Chapter 6
Decentralized Wastewater Evaluations

CHAPTER 6

DECENTRALIZED WASTEWATER EVALUATIONS

6.1 INTRODUCTION

A. **Purpose.** The purpose of this Chapter is to identify and screen decentralized wastewater treatment and discharge technologies which could be used to mitigate the documented problems in the Areas of Concern (AOCs) identified in the Needs Assessment Report and the Massachusetts Estuaries Project. Decentralized alternatives will be integrated and evaluated with centralized alternatives as part of Chapter 9. Detailed descriptions of each technology evaluated as part of this section is included in Appendix N.

Decentralized treatment and discharge technologies are systems that would not be connected to the Chatham WWTF. These types of systems include individual and multiple home systems that have total flows less than 10,000 gpd, and do not require a groundwater discharge permit. The multiple home systems will require a small wastewater collection system, and are often called cluster systems. Decentralized treatment and discharge technologies also include small wastewater treatment facilities that treat and discharge flows greater than 10,000 gpd, and therefore, require a groundwater discharge permit. Cluster systems and small wastewater treatment systems are typically designed for greater performance than a standard Title 5 septic system because they treat larger flows, and because they are usually regulated by more stringent local (Town/Cape Cod Commission) requirements or by the State through a groundwater discharge permit, and achieve less than 10 mg/L TN.

Decentralized treatment and discharge alternatives selected for further consideration will be included in the identification of alternative plans in Chapter 9 of this Report.

6.2 INDIVIDUAL ON-SITE SYSTEMS

A. **Introduction.** Individual on-site systems are used to treat wastewater from individual lots and may utilize one of several Innovative and Alternative (I/A) technologies as defined by MassDEP. Wastewater flows less than 10,000 gpd are regulated by the Title 5 code, 310 CMR 15.000. Flows greater than 10,000 gpd require a state-issued groundwater discharge permit per 314 CMR 5.00.

This Chapter identifies these technologies and narrows their performance and general issues. The individual technologies are described in detail in Appendix N with their advantages and disadvantages.

The following is the definition of I/A technologies in accordance with Title 5 Regulations (310 CMR 15.002):

> "Alternative Systems – Systems designed to provide or enhance on-site sewage disposal which either do not contain all of the components of an on-site disposal system constructed in accordance with 310 CMR 15.100 through 15.293 or which contain components in addition to those specified in 310 CMR 15.100 through 15.293 and which are proposed to the local approving authority and/or the Department for remedial, pilot, provisional, or general use approval pursuant to 310 CMR 15.280 through 15.289."

MassDEP has identified the allowable uses for each approved I/A system and has assigned each into one of four categories: remedial, pilot, provisional, and general use. Each of these categories is defined below.

> "The purpose of a **Piloting Approval** is to provide field testing and technical demonstration that an I/A technology can or can not function effectively under relevant physical and climatological conditions at one or more pilot facilities. Although information obtained during piloting is likely to be relevant to long term operation and maintenance concerns about a particular alternative system, approval for piloting is not intended, in and by itself, to provide a full evaluation of these issues.

Provisional Approval is intended to designate alternative systems that appear technically capable of providing levels of protection at least equivalent to those of standard on-site disposal systems and to determine whether, under actual field conditions in Massachusetts with broader usage than a controlled pilot setting, general use of the alternative system will provide such protection, and whether any additional conditions addressing long-term operation and maintenance and monitoring considerations are necessary to ensure that such protection will be provided.

Certification for **General Use** is intended to facilitate the use, under appropriate conditions, of alternative systems that have been demonstrated to provide levels of environmental protection at least equivalent to those of standard on-site systems.

The purpose of approval for **Remedial Use** is to allow for the rapid approval of an alternative system that is likely to improve existing conditions at a particular facility or facilities currently served by a failed, failing or nonconforming system."

