collection system currently quantified at 0.08 mgd or 6 percent of the wastewater generation.

It is noted that the 2007 WWFP estimated wastewater flows to the WPCF for the design year 2014 (summarized in Table 2-3). This projection appears to be accurate based on the sewer extensions completed and the current flows experienced at the Hyannis WPCF.

Developing treatment capacity for the existing and planned wastewater flows to the Hyannis WPCF in the future (and possibly buildout) condition will be an important wastewater need to address in subsequent portions of the CWMP Project.

F. **Estimated Water-Consumption and Wastewater Generation Estimates for the Design Year of 2035.**

The previous two report sections (Section 5.12.D and E) investigated land use, and the resulting water consumption and wastewater generation for the buildout conditions as allowed by current zoning. As observed in Table 5-7 there is the potential for significant additional growth in Hyannis, Barnstable Village, and West Barnstable. The other villages have less potential for growth.

Hyannis' growth is expected to occur in the Growth Incentive Zone (GIZ) which was created to accommodate growth in this regional center. Much of Barnstable Village's growth will occur south of Route 6 in the Independence Park area.

A CWMP project needs to estimate future growth and projected wastewater flows at the buildout condition. It also needs to understand if the buildout conditions will be attained in the project planning period of 2015 to 2035.

An evaluation was completed to investigate Barnstable's past growth trends from 1998 to 2010, and to estimate if the buildout conditions would be attained by the design year of 2035. The period of 1998 to 2010 was chosen because it included times of economic growth as well as recession in Barnstable. It also was the time period with the best data (from the Assessors Department) for the number of residential dwelling units and non-residential building square footage per Fire District. A regression analysis was completed on this data, the findings are summarized below.

TABLE 5-16

SUMMARY OF GROWTH TRENDS FROM 1998 TO 2010

VILLAGE/FIRE DISTRICT[1]	RESIDENTIAL GROWTH (NEW DWELLING UNITS PER YEAR)	NON-RESIDENTIAL GROWTH (NEW SQUARE FOOTAGE PER YEAR)
Barnstable	19	51,000
C-O-MM	167	37,000
Cotuit	42	2,500
Hyannis	69	99,000
West Barnstable	20	7,400
Town-Wide	317	197,000

Notes:
(1) The data was available per Fire District and not available per village for the C-O-MM Fire District.

The full regression analysis is attached in Appendix 5-5.

Based on these growth rates, the projected land use was calculated for the end of the Design year of 2035; and the year when buildout would occur was estimated.

TABLE 5-17

PROJECTED LAND USE IN 2035, AND ESTIMATED YEAR OF BUILDOUT

VILLAGE/FIRE DISTRICT	PROJECTED LAND USE IN 2035		FUTURE YEAR WHEN DWELLING UNIT BUILDOUT IS ESTIMATED[2]	FUTURE YEAR WHEN NON-RES. SQ. FT. BUILDOUT IS ESTIMATED[2]
	Number of Dwelling Units	Non-Residential Building Square Footage		
Barnstable	2,393	3,870,000	2105	2129
C-O-MM	14,256	3,140,000	2016	2065
Cotuit	2,634	220,000	2015	2063
Hyannis	10,619	11,910,000	2053	2206
West Barnstable	1,837	730,000	2046	2095
Town-Wide	31,738	19,870,000	2061	2153

Notes:
(1) The data was available per Fire District and not available per village for the C-O-MM Fire District.
(2) Based on the land use of 2010, projected buildout conditions resulting from zoning as of 2010, and the observed growth rates from 1998 to 2010.

It is noted that this evaluation has several simplifying assumptions including:

- Linear growth as observed from 1998 to 2035 projected into the future.
- Growth stopping once buildout is attained.
- No changes to the current zoning.
- No variances from the current zoning.

Even with these simplifying assumptions it allows an estimate of the projected water use and wastewater generation in the design year of 2035 as summarized below.

TABLE 5-18

PROJECTED WATER CONSUMPTION AND WASTEWATER GENERATION IN 2035

VILLAGE	WATER CONSUMPTION (MGD)			WASTEWATER GENERATION (MGD)		
	Residential	Non-Residential	Total	Residential	Non-Residential	Total
Barnstable	0.49	0.18	0.67	0.44	0.16	0.60
C-O-MM	3.0	0.22	3.3	2.74	0.20	2.9
Cotuit	0.55	0.02	0.57	0.5	0.02	0.51
Hyannis	1.7	0.99	2.7	1.5	0.89	2.4
West Barnstable	0.43	0.03	0.46	0.39	0.03	0.41
Town-Wide	6.0	1.5	7.5	5.4	1.3	6.7

These estimates of land use, water consumption, and wastewater generation for the existing, Design Year 2035, and buildout conditions in Barnstable are part of a useful GIS tool to understand and project these characteristics for any part of the town. This tool will be valuable once detailed evaluations start to develop solutions for the wastewater areas of need.