# Chapter 6

# Future Conditions

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# FUTURE CONDITIONS

## 6.1 INTRODUCTION

The purpose of this chapter is to present the projected future conditions of the Town of Chatham with respect to population, water supply, and wastewater flows and loadings. The design year for the future conditions will be 2020. The Town may be at buildout in the next 20 years; therefore, the buildout conditions will be the focus of this Chapter.

## 6.2 GROWTH PLAN

The Town's Growth Policy Plan developed in 1987–1988, provided goals for growth management with respect to eight specific issues: water supply/sewage disposal; affordable housing; surface water quality; traffic/parking; public access to beaches, ponds and open space; solid waste/recycling; population and human services; and management of residential and commercial growth. The following goals were identified as the issues of interest in the Comprehensive Wastewater Management Planning Study.

- "To protect the quality and quantity of the Town's drinking water supply and provide for safe, effective treatment of septic waste."
- "To protect the quality of Chatham's coastal and inland waterways and ponds for recreation, fishing and related uses."
- "To maintain, protect and expand the Town's open space resources for watershed protection, conservation and recreation."
- "To provide safe, effective disposal of solid waste, encouraging recycling and reuse to conserve natural resources."

- "Encourage a stable but diverse population base, providing the necessary services for a variety of income levels and age groups."

- "To control the location and rate of residential and commercial development in order to protect the natural environment, preserve the historic and aesthetic character of the Town, and continue the vitality of the Town's business areas."

The Growth Policy Plan was developed to provide the Town with goals for managing the increasing growth experienced between 1970 and 1987. In that time over 2,000 new dwellings were constructed, a 52 percent increase during that seventeen year period. The majority of that growth was in the seasonal population and retired year-round residents, putting an increased demand on Town services. Chatham is now faced with less available land for housing, natural resources, open space, or services. However, the Town still has many properties that can be subdivided in accordance with local zoning regulations to create new properties.

Since the development of the Plan in 1988, the majority of its goals have been met. The implementation of this Plan has resulted in the following achievements.

- Over 90 percent of the Town's developed properties are supplied with public water.
- Land acquisition each year for conservation and resource protection.
- New zoning laws for the Town Water Resource Protection District.
- Several Town-wide groundwater modeling and water quality studies to better characterize the Town's water supply and natural resources.
- Closure of the Town landfill.
- Upgrade of the Chatham WPCF to limit nitrogen discharges into the groundwater system.
- Installation of pumpout stations and designation of a "No Discharge Area" for the Stage Harbor complex.
- Development of additional Town landings.

The Town is currently preparing a Local Comprehensive Plan (LCP) in accordance with the Cape Cod Commission Regional Policy Plan. Several chapters (elements) of the LCP have been drafted (as of April 1999), and the LCP is scheduled for completion in 1999. The draft version of the Community Facilities Element states the following goals with respect to wastewater and environmental issues.

- Water Supply: Provision of an adequate supply of clean, safe water to meet projected needs through the year 2020.

- Wastewater Treatment Facilities: Provision of an environmentally sound wastewater collection, treatment, and disposal system(s) to serve those areas of town where existing conditions are not suitable for on-site treatment and disposal.

- Solid Waste Management: Provide Chatham residents and visitors with an efficient and economical system of solid waste disposal.

- Stormwater Facilities: Protect surface and groundwater resources from stormwater pollution from public buildings, roofs and parking areas.

It is noted that this Community Facilities Element is in draft form, and these goals may be modified in the final LCP.

In summary, the goal of these plans is for the Town to live within the limits of their resources. Since the 1988 plan was developed, Chatham has successfully achieved their initial goals in growth management, and will use the LCP to identify and achieve future goals. Growth will continue to be an issue, impacting wastewater facilities, water supply, natural resources, and Town-wide services.

## 6.3 BUILDOUT ANALYSIS

**A. Introduction.** The buildout analysis provides a planning tool to help assess the capacity of the Town, and determine any future growth constraints. The buildout analysis predicts the future condition in Town at the point when all the developable space has been used. This provides a worse case scenario from which to assess the Town's resource strengths and deficiencies.

**B. Monomoy Capacity Analysis Findings.** The Monomoy Capacity Study, developed by the CCC, included a buildout analysis for the Town of Chatham and the four other towns included in the Monomoy Lens. The study outlined a four-step process for projecting a Town's buildout condition:

- **Step 1 – Establish development potential for each parcel in Town, based on State Class Codes obtained from the CCC GIS database**. The specific State Class Codes were grouped into eight categories: existing residential, developable residential, existing multi-family, existing commercial, developable commercial, existing industrial, developable industrial, and undevelopable land. Municipal land was assumed to remain Town owned and was not included in the buildout analysis.

- **Step 2 – Evaluation of buildout potential based on existing zoning.** Residential properties were compared to minimum lot sizes requirements to determine future subdivisions, and commercial properties were compared to the ratio of maximum commercial space per acre allowed by zoning.

- **Step 3 – Determination of commercial and industrial buildout potential.** Using the information identified in Steps 1 and 2, expansion potential for each property was calculated. Existing commercial space was compared to the maximum allowed, to determine expansion potential for these properties.

