Falmouth WWTF
Fiscal Sustainability Plan

Including a Plant Evaluation and
Condition Assessment

Town of Falmouth, MA

Final Report

December 2020

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List of Common Acronyms

AC	Alternating Current
ATS	Automatic Transfer Switch
BOD	Biological Oxygen Demand
CEC	Chemicals of Emerging Concern
CIP	Capital Improvement Plan
CoF	Consequence of Failure
CWMP	Comprehensive Wastewater Management Plan
DC	Direct Current
DO	Dissolved Oxygen
ESRA	Existing Collection System Redevelopment Allocation
EQ	Equalization
FEMA	Federal Emergency Management Agency
FOG	Fats, Oils, and Grease
GAC	Granular Activated Carbon
GBT	Gravity Belt Thickener
GHG	Greenhouse Gas
gpd	gallons per day
HVAC	Heating, Ventilation, and Air Conditioning
IUP	Intended Use Plan
I/I	Infiltration and Inflow
kW	kilowatt
LoF	Likelihood of Failure
LPSA	Little Pond Sewer Area
MassDEP	Massachusetts Department of Environmental Protection
MBR	Membrane Bioreactor
mgd	million gallons per day
mg/L	milligrams per liter
NaOH	Sodium Hydroxide
NFPA	National Fire Protection Association
NPDES	National Pollutant Discharge Elimination System
PFAS	Perfluoroalkyl/Polyfluoroalkyl

PLC	Programmable Logic Controller
psia	pounds per square inch absolute
PV	Photovoltaic
RDT	Rotary Drum Thickener
SBR	Sequencing Batch Reactor
SCADA	Supervisory Control and Data Acquisition
TASA	Teaticket Acapesket Sewer Area
TDH	Total Dynamic Head
TM	Technical Memorandum
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
TSS	Total Suspended Solids
TWMP	Targeted Watershed Management Plan
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
UV	Ultraviolet
VFD	Variable Frequency Drive
WAS	Waste Activated Sludge
WWTF	Wastewater Treatment Facility

Executive Summary

This report serves as a fiscal sustainability plan for the Town of Falmouth to help prioritize upgrades and expansions for the Wastewater Treatment Facility (WWTF). This fiscal sustainability plan is developed to follow the South Coast Embayments – Notice of Project Change Update report prepared by GHD in December 2019.

This report analyzes the Town's wastewater management needs and evaluates the current and future influent flows to the WWTF. The existing flows encompass all current flow to the facility including septage and wastewater. Wastewater influent includes flow from the Little Pond Sewer Area (LPSA), which is the most recent collection system expansion. The future flows include Teaticket Acapesket Sewer Area (TASA) and the Existing Collection System Redevelopment Allocation (ESRA).

This report includes an evaluation of the existing processes at the WWTF. The existing process evaluation includes a description of the major systems at the facility; an evaluation of the system standards and guidelines to determine the system's capacity to handle future flows; an explanation of the operational issues of the system which were determined through site visits as well as comments from the Town; and recommendations for upgrades to accommodate the future influent wastewater flows from TASA and ESRA, address identified operational issues and meet the facility's groundwater discharge permit.

From the existing process evaluation and recommendations, a criticality matrix is developed to rank the needs of the existing processes at the facility. The criticality matrix assesses the performance and condition of the processes and assigns a risk rating from Low to Very High to each piece of equipment. This risk ranking is a function of the probability the equipment will fail and the consequence of it failing.

Using the criticality matrix, recommendations are made regarding the scope of the next wastewater treatment facility upgrade, the WWTF TASA Improvements Project. Planning level capital costs are estimated each recommended process improvement. Based on these recommendations and cost evaluation, it is estimated that the WWTF TASA Improvements Project would be approximately $19,000,000 in 2023 dollars (mid-point of construction) with a $1.7 M design that would precede the construction phase. These improvements and costs are summarized in Table ES.1.

Table ES.1 Planning Level Capital Improvement Costs for WWTF TASA Improvements Project

Lump Sum Work	Conceptual Design
Equalization Tank	$ 674,000
SBR	$ 3,156,000
Denitrification Pumps and UV	$ 779,000
Sludge Processing	
– Blended Sludge Tank	$ 1,532,000
– Sludge Processing	$ 1,228,000
– Thickened Sludge Tank	$ 806,000

Lump Sum Work	Conceptual Design
Sludge Processing Building HVAC	$ 213,000
New Electrical and HVAC Building	$ 270,000
Operations Building	
– Architectural Modifications	$ 2,030,000
– HVAC	$ 269,000
– Garage	$ 887,000
Generator Modifications	$ 311,000
Subtotal of Project Cost Estimate	$ 12,200,000
Contingency	$ 3,050,000
TOTAL CONSTRUCTION	$ 15,300,000
Construction Engineering	$ 2,300,000
TOTAL CAPITAL COSTS (ENR - January 2020 = 11392)	$ 17,600,000
"TOTAL CAPITAL COSTS TO MIDPOINT OF CONSTRUCTION (ENR - June 2023 = 12562)"	$ 19,000,000
Design Engineering	$ 1,700,000
Total Project Costs	$ 20,700,000
Alternate No. 1 – Odor Control	$ 690,000

The evaluation included sustainability considerations to reduce the carbon footprint of the facility and to realize operational savings through the minimization of wasted power.

In addition, consideration was given to how additional potential future expansion could be accommodated on the WWTF site if needed.

This report is part of continuing work at the Falmouth WWTF. The report is expected to be followed by the design of the WWTF TASA Improvements Project in 2021 and potential construction from 2022 through 2024 pending Town approval and funding appropriation. See Table ES.2 for a summary of the project schedule.

Table ES.2 Schedule

Task	Estimated Date
Submit SRF Project Evaluation Form (PEF)	August 14, 2020
Appropriate money for design	Fall Town Meeting 2020
Design	December 2020 – October 2021
Release of the Intended Use Plan (DEP)	February 2021
Appropriate money for construction and CPS	Spring Town Meeting 2021
Funding appropriation in place	July 1, 2021
Submit DEP Application	October 15, 2021
Receive approval from DEP to Bid	February 1, 2022
Bid Phase	Feb 1 – March 15, 2022
Notice to Proceed	June 1, 2022
Construction	June 1, 2022 – June 1, 2024

1. Introduction

This fiscal sustainability report is developed to follow the South Coast Embayments – Notice of Project Change Update report prepared by GHD in December 2019. This report serves as a fiscal sustainability plan for the Town to help prioritize upgrades and expansions for the Wastewater Treatment Facility (WWTF). The report shall also be used to supplement the Intended Use Plan (IUP) application.

1.1 Background

The Falmouth WWTF is located at 154 Blacksmith Shop Road. Originally constructed in the 1980s, the existing facility went through a major upgrade in 2005, designed by Maguire Group, with multiple minor upgrades since including one during 2015/2016 designed by GHD Inc According to Maguire Group design documents, the 2005 facility was designed to treat an average of 1.2 million gallons per day (mgd). Only about 11% of the developed properties in Falmouth are connected to the sewer system. The remaining properties have septic systems or cesspools; septage from these systems is delivered by private haulers to the WWTF for management. Therefore, septage receiving at the WWTF is a key service to the Town, and septage volume and load are an important consideration in WWTF design.

The WWTF currently employs an influent fine screen followed by two sequencing batch reactors (SBRs) followed by denitrification filters and ultraviolet (UV) disinfection. The groundwater discharge permit for the WWTF includes a maximum day total nitrogen concentration limit of 10 mg/L, and the requirement to employ “best efforts” to meet an annual average effluent total nitrogen concentration of 3 mg/L.

Septage and waste sludge from the SBRs are thickened with “SOMAT” augers. Thickened sludge is hauled offsite for disposal (normally at an incinerator) and the liquid from the sludge thickening system is returned to the influent wet well for treatment.

Treated wastewater from the WWTF is discharged to infiltration basins (open sand beds 1-15). Open sand beds 1-13 are located in the watershed to West Falmouth Harbor which has a Total Maximum Daily Load for nitrogen established by the state. The groundwater discharge permit limits average daily effluent flow to beds 1-13 to 450,000 gallons per day (maximum day of 800,000 gallons per day), and the permit includes a cumulative annual total nitrogen load target for discharge to beds 1-13 (within the West Falmouth Harbor watershed) of 4,109 lbs/year. This cumulative load target is based on 450,000 gallons per day of discharge at a total nitrogen concentration of 3 mg/L.

Open sand beds 14-15 are located outside of (north of) the West Falmouth Harbor watershed. The permit limits average annual flow to open sand beds 14-15 to 260,000 gallons per day and limits maximum day flow to 470,000 gallons per day.

The WWTF TASA Improvements Project will be designed to accommodate the future influent wastewater flows from TASA and ESRA, address identified operational issues and meet the facility’s groundwater discharge permit.

1.2 Purpose and Scope

The purpose of this report is to present an evaluation of the existing processes and upgrades for an expansion of the plant at the Falmouth WWTF.

In March of 2020, the Town of Falmouth retained GHD to perform a fiscal sustainability plan incorporating a plant evaluation and condition assessment for the Falmouth WWTF. The scope of services for this project are outlined below.

- Review of background data and previous projects and reports.
- A review of the Town's 20-year wastewater needs.
- Evaluation of the functionality and capacity of existing liquid treatment processes.
- Evaluation of the functionality and capacity of existing solids holding and treatment processes.
- Evaluation of future needs and options with regards to sludge processing and disposal.
- Evaluation of non-treatment facilities.
- Consideration of a sustainable design for future upgrades to the WWTF.
- Consideration of Contaminants of Emerging Concern during the analysis of technologies and planning.

1.3 Limitations

This project is intended to be an evaluation of the existing and future needs of the WWTF. Drawings and engineer's opinion of probable costs are intended to be for evaluation purposes. Products from this evaluation should be considered conceptual and do not represent either a preliminary or final design.

1.4 References and Guidelines

Below is a list of references and guidelines that were used for this project.

- TR-16 Guides for the Design of Wastewater Treatment Works, prepared by the New England Interstate Water Pollution Control Commission, 2011 Edition Revised in 2016
- Water Environment Federation; "Design of Municipal Wastewater Treatment Plants"; WEF Manual of Practice No 8; Fifth Edition; 2010
- Tchobanoglous, George; Burton, L. Franklin; Stensel, H. David; "Wastewater Engineering: Treatment and Reuse"; Metcalf and Eddy, Inc.; Fifth Edition; 2014
- Sequencing Batch Reactor Design and Operational Considerations, prepared by the New England Interstate Water Pollution Control Commission, 2005.

1.5 Summary of Other Projects and Reports

Below is a list of related reports that were previously produced for the Town of Falmouth and have been used as background for this report.

- Teaticket / Acapesket Study Area Conceptual Layouts and Preliminary Costs Estimates Evaluation – Technical Memorandum No. 7 (TASA TM-7) South Coast Embayments – Preliminary Evaluations and Notice of Project Change Project. GHD Inc. October 2019. (11153041)
- Wastewater and Nutrient Services Existing WWTF and Vent Evaluation – Technical Memorandum WW-1. GHD Inc. March 2013. (8615097)
- Falmouth, MA WWTF Improvements Project. Basis of Design Memos– Flows and Loads, and Treatment Goals. GHD Inc. November 2013. (8616146)
- Comprehensive Wastewater Management Plan and Final Environmental Impact Report, and Targeted Watershed Management Plan. GHD Inc. September 2013. (8612163)

2. Influent and Effluent Characteristics

2.1 Flows

Typically, a plant evaluation will include an evaluation of flows over an extended period of time. However, this is not feasible as the Town has recently completed a major expansion of the collection system. There has not been an extended period of time that is reflective of a stable number of connections. A thorough evaluation of flows and loads was completed as part of the LPSA project. This flow evaluation will build upon the past project evaluations and projections.

