Chapter 5

Centralized Wastewater Evaluations

CHAPTER 5

CENTRALIZED WASTEWATER EVALUATIONS

5.1 INTRODUCTION

A. **Purpose**. The purpose of this chapter is to identify technologies that can be used by the Town of Chatham as part of an upgrade to the Chatham WWTF or for one or more smaller wastewater treatment facilities as one method to address the Town's AOCs. The recommended technologies will be considered for further detailed evaluation as part this DCWMP/DEIR. Wastewater treatment alternatives are divided into the following groups:

- Centralized Nitrogen Treatment Processes
- Effluent Disinfection
- Residuals Management
- Collection Systems

Each group of technologies is presented and screened in a separate section of this chapter. Treated water recharge alternatives are discussed in Chapter 7.

B. **Alternative Screening Methodology and Criteria.** The identification and screening of the various types of wastewater treatment technologies and process configurations is completed with a standard methodology and set of comparative criteria. In the following text, categories of technologies are identified and then screened with respect to their main advantages and disadvantages to allow a side by side comparison. The criteria that are used are listed and briefly described below:

1. **Relative Capital Costs.** Relative capital costs for each alternative will be identified and compared to the other alternatives.

2. **Relative Operation and Maintenance Costs.** Costs to operate and maintain a typical installation of an alternative will be identified and compared to other alternatives.

3. **Flexibility.** Flexibility of a treatment system relates to the ability of that system to respond to seasonal or future changes in flows, loads, and effluent requirements.

4. **Energy Use.** Energy used to operate an alternative (relative) will be noted and compared to the other alternatives.

5. **Effluent Quality.** Wastewater treatment systems provide various degrees of pollutant removal of BOD, TSS, and nitrogen. The expected effluent quality for each treatment technology will be identified and compared.

6. **Regulatory Requirements.** This criterion includes a discussion regarding the permits, variances, and monitoring requirements of federal, state, and regional regulatory agencies.

7. **Potential for Air Emissions.** The potential for odors and other air emissions from treatment systems will be discussed.

8. **Land Requirements.** The amount of land needed for each alternative treatment system will be discussed.

9. **Anticipated Public Acceptance.** This criterion involves how the public may react to a specific type of treatment system. Major public concerns regarding these alternatives are expected to include relative cost of installation; visibility; potential for odors; operation and maintenance requirements; and the perceived impact of proposed facilities on neighboring residents.

10. **Ease of Implementation.** Implementation issues will be discussed, such as methods the Town could use to monitor and operate on-site systems or treatment plants over the expected lifetime of the treatment system. Management issues to be discussed include public or private ownership of treatment facilities, obtaining land for multiple home treatment sites, and Town regulations needed to address the potential administrative issues.

11. **Maintenance Requirements and Complexity of Operation.** This criterion is related to the complexity and number of mechanical components of each treatment process. Long-term track record (reliability) and the level of skill needed to maintain a technology will be considered. Reliability and technical feasibility of a process or plan is a function of how consistently it is expected to function and to achieve required effluent limits. In general, long-term reliability decreases as the complexity of mechanical equipment increases.

5.2 OVERVIEW OF WASTEWATER TREATMENT COMPONENTS AND CATEGORIES OF NITROGEN REMOVAL PERFORMANCE

A. **Introduction.** Centralized wastewater treatment processes commonly include the following process components:

- Preliminary treatment (screening and grit removal)
- Primary Treatment (removal of settleable solids)
- Flow Equalization (wastewater storage to dampen peaks)
- Secondary and Advanced/Secondary Treatment Alternatives (removal of organic materials and nitrogen)
- Effluent Polishing (filters)

The following text briefly describes those process components.

1. **Preliminary Treatment.** Preliminary treatment is designed to remove large abrasive objects and solids from wastewater, and is usually the first process of a centralized treatment facility. The removal of these objects prevents damage to treatment equipment such as pumps, valves, and pipelines. Preliminary treatment is often broken into two components: Influent screens to remove larger objects from the flow stream and grit removal that works to remove finer particulate matter from the flow stream.

Influent screens (hand cleaned and mechanical types are common) are used to remove large objects at the beginning of the wastewater treatment process, and the material removed is referred to as screenings. They can be coarse screens (typically with opening greater than 1 inch) or fine screens (often designed with less than ¼ inch openings).

Grit removal facilities are designed to remove sand, and other abrasive materials from the wastewater to prevent excessive wear on moving equipment and minimize heavy deposits in pipelines and channels. Grit removal equipment often consists of tanks or specialized process equipment which allows grit and heavy solids to settle or be pulled from the flow stream. Aeration is often used to keep organic materials in suspension to be treated in subsequent treatment processes. Screenings and grit are two types of wastewater treatment residuals; and treatment and disposal alternatives for these residuals are presented later in this chapter.

2. **Primary Treatment.** Primary treatment is a process to remove readily settleable solids and floatables from the wastewater flow. The solids are removed by gravity settling and can be collected using mechanical equipment or by pumping. Primary treatment methods include primary clarification and primary treatment in septic tanks.

Primary clarification typically utilizes large circular or rectangular tanks with mechanical equipment for collection and removal of settled solids and floating scum. As wastewater flows through the tank, solids settle to the bottom of the tank and the floatables rise to the top of the tank, both are then collected and removed by mechanical equipment.

Septic tanks are typically used for decentralized wastewater treatment. However, several tanks can be arranged in series to provide primary treatment at smaller centralized treatment facilities. Septic tanks at a centralized treatment facility require frequent pumping, but typically do not have moving parts such as those used in primary clarifiers.

3. **Flow Equalization.** Flow equalization is used to even out the excessive flow peaks at a treatment facility. This can reduce the size of some components and improve efficiency. Most of the wastewater is produced during two to three hours in the morning and evening when people have their highest water usage. Flow equalization utilizes one or more aerated storage tanks to store the wastewater during the hourly peaks and feed it into the treatment process evenly throughout the day.

4. **Secondary and Advanced/Secondary Treatment Concepts and Configurations.** Secondary treatment processes are designed to remove dissolved and fine-suspended solids from wastewater reducing the biochemical oxygen demand (BOD) and total suspended solids (TSS) concentrations. Advanced/Secondary treatment processes also remove nutrients such as nitrogen

and phosphorous. The most common and least expensive secondary and advanced/secondary treatment processes are biological processes.

Biological treatment of wastewater utilizes microorganisms to transform solids and organic matter into biological cell mass, carbon dioxide, and/or nitrogen gas. Biological processes provide an environment for microbial growth using nutrients, BOD, and TSS in the wastewater as a food source. Microorganisms are removed from the wastewater as settled sludge (also called biosolids) and the carbon dioxide and nitrogen gas are released to the atmosphere where they comprise a large percentage of the air around us.

Biological processes are classified as aerobic, anoxic, or anaerobic processes. Aerobic processes are those which occur only in the presence of oxygen; anoxic processes occur when there is minimal oxygen but sufficient nitrate nitrogen to act as an oxygen source; and anaerobic processes occur when there is no oxygen or nitrate present.

