Appendix 4-4

Summary of Detailed Evaluation for Sludge Management

1 Sludge Management Evaluations

The purpose of this Appendix is to summarize sludge management evaluations completed in the November 2007 Alternatives Screening Analysis Report and additional analysis. Sludge management represents a large cost of operating a modern WWTF as well as a potential source of odors; therefore understanding the various options to manage sludge is critical.

Sludge (also called biosolids) is a combination of microorganisms, and organic and inorganic material generated in advanced treatment processes. Sludge is produced from the treatment process 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 (or reused) at regional facilities at a concentration of 4-6 percent total solids. Also, it can be dewatered and disposed (or reused) at regional facilities as a sludge cake at a concentration of 15 to 25 percent total solids. It can also be dewatered and composted on site to produce a soil conditioner material of approximately 35 to 50 percent total solids.

The following text identifies the main methods to process sludge and the sludge management alternatives (comprised of the processing methods) evaluated.

1.1 Sludge Processing Methods

Sludge processing methods are divided into the four main categories as detailed below:

1.1.1 Sludge Thickening

Sludge thickening is a process to concentrate sludge, generally to 4-6 percent solids, by removing a portion of the liquid fraction. Sludge thickening reduces transportation and disposal costs and facilitates additional sludge treatment processes, including dewatering and stabilization. Sludge thickening can be accomplished by several processes. The simplest thickening process involves storing sludge in an aerated tank and periodically stopping aeration to allow sludge to settle and excess liquid to be decanted to the main wastewater treatment process. Other thickening processes are more complicated and utilize equipment such as filters, centrifuges, and rotating drums. Thickening with these types of mechanical equipment (mechanical thickening) often requires a covered process building, odor control facilities, and additional process equipment such as feed pumps and piping. Mechanical thickening also typically requires the addition of chemicals, such as polymer, to condition the sludge and facilitate the thickening process. The existing Blacksmith Shop Road WWTF utilizes a mechanical sludge thickening process, and the thickened sludge is transported to a regional facility for disposal or reuse as allowed by the transportation contract.

1.1.2 Sludge Dewatering

Sludge dewatering is a physical process, using equipment such as a belt filter press or centrifuge to reduce the water content of thickened sludge to 15-25 percent solids. Dewatered sludge, also known as sludge cake, has the consistency of moist sawdust and requires less volume for storage or transportation to a disposal (or reuse) site.

1.1.3 Sludge Stabilization – Composting, Digestion, Alkaline Stabilization or Heat Treatment/Drying

Sludge is often stabilized to reduce pathogens, odors, and the potential for the sludge to biologically decay. Sludge stabilization processes can be used prior to or following sludge dewatering. Common sludge stabilization technologies include composting, digestion, alkaline stabilization, and heat treatment and drying.

1.1.4 Composting

Composting is a biological sludge stabilization process that destroys pathogens, reduces the water and organic solids content of dewatered sludge, and produces a granular, soil-like material of 35-50 percent solids. Sludge composting processes typically include the following three steps:

1) Dewatered sludge is mixed with a bulking agent such as wood chips, yard waste, or sawdust.
2) The mixture is aerated or regularly mixed, which increases the temperature of the mixture, killing pathogens and degrading the highly volatile solids of the sludge.
3) The composted material is cured and stored for distribution.

Finished compost can be distributed to the public if it meets numerous rigorous criteria established by MassDEP regulations. Composting is typically most successful if the sludge to be composted has already been digested because the material is partially stabilized, there is less potential for generation of odors, and the sludge is easier to handle. Although composting can provide a beneficial reuse of sludge, it is usually not cost effective for low sludge flows (WWTF less than 3 mgd in size). Sludge composting facilities often consist of large covered structures to shelter the compost machinery and odor control facilities. The facility would need to include a liner / containment to prevent runoff offsite and/or leaching to groundwater, particularly given the nutrient management concerns in the Town of Falmouth. Land areas and capital costs are usually relatively high for composting facilities.