Flowrates for existing and future flows were estimated during previous projects and included in previous reports prepared by GHD. The flows can be divided into four different groups as follows:

- The flow to the WWTF before the LPSA expansion (WWTF Pre-LPSA).
- Little Pond Sewer Area (LPSA) – this is the most recent collection system expansion that is nearly complete with regard to connections.
- Teaticket Acapesket Sewer Area (TASA) – this is a future flow.
- Existing Collection System Redevelopment Allocation (ESRA) – this is a future flow.

WWTF flows prior to LPSA connection (WWTF Pre-LPSA) were calculated based on the flows from November 2010 through November 2012.

The LPSA flows were first estimated based on parcel and water use data for the proposed sewered area and presented in Technical Memorandum (TM) WW-1 prepared in 2013. The flow estimates were then updated in the TASA TM 7 based on refined sewered parcel information.

The TASA and ESRA flows were estimated and presented in TASA TM 7. The TASA flows were based on parcel and water use data for 2014, 2015, and 2016 for the proposed sewered area. The ESRA flows were estimated based on further buildout of properties in the existing collection system area. The ESRA flow was established in the TASA TM-7 memorandum as 20 percent of the facility's 2015 permitted flow.

2.1.1 Peaking Factors

Maximum monthly flows for TASA and ESRA were previously estimated and included in TASA TM 7. The maximum monthly flows for WWTF Pre-LPSA and LPSA have not been presented in past reports. The review of the existing influent flow data from 2016 to 2018 showed a maximum monthly peaking factor of 1.8. This peaking factor was applied to the average daily flow rates for WWTF Pre-LPSA and LPSA to determine maximum monthly flow rates. Maximum daily flows and peak hour flows for all areas were previously estimated and included in TASA TM 7. The flows are shown in the following table.

Table 2.1 Flow Rates

Parameter	WWTF Pre-LPSA (mgd) [1]	LPSA (mgd) [2]	TASA (mgd) [3]	ESRA (mgd) [4]	Total Future Flow (mgd)
Average Day	0.36	0.26	0.36	0.14	**1.12**
Maximum Month	0.65[5]	0.47[5]	0.59	0.26	**1.97**
Maximum Day	0.68	0.47	0.61	0.27	**2.03**
Peak Hour	1.22	1.08	1.04	0.48	**3.82**

Notes:
1. Flows from TASA TM-7 and WW-1.
2. Flows from TASA TM-7. Flows were updated for the LPSA in the TASA TM-7, past flow predictions from WW-1 were superseded.
3. Flows from TASA TM-7.
4. Flow from TASA TM-7.
5. Max month peaking factor calculated (1.8) from WWTF flow data and applied to average day rate for "WWTF Pre-LPSA" and "LPSA".

2.1.2 Estimated Future Flows

The Comprehensive Wastewater Management Plan – Little Pond, Great Pond, Green Pond, Bourne's Pond, Eel Pond, and Waquoit Bay Watersheds Needs Assessment Report was produced by Stearns and Wheler in 2007. The report estimates that a future treatment facility may need to be sized to approximately 3 mgd on an average annual basis to meet the total maximum daily load (TMDL) and to pick up the flow from adjacent coastal areas in the future.

As part of the next phase of planning work—the Great Pond Targeted Wastewater Management Plan—GHD will be working with the Town and the Falmouth Water Quality Management Committee to establish anticipated future wastewater flows and will be developing updated flows based on updated water use data.

As part of this evaluation, consideration is given to how the WWTF may expand into the future beyond the TASA and ESRA expansion, and all proposed upgrades detailed within this report consider the proposed plans for future expansion. Section 5 presents a future expansion plan for this existing facility.

2.2 Loads

Influent concentration and load data from the WWTF was used in conjunction with guidelines from TR-16 to determine the existing and future loading rates for Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Total Nitrogen (TN), and Total Phosphorous (TP). The future loading rates were determined as follows:

Future Loads = WWTF Pre-LPSA Loads + LPSA Loads + TASA Loads + ESRA Loads

The WWTF Pre-LPSA rates represent loading from primarily commercial properties and septage, though some residential properties are located in the Pre-LPSA service area. Influent loads and concentrations were recorded between January 2006 and November 2012 and applied as the WWTF Pre-LPSA loads in TM WW-1. The total phosphorus was not recorded in TM WW-1. TR-16 has average loading rates for TN and TP rates. The ratio of TR-16 phosphorus and nitrogen concentrations was applied to the TN loads to estimate the TP concentration and load.

The LPSA is primarily a residential area. TR-16 provides average loading rates and flow rate per capita for residential areas. Using the information from TR-16, an estimated average concentration was determined. The flows presented in the previous section were then used to estimate average loads.

The TASA is primarily a residential area. The TASA loading rates were determined during a previous project. The loading rates were estimated using the TR-16 loading rates per capita and the number of people in the TASA.

The ESRA flow is expected to be primarily commercial and multi-family residential. The concentration from the WWTF Pre-LPSA was applied to the ESRA average daily flow rate to determine loading rates for ESRA.

The average daily loads for each segment and the total are listed below.

Table 2.2 Average Loads

Influent Characteristic	WWTF Pre-LPSA (lb/day)	LPSA (lb/day)	TASSA (lb/day)	ESRA (lb/day)	Total (lb/day)
BOD	620	630	680	210	**2100**
TSS	640	740	800	220	**2400**
TN	89	150	160	34	**430**
TP	13	22	24	5	**65**

Note: Totals are shown rounded to two significant figures.

Using the loading rates shown in Table 2.2 and the flows for each area, the resulting load concentration for the WWTF influent is determined to be as shown in Table 2.3.

Table 2.3 Concentration

Influent Characteristic	Total (mg/L)
BOD	230
TSS	260
TN	46
TP	7

Peaking factors for the loads were determined or estimated in two ways. First, for the primarily residential areas (LPSA and TASA), TR-16 guidelines were used. TR-16 provides peaking factors for the maximum daily and maximum monthly load rates for residential properties. The TR-16 peaking factors were applied to the LPSA and TASA average daily loads. For the areas of Town that are not dominated by residential properties (WWTF Pre-LPSA and ESRA), plant data was used to determine peaking factors because residential peaking factors from TR-16 values would not apply. Using the described methods, the maximum daily and monthly loading rates were estimated and are shown in Table 2.4.

Table 2.4 Maximum Loads

Influent Characteristic	Total Maximum Day Loads (lb/day)	Total Maximum Month Loads (lb/day)
BOD	5200	3900
TSS	7900	5600
TN	810	670
TP	120	98

2.3 Existing Effluent Limits

A modified individual groundwater discharge permit was issued to the Town of Falmouth in March, 2015. The effluent discharge limits included in the groundwater discharge permit are presented in Table 2.5.

Table 2.5 Permits Limit

Effluent Characteristics	Discharge Limitations
Flow to Sand Beds 1 to 13	450,000 gpd annual average 800,000 gpd maximum day
Flow to Sand Beds 14 and 15	260,000 gpd annual average 470,000 gpd maximum day
Oil and Grease	15 mg/L
Total Suspended Solids (TSS)	30 mg/L
Total Nitrogen	10 mg/L daily maximum and best efforts to meet an annual average concentration of 3 mg/L
Nitrate-Nitrogen	10 mg/L and best efforts to meet an annual average concentration of 3 mg/L
Cumulative Nitrogen Annual Load within the West Falmouth Harbor Watershed	4,109 pounds per calendar year
Biochemical Oxygen Demand, 5-day @ 20 degrees C (BOD_5)	30 mg/L

Effluent Characteristics	Discharge Limitations
Fecal Coliform	200 colonies/100mL

2.4 Performance Issues

The WWTF generally runs well and meets its goals and permit limitations, but there have been periods of performance problems caused in particular by equipment failures, fluctuations in influent load, and cold temperatures. Since the last upgrade in 2016, the most notable issue was caused by a mechanical equipment failure.

The failure of a flex joint in the decanter arm of SBR No. 1 in 2019 caused the WWTF to fall short of meeting the nitrogen discharge goal outlined in the groundwater discharge permit. The WWTF ground water discharge permit outlines a nitrogen limit of 10 mg/L daily maximum with a “best effort” to meet an annual average concentration of 3 mg/L and less than 4,109 pounds of nitrogen load to the West Falmouth Harbor Watershed per calendar year. In 2019, the total nitrogen load discharged from the Town’s WWTF to the West Falmouth Harbor Watershed was 5,885 lbs.

The equipment that failed was well under its expected lifespan and thus the break was unexpected. The Town reported the WWTFs performance as well as the cause and resolution of the issue to the Department of Environmental Protection and the Town’s Board of Health in the Town’s monthly Discharge Monitoring Reports in 2019. The Town also addressed this issue in its Draft South Coast Embayments CWMP/TWMP Notice of Project Change submitted to the state in December 2019.

2.5 Contaminants of Emerging Concern

Contaminants of Emerging Concern (CEC) are a new category of contaminants that are comprised of three sub-groups: endocrine disruptors, pharmaceuticals, and personal care products. These CECs are being measured in water and wastewater in extremely small concentrations because analytical methods have improved and use of pharmaceuticals and personal care products have become more widespread. They are considered “emerging” because there are few limits or standards on the amounts that might cause human or environmental health risk. Additional advanced treatment processes are typically added to the biological process to reduce CECs:

- Coagulation and flocculation
- Membrane separation
- Advanced oxidation
- Granular activated carbon (GAC) adsorption

Although there are thousands of contaminants that fall into the category of CECs, per- and polyfluoroalkyl substances (PFAS) is a group of contaminants that has recently gained attention. PFAS is a manmade contaminant used in many products including household cleaning products and sprays, food packaging, and firefighting foam. PFAS contaminants are linked to negative health effects including cancer and thyroid hormone distribution. PFAS has been found in groundwater and drinking water supplies throughout the United States and the world.

Currently, the only local permit requirements that address CECs applies when a treated water discharge is to a Zone I or II groundwater area. In these designated aquifers and in areas such as these, the State requires the removal of Total Organic Carbon (TOC), which is used as a surrogate measure of CECs. The existing and future discharge areas for the Falmouth WWTF are not in Zone I or II groundwater areas and thus the TOC limit does not apply. Absent of a specific limit, it is difficult to provide any further design information on the best technology to use to remove PFAS or other CECs. However, it should be noted that the technologies listed above are all candidates to be used to reduce CECs in wastewater effluent. It should be noted that multiple types of the above processes may be needed to meet some goals (such as coagulation and flocculation followed by granular activated carbon). However, it is understood that EPA may provide guidance on PFAS in biosolids and/or point source discharges as soon as the end of 2021. Any guidance provided would need to be considered in the context of recommendations provided in this report.

3. Criticality Analysis Methodology

A criticality analysis is a decision-making tool that can be used to prioritize projects. It outlines capital projects recommended to maintain the existing level of service for the Town's infrastructure. No cost considerations are included for potential improvements required to meet a future, more stringent effluent permit or for improvements to existing infrastructure (such as flood-proofing infrastructure to adapt to recently redefined Federal Emergency Management Agency (FEMA) floodplain definitions or upgrading a room/building to meet updated Building Code requirements). This report also does not take into consideration any future expansions or upgrade plans for the facility. It is recommended that the Town review any future expansion plans with the recommendations of this report in order to determine the most cost-effective approach to meet both objectives for major equipment. For example, if a planning effort shows that a pumping station's flow is expected to increase substantially in the future, the future flow should be considered in the sizing of the replacement equipment (instead of replacing the equipment in-kind).

The design life of mechanical equipment is typically 20 years. The design life of concrete structures (buildings and tanks) is assumed to be a minimum of 50 years.

