Chapter 4

Existing Wastewater and Water Supply Systems

CHAPTER 4

EXISTING WASTEWATER AND WATER INFRASTRUCTURE

4.1 INTRODUCTION

The Town's existing wastewater and water facilities are described in this chapter, and pertinent system characteristics are summarized.

A. **Wastewater Facilities.** The Town of Barnstable DPW operates three wastewater treatment facilities: the Hyannis Water Pollution Control Facility (WPCF), Marstons Mills Wastewater Treatment Facility (WWTF), and Red Lily Pond cluster system.

There are two privately owned WWTF's in Barnstable: the Cotuit Stop and Shop WWTF, and the Cape Regency Skilled Nursing and Rehabilitation Center WWTF.

There are 71 Innovative/Alternative (I/A) individual home treatment systems in Barnstable as regulated by the MassDEP Title 5 regulations. These are systems that typically provide a greater level of nitrogen removal as compared to regular Title 5 septic systems.

The great majority of properties in Barnstable utilize septic systems as regulated by MassDEP Title 5 regulations. These septic systems have been identified as the largest source of nitrogen to the coastal estuaries by the Massachusetts Estuaries Project.

B. **Water Supply Facilities.** There are four water purveyors that provide public water supply to the properties in Barnstable.

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 (COMM) Fire District Water Department provides water supply to those three villages.
- The Cotuit Water District provides water supply to that village.

The West Barnstable Fire District has a Water Commission but does not currently provide any Water Supply infrastructure. A few properties in the Fire District/Village area are served by neighboring Fire/Water Districts.

West Barnstable is the only village that relies almost exclusively on private water supply wells; though there are a few properties in the other villages that still utilize private wells.

4.2 HYANNIS WATER POLLUTION CONTROL FACILITY (WPCF)

A. **History of Hyannis WPCF.** A primary wastewater treatment facility utilizing an Imhoff tank was constructed at the present site on Bearses Way around 1936. Effluent discharge to groundwater via sand infiltration beds has been continuously practiced at this site since that time. The facility provided primary treatment until completion of the secondary upgrade in 1980. Most of the facilities presently in use were added under six construction projects, which are described below. Figure 4-1 is a site plan showing the present site layout.

1. **Pretreatment Building Construction**. The pretreatment building was completed and placed in service in 1975. The building included an influent receiving well, a hand-cleaned bar screen, one comminutor, an aerated grit chamber, and a Parshall flume. The project also added a septage receiving station and two 15,000-gallon septage storage tanks. (This building has since been upgraded as described in a subsequent project.)

2. **Secondary Treatment Additions**. The main secondary treatment upgrade was completed and began operation in 1980. This project added the existing primary clarifiers, aeration tanks, final settling tanks, post-chlorination tanks, control building, effluent pumps, sludge handling facility, and two centrifuges. One of the old primary settling tanks was converted to a sludge thickener. The sludge holding tanks were covered and mixers were installed.

3. **Septage and Odor Control Additions**. A construction contract completed in 1991 added a new septage receiving station and septage processing building. The septage processing building contains septage storage and degritting facilities, two gravity belt thickeners, and grease concentration equipment. A Sludge Process Blower Building was constructed to provide aeration of the sludge holding tanks. Three new odor control systems were added at the pretreatment building, septage handling building, and the sludge process blower building.

4. **New Secondary Clarifier Additions**. A construction contract completed in 1997 added a new 85-foot diameter clarifier, new return sludge pumps, and new waste sludge pumps. A flow distribution box was also added between the aeration tank and the clarifiers to replace a butterfly valve flow splitting arrangement to provide more accurate flow splitting.

5. **Modified Ludzak Ettinger (MLE) Process Addition with Diffused Aeration**. A construction contract completed in 2001 converted the biological treatment process to the MLE nitrogen removal process in Aeration Tank Nos. 1 and 2. The aeration technology was converted from surface aeration to diffused aeration and a blower building was added with four blowers.

6. **Aeration Tank Expansion and Other Improvements**. A construction contract completed in 2009 added a third aeration tank and one new blower in the blower building to enhance the treatment capacity and redundancy by 50 percent. The following improvements were also made:

a. Pretreatment building improvements to replace flow metering, grit removal, and screening equipment.

b. Primary sludge pump replacement.

c. Yard piping to allow primary sludge pumping to the pretreatment building.

d. Piping and site modifications to new improved tanker truck loading.

e. Pretreatment building drain improvements to allow both gravity belt thickeners to operate at the same time.

f. Additional odor control facilities added.

B. **Summary of Existing Centralized Wastewater Flows and Loadings.** Wastewater treatment facility staff regularly sample and record the flows of wastewater and septage. Much of the recorded data is reported to MassDEP in monthly reports, while other data is utilized by the WPCF staff as part of their monitoring and process control operations. As part of this project, three years of data (September 2006 through August 2009) was analyzed to determine the current flows and loadings to performance of the Hyannis WPCF. The flow data that was used for flow analysis was from the period of January 2008 through August 2009. Wastewater flow data before January 2008 was recorded with the old flow meter which is believed to have been reading high. Monthly averages were computed and are summarized in Appendix 4-1.

1. **Plant Influent.** Plant influent is a combination of wastewater from the collection system and septage. Wastewater from the collection system arrives at the WPCF via several force mains that terminate at the pretreatment building. The daily flows are recorded and reported to MassDEP in a monthly report. A typical monthly report is attached in Appendix 4-2. Septage is transported to the WPCF by septage haulers. The volume of septage is recorded on the monthly report.

Table 4-1 summarizes the average annual, minimum month, maximum month, and peak day influent flows during the period of January 2008 through August 2009.

TABLE 4-1

INFLUENT FLOWS, HYANNIS WPCF

FLOW AVERAGE	SEWAGE FLOW (MGD)	SEPTAGE FLOW (MGD)	TOTAL FLOW (MGD)	TIME OF OCCURRENCE(1)
Average annual	1.46	0.04	-	-
Maximum month	1.94	-	-	August 2009
Minimum month	0.85	-	-	January 2008
Peak day(2)	2.38	0.07	2.45	August 29, 2009

Notes:
(1) Dates of sewage flow for maximum month, minimum month, and peak day.
(2) The total for peak day is a summation of the sewage flow and septage flow that occurred on their respective peak flow dates.

A representative sample of the primary effluent (as an indicator of plant influent) is analyzed twice weekly for 5-day biochemical oxygen demand (BOD_5) and total suspended solids (TSS). This sample is taken from the effluent of the primary settling process because it best describes the influent to the biological treatment process which needs the best influent data for process control. The plant influent load will be higher than the primary effluent load because some of the BOD, TSS, and nitrogen is removed in the primary settling tanks. The WPCF effluent is sampled two times per week and analyzed for BOD_5, TSS, nitrate nitrogen (NO_3-N), and total Kjeldahl nitrogen (TKN).

BOD_5 is used to gauge the strength of wastewater, as it is a measure of the quantity of oxygen that will be required to biologically stabilize the organic matter present in the wastewater. The nitrogen analysis of the effluent provides a measure of the nitrogen loading to the groundwater system.

2. **Septage.** The Hyannis WPCF receives and treats septage and trap grease (all referred to as "septage") from haulers located in and around Hyannis. The WPCF tracks the number of septage loads discharged to the system and the gallons of septage. Septage treatment includes grit removal and aeration before it is thickened for transport off site.