- **Step 4 – Calculation of residential buildout potential.** This database identified all developable residential properties in residential zones. Buildout potential was then calculated by subdividing each of these parcels to the minimum lot size allowable by current zoning.

The following are several assumptions made during the buildout analysis:

- The highest and best use of a parcel was assumed at buildout conditions.
- Lots less than 5,000 square feet were not included in the analysis.
- Large, "land rich", commercial properties such as summer camps and private golf courses are assumed to be redeveloped as part of the buildout analysis.
- Municipal properties were assumed to remain municipal properties

The buildout analysis estimated potential growth of commercial, industrial, and residential properties using town assessor and GIS database information. The following table summarizes the findings of the Commission's buildout analysis.

| | Existing Conditions | Buildout Conditions |
|---|---|---|
| Commercial (sq. ft) | 899,399 | 1,551,404 |
| Industrial (sq. ft) | 134,598 | 1,832,830 |
| Residential (units) | 6,094 | 8,047 |

The Study predicted that Chatham will reach buildout of residential properties well in advance of reaching buildout for commercial or industrial properties. Large increases in commercial and industrial square footages are a result of buildout calculations based on current zoning. A large number of existing residential properties are located in areas zoned commercial or industrial, thus, at buildout these properties are "converted" to match zoning. As defined in the Monomoy Capacity Study, "buildout is a fictional future used as a point of departure for studying the carrying capacity of the region…While the point of maximum buildout will likely never be reached in the future…". These buildout numbers were used as the basis for the CCC's water, transportation, natural resource and fiscal studies.

**C. Updated Buildout Analysis.** An updated buildout analysis was performed as part of this Needs Assessment. The following steps depict the methodology used to identify the maximum number of parcels that can be developed.

- The GIS database was used to identify the maximum number of parcels (residential, commercial and industrial) that could be created from the existing parcels according to the existing zoning regulations.

- Commercial growth was considered in the following village centers: South Chatham, West Chatham, Cornfield, Crowell Road, and North Chatham. Modifications to the Town's zoning regulations are being considered as part of the local comprehensive planning effort to encourage growth in the village centers and not let it sprawl along Route 28 as currently zoned. The properties in the village centers would subdivide into (average) 10,000 square foot properties, and each property would have mixed use of 2,500 square feet of commercial area and a two bedroom residential area. Commercially zoned area along Route 28 outside of these village centers is expected to become more residential.

- GIS mapping was created to illustrate potential future parcels based on the first two steps.

- The mapping was reviewed with the Town Planner, Tax Assessor, and Water Quality Laboratory Director to identify properties that could not be developed to this potential due to wetlands, road frontage limitations, and other site specific conditions.

- All existing one-bedroom and two-bedroom properties would be redeveloped to add one additional bedroom.

- Land purchase by the land bank was considered over the next 20-years. This consideration was based on ten bedrooms per year being removed from development. These 200 bedrooms (total over a 20-year period) were distributed (and then removed from the buildout analysis) based on watershed size.

The following table summarizes the total number of properties that will result at the buildout conditions.

| SUMMARY OF CHATHAM LAND USE AT BUILDOUT | | |
|---|---|---|
| **Land Use Grouping** | **Number of Properties** | **Percentage of Total** |
| Residential | 7,758 | 85 |
| Commercial | 476 | 5 |
| Industrial | 219 | 2 |
| Institutional | 288 | 3 |
| Undevelopable | 396 | 5 |
| Subtotal | 9,137 | 100 |

Most of the land use and wastewater production in Chatham is from residential sources. Future residential wastewater flow (and Nitrogen loading) is based on a water consumption rate of 50 gallons per day per bedroom which is the existing Town average based on water consumption and Tax Assessor data. The buildout analysis indicated an approximate 46 percent increase in bedrooms from 18,212 existing bedrooms to 26,674 bedrooms at buildout. Bedroom data is summarized for each watershed in Appendix P.

This analysis projected that there would be fewer developable properties in the future than the number projected by the Cape Cod Commission. This difference was a result of changes in assumptions as described above and also listed below.

- Large commercial properties (like golf courses) would not be redeveloped completely as residential.

- Zoning modifications (Village Centers) based on input from the Town Planning Department were used instead of existing zoning districts.

## 6.4 FUTURE POPULATION

Two recent studies have been performed to project future populations for Chatham and other towns on Cape Cod.

The Massachusetts Institute for Social and Economic Research (MISER), University of Massachusetts at Amherst published "Projections of the Populations (for) Massachusetts Cities and Towns, Year 2000 and 2010", in December 1994. This report only investigated year-round population, and based its projections on births and deaths in Chatham and estimates of year-round population migration in and out of Chatham. This report stated that Chatham had reached a peak year-round population of 6,579 in the year 1990 and projected a decline in population to 6,068 by the year 2010. This report has limited value because it does not consider the seasonal population, and does not adequately represent population migration onto Cape Cod.

