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Memorandum

To	George Meservey, Director of Planning & Community Development Michael Domenica, PE, Program Manager
CC	Betsy Shreve, AICP, AECOM Project Director Jeff Reade, AECOM WW Treatment, Reuse and Biosolids Task Lead Paula Winchell, AECOM
Subject	**Town of Orleans, MA** **Water Quality and Wastewater Planning** **Task Number 1 – Facilities Engineering** **Deliverable 1.c.10 – Final Technical Memorandum on Wastewater Treatment, Residuals, Septage Management, Effluent Transmission and Pumping Components of the WWTF**
Project Number	60476644
From	Thomas Parece, P.E., AECOM Project Manager
Date	03/31/16

1. Background

a. In addition to evaluating “non-traditional” technologies, a component of the Water Quality and Planning effort currently on-going with the Town of Orleans (Town) includes evaluating conventional treatment options to address areas of the town where non-traditional technologies are not believed to be sufficient to address water quality issues. Previous evaluations have identified the Downtown Area commercial district as well as the residential area in the vicinity of Meetinghouse Pond Area as two areas of town where conventional wastewater treatment is the appropriate solution to the Town’s water quality issues.

b. Even under the banner of conventional wastewater treatment, there’s a broad range of technology options available. Task 1.c.2 is intended to better define the appropriate array of technologies for the treatment of wastewater, to include the management of treatment plant residuals, septage, and the conveyance of treated effluent to its ultimate disposal location. While initially intended to be part of this TM, the discussion of treated effluent conveyance and disposal will be addressed under separate cover.

2. Introduction

a. As part of Task 1.b, AECOM developed wastewater projections for both the downtown and Meeting House Pond areas of Town. The development of these projections has been discussed in a separate memorandum, but essentially projections were made for the current level of development, as well as a “future build-out” condition. The future build-out condition for the downtown area addressed possible re-zoning impacts and different property utilization scenarios. The future build-out condition for the Meeting House Pond was derived by simply assuming residential properties not currently developed might be so in the future. This analysis yielded the annual average flow projections listed in Table 2-1 below.

Table 2-1 - Initial and Future Build-out Flow Projections for Downtown and Meetinghouse Pond Areas

Downtown Area		Meetinghouse Pond Area	
Initial Design Flow	Future Build-out Condition	Initial Design Flow	Future Build-out Condition
184,000 gpd	250,000 gpd	70,000 gpd	110,000 gpd

Even after the completion of a sewage collection and transmission system for these two areas, there will still be a significant amount of properties in Town that continue to rely on septic systems. In addition, there will continue to be a need for septage disposal capacity to service the surrounding communities in the lower/outer Cape.

Based on a previous study[1], the existing Tri-Town Septage Treatment Facility has averaged in the order of 9 million gallons of septage annually over the past several years. The sewering of some parts of the Town will obviously decrease septage generation within Orleans. In addition, some permanent loss of market might be expected from some of the communities proximate to the Yarmouth-Dennis facility, as it expands operations to fill the void left by the closure of the existing Tri-Town Septage Treatment Facility. AECOM has conservatively prorated the existing Tri-Town Septage Treatment Facility receiving rates on a town by town basis to what they might be expected to be in the future and has arrived at a projected “high-end” septage loading of 6 million gallons annually, or 16,000 gal/d. While this rate will depend on how the Town chooses to operate the proposed Overland Way WWTF, this is considered a reasonable assumption with which to estimate loadings to the facility.

2.2 As important as flow projections, an estimate of pollutant concentrations is required to properly size WWTFs. Because there is no existing sewage collection or treatment system in place, there is no data from which to project sewage pollutant concentrations. Normal textbook[2] ranges for the key parameters of BOD, TKN and TSS are as shown in the table below. To reflect the fact that this will be a new collection system where ingress/infiltration will be low, the concentrations were assumed to be on the medium to higher end of the range.

Table 2-2 - Assumed Sewage Pollutant Concentrations

Constituent	Typical Ranges: Low	Typical Ranges: Medium	Typical Ranges: High	Value Assumed
BOD, mg/l	110	190	350	270
TKN, mg/l	20	40	70	55
TSS, mg/l	120	210	400	310

To address what impact septage receiving would have, actual annual average data from the existing Tri-Town Septage Treatment Facility was used. It was assumed that septage would be received only at the proposed Overland Way WWTF servicing the Downtown Area. Additionally, it is assumed that it will be processed with biosolids from the facility, so that only septage filtrate would be mixed with raw sewage influent to reduce solids loadings on the biological process.

[1] “Septage and Food Waste Market Study Technical Memorandum”, Stantec Consulting Services, Dec 2014
[2] “Wastewater Engineering, Treatment and Reuse”, Metcalf & Eddy, 4th ed.

The resulted blended influent as well as the influent characterization for the proposed Meetinghouse Pond WWTF are as shown in Table 2-3.

Table 2-3 - Assumed WWTF Influent Pollutant Concentrations

Constituent	Downtown Area	Meetinghouse Pond Area
BOD, mg/l	340	270
TKN, mg/l	60	55
TSS, mg/l	300	310

With the flow and concentrations defined, an analysis of treatment options for each service area was evaluated. A summary of the design criteria for both locations is included in Appendix A.

3. Description and Discussion of WWTF Options

The existing Tri-Town Septage Treatment Facility is located on a 26-acre parcel to the northwest of the Exit 12 cloverleaf. Because of the planned decommissioning of the facility, and the proximity of this location to the Downtown Area, it is a logical choice for siting a proposed Overland Way WWTF to receive flow from the Downtown Area. The Meetinghouse Pond Area however is a fair distance from this location, and would require a force main several miles long to bring flow from the eastern edges of town to either the proposed Overland Way WWTF site or the proposed Downtown Area collection area. For the purpose of this evaluation, it was assumed that a proposed smaller, satellite WWTF would be dedicated to this service area, located on the Town owned property at 223 Beach Road. The higher degree of neighborhood sensitivity associated with the Beach Road site requires as small and unobtrusive a facility as possible. This combined with the economy of scale of providing biosolids/septage processing capacity at one location led to the decision that the Beach Road site would not receive septage, and that any WWTF residuals generated would be trucked over to the proposed larger Overland Way WWTF located at the existing Tri-Town Septage Treatment Facility site. With these factors built into the basis of design, an analysis of treatment options for each location was performed as follows.