Biological processes are also classified by the physical configuration used for promoting microbial growth. The following sections provide a brief description of the four major types of biological processes:

a. **Attached Growth Processes.** Attached growth processes utilize an inert medium of plastic, stone, sand or other material on which the microorganisms grow and multiply. The wastewater is brought in contact with the microorganisms (also called biomass) on the medium, and the biomass consumes the solids and organic material to produce more biomass. Attached growth processes (also known as fixed-film processes) include trickling filters, rotating biological contactors (RBCs), aerated biological filters, packed beds, and fluidized beds. These process names identify the configuration of the support medium.

b. **Suspended Growth Processes (Activated Sludge).** Suspended growth processes are biological processes which maintain a concentrated supply of microorganisms suspended in the wastewater. The supply of microorganisms and organic solids are collectively referred to as mixed liquor suspended solids (MLSS). Decomposition of solids and organic matter is achieved by combining untreated wastewater and MLSS in a contact tank. The microorganisms grow and consume the solids and organic material. The microorganisms multiply and are later separated from the treated water to be reused in the process. Excess biological growth is wasted as sludge. A hybrid to this type of system is the "membrane bioreactors" where a traditional suspended growth process is modified with membrane filtration to allow increased MLSS, and elimination of clarifiers or additional filtration.

c. **Natural Treatment Systems.** Natural treatment systems are less conventional technologies and are only recently being more widely applied for wastewater nitrogen removal. They are not as well defined in terms of predictable performance and design criteria as are more conventional systems, and they have large land area requirements. The performance of these systems is generally considered as highly variable and may require pilot testing. Natural treatment systems include hydroponic systems (like Solar Aquatics) and constructed wetlands. These systems rely on naturally occurring plants, aquatic life, fish, and sunlight to remove contaminants.

d. **Nitrogen Removal Processes.** Many biological treatment processes will achieve significant nitrogen removal; however, these processes, when used for total nitrogen removal, often require more energy, larger tanks, chemical addition, and/or multiple stages. Nitrogen removal from wastewater is an established technology but it often requires more skilled operation. Nitrogen removal includes the two steps of nitrification and denitrification. Nitrification converts ammonia-nitrogen to nitrate-nitrogen and denitrification converts nitrate-nitrogen into nitrogen gas which is released to the atmosphere. Several nitrogen removal technologies are available and are identified in the following sections based on their ability to meet specific levels of nitrogen removal.

B. **Centralized Treatment Nitrogen-Removal Performance.** Wastewater treatment processes can be grouped based on their expected level of nitrogen removal performance. Any wastewater treatment facility serving over 10,000 gpd is expected to achieve a "moderate" level of performance in order to meet 10 mg/L TN in their effluent. In areas which are nitrogen sensitive, a greater level of nitrogen removal may be expected. And in some situations the limit of conventional technology (considered by many as 3 mg/L TN) may be expected. The following is a list of technologies grouped by their accepted performance level. A more detailed description of each technology has been included in Appendix J.

1. **Moderate Level of Performance (6 – 10 mg/L TN on a maximum daily basis).** Systems designed to treat to this level of performance (averaging 7 mg/L TN) are often called

"BNR" processes. This refers to the fact that they are "Biological Nitrogen Removal" processes that remove significantly more nitrogen than the "conventional secondary" treatment processes that were designed to only remove BOD and TSS components. These types of BNR systems were required on Cape Cod in the late 1980's when USEPA and MassDEP declared Cape Cod to have a "Sole Source Aquifer". As a result, all treated water recharged from treatment facilities (greater than 10,000 gpd capacity) had to meet the drinking water standard of 10 mg/L TN on a maximum daily basis. MassDEP groundwater discharge permitting requires a minimum of this level of performance.

These technologies are often the backbone for a treatment process used to achieve even greater nitrogen removal. The following technologies typically achieve the 6 to 10 mg/L TN performance level of "BNR":

a. **Activated Sludge / Modified Ludzack-Ettinger (MLE) Process.**
b. **Activated Sludge / Extended Aeration.** Typical extended aeration processes are:
    1) Oxidation Ditch.
    2) Biolac Lagoon.
    3) Schreiber Process.
c. **Rotating Biological Contactors (RBC).**
d. **Sequencing Batch Reactors (SBR).**

2. **Higher Level of Performance (3 mg/L TN on average with a maximum daily limit of 10 mg/L)** When "BNR" systems are upgraded to this limit, they are often called Enhanced Nitrogen Removal Systems or "ENR" systems. This ENR nomenclature was started by the State of Maryland which established an aggressive grant-funding and nitrogen-remediation program to upgrade the states treatment plants to a 3 mg/L TN limit. This limit is typically considered the performance limit of conventional wastewater technology. Technologies needed to treat the nitrogen to levels below 3 mg/L (discussed in Section 5.3) are used for specific industrial processes, and are still experimental for municipal wastewater treatment.

The methods required to meet the 3 mg/L TN (on average) limit uses proven technologies but requires more complex design and operation for reliable performance. Typical process configurations to meet the limits include:

a. **Activated Sludge / MLE followed by post anoxic reactors and filtration.**
b. **Sequencing Batch Reactor (SBR) followed by denitrification filters.**
c. **Activated Sludge / Extended Aeration followed by filtration.**
d. **Some Membrane Bioreactor (MBR).**
e. **Some Fixed Film Systems.**

3. **Reuse Technologies.** Beyond the nitrogen removal performances identified previously (BNR and ENR processes), additional treatment can be provided downstream of most of the technologies discussed previously. These “reuse” technologies would be recommended for applications where the goal is to obtain an effluent quality suitable for a variety of water reuse options such as spray irrigation in an area with public access. These technologies include:

a. **Reverse Osmosis (RO)**
b. **Ultrafiltration.**
c. **Electrodialysis**.

5.3 FURTHER ADVANCED/EXPERIMENTAL NITROGEN REMOVAL

The need to treat to levels below 3 mg/L is rare and, therefore, there is limited experience with full scale municipal systems in the application of the necessary technologies to meet these lower limits. However, if necessary, the following technologies could be added to an ENR process to get below 3 mg/L TN:

- Absorption (removes soluble organics: and nitrogen)
- Advanced Oxidation (breaks down refractory nitrogen compounds)
- Precipitation (further ammonia removal)
- Ion Exchange (targets specific ions such as nitrate)
- Break Point Chlorination (further ammonia removal)
- Membrane filtration / Reverse Osmosis (can remove nearly all dissolved compounds)

These processes would need to have pilot testing with the Town’s wastewater before they could be fully approved by MassDEP and implemented.

5.4 ALTERNATIVES TO EXPAND NITROGEN REMOVAL CAPACITY IN THE EXISTING CHATHAM WWTF TANKAGE

A. **Introduction.** This section presents possible expansion alternatives for Chatham's existing WWTF within the existing aeration tanks. An increase in wastewater flow to the Chatham WWTF would result from expansion of the collection system to incorporate some or all of the Areas of Concern (AOCs). Therefore, this section examines some of the technologies that the Town of Chatham can use to treat larger future wastewater flows in the existing tankage at the Chatham WWTF.

B. **Existing Centralized Facilities**. The existing wastewater treatment tankage is comprised of the following major components: pretreatment facilities, aeration tanks, and secondary clarifier facilities. The existing site plan, Figure 2-1, shows the arrangement of these facilities on the WWTF site. These facilities are described in detail in Chapter 5 of the 1999 NAR and Chapter 2 of this report.

The capacity of these components was assessed as part of the 1999 NAR. Capacity determinations were based on hydraulic calculations, review of current performance, comparison with accepted design standards, and process calculations. The following is a summary of those findings.

The biological treatment process capacity was evaluated using methods developed by Stearns & Wheler and others as documented by the USEPA Nitrogen Control Manual. Capacity of the aeration system was evaluated, as well as the volume of the aeration tanks. The four aeration tanks were originally rated at a capacity of 0.44 mgd (0.11 mgd per tank) for secondary treatment. Additional evaluations indicate that the surface aeration system can provide sufficient oxygen transfer to treat a flow of 0.1 mgd per tank at the maximum month BOD and TKN concentrations of 250 and 45 mg/L, respectively. If diffused aeration was installed in the tanks, the aeration capacity and tank capacity could be increased to 0.15 mgd per tank or 0.3 mgd for two tanks. The winter capacity is approximately equal to the summer capacity due to the ability to carry a higher mixed liquid suspended solids in winter and a higher oxygen solubility at colder temperatures. These two factors tend to offset lower biological activity rates that occur at colder temperatures.