The Monomoy Capacity Study, developed by the Cape Cod Commission in 1996, presents the most comprehensive approach to projecting Chatham's year round population. The study reported that Chatham's population would steadily rise from 6,363 in 1995 to 7,594 by 2015. The following assumptions were made in this study regarding future populations and development:

- Average annual residential and commercial/industrial growth rates for the study area were derived from 1985 to 1994 US Census Data.

- Residential growth rates represent the median number of housing units constructed during that 10-year period (59 for Chatham).

- A portion of these housing units is assumed to be seasonal.

- Commercial/Industrial growth rates were based on a correlation between growth in jobs and growth in square feet of commercial/industrial space (19,600 square feet for Chatham).

- Buildout analyses used State and Town zoning to develop buildout conditions.

- Highest and best use of land was assumed in developing buildout conditions.

The Monomoy Capacity Study is the most current and complete evaluation done to date, and their population projections for the year 2015 are utilized in this Needs Assessment Report. To reach the design year of 2020, the CCC trend was adopted and continued over this five-year period to reach the year 2020 year-round (census) population of 7,903. This population is reduced by ten percent to estimate the minimum month population. The July and August population is calculated using the existing ratio between year-round population and July and August population.

Future (2020) populations for Chatham are summarized below.

| GROUPING | POPULATION | PEAKING FACTOR |
|---|---|---|
| Year-Round Population | 7,900 | 1.0 |
| Summer Population | 27,000 | 3.4 |
| Minimum-Month Population | 7,100 | 0.9 |

The peaking factor is developed by dividing the population number for a grouping by 7,900, which is the year-round population number. The peaking factor provides a relative measure of the summer and minimum-month populations compared to the year-round population.

## 6.5 FUTURE WATER DEMAND AND CAPACITY

**A. Introduction.** As discussed previously in Chapter 5, the Town of Chatham's drinking water is supplied by the Monomoy Lens. Chatham uses six of their seven drinking water supply wells to provide water to the Town. The Town is also exploring five additional locations for future wells.

**B. Projected Water Use at Buildout.**

**1. Monomoy Capacity Analysis.** The Monomoy Capacity Study evaluated Chatham's water use in five-year intervals from 1995 to 2020. Future water consumption for each town was developed based on the various buildout scenarios and the Department of Environmental Management's population and water consumption projections for the year 2020.

A comparison was performed of the Town's water demand versus the availability of the supply. Three conditions were examined during the analysis.

- Existing conditions based on Town information.
- Supply and demand, for the years 2005, 2010, 2015, and 2015 with a 50 percent shift in summer home use to year round use.
- Future conditions for 2020, based on Massachusetts Department of Environmental Management (DEM) projections.

Title 5 design flows were used to approximate water usage at the different design years, including buildout conditions. The following assumptions were made.

- Year round housing units would consume 330gpd/unit.
- Seasonal housing units would consume 110gpd/unit.
- Commercial properties would consume 75gpd/1000 sq. ft.

The total water demand was calculated based on these assumptions. Total water demand for the Town was then adjusted to account for the Town's largest well being off-line.

These values were then compared to the existing well capacity. The following table presents the CCC 's projected water values.

| PROJECTED WATER DEMAND IN MILLION GALLONS PER DAY (mgd) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Year** | **Average Day (mgd)** | | | **Maximum Day (mgd)** | | | | |
| | **Adj. Demand (3)** | **Supply (16hr/d)** | **Excess/ Shortfall** | **Adj. Demand (3)** | **Supply (16hr/d)** | **Excess/ Shortfall** | **Supply (24hr/d)** | **Excess/ Shortfall** |
| 1995 | 2.43 | 3.12 | 0.69 | 4.07 | 3.12 | -0.95 | 4.68 | 0.61 |
| 2005 | 3.00 | 3.70 | 0.70 | 5.90 | 3.70 | -2.20 | 5.59 | -0.30 |
| 2010 | 3.07 | 4.27 | 1.20 | 6.11 | 4.27 | -1.83 | 6.41 | 0.30 |
| 2015 (1) | 3.15 | 4.85 | 1.70 | 6.32 | 4.85 | -1.47 | 7.27 | 0.96 |
| 2015 (2) | 3.50 | 4.85 | 1.35 | 7.28 | 4.85 | -2.43 | 7.27 | -0.01 |

Notes:
1. 2015 with current mix of seasonal and year round properties.
2. 2015 with a shift of seasonal properties to year round properties.
3. Adjusted Demand assumes the largest well is off-line (1.34 mgd for Chatham), and therefore added to the water demand.

The CCC projected that the current capacity is sufficient for projected water demand at the average day conditions, but predicted that current capacity is not sufficient for projected water demand at the maximum day conditions. These projected water demands are based on Title 5 wastewater design flows and are very conservative.