MassDEP has also identified I/A systems which are approved for general use and receive nitrogen reduction credits in nitrogen-sensitive areas. For the purposes of this evaluation, the various on-site treatment system technologies are grouped as follows:

1. On-site systems, approved for general use by MassDEP, but not credited for nitrogen removal, include:

- Title 5 septic systems
- JET aerobic wastewater treatment
- Orenco Systems® intermittent sand filter
- Peat systems

2. Non-discharge systems

- Tight tanks
- Waterless toilets

3. On-site I/A nitrogen removal systems:

- Nitrogen removal systems approved for general use by MassDEP in nitrogen-sensitive areas, include recirculating sand filters that comply with Title 5, and RUCK® systems (for flows less than 2,000 gpd).

- Nitrogen removal systems approved for provisional use by MassDEP in nitrogen-sensitive areas, including:
  - Bioclere™
  - MircoFAST®, Single Home FAST®, and Modular FAST®
  - Waterloo Biofilter®
  - Amphidrome®
  - ZenoGem/Cycle-Let

- Nitrogen removal systems approved for piloting use by MassDEP in nitrogen-sensitive areas, including:
  - OAR
  - RUCK® CFT
  - Cromaglass WWT System
  - Amphidrome® Process
  - MicroSeptec EnviroServer
  - Norweco Singulair®
  - Nitrex™
  - SeptiTech

The general performance documented in this Report is based on manufacturer's information, and the Barnstable County Department of Health and Environment's report summarizing the performance of various individual I/A systems installed across Cape Cod.

The Barnstable County Department of Health and Environment's report entitled "Performance of Innovative Alternative Onsite Septic Systems for the Removal of Nitrogen in Barnstable County, Massachusetts 1999-2007" presents a summary of data collected from single and multi-family I/A systems across Cape Cod. The findings of this report indicated that, in general, 69% of single family I/A systems and 60% of the multi family I/A systems have median effluent concentrations of 19 mg/L total nitrogen. However the data contained within the reports showed the high variability of effluent quality for these types of systems and the report discusses the difficulty of assigning removal performance to these systems with the limited influent data available and variability of results.

The report concludes that "…data suggests that the incorporation of individual onsite denitrifying technologies into watershed modeling scenarios should be done with caution and consider the variability reported here {the Barnstable County Report}." The County Health and Environmental Department also stated that their efforts will continue with the further evaluation of these systems and development of "realistic assumptions for towns to incorporate I/A systems into their watershed nitrogen management strategies."

Systems evaluated as part of the Barnstable County report include, FAST®, Bioclere™, Recirculating Sand Filters, Singulair®, RUCK®, SeptiTech, Advantex, Amphidrome®, Waterloo Biofilter®, Nitrex™, and Composting Toilets.

6.3 CLUSTER TREATMENT SYSTEMS

Cluster treatment systems are systems which typically fall between individual on-site systems and large municipal facilities designed to serve large areas of a town. These systems are typically designed to treat and discharge wastewater generated within small neighborhoods or developments. Chatham currently has a couple of these types of systems, for example Bailey's Path is a Bioclere™ system serving a 20 lot development, and the Chatham's Bar Inn has an Amphidrome® type system serving most of its facilities.

The main difference between cluster systems and centralized wastewater treatment facilities is the location of the treatment and effluent disposal. For the purpose of this project, centralized wastewater facilities are those which collect wastewater from various sewersheds and recharge the treated water at the facility site (i.e., the existing Chatham WWTF) or remote sites.

Cluster systems can range in size from serving small groups of homes or businesses to an entire planning area (neighborhood, sewershed, AOC, etc). Cluster treatment systems may utilize any one of the on-site technologies identified previously, or could be served by a small wastewater treatment system for flows over 10,000 gpd, like those identified in Chapter 5. Because cluster systems are designed to handle "clusters" of properties, they require a collection system to transport the wastewater from the properties to the treatment facility. The collection system technology may be any one of the collection systems (or combinations) described in Chapter 5.

Cluster treatment systems require greater land area for effluent disposal than individual on-site systems due to the larger wastewater flows.

6.4 SMALL WASTEWATER TREATMENT FACILITIES INCORPORATING BIOLOGICAL NITROGEN REMOVAL

Small wastewater treatment facilities incorporating biological nitrogen removal (BNR) are designed to treat and discharge wastewater flows greater than 10,000 gpd. These treatment systems serve many properties and require a wastewater collection system. These systems can use the same technologies described for individual on-site I/A systems or those technologies described in Chapter 5 for centralized facilities. These systems are described in Appendix N.