a. Downtown Service Area

1) Liquid Train - With the site selected and flow/loadings to the facility defined, AECOM used its experience with similar projects to define a list of applicable technology options for the proposed Overland Way WWTF. A list of attributes important in the selection of an appropriate liquid train treatment technology was developed, and weighting factors applied to reflect the importance of each attribute to the overall selection process. Lastly, AECOM's wastewater process team ranked each technology selection on how well it met the requirements of each attribute. A weighted ranking was then totaled for each technology. The technologies selected for evaluation and a brief description of each were as follows. The discussion will focus on the biological process, which is the heart of the treatment train and drives what systems are required up/down stream.

a) Conventional Activated Sludge ("CAS")

A commonly applied technology for medium to larger facilities, CAS consists of bioreactors containing a completely mixed combination of wastewater and a controlled population of microorganisms ("mixed liquor"). One can achieve different process objectives by controlling the conditions in separate tanks within the same process train, or segregated zones within a given tank. The key element to this technology is that after flowing through the bioreactor(s), the mixed liquor goes to a settling tank where the microorganism settle to the bottom where they are sent back to the bioreactor, while the clarified supernatant flows over weirs at the top.

b) Sequencing Batch Reactor ("SBR")

SBRs are often used for medium to smaller facilities. On Cape Cod, Provincetown and Falmouth would be examples of where SBRs are employed. SBR's combine the function of the bioreactor and settling tank into one vessel. The SBR runs in a sequential cycle broken up into different segments for filling, reacting, settling and decanting. Although they don't require a separate settling tank, they typically require flow equalization, which reduces the cost/space savings that would otherwise be realized.

c) Integrated Fixed Film Activated Sludge ("IFAS")

IFAS is a variant of CAS where media, often small plastic wheels, are retained in the bioreactor. Biofilm is allowed to grow on the media increasing the mass of microorganisms that would otherwise be suspended in the mixed liquor. Because it increases the biomass per unit volume, a smaller bioreactor is required than would be with CAS. The media itself is very expensive however, effectively eliminating the cost savings of a smaller tank. Like CAS, IFAS requires a separate settling tank.

d) Membrane Bioreactor ("MBR")

MBRs are another variant of CAS, however instead of using a settling tank, membrane filtration is used to separate the microorganism from the treated effluent. Because it does not need to rely on settling or quiescent conditions, the membrane tank can be much smaller than a conventional settling tank. The microorganism concentration within the bioreactor can be 2 to 3 times what is possible in CAS or SBR, substantially reducing the bioreactor volume required. The trade-off is in the energy required to operate the membrane separation step.

e) Rotating Biological Contactor ("RBC")

RBCs are the technology currently employed at the existing Tri-Town Septage Treatment Facility. Unlike all the other technologies, the vast majority of the microorganism providing treatment reside as a biofilm on large diameter circular disks mounted on a common shaft. The disks are semi-submerged and rotated at slow speed so that the biofilm alternates between being submerged in the wastewater, and being subject to air for oxygen replenishment. The primary advantage of RBCs is that they are a low energy consumer; however they lack appreciable process flexibility. Once commonly employed for smaller facilities, very few new installations exist and most older installations have been retrofitted to new technologies.

The criteria ranking and scoring sheet resulting from the comparison of these technologies for a wastewater treatment facility to service the Downtown Area are shown on the following page.

Table 3-1 - Wastewater Treatment Technology Selection Worksheet – Overland Way WWTF Servicing the Downtown Area

Town of Orleans, Massachusetts
Water Quality and Wastewater Planning
Downtown Area WWTF Treatment Technology Evaluation

Criteria	Criteria Weight	Technology A CAS Rating	Technology A CAS Score	Technology B SBR Rating	Technology B SBR Score	Technology C IFAS Rating	Technology C IFAS Score	Technology D MBR Rating	Technology D MBR Score	Technology E RBCs Rating	Technology E RBCs Score
Project Evaluation											
Energy/GHG Footprint	2	2	4	2	4	1	2	1	2	3	6
Capital Cost	2	2	4	3	6	1	2	2	4	2	4
LCC	2	2	4	2	4	1	2	2	4	2	4
Operational Complexity	3	2	6	1	3	1	3	3	9	2	6
Degree of Preliminary Treatment Required	1	2	2	2	2	1	1	1	1	2	2
Expansion Capability (flow/load)	3	2	6	2	6	3	9	3	9	1	3
Biosolids Production	2	2	4	2	4	3	6	3	6	3	6
Ability to Achieve Potential Stricter Limits (P, lower N)	3	2	6	1	3	2	6	2	6	1	3
Ability to Process Septage Filtrate	3	2	6	2	6	2	6	2	6	2	6
Compatibility w/Wick Well for Effluent Disposal	3	2	6	2	6	2	6	3	9	1	3
Compatibility w/Site											
Footprint Required	3	1	3	2	6	3	9	3	9	2	6
Impact on Neighbors (odors, noise)	2	2	4	2	4	2	4	2	4	2	4
Other/Overriding Considerations											
Proven acceptance by DEP	2	3	6	3	6	1	2	2	4	2	4
Market Availability (widespread availability vs. proprietary process from limited vendors)	1	3	3	2	2	2	2	2	2	2	2
Total Criteria Points		**64**		**62**		**60**		**75**		**59**	
Rank		**2**		**3**		**4**		**1**		**5**	

Notes:
High Criteria Weight = Greater Importance
Higher Rating = Better Conditions

Remarks

As can be seen in the ranking sheet, MBR achieved the highest weighted score by a fairly large margin. A previous report[3] concluded that SBR or MBR would be appropriate for a proposed Overland Way WWTF at the existing Tri-Town Treatment Facility site, but concluded that SBR was preferred because MBRs had limited track record at the time. In the ensuing years, municipal applications of MBRs have become much more common, resolving this particular concern. In this particular analysis, key differentiators were the low degree of operational complexity, expansion capability, the ability to reach potential lower permit limits in the future, and compatibility with the possible use of a Wick Well for effluent disposal, all of which MBR received higher ratings on.

MBRs in this size range are often supplied in modular package facilities. An example of a modular MBR treatment train is as shown in Figure 3-1. These units include all of the steps required of liquid train treatment to include fine screening, segregated bioreactor zones, aeration, solids separation, and UV disinfection.

Figure 3-1 Single Train MBR Treatment Module

2) Residuals/Septage Treatment - For reasons of economy of scale, impact to neighbors, and site constraints, it is anticipated that all treatment plant residuals from the proposed Meetinghouse Pond WWTF will be trucked to the proposed Overland Way WWTF site and co-processed with residuals there. Similarly, it is anticipated that septage receiving will occur only at the proposed Overland Way WWTF. AECOM would recommend that septage be processed directly with WWTF residuals to avoid the solids loading to the biological process that would result if it was introduced directly to the liquid train. An estimate of average solids generation from each source is summarized in table 3-2.