2. **DEM Analysis.** The DEM projected Chatham's water demand based on documented seasonal water consumption from 1986 to 1990. Water demands were taken from the "Water Supply Statistics Report" submitted to DEP each year. These values were used to calculate seasonal variations of water use, and were averaged to calculate a base value for the projections. Seasonal drinking water projections were developed for 1995, 2000, 2010, and 2020. The following table presents these projected water values.

| PROJECTED WATER DEMAND IN MILLION GALLONS PER DAY (mgd) | | | |
|---|---|---|---|
| **Year** | **Off-Season (mgd)** | **In-Season (mgd)** | **Annual Average (mgd)** |
| Base | 0.63 | 1.30 | 0.80 |
| 1995 | 0.82 | 1.47 | 1.09 |
| 2000 | 0.84 | 1.51 | 1.12 |
| 2010 | 0.86 | 1.60 | 1.17 |
| 2020 | 0.91 | 1.76 | 1.26 |

These values are much lower than the CCC projections. This discrepancy can be attributed to the DEM's use of statistical reports for initial usage values, and the CCC's use of Title 5 design flows. The DEM also did not use the assumption that the largest of the Town's wells would be off-line.

Compared to the current water supply capacity for Chatham, the DEM demand values are not predicted to exceed the supply. Capacity would only be reached at the predicted 2020 demand when the largest well in Chatham was off-line.

**3. Updated Analysis.** Projected water demand at buildout was developed following the development of a Town-wide buildout analysis, as described earlier in this Chapter. Buildout water flows are a combination of existing Town-wide flows, as developed in Chapter 5, and the additional flow associated with development of vacant properties in Town, and the addition of new bedrooms at existing properties.

Additional future water flows were developed for the four major land uses: Residential, Commercial, Industrial, and Institutional. Residential flows were calculated using the number of additional bedrooms, which would exist at buildout. Bedroom numbers were developed in the following manner:

- Any new property created by a subdivision of a previously developed or vacant property is assumed to be built out with a three-bedroom house.

- Any existing property with an existing one or two-bedroom house is assumed to have an additional bedroom at buildout in addition to any new three-bedroom houses on the newly created properties resulting from the subdivision.

- Any property with three or more existing bedrooms (prior to the subdivision) is assumed to have no additional bedrooms at buildout, except for those generated by any new three-bedroom houses created as a result of the property subdividing.

The buildout analysis projected 8,462 new bedrooms would be created in Chatham. These bedrooms are then multiplied by 50 gpd per bedroom equaling an additional 420,000 gpd of new water demand on an average annual basis.

Additional future flow from commercial properties is developed by assuming each new commercial property will be built out with 2,500 sq. ft. of commercial space and two bedrooms of residential space. The flow for these new commercial properties equals 75 gpd per 1,000 sq. ft. of commercial space and 50 gpd per bedroom, totaling approximately 290 gpd per new property. This additional water demand is equal to 150,000 gpd. This future growth is projected to occur in the village center areas.

The additional industrial flow is developed by increasing the existing water demand by 10-percent for existing properties and adding flow from potential new industrial subdivision in the industrial zoned areas. All new industrial properties are assumed to have one-third of the property developed, and 37 gpd per 1,000 square feet based on half of the Title 5 flow of 75 gpd per 1,000 square feet. This additional industrial flow is equal to 10,000 gpd.

Future institutional flow is assumed to be 110 percent of the existing water demand for those properties, to account for additional usage of those properties.

The following table summarizes the existing, additional, and total buildout flows based on these assumptions.

| **Town-wide Average Annual Water Flows (Demand)** | | | |
|---|---|---|---|
| **Land Use** | **Existing Demand (gpd)** | **Additional Demand (gpd)** | **Total Buildout Demand (gpd)** |
| Residential | 720,000 | 410,000 | 1,120,000 |
| Commercial | 190,000 | 150,000 | 340,000 |
| Industrial | 20,000 | 10,000 | 30,000 |
| Institutional | 10,000 | 1,000 | 11,000 |
| Total | 940,000 | 570,000 | 1,500,000 |

The total buildout demand is then compared to the existing pumping capacity for the Town. As described in Chapter 5 (Section 5.4), the Town has seven existing wells and two proposed wells which are in the process of being developed and permitted. Of the seven existing wells, the Indian Hill Well is currently not being used by the Town. This leaves the Town with a total pumping capacity of 4.75 mgd if these wells are pumped for

24 hours per day. When assessing the impacts of future demand on the existing capacity, typically the largest well in the system is assumed to be offline to simulate a worst case scenario.

The Town has stated that the true worst case would be the South Chatham Well Field (three wells) being offline, reducing the capacity by 2.1 mgd. If this situation did occur, the Indian Hill Well would be brought on line providing an additional 1 mgd capacity. The following table presents the future demands and the existing capacities.

| COMPARISON OF DEMAND AND CAPACITY AT BUILDOUT CONDITIONS | | | | | |
|---|---|---|---|---|---|
| | **Demand (mgd)** | **Existing Capacity[1] (mgd)** | **Adjusted Capacity [2] (mgd)** | **Impact on Existing Capacity [3] (mgd)** | **Impact on Adjusted Capacity [3] (mgd)** |
| Average Annual | 1.5 | 4.75 | 3.70 | + 3.25 | + 2.2 |
| Peak Day | 5.2[4] | 4.75 | 3.70 | - 0.45 | - 1.5 |

Notes: 1. This does not include the Indian Hill Well capacity, which is currently not in use. This capacity is based on wells pumping 24 hrs/day.