Small wastewater treatment facilities utilize BNR processes that are compact in size and are generally more complex than the individual and multiple-home, on-site-type systems previously presented. These facilities can produce a treated effluent that meets the Class I permit standards of 30 mg/L BOD_5, 30 mg/L TSS, less than 10 mg/L nitrate-N, and less than 10mg/L total nitrogen. When properly designed and operated, they will provide even better treatment. The following BNR processes are identified and screened as part of this alternative:

- rotating biological contactors (RBCs)
- sequencing batch reactors (SBRs)
- Amphidrome® system
- Bioclere™membrane bioreactor (MBR)
- FAST® systems.

In general system components for these types of systems are similar to those described in Chapter 5:

- Preliminary treatment
- Primary treatment
- Secondary treatment
- Filtration
- Disinfection
- Solids handling and disposal
- Treated water recharge

A. **Regulatory Impacts and Treatment Standards.** Wastewater discharges greater than 10,000 gpd require a groundwater discharge permit as required by the Massachusetts Discharge Permit Program and Groundwater Quality Standards described in 314 CMR 5.00 and 6.00, respectively. These facilities, depending on their location relative to Zone IIs (zones of contribution to public water supply wells) may also be required to meet MassDEP guidelines on reclaimed water use.

The New England States Guides for the Design of Wastewater Treatment Works (often called the TR-16 Guide) and the MassDEP guidelines entitled "Guidelines for the Construction, Operation, and Maintenance of Small Treatment Facilities with Land Disposal" have been published by the New England Interstate Water Pollution Control Commission and MassDEP respectively to guide the design of these types of treatment facilities. These guidelines provide detailed design criteria for treatment and discharge facilities and were followed as part as these evaluations.

B. **Sizing and Land Area Considerations for Cluster Systems.** The land area required for a small wastewater treatment facility is determined by three primary factors:

1. Land area needed for process equipment and operations building.

2. Land area needed for treated water recharge facilities, such as sand infiltration beds or leaching beds.

3. The necessary buffer area to visually screen neighboring properties.

The land area of the process equipment and operations buildings is approximately the same for the different biological nitrogen removal processes identified. The RBC process may require slightly more area because of the need for secondary clarifiers and the SBR process may require slightly less area because of the compact tank design and multiple processes being performed in one tank, but these incremental increases are small when compared to the land area requirements for treated water recharge facilities and buffer area.

Treated water recharge area requirements for evaluation and screening purposes are based on the use of sand infiltration beds that require the least space and are the easiest to maintain. Subsurface leaching fields have a larger area requirement, but may have an advantage if they can be located under a parking area or other open space that has a multiple use. The buffer areas required for a particular small wastewater treatment facility will depend on the site selected and the neighboring properties. The buffer areas are based on a separation distance of 100 feet between the property boundary and the process facilities. This separation distance is greater than the distances presented in MassDEP's guidelines, but would allow space for a driveway access and sufficient planting to provide a visual screen from adjoining properties.

Typical land area requirements for small wastewater treatment facilities to treat wastewater flows of 10,000, 35,000, and 110,000 gpd (typical flows that might be expected for cluster systems in planning areas) are 2, 3, and 4 acres, respectively. Area requirements are highly dependant on the configuration of the parcel being considered and the site's physical features. Other considerations (for example recharge within a Zone II) would require additional treatment facilities to meet the more stringent effluent quality requirements, and therefore impact the size of the facility. Wastewater characteristics of the area being served (primarily residential, schools, commercial, industrial, or some combination) will also impact the size of the treatment technology and therefore the site.

6.5 IDENTIFICATION OF AVAILABLE WASTEWATER TREATMENT FACILITY SITES FOR AREAS OF CONCERN

Site identification and screening for decentralized facilities (which are frequently private facilities) will include those sites needed for cluster systems, and small wastewater treatment and

recharge facilities. Sites are identified in Chatham based on the vacant developable properties identified using the Town GIS information greater than 1 acre in size within the AOCs. These sites are then grouped by land size. Table 6-1 summarizes the number and size range of potentially developable vacant property, as identified by state class codes, for each AOC. Although sites were identified as "vacant", their actual availability would be a function of ownership, cost and other factors. This does not include currently publicly owned land, and may include properties that have since been developed. Additional site evaluation is included in Chapter 7 for remote recharge of treated water.