The capacity of the secondary clarifiers is assessed based upon surface overflow rate and solids loading rate. Facilities that maintain the longer solids retention times necessary for nitrification often produce a slower settling sludge than facilities with shorter solids retention times. Surface overflow rates for Chatham's clarifiers should generally be maintained at less than 240 gpd/ft^2 average and 560 gpd/ft^2 peak due to the low side water depth (seven feet) of the clarifiers and occasional poor settling characteristics of the sludge. Solids loading rates for Chatham's clarifiers should generally be maintained at 25 lbs/ft^2/day or less. Based upon the above criteria, the existing secondary clarifier capacity is approximately 0.3 mgd at annual average flow and 0.8 mgd at peak hour flow with two clarifiers in service.

B. **Modifications to the Existing MLE/Activated Sludge Tanks.** Three options were considered to modify the existing facilities to increase capacity and performance.

1. **Upgrade of Existing Mechanical Aerators to Diffused Aeration.** Currently, mechanical aerators are used to provide aeration to the existing MLE process. Conversion to diffused air and the addition of DO controls would provide a capacity of 0.30 mgd for the MLE process in the existing 2 aeration tanks, and greater process control for the operators. The replacement of the mechanical aerators with a fine bubble diffuser system would allow for a 70 percent increase in capacity under the existing MLE configuration.

Upgrade of existing MLE process to diffused aeration has the following advantages:

- Reuse of existing facilities, including existing clarifiers.
- Increased capacity.
- Greater process control.

Upgrade of the existing MLE process to diffused aeration has the following disadvantages:

- Requires taking Tanks No. 3 and 4 off-line to complete the conversion.
- Requires construction of a blower building.
- Higher electrical costs associated with diffused aeration.
- It will only provide 0.30 mgd capacity at a 7 to 10 mg/L TN limit, and significantly more capacity is needed to meet the TMDLs.

2. **Upgrade and Expansion of MLE Process to Four Tanks and Diffused Aeration.** Similar to the first modification discussed, the mechanical aerators would be replaced with fine bubble diffusers and DO controls added. In addition, the MLE process would be expanded into Tanks No. 1 and 2, which are currently being used for septage processing. This would involve the construction of baffle walls in each of these tanks, similar to Tanks No. 3 and 4. This upgrade and expansion would provide for an additional 0.34 mgd future capacity in Tanks No. 1 and 2 and a total future capacity of 0.60 mgd.

Upgrade of existing MLE process to diffused aeration and four process tanks has the following advantages:

- Reuse of existing facilities.
- Increased capacity.
- Greater process control.

Upgrade of the existing MLE process to diffused aeration and four process tanks has the following disadvantages:

- Requires taking each of the existing tanks off-line to complete the conversion.
- Requires construction of a blower building.
- Higher electrical costs associated with diffused aeration.
- Requires the construction of new secondary clarifiers.
- May require new RAS and WAS pumps to handle the increased sludge flows, which are greater than those based on the original WWTF design of 0.44 mgd.
- New septage handling facilities would be required.
- It will only provide 0.60 mgd capacity at a 7 to 10 mg/L TN limit, and significantly more capacity is needed to meet the TMDLs.

3. **Conversion of Process Tanks to Zenon.** Conversion of the existing process tanks to Zenon technologies would include the replacement of the MLE process with the ZenoGem® membrane technology. This technology allows the biological process to operate at higher mixed liquid suspended solids (MLSS) concentrations, in the range of 10,000 to 12,000 mg/L, compared to 3,000 to 5,000 mg/L of conventional systems. This allows the system to achieve the necessary organic loading rates at much lower hydraulic residence times. These

modifications could be made in any combination of the existing tanks, with each new reactor operated with an anoxic and aerobic chamber. Tanks not used could be converted to equalization tanks or continued to be used as part of the septage treatment process. Flow equalization, prior to the Zenon reactor allows for reduced membrane sizes.

Based on preliminary estimates from the manufacturer, this conversion could provide a capacity of 0.8 mgd to a limit of 7 mg/L if all 4 tanks were converted.

Conversion of existing MLE process to Zenon has the following advantages:

- Reuse of existing facilities.
- Increased capacity.

Conversion of the existing MLE process to Zenon has the following disadvantages:

- Requires taking each of the existing tanks off-line to complete the conversion.
- Requires construction of a blower building.
- Higher electrical costs associated with diffused aeration.
- Capital costs are high for this technology.
- Membrane replacement costs are high.
- Few installations to verify performance.
- It will only provide 0.8 mgd capacity to meet a 7 mg/L limit which is not sufficient to meet the TMDLs.

4. **Summary.** Modifications to the existing MLE / Activated Sludge Tanks would not provide sufficient capacity or nitrogen removal performance to meet the Nitrogen TMDLs.

5.5 ALTERNATIVES TO EXPAND NITROGEN REMOVAL CAPACITY WITH NEW TANKAGE AND PROCESSES

Because of the limited capacity of the existing WWTF tankage, technologies identified in this section are screened for possible use in an upgrade and expansion at the WWTF site. The screening of advanced/secondary treatment technologies is based upon a description of each technology, their respective advantages and disadvantages as described in Appendix J, and the screening criteria identified above. Table 5-1 summarizes the descriptions, advantages, and disadvantages of these technologies. Also, a brief summary of the findings is provided below.

The activated sludge/MLE process is a proven and reliable technology with moderate capital and O&M costs. Land area requirements for activated sludge process tanks and equipment are relatively low. Primary treatment equipment would not be required, but effluent clarification with final settling tanks would be required. This process would have higher capital costs than an SBR, which will yield similar effluent quality. The Chatham WWTF currently has an MLE type process, and typically meets the 10 mg/L TN limit, providing BNR treatment.

RBCs are less desirable due to their requirement for primary treatment, necessity to cover equipment due to cold weather, high capital costs, and limited process control. Thus, this process is not considered for further evaluation.

SBRs perform all treatment phases in a single basin, are flexible in operation, can achieve consistent nitrogen removal in the BNR range. They can provide ENR performance when they are followed by denitrification filters for effluent polishing and additional nitrate removal. SBRs do have complicated operations and higher operating costs because they are not “flow through” operations. They also tend to have higher electrical costs due to the need to pump the water to some of the process components. They tend to have lower capital costs due to the minimization of process technology and will be retained for further considerations.

Zenon are more commonly used for small wastewater treatment plants or as a retrofit to an existing tankage (as discussed earlier), but there are a limited number of large installations in Massachusetts; therefore, large-scale performance data is limited. These processes are often more complicated and have higher operation and maintenance costs associated with membrane technology and thus will not be considered for further evaluation for centralized facilities, but will be considered for cluster systems, as described in Chapter 6.

Oxidation ditches provide good nitrogen removal when using additional pre- and/or post-anoxic tanks (A^2O or MLE processes) designed for additional nitrogen removal. They can achieve nitrogen removal to the BNR range and can provide ENR performance when followed by polishing filters. The system provides relatively easy operation, but the large tank requirements have higher capital costs than other processes. Use of oxidation ditches is a traditional and well-proven process that should be evaluated in detail.

Solar aquatics have high land area requirements and would be unsuitable for use in Chatham due to the high maintenance requirements, low process control, minimal operational data for large installations, and cold weather performance. Solar aquatics should not be considered for further evaluation.

Constructed wetlands would require an extensive area, and may not provide consistently reliable effluent nitrogen quality. Also, they are typically limited in cold weather performance. This process has been shown in studies to perform denitrification, although a pilot study may be necessary to prove its effectiveness due to cold weather constraints. Constructed wetlands should not be considered for further evaluation as a wastewater treatment process; however, their use as a mitigation measure for treating groundwater or stormwater in watersheds should be further examined.