Table 3-2 - Estimate of Average Solids Production from WWTF and Septage Receiving

Item / Constituent	Meetinghouse Pond WWTF Residuals	Overland Way WWTF Residuals	Septage Receiving at Overland Way WWTF	Combined Totals
Gal/d	1,157	2,625	16,000	19,782
TSS, %	1.80	1.80	0.36	0.64
TSS, lb/d	174	394	480	1,048

A similar process to what was used to evaluate the liquid train options was conducted for residuals/septage treatment.

Under separate cover, AECOM has made the recommendation that solids processing portions of the existing Tri-Town Septage Treatment Facility be mothballed for reuse when the proposed Overland Way WWTF is constructed, however as of this writing, it is unclear whether this will happen, or the entire facility be demolished and the site restored. For the purpose of this evaluation, it was assumed that the Town will opt for the recommendation to keep portions of the existing facility for reuse.

3 “Tri-Town Septage Treatment Facility Evaluation”, Wright-Pierce, 2005

With the site selected and projected residuals/septage quantities defined, AECOM used its experience with similar projects to define a list of applicable technology options. While dewatering is usually a two-step process requiring thickening first, there are a few technologies available that allow dewatering to acceptable solids levels with one device. Two thickening technologies, two dewatering technologies, and two combined thickening/dewatering technologies were selected for evaluation. A list of attributes important in the selection of an appropriate septage/residuals treatment technology was developed, and weighting factors applied to reflect the importance of each attribute to the overall selection process. AECOM's wastewater process team ranked each technology selection on how well it met the requirements of each attribute. A weighted ranking was then totaled for each technology. The technologies selected for evaluation and a brief description of each were as follows.

a) Gravity Belt Thickener (GBT)

GBTs consist of a porous belt that moves over rollers driven by a variable speed drive unit. Feed sludge is spread evenly across the width of the belt. Water drains as the sludge travels down the length of travel. Towards the end of travel, there is typically a series of plow blades to furrow the sludge and allow for a pathway for the water released from the sludge to pass through the belt. The existing Tri-Town Septage Treatment Facility currently uses GBTs for thickening. A GBT will produce a liquid sludge at about 5 percent solids, which then can be further processed in a separate dewatering step.

b) Rotary Drum Thickener (RDT)

In a RDT, dewatering takes place along a multi-zone drum cylinder. The zones can have different size mesh media to augment capture efficiency as the sludge moves along the length of the cylinder. Finer mesh is generally used in the feed end where material is thinner, while downstream zones have larger openings to enhance water removal. A RDT processing sewage sludges typically produces a liquid sludge thickened to approximately 4 to 6 percent solids, which can they be further processed in a separate dewatering step. Unlike GBTs, where the material being processes is open to the ambient, RDTs are an enclosed unit which simplifies housekeeping and odor control.

c) Belt Filter Press (BFP)

Belt filter presses typically consist of three zones, a gravity zone, low pressure zone, and high pressure zone. The gravity zone acts similarly to a gravity belt thickener. In both the pressure zones, sludge is squeezed between two sets of porous belts. The belts travel through multiple sets of rollers, often oriented to so that the belts travel in a serpentine path. Eventually at the end of travel the squeezed dry sludge is scraped off the belt. These systems are very common in the municipal wastewater industry, however they require independent pre-thickening to achieve acceptable solids dryness.

d) Rotary Press

With a rotary press, sludge is fed into a rectangular channel, and rotated between two parallel revolving stainless steel chrome plated screens. The filtrate passes through the screens as the flocculated sludge advances within the channel. The sludge continues to dewater as it travels around the channel, eventually forming a cake near the outlet side of the press. The frictional force of the slow moving screens, coupled with the controlled outlet restriction, results in the extrusion of a very dry cake. These types of presses require independent pre-thickening to achieve acceptable solids dryness. Like rotary drum thickeners, a key differentiator of the rotary press is that it's enclosed system, making housekeeping and odor control simpler.

e) Belt Filter Press w/pre-Thickening Zone

A conventional belt filter press requires pre-thickening of the sludge prior to dewatering. There are some manufacturers however that market units that combine the features of a gravity belt thickening with a belt filter press. These units are provided with an independent gravity deck that has the capability to take sludges that are less than 1 percent feed solids and thicken more efficiently in the gravity section so that the sludge is better prepared for the high pressure zone. The independent gravity deck has the ability to run at different speeds than the pressure zone. Thinner sludges can be fed at high hydraulic feed rates to a faster moving belt on the gravity section, which then feeds a thicker sludge to the slower moving belts through the wedge and high-pressure section. The result is a machine that is not limited to the standard hydraulic and loading rates of typical two belt machines. These machines are specifically designed for sludges with feed solids less than 1.5 percent, which typically means the plant can eliminate the need for a gravity thickener or holding tank to thicken sludge prior to the belt press

f) Screw Press

Screw presses are used in an extremely wide variety of liquid-solid separation, or dewatering applications. A screw press can be used in the same applications where belt presses, centrifuges, and filter presses have traditionally been used. The screw press is a very simple, slow moving mechanical devise. Dewatering is continuous and is accomplished by gravity drainage at the inlet end of the screw and then by reducing the volume as the material being dewatered is conveyed from the inlet to the discharge end of the screw press. Proper screw design is critical, as different materials require different screw speeds, screw configurations, and screens in order to dewater to a high outlet consistency while maintaining an excellent capture rate. Like rotary drum thickeners, screw presses are enclosed units which simplifies odor control and housekeeping.

The criteria ranking and scoring sheet resulting from the comparison of these technologies is shown on the following page.

Table 3-3 - Septage/Residuals Treatment Technology Selection Worksheet – Overland Way WWTF Servicing the Downtown Area

Town of Orleans, Massachusetts
Water Quality and Wastewater Planning
Downtown Area WWTF Residuals Processing Technology Evaluation

		Thickening				Dewatering				Combined			
		Technology A		Technology B		Technology C		Technology D		Technology E		Technology E	
	Criteria	GBT		RDT		BFP		Rotary press		Combined GBT/BFP		Screw press	
Criteria	Weight	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Project Evaluation													
Operating Costs	2	2	4	2	4	2	4	2	4	2	4	2	4
Capital Cost	2	2	4	1	2	2	4	2	4	3	6	3	6
LCC	2	2	4	2	4	2	4	2	4	2	4	2	4
Operational Complexity	2	2	4	2	4	2	4	2	4	3	6	3	6
Transportation Costs	2	2	4	2	4	2	4	2	4	2	4	2	4
Solids Quality	2	2	4	2	4	2	4	2	4	2	4	2	4
Compatibility w/Site													
Footprint Required	2	2	4	2	4	2	4	2	4	2	4	3	6
Impact on Neighbors (odors, noise)	3	1	3	3	9	1	3	3	9	1	3	3	9
Other/Overriding Considerations													
Proven acceptance by DEP	2	2	4	2	4	2	4	2	4	2	4	2	4
Market Availability (widespread availability vs. proprietary process from limited vendors)	2	2	4	2	4	2	4	2	4	2	4	2	4
Total Criteria Points		**39**		**43**		**39**		**45**		**43**		**51**	
Rank		**5**		**3**		**5**		**2**		**3**		**1**	