A criticality analysis is conducted by establishing a rating for three variables:

- Likelihood of Failure (LoF)
- Consequence of Failure (CoF)
- Risk Assessment Rating

The methodology used to determine each variable is described in this section.

3.1 Likelihood of Failure (LoF)

LoF is determined by considering both the condition and performance of existing equipment.

3.1.1 Condition Assessment

Knowledge of the remaining life of an asset allows a facility to make a sound decision related to rehabilitation options and the timing of replacements. The challenge for most facilities is to spend less time on reactive maintenance and more time on preventative maintenance. When work can be planned, the cost of maintenance has been shown to be less.

Condition issues exist if the asset currently operates sufficiently, but either the critical equipment or structure is aged or in a deteriorated state. For this study, the design life of mechanical equipment is considered to be 20 years and the design life of concrete structures and underground pipes is a minimum of 50 years.

The criteria used in the condition assessment is outlined in Table 3.1.

Table 3.1 Condition Assessment

Rating Guidelines		
Condition Score	Condition Description of Asset	Range of Remaining Life
1 – Excellent	Asset is like new, fully operable, and well maintained.	80 to 100% remaining life left
2 – Good	Asset is sound and well maintained but may be showing some signs of wear.	55 to 80% remaining life left
3 – Moderate	Asset is functionally sound, showing normal signs of wear relative to use and age.	25 to 55% remaining life left
4 – Poor	Asset functions but requires a sustained high level of maintenance to remain operational.	10 to 25% remaining life left
5 - Failing	Effective life exceeded and/or excessive maintenance cost incurred.	10% or less remaining life left

3.1.2 Performance Assessment

Performance issues exist if the asset is either unable to sufficiently meet a level of service or if extraordinary means are necessary to keep it working properly to meet a level of service. Performance issues were noted during site walk-throughs and/or during discussions with WWTF staff. The criteria used for the performance assessment is outlined in Table 3.2.

Table 3.2 Performance Assessment

Rating Guidelines	
Performance Score	Performance Description of Asset
1 – Excellent	Asset consistently performs at or above required design standard and performs at full efficiency.
2 – Good	Asset is performing at required design standard. Efficiency of equipment may be slightly diminished.
3 – Moderate	Asset meets basic design standards but may require regular maintenance or other measures to perform at a high level. Asset has minor failures or diminished efficiency and some performance deterioration. Likely showing modest, increased maintenance and/operations costs.
4 – Poor	Asset cannot meet all required design standards (e.g., cannot meet peak conditions). Significant operational maintenance or other measures are required to sustain performance. Near-term scheduled rehabilitation or replacement needed.
5 - Failing	Asset cannot meet the required design standard. Immediate replacement or rehabilitation is needed.

3.1.3 LoF Ranking

After both a condition and performance score have been assessed, the higher of the two rankings is used as the LoF. For example, if a piece of equipment was installed a year ago (condition assessment rating of 1) but requires significant maintenance (performance assessment rating of 4), the LoF is rated as 4. For the WWTF, since the majority of the equipment is past its useful life and has the same condition rating (5), the performance assessment was used to sub-rank equipment with the same condition rating.

3.2 Consequence of Failure (CoF)

The criticality of a piece of equipment is determined by the CoF. Criticality can be significant in several areas including health and safety of personnel, meeting the facility's discharge permit limits, treatment process viability, damage to other assets that rely on the equipment, and the cost for rehabilitation or replacement. The guidelines used to establish a CoF are outlined in Table 3.3.

Table 3.3 CoF Guidelines

Rating	Guidelines	WWTF Examples
1 – Negligible	Failure of asset will not result in significant consequential damages. Alternative systems or processes are in place to allow the asset to be out of service for an extended time period until repair/replacement, with negligible impact on performance or safety.	Failure of a plant water system if the facility can use potable water backup for all processes; or failure of an automatic control system for a process normally operated in manual mode; or failure of an HVAC system in a non-occupied building without cold or heat-sensitive equipment.
2 – Marginal	Failure of asset may result in minor to moderate consequential damages, minor violations, inconvenience to personnel, inability to meet required design standard, or some adverse publicity or complaints. Often used for assets which can be repaired or replaced prior to critical consequences occurring.	Failure of gate/valves infrequently used; or failure of an HVAC system in a normally occupied building such as a Control Building; or failure of instrumentation used for monitoring only where manual samples could be used instead; or failure of an odor control system which could lead to some complaints but not major negative publicity.
3 – Critical	Failure of asset likely to result in injury, significant permit violation, significant consequential damages, or significant negative publicity.	Failure of an influent pumping system, resulting in sewage overflow until a bypass system can be put in place; or failure of treatment processes which could result in effluent permit violation.
4 - Catastrophic	Failure of asset likely to cause serious injury or loss of life, long-term environmental damage, or sudden failure of other significant assets.	Failure of the main power distribution system, resulting in loss of entire treatment facility operation; or failure of gaseous chlorination system which could cause serious injury or loss of life.

3.3 Prioritization of Needs Using the Risk Assessment Matrix

The concept of risk can be used to prioritize scarce capital and operating budgets. The risk of not meeting the established level of service for a portion of the infrastructure is a function of the probability the equipment will fail (LoF) and the consequence of it failing (CoF). The two variables are used to assign a risk rating from the risk assessment matrix, shown in Table 3.4. The risk assessment matrix allows the Town to develop a plan to prioritize projects by the risk they pose.

Table 3.4 Risk Assessment Matrix

CoF Rating → ↓ LoF Rating	Negligible (1)	Marginal (2)	Critical (3)	Catastrophic (4)
Failing (5)	Medium	High	Very High	Very High
Poor (4)	Medium	High	Very High	Very High
Moderate (3)	Low	Medium	High	Very High
Good (2)	Low	Low	Medium	High
Excellent (1)	Low	Low	Medium	High

4. Existing Process Evaluation

Wastewater and sludge treatment unit processes provided at the Falmouth WWTF have been evaluated based upon current industry design practice and guidelines. The guidelines and design standards used are outlined in Section 1.4 References and Guidelines. The evaluation is presented in four sections as described below.

- Description—This section describes the process under evaluation. This includes a description of location of the process in the treatment process as well as the use of the process.
- Evaluation—This is a comparison of the engineering standards and guidelines with the existing process. In the evaluation, the sizing of the existing process is analyzed using standards and guidelines to determine its capacity to handle existing WWTF, LPSA, and ESRA flows.
- Operational Issues (Performance and Condition)—This section describes the operational issues with the processes. The information in the section was obtained through site visits as well as comments from the Town. This section includes descriptions of both the performance and condition of the process.
- Recommendations—This section describes upgrades that are recommended to meet the new influent wastewater flows including TASA and ESRA. The recommendations are made using the information from the evaluation of the guidelines and regulations and the operational issues.

4.1 Service Road Force Main and Vent

4.1.1 Description

Raw wastewater enters the Falmouth WWTF through an 18-inch diameter force main from Jones-Palmer Lift Station. Prior to entering the WWTF the 18-inch force main discharges into a gravity manhole on Service Road. Flow then continues through an 18-inch gravity sewer to the WWTF. The manhole on Service Road is connected to a biofilter fan that pulls air out of the manhole and blows it into a biofilter concrete tank that contains hardwood media to minimize odor.

4.1.2 Evaluation

The 18-inch gravity sewer that carries flow into the WWTF is sized for 6.8 mgd at full pipe capacity. The slope and velocity of the gravity sewer meets TR-16 design criteria. When the total future flows as defined in Section 2.1 (a peak hour flow of 3.8 mgd) are compared to this capacity, the influent gravity sewer will only be at 60% capacity and can accommodate this future design flow.

4.1.3 Operational Issues (Performance and Condition)

The Town noted that since the odor control was installed in 2016 at the force main and gravity sewer connection, odor complaints have significantly decreased and may only be from one resident. While there are occasional odor issues, there were no other noted operational issues with the influent gravity sewer.

4.1.4 Recommendations

The evaluation indicates that the service road force main and vent are appropriately sized to handle the TASA and ESRA flows. A second force main or an increase in size of the force main pipe is not recommended at this time. If odors continue to be an issue for any residents the Town could pursue an odor study to help determine the source of the odors.

4.2 Preliminary Treatment

4.2.1 Description

The preliminary treatment system at the treatment facility consists of an aerated grit chamber and influent screen. The aerated grit chamber is currently bypassed. Influent is directed to the preliminary treatment screening channel, where flow is directed through a mechanical fine screen or a coarse bar rack bypass. The mechanical fine screen is a Marck XV-Cw screw screen, supplied by Schloss Engineering with a ¼-inch bar spacing and a 35-degree angle of inclination. The screen removes finer solids from the wastewater including floatables, rags, or other trash that may be conveyed to the screening unit. The debris builds up, raising the water level, and initiating a cleaning cycle. The screenings are collected, washed, compacted, and removed from the screenings channel.

4.2.2 Evaluation

The existing structure, and much of the equipment in this area of the facility, dates back to the original construction of the plant in 1986. Thus, most existing facilities that have not been replaced have exceeded their design life. However, these older facilities are no longer in use, at least not for their original purpose. The grit chamber is out of service and all equipment related to it has been abandoned in place. The building serves as a storage area and a place where some electrical panels have been located.

The screen is the lone exception in that it was placed into service in 2005.

Based on the TR-16 recommendation that SBRs be preceded by fine screens with a clear spacing of ¼-inch or smaller, the existing mechanical fine screen is sized adequately. In addition, the fine screen has a bypass in the event of a failure of the fine screen, which is also recommended in TR-16. The design flow for the mechanical fine screen is higher than the future flows projected for the TASA and ESRA upgrade and is adequately sized for the future design flows indicated in Section 2.1. However, at the future peak flow, the screen would be at 90 percent capacity; a future upgrade in flow would increase flows to a point where they are likely to exceed the mechanical fine screen capacity.

4.2.3 Operational Issues (Condition and Performance)

The Town noted issues with replacing the brush that cleans the perforated screen as well as occasional glitches with the level sensor. The level sensor had to be rebuilt in recent years and the Town noted issues getting replacement parts.

4.2.4 Recommendations

While the Town noted issues with replacing the brush, since the unit works and is adequately sized for future flows there are no recommendations for replacement of the unit if the WWTF maintains SBRs for their secondary treatment process. It should be noted, however, if the facility upgrades to Membrane Bioreactors (MBR) for secondary treatment that a finer screen will be required and the ¼-inch mechanical screen should be replaced

However, it should be noted that the Preliminary Treatment Building has exceeded its design life and may require attention in the future. Although there are no specific recommendations for this area, it would be prudent to carry an allowance for future work in this area to update existing equipment if it will be expected to continue to be functional into the future (door replacement, etc.). A summary of the recommendations for the preliminary treatment system is shown in the following table.

Table 4.1 Preliminary Treatment Recommendations

Issues	Recommended Improvements
Facilities beyond their design life	It may be prudent to consider some basic updating for this facility at some point if it will be expected to continue to function well into the future, but no immediate concerns were raised so these are not current concerns. Any updating is long-term consideration.
Fine Screen not sufficient for MBR	Replace ¼-inch mechanical fine screen with 1/8-inch fine screen if the WWTF upgrades to MBR for secondary treatment.

4.3 Influent Pumping

4.3.1 Description

From preliminary treatment, screened wastewater flows by gravity through a 30-inch-diameter pipe into either of two influent wet wells. Hydraulically the influent wet wells are the lowest elevation in the WWTF. All gravity and process-related streams flow back to the influent wet wells. The total working tank volume of the two wet wells is 60,000 gallons (30,000 gallons each). Either tank can be isolated by a sluice gate. Two small pumps and two larger constant-speed pumps are provided to convey wastewater from either influent wet well to either SBR tank. The pump data and equipment information are shown in Table 4.2. The dry well also contains a set of duplex Redlon & Johnson sump pumps with a pump capacity of up to 185 gpm at 38 total dynamic head (TDH). The sump pumps discharge into wet well #1. A magnetic flow meter is installed on the discharge force main from the influent wet well to measure flow to the SBRs.