Aerated biological filters are typically used to provide BOD and TSS removal and nitrification. It would need to be followed by a denitrification filter, which would then denitrify the full nitrogen loading (approximately 30 mg/L of nitrate nitrogen) because minimal denitrification is achieved in the ABFs. This technology takes up minimal space and is useful at treatment plant sites that have no room for expansion or where only nitrification is needed. ABFs also have high capital costs. Due to the factors listed above, this process will not be considered for further evaluation.

Denitrification filters provide denitrification and filtering of a previously nitrified effluent. They can be used to denitrify the full nitrogen loading (approximately 30 mg/L of nitrate nitrogen) when they are preceded by an ABF or an activated sludge, extended aeration process; or they can be used to denitrify (polish) a greatly reduced nitrogen loading (approximately 5 to 10 mg/L of nitrate nitrogen) when they are preceded by one of the nitrification and denitrification processes previously described. They can be sized smaller (and have lower capital costs) and will use less methanol when they are used to polish a previously nitrified and denitrified effluent. This process should be evaluated further for effluent polishing only.

Effluent filters are not a biological nitrogen removal process but are effective at removing fine suspended solids from the effluent of advanced/secondary processes. They remove the solids with sand or cloth media and, as a result, remove the additional amounts of nitrogen that is contained in the solids. They are less expensive and have lower operating requirements than denitrification filters. Effluent filters are retained for further evaluation.

The following technologies will be evaluated further for an upgrade and/or expansion to the WWTF:

- Sequencing batch reactors.
- Oxidation ditch technologies with pre and post anoxic zones.
- Effluent polishing with denitrification filters.
- Effluent polishing with conventional sand or cloth filters.

5.6 DISINFECTION

The Chatham WWTF currently does not disinfect the treated water before it is recharged to the ground through sand infiltration beds. MassDEP has not required disinfection at this WWTF in the past due to the minimal risk that any pathogens (bacteria or viruses) could cause human or environmental health concerns at this recharge location. Research has shown that bacteria are too large to travel in the groundwater and are removed at the infiltration site. Viruses are small enough that they can move with the groundwater but they typically die off after 6 months.

MassDEP typically requires disinfection for new or upgrade WWTFs, and may require it for an upgrade to the Chatham WWTF.

The three most common methods used for disinfection include:

- Chlorination (using sodium hypochlorate).
- Ozone.
- Ultraviolet (UV) Radiation.

Appendix J includes descriptions of each of the technologies and their advantages and disadvantages.

Table 5-2 presents a matrix summary of the screening criteria for each of the disinfection alternatives, and the findings of the screening process are briefly summarized below.

Sodium hypochlorite is not recommended due to potential liabilities associated with the transportation and storage of hypochlorite which is corrosive and toxic, and it has the potential to produce trihalomethanes in the treated effluent.

Ozonation is not recommended for further evaluation due to its high costs, complex operation, and the fact that it may potentially produce toxic compounds.

Ultraviolet (UV) is currently the most common disinfection technology. Its costs (capital and O&M), reliability, simplicity, and minimal chemical requirements (cleaning solutions), make this the most favorable of the technologies and therefore is the recommended technology.

5.7 RESIDUALS MANAGEMENT ALTERNATIVES

A. **Introduction.** The purpose of this section is to identify and screen technologies which could be used to properly treat and dispose of residuals from an upgraded Chatham WWTF or a new centralized wastewater treatment facility. Residuals are byproducts of wastewater treatment and are often difficult to handle, expensive to dispose of, and can be a source of odors. The following is a description of the various types of residuals associated with municipal wastewater treatment:

1. **Septage.** Septage is comprised of wastewater solids that accumulate in septic tanks, tights tanks, and cesspools, and includes sludge, scum, and liquids. This material is currently transported to the Chatham WWTF for treatment.

2. **Trap Grease.** Trap grease is the material that is periodically pumped out of grease traps and is a combination of solid floatable grease, settleable solids, and water. Trap grease is difficult to handle, difficult to dispose of, and should be isolated from other treatment processes because it fouls piping, valves, and other treatment equipment.

3. **Screenings and Grit.** Screenings and grit are byproducts of treating wastewater, septage, and trap grease at a centralized treatment facility. Screenings are large solid objects removed from wastewater in bar screens during preliminary treatment. Grit consists primarily of sand and gravel, and it is also removed during the preliminary treatment process. Removing screenings and grit from wastewater and sludge treatment processes is important to prevent damage to pumps, valves and pipelines. These two items are typically disposed as a solid waste

4. **Sludge.** Sludge is the organic and waste material (residual biosolids) removed from various wastewater treatment processes (most commonly from primary and secondary treatment). Wastewater sludge is solid material which settles by gravity in a primary wastewater treatment process, or is a combination of microorganisms and organic material generated in advanced treatment processes. Sludge is produced as a liquid and typically has a solids concentration of 5,000 to 20,000 mg/l (0.5 to 2 percent total solids). It is typically thickened and disposed at regional disposal facilities at a concentration of 5 percent total solids. Also, it can be dewatered and disposed at regional disposal facilities as a sludge cake at a concentration of 15 to 25 percent total solids. It can also be dewatered and then composted to produce a soil conditioner material of approximately 35 to 50 percent total solids.

The existing WWTF currently dewaters the sludge to produce a sludge cake; and then transports it to Yarmouth where it is mixed with sludge cake from other treatment plants. It is then transported to a regional disposal facility off Cape. This is a very economical method of sludge processing and disposal because it minimizes the amount of waste that is transported and disposed, as well as minimizes the amount of sludge holding time and processing to produce a product that can be disposed or reused.

B. **Septage and Trap Grease Treatment and Disposal.**

Septage and trap grease are most commonly addressed with pre-engineered receiving units that process the septage and remove grit and solids and allow the supernatant to be passed onto the headworks of the facility.

The Town also could proceed with its current practice of receiving septage at the WWTF, where septage haulers discharge through a coarse screen into a receiving tank. In the tank the septage is aerated and degritted, and then mixed with waste sludge (biosolids) from the current advanced/secondary (MLE) process. This mixture is further aerated and then decanted, and the supernatant is introduced into the wastewater flow stream.

The Town could incorporate special septage pretreatment equipment as part of a new/upgraded centralized wastewater treatment facility. However, the current practice of disposal at the existing Chatham WWTF is working well; the operations staff is very effective at using it; and this process should be retained (and expanded) for future use.

C. **Sludge Processing.** As discussed previously, sludge is a byproduct of centralized wastewater treatment processes and must be treated properly to avoid odors, reduce disposal costs, and minimize potential risks to human health. Sludge processing alternatives are divided into the following categories:

- Sludge Thickening
- Sludge Dewatering
- Sludge Stabilization and Composting
  - Composting.
  - Digestion.
  - Alkaline Stabilization.
  - Heat Treatment and Drying.
- Sludge Disposal

A detailed description of each process is included in Appendix J and a summary of sludge disposal alternatives and a side-by-side comparison of screening criteria are included in Table 5-3.

Based on the various sludge treatment and disposal options available the following have been identified for consideration for any new WWTF.

- Sludge storage/thickening and disposal at a regional facility.
- Sludge dewatering and disposal at a regional facility (WWTF current operation).
- Sludge dewatering, composting, and distribution to the public.

5.8 COLLECTION SYSTEMS

A. **Purpose.** The purpose of this section is to identify and screen collection system (sewer) alternatives which could be used to provide sanitary sewer service to the various Areas of Concern (AOCs) in Chatham.