3. **Waste-Activated Sludge (WAS).** WAS from the aeration tanks is pumped to two gravity belt thickeners (GBT) located in the Septage Processing Building or to a blended-sludge tank within this building. Thickened sludge from the GBTs is pumped by plunger pumps into thickened sludge tanks where it is stored until it is trucked to a regional disposal facility.

4. **Screenings and Grit.** Grit is collected in the septage receiving building and the pretreatment building. It is disposed of as a solid waste at a permitted landfill.

C. **Summary of Overall WPCF Performance.** Overall facility performance is indicated by the quality of the treated effluent recharged at the sand infiltration beds. Monthly averages of the WPCF influent and effluent from 2006-2009 are plotted on Figure 4-2 for BOD_5, Figure 4-3 for TSS, and Figure 4-4 for nitrogen (effluent only).

Figure 4-2 indicates that the facility performs well at removing BOD with an average annual removal rate of 97 percent and an average effluent concentration of 6.0 mg/L. The current groundwater discharge limit is 30 mg/L of BOD. The monthly average BOD concentrations evaluated have not exceeded this value.

Figure 4-3 indicates that the facility performs well at removing TSS with an average annual effluent concentration of 7 mg/L. The current groundwater discharge limit for the Hyannis WPCF is 30 mg/L of TSS.

Figure 4-4 indicates that the facility performs well at removing Total Nitrogen (TN), Amonia Nitrogen (NH_3–N) and Nitrate Nitrogen (NO_3-N) with an average TN effluent concentration of 5 mg/L. The current groundwater discharge limit for the Hyannis WPCF is 10 mg/L TN.

The Hyannis WPCF recharges its treated water into portions of three Zone II areas (areas of land that could contribute groundwater to a public water supply well), and MassDEP may require that the WPCF meet a new effluent limit of 3 mg/L total organic carbon (TOC), especially if the plant is expanded. This parameter is not currently monitored but several samples have been collected and analyzed since October 2009, and the average TOC concentration in the treated water was 7.1.

D. **Existing Wastewater Treatment Facilities.** The Hyannis WPCF is comprised of septage handling, pretreatment, primary, secondary, and disinfection treatment facilities. These facilities are illustrated on the Site Plan of Figure 4-1. The existing wastewater and septage treatment flow schematics are presented on Figures 4-5 and 4-6, respectively. The sludge flow schematic is illustrated on Figure 4-7. An inventory of the treatment facilities and process equipment is presented in Appendix 4-3.

1. **Pretreatment Facilities.** The pretreatment facilities consist of a manual bar screen, an automated mechanically cleaned climber screen, a shaftless screw conveyor for the screenings, a Parshall flume for flow measurement, an aerated grit chamber and associated blowers, cyclone, and classifier. The aerated grit chamber is designed to remove grit solids and heavier inert solids from the influent wastewater through the use of diffused aeration and a grit screw conveyor. There is also odor control equipment consisting of a caustic/hypochlorite scrubber and hydrogen peroxide chemical addition.

2. **Primary Clarification.** Following pretreatment, the wastewater flows by gravity to a junction box which is a concrete structure that divides the flow between two primary clarifiers.

Each primary clarifier is a circular 60-foot diameter tank with a 10-foot sidewater depth. Based on a design surface overflow rate of 1,000 gal/ft^2/day and a peak overflow rate of 3,000 gal/ft^2/day from *"Guidelines for the Design of Wastewater Treatment Works,"* New England Interstate Water Pollution Control Commission (NEIWPCC), the capacity of the primary clarifiers is 6.8 mgd average and 17 mgd peak.

Underflow from the primary clarifiers is removed by two variable speed progressive cavity pumps located in the primary pump building. These pumps were installed in 2009 and are in "like-new" condition. Each pump suction line is equipped with a 3 HP grinder. The grinders are similar to each other; one was installed in 1993 and one in 2009. The pump room, which is located below grade, is served by a single Myers sump pump that is in good operating condition.

3. **Aeration Facilities/MLE Process.** In 2001, the existing aeration tanks were upgraded to a MLE process with diffused aeration. This process consists of an anoxic zone at the start of the flow train followed by a switch zone (a zone that can be anoxic or aerobic depending on the seasonal loadings) and then an aerobic zone. The MLE process utilizes an internal recycle of nitrified effluent from the nitrification (aerobic) zone to the anoxic zone for denitrification.

There are three parallel reactor trains, each with a volume of 170,000 cubic feet. This process has a capacity of 4.2 mgd on a maximum month basis.

Aeration is provided by a bank of five 100 HP, multi-stage centrifugal blowers located in the blower building. The blowers are equipped with electrically operated butterfly valves for inlet throttling control. The blower control valves are controlled by a pressure signal from sensors in the common discharge header. There are also electrically operated butterfly valves in the air distribution piping. Dissolved oxygen (DO) probes in the aeration tanks provide a control signal for the distribution valves.

Non-aerated compartments of the reactors are equipped with two 6 HP submersible mixers in each tank.

Nitrate recycle is achieved by a single 10 HP speed-controlled submersible pump located at the end of the aerobic section of each train. Anoxic sections of the reactors are covered and vented to a biofilter for odor control. The biofilter was installed in 2009 and is equipped with a single 20 HP fan with a nominal capacity of 5,000 scfm.

4. **Secondary Clarification.** Prior to November 1997, there were two 70-foot diameter circular secondary clarifiers with side-water depths (swd) of 10 feet. A third 85-foot diameter clarifier was constructed in November 1997 with a swd of 13 feet. In 2001, the MLE process with diffused aeration and an anoxic selector was installed in the aeration tanks. Based on a Peak Hourly overflow rate of 800 gpd/sf and adjusting that rate for the shallow swd of the clarifiers (especially the 2 older 70-foot diameter clarifiers) the Peak Hour capacity of the three clarifiers is 7.1 mgd. This capacity is correlated to a Maximum Day capacity of 4.7 mgd at a Peak Hour to Maximum Day ratio of 1.5, and to a Maximum Month capacity of 4.4 mgd at the current Maximum Day to Maximum Month ratio of 1.1.

Underflow from the secondary clarifiers is recirculated to the aeration process by three 10 HP variable speed, horizontal end suction centrifugal pumps (return activated sludge pumps) located in the secondary pump building. Flow rate is metered by a 12-inch magnetic flow meter on the discharge header.

Waste sludge is sent to a sludge holding tank or directly to thickening equipment by two progressive cavity pumps located in the secondary pump building. These pumps are 15 HP and are speed controlled by an adjustable belt drive.

5. **Disinfection.** The Hyannis WPCF utilizes sodium hypochlorite for effluent disinfection. The facilities consist of two parallel chlorine contact chambers, each with a volume of 9,800 cubic feet. Based on a peak flow contact time of 15 minutes (NEIWPCC), the capacity of the chlorination facilities is 13.8 mgd. The hypochlorite feed system consists of a storage tank, two diaphragm metering pumps, and a water circulating pump.

6. **Treated Water Pumping Facilities.** The disinfected treated water pumping facilities include four 50 HP, vertical centrifugal pumps locate in the basement of the control building. The pumps are controlled by a bubbler-type level control system in the pump wet well. One pump is controlled by a VFD.