2. Adjusted Capacity equals Existing Capacity minus 1.1 mgd to account for the South Chatham Wells offline and Indian Hill Well online.

3. Difference between Capacity and Demand where (+) indicates sufficient capacity, (-) indicates insufficient capacity to meet future demand.

4. Calculated by multiplying the average annual demand by the seasonal peaking factor of 3.46 as observed for existing total metered water flow (see Table 5-14).

Currently the Towns wells provide sufficient amounts of water to meet projected average annual demand, but are insufficient to meet future peak day water demands. The future addition of two proposed wells (Town Forest Well & Training Field Well), within the next three to five years, has the potential to add an additional 2 mgd of capacity. This additional capacity will provide the necessary flow to meet the future peak day demand at buildout.

## 6.6 FUTURE WASTEWATER, SEPTAGE, TRAP GREASE, AND MARINE WASTE GENERATION

**A. Wastewater.** Future wastewater will be generated as a function of the future water consumption. The future Town-wide wastewater flows and loadings are calculated using the following factors.

- Wastewater flow at approximately 90 percent of water flow (average annual demand).
- Typical wastewater concentrations (as indicated by Chatham WPCF analyses) of BOD, TSS, and Total Nitrogen of 250,200, and 35 ppm, respectively.

These flow and loading values are summarized below.

| TOWN-WIDE WASTEWATER FLOWS AND LOADINGS | |
|---|---|
| Flow, gpd | 1,350,000 |
| BOD, lb/day | 2,800 |
| TSS, lb/day | 2,300 |
| TN, lb/day | 400 |

The determination of whether Nitrogen in these projected wastewater flows will impact the Town's embayments is presented in the following chapter section.

**B. Septage.** The buildout analysis indicates that there will be approximately 8,741 developed parcels at buildout. Future septage production is calculated based on the following:

- Approximately five percent of the properties have more than one septic tank.
- 300 parcels are sewered and do not produce septage.
- The septic tanks are pumped every five-years on average.
- The average volume pumped is 1,200 gallons per pumping.

This indicates an average septage production of approximately 5,800 gallons per day.

Septage pumping records reviewed for 1997 indicated that only 72 percent of the Town's septage was delivered to the Chatham WPCF for treatment. The remaining 28 percent was taken to a regional septage treatment and disposal facility. Using this same percentage, approximately 4,200 gpd of septage would be taken to the Chatham WPCF for treatment. This represents two or three deliveries per day.

**C. Trap Grease.** Trap grease is pumped regularly in Chatham due to the Town's sewer use regulations. The quantities of trap grease are not expected to increase significantly. The current flow of trap grease is 600 gallons per day. A 50 percent increase would produce a flow of 900 gallons per day.

**D. Marine Waste.** These are wastes that are collected from the marine pumpout facilities and are disposed as septage at the Chatham WPCF. They represent a small fraction of the flow that is taken to the Chatham WPCF. In 1994, 6,000 gallons (average flow of 16 gallons per day) was disposed at the Chatham WPCF. This increased to 8,000 gallons in 1995 (22 gallons per day). If this flow increases ten times, it would represent an average annual flow of 220 gpd, which is approximately the average flow of a four or five-bedroom house in Chatham.

## 6.7 FUTURE NITROGEN LOADING TO COASTAL EMBAYMENTS

**A. Introduction.** A primary concern of increased wastewater flows in Chatham and effluent discharge through on-site systems is the increased nitrogen loading to the Town's coastal embayments.

Portions of Chapter 4 identified the existing nitrogen loadings to the embayments based on wastewater flows, stormwater runoff, fertilizer use, and recharge from natural areas. The wastewater loadings were calculated three different ways: Title 5 design flow, flows based on 1997 water consumption, and flows based on population statistics and assumptions in Cape Cod Commission's Technical Bulletin 91-001 (CCC, 1991). The wastewater loading based on 1997 water consumption was adopted for this report following a TAC and CAC decision made during the public participation process. This is believed to be the most accurate indicator of wastewater flow and nitrogen loading.

Critical nitrogen loading values were developed for the embayments based on State classification and Cape Cod Commission published works. Future nitrogen loadings in the Stage Harbor Embayment and South Coast Embayment Watersheds are based on the existing nitrogen loadings plus the additional nitrogen from future development as indicated by the buildout analysis. Future nitrogen loadings in the Pleasant Bay Embayment were developed by the Cape Cod Commission as part of their work on the Pleasant Bay Management Plan. These future loadings are described and presented below.

**B. Pleasant Bay Embayments.** Future development and nitrogen loading in the Pleasant Bay Watersheds is described by the following excerpt from the Pleasant Bay Nitrogen Loading Study (CCC, 1998).

> "Future development potential within the Pleasant Bay Watersheds is based of the number of parcels classified as "developable" by the town assessors. The total number of potential residential units is determined by evaluating each parcel; if a parcel can be subdivided into two or more parcels under current zoning, it is counted as having the highest number of potential parcels based strictly on lot size. This evaluation method does not account for other zoning issues, such as frontage requirements, but it is a reasonable first approximation of potential residential lots. Staff evaluated development of future residential parcels based on both seasonal and year-round occupancy. No subdivisions of commercial and industrial developable parcels are assumed and future wastewater nitrogen loads from

these lots are assumed to be equal to the average of existing commercial and industrial land uses within the Pleasant Bay watershed or specific subwatershed.