There have been 3 failed attempts of sludge composting on Cape Cod since the 1980s. They were at the Otis WWTF, the Tri-Town Septage Treatment Facility, and the Yarmouth Dennis Septage Treatment Facility. They have failed due to a combination of odor generation, inability to consistently meet MassDEP requirements to allow distribution of the compost material, complex operational and mechanical problems, and economics. All of the sludge produced at Cape Cod WWTFs is currently transported off Cape for disposal or reuse at regional facilities. It is believed that any future composting facility would need to be an enclosed system with excellent process control to eliminate odors, operational problems, and fully meet the MassDEP requirements.

1.1.5 Digestion

Digestion is a biological stabilization process that reduces the number of pathogens and the overall solids content of sludge through the use of microorganisms. The microorganisms feed on the organic material in the sludge and are utilized in two types of sludge digestion processes: anaerobic digestion and aerobic digestion. Digested sludge can be dewatered, composted, or disposed of at a regional facility. Anaerobic digestion produces methane gas that can be used as a fuel source.

Anaerobic and aerobic sludge digestion processes typically include two or more large covered tanks. Thickened sludge is fed into the tanks where anaerobic or aerobic microorganisms decompose the sludge. Mixing and/or aeration equipment is required to improve the digestion process and maintain either an anaerobic or aerobic environment. The digestion process also requires covered buildings to protect process equipment and odor control facilities. Anaerobic digestion produces methane gas which, if produced in large enough volumes, can be used as a supplementary energy source. Sludge digestion is typically not cost effective for small WWTF (WWTF less than 3 mgd in size.

1.1.6 Alkaline Stabilization

Alkaline stabilization is a process in which dewatered sludge is combined with an alkaline material, such as cement kiln dust or lime to raise the pH, raise the temperature, and reduce the water content of the

sludge. Raising the pH and temperature of the sludge creates an environment which is hostile for pathogen growth and reproduction. Alkaline stabilization, like composting, can produce a material that meets MassDEP's requirements for distribution to the public.

The primary market for an alkaline stabilized sludge is the agricultural industry. The alkaline stabilized sludge has alkalinity and nutrients that are useful for growing field crops; however, this type of agricultural market does not exist on a sufficient scale on Cape Cod or in southeastern Massachusetts to justify alkaline stabilization of sludge on Cape Cod. The facilities required for alkaline stabilization include enclosed areas for storing alkaline materials, processing the sludge-alkaline material mixture, and storing the final product. Equipment requirements include screw conveyors for transferring the alkaline materials, a mixing unit that combines dewatered sludge and alkaline material, and a drying process for the blended material. Land area requirements and capital and operations costs are comparable to those of a composting facility. Alkaline stabilization is typically not cost effective for small WWTF or in places where there is not a market for the final product.

1.1.7 Heat Treatment and Drying

Heat treatment and drying are thermal stabilization processes that involve heating sludge under pressure to disinfect and dry the sludge. The resulting material is easier to dewater and may be dried to produce a powdered or pelletized product, which can be used as a fertilizer or soil conditioner.

These processes generally have high capital costs, high level of complexity, high energy usage and operation costs. In addition, thermal processes require a continuous flow of sludge to keep the process running and are therefore usually not cost effective for low sludge flows at small WWTFs.

1.2 Sludge Management Alternatives

The sludge processing methods described in the section above have been paired with reuse/disposal options to form several overall Sludge Management Alternatives for further evaluation: sludge thickening and transport to a regional facility for disposal or reuse; sludge dewatering and transport to a regional facility for disposal or reuse; sludge dewatering, composting (and/or other stabilization processes), and distribution to the public; sludge thickening and/or dewatering and land application.

Under each of these alternatives, the new sludge processing facilities could be constructed at a new WWTF site or at the Town's existing main WWTF site on Blacksmith Shop Road (BSR). The existing sludge processing facilities at the Town's main WWTF would need to be substantially modified and expanded to accommodate the wastewater sludge from the current Planning Area under any of the alternatives. Also, if sludge management is centralized at one site, but wastewater treatment continues at more than one site (existing BSR site and at a new WWTF site), un-thickened sludge would need to be hauled from one site to the other for processing.