Notes:
High Criteria Weight = Greater Importance
Higher Rating = Better Conditions

Remarks

As can be seen in the ranking sheet, the screw press achieved the highest weighted score by a fairly large margin. A key differentiator in this analysis was the fact that the screw press didn't require a separate thickening step, which reduced the overall capital cost and footprint required for solids processing. Another category that set it apart was that because it is an enclosed system, control of odors and housekeeping are significantly less of an issue than with belt types of processes where the product is open to the ambient.

3) Overall Site Layout and Costs - AECOM estimates that if some of the existing tankage is utilized to mitigate hourly fluctuations in flow, four modular MBR treatment trains would be needed to satisfy initial design conditions. A fifth treatment train would be needed to accommodate future build-out conditions. Although AECOM would recommend the installation of only four treatment trains for now, the concrete pad, piping and connections should be designed to accommodate the fifth future train should the full build-out condition materialize. A layout of a five train configuration is shown in Figure 3-2 below.

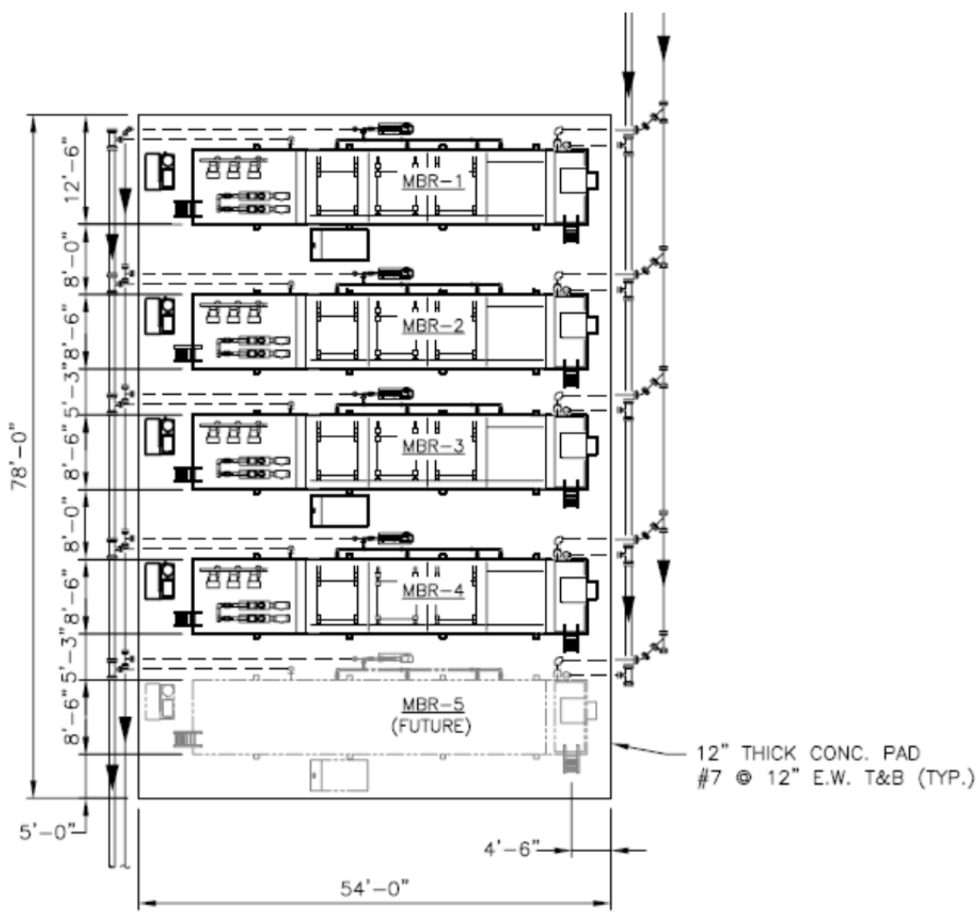


Figure 3-2 - Five Module MBR Treatment System

The overall concrete pad dimensions required for the four module build-out condition are 54 feet by 78 feet. AECOM believes a good location for the MBR system would be in the vicinity of where the primary clarifiers and RBCs are currently located. Site layouts of the current site and the proposed configuration are shown on the following pages.

Figure 3-3 - Current Site Layout at the Existing Tri-town Septage Treatment Facility