Once all the land uses and wastewater estimates have been determined in each of the Pleasant Bay subwatersheds, staff used the TB91-001 nitrogen loading factors to estimate nitrogen loads within each subwatershed and to the system as a whole."

The existing and future nitrogen loading values developed by the Pleasant Bay Study are presented below.

| PLEASANT BAY EMBAYMENTS [1]<br>SUMMARY OF EXISTING AND FUTURE NITROGEN LOADING (kg/yr.) | | | |
|---|---|---|---|
| | | **Buildout** | |
| | **Existing Seasonal** | **Seasonal** | **Year-Round** |
| Pleasant Bay Estuary | 92,218 | 116,932 | 123,572 |
| Bassing Harbor System | 18,878 | 22,254 | 23,451 |
| Ryder Cove Total | 15,343 | 18,048 | 18,964 |
| Ryder Cove Proper | 5,473 | 6,617 | 7,097 |
| Frost Fish Creek | 9,870 | 11,431 | 11,867 |
| Crows Pond | 2,066 | 2,317 | 2,422 |
| Bassing Harbor | 1,469 | 1,889 | 2,065 |
| Muddy Creek Total | 10,947 | 19,402 | 20,847 |
| Muddy Creek (Harwich) | 6,480 | 13,327 | 14,096 |
| Muddy Creek (Chatham) | 4,467 | 6,075 | 6,751 |
| Notes: 1. Existing and future loadings are based on Cape Cod Commission Technical Bulletin 91-001, and buildout conditions discussed in the Pleasant Bay Nitrogen Loading Study (CCC, 1998). | | | |

Critical nitrogen loadings for the Pleasant Bay Embayment as discussed in Chapter 4 are summarized below.

| PLEASANT BAY EMBAYMENTS<br>SUMMARY OF CRITICAL NITROGEN LOADINGS (kg/yr.) | | | | |
|---|---|---|---|---|
| Embayment | BBP ORW Critical Load[1] | | ORW-N Critical Load[1] | |
| | Existing | Pre-Break | Existing | Pre-Break |
| Pleasant Bay Estuary | 2,211,417 | 1,975,943 | 1,053,627 | 938,686 |
| Bassing Harbor System | 79,792 | 70,843 | 37,670 | 33,324 |
| Ryder Cove | 35,399 | 32,042 | 16,887 | 15,248 |
| Crows Pond | 32,076 | 28,367 | 15,028 | 13,234 |
| Muddy Creek | 662 | 662 | 478 | 372 |
| Note: 1. BBP ORW and ORW-N water quality standards are discussed in the text (Section 4.2 E (3)(b)) | | | | |

The following findings are noted from the comparison of the future nitrogen loadings and the pre-break critical nitrogen loading values.

- All of the embayments can meet these standards at all conditions except Muddy Creek and Ryder Cove.

- Critical loading values were not calculated for Bassing Harbor, because that portion is close to Pleasant Bay and is well flushed. The nitrogen loading is therefore not expected to exceed critical nitrogen loading in the Bassing Harbor portion of the total Bassing Harbor System.

- Muddy Creek greatly exceeds the critical nitrogen loading value.

- Ryder Cove nitrogen loading exceeds critical nitrogen loading for the ORW-N water quality standard. A large portion of this loading may be in the Frost Fish Creek

Watershed, which empties into the outer part of Ryder Cove. Additional flushing data has been requested for future evaluation.

These watersheds will be identified as Wastewater Areas of Concern, and management options will be developed for these areas in following phases of this Study.

**C. Stage Harbor Embayments.** Future development is projected for the Stage Harbor Embayment Watersheds as described earlier in this chapter in the buildout analysis. Future nitrogen loadings within the watershed are developed similar to existing nitrogen loadings described in Chapter 4. Wastewater loadings are calculated based on wastewater flows and typical Title 5 effluent nitrogen concentrations of 35 ppm. Non-wastewater loadings (lawn and fertilizer inputs, runoff from impervious surfaces, and loadings from natural areas) are calculated based on the factors in the Commission's TB 91-001.

Existing and future loading for the Stage Harbor Embayments are summarized below with the critical nitrogen loadings developed (and discussed) in Chapter 4.