Table 4.2 Summary of Pump Data

Equipment Information	WWP-1 and WWP-2	WWP-3 and WWP-4
Number of Pumps	2	2
Manufacturer	Flowserve	Flowserve
Model	Worthington 4MF-9	Worthington 6MF-11
Capacity	830 gpm, 1.2 mgd	1,530 gpm, 2.2 mgd
Pump Speed	1,770 rpm	1,770 rpm
Motor Rating	15 hp	25 hp
Motor Speed	1,800 rpm	1,800 rpm
Total Dynamic Head	35.2 ft	45.2 ft
Suction Elbow Inlet Flange Size	6 in	8 in
Pump Discharge Flange Size	4 in	6 in
Year Placed Into Service	2005	2005

4.3.2 Evaluation

With respect to the future flows of the facility, pumps were sized for a future flow that is higher than the projected future flows estimated in Section 2.1. Thus, the pumps, with the largest pump out of service, are at 83 percent capacity under design peak hour flows. TR-16 recommends that pumping station pumps be capable of passing at least a 3-inch diameter sphere and these pumps appear to be able to do.

The “Sequencing Batch Reactor Design and Operational Considerations” guidelines suggest having equalization volume upstream of SBRs. Equalization will help to buffer flows when the SBRs are actively treating. Currently, if one SBR finishes filling while the other SBR is running, there is limited storage volume before flow must be added to the actively running SBR; the addition of a third SBR (discussed in the next section) will reduce this strain.

The existing wet well has a storage capacity of 60,000 gallons. An expansion of this volume can be constructed to double the capacity of the wet well. By enlarging the equalization volume to 120,000 gallons the facility will be able to skim the peak influent flow during high flow events, as well as hold part of a denitrification filter backwash volume and sludge process filtrate. This volume is also approximately equivalent to the volume of two vertical feet of fluid in one of the SBRs (40,000 gallons per ft.).

4.3.3 Operational Issues (Performance and Condition)

The Town noted the following operational issues for the influent wet well and pumps:

- Need for upgrading the Programmable Logic Controller (PLC).
- Difficulty replacing parts and seals for the influent pumps.

4.3.4 Recommendations

Based on the foregoing evaluation of the existing facility and additional issues noted, the following is recommended:

Table 4.3 Influent Pumping Recommendations

Issues	Recommended Improvements
Outdated PLC	Upgrade PLC
Equalization volume	Expand wet well volume for equalization

The influent wet well pumps are sized appropriately for the TASA and ESRA expansion. Replacement of the influent pumps is not required for capacity reasons. However, the Town has noted that they have had difficulty replacing parts and seals for pumps. Therefore, replacement of the pumps may be recommended soon.

4.4 Secondary Treatment

4.4.1 Description

Wastewater is pumped from the influent wet well into one of two AquaSBR Sequencing Batch Reactor (SBR) tanks. Sludge is wasted by gravity using a manual valve and a pneumatic motor operated valve controlled by a timer. There is a flow meter on the sludge line. The system also has a waste activated sludge (WAS) pump. The SBR sequence includes six steps:

1. Mixed Fill—True anoxic mixing, independent of aeration, with influent. Mixing is accomplished with a DDM-FSS Direct Driver Mixer/Blender.
2. React Fill—Aerated mixing with influent introduction into the tank. The tank is aerated through a fine bubble diffuser system with a nominal operating airflow range of 2-28 square cubic feet per minute per duplex diffuser.
3. React—Aerated mixing under true batch conditions.
4. Settle—Solids/liquids separation.
5. Decant/Idle—Effluent withdrawal to the post-equalization tank through a mechanical floating-type gravity decanter. The decanter has a maximum decanting rate of 4,583 gpm.
6. Sludge Waste—Removal of excess biological sludge to sludge holding tanks.

Oxygen is fed to the system through three SBR aeration blowers. Each blower is designed to provide process air over the range of 1,000 SCFM to 2,030 SCFM. Under normal operating conditions each tank has a dedicated blower with the third used as a standby unit. The blowers were installed during the 2005 upgrade. Each SBR tank has eight retrievable air diffuser assemblies, two of which were added in 2016. Each of the SBRs decanter assemblies was replaced in 2016.

The SBR tanks are programmed to work in tandem so that one tank is always in a fill mode. During the decant mode the same amount of water that entered the tank during the mixed fill and react fill stage flows to the post-equalization tank.

4.4.2 Evaluation

With respect to the future flows and loads for the facility, the existing tanks and equipment are undersized. There are two options for increasing capacity to meet the design flows and loads as follows:

- Maintain the SBR process and add a third SBR tank complete with aeration system and decanter assembly.
- Convert the SBR process to a MBR system.

Sequencing Batch Reactor

To accommodate the expanded flowrate from the TASA and ESRA expansion, the addition of a third SBR has been analyzed. The three SBRs are designed to treat the influent flow and loads rates listed in Section 2 Influent and Effluent Characteristics. The third basin would be equally sized to the existing two basins; the dimensions of the proposed basin are presented in the following table.

Table 4.4 SBR Dimensions

Dimension	Value (ft)
Length	75
Width	75
Depth	23.5

The new basin is designed to have an average cycle time of six hours per cycle which includes the fill, react, settle, and decant stages. The third tank would be equipped with the following accessories similar to the existing tanks:

- One (1) Decanter Assembly.
- Eight (8) Removable Fine Bubble Diffuser Assemblies.
- One (1) Mixer and Cable Removal System.
- One (1) 2.7 HP Submersible Transfer Pump.
- Two (2) 100 HP Positive Displacement Blowers.
- One (1) Submersible Pressure Transducer.
- One (1) Float Switch Assembly.
- One (1) Dissolved Oxygen Probe Assembly.
- One (1) Control Panel for the new SBR tank system.

The existing WAS pumps, process air blowers, and piping gallery are located in the SBR Building. For consistency it is recommended that the additional WAS pump, blowers, and connection piping be placed with the existing equipment. This would require enlargement of the Blower Room and routing the influent, waste sludge, and air piping to the third tank from the existing SBR Building. Thus two routing options were evaluated:

- Routing the SBR influent west around the existing tanks, extending the existing SBR drain line north to the new tank, and routing both the waste sludge piping and air piping from the Blower Room in the SBR Building through SBR No. 2 and into SBR No. 3.
- Routing the SBR influent west around the existing tanks, extending the existing SBR drain line north to the new tank, routing the air piping from the Blower Room in the SBR Building through SBR No. 2 and into SBR No. 3, and building a pump and piping gallery north of the existing SBR tanks to accommodate waste sludge piping and pumping.

In order to accommodate a more controlled way of draining, it is recommended that a drain box is installed adjacent to the new SBR tank. This would be a concrete structure with a submersible pump in the bottom to allow for a controlled manner of draining the SBR tanks.

See the following figure for proposed layout of the addition of SBR Tank No. 3 to accommodate the TASA and ESRA flows.

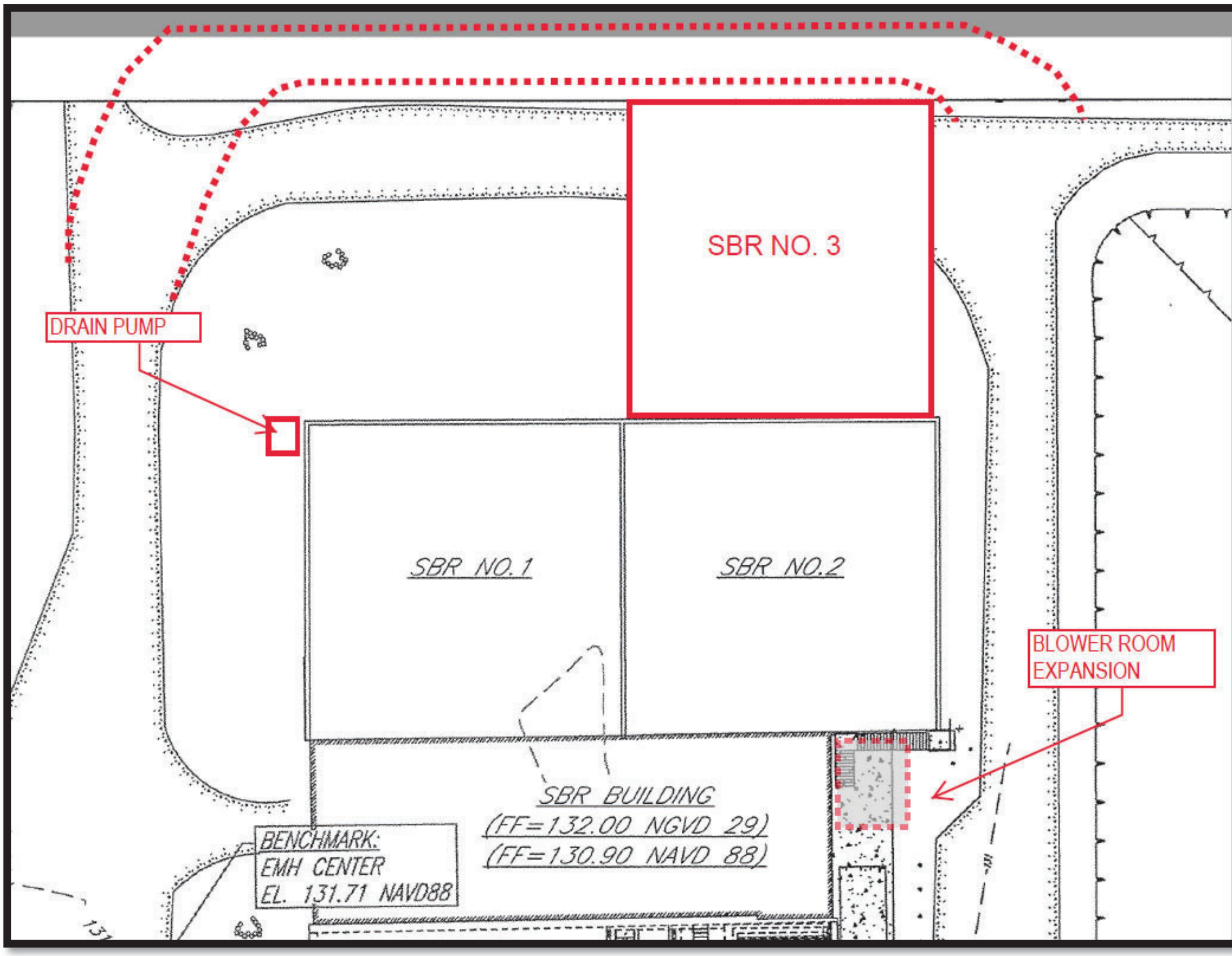

Figure 4.1 SBR Layout

Membrane Bioreactor

Membrane Bioreactors (MBRs) are activated sludge processes that utilize membrane filter modules (instead of settling tanks) to separate the treated water from the suspended solids.

An MBR uses biological treatment to break down the waste in wastewater. The biological treatment is carried out through activated sludge. After the wastewater is biologically treated it flows through a membrane where the activated sludge is separated from the treated liquid effluent. The concentration of activated sludge is able to be greater in an MBR than a system such as a SBR because more activated sludge can be strained out through filtration than can be settled in the settling phase of an SBR. The higher concentration of activated sludge allows more treatment in a smaller volume.