7. **Sand Infiltration Beds.** The treated water from the chlorine contact tanks is currently pumped to four groups of sand infiltration beds. Routing of the treated water is controlled through manual operation of valves. The four groups contain 47 beds in total and a

total of 1,127,000 square feet of bed area. These sand infiltration beds are illustrated on Figure 4-8.

It is noted that new alternative energy generating facilities will be constructed on these beds (construction starting in 2010).

A photovoltaic energy system will be constructed on beds 2 – 7 and 9 – 10. Possibly, the system will expand during construction to include bed No. 1. Once the photovoltaic system is installed, these beds cannot be used for treated water recharge. Also, bed No. 8 cannot be used for treated water recharge because it will be isolated from the treated-water distribution system.

A wind turbine system (2 turbines) will be installed on beds 33 and 34 which will remove these beds from treated-water recharge operations.

The beds that can no longer be used for treated water recharge after construction of the alternative generating facilities are also illustrated on Figure 4-8. Once the beds are removed from service, the 36 remaining beds will have a total area of 851,000 sf.

The infiltration beds contain four feet of sand with an effective size of 0.30 to 0.60 mm. The sides of the beds are covered with four inches of crushed stone screened to obtain a size of 1-1/2 to 3-1/2 inches. The soils under the sand and crushed stone are predominately native soils and some fill material classified as a clean sand or gravel. The O&M manual for the WPCF states that the average design hydraulic loading of the sand beds is 10 gallons per day per square foot of bed area (gpd/sf). Based on a total of 851,000 square feet of bed area, a hydraulic loading of 10 gpd/sf, and the assumption that 30 percent of the beds should be held in reserve at the maximum month condition, a total sand bed capacity of 6 mgd is estimated. In practice, plant personnel have had no problems with ponding in the sand beds and have never had trouble recharging the treated water. Operating experience indicates that the beds themselves can pass more than 6 mgd. The plant staff has observed that some beds provide faster infiltration than others. Consideration should be given to completing a hydraulic load test to develop a more empirical design hydraulic loading rate.

Though the sand layers of the infiltration beds may be capable of passing more than 6 mgd, the ultimate capacity of the beds is uncertain. This is due to many site specific considerations that are independent of the WPCF recharge such as seasonal and multi-year variations in the height of the groundwater table. Due to this uncertainty in the physical capacity in the groundwater system, the 2007 WWFP was approved with an Adaptive Use Management Plan that allows treated water recharge up to 4.2 mgd with the following actions identified if seasonal high groundwater levels become too high:

- Permitting and construction of new recharge facilities at an approved (in the 2007 WWFP) site near the Route 6 and Route 132 interchange.
- Continued evaluation of additional treated water recharge sites and concepts.
- Further evaluation of the high groundwater impacts to verify they are correlated to the WPCF recharge.
- Installation of additional monitoring wells.
- Potential additional groundwater modeling.
- Drainage modifications and groundwater pumping to mitigate the impacts.
- Approval requests, permitting, and implementation of additional treated water recharge sites and concepts.
- Discontinuation of sewer extension until the impacts are addressed.
- Possible purchase of affected properties and creation of open space.
- Diversion of flow to the new site at the Route 6 and Route 132 interchange.

8. **Septage Receiving and Handling Facilities.** The Hyannis WPCF currently treats and produces several types of wastewater residuals, including sludge, septage, trap grease, screenings, and grit. Septage and trap grease are collected from Town residences and commercial establishments and hauled to the Hyannis WPCF for treatment. Screenings, grit, and sludge are produced by the Hyannis WPCF as a result of treating wastewater, septage, and trap grease, and must be disposed of off site.

A flow schematic of the septage facility is shown in Figure 4-6. The septage handling facilities are housed within the septage processing building. Septage is off-loaded from transport trucks into a receiving station equipped with a rock trap and bar rack before flowing to a 50,000-gallon raw septage storage tank. The raw septage is then pumped to a single screw-type grit classifier through two parallel trains each consisting of a 3 HP grinder, a 50 HP recessed impeller pump, and a cyclone degritter. The degritted sludge flows by gravity to one of two degritted septage storage tanks where it is co-mingled with the primary and/or WAS. The combined sludge is then thickened by two parallel trains, each consisting of a 3 HP grinder, a 20 HP variable speed progressive cavity pump, and two 2-meter gravity belt thickeners (GBTs). The GBTs have a total capacity of 1,440,000 gallons per week based on a loading rate of 400 gpm per machine and an operating frequency of six hours per day, five days per week. Thickened sludge discharged from each GBT is pumped to a storage tank by one of two 5 HP, 9-inch, duplex plunger pumps. The contents of the thickened sludge storage tank are pumped to a truck and disposed of off site. All four storage tanks are mixed and aerated by five positive displacement blowers. Most of the septage handling equipment has been in service since 1991.

9. **Plant Water System.** Water for in-plant use is supplied by three 15 HP horizontal centrifugal pumps located in the secondary pump building. The pumps are controlled by VFDs to maintain a pressure setpoint in the common pump discharge header. These pumps were placed in service in 2000 and appear to be in good operating condition.

10. **Summary of Facility Capacities.** The treatment and/or flow capacities of the major treatment facilities are summarized below:

TABLE 4-2

CAPACITY SUMMARY OF EXISTING HYANNIS WPCF PROCESSES

COMPONENT	CAPACITY (MGD)
Parshall Flumes Minimum Peak	 0.6 15.6
Aerated Grit Chamber (Peak Hour)	20
Primary Clarifiers Maximum Month Peak Hour	 6.8 17
Aeration Tanks (Maximum Month)	4.2
Secondary Clarifiers Maximum Month Maximum Day Peak Hour	 4.4 4.7 7.1
Chlorination Facilities (Peak Hour)	13.8
Sand Infiltration Beds (Maximum Month)	6

4.3 HYANNIS WPCF COLLECTION SYSTEM

A. **System History and Description.** Figure 4-9 illustrates the existing (January 2010) collection system in the Town of Barnstable. (Construction was started on the Stewarts Creek {AOC H1} Sewer Extension and the new Lincoln Road/Main Street Pump Station in Spring of 2010.)

The earliest gravity sewer lines were constructed in downtown Hyannis in 1937. A majority of the downtown area is sewered with 8- and 10-inch vitrified clay sewers. A trunk line runs the length of South Street, and ranges in size from 8- to 10-inches in diameter. Prior to 1989, the trunk line ran to a pump station at South Street. This station was replaced in 1989 by a new pump station located at Old Colony Road. The downtown sewer area has been expanded a number of times, through the addition of gravity sewers and small pump stations. A majority of the sewage eventually flows to the trunk lines on South Street and into the Old Colony Station.

Sewers were added along Ocean Street and the Bay Shore Road area in 1968. These asbestos cement (AC) sewer pipes range from 8- to 16-inch in diameter, with 8-inch being used on most of the residential streets. The sewage is pumped via three pump stations. Two pump stations share a common force main which connects with the Old Colony Road station force main in route to the wastewater treatment facility.

The sewers along West Main Street are 8- to 18-inches asbestos cement lines which are constructed in 1972. This trunk line served a large commercial area of Hyannis, and ends at the Main Street station. The Main Street station originally discharged to the South Street gravity line and to the Old Colony Road station; but in 2009 a new force main was installed from the Main Street station to the Hyannis WPCF.