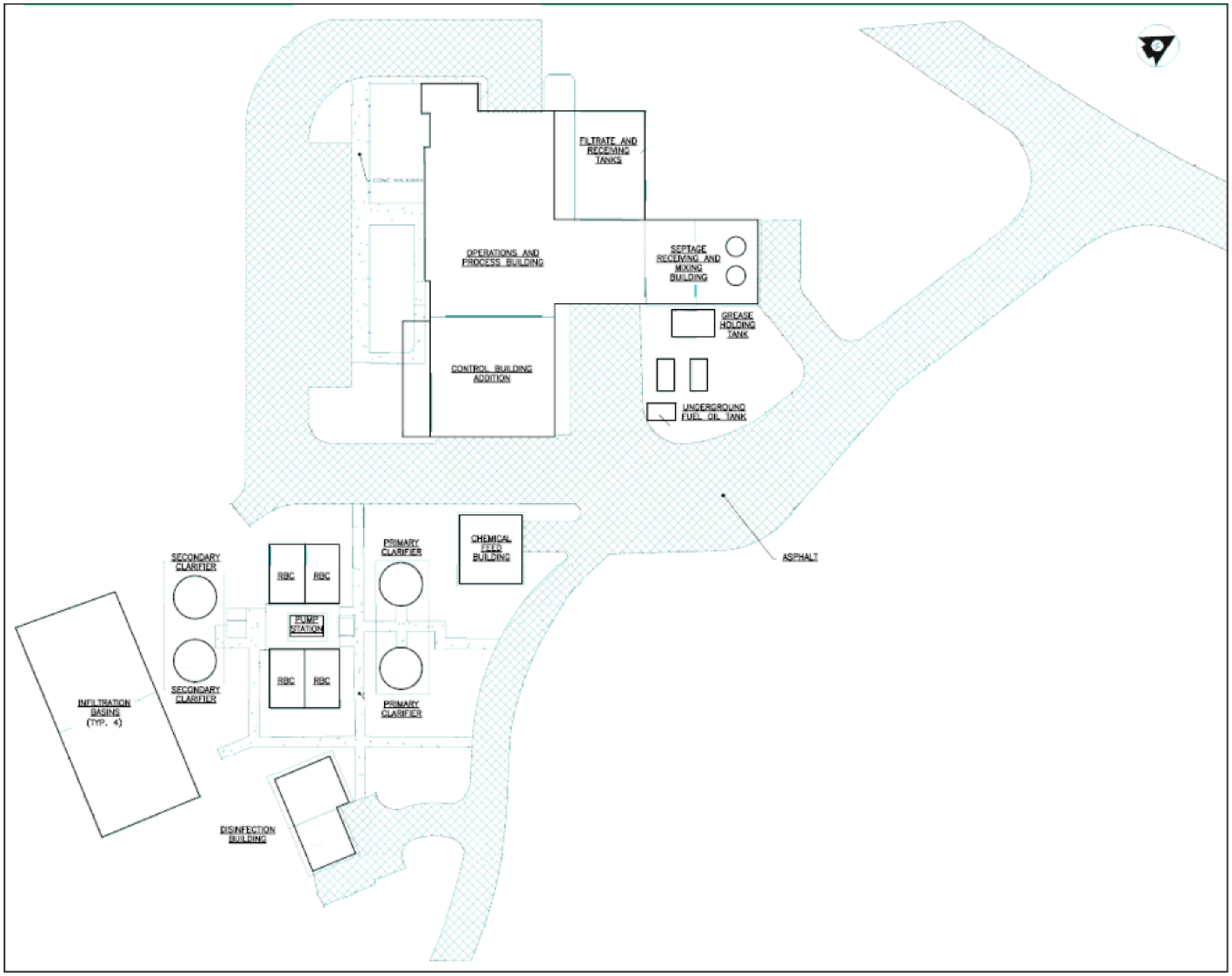
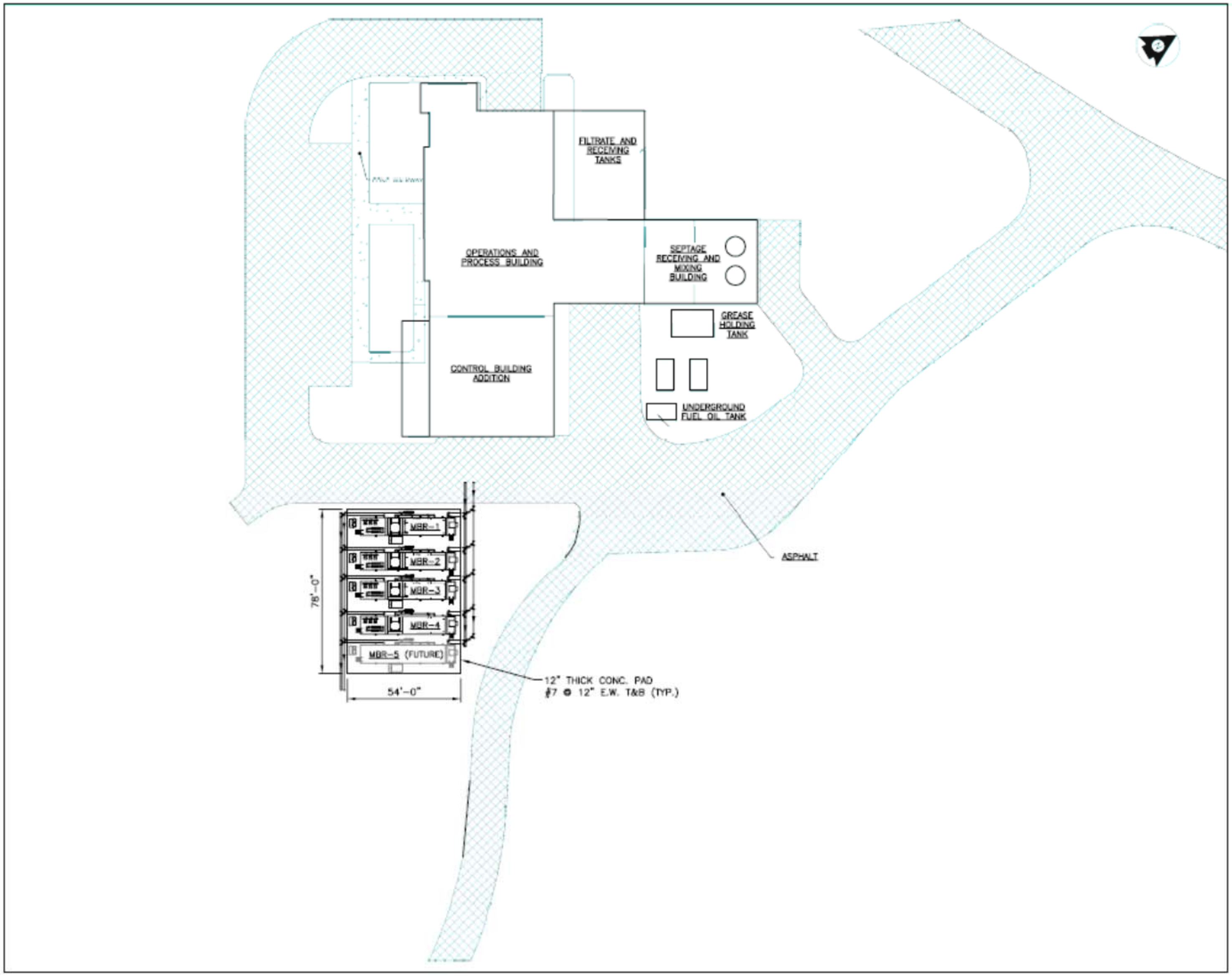


Figure 3-4: Proposed Overland Way WWTF Layout at the Former Tri-Town Septage Treatment Facility Site



With the assumption that all of the structures to the project north side of the road adjacent of the Chemical Feed Building are retained, the total estimated project capital cost was estimated at $16.5M as shown in Table 3-4.