The proposed MBR system is designed to treat the influent flow and loads rates listed in Section 2 Influent and Effluent Characteristics. The MBR is designed to be placed in the existing two SBR basins. The specific layout of the MBR would be refined during the design of the upgrade, however an example layout of the MBR is presented in Table 4.5. The example layout is intended to show there is adequate volume, but a revised layout would be needed to allow the facility to remain in operation during construction.

Table 4.5 Design Parameters

Design Parameter	Value
Pre-Anoxic Volume	183,000 gal
Aerobic Volume	820,500 gal
Post-Anoxic Volume	266,00 gal
Total Bioreactor Volume	1,269,500 gal
HRT	15 hours
SRT	14 days
Waste Sludge Volume	40,600 gal
MLSS concentration	Less than 8,000 mg/L
AOR	6,100 lb O2/day

The proposed MBR is set up to have two trains of flow and three membrane trains (as shown in the following figure).

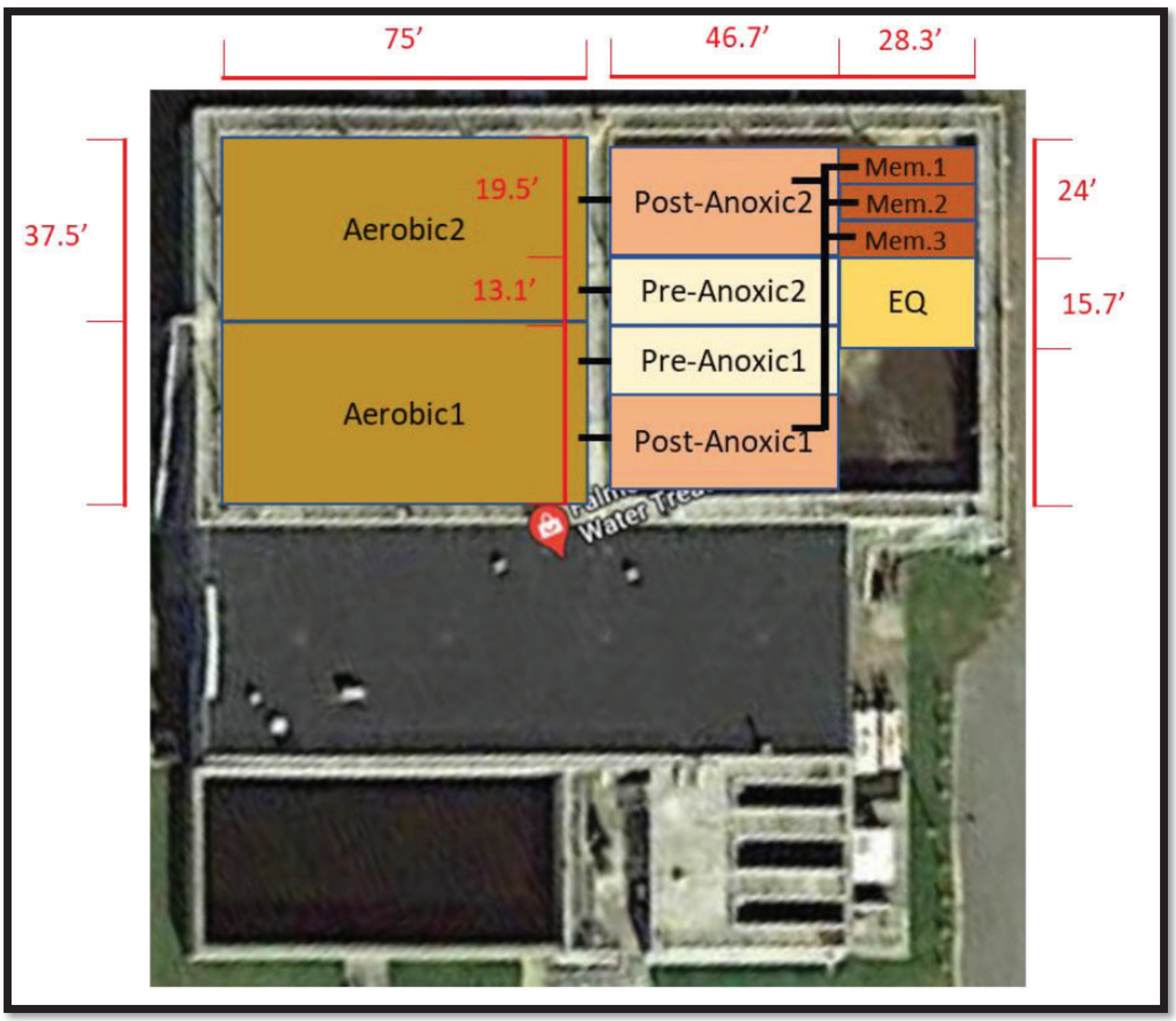

Figure 4.2 MBR Layout

The flow path is through equalization basin into pre-anoxic into aerobic into post anoxic and then through membranes. The processes for the membrane are outlined in the following table.

Table 4.6 MBR Process

Process	Number of Units	Description
Equalization (EQ)	1 Tank	Used to hold wastewater before secondary treatment and to buffer high flowrates.
Pre-Anoxic	2 Tanks	Low oxygen zone
Aerobic	2 Tanks	Aerated zone
Post-Anoxic	2 Tanks	Low oxygen zone
Membrane	3 Membrane Trains	Ultrafiltration

To update the secondary treatment process to an MBR a finer screen and grit removal system would be recommended. The denitrification filters would no longer be necessary at the plant as the MBR would be sized to treat to the final nitrogen and TSS limits. For the MBR system the filtrate from the sludge process would be routed to go through the headworks screen before being returned to the secondary treatment process. Currently, the filtrate from the solids processing is routed to the wet well and bypasses the headworks screen. Because grit can wear down the material in the membrane it is important to remove the grit in the filtrate by screening it with a 2 mm opening screen.

Cost Evaluation

Both the SBR and MBRs were evaluated for upgrading at the facility's secondary process to accommodate the TASA and ESRA flow increases. While both options were viable from a process perspective, the cost comparison of adding a third SBR tank versus retrofitting the existing SBR tanks with new MBR process resulted in the MBR process being more expensive on a capital cost basis. In addition, MBRs are typically more expensive to operate than any other commonly used secondary treatment process. As such, it is recommended that the facility maintain an SBR process and expand the existing processes in order to accommodate the increased flows.

4.4.3 Operational Issues

The Town noted the following operational issues:

- Diffuser assemblies are difficult to remove from the SBR tanks for servicing. This has primarily been experienced when the diffusers are close to failure and may allow more sludge to settle on them or allow water to backup into the diffuser pipes.
- There is not space or means to remove blowers from the blower room and from the building for service or replacement.

4.4.4 Recommendations

Based on the evaluation of the existing facility, the cost comparison of the MBR and SBR processes, and the additional issues noted above, the following is recommended:

Table 4.7 SBR Recommendations

Issues	Recommended Improvements
SBR capacity undersized for design flows	Add a third SBR tank, complete with the following Aqua-Aerobic accessories. It is recommended that this equipment be sole-sourced in order to maintain consistency of equipment and spare parts. • One (1) Decanter Assembly • Eight (8) Removable Fine Bubble Diffuser Assemblies • One (1) Mixer and Cable Removal System • One (1) 2.7 HP Submersible Transfer Pump • Two (2) 100 HP Positive Displacement Blowers • One (1) Submersible Pressure Transducer • One (1) Float Switch Assembly • One (1) Dissolved Oxygen Probe Assembly • One (1) Control Panel for the new SBR tank system

4.5 Denitrification Filters

4.5.1 Description

The WWTF has three DeNora (previously Severn Trent) denitrification filters. The denitrification filters are designed to remove nitrates through a fixed film biological process and to filter out suspended solids. Flow is pumped by two 1,650 gpm variable speed centrifugal Flowserve pumps from the post equalization tanks to the three denitrification filters. The pumps are designed with 23 feet of TDH. Effluent flows through seven feet of media in the denitrification filters to a 36,000 gallon clear well. Periodically the filters are backwashed to release solids that have collected in the filter. The filters backwash independently of each other and each backwash takes approximately 20 minutes. The backwash is conducted using two Flowserve 15 hp centrifugal backwash pumps which pump effluent from the clear well back into the filter. Each backwash pump has a 1,410 gpm capacity with 27 feet TDH. Two Aerzen positive displacement blowers located in the blower room in the SBR building feed air to the denitrification filters for backwash. Each blower has a 1044 SCFM capacity at 14.5 psia and 100 degrees F. Effluent from the clear well overflows into the UV disinfection channel. The design criteria of the existing filters is displayed in the following table.

Table 4.8 Denitrification Filter Size

Peak Hour Hydraulic Loading Rate	3.25 gpm/ft2
Media Width	8 ft
Media Length	23.5 ft
Media Depth	7 ft
Media Type	6x9 Mesh Sand

4.5.2 Evaluation

According to the design documents for the facility, the denitrification filters were designed to reduce nitrates from 8 mg/L to 1 mg/L. However, the SBRs were designed to treat total nitrogen down to levels of approximately 3 mg/L. Therefore, when the SBRs are treating to a low nitrogen level, the filters serve mainly as polishing filters. According to the manufacturer the media and underdrain in the filter should last at least 20 years.

The filters were designed for a peak hour hydraulic loading rate of 3.25 gpm/ft^2 with one filter out of service. For the existing flowrates at the WWTF the filters meet the design flows. However, in the most recent edition of TR-16, the redundancy requirement for filters was updated. According to TR-16 the redundancy for filter systems that require year-round operation to meet effluent limits, such as the Falmouth WWTF, should provide capacity to treat peak hourly flow with one filter backwashing and one filter offline for maintenance.

The current filter system should be able to meet the TR-16 requirements with new TASA and ESRA expansion, by using the upstream equalization basin and pushing a higher hydraulic loading rate trough the filter. The estimated peak hourly flow for the system is 3.82 mgd. This translates to 159,000 gallons of flow being pumped to the filters during one hour. The upstream equalization tank is able to hold 175,000 gallons. Therefore, the equalization basin is large enough to hold the full peak hour volume and can be used to buffer flow to allow the system to handle a peak hour flow event.

Furthermore, after discussions with the manufacturer, DeNora, the filters can be expected to run at a hydraulic loading rate of up to 5 gpm/ft^2 when needed during peak flows. The added capacity by changing the hydraulic loading rate from 3.25 gpm/ft^2 to 5 gpm/ft^2 should add an extra 20,000 gallons of capacity per filter during one hour. However, additional flow beyond what is planned for the upcoming expansion will likely require additional filtration capacity. This could be reassessed during design, but as of the writing of this report, other needs superseded the need for additional filtration capacity as the existing filtration capacity appears to be adequate at this time.

The denitrification filters are only needed if the WWTF chooses to go with an additional SBR for the TASA and ESRA expansion. If the WWTF changes to a MBR system, the denitrification filters are not needed and can be decommissioned.

4.5.3 Operational Issues

In addition, the following issues were noted:

- The filter has not been operated as a denitrification filter for any substantial length of time.

4.5.4 Recommendations

The denitrification filters are only needed if the Town continues to use SBRs for secondary treatment. If MBRs are used the denitrification filters are not needed. Based on the equalization storage capacity the denitrification filters should be able to handle the TASA and ESRA flows. The equalization tank volume will need to be finely monitored to be able to be used to hold peak flows.

4.6 Ultraviolet Disinfection

4.6.1 Description

Effluent flows from the clear well in the denitrification filters into a Sunlight Systems UV disinfection system. Sunlight Systems LLC was bought by Siemens Water Technologies in 2007. In 2011 Donnellan UV, under the trade name Germicidal Systems, acquired the rights from Siemens Water Technologies to manufacture and sell the Sunlight Systems' municipal products line. The UV system is a horizontal UV system made up of 48 UV lamps divided into two banks placed in one 30-foot long channel. The system is designed to treat an average flow of 1.2 mgd with a peak design flow of 1.83 mgd. By expanding the channel width and upgrading the system, the system can be expanded to reach a peak future flow of 2.2 mgd. The system was designed with 100 percent redundancy, meaning either bank of lamps is capable of disinfecting the maximum daily flow. The design criteria for the UV system is presented in the table below.