The sewers serving the areas surrounding Gosnold Street, Old Colony Road, and Oak Neck Road are 8-inch and 10-inch PVC lines which were installed in 1989. The sewage is pumped through a combination of 5 separate pump stations to the intersection of South Street and Ocean Street, where it flows to the Old Colony station.

The Village of Barnstable system was constructed in 1980, and serves Main Street (Route 6A), Hyannis Road, Millway Road, Commerce Road, and the residential streets off Commerce Road. All of the residential streets are served by 8-inch sewers, which flow to 14- to 18-inch trunk lines at the end of Freezer Road Pump Station. All of the sewers installed under this contract are asbestos cement.

The sewers in Independence Park and the surrounding commercial areas are 8- to 21-inch PVC lines and were constructed in 1994. They lead to two pump stations, one on Independence Drive and the second at the end of Enterprise Road (at the Hyannis WPCF site).

The vacuum sewer system is located in Bearses Way and Route 28 and leads to the vacuum sewer station at the Hyannis WPCF site. This system was constructed in 2003. The vacuum lines range from 6- to 10-inch PVC vacuum lines.

There has been infilling after these major sewer extensions to connect additional areas and roads including:

- Corporation Street
- Summerside Lane
- An additional portion of North Street

A sanitary sewer typically has a rated design life of 50 years. However, with proper system maintenance and appropriate repairs, it is possible to extend the life of a sewer significantly. A breakdown of the age and lengths of various lines in the system is presented in Table 4-3 below:

TABLE 4-3

OVERVIEW OF HYANNIS WPCF SEWER SYSTEM

TIME PERIOD	APPROXIMATE LENGTH OF SEWERS INSTALLED (FEET)	PREDOMINANT MATERIAL	OVERALL PERCENTAGE
1937 - 1940	20,000	Vitrified clay	9
Unknown*	15,000	Vitrified clay	7
1944 – 1958	7,000	Asbestos cement	3
1965 – 1969	21,000	Asbestos cement	10
1970 – 1980	52,000	Asbestos cement	25
1981 – 1990	69,000	PVC	32
1991 - 2009	30,000	PVC	14

* No year was listed on record drawings, or record drawings were not located as reported in 1993 Needs Assessment Report.

Most of the sewers in the Town of Barnstable are well under 50 years old. The earliest downtown Hyannis lines reached a 50-year life in 1987. However, based on information received from the operation and maintenance staff, these sewers are inspected and maintained regularly, and are operating with minimal problems.

B. **Summary of Existing Collection System Facilities.**

1. **Gravity and Vacuum Sewers.** The Town of Barnstable's wastewater collection system consists of approximately 41 miles of 8- through 21-inch gravity and vacuum sanitary sewers (exclusive of building laterals) within the Villages of Barnstable and Hyannis. A majority of the lines are 8 inches in diameter serving the side streets.

As discussed in Chapter 2, the 2007 WWFP documents the Town plan to extend sewers to several Wastewater Areas of Concern and to improve several bottlenecks in the existing collection system. These extensions and improvements as detailed in the plan would add up to 46 miles of new collection system.

2. **Pump Stations and Force Mains.** In addition to the sewers, the Town of Barnstable owns, operates, and maintains 24 pump stations. These range in size from very small stations serving private developments to larger stations which serve downtown areas while also accepting flow from one or more smaller stations.

Most of the pump station force mains discharge to gravity sewers. Some, however, discharge into shared force mains which pump directly to the treatment facility. A schematic of the stations showing the general flow pattern is presented in Figure 4-10. There is a total of approximately 11 miles of force mains, ranging in size from 4-inch to 20-inch diameter.

Table 4-4 summarizes information on the force mains for each of the Town owned stations, including size, material, age, and location of discharge.

In addition to the stations maintained by the Town, there are a number of pump stations which discharge into the sanitary sewer system, but are privately maintained. No specific records are kept on these stations, and a listing is presented in Table 4-5.

TABLE 4-4

HYANNIS WPCF SUMMARY OF PUMP STATIONS AND FORCEMAINS

PUMP STATION [1]	YEAR BUILT	PUMP HORSEPOWER	PUMP STATION DESIGN FLOW (GPM)	FORCE MAIN SIZE (INCHES)	FORCE MAIN MATERIAL	APPROXIMATE LENGTH FORCE MAIN (FT)	DISCHARGE LOCATION
Freezer Road	1975	50	750	12 [2]	DIP	17,000	Water Pollution Control Facility
Rendevous Lane	1975	3	75	4	DIP	1,700	Gravity sewer on Rendezvous Lane
Route 6A	1975	5	350	8	DIP	1,300	Gravity sewer on Main Street
Main Street	2009/1972	16	650	8 / 14	DIP	8,600	Water Pollution Control Facility
Old Colony Road	1989/1956	75	2300	16 / 20	AC	10,000	Water Pollution Control Facility
Brant Lane	1986	5	80	4	DIP	1,100	10-inch gravity sewer on Old Strawberry Hill Road
Mark's Path	1989	30	300	6	DIP	1,900	Water Pollution Control Facility
Sea Meadow	1988	7 ½		4	DIP	2,700	Water Pollution Control Facility
Sudbury Lane	1984	1	100		N/A	N/A	Gravity sewer on LaFrance
Kalmus Beach	1989	20	450	8	DIP	5,700	15-inch gravity sewer at intersection of South and Ocean Streets
Estey Avenue	1989	7 ½	400	8	PVC	410	Gravity sewer on Estey Avenue
Sea Street	1981	n/a	200	4	DIP	860	8-inch gravity sewer on Sea Street
Toby Circle	1989	n/a	170	6	PVC	1,500	Gravity sewer on Old Colony Road
Oak Neck Road	1989	3 ¾	120	4	PVC	450	Gravity sewer on Chase Street
Sea Street Beach	1989	n/a	100	4	PVC	520	Gravity sewer at intersection of Sea/Gosnold & Morris

TABLE 4-4 (continued)

PUMP STATION [1]	YEAR BUILT	PUMP HORSEPOWER	PUMP STATION DESIGN FLOW (GPM)	FORCE MAIN SIZE (INCHES)	FORCE MAIN MATERIAL	APPROXIMATE LENGTH FORCE MAIN (FT)	DISCHARGE LOCATION
Periwinkle	1981	3	130	4	PVC	1,000	8-inch gravity sewer on Sea Street
Bay Shore Road	1968	30	450	8/10	AC	1,700	10-force main at Ocean Street pump station
Baxter Road	1983	2	500	4	PVC	230	8-inch gravity sewer on Baxter Road
Gosnold Street	1968	3	2200	6	AC	1,000	8-inch gravity sewer on Ocean Street
Ocean Street	1968	30	380	10	AC	1,100	20-inch force main at South Street
Independence Drive			230			1,300	Gravity sewer on Independence Drive
Enterprise Road			1500			100	Water Pollution Control Facility
Bearses Vacuum Station	2003	15	280	6	DIP	700	Water Pollution Control Facility
West Main Street/ Lincoln Road[2]	2011	60	600	8 / 12	DIP	8,400	Water Pollution Control Facility
Marston Ave/ H1[2]	2011	15	600	4	DIP	4,200	Gravity sewer on West Main Street

Notes:

1. All stations have two pumps, with the exception of Old Colony Road, which has three pumps.
2. This station and Force Main is currently under construction with completion estimated in 2011. Once complete it will have two pumps with 600 gpm capacity, and space for two additional pumps.
3. Approximately 8,500' of 4- and 6-inch dual force main was installed in Route 132 as part of that road reconstruction to service a planned pump station at the Cape Cod Community College as discussed in Chapter 2.