Table 3-4 - Estimate of Capital Costs for the Overland Way WWTF Servicing the Downtown Area

Wastewater Treatment Facility - Downtown Area (Overland Way)					
Components	**Quantity**	**Unit**	**Unit Cost**	**Extended Total**	**Remarks/Notes**
Mobilization and Demobilization	1	LS	$ 382,550	$ 382,600	5% of Other Items
MBR Modules	1	Allow.	$ 4,500,000	$ 4,500,000	Includes fifth train for final build-out.
Storage Tank Rehab w/mixing	1	Allow.	$ 250,000	$ 250,000	
Intermediate and effluent pumping	1	Allow.	$ 225,000	$ 225,000	
Admin/sludge Bldg Rehab	1	Allow.	$ 1,000,000	$ 1,000,000	
Septic Receiving Station	1	Allow.	$ 210,000	$ 210,000	
Screw Press	1	Allow.	$ 150,000	$ 150,000	
Odor Control	1	Allow.	$ 300,000	$ 300,000	
Plant Water	1	Allow.	$ 133,000	$ 133,000	
Yard Piping	1	Allow.	$ 133,000	$ 133,000	
Electrical	1	Allow.	$ 500,000	$ 500,000	
SCADA	1	Allow.	$ 250,000	$ 250,000	
	-		$ -	$ -	
	-		$ -	$ -	
	-		$ -	$ -	
		Subtotal		$ 8,033,600	
		Overhead and Profit	22.0%	$ 1,767,400	
		Subtotal		$ 9,801,000	
		Contingency	25.0%	$ 2,450,300	
		Construction Total		$ 12,251,300	
		Town Administration and Engineering			
		Town Administration	5.0%	$ 612,600	
		Engineering - Planning/Consultation	5.0%	$ 612,600	
		Engineering - Design	10.0%	$ 1,225,100	
		Engineering - Construction	15.0%	$ 1,837,700	
		Total Estimated Project Cost		**$ 16,539,300**	Engineering News Record (ENR) = 10182 (Feb. 2016)

Annual Operation and Maintenance (O&M) Costs were estimated at approximately $972K/year using the following key assumptions.

- Three full time O&M technicians and one part time administrative assistant. While this is fewer staff than the existing Tri-Town Septage Treatment Facility, the proposed facility is highly automated and will require far less operator intervention for both liquid train and residuals/septage processing. It is also more in line with similarly sized facilities in the area.

- Heating costs were based on current expenses at the existing Tri-Town Septage Treatment Facility. The proposed design incorporates much of the same building space so heating expenses would not be expected to change appreciably.

- Electricity costs were estimated using existing Tri-Town Septage Treatment Facility expenses adjusted for changes in liquid train treatment systems.

- Dewatered septage/residuals hauling and disposal were conservatively estimated using disposal costs at the merchant sludge processing facility in Woonsocket, RI and transportation being provided by a private hauler.

Table 3-5 - Estimate of Operation and Maintenance Costs for the Overland Way WWTF Servicing the Downtown Area

Components	Quantity	Unit	Unit Cost	Extended Total	Remarks/Notes
Wastewater Treatment Facility - Downtown Area (Overland Way)					
Operations	7,280	Hrs.	$ 65	$ 473,200	Three O&M technicians, one half-time
Heat	1	Allow.	$ 25,000	$ 25,000	
Electricity	1	Allow.	$ 99,563	$ 99,600	
Chems	1	Allow.	$ 54,698	$ 54,700	
Sludge Hauling/Disposal	1	Allow.	$ 88,281	$ 88,300	
Routine Maintenance	1	Allow.	$ 50,000	$ 50,000	
General Office/Lab Expenses	1	Allow.	$ 50,000	$ 50,000	
Outside Analytical Expenses	1	Allow.	$ 17,000	$ 17,000	
	-		$ -	$ -	
	-		$ -	$ -	
		Subtotal		$ 857,800	
		Contingency	10.0%	$ 85,800	
		Subtotal		$ 943,600	
Town Administration and Engineering					
		Town Administration	3.0%	$ 28,300	
		Engineering - Planning/Consultation	0.0%	$ -	
		Engineering - Design	0.0%	$ -	
		Engineering - Construction	0.0%	$ -	
Total Estimated Annual O&M Costs				**$ 971,900**	Engineering News Record (ENR) = 10182 (Feb. 2016)

At its discretion, the Town could also consider annual the funding of a capital repair and replacement account for non-routine maintenance needs that may arise over the longer term of the project life. Using a metric developed by the Society for Maintenance Reliability Professionals (SMRP), AECOM estimated annual funding of such an account to be in the order of $270K/year.

b. Meetinghouse Pond Service Area

1) Liquid Train - A very similar evaluation of options for technologies was conducted for the proposed Meetinghouse Pond WWTF intended to service the Meetinghouse Pond service area. The same technologies evaluated for the proposed Overland Way WWTF were evaluated, with some minor changes to criteria and weighting. The primary changes were the addition of a selection criterion that favored commonality with the technology choice at the proposed Overland Way WWTF, and a stronger weighting for the impact on surrounding neighbors to reflect the more residential nature around the Beach Road site. The criteria ranking and scoring sheet resulting from the comparison of these technologies for the proposed Meetinghouse Pond WWTF to service the Meetinghouse Pond area are shown on the following page.

Table 3-6 - Septage/Residuals Treatment Technology Selection Worksheet – Meetinghouse Pond WWTF

Town of Orleans, Massachusetts
Water Quality and Wastewater Planning
Meetinghouse Pond Area WWTF Treatment Technology Evaluation

Criteria	Criteria Weight	Technology A CAS		Technology B SBR		Technology C IFAS		Technology D MBR		Technology E RBCs	
		Rating	Score	Rating	Score	Rating	Score	Rating	Score	Rating	Score
Project Evaluation											
O&M Cost	2	2	4	2	4	1	2	1	2	3	6
Capital Cost	2	2	4	3	6	1	2	2	4	2	4
LCC	3	2	6	2	6	1	3	2	6	2	6
Operational Complexity	1	2	2	1	1	1	1	3	3	2	2
Degree of Preliminary Treatment Required	3	2	6	2	6	1	3	1	3	2	6
Expansion Capability (flow/load)	2	2	4	2	4	3	6	3	6	1	2
Biosolids Production	3	2	6	2	6	3	9	3	9	3	9
Ability to Achieve Potential Stricter Limits (P, lower N)	3	2	6	1	3	2	6	2	6	1	3
Compatibility w/Wick Well for Effluent Disposal	3	2	6	2	6	2	6	3	9	2	6
Compatibility w/Site											
Footprint Required	3	1	3	2	6	3	9	3	9	1	3
Impact on Neighbors (odors, noise)	3	2	6	2	6	2	6	2	6	2	6
											-
Other/Overriding Considerations											
Commonality with Tri-Town	2	1	2	1	2	1	2	3	6	1	2
Proven acceptance by DEP	2	3	6	3	6	1	2	2	4	2	4
Market Availability (widespread availability vs. proprietary process from limited vendors)	1	3	3	2	2	2	2	2	2	2	2
Total Criteria Points		**64**		**64**		**59**		**75**		**61**	
Rank		**2**		**2**		**5**		**1**		**4**	