B. **Description of Existing Collection Systems.** The majority of the Town's sewer system was constructed in downtown Chatham in 1971. The downtown area is sewered with 4, 6, 8, 10, and 12-inch diameter pipe, and all branches eventually lead to the Stage Harbor Pump Station which then pumps the wastewater to the WWTF. The collection system has been slightly expanded since 1972.

The Town has approximately 27,000 linear feet of gravity sewers (approximately 5.1 miles). The Town owns and operates four pumping stations: Stage Harbor, Chatham Housing Authority, Queen Anne, and Mill Pond. Four additional pumping stations are outside the responsibility of the Town's Water and Sewer Department and are located at the High School, Old Harbor Fish Market, the former site of Frog Pond Laundry, and the "Corn Field". There are approximately four miles of force main in Chatham ranging in size from four to eight inches in diameter.

Most of the sewers in the Town of Chatham are well under 50 years old. The earliest any of Chatham's collection system will reach the 50-year design life is in 2021. Also, based on the information received from the Chatham WWTF operators, these sewers have been maintained regularly and are operating with minimal problems.

A detailed description of the collection system can be found in Chapter 5 of the 1999 Needs Assessment Report. The extent of the existing collection system is shown on Figure 2-2.

C. **Collection System Technologies.** As discussed above, centralized wastewater collection is currently provided in the downtown Chatham area. Additional wastewater collection facilities will be required in some of the AOCs in order to meet the findings of the MEP reports and nitrogen TMDLs. Collection systems may also be used in those AOCs where the nitrogen loading thresholds are not as restrictive if construction of a decentralized facility or expansion of the existing centralized facility is determined to be the most feasible method to address the wastewater problems in these areas.

The final layout and design of a collection system depends upon several factors. The key factors include the type of collection system technology, the topography of the service area, utilities located in the road right-of-way (ROW), groundwater elevations, and the location of the treatment and recharge site(s). Many of these factors were determined as part of a preliminary design prepared for the Town in 2006, while many of the site specific factors would be determined when a system is designed.

The installation of a wastewater collection system in the road ROW is very disruptive to traffic activity. This will be particularly true in Chatham with relatively narrow streets and increased automobile and pedestrian traffic during the summer season. To the Town's benefit, the most congested and heavily trafficked part of Town (the downtown area) is already sewered, helping to minimize these impacts. The use of trenchless technology to install a collection system must be considered during the design processes to minimize disruptions. Trenchless technology is a process that installs a sewer pipe without digging a trench. The recent sewer relocation (2007) at the Saint Christopher's Church on Main Street utilized trenchless technology to minimize traffic and other impacts.

Each type of collection system technology offers some flexibility on how (or where) individual sewers are installed, but the overall system coverage for the various technologies will be generally the same. Some collection technologies allow for the majority of the construction to be performed within the ROW but outside of finished pavement along the road shoulders, minimizing pavement disturbance. This however is dependant on the availability of the road shoulder.

The following types of sanitary sewer collection systems are in use throughout the United States.

- Gravity Sewers and Pumping Stations.
- Pressure Sewers with Grinder Pumps.
- Septic Tank Effluent Sewers (two types):
  - Septic Tank Effluent Pump (STEP) System.
  - Septic Tank Effluent Gravity (STEG) System.
- Vacuum Sewers.

Each system has its own set of advantages and disadvantages as discussed in detail in Appendix J. Careful analysis, for all areas being sewered, must be performed during design to determine the feasibility of a particular collection system. This type of review was initiated during planning and preliminary design in Chatham with several presentations and discussions with the Wastewater Citizens Advisory Committee, the Technical Advisory Committee, and the Board of Selectmen. Through these presentations and discussions, it was decided to maximize the use of gravity sewers and use pressure sewers with grinder pumps only where gravity sewers were not feasible.

The following text summarizes the main issues related to the various technologies as discussed in detail in the Appendix J and summarized in Table 5-4.

Wastewater collection with gravity sewers and pumping stations is a widely used, simple, and reliable technology. Gravity sewers can be easily expanded to accommodate additional flows. The relative cost of gravity sewers depends on environmental conditions and increases with the number of pumping stations required and depth of excavations.

Pressure sewers are the second most common sewer type behind gravity sewers. They have relatively low construction costs and are readily adaptable to changes in topography. Public acceptance of pressure sewers may be low due to the need for a pump at each individual home or business. In addition, pressure sewers rely on electrical power, and flow backup can occur during power outages. Ownership of the pumps can also be an issue with these systems. Maintenance programs, easements, emergency power requirements and costs will need to be considered.

Septic tank effluent sewers require installation of special pumping equipment and piping at each point of connection to the gravity system. The main advantage of these systems is the reduced amount of solids transported in the collection system and the reduced potential for sewer blockage caused by solids deposition. Unfortunately, the lack of organic solids in the sewage delivered to the treatment plant will make the nitrogen removal process more difficult. These systems also require periodic pumping of the individual septic systems, which adds a high operational cost and potential for odor generation. They also do not lend themselves to being added to existing collection systems that transport all the solids. As a result, they are not recommended for Chatham.

Vacuum sewers have similar maintenance requirements as low pressure systems and require greater staff training for implementation. Vacuum sewers are not easily expandable and require accurate flow estimates prior to construction. The capital costs of vacuum sewers are typically higher than pressure systems. Vacuum systems have a greater reliability of continued operation during power outages than low pressure systems because electrical service is not required at the valve pit or buffer tank. However, Chatham's rolling topography and sizable distances between service areas limit the effectiveness of this technology, and therefore will not be considered for further evaluation.

The following collection system technologies will be further evaluated:

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

5.9 SUMMARY OF TECHNOLOGY SCREENING EVALUATIONS FOR UPGRADE AND EXPANSION OF THE CHATHAM WWTF

A. **Technologies for Further Evaluation.** The following technologies were identified for further evaluation:

1. Wastewater Treatment for BNR (approximately 6-10 mg/L TN) treatment requirements:

- SBRs
- Oxidation Ditches with a pre anoxic zone

2. Wastewater treatment for ENR (3mg/L TN on average) treatment requirements:

- SBRs followed by denitrification filters
- Oxidation ditches with pre and post anoxic zones, and followed by effluent polishing filters

3. Disinfection (if required by MassDEP)

- UV disinfection.

4. Residuals Management:

- Screenings and grit removal in the headworks
- Reuse/conversion of existing tanks for sludge and septage storage and thickening
- Reuse of existing sludge dewatering facilities

5. Wastewater Collection:

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

5.10 EVALUATIONS FOR FINAL SCREENING AND PRELIMINARY DESIGN OF A POTENTIAL TOWN-WIDE COLLECTION AND TRATMENT SYSTEM

A. **Introduction.** As discussed in Chapter 2, the Town Selectmen wanted to consider wastewater implementation options at a time when the CWMP Project was on hold as MassDEP and MEP developed revised nitrogen limits. The Selectmen wanted to know the costs if the whole Town were sewered and the wastewater was treated at an upgraded and expanded WWTF.

These costs were needed to decide if such a large capital project was affordable in Chatham, and if other capital projects in Chatham should still be considered. The preliminary design was also completed at this time for the following additional reasons:

- The preliminary design of a collection system would define sewershed areas based on topography, road layout areas, and maximum practical use of gravity systems as requested by previous alternative evaluations. This sewershed identification and the linking of sewersheds with a series of pump stations would provide a sewer system master plan that could be implemented over time to meet several sewering priorities and to provide flexibility of being incorporated with other Town (and private redevelopment) projects.
- The preliminary design of the upgraded and expanded WWTF would define a robust treatment process that could be modified if additional treatment requirements (beyond nitrogen and the traditional sanitary parameters) were required by MassDEP in the future. It would also define the full size and costs to treat flows from the whole Town. This knowledge allows the major treatment components to be planned in phases (modular components) to reduce costs and allow flexibility of collection system implementation.
- The preliminary design allowed a complete investigation of a total centralized wastewater system for Chatham by Stearns & Wheler, the Chatham WWTF operation's Supervisor, and the TAG members.