DIP= Ductile iron pipe
AC=Asbestos cement
PVC=Polyvinyl chloride

TABLE 4-5

LISTING OF PRIVATE PUMP STATIONS

Baxter, Hudson	133 Pleasant Street
Barnstable Airport	660 Barnstable Road
Barnstable Housing Authority	200 Stevens Street
Baxter, Warren	77 Pleasant Street
BJ's	420 Attucks Lane
Calvery Baptist Church	25 Lincoln Road
Cape Cod Hospital	27 Park Street
Cape Cod Mall	793 Iyannough Road
Cape Crossroads	800 Bearse's Way
Christmas Tree Shop	655 Route 132
Christy's Plaza	489 Bearse's Way
Christy's/Dunkin Donuts	317 Falmouth Road
D'Angelo's	702 Iyannough Road
D'Angelo's, Minuteman Press & others	181 Falmouth Road
Day's Inn	702 Iyanough Road
D'Olympio's	55 Iyannough Road
Four Points Sheraton	1255 Iyannough Road
Gosnold Treatment Center	71 Pleasant Street
Heritage House Motel	259 Main Street
Holiday Inn	707 Iyannough Road
Hyannis Marina	21 Arlington Street
Hyannis Nissan	268 Stevens Street
Hyannis Regency	1127 Iyannough Road
Hyannis Resort	287 Iyannough Road
Independence Medical LLC	70 Independence Drive

Infinium Software	75 Attucks Lane
Main Street Apartments	30 Main Street
New England Telephone	49 Ocean Street
New Hope Com. Baptist Church	105 Stevens Street
New World Bank	417 Barnstable Road
Northeast Dental	274 Barnstable Road
Off Track Bedding	167 Corporation Street
Pet Supplies	685 Route 132
Pixy 103 Radio	154 Barnstable Road
Royal Hyannis Hotel	1470 Iyannough Road
Sentinel Products Corp.	70 Airport Road
Steamship Authority	71 South Street
Tiki Port Restaurant	720 Iyannough Road
Tracy Volkswagen	686 Iyannough Road
Woman's Body Shop	155 Attucks Lane

C. **Sewer Capacity.** The hydraulic capacity of the collection system was completed in 1993 as summarized in the Needs Assessment Report of the 2007 WWFP. The analysis identified several bottlenecks related to existing flows and several have since been corrected. Others are recommended for improvements as listed in Chapter 2.

Infrastructure evaluations for the Hyannis Growth Incentive Zone developed a limited SewerCAD model for the collection system in the downtown Hyannis area. This model developed additional capacity information for this area of Town and led to recommendations to upgrade the Main Street and Old Colony Road pump stations, make improvements to the South Street gravity lines, and develop a new pump station at West Main Street/Lincoln Road to intercept future flows from the western part of town and direct that flow to the Hyannis WPCF. The Main Street pump station modifications are now complete and the West Main Street/Lincoln Road pump station is scheduled for completion in 2011.

The SewerCAD model should be expanded to the complete collection system and incorporate the sewer extensions proposed by the 2007 WWFP. Use of the SewerCAD model is the most efficient way to evaluate capacity limitations especially as alternative sewer routes are considered.

D. **Infiltration/Inflow (I/I).** Infiltration is the leakage of groundwater into the sewer through cracks or openings in the sewer pipes and/or manholes. Inflow is the flow of surface water into the sewer through storm drains, roof leaders, and/or sump pumps in basements of buildings.

The last infiltration/inflow (I/I) investigation was completed in 1988 by Whitman and Howard Engineers. They found no pattern of increased wastewater flow during or immediately following rain events. This finding indicates that inflow is negligible. This finding makes sense because there are no combined sewers in Barnstable; therefore there is no inflow from storm drains. Also, the Town enforces the sewer use regulations that specifically do not allow connection to roof leaders or sump pumps to the sewers; therefore, there should be no inflow from these sources.

The 1988 I/I investigations did estimate as much as 0.55 mgd of infiltration on average and 0.7 mgd of peak infiltration based on measurements of nighttime inflow that was assumed to be infiltration.

When the I/I investigation report was submitted, the Town questioned the assumption that the nighttime flows were equivalent to infiltration because there are a large number of commercial establishments that can contribute nighttime flow including motels, restaurants, nightclubs, and the Cape Cod Hospital. The nature of these businesses in a tourist area makes it plausible that nighttime activities and after hours cleanup cause a sewer discharge during the early morning hours. The Town performed BOD testing in an attempt to determine the components of the nighttime flows. Low BOD values would support the idea that most of the flow would be infiltration; however, the results showed BOD levels which were close to or higher than domestic sewage.

The Town also questioned the possibility of infiltration occurring where the sanitary sewers are above groundwater. Infiltration which occurs in the wastewater collection system is directly related to groundwater levels. Thus, infiltration should be prevalent only in those sewers which are below the groundwater table. The fact that Whitman & Howard identified most of the infiltration coming from three subareas where the sewer lines are above the groundwater further justified the Town's belief that nighttime flows should not be classified as I/I. An anomaly existed in the data, which could not be resolved without further investigative work.

During the 1993 Needs Assessment evaluation for the 2007 WWFP, performing additional sampling, inspection, and/or television inspection work was recommended. It was understood that infiltration and inflow do not have significant impacts on existing treatment plant operations or permit compliance. Therefore, it was decided not to pursue further I/I investigations with the exception of yearly television inspection work.

As part of the 1993 Needs Assessment evaluation for the 2007 WWFP, it was decided to reduce the previous average infiltration estimate by 100,000 gpd to adjust for the data anomaly.

As part of the CWMP Project, the average water consumption for all of the properties connected to the Hyannis WPCF was summed and compared to the average influent flow at the WPCF. The average water consumption was 1.53 mgd and the WPCF influent (summarized on Table 4-1) was 1.46. It is understood that not all water consumption becomes wastewater due to non-potable water uses of irrigation, outdoor car and boat washing, etc. A factor of 90 percent is used to convert water consumption to wastewater generation rates. Using this approach, an average annual infiltration of 0.08 mgd is estimated. This value represents 6 percent of wastewater generation summed for all the properties served, and 6.5 percent of the total flow to the Hyannis WPCF. When this average annual I/I value is used with the gravity sewer lengths and diameters discussed previously, an infiltration rate of 210 gallons per day per inch mile (gpdim) is calculated which is slightly below the typical range of 250 to 500 gpdim as recommended by the New England Interstate Water Pollution Control Commission (NEIWPCC) in their "Guides for the Design of Wastewater Treatment Works" (also referenced as Technical Report No. 16 or TR-16). It is understood that I/I will increase at times of rainy weather and high groundwater conditions. And maximum month and peak day escalating factors should reflect these periodic increases.

It is generally considered not cost effective to remove infiltration where less than 10,000 gpdim exists. The cost of locating and removing it are generally greater than the cost of transportation and treatment.

4.4 MARSTONS MILLS WWTF

A. **Background.** The Marstons Mills WWTF is located at 730 Osterville-West Barnstable Road. The facility serves an elementary school, middle school, associated athletic fields, as well as a residential neighborhood of 30 homes. The Site Plan for this facility is illustrated in Figure 4-11.