Using these land area ranges and typical wastewater treatment system sizes, the average feasible wastewater treatment facility capacity for each range of land area was estimated. Table 6-2 summarizes the average wastewater facility capacity, including treated water recharge areas that each of these land area ranges might be sufficient to handle.

It is noted from these two tables that there are few large undeveloped (greater than one acre) sites in Chatham. It is also understood that siting a wastewater treatment plant (even a small one) would be difficult on any of these sites. The smaller the flow, the greater the number of decentralized treatment plants that would need to be sited and operated.

6.6 COLLECTION SYSTEMS FOR DECENTRALIZED ALTERNATIVES AND FOR CONNECTION TO CHATHAM WWTF

Collection systems will be needed for multiple unit on-site systems, small wastewater treatment facilities and, as discussed in Chapter 5, connection of AOCs to the Chatham WWTF. Five collection system technologies are identified and screened in Chapter 5, and the following technologies were retained for evaluation:

- Gravity sewers and pumping stations
- Pressure sewers with grinder pumps

The type of collection system selected for a particular multiple unit on-site system or small wastewater treatment facility will be very site-specific and is typically decided during design of the facilities based on detailed survey information. Typically, the collection system implemented is a combination of technologies that utilize the advantages of gravity sewers for sloping upland

areas, and low pressure sewers and grinder pumps for flat, low-elevation coastal areas that have high groundwater conditions.

Costs for pressure sewers and grinder pump systems are comparable and possibly less expensive than gravity sewers and pumping stations based on pipe size and depth of bury. The pressure sewers have the main disadvantage that grinder pump stations are needed at each property and require homeowner and/or management district operation and maintenance. A mobile electric generator is also needed to operate grinder pumps during extended power outages. Gravity sewers and pumping stations are the preferred collection system unless the topography and groundwater conditions make it difficult and/or cost prohibitive to construct. Ownership and management of these systems will have a significant impact on costs.

Costs for decentralized collection systems were considered to be the same as those developed by sewershed as part of the large collection system. Because the sewersheds were developed based on maximizing sewer coverage with one pumping station, these would mimic what might be found for a cluster or small wastewater treatment facility, and were developed based on topography and available pumping station site locations vs. watersheds.

6.7 POSSIBLE WASTEWATER MANAGEMENT DISTRICT FORMATION FOR OPERATION MAINTENANCE AND MONITORING OF DENITRIFYING ON-SITE SYSTEMS

Large-scale implementation of denitrifying on-site systems does not lend itself to individual operation, maintenance and monitoring of these systems. Denitrifying systems are a larger investment that must be properly operated and monitored if they are expected to achieve the required nitrogen removal. They will require operation, maintenance, and monitoring knowledge and skill that was not required for Title 5 systems. Many individual homeowners will not have the skill or desire to properly operate and maintain these systems. Most town health departments do not have the resources to regulate large-scale implementation of these systems.

The possible formation of decentralized management districts could address the concerns about maintenance, operations, and monitoring of these systems. A decentralized management district could be set up similar to a sewer or water district through special legislation in the

Massachusetts Legislature. That legislation would define the limits, function, and responsibility of the district. The district would be staffed to provide the following possible functions:

- On-site system records storage
  - system pumping records
  - system design
  - monitoring and performance data
- System maintenance and repairs
- Regulatory enforcement
- Summary reporting on district (watershed) performance
- Monitoring on other district or watershed issues such as fertilizer usage or stormwater system operations

This type of district could report to the Board of Selectman, Board of Health or other similar entity.

6.8 OPTIONS FOR OWNERSHIP AND MANAGEMENT OF DECENTRALIZED FACILITIES

Several documents have been developed on the Regional, State and Federal level discussing management options if Chatham chooses to develop such a District or additional Town department.