| STAGE HARBOR EMBAYMENTS<br>SUMMARY OF EXISTING AND FUTURE LOADINGS (kg/yr.) AND<br>CRITICAL LOADINGS (kg/yr.) FOR ALL WATER QUALITY STANDARDS | | | | | | |
|---|---|---|---|---|---|---|
| | **Existing Loadings[1]** | | **Critical Nitrogen Loading[2]** | | | |
| **Embayment** | **Existing** | **Future** | **BBP SA** | **SA-N** | **BBP-ORW** | **ORW-N** |
| Oyster Pond | 4,200 | 8,900 | 95,200 | 67,700 | 47,600 | 22,600 |
| Oyster Pond River | 3,500 | 5,200 | 60,600 | 43,400 | 30,300 | 14,500 |
| Stage Harbor | 1,200 | 1,800 | 202,000 | 144,000 | 101,000 | 48,000 |
| Mitchell River | 1,200 | 1,500 | 56,000 | 40,300 | 28,300 | 13,400 |
| Mill Pond | 1,800 | 2,200 | 46,000 | 32,600 | 23,000 | 10,800 |
| Little Mill Pond | 1,400 | 1,800 | 6,000 | 4,300 | 3,000 | 1,400 |

| |
|---|
| Notes: 1. Based on 1997 water usage and buildout conditions as described in the text.<br>2. Based on water quality standards described in the text. |

The following findings are noted from the comparison of the future nitrogen loadings and the critical nitrogen loading values.

- All the embayment watersheds have existing and future loadings less than the critical loading values except Little Mill Pond, which exceeds the ORW-N standard.

- The other future loadings are significantly below the critical nitrogen loading values due to the tidal flushing of this embayment system and relatively small watersheds.

The Little Mill Pond Watershed is identified as a Wastewater Area of Concern, and management options will be developed for this area in following phases of this Study.

**D. South Coast Embayments.** Future development is projected for the South Coast Embayment Watersheds as described earlier in this chapter in the buildout analysis. Future nitrogen loadings within the watersheds are developed similar to existing nitrogen loadings described in Chapter 4. Wastewater loadings are calculated based on wastewater flows and typical Title 5 effluent nitrogen concentrations of 35 ppm. Non-wastewater loadings (lawn and fertilizer inputs, runoff from impervious surfaces, and loadings from natural areas) are calculated based on the factors in the Commission's TB91-001.

Existing and future loadings from the South Coast Embayments are summarized below with the critical nitrogen loadings developed (and discussed) in Chapter 4.

| SOUTH COAST EMBAYMENTS<br>SUMMARY OF EXISTING AND FUTURE LOADINGS (kg/yr.) AND<br>CRITICAL LOADINGS (kg/yr.) FOR ALL WATER QUALITY STANDARDS | | | | | | |
|---|---|---|---|---|---|---|
| **Embayment** | **Nitrogen Loadings**[1] | | **Critical Nitrogen Loading**[2] | | | |
| | Existing | Future | BBP SA | SA-N | BBP-ORW | ORW-N |
| Taylor Pond | 2,800 | 5,400 | 6,100 | 4,300 | 3,100 | 1,400 |
| Mill Creek | 2,200 | 3,700 | 11,100 | 8,100 | 5,500 | 2,700 |
| Taylor Pond/Mill Creek | 5,000 | 9,100 | 17,200 | 12,400 | 8,600 | 4,100 |
| Sulfur Springs | 5,600 | 10,700 | 15,800 | 11,500 | 7,900 | 3,800 |
| Bucks Creek | 600 | 600 | 5,300 | 3,800 | 2,600 | 1,300 |
| Sulfur Springs/Bucks Creek | 6,200 | 11,300 | 21,000 | 15,300 | 10,500 | 5,100 |
| Cockle Cove Creek | 3,100 | 4,200 | - | - | - | - |
| Notes: 1. Based on 1997 water usage and buildout conditions as described in the text.<br>2. Based on water quality standards described in the text. | | | | | | |

Comparison of the future nitrogen loading and the critical nitrogen loading values indicates the following findings.

- Future loadings in the Taylor Pond Watershed exceed the critical nitrogen loadings for all standards except BBP-SA.

- Future loadings in the Mill Creek and Sulfur Springs Watersheds exceed the critical nitrogen loadings for the ORW-N standard.

- The Bucks Creek Watershed is relatively small, and does not exceed any of the critical nitrogen loading standards.

Taylor Pond, Mill Creek and Sulfur Springs Watersheds are identified as Wastewater Areas of Concern, and management options will be developed for these areas in following phases of this Study.

**E. Nitrogen Loading Assessment Sensitivity Analysis**. As part of the nitrogen loading analysis for the Pleasant Bay, Stage Harbor, and South Coastal Embayments, a sensitivity analysis was performed to identify embayments which might be close to exceeding the ORW-N limit in the future. As identified previously in this chapter, embayments projected to exceed the most stringent ORW-N critical nitrogen loading criteria are: Ryder Cove, Muddy Creek, Little Mill Pond, Taylor Pond, Mill Creek, and Sulfur Springs.

Nitrogen increases of 50 and 100 percent of future nitrogen loading values were used to determine if additional coastal embayment watersheds should be identified as Areas of Concern (AOCs). Results of this analysis indicated that a 50 percent increase in nitrogen loading would not add any additional watersheds to the list of AOCs previously identified. A 100 percent increase forced only the Bassing Harbor System to exceed the ORW-N critical nitrogen loading. No other coastal embayments would exceed the ORW-N limit if their previously calculated future nitrogen loading were increased 50 or 100 percent.