B. **Treatment Facilities.** The facility is a satellite wastewater treatment facility recharging to 34 leaching pits located in the athletic fields. The permitted design flow for this system is 32,000 gpd. Currently, the existing facility treats up to 22,000 gpd (based on monthly reports provided by the WWTF operations staff).

Each school and the housing complex is served by a septic tank. The schools are also served by grease traps prior to the septic tanks. The septic tanks are used for primary settling and grit removal. The septic tanks for the housing complex and the elementary school are 18,000 gallons, and the middle school septic tank is 30,000 gallons. The septic tank serving the middle school also receives return flows from the treatment facilities' denitrification filter's backwash and waste sludge from the secondary process.

The two flows are then combined in an 18,000 gpd flow-equalization tank, located at the head end of the existing WWTF. The combined wastewater flow is aerated in this tank by coarse bubble diffusers which mix the wastewater and reduce the potential for odors. Air for the flow-equalization tank is provided by two positive displacement blowers. The contents of the flow-equalization tank is pumped to the distribution box where the influent flow is split using V-notch weirs to two rotating biological contactor (RBC) units for removal of BOD and ammonia-nitrogen (NH_3-N). NH_3-N is converted to NO_3-N by biological nitrification. Currently, a portion of the flow entering the distribution box from this tank is recycled back to the flow-equalization tank through a gravity drain in the bottom of the splitter box. This provides some treatment (low BOD influent).

Each RBC unit is 12 feet in diameter by 21 feet long and provides a site for biological microbial growth. The rotating shaft brings the microorganisms in contact with both the organic matter in the wastewater and oxygen in the atmosphere, and also keeps the system mixed. The two RBCs at the facility offer a combined total surface area of 158,000 ft^2. Following RBC treatment, the wastewater flows by gravity from the RBCs into the 10-foot diameter clarifier for removal of the settleable solids and the floatable scum. Polymer is added to the RBC effluent to facilitate better clarification. The sludge and scum are collected and flow into a mudwell where they are eventually mixed with backwash water from the denitrification filters and recycled back to the 30,000-gallon septic tank serving the middle school.

After leaving the secondary clarifier, the secondary effluent passes through two denitrification filters which biologically remove nitrate (nitrate is biologically converted to nitrogen gas which is released to the atmosphere) and filter out any remaining suspended solids. Methanol is added to the flow to provide a supplemental carbon source before the denitrifying filters to assist the biological denitrification. Each filter is backwashed every other day into the mudwell, where backwash is combined with the sludge and scum from the secondary clarifier and returned to the 30,000-gallon septic tank. The existing filters provide a total filtering area of approximately 54 ft^2. Treated water from the denitrification filter flows through and then is collected in a clearwell and flows through an ultraviolet light disinfection chamber and a V-notch weir for flow measurement.

Flow from the clearwell enters the dosing chamber, which can be aerated. The final effluent is alternately distributed between two leaching areas by the two dosing pumps. Two-thirds of the flow is pumped to an area of 22 leaching pits located beneath the middle school football field area. The remaining flow is distributed to 12 leaching pits located beneath the elementary school softball field area.

Figure 4-12 illustrates the flow schematic of this WWTF.

This WWTF was originally constructed in 1994 to serve two schools and the athletic fields. In 2006 it was upgraded and expanded to serve a new residential neighborhood. Before 2006 the performance of the WWTF was very poor due to irregular flows (that are typical of a school system) and other factors. The residential neighborhood helped even out the flows and the operation of the WWTF was conveyed from the Barnstable School Department to the Barnstable Department of Public Works Water Pollution Control Division (WPCD). The WPCD staff has improved operations and plant performance significantly. Since December 2008, there have been no permit exceedances and effluent total nitrogen has been less than 5 mg/L

Monthly operating data was analyzed for the period of October 2006 through September 2009 to evaluate system performances. This data is summarized in Appendix 4-4 and the influent and effluent trends are illustrated on the following figures:

- Figure 4-13, Effluent Flows
- Figure 4-14, Influent and Effluent BOD concentrations
- Figure 4-15, Influent and Effluent TSS concentrations
- Figure 4-16, Effluent Nitrogen concentrations.

The discharge of this WWTF is in the Zone II area (an area of land that could contribute groundwater to a public water supply well), and MassDEP may require that the WWTF meet a new effluent limit of less than 3 mg/L total organic carbon (TOC), especially if the plant is expanded. This parameter is not currently monitored but four samples have been analyzed since October 2009 and the average TOC concentration in the effluent was 8.4.

4.5 RED LILY POND CLUSTER SYSTEM

The Red Lily Pond cluster septic system is located west of the Red Lily Pond and Elizabeth Lake in Centerville. Figure 4-17 illustrates the site plan of this cluster system.

The system is comprised of a low-pressure collection system and grinder pumps. The wastewater flow is conveyed to two septic tanks, and the septic tank effluent flows to two sets of infiltration chambers. The Town Department of Public Works, Water Pollution Control Division operates the system.

The system was constructed in 1993 to reduce phosphorus impacts to Red Lily Pond and Elizabeth Lake from the individual septic tank discharges that were occurring before 1993. The system was not designed for nitrogen and phosphorus removal, but was designed to relocate the septic tank effluent to a new location that is outside of the watersheds to the ponds. No performance sampling of the system occurs and it is assumed to produce comparable effluent to any conventional single family septic system.

4.6 PRIVATE WASTEWATER TREATMENT FACILITIES

There are two privately owned WWTF facilities in Barnstable located at the Cotuit Stop and Shop Plaza along Route 28 and the Cape Regency Skilled Nursing and Rehabilitation Center in Centerville as illustrated on Figure 4-18. These treatment systems were required by MassDEP because the properties were located too far from an existing public sewer to connect and they have land uses that could produce wastewater flows greater than 10,000 gallons per day. When properties exceed this flow threshold, they are required to meet some stringent treatment requirements (compared to the MassDEP Title 5 requirements), and comply with a MassDEP discharge permit.

The following text briefly describes these small privately owned WWTF's.

A. **Cotuit Landing Stop and Shop WWTF.** This WWTF is a membrane bioreactor (MBR) treatment system with a permitted maximum-day capacity of 21,600 gpd (0.022 million gallons per day). It started operations several years ago (pre 2006) and has operated well. Performance data was reviewed for 2006 through 2009 and the WWTF typically produces treated water in the 2 to 7 mg/L total nitrogen range. The plant did have a few exceedances above 10 mg/L total nitrogen during that period. The influent flow is typically in the range of 0.005 to 0.009 mgd, but there have been a couple of peak day readings at 0.02 mgd.

This WWTF was designed with a larger capacity than was needed for the shopping center so that additional flow could be connected in the future if needed. The finding that the WWTF has seen a couple of peak day readings near its flow capacity indicate that it may not have as much reserve capacity as originally believed.

B. **Cape Regency Skilled Nursing and Rehabilitation Center WWTF.** This WWTF is also a MBR treatment system with a permitted maximum day capacity of 0.02 mgd. It started operations in 2009 and eight months of data was reviewed. During that time the plant performed well. Effluent total nitrogen was in the range of 3 to 5 mg/L and the maximum day flow at the plant was 0.013 mgd.