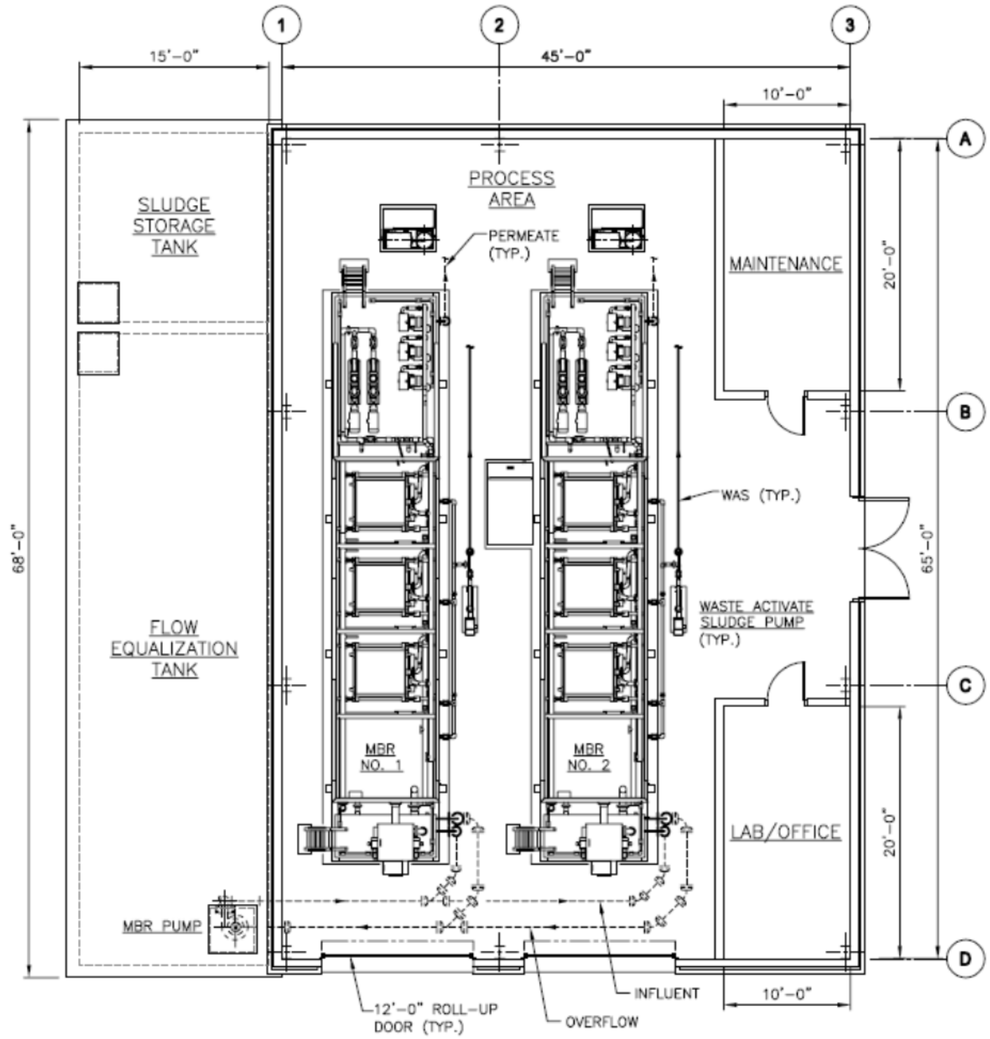
Notes:
High Criteria Weight = Greater Importance
Higher Rating = Better Conditions

As was the case for the proposed Overland Way WWTF, and for similar reasons, MBR achieved the highest weighted score by a fairly large margin. Again, key differentiators were the low degree of operational complexity, expansion capability, the ability to reach potential lower permit limits in the future, and compatibility with the possible use of a Wick Well for effluent disposal, for all of which MBR received higher ratings. Factors favoring MBR specific to the proposed Meetinghouse Pond WWTF were lower impact on neighbors and compatibility with the technology selection for proposed Overland Way WWTF.

2) Overall Site Layout and Costs - AECOM estimates that if upstream flow equalization is employed to mitigate hourly fluctuations in flow, two modular MBR treatment trains would be needed to satisfy initial design conditions, but would also have sufficient spare capacity to accommodate future build-out conditions. Flow equalization to mitigate hourly peaks would require a tank in the order of 65,000 gallons in volume. Waste sludge storage capacity is also needed and estimated at approximately 10,000 gals, which would supply about seven days of storage under future build-out conditions.

   Because the proposed Overland Way WWTF site is in a more residential/recreational area, it assumed that measures will need to be taken to minimize the impact on the neighborhood from both the standpoint of odors, noise and visual aesthetics. AECOM recommends that the MBR modules and their ancillary equipment be housed in a building designed to match the visual appearance of the surrounding area to the extent possible. Similarly, the storage tanks can be located mostly below grade. AECOM estimates a building with a footprint of 45-feet x 65-feet will be required to house two MBR units and have additional lab and maintenance space. The equalization and storage tanks will be adjacent to the building along one of the 65-foot walls, projecting 15-feet from the wall, and having a total depth of 12-feet (10-below grade). A layout of the proposed building is shown in Figure 3-3.

Figure 3-5: Proposed Meetinghouse Pond WWTF
Layout at 223 Beach Road Site



Capital and O&M costs were estimated as shown in Tables 3-7 and 3-8 below. As previously indicated, capital costs assumed the proposed Meetinghouse Pond WWTF would be housed inside a building to lessen aesthetic and odor impacts on the surrounding neighborhood. Below grade storage tanks were included for both influent flow equalization, as well as waste biosolids storage. All biosolids processing was assumed to take place at the proposed Overland Way WWTF.