Table 4.9 Ultraviolet Design Parameters

Manufacturer		Sunlight Systems
Model		Wt-2L6x-AM300
Type		Low-pressure, high-intensity lamps
Number of Channels		1 channel
Banks		2 banks
Lamps per Bank	Design Flow	24 lamps
	Future Flow	30 lamps
UV dosage (uWs/cm2)	Design Flow	36,048 uWs/cm2 @ 1.83 mgd
	Future Flow	>36,000 uWs/cm2 @ 2.2 mgd
Ultraviolet Transmittance @ 253.7 nm		65% minimum
Channel Length		30 ft
Channel Width	Design Flow	16 in
	Future Flow	20 in
Channel Depth		54 in
Peak Flow	Design Flow	1.83 mgd
	Future Flow	2.2 mgd
Average Flow		1.2 mgd
Minimum Flow		0.5 mgd
Percent Redundancy		100%

4.6.2 Evaluation

The existing Sunlight Systems' UV system does not function well or treat flow reliably. TR-16 recommends that the UV module and electrical equipment area is covered either with a weather-protective canopy or is enclosed within a building. The existing UV system is not under a cover; a cover would help protect and lengthen the lifespan of the equipment and would make it easier for operators to access the equipment protected from the elements.

TR-16 states that systems that require continuous, uninterrupted disinfection, such as the Falmouth WWTF, should have more than one UV reactor channel. The existing UV system only has one channel. As this upgrade will be a simple replacement of equipment and not an expansion of the UV system, one channel will suffice. In future expansions that include an increase flow, a second channel would be needed.

GHD obtained proposals for a new UV system that is capable of treating the future peak flow. A vertical UV system proposal was provided by Ultratech and a horizontal UV treatment system was provided by Trojan. Both systems are sized to fit into the existing UV channel. The Ultratech vertical UV system equipment is very close in width to the existing channel width. Before final design of the expansion, it would be advantageous to get a more precise measurement of the UV channel width to determine whether minor changes to the channel walls would be required to fit the Ultratech UV system. Information about the two proposals is shown in the following table.

Table 4.10 UV Disinfection Equipment Sizing

System	Manufacturer	Number of Modules	Depth	Width	Length
Horizontal	Trojan	2	62-inches	20-inches	22-feet
Vertical	Ultratech	3	60-inches	20-inches	20-feet

4.6.3 Operational Issues

In addition, the following issues were noted by the Town:

- UV system operation is not reliable.
- A weather protective canopy should be installed to protect electrical equipment.
- Parts and maintenance have been difficult to obtain through Donnelllan UV.
- The UV intensity measurement reading is not reliable.
- The flow pacing in the UV system is not reliable.

4.6.4 Recommendations

Based on the evaluation of the existing UV system and the review of operational issues, the following table lists the recommended improvements for the UV system.

Table 4.11 Ultraviolet Disinfection Recommendations

Issues	Recommended Improvements
System is not reliable and is undersized to handle updated flows.	Install new UV equipment that can treat flow rates, is more reliable, and is easier to operate and maintain.
UV system is exposed to the elements.	Install canopy or covering over new equipment to protect equipment and shield operators from the elements.

4.7 Effluent Distribution, Monitoring, and Disposal

4.7.1 Description

The Effluent Distribution Structure has three channels which allow flow to be directed, depending on which weir is lowered, to open sand beds 1 through 8 (original plant), open sand beds 9 through 13

(2005 upgrade), open sand beds 14 and 15 (2016 improvements), or to the spray irrigation wet well. Spray irrigation is no longer used at the facility, but plant water is currently withdrawn from the spray irrigation wet well. Because plant water is drawn after effluent flow measurement it is erroneously included with the facility's effluent flow.

Open sand beds 1 through 13 are in the West Falmouth Harbor Watershed while 14 and 15 are outside the West Falmouth Harbor Watershed. Open sand beds 14 and 15 were sized to dispose a flow rate equivalent to the flow from the LPSA. The locations of the open sand beds are shown in the following figure.

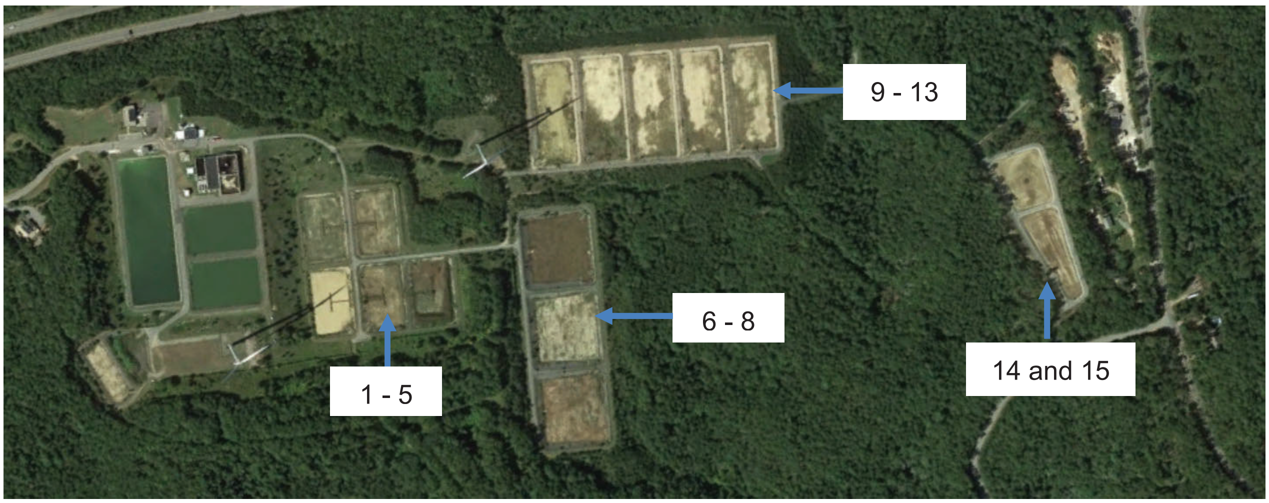

Figure 4.3 Existing Open Sand Beds

During the WWTF Phase 2 Improvements project in 2016, the Effluent Distribution Structure was covered to help reduce the algae growth that had been occurring in the structure.

4.7.2 Evaluation

Modified Groundwater Discharge Permit No. 168-5. Effective date December 12, 2015 (2015 Permit) allocates effluent flow limits by watershed. The 2015 WWTF Permit limits the cumulative nitrogen annual load that can be discharged within the West Falmouth Harbor watershed to 4,109 pounds of nitrogen per calendar year (assuming that sewer is not extended within the West Falmouth Harbor watershed and no other nitrogen reductions are credited within this watershed). Open Sand Beds 14 and 15 are in a separate watershed and have been sized to recharge treated effluent from LPSA. The Town is currently investigating options for additional disposal capacity for TASA, ESRA, and future flows. The existing effluent distribution structure contains flow measurement for the existing sand beds. The distribution structure was upgraded in 2016 and provides adequate flow monitoring.

4.7.3 Operational Issues

The following operational issues were noted by the Town:

- Open sand beds 1 through 5 have growth on the surface and are not currently functioning.

4.7.4 Recommendations

The Town is currently evaluating multiple effluent disposal options as part of the Great Pond TWMP development to allow for disposal of TASA and ESRA flows.

4.8 Septage Receiving

4.8.1 Description

The septage receiving facility is located adjacent to and within the Operations Building. Built as part of the original 1986 plant, the system includes four below-grade septage holding tanks. In 2016, the septage receiving area (exterior of the tanks and the paved area) was upgraded. A septage grit tank was installed at the septage receiving area immediately upstream of septage holding tank #4 to settle out larger materials such as rocks and grit. The grit tank is followed by a manual bar rack in the existing septage holding tank to capture rags. Pneumatic ejectors (original to the 1986 plant) are used to pump out the screened septage.

4.8.2 Evaluation

The septage volume is not expected to increase as a result of the TASA and ESRA expansion. As more of the Town is being sewered, the number of active septic systems is being reduced. The septage receiving station was updated in 2016 with a grit removal tank. The septage receiving station is sized for the TASA and ESRA expansion.

It should be noted that the original pneumatic ejector pumps are over 40 years old. The Town has invested in extending the life of this equipment by rebuilding and repairing the equipment over the years. The Town reports that the ejectors are in acceptable condition and run reliably. Therefore, it is not recommended this equipment be replaced.

4.8.3 Operational Issues

The following operational issues were noted by the Town:

- Coarse air diffuser is approximately 30 years old, near its life expectancy, and has had operational issues.
- One of the septage blowers is approximately 30 years old and near its life expectancy.
- The septage odor control blower is located in the operations building in a National Fire Protection Association (NFPA) 820 unclassified area. This does not meet NFPA 820 requirements.

4.8.4 Recommendations

The following table displays recommended improvements to the septage receiving facility that are intended for the next plant upgrade.

Table 4.12 Septage Receiving Recommendations

Issues	Recommended Improvements
Septage system odor control blower placement does not meet NFPA 820 requirements.	Install a replacement blower outside of the building and install new ductwork to avoid rating the basement area a Div. 2 area.
Coarse air diffuser is near its life expectancy (30 years) and has had operational issues.	Replace air diffusers in tanks.

4.9 Sludge Storage and Processing Facilities

4.9.1 Description

Sludge at the Falmouth WWTF consists of WAS from the SBR and septage. These sludges are stored, thickened to remove some water, and then hauled off site. A layout of the sludge storage and processing facility is shown in the following figure. The figure includes two blended sludge tanks, two thickened sludge tanks, and the processing building which houses the Somat thickening unit.

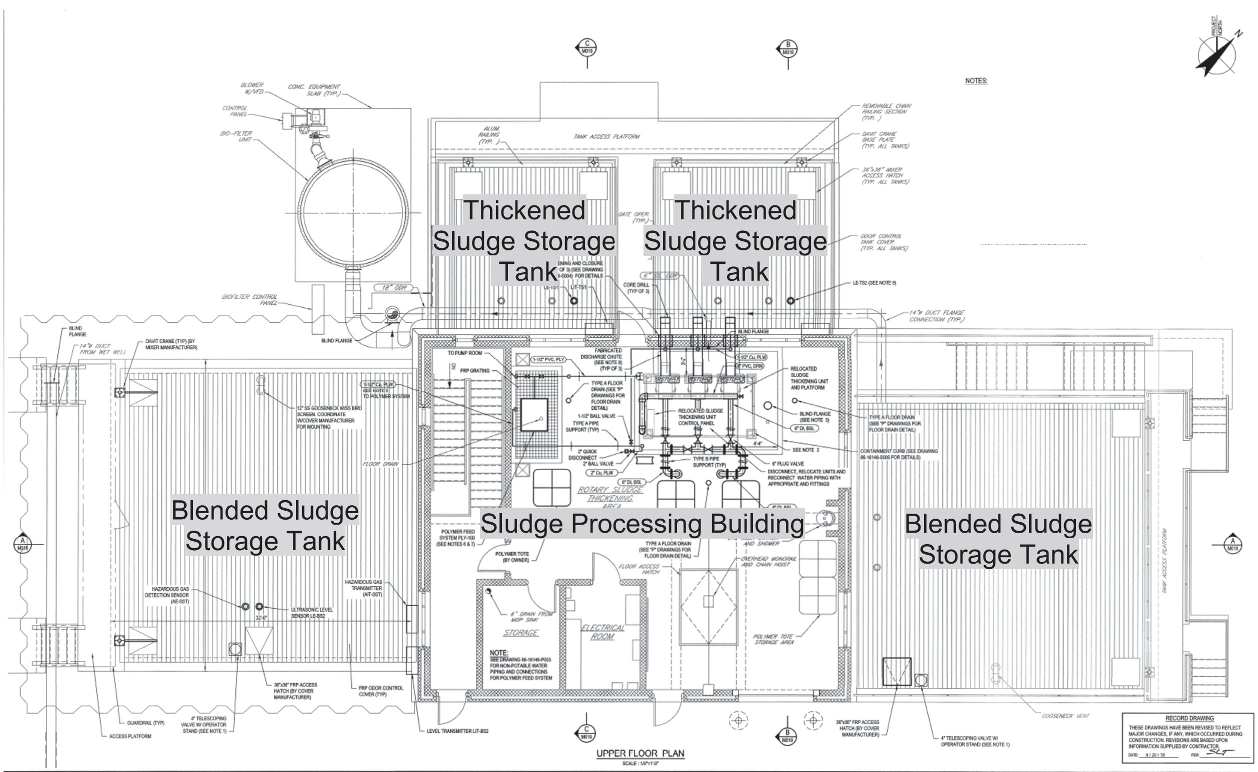

Figure 4.4 Existing Sludge Storage and Processing Facility

Septage and WAS are stored in the facility's two sludge holding tanks ("blended sludge tanks") which each have a capacity of approximately 100,000 gallons. The second sludge holding tank was installed in 2016. Typically, septage is sent to Blended Sludge Tank No. 1 and the WAS is sent to