B. **Final Screening Evaluation for Wastewater Treatment Technologies.** These evaluations were made through several meetings and the review of several technologies and specific manufacturers. The following understanding was decided early in the process:

- The technology chosen must be well proven, robust, and modular to allow efficient expansion in treatment requirements (nitrogen removal limits) and in capacity.
- A new headworks was needed for screenings and grit removal.
- The oxidation ditch configuration offered the most robust process with the simplest operational requirements. It could be easily modified to go from BNR standards to ENR standards. Some of the oxidation ditch configurations also provide significant phosphorus removal.

- If effluent disinfection is required by MassDEP it should be a UV radiation system, and system costs should be understood for future discussions with MassDEP.
- Treated water recharge should be as close to the WWTF as possible to minimize pumping costs and MassDEP permitting (and monitoring) requirements. Additional efforts were initiated to model the groundwater flow resulting from an increased recharge (this work is described in Chapter 7). This method was believed to be the most cost effective, but a scenario to reuse the treated water for spray irrigation around Town was also completed (also described in Chapter 7).

Two trips (by Stearns & Wheler staff, TAG members, and operations staff) were completed to the Chesapeake Bay area and Wisconsin, to tour treatment plants and determine the suitability of the available technologies to achieve low levels of effluent nitrogen in cold climates. An oxidation ditch configuration with concentric rings (Orbal® type of process) was decided to be the most practical and flexible, as a long-term technology solution in Chatham.

C. **Final Screening Evaluations for Wastewater Collection Technologies.** These evaluations included several meetings and the review of several technologies and manufacturers of the collection system equipment. Presentations were made to the TAG, CAC, and Board of Selectmen on the issues related to collection system technologies. The following understanding was decided early in the process:

- The use of gravity wastewater collection should be maximized to avoid having to place grinder pumps on many properties.
- A sewer model should be developed to evaluate the limits of individual sewersheds and to become a master plan for sewer implementation.
- The sewer master plan would identify the relay sewersheds and pump stations that would become conduits for wastewater flows from other sewersheds on the way to the WWTF.

A field trip was made to a coastal Massachusetts town (Mattapoisett) that is in the middle of a sewer expansion program and has standardized on a similar type of collection system as the type envisioned for Chatham. A second trip was made to the manufacturer of a suction lift pump that would be a robust standardized type of pumping station.

From these evaluations a sewer model and master plan was developed incorporating the concepts discussed above. This master plan is illustrated in Figure 5-1.

Tables

<u>**TABLE 5-1**</u>

SUMMARY OF ADVANCED SECONDARY TREATMENT TECHNOLOGIES

ALTERNATIVE	REGULATORY REQUIREMENTS	EFFLUENT QUALITY	MAINTENANCE REQUIREMENTS AND COMPLEXITY OF OPERATION	FLEXIBILITY	ENERGY USE	LAND REQUIREMENTS	POTENTIAL FOR AIR EMISSIONS	PUBLIC ACCEPTANCE	EASE OF IMPLEMENTATION	RELATIVE CAPITAL COSTS	RELATIVE O&M COSTS	SELECTED FOR FURTHER EVALUATION
Activated Sludge MLE Process	All these processes need MassDEP approval and require an effluent discharge permit.	Effluent N, 3 to 10 mg/l. BNR/ENR	Moderately complex. High reliability and proven performance. Good process control allows adjustable performance	High flexibility with good process control.	High energy use for aeration.	Relatively small building and equipment footprint required.	Not a significant source of odors.	High. Would require modification of existing tanks.	Requires modification of existing facilities.	Moderate, compared to other facilities.	Moderate, compared to other facilities.	No, reuse of existing facilities with modifications would not provide sufficient capacity. New larger facilities would be required.
Rotating Biological Contactor (RBC)		Effluent N, 6 to 10 mg/L. BNR	Relatively easy operations.	Moderate, with minimal process control.	Low energy use for aeration.	High for large covered process.	Not a source of problems in existing installations.	Moderate. Would require construction of new tanks at high cost.	Requires construction of new facilities.	High capital costs.	Low compared to other facilities.	No, primary treatment required. High capital costs.
Sequencing Batch Reactor (SBR) following denite filter		Can meet 3 to 10 mg/L total nitrogen. BNR/ENR	High reliability and proven performance at limited number of facilities. Good process control allows adjustable performance.	Unique operator control of process cycles accommodates variable influent flows and loadings.	Aeration and effluent pumping equipment requirements.	Relatively small.	Not a source of problems in existing installations.	Moderate. Reliable technology with proven performance.	Requires construction of new facilities.	Moderate capital costs.	Moderate, compared to other facilities.	Yes, due to proven reliability and performance and moderate capital costs.
Membrane Bioreactors (Zenon, Enviroquip)		Effluent N, 3 to 6 mg/L. BNR/ENR	Need to clean membrane filters. More complex operations.	High flexibility with good process control.	Aeration and pumping requirements.	Relatively small.	Not a significant source of odors.	Moderate.	Requires modification of existing facilities.	Moderate capital costs. No large installations exist.	Moderate. Automated processes reduce costs; maintenance of mechanical equipment increases costs.	No, due to complexity, and O&M requirements.
Activated Sludge/Extended Air in new tankage (Carrousel, Orbal)		Can meet 3 on average total nitrogen. BNR/ENR	High reliability and proven performance. Good process control allows adjustable performance	Somewhat less flexible than other technologies.	Lower aeration requirements than for MLE processes.	Higher due to size and number of tanks required.	Not a source of problems in existing installations.	Moderate. Many successful installations, but requires new large tanks.	Requires construction of new facilities.	High capital costs compared to other facilities.	Moderate compared to other facilities.	Yes, due to proven reliability and performance and low O&M costs.
Aerated Biological Filter (Biofor, Biostyr)	All these processes need MassDEP approval and require an effluent discharge permit.	Typically provides nitrification but not denitrification.	Relatively simple filter operations and maintenance.	Less flexibility and process control.	Aeration and pumping requirements.	Relatively small.	Not a significant source of odors.	Moderate. Requires new facilities.	Requires construction of new facilities.	Moderate capital costs.	Moderate.	No. It is best to obtain combined nitrification and denitrification.
Denit Filter		Process can meet 3 to 5 mg/L total nitrogen (and reduce BOD and TSS) with methanol feed and upstream nitrification.	High reliability and proven performance. Relatively simple operations.	Control of methanol feed allows good treatment of variable nitrate loadings. Filtration enhances process flexibility.	Filter backwash and possible effluent pumping.	Relatively small.	Minimal potential.	Moderate. Requires new facilities.	Can be added to end of various treatment trains easily.	Moderate capital costs when used in conjunction with other nitrogen removal processes.	Moderate for methanol feed.	Yes. Denitrifying filters can reliably produce an effluent of 3 to 5 mg/L total nitrogen and should be considered for effluent polishing.
Solar Aquatics	All these processes need MassDEP approval and require an effluent discharge permit. They may also need pilot testing.	Not expected to reliably produce a high quality effluent year-round.	High operations and maintenance requirements.	Minimal process control.	Minimal.	High compared to other centralized alternatives.	Odors are possible, although treatment is spread over a large area.	Moderate; systems are typically popular because they use natural processes, but have high capital costs and use large land areas.	Extensive site work required to accommodate all the area needed for wetland construction. Piloting may be needed.	High costs for site work and facility construction.	Moderate due to energy use and high maintenance requirements.	No, due to high land requirements, siting issues, and the inability of process to provide consistent quality effluent year-round.
Constructed Wetlands		Not expected to reliably produce a high quality effluent year-round.	Simple system with minimal process control. Likely to have lower quality effluent in winter.	Moderate; can be expanded for additional flows.	Minimal.	Very high compared to other centralized alternatives.	Odors are possible if flooding occurs.	Moderate; systems are typically popular because they use natural processes, but have high capital costs.	Extensive site work required to accommodate all the area needed for wetland construction. Piloting may be needed.	High costs for site work and facility construction.	Low due to low energy requirements and vegetation harvesting.	No, due to high land requirements, siting issues, and the inability of process to provide consistent quality effluent year round.