4.7 INDIVIDUAL-HOME I/A SYSTEMS.

There are a total of 71 properties with individual-home I/A systems as illustrated on Figure 4-18. These are individual-home septic systems that are typically designed to provide greater treatment of dissolved and suspended solids and nitrogen. Their installation is typically required by the Board of Health or other local regulating agency to replace a failed septic system or allow development of a property that might not allow the use of a regular Title 5 septic system. The locations of these systems are quite scattered across the Town except for two concentrations in the Craigville Beach area and along Falling Leaf Pond in Osterville. The ones at the Craigville Beach area are reflective of the high groundwater conditions, dense development, and past failing septic systems as documented in the 2007 WWFP (this area was recommended for sewer extension in the 2007 WWFP). The concentration at Falling Leaf Pond in Osterville was for nitrogen removal requirements.

These systems are typically comprised of an engineered treatment process that is located between the septic tank and the leaching (recharge) system of a conventional Title 5 septic system. They have aerated and anoxic components that support the biological treatment system. MassDEP requires that these systems remove approximately 50 percent of the nitrogen in the wastewater and produce an effluent of less than 19 mg/L total nitrogen. Research of these systems at the Septic System Test Center located at the Massachusetts Military Reservation and overseen by the Barnstable County Department of Health and Environment indicates that these systems can provide this level of nitrogen removal performance when they are sited, designed, constructed, and operated properly. Studies by Barnstable County Department of health and Environment of the systems that are actually installed at peoples homes across Cape Cod often do not perform this well at nitrogen removal. Approximately half of the systems at Cape Cod homes meet the 19 mg/L requirement and the other half does not meet it. The research for the requirement exceedances includes insufficient design and operations.

Review of the data from the 71 systems in Barnstable indicates similar performance. These systems did not meet the expected performance forty percent of the time which is slightly better than the Cape Cod system performance.

4.8 INDIVIDUAL HOME SEPTIC SYSTEMS

The great majority of properties in Barnstable are served by individual-home traditional septic systems. These systems are generally very good at removing suspended solids from the raw wastewater in a septic tank so that the septic tank effluent can be infiltrated into the ground and returned to the groundwater system. This feature of traditional septic systems protects against the fouling (plugging) of the infiltration system which would cause a system failure and bring the wastewater to the ground surface. As a result they are good at protecting human health because they prevent human exposure to the wastewater. They are not very good at protecting environmental health. Research indicates that they only remove 25 to 40 percent of nitrogen in the septic tank and in the leaching system so that the discharge that reaches the groundwater system has a nitrogen concentration of approximately 24 mg/L total nitrogen. The Massachusetts Estuaries Project uses this value (23.63 mg/L total nitrogen) in their nitrogen modeling evaluations. Due to this high nitrogen discharge concentration, and the high wastewater flow coming from all the individual septic systems in Town; the groundwater system receives a high nitrogen load which is then conveyed to the estuaries. The Massachusetts Estuaries Project (discussed in detail in the next chapter) has determined that individual septic systems are the largest source of nitrogen to the estuaries. Typically this source comprises 75 to 85 percent of the total nitrogen load to the estuaries.

Remediating the current nitrogen load from individual-home septic systems to the estuaries will be the most significant need of this project.

4.9 COMMUNAL SEWAGE HOLDING (TIGHT) TANKS

The Cape Cod Condominium Complex was a cottage community in the northeast corner of Barnstable (illustrated on Figure 4-18) that was converted to condominiums. This portion of Barnstable has soils with low infiltration capacity and the individual septic systems at this site have failed. Due to the septic failures and the long distance of the site from the municipal sewers, the condominium complex has installed a sewage holding tight tank which must be pumped out periodically. The property owners have investigated other options of wastewater management that have not proceeded.

4.10 WATER SUPPLY INFORMATION

A. **Description of Existing Facilities.** Water supply in the Town of Barnstable is provided by four different water purveyors. The Town of Barnstable Hyannis Water System provides water to the Village of Hyannis and has 12 supply wells. The Barnstable Fire District provides water to the Village of Barnstable by means of four active supply wells. The Cotuit Water District actively uses five wells to provide water to the Village of Cotuit. The Centerville-Osterville-Marstons Mills (C-O-MM) Water District utilizes 19 wells for supplying water to the Villages of Centerville, Osterville, and Marstons Mills. The Village of West Barnstable does not currently have a public water supply system, although some of the neighboring water districts have fire hydrants within the Village and provide water service to a few properties in West Barnstable. The West Barnstable Fire District has a Water Commission and an approved well site, but no wells or distribution system. All of these wells have Zone II delineations in accordance with MassDEP requirements. The Zone II delineation is the area of the land that could contribute groundwater to the well under "the most severe pumping and recharge conditions that can be realistically anticipated." The regulations define these conditions as 180 days of pumping at safe yield and no recharge from precipitation. The Zone II areas are typically determined by a hydrogeologic study involving particle transport computer modeling at the time that the water supply well is permitted. The delineation provides specific land use restrictions as identified in Chapter 2, Section 2.3.B.

The Town of Barnstable has delineated Zone of Contributions (ZOC) areas which are similar to the Zone II areas but created by a separate computer modeling study. These ZOC areas have become a zoning overlay. It is noted that the Town is currently rechecking its Zone II delineations through a contract with the Cape Cod Commission as identified in Chapter 2, Section 2.6.A.

Figure 4-18 illustrates the areas of Town served by public water supplies, and the ZOC areas. It is noted that most of the Town is served by public water supply except the village of West Barnstable.

The following table summarizes average monthly pumping flows for the four water purveyors. The data is a compilation of three years' worth of data (2006, 2007, and 2008) from annual reports submitted to MassDEP.

TABLE 4-6

AVERAGE MONTHLY WATER SUPPLY PUMPAGE(1, 2)

MONTH	WATER PURVEYOR				
	BARNSTABLE FIRE DISTRICT	C-O-MM	COTUIT	HYANNIS WATER SUPPLY	TOTAL
January	0.3	1.4	0.3	1.9	3.9
February	0.3	1.4	0.3	1.9	3.9
March	0.2	1.5	0.3	1.8	3.8
April	0.3	1.8	0.4	2.1	4.6
May	0.5	2.9	0.6	2.6	6.7
June	0.7	4.5	0.9	3.3	9.4
July	0.9	5.5	1.1	4.0	11.5
August	0.9	5.4	1.0	3.9	11.2
September	0.6	3.9	0.8	3.0	8.4
October	0.4	2.3	0.5	2.4	5.5
November	0.3	1.5	0.3	1.9	4.1
December	0.3	1.5	0.3	2.7	4.9
Average Annual	0.5	2.8	0.6	2.6	6.5
Maximum Month(3)	0.9	5.5	1.1	4.0	11.5
Minimum Month(4)	0.2	1.4	0.3	1.8	3.8

Notes:

(1) All values are in millions of gallons per day (mgd).
(2) Data based on annual reports from 2006, 2007, and 2008 to MassDEP.
(3) Maximum month for all water purveyors was July.
(4) Minimum month was February for C-O-MM and Hyannis Water Supply, March for Barnstable Fire District, and December for Cotuit.

Comparison of the average annual, minimum month, and maximum month averages indicates the land use (and water consumption) seasonality in these villages. Peaking factors have been summarized in the following table to illustrate how minimum month and maximum month pumpage compares with the average annual pumpage for that purveyor.