Blended Sludge Tank No. 2. Each blended sludge tank has two submersible mixers. One replacement mixer SMXR-5 was installed in Blended Sludge Tank No. 1 in 2016. Two new mixers—SMXR-7 and SMXR-8—were installed in Blended Sludge Tank No. 2 in 2016.

Sludge is pumped from the holding tank to the thickening equipment by two positive displacement pumps (BS-1 and BS-2), located in the basement of the Sludge Processing Building. Each pump is rated for the following design conditions:

- 250 gpm at 19.5-feet of total dynamic head (TDH) with 2% solids.
- 250 gpm at 59.5-feet TDH with 6% solids.
- 250 gpm at 105-feet TDH with 6% solids.

Sludge is thickened by three Somat Som-A-Press rotary presses. Each unit is rated at 250 gpm and designed to accept an average feed rate of 0.5–1.5% solids and thicken to 5–8% solids. Once thickened, sludge flows by gravity to the thickened sludge tanks for storage. Sludge is pumped from the thickened sludge tanks to tanker trucks, which haul the thickened sludge offsite. There are two thickened sludge pumps located in the basement of the Sludge Processing Building; one existing pump and one new (2016) positive displacement pump (TS-1). TS-1 is rated for the following design conditions:

- 300 gpm at 26-feet TDH with 2% solids.
- 300 gpm at 36-feet TDH with 4% solids.
- 300 gpm at 103-feet TDH with 6% solids.

Overflow from the blended sludge tank is directed to the influent wet well.

The plant has two existing thickened sludge tanks adjacent to the Sludge Processing Building, each having a capacity of 25,000 gallons. There are two submersible mixers in each of the thickened sludge tanks. One submersible mixer in each tank (SMXR-2 and SMXR-3) was replaced in 2016. The two thickened sludge tanks are separated approximately 5-feet apart, interconnected by a 12-inch ductile iron pipe with a 12-inch x 12-inch slide gate in Thickened Sludge Tank No. 2 and are fed through one tank.

4.9.2 Evaluation

4.9.2.1 Blended Sludge Storage Evaluation

Blended sludge storage at the facility should have the capacity to store a long weekend (3 days) of waste sludge and septage in tanks. Based on future flows and loads defined in Section 2, the future waste sludge and septage are defined in the following table.

Table 4.13 Design WAS and Septage Volumes

	Current Blended Sludge Volume (gpd)	SBR Design Waste Sludge Volume (gpd)	MBR Design Waste Sludge Volume (gpd)	Future Septage Volume (gpd)	Total Design Blended Sludge Volume (gpd)
Max Month	89,110	48,000	40,500	74,800	122,900
Average	56,260	-	-	27,200	75,300

The facility has two existing Blended Sludge Tanks, the storage capacity of which are defined in the following table.

Table 4.14 Blended Sludge Storage Capacity

Parameter	Value
Number of Blended Sludge Tanks	2
Volume Per Tank (gallons)	103,000
No. of Tanks Required for Three Days of Storage (Max Month)	3.6
No. of Tanks Required for Three Days of Storage (Avg)	2.2

The existing two blended sludge tanks hold less than two days' worth of storage. Thus, the existing storage capacity is undersized for the future flows as defined in Tables 4.13 and 4.14 above. In order to hold three days' worth of storage under max month conditions, a third tank should be added.

4.9.2.2 Sludge Processing Evaluation

The sludge processing facilities were originally designed to thicken to five to eight percent solids. However, for many years the facility had trouble achieving this design thickness and was only thickening to 0.5–2.5 percent solids. In 2016, modifications were made to the process to improve its performance including: a new Blended Sludge Holding Tank, new pumps, a new polymer system, new screens in the Somat units, and a chute to direct sludge into the thickened sludge holding tanks. However, the Somat units reportedly were not designed for handling septage and this leads to excessive wear on the screens. In addition, the Somat line has been sold and they no longer market to the municipal market. Replacement units are not sold, only spare parts. The system is approaching the end of its life, is no longer being marketed to municipalities, and was not appropriately chosen as it was not designed to thicken septage. Thus, it is risky to continue to rely on the long-term use of this process.

For sludge processing, both dewatering and thickening processing options have been evaluated to treat TASA and ESRA flow expansions.

Sludge thickening produces a more concentrated liquid with solids concentrations of up to 10 percent, but six percent being more typical. Sludge dewatering removes water from solids such that the volume is reduced enough to produce material suitable for further processing, beneficial use, or disposal, dewatered sludge solids concentrations can be 20 to 40 percent. While the thickening process generates a liquid product, dewatering produces a cake that behaves like a semi-solid.

Currently, the Falmouth WWTF has sludge thickening equipment. The following equipment options were evaluated for sludge thickening:

- Gravity Belt Thickener
- Rotary Drum Thickener

The following equipment options were evaluated for sludge dewatering:

- Belt Filter Press
- Screw Press

- Fournier Press
- Centrifuge

The current sludge thickening equipment has operational issues and is undersized for the design flows. The current and design volumes of anticipated waste activated sludge and septage to be processed are noted in Table 4.15. To process the design volumes provided in the table, the new equipment will be sized to process the total volume of seven days of septage and WAS over a five-day period, for six hours each day. The following table summarizes the minimum and maximum sludge processing flows for the equipment.

Table 4.15 Sludge Processing Equipment Design Criteria

Parameter	Value
Maximum Month Weekday Septage + WAS	123,000 gpd
Maximum Sludge Processing Flows (Max Month WAS + Max Month Septage)	395 gpm
Minimum Daily Weekday Septage + WAS	48,400 gpd
Minimum Sludge Processing Flows (Max Month WAS + Minimum Daily Septage)	190 gpm

The new sludge processing equipment will be installed in the existing Sludge Processing Building to make use of the existing building, sludge storage, and pumping infrastructure. Of the options detailed above, the equipment evaluated included only those pieces of equipment that could fit in the existing Sludge Processing Building.

Sludge Thickening Equipment

Two sludge thickening options were evaluated for sludge thickening at Falmouth WWTF: a gravity belt thickener (GBT) and rotary drum thickener (RDT). A GBT is a conveyor belt that the sludge flows along with perpendicular sections of feet that separates the sludge into separate trains as it travels down the conveyor belt. As the sludge travels through each section of feet on the belt, water drains out through the bottom of the perforated belt and thickens as it gets to the end of the belt. A RDT is a large cylindrical drum that rotates and allows water to fall out by gravity through the perforated screen, thickening as the sludge travels down the rotating drum. Both sludge thickening process requires the addition of polymer to mix with the incoming blended sludge and can produce solids with a range of 5 to 8 percent solids. Both the GBT and RDT were evaluated through a number of meetings with the Town and GHD, the minutes and presentations for these meetings are included in Appendices A and B, respectively. The RDT has perforated screens that are cleaned with a brush. The perforated plate arrangement in the RDT was considered risky by the Town and GHD due to the volume of abrasive septage that is processed. Thus, the RDT is not recommended.

To process the total sludge volumes in Table 4.15, one (1) 2-meter GBT or two (2) 1-meter GBTs would be required. The two 1-meter GBT would each be able to treat half of the max month sludge processing rate outlined in Table 4.15. Both options should be able to fit in the existing sludge processing building, with some modifications to the building.

The two 1-meter units would provide redundancy in the event one unit was out of service for repairs or maintenance. The two 1-meter units can be placed in the existing sludge processing building parallel to one another. For this configuration the electrical room and storage room would be removed from the building. The wall next to the staircase would be removed and the lower half of the stairwell would be covered with a concrete slab to extend the useable amount of room on the main floor. The GBTs would be placed so that each thickener could discharge thickened sludge into one of the two existing thickened sludge tanks. The GBTs are also laid out so there is enough room to remove the rollers that the belt sits on for maintenance. The polymer systems and polymer totes can be placed along the wall for easy access. Roll-up doors or removable panels would be recommended on the outside wall across form the GBTs to allow for the thickeners to be removed as needed for maintenance or replacement and to also facilitate simple delivery of the polymer totes. A schematic of the sludge processing building layout for the two 1-meter GBT option is shown in the following figure.