TABLE 5-2

SUMMARY OF DISINFECTION TECHNOLOGIES

ALTERNATIVE	REGULATORY REQUIREMENTS	EFFLUENT QUALITY	FLEXIBILITY	ENERGY USE	LAND REQUIREMENTS	POTENTIAL FOR AIR EMISSIONS	ANTICIPATED PUBLIC ACCEPTANCE	EASE OF IMPLEMENTATION	MAINTENANCE REQUIREMENTS AND COMPLEXITY OF OPERATION	RELATIVE CAPITAL COSTS	RELATIVE O&M COSTS	SELECTED FOR FURTHER EVALUATION
Chlorination using Sodium Hypochlorite	Chemical storage requirements	Fecal coliform of <200/100 ml. Potential production of THM in effluent.	Process control will vary the chemical feed rate with variable effluent flows.	Low energy use for chemical feed only.	Highest for chlorine contact tank.	Minimal for stored liquid chlorine solutions.	High, with sufficient precautions in case of chemical release.	Requires the construction of a new large contact tank.	Well-proven technology, with proven reliability. Minimal maintenance.	Moderate cost for new contact tanks and feed equipment.	Moderate due to costs for NaOCl.	No, due to liabilities of hypochlorinite transportation and storage, potential THM production in the groundwater.
Disinfection with ozone	Chemical storage requirements	Fecal coliform of <200/100 ml.	Process control will vary the chemical feed rate with variable effluent flows.	High electricity use for generation of ozone.	Low	Potential release of ozone gas. Off-gas is normally treated to remove (and destroy) ozone.	High, with sufficient precautions in case of chemical release.	Easy	More complicated equipment with maintenance.	High costs for ozone equipment.	High electrical cost for generation of ozone.	No, due to high capital and O&M cost and less proven technology in the United States.
Disinfection with UV radiation	None	Fecal coliform of <200/100 ml.	Less process control. Unable to adjust to variable effluent flows.	Moderate electricity use to power UV bulbs.	Low	Minimal potential because no gases are used.	High public acceptance.	Easy	UV radiation is an accepted technology, with proven reliability. UV bulbs must be cleaned.	Moderate costs for UV radiation equipment.	Moderate electrical cost to power bulbs and maintenance costs to clean and replace bulbs.	Yes

TABLE 5-3

SUMMARY OF SLUDGE PROCESSING AND DISPOSAL ALTERNATIVES

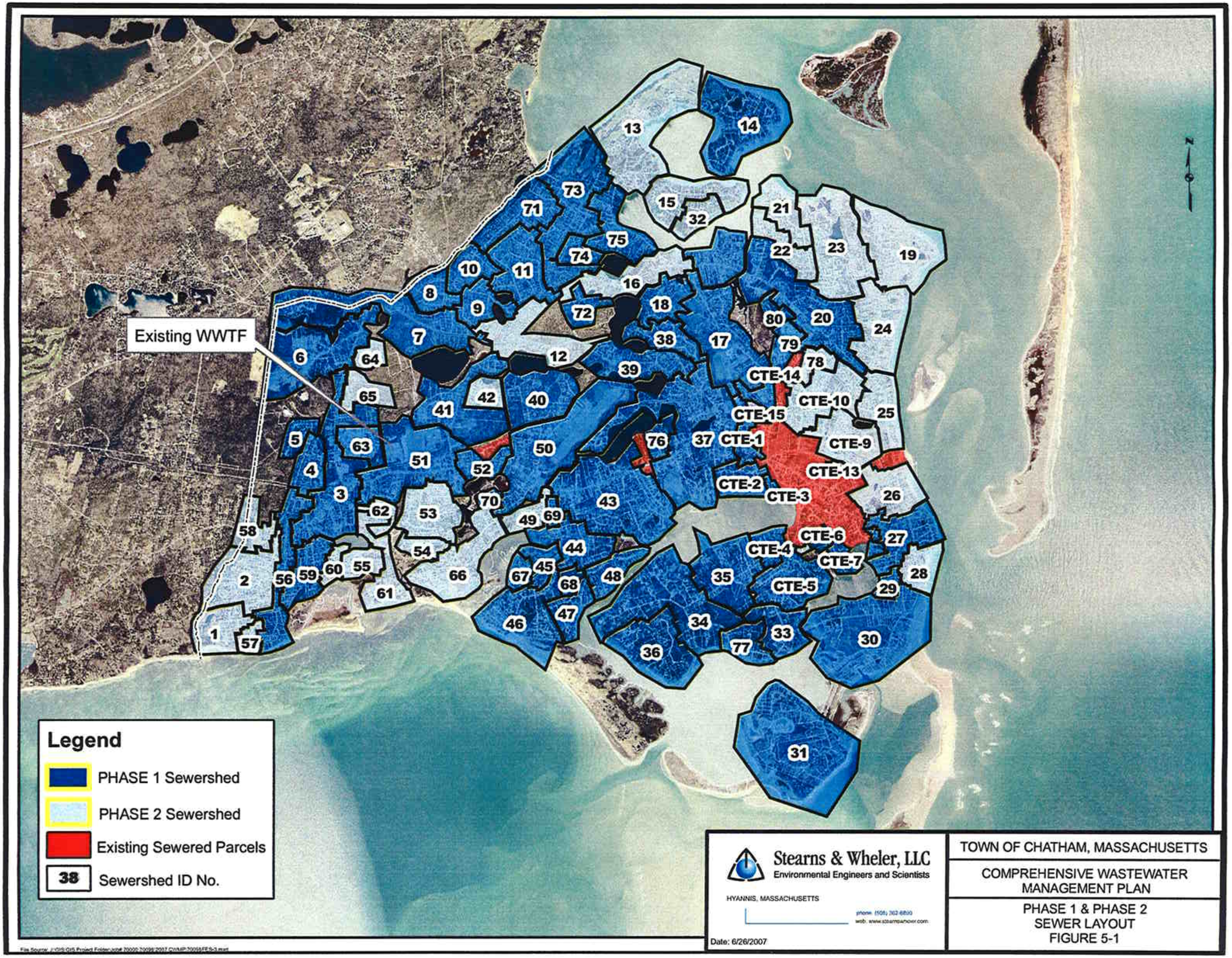
ALTERNATIVE	REGULATORY REQUIREMENTS	EFFLUENT QUALITY	MAINTENANCE REQUIREMENTS AND COMPLEXITY OF OPERATION	FLEXIBILITY	ENERGY USE	LAND REQUIREMENTS	POTENTIAL FOR AIR EMISSIONS	PUBLIC ACCEPTANCE	EASE OF IMPLEMENTATION	RELATIVE CAPITAL COSTS	RELATIVE O&M COSTS	SELECTED FOR FURTHER EVALUATION
Sludge thickening and disposal at a regional facility	Siting, design, and permitting requirements for new facilities.	Responsibility of regional facility and not applicable to disposal evaluation.	Town depends on outside source for reliable disposal.	Variety of disposal facilities accept thickened sludge both on and off-Cape.	Low.	Low.	Odor control facilities are often required.	Thickening facilities could be part of a new large facility, or use/expansion of the existing Chatham facility.	Easiest. Many regional facilities accept liquid sludge.	Relatively low compared to other disposal alternatives.	Disposal costs are typically competitive with disposal of dewatered sludge. Equipment maintenance is minimal.	Yes, due to the need to have flexible operations, and take advantage of existing facilities at the existing Chatham WWTF.
Sludge dewatering and disposal at a regional facility	Siting, design, and permitting requirements for new facilities.	Responsibility of regional facility and not applicable to disposal evaluation.	Town depends on outside source for reliable disposal. Dewatering equipment is typically reliable.	Limited number of facilities receiving dewatered sludge	Moderate due to operation of dewatering equipment.	Low.	Odor control facilities are often required.	Dewatering facilities would be part of a large centralized facility.	Relatively easy due to existing facilities.	Moderate due to dewatering equipment and building.	Disposal costs can be reduced because solids are consolidated. Equipment maintenance costs are higher.	Yes. Taking advantage of the existing facilities.
Sludge thickening, dewatering, and composting (or alkaline stabilization)	Siting, design, and permitting requirements for new facilities.	Capable of producing a material that can be distributed to the public.	Previous installations on Cape Cod were shut down due to odors and poor economics.	Limited options for disposal if public interest in taking material is low.	High due to extensive equipment and odor control facilities.	High for covered structures, storing, and loading areas.	High potential for odors. Previous facilities on Cape Cod shut down due to odors.	Adjacent property owners may not accept this process due to odors, large land requirements, and visual impacts.	Difficult due to construction of new facilities and extensive permitting.	High compared to thickening and dewatering.	High due to purchase of materials, operation and maintenance of equipment, and operator requirements.	No, due to higher costs and uncertain demand and/or markets for the finished product
Sludge thickening and/or dewatering and land application	Siting, design, and permitting requirements for new facilities. Regular sampling, analysis, and reporting to DEP.	There is a risk that nitrogen will leach from the sludge and enter the groundwater system.	Relatively simple in agricultural areas, but expected to have difficult permit requirements in Chatham.	Can be flexible if there is sufficient land area.	Low.	High.	High.	Low.	Extensive permitting requirements and minimal locations for the land application.	Low if there is a nearby agricultural economy.		No, this method is not appropriate for Chatham because there are few expansive agricultural areas.