A. **Federal Guidance.** USEPA published in March 2003 the "Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems." This document presents five different management models that could be employed by a Town or Regional Management Entity. The five models identified are as follows:

1. **Model 1 – Homeowner Awareness Model.** The homeowner is educated on their system, including operations and maintenance requirements.

2. **Model 2 – Maintenance Contract Model.** The homeowner is required to contract with a maintenance company to maintain their system, usually for those onsite systems that would go beyond a standard Title 5 system in Massachusetts.

3. **Model 3 – Operating Permit Model.** This would be applicable to those properties in Chatham that would be required to have an I/A system based on their location or the current Interim Nitrogen Loading Regulations. This would be similar to a groundwater discharge permit for each individual property falling into this category.

4. **Model 4 – Responsible Management Entity (RME) Operation and Maintenance Model.** This would be similar to Model 3, except a management district would be responsible for permit compliance, however the system would still be owned by the homeowner.

5. **Model 5 – RME Ownership Model.** This is taking Model 4 to the next level where the system ownership and maintenance requirements fall on the management district and the homeowner is no longer responsible for the system.

A more detailed summary of the Management Models presented in the above referenced document is included in Appendix O.

B. **State Guidance.** MassDEP also prepared a guidance document as part of the Massachusetts Estuaries Project. This document entitled "Embayment Restoration and Guidance for Implementation Strategies" was published in 2003 and discusses several approaches to nitrogen reduction including the formation of management districts.

This document summarizes the advantages of a "District Approach" in dealing with nitrogen reduction, including the flexibility and funding advantages this type of approach to management could provide. The document also identifies the three legal options for creation of such districts:

1. **Massachusetts General Law.**

- Formation of "Water Pollution Abatement Districts", as defined under the Massachusetts Clean Water Act.
- Creation of "Independent Water and Sewer Commissions and Inter-municipal Agreements".
- Creation of "Regional Health Districts" for two or more municipalities.

2. **Special Act of the Legislature.** Allows municipalities to file home rule petitions requesting enactment of a special law. The best example of this on Cape Cod is Provincetown's legislation on the "checkerboard" approach to sewering.

3. **Municipal Home Rule Authority, Bylaws, and Regulations.** Essentially this provides the municipality the ability to use Zoning Bylaws, General Bylaws and Local Boards of Health to regulate wastewater. This is currently being applied in Chatham with the Board of Health's Interim Nitrogen Loading Regulations.

C. **Regional Guidance.** The Cape Cod Commission (CCC) also developed a "Cape Cod Comprehensive Regional Wastewater Management Strategy Development Project" Report published in June 2003. This document also discussed Wastewater Management Districts.

The formation of a District or Town department to manage these types of systems will be considered as part of any alternative plan.

6.9 SCREENING OF ALTERNATIVE DECENTRALIZED TECHNOLOGIES

A. **Introduction.** Several standard criteria were used to evaluate the various decentralized technologies in a similar manner as for the Centralized treatment systems in Chapter 5. These include:

- Relative Capital Costs
- Relative Operation and Maintenance Costs
- Flexibility
- Energy Use
- Effluent Quality
- Regulatory Requirements.
- Potential for Air Emissions
- Land Requirements.
- Anticipated Public Acceptance
- Ease of Implementation
- Maintenance Requirements and Complexity of Operation

B. **Summary of Screening and Findings.** The feasibility and eventual acceptability of an alternative depends not only on cost, but also on non-monetary considerations including the conditions within each AOC, operability, construction feasibility, and environmental impacts on the surrounding facilities and neighborhoods. For any recommended alternative or technology, a more detailed evaluation is included in Chapters 9 and 10 of this Report.

Table 6-3 summarizes key information for each technology alternative with respect to the screening criteria discussed previously and the main findings of the screening are listed below:

1. The following technologies provide acceptable individual on-site treatment in areas where nitrogen removal is not needed.