TABLE 4-7

PUMPAGE PEAKING FACTORS

MONTH	WATER PURVEYOR[2]				
	BARNSTABLE FIRE DISTRICT	C-O-MM	COTUIT	HYANNIS WATER SUPPLY	TOTAL
Average Annual[1]	0.5	2.8	0.6	2.6	6.5
Maximum Month[1, 3]	0.9	5.5	1.1	4.0	11.5
Minimum Month[1, 4]	0.2	1.4	0.3	1.8	3.8
Maximum Month Peaking Factor[5]	1.9	2.0	1.9	1.5	1.8
Minimum Month Peaking Factor[5]	0.5	0.5	0.5	0.7	0.6

Notes:

(1) Values are in millions of gallons per day (mgd).
(2) Data based on annual reports from 2006, 2007, and 2008 to MassDEP.
(3) Maximum month for all water purveyors was July.
(4) Minimum month was February for C-O-MM and Hyannis Water Supply, March for Barnstable Fire District, and December for Cotuit.
(5) Peaking factors are the ratio of the maximum or minimum month flow divided by the average annual flow.

These peaking factors will be used to estimate seasonal variations in wastewater flow generation.

B. **Capacity.** Each supply well has an associated pumping capacity, as reported at the time of the Zone II delineation for each well. These capacity values (based on active, inactive, and potential wells) are summarized in Table 4-8 and are compared to the average-annual and maximum-month pumping rates of the water purveyors. This comparison indicates sufficient capacity for existing water demands.

TABLE 4-8

SUMMARY OF WATER SUPPLIES, PUMPING RATES, AND CAPACITIES 2006-2008

WATER SUPPLY	AVERAGE ANNUAL PUMPING RATE (MGD)	AVERAGE MAX MONTH PUMPING RATE (MGD)	RATED CAPACITY (MGD)
Barnstable Fire District	0.5	0.9	5.3
C-O-MM Fire District	2.8	5.5	14.7
Cotuit Fire District	0.6	1.1	4.4
Hyannis Water Supply	2.6	4.0	11.7
TOTAL	**6.5**	**11.5**	**36**

4.11 WATER CONSERVATION EFFORTS

Each water district and purveyor has developed several ways to promote water conservation by their customers.

A. **Barnstable Fire District.** The Barnstable Fire District Water Department implements water conservation through the three primary mechanisms described below.

1. An inclining usage rate is in place for all users to encourage water conservation by charging higher rates for larger volumes. The rate schedule is as follows:

    - $3.00 per thousand gallons for the first 45,000 gallons of use per six months.
    - $4.25 per gallon for water use between 45,000 and 200,000 gallons.
    - $7.00 per gallon for water use over 200,000 gallons.

2. The Water Department includes tips for efficient water use in its annual Consumer Confidence Report (CCR).

3. Periodically, the Water Department includes water conservation messages and reminders in water bills.

B. **C-O-MM.** The C-O-MM Water Department utilizes a variety of conservation measures, as discussed below.

1. An inclining usage rate is in place for all users, both residential and commercial, which encourages water conservation by charging higher rates for larger volumes. The rate schedule is as follows:

    - $35.00 for the first 20,000 gallons of use per six months (cost of $1.75 per thousand gallons for the first 20,000 gallons).
    - $2.90 per thousand gallons between 21,000 – 200,000 gallons.
    - $3.95 per thousand gallons from 201,000 gallons and up.

2. A list of voluntary water conservation steps is posted on the website (www.commwater.com) and is also distributed with the summer water bills. The voluntary measures include:

    - Avoid outside water use between 9:00 AM and 6:00 PM.
    - Odd numbered houses water on odd numbered days of the month and even numbered house water on even numbered days of the month.
    - Maintain lawn minimum height at 2-inches to protect roots and retain soil moisture.
    - Install rain shutoff devices on automatic sprinklers.

3. Public education measures include annual visits to local school and extensive material on the website (http://www.commwater.com/default.htm), including water conservation tips and a "Kids Korner" for young children.

4. Water efficient devices, including low flow showerhead and aerated faucets, are available to users at the office and are also made available at the annual Marstons Mills River Day and the Annual Meeting.

The Water Department has considered other conservation measures, such as moisture sensors for automatic sprinklers and a toilet rebate program to encourage replacement of 7-gallon-per-flush toilets. However, these measures have proved cost prohibitive and have not been able to be implemented.

C. **Cotuit Fire District**. The Cotuit Fire District Water Department currently implements several conservation measures, described below.

1. The Cotuit Fire District's Water Department has implemented an ascending rate fee structure, with unit costs increasing as water use increases, to encourage efficient water use. Water rates are as follows:

- $1.80 per 1,000 gallons for the first 30,000 gallons of water used per six months.
- $2.45 per thousand gallons between 30,000 – 80,000 gallons.
- $2.70 per thousand gallons between 80,000 – 120,000 gallons.
- $3.00 per thousand gallons over 120,000 gallons.

2. The Water Department dedicates a full page of their annual Consumer Confidence Report (CCR) to conservation and water use efficiency measures. The CCR presents information on ways in which water may be inadvertently wasted, including how much water is typically used for different uses, how much water is lost from hoses and dripping faucets, etc. In addition, conservation tips are provided, including a discussion on xeriscape techniques to reduce outdoor water use.

3. The Water Department provides indoor and outdoor water conservation kits free of charge, available at the Department office.

4. Each summer, the Water Department takes out an advertisement in the local newspaper encouraging the community to implement voluntary water conservation measures, including asking even-numbered houses to limit lawn watering to even-numbered days of the month while odd-numbered houses limit watering to odd-numbered days of the month.

The Water Department does not currently have an education program in place targeting schools, but may implement such a program in the future. Similarly, the Department may implement a rebate program for water-efficient devices in the future.

D. **Hyannis Water Supply.** The Hyannis Water Supply has a multi-faceted conservation program as listed below:

1. The residential fee structure is a primary means of encouraging water conservation. Residential water users are subject to an inclining user fee, which involves increased unit costs as the water use increases. The rates encourage the users to consume as little as possible.

2. The Water Supply Division provides water-efficient devices free of charge, including shower timers, faucet aerators, low flow showerheads, and toilet flappers, to its customers.

3. Public education efforts make up another facet of the conservation program. The Water Supply Division has teamed with private companies to encourage use of water-conserving devices. It has also teamed with the Cape Cod Commission and AmeriCorps to provide water fairs at local schools. Coloring books are provided as an education tool for children.

4. The Water District leak detection program inspects half of the system every year, which means the entire system is checked for leaks every two years. When leaks are detected, they are repaired as soon as possible.

It is noted that commercial users are subject to a flat fee structure due to the inherently variable water demands of various commercial establishments. For example, an insurance office has a significantly smaller use than a restaurant.

In addition to the conservation measures currently in place, the Hyannis Water Supply Division plans to improve in various areas. They would like to be able to target commercial water users in a way that takes into account the variable nature of commercial uses. They would like to promote conservation in relation to lawn irrigation. Discussion with District staff indicates that many municipal and state buildings have outdated devices, and the Water Supply Division would like to be able to develop and implement a program to upgrade the devices to more efficient ones. In addition, the Division would like to be able to be able to perform a statistical performance evaluation to determine what parts of the conservation program are working and where improvement needs to be made.