The recently constructed (2005) sludge management facilities at the existing main Falmouth WWTF include the following processes:

- Sludge storage
- Sludge and septage thickening
- Thickened sludge disposal by a contracted sludge trucking company at a MassDEP-approved sludge disposal and/or reuse facility

This disposal option was determined to be the most cost effective in the 2001 Wastewater Facilities Plan after evaluation of several sludge processing and disposal alternatives.

The sludge management alternatives evaluation is summarized on the following pages. A diagram identifying potential sludge management alternatives is included as Figure 5-11.

1.2.1 Sludge Thickening and Transport to a Regional Facility for Disposal or Reuse

This alternative would involve the transportation and disposal (or reuse) of thickened sludge at a regional facility. This would require the construction of sludge storage and thickening facilities. The thickened sludge would be transported to a regional facility for disposal or reuse (typically to Cranston RI or Fitchburg MA for incineration).

This alternative has the following advantages:

- Minimizes capital costs and equipment operational costs.
- Reduces risk of odor generation.

This alternative has the following disadvantages:

- It may not meet some public desires to reuse the material locally. Thickening results in a larger volume of “thinner” sludge for hauling/disposal than dewatering or stabilization/composting.

1.2.2 Sludge Dewatering and Transport to a Regional Facility for Disposal or Reuse

Using this alternative, facilities would be constructed to store and dewater the sludge, and sludge cake would be transported to a regional facility for disposal/reuse.

This alternative has the following advantages:

- Disposal costs for sludge cake are less than those for thickened liquid sludge.

This alternative has the following disadvantages:

- Dewatering equipment is generally more expensive to purchase/install than simple thickening equipment.
- There are few regional disposal facilities that accept sludge cake and the cost savings with sludge cake disposal do not offset the higher cost to produce it.
- The sludge dewatering process provides a greater potential for release of odors than thickening.

1.2.3 Sludge Dewatering, Composting (or other stabilization process), and Distribution to the Public

This alternative involves the construction of sludge storage, dewatering and composting facilities, with the primary goal to produce a material that could be distributed to the public or to the agricultural market. Experience indicates that the public will pick up and use composted material if it is free and of good quality; however it is unknown whether the demand would be sufficient in Falmouth such that all material would be picked up by local end users, or whether some material would have to be transported offsite to other regional users.

Composting (or other stabilization process) and distribution of compost would have the following advantages:

- The Town would not have to pay for sludge disposal (if sufficient demand was found for free pick up of the composted product).
- Beneficial reuse is provided.

- The Town has more control over sludge management and is not dependent on a regional sludge facility.
- Sludge generated and thickened at multiple facilities could be dewatered and composted at one centralized location.

This alternative would have the following disadvantages:

- The demand for a composted product is low due to the relatively low number/size of agricultural areas in Cape Cod and Eastern Massachusetts. Also, the large volumes of free yard waste compost produced by municipalities on Cape Cod have reduced the local demand for soil conditioners.
- Construction and O&M costs are typically highest for this alternative.
- Extensive permitting and monitoring is required by MassDEP and USEPA prior to distribution of the finished material.
- The potential for odors is increased and adjacent property owners may not welcome this type of process.
- Large land area is required.
- It would be necessary to transport sludge to this facility from either the existing WWTF or a new WWTF or both.
- These processes require high skill levels for operation and maintenance of the complex machinery and process.

1.2.4 Sludge Thickening and/or Dewatering and Land Application

This alternative involves the thickening and/or dewatering of sludge and subsequent spreading of sludge (in very controlled application rates) onto and into the land. The land is then seeded with an agricultural crop to utilize the sludge's nutrients and turn it into soil material. This type of sludge disposal is common in the Midwestern United States, where there are large farms that welcome the nutrients. It has also been used in other places to produce inexpensive topsoil for the construction of landfill caps. This method of sludge disposal is not recommended for Falmouth because there are no large agricultural lands nearby that could use (or want) the sludge. Also, sludge contains significant amounts of nitrogen, which typically does not lend itself to application in Falmouth and the many watersheds to sensitive coastal embayments.