TABLE 5-4

SUMMARY OF COLLECTION SYSTEM TECHNOLOGIES

TECHNOLOGY	RELIABILITY	FLEXIBILITY	ENERGY USE	LAND REQUIREMENTS	PUBLIC ACCEPTANCE	IMPLEMENTATION	RELATIVE CAPITAL COSTS	RELATIVE O&M COSTS	SELECTED FOR FURTHER EVALUATION
Gravity Sewers and Pumping Stations	Very reliable. Longest track record and widely used. Pumping stations do require electricity, but generators are typically provided.	Can be expanded to serve additional areas. Initial flows not critical.	Pumping stations require energy and typically have emergency generators to keep system operational.	Sewer typically located in street. Land may be required for pumping stations. Easements may be required for sewers.	Well-known technology. Deep excavations can cause traffic disruption. Low chance of backups into structures.	Most difficult implementation due to deeper excavations and the need for constant slope.	Moderate. Installation cost depends upon topography in area. Pumping stations or deep lines can increase costs.	Moderate since pumping stations must be maintained. Sewer line requires little maintenance.	Yes, due to wide use, simplicity, reliability of technology and low maintenance requirements.
Pressure Sewers and Grinder Pumps	Reliable. Large number of grinder pumps and dependence on electricity limit reliability.	Can easily be expanded to serve additional areas within head limitations of system. Initial flows not critical.	Pumps require energy for operation. System cannot be operated during power failures unless each pump has standby power.	Sewers typically located in street or road ROWs. No land requirements. Easements may be required for sewers.	Each home or group must have a pump. Power outage can cause backup into structures and reduce potential public acceptance.	Easier installation due to shallower excavations and less critical slopes.	Moderate. Pipelines installed at minimum depth. Pump required at each home or group of homes.	Moderate since grinder pumps must be maintained. Seasonal homes require flushing.	Yes, due to adaptability in areas of varying topography and low construction costs.
Septic Tank Effluent Pump (STEP) System	Somewhat reliable. Large number of STEP pumps and dependence on electricity limit reliability.	Can be expanded within pressure limitations of pump. Initial flows somewhat critical.	Pumps require energy for operation. System cannot be operated during power failure unless each pumping station has standby power.	Sewers typically in street. Land requirements for septic tanks and pumps may be on individual properties. Easements may be required for sewers.	Each home must have a pump and septic tank. Odor potential may reduce public acceptance.	Easier installation due to shallower excavations and less critical slopes. May impact nitrogen removal at the WPCF.	Moderate. Pumps required at each home. Lines installed at minimal depth.	High due to maintenance of pumps and operator training. Septic tanks must be pumped periodically.	No, based on solids handling requirements, special equipment at connection points and integrity of existing septic tanks cited, and impacts on nitrogen removal at WCPF.
Septic Tank Effluent Gravity (STEG) System.	Very reliable but less widely used. System does not require mechanical components.	Can be expanded. Initial flows not critical.	Sewers do not require energy. Pumping stations require energy and typically have generators to keep system operational.	Sewers typically in street. Land requirements for septic tanks and pumps may be on individual properties. Easements may be required for sewers.	Each home must have a septic tank. Odor potential may lower acceptance. Chance of backup is minimal.	Easier installation due to shallower excavations, but constant slopes must be maintained. Not feasible where septic tank elevations are low. May impact nitrogen removal at the WPCF.	Moderate. Pipelines installed at shallow depths. Pumping stations can increase costs.	Moderate. Sewer line requires little maintenance. Septic tanks must be pumped periodically. Pumping stations must be maintained.	No, based on the solids handling requirements, special equipment at connection points and integrity of existing septic tanks cited, and impacts on nitrogen removal at WCPF.
Vacuum Sewers	Reliable. Maintaining vacuum pressure limits the reliability of the system, however no power is required at individual properties for valve pits.	Difficult to expand. Initial flows must be accurately estimated and expansion is limited. More difficult to make future connections if not planned ahead.	Energy is required to maintain vacuum at stations. Power typically supplied by generator during outages. Power not required at valve pits.	Sewers in street or road ROWs. Land will be required for vacuum stations. Easements may be required for sewers.	Valve pits are required at each property and vents are required on each gravity lateral reducing public acceptance. Multiple connections per valve pit create potential for backups.	Shallower excavations than gravity sewers; however, more complex system with critical design features that must be installed properly for the system to function properly. High level of testing required during sewer installation.	High. Large number of vacuum stations may be required and valve pits are required.	High. Valve pits and vacuum stations must be maintained. Additional operating training will be required.	No, topography and distance between homes and size of services areas will make this cost prohibitive. O&M is expected to be greater than other technologies.

Figures


Existing WWTF
Legend
PHASE 1 Sewershed
PHASE 2 Sewershed
Existing Sewered Parcels
38 Sewershed ID No.
Stearns & Wheler, LLC
Environmental Engineers and Scientists
HYANNIS, MASSACHUSETTS
Date: 6/26/2007
TOWN OF CHATHAM, MASSACHUSETTS
COMPREHENSIVE WASTEWATER MANAGEMENT PLAN
PHASE 1 & PHASE 2 SEWER LAYOUT
FIGURE 5-1
CTE-1
CTE-2
CTE-3
CTE-4
CTE-5
CTE-6
CTE-7
CTE-9
CTE-10
CTE-13
CTE-14
CTE-15