In addition to the sensitivity analysis described above, results of two nitrogen calculation methodologies were compared. The two methodologies were the S&W method and the Technical Bulletin 91-001 method. Both methods first calculate the existing nitrogen loading; then, based on developable properties and buildout conditions, a future additional nitrogen component is calculated. The CCC standard nitrogen loading calculation spreadsheet, used for the Pleasant Bay Study, was used to calculate the Technical Bulletin 91-001 future nitrogen loading for the other coastal embayments. The Technical Bulletin calculation makes the following general assumptions:

- Census population data of 2.14 people per household (year round), 5 people per household (seasonal)
- Future development = number of vacant developable properties.
- Three bedrooms per single family residence.
- 50% of the properties are year-round.

- Seasonal flow is generated over a three-month period.
- Future year round calculations assume 100% of the NEW (developable) properties will be year round residences.

The Stearns & Wheler calculation methodology uses a similar spreadsheet calculation and makes the following general assumptions:

- Wastewater flow is based on water consumption values
- Future development = number of new and vacant developable properties and bedrooms as identified in the buildout analysis.
- Population is not used.

Findings of this comparison are summarized below.

| FUTURE NITROGEN LOADING COMPARISON AT BUILDOUT, kg/yr (TABLE 1) | | | | |
|---|---|---|---|---|
| **Embayment** | **CCC-TB 91-001** | | **S&W Calculation** | **Critical Nitrogen Loading Standard (ORW-N)** |
| | **Seasonal** | **Year-round** | | |
| **Stage Harbor Complex** | | | | |
| Oyster Pond | 6,600 | 6,900 | 8,900 | 22,600 |
| Oyster Pond River | 6,900 | 7,000 | 5,200 | 14,500 |
| Stage Harbor | 2,100 | 2,200 | 1,800 | 48,000 |
| Mitchell River | 1,800 | 1,800 | 1,500 | 13,400 |
| Mill Pond | 2,900 | 2,900 | 2,200 | 10,800 |
| Little Mill Pond | 2,000 | 2,000 | 1,800 | 1,400 |

Notes: NA = Not Applicable

| FUTURE NITROGEN LOADING COMPARISON AT BUILDOUT, kg/yr (TABLE 2) | | | | |
|---|---|---|---|---|
| **Embayment** | **CCC-TB 91-001** | | **S&W Calculation** | **Critical Nitrogen Loading Standard (ORW-N)** |
| **South Coast Embayments** | | | | |
| Taylor Pond | 7,000 | 7,200 | 5,400 | 1,400 |
| Mill Creek | 4,300 | 4,400 | 3,700 | 2,700 |
| Taylor Pond/Mill Creek | 11,300 | 11,600 | 9,100 | 4,100 |
| Sulfur Springs | 10,400 | 10,700 | 10,700 | 3,800 |
| Bucks Creek | 1,100 | 1,100 | 600 | 1,300 |
| Sulfur Spring/Bucks Creek | 11,500 | 11,800 | 11,300 | 5,100 |
| Cockle Cove Creek | 5,100 | 5,300 | 4,200 | NA |

Notes: NA = Not Applicable

These calculations indicate that no new coastal embayments would be identified as exceeding the ORW-N using the Technical Bulletin calculation vs. the Stearns & Wheler method.

The results of this sensitivity analyses indicates that no additional coastal embayments should be identified as areas of concern based on the water quality standards and calculation methodology presented.

Stearns & Wheler also investigated if using the second most stringent BBP-ORW critical Nitrogen loading standard (versus the ORW-N standard) would eliminate many of the coastal embayment watersheds from the list of Wastewater Areas of Concern (AOC). This investigation indicated that Little Mill Pond, Mill Creek and Ryder Cove would no longer be AOC if the BBP-ORW standard was used. We then performed a sensitivity analysis to investigate how close these three embayments are to the BBP-ORW limit and found that the Mill Creek watershed would exceed the BBP-ORW limit if its Nitrogen loading was increased by 50 percent. Little Mill Pond and Ryder Cover watersheds would exceed the BBP-ORW limit if their Nitrogen loading was increased by 100 percent. These findings indicate that Little Mill Pond is closer to exceeding the BBP-ORW limit than the other embayments.

The Study Citizens Advisory Committee (CAC) and Technical Advisory Committee (TAC) reviewed these findings and made several decisions on which water quality standards will be used for future evaluations. These decisions are listed below:

- Little Mill Pond will be evaluated using both the ORW-N and the BBP-ORW standards.

- Taylor Pond will be evaluated using the SA-N, BBP-ORW, and the ORW-N standards.

- Mill Creek will be evaluated using the BBP-ORW and the ORW-N standards.

- Sulfur Springs/Bucks Creek will be evaluated as one system using the ORW-N, BBP-ORW, and SA-N standards.

- Sulfur Springs will be evaluated using the SA-N, BBP-ORW, and ORW-N standards.

- Muddy Creek will be unable to meet any standard and other options of increased flushing or conversion to a fresh water system will be evaluated.

- Ryder Cove needs to be evaluated further using the ORW-N standard based on the additional flushing information which has been requested. (Discussed in Section 8.9, Data Gaps)

- All other watersheds and embayments will be evaluated using the ORW-N standard which is the most stringent standard used.