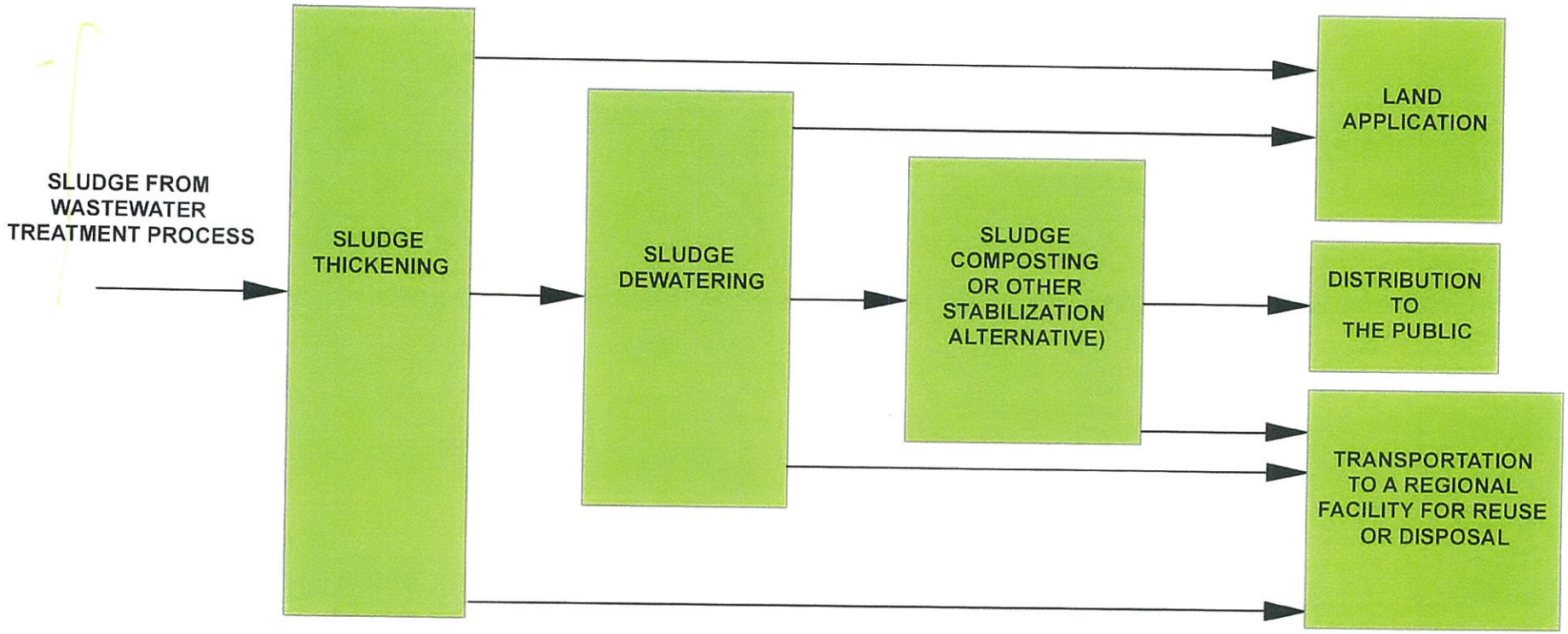
1.3 Comparison of Sludge Management Alternatives and Recommendations

The comparison of sludge management alternatives is based on the description provided for each alternative and its advantages and disadvantages. A summary of sludge management alternatives and a side-by-side comparison of standard criteria are included in Table 4-1.

Sludge thickening is a relatively simple process with lower capital costs and lower operation, maintenance, and energy requirements than any of the other alternatives. Thickened sludge can be disposed of (or reused) at a number of regional facilities. Sludge thickening is the first step required for the more complicated sludge management processes of sludge dewatering and composting and other stabilization processes; therefore these additional processes could be added in the future if desired as sludge flows increase.

Thickened sludge is believed to be the most practical sludge disposal/reuse alternative and is the recommended sludge management alternative. As the wastewater flows increase, and if energy costs and disposal costs increase significantly, this strategy could be re-evaluated for the higher flows.

Costs for the sludge management facilities are included in the cost summaries for the alternative wastewater management scenarios



Town of Falmouth, MA
CWMP

SLUDGE MANAGEMENT ALTERNATIVES

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Figure 5-11

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