- Standard (certified) Title 5 systems
- JET aerobic systems
- Orenco Systems® intermittent sand filters
- Peat systems

2. The following non-discharge systems were considered for Chatham and are not appropriated for large-scale application to the Town's AOC to manage nitrogen loading to the estuaries:

- Tight Tanks
- Waterless Toilets (incineration or composting)

3. The following nitrogen removal systems have indicated an ability to remove nitrogen when properly installed and operated and have MassDEP general approval for installation in nitrogen sensitive areas:

- Non-proprietary recirculating sand filters
- RUCK® systems

An evaluation of the long-term performance of these systems and other proprietary I/A systems on Cape Cod by the Barnstable County Department of Health and Environment indicated that performance is highly variable for these types of systems. Discussions with County staff found

that long-term performance indicates that these systems typically (often between 50 and 70%) can achieve a median concentration of 19 mg/l TN in the effluent. The County Department of Health and Environmental stopped short of equating that to a percent reduction in total nitrogen, citing the lack of influent data. These I/A systems cannot be expected to consistently meet lower targets especially in seasonal communities that have intermittent use of these biological systems. However, the County Department is working to develop standards to assist Towns in the incorporation of I/A systems into watershed management, however their application "into watershed modeling scenarios should be done with caution and consider the variability reported here" (Barnstable County, 2007).

These systems will be considered (based on effluent concentrations of 19 mg/L total nitrogen based on this regional data) for implementation in portions of the Town where the TMDL indicates wastewater removal at less than 50% as part of future evaluations.

4. The following nitrogen removal systems have indicated an ability to remove nitrogen when properly installed and operated and have MassDEP "Provisional" approval for use in nitrogen sensitive areas:

- Bioclere™ systems
- FAST® systems
- Amphidrome® Systems
- Waterloo Biofilters®
- ZeroGem Systems

As stated in Section 6.2.A.3. above, an evaluation of the long-term performance of several of these systems on Cape Cod by the Barnstable County Department of Health and Environment indicated that 60-70 percent of these types of systems can achieve a median concentration of 19 mg/L total nitrogen in the effluent or better. However, based on this data they are not expected to consistently provide an effluent quality low enough to achieve a total nitrogen TMDL because of the seasonal nature of the community with intermittent (summer) use of these biological systems.

These systems will be considered (based on effluent concentrations of 19 mg/L total nitrogen based on this regional data) for implementation in portions of the Town where the TMDL indicates wastewater removal at less than 50% as part of future evaluations.

5. The following nitrogen removal systems have indicated an ability to remove nitrogen when properly installed and operated and have MassDEP "Pilot" approval for use in nitrogen sensitive areas:

- OAR systems
- RUCK® CFT systems
- Chromaglass® systems
- MicroSeptic systems
- Norweco® systems
- Nitrex™ systems
- SeptiTech

These, like the technologies evaluated in Sections 3 and 4 of this chapter, were evaluated by Barnstable County Department of Health and Environment with similar performance results and cannot be expected to consistently meet lower targets especially in seasonal communities that have intermittent use of these biological systems.

These systems will be considered (based on effluent concentrations of 19 mg/L total nitrogen based on this regional data) for implementation in portions of the Town where the TMDL indicates wastewater removal at less than 50% as part of future evaluations.

It is noted that some of these technologies identified above do not have long-term performance data for nitrogen removal on Cape Cod, or have a large number of facilities on Cape Cod, therefore, they were either not include by the County Department of Health and Environment, or the limited amount of effluent nitrogen data constrained the conclusions that could be drawn from that data. Some of these systems do show promise to achieve effluent quality below 19 mg/l TN. For now, these systems should only be considered in areas requiring less than 50% removal until they have sufficient long-term data that demonstrates performance in many individual on-site installations.

6. Use of cluster or small wastewater treatment facilities to address Chatham's needs are not considered a viable option based on the limited number of parcels available to manage these systems and the added responsibility and cost of operating and managing multiple smaller facilities when the current Town WWTF site has sufficient land area to support a centralized facility. It is noted that the existing WWTF site is fairly centrally located in the Town and collection system transmission distances are not extremely long compared to the typical distances for a cluster system or small WWTF.

Also, small WWTF used for cluster systems are typically designed to meet BNR (6 to 10 mg/l TN) standards; but long-term monitoring data indicates that they often exceed their maximum daily limit of 10 mg/l; and many plants are in violation of their discharge permits. The Town should not take on the burden of siting, building, operating, and managing many small WWTFs.