Table 3-7 - Estimate of Capital Costs for the Meetinghouse Pond WWTF Servicing the Meetinghouse Pond Area

Wastewater Treatment Facility - Meetinghouse Pond (223 Beach Road)

Components	Quantity	Unit	Unit Cost	Extended Total	Remarks/Notes
Mobilization and Demobilization	1	LS	$ 185,115	$ 185,100	5% of Other Items
MBR Modules	1	Allow.	$ 1,800,000	$ 1,800,000	Includes two trains for final build-out.
EQ/Sludge Storage Tank	1	Allow.	$ 150,000	$ 150,000	
Intermediate and effluent pumping	1	Allow.	$ 75,000	$ 75,000	
New Building	1	Allow.	$ 1,000,000	$ 1,000,000	
Site Paving/Fencing	1	Allow.	$ 75,000	$ 75,000	
Loadout station	1	Allow.	$ 52,500	$ 52,500	
Odor Control	1	Allow.	$ 150,000	$ 150,000	
Plant Water	1	Allow.	$ 66,500	$ 66,500	
Yard Piping	1	Allow.	$ 33,250	$ 33,300	
Electrical	1	Allow.	$ 225,000	$ 225,000	
SCADA	1	Allow.	$ 75,000	$ 75,000	
	-		$ -	$ -	
	-		$ -	$ -	
	-		$ -	$ -	
		Subtotal		$ 3,887,400	
		Overhead and Profit	22.0%	$ 855,200	
		Subtotal		$ 4,742,600	
		Contingency	25.0%	$ 1,185,700	
		Construction Total		$ 5,928,300	
		Town Administration and Engineering			
		Town Administration	5.0%	$ 296,400	
		Engineering - Planning/Consultation	5.0%	$ 296,400	
		Engineering - Design	10.0%	$ 592,800	
		Engineering - Construction	15.0%	$ 889,200	
Total Estimated Project Cost				**$ 8,003,100**	Engineering News Record (ENR) = 10182 (Feb. 2016)

As shown in Table 3-8, annual Operation & Maintenance (O&M) Costs were estimated at approximately $300K/year using the following key assumptions.

- One full time O&M technician. The proposed modular MBR system is highly automated and operator intervention should be minimal. It is assumed that there will be some sharing of staff with the larger Overland Road facility for vacation/sick coverage, but the overall labor burden for this facility equates to one full time equivalent (FTE).
- Heating costs were based on current expenses at Tri-town, prorated for the smaller footprint of this facility.
- Electricity costs were based on MBR vendor supplied information with an additional 20% allowance for building lighting, HVAC and ancillary equipment.
- Sludge hauling to the Overland Road site assumed to be provided by a private hauler.

Table 3-8 - Estimate of Operation and Maintenance Costs for
The Meeting house Pond WWTF Servicing the Meetinghouse Pond Area

Components	Quantity	Unit	Unit Cost	Extended Total	Remarks/Notes
Wastewater Treatment Facility - Meetinghouse Pond (223 Beach Road)					
Operations	2,080	Hrs.	$ 65	$ 135,200	Assume one O&M technician
Heat	1	Allow.	$ 20,000	$ 20,000	
Electricity	1	Allow.	$ 13,288	$ 13,300	
Chems	1	Allow.	$ 26,400	$ 26,400	
Sludge Hauling	1	Allow.	$ 24,000	$ 24,000	
Routine Maintenance	1	Allow.	$ 22,000	$ 22,000	
General Office/Lab Expenses	1	Allow.	$ 10,000	$ 10,000	
Outside Analytical Expenses	1	Allow.	$ 17,000	$ 17,000	
	-		$ -	$ -	
	-		$ -	$ -	
		Subtotal		$ 267,900	
		Contingency	10.0%	$ 26,800	
		Subtotal		$ 294,700	
Town Administration and Engineering					
Town Administration			3.0%	$ 8,800	
Engineering - Planning/Consultation			0.0%	$ -	
Engineering - Design			0.0%	$ -	
Engineering - Construction			0.0%	$ -	
Total Estimated Annual O&M Costs				**$ 303,500**	Engineering News Record (ENR) = 10182 (Feb. 2016)

As discussed in the section pertaining to the Overland Road site, the Town could also consider annual funding of a capital repair and replacement account for non-routine maintenance needs that may arise over the longer term of the project life. Using a metric developed by the Society for Maintenance Reliability Professionals (SMRP), AECOM estimated annual funding of such an account to be in the order of $120K/year for the Beach Road WWTF.

4. Summary

A preliminary wastewater characterization has been developed which projects the concentration of major constituents in wastewater for both the Overland Road and Beach Road sites. Coupled with projected flows and typical peaking factors, design loadings were developed and liquid train treatment alternatives evaluated. Similarly, septage/WWTF residuals process options have been evaluated.

The liquid train technology recommended for both sites is the membrane bioreactor (MBR). This technology is recommended because of its expansion capability, ability to achieve potentially lower TN limits in the future, its small footprint, and it's ease of operation. This technology is available in discrete modules, which facilitates the phasing in of capacity as needed to coincide with the development of the collection system.

For septage/WWTF residuals processing (i.e. "WAS"), AECOM recommends that all processing for both WWTFs be conducted at the Overland Road location. Similarly, it is recommended that septage receiving only be conducted at Overland Road. This takes advantage of some of the infrastructure already at the site, achieves economy of scale in terms of process equipment, and reduces the potential for odors and/or traffic issues at the Beach Road location. AECOM recommends that septage received be blended with WAS and co-dewatered. It is anticipated that a blend of septage/WAS will have better dewatering characteristics, and processing the septage in this manner decreases the solids loading on the biological process as opposed to blending septage with raw sewage for processing in the liquid train.

A summary of capital and operating expenses for each location is found in table 4-1 below.

Table 4-1 - Estimate of Operation and Maintenance Costs for
WWTF Servicing Meeting House Pond Area

	Overland Way		Beach Road
Full Build-out Average Daily Flow, gal/d	250,000		110,000
Full Build-out Project Cost (includes design and construction services), $	$16.5 million		$8.0 million
Annual O&M Costs, $/yr	$972,000		$303,500
Optional Annual Capital Repair & Replacement Funding, $/yr	$270,000		$120,000

AECOM would recommend that these costs and the pros/cons of modular construction be revisited during the next design phases, but believes the concepts developed herein provide a sound strategy and planning level costs for consideration and funding allocation as the Town proceeds with its Water Quality and Wastewater Planning efforts. The evaluation of effluent disposal transmission/pumping alternatives will be addressed separately and discussed in a stand-alone Technical Memorandum.

Appendix A

Basis of Design for WWTFs to Service Downtown and Meeting House Pond Areas

	Downtown Area			**Meeting House Pond Area**	
Design Flow	Initial Design	Full Build-out		Initial Design	Full Build-out
AA, mgd	0.184	0.250		0.070	0.110
MM, mgd	0.368	0.500		0.140	0.220
MD, mgd	0.515	0.675		0.210	0.330
PH, mgd	0.901	1.225		0.392	0.616
Influent/Filtrate					
BOD, mg/l	320			270	
TKN, mg/l	60			55	
TSS, mg/l	300			310	
Min Month Design Temp, 'C	10			10	
Effluent Limits					
BOD, mg/l	30			30	
TSS, mg/l	30			30	
TN, mg/l	10			10	
Fecal Coliform, cfu/100 mil	100			100	