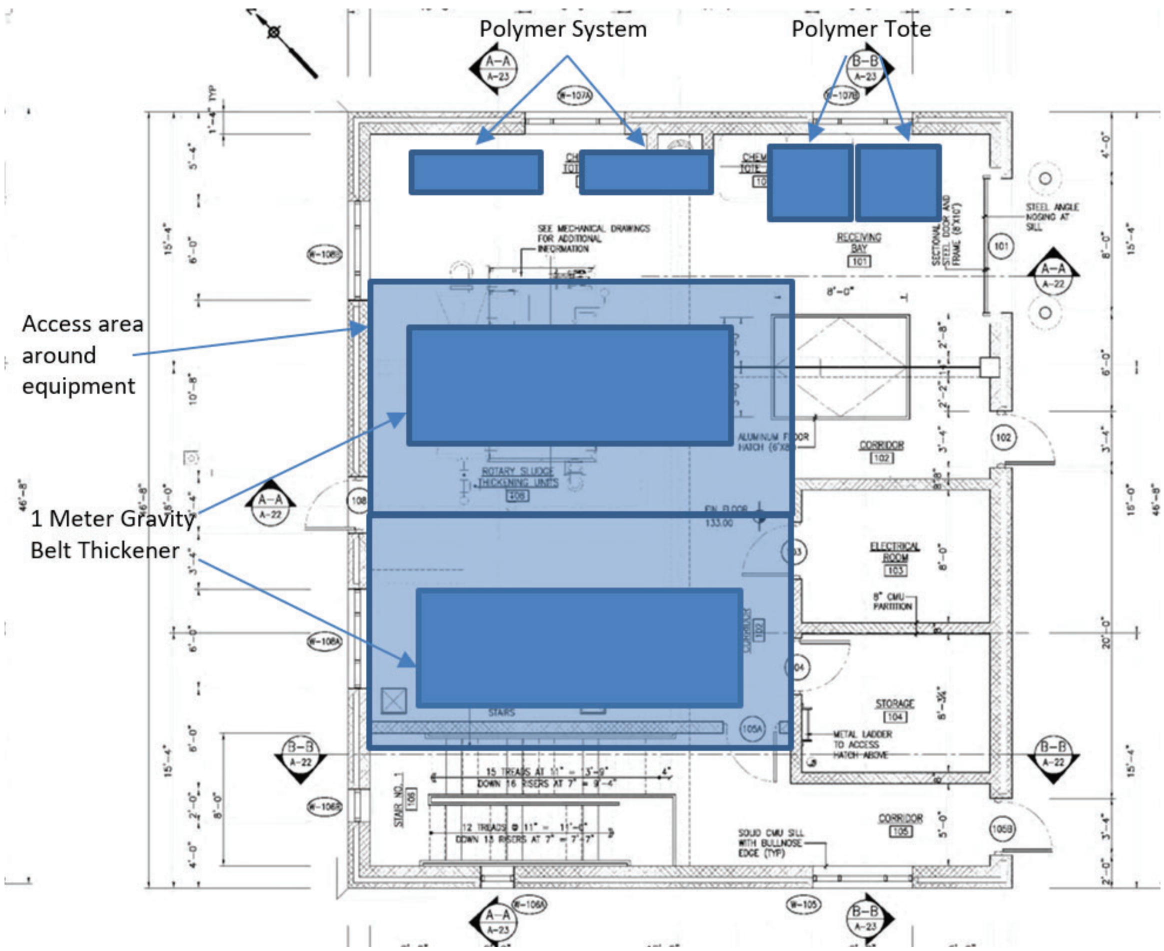

Figure 4.5 Sludge Processing Building Layout

Sludge Dewatering Equipment

Several options were evaluated for sludge dewatering at the Falmouth WWTF including: a screw press, Fournier press, belt filter press, and centrifuge. A screw press is an inclined drum that contains a rotating screw that conveys the sludge. As the sludge moves up the rotating screw it is pressed against the top plate to produce a thickened and dewatered sludge. Fournier press is a proprietary system that dewaters by feeding sludge at low pressure between two parallel rotating steel filter plates. Both the screw press system and Fournier presses did not fit adequately into the existing Sludge Processing Building with space for equipment maintenance. These were not further considered. The belt filter press is a dewatering system that uses filter belts to dewater sludge. The first portion of the belt filter press is a GBT where the sludge is thickened using gravity; the thickened sludge then drops to a portion of the equipment where it is pressed between two porous cloth belts and is dewatered. One belt filter press fit adequately in the sludge processing building; however two separate presses did not fit. Therefore, redundancy could not be achieved with the belt filter press. The centrifuge equipment fit in the existing building and was further evaluated for sludge dewatering. A centrifuge separates solids from one or two liquid phases in one single continuous process. Using centrifugal forces, the denser solid particles are pressed outwards against the rotating bowl wall, while a less dense liquid phase is formed on a concentric inner layer. Perpendicular to the centrifuge body are dam plates used to vary the depth of the liquid. A screw conveyor rotates around the bowl, removing solid particles continuously and compacting the solids such that the surplus liquid is expelled. The solids load can be varied by adjusting the speed of the screw conveyor through use of a VFD. A centrifuge can achieve 20 to 40 percent dry dewatered solids.

As the facility has been built and set up for sludge thickening it would be more costly to convert to a sludge dewatering facility. However, it is less costly to haul dewatered sludge than thickened sludge. Based on current hauling costs, it was estimated that the conversion to a dewatered sludge processing system would not pay for itself in a 20-year period, the typical timeframe allowed for municipal paybacks. Thus, dewatering was not considered further. Another dewatering sludge processing procedure that was investigated was the use of geotextile dewatering bags. These bags are made of a porous material; the bags are filled with sludge and then hydrostatic pressure in the bags is used to force the water out of the sludge and out of the bag to create a dewatered sludge. The bags can be filled with unprocessed sludge (1 to 1.5% solids) or thickened sludge (6% solids). On average it takes six to ten weeks to dewater the sludge in the bag. The expected sludge production rate for the expanded Falmouth WWTF is approximately 120,000 gallons of sludge per day. Assuming that unthickened sludge is placed into the geotextile bag, a new bag that is approximately 70 feet long with an end diameter of 15 feet would be needed each day to hold one day’s worth of sludge production. If the bags are held on site for six weeks than approximately 40 bags would need to be stored on the site at one time. Odors produced by the sludge may cause an issue if the sludge is held on site for six to ten weeks. When the sludge has been dewatered the bags are demolished to remove and haul away the sludge. Each 70 foot long, 15 foot diameter bag costs approximately $1,000 dollars (one bag is needed per day) plus costs for hauling and disposal of the filled bags, and costs to collect and treat the liquid byproduct from the bags. Additionally, onsite equipment would be required to load and move the sludge and bags. Due to cost, land intensity, labor intensity, and odor concerns the geotextile dewatering bags are not recommended for use at the Falmouth WWTF.

4.9.2.3 Thickened Sludge Storage Evaluation

The facility has two existing Thickened Sludge Storage tanks. Based on the future waste sludge and septage defined in Section 4, the future thickened sludge volume and existing storage capacity is shown in Table 4.16. To store three days’ worth of capacity under max month conditions the existing two Thickened Sludge Tanks are insufficient. A third tank of volume is recommended to accommodate the design flows defined herein.

Table 4.16 Thickened Sludge Volume and Storage Capacity

Parameter	Value
Number of Thickened Sludge Tanks	2
Volume Per Tank (gallons)	28,000
Max Month Thickened Sludge Volume (gpd)	23,700
No. of Tanks Required for Three Days of Storage (Max Month)	2.5
Average Thickened Sludge Volume (gpd)	17,500
No. of Tanks Required for Three Days of Storage (Avg)	2

4.9.3 Operational Issues

The existing Somat unit is currently used for septage processing, which it was not designed to handle. This is causing higher abrasion on screens than the screens were designed for.

4.9.4 Recommendations

In order to accommodate the future flows and loads at the facility, additional tanks and a conversion to a new sludge thickening system is recommended. Two 1-meter GBTs and two polymer systems are recommended. In addition, expansion of the thickened sludge capacity and one new blended sludge tank are needed. Furthermore, in order to accommodate the additional blended sludge tank and pump the sludge to the processing equipment, a new pipe and pump gallery is recommended. Based on the evaluation of the existing facility and additional issues noted above, the following is recommended:

Table 4.17 Sludge Storage and Processing Recommendations

Issues	Recommended Improvements
Existing Blended Sludge Tanks insufficient to store three days of septage and WAS under maximum month conditions.	• Add one new Blended Sludge Tank with mixers. • Add pipe and pump gallery adjacent to the Blended Sludge Tanks
Sludge Processing inefficiencies.	Replace the Somat units: Gravity Belt Thickening System
Existing Thickened Sludge Tanks insufficient to store three days of thickened sludge under maximum month conditions.	Add one new Thickened Sludge Tank with Mixers. *OR* Increase the size of both existing Thickened Sludge Tanks to anticipate future flows.

To accommodate TASA and ESRA flows installation of two (2) 1-meter GBTs is recommended. The two 1-meter GBTs should be able to handle the high septage content in the sludge and would provide the Town with redundancy in equipment. To install the GBTs an upgrade of the sludge processing building is recommended. The upgrade would include removing the electrical and storage rooms, removing the wall next to the staircase, and covering the lower half of the stairwell to increase the functional space on the main floor. A proposed layout of the upgraded sludge building is shown in Figure 4.6.

The following figure shows the proposed overall layout of the sludge process upgrades proposed for the TASA and ESRA flows.

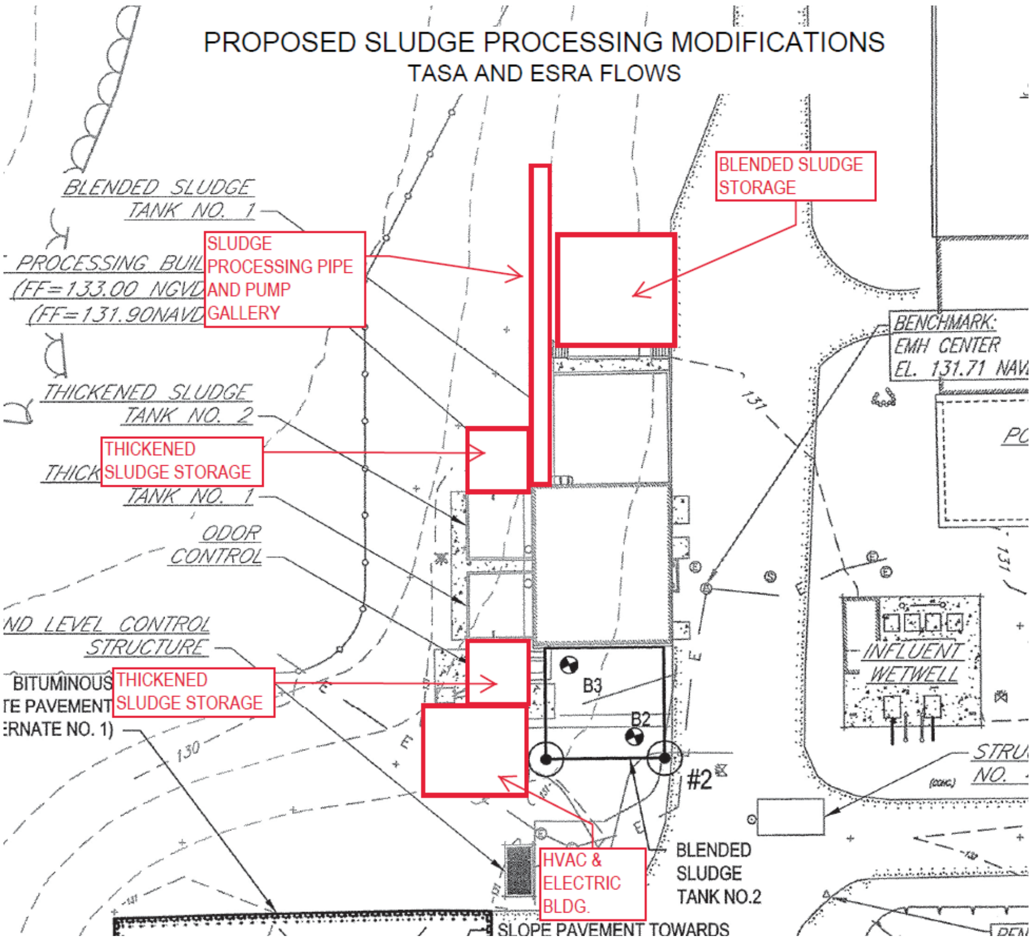

Figure 4.6 Proposed Sludge Processing Modifications – TASA and ESRA Flows

4.10 Plant Water System

4.10.1 Description

The facility has two plant water systems—a low pressure system located in the basement of the Operations Building and a high-pressure system located in the denitrification filter pump pit in the SBR Building.

The high-pressure system is a G&L Aquaforce package booster system comprised of two 125 gpm/15 hp vertical close coupled centrifugal pumps, each with a discharge pressure rating of 70 psi. The system pumps plant water from the clear well to the following locations:

- Post hydrants (2) located in the SBR tanks. These hydrants are used to control Nocardia foam, fats, oils, and grease (FOG), and for tank cleaning.
- Half-inch flushing connection (1) located on the WAS piping. The connection allows operators to periodically flush out any solids that have settled in the gravity pipe.
- Freeze-proof hydrant (1) located outside near the UV channel and clear well. This hydrant is used for cleaning the UV lamps and for wash-down purposes in the area.

- Freeze-proof hydrants (2) next to the sludge truck fill station and blended sludge tank.
- Freeze proof hydrant (1) next to the sludge thickened tanks.

The low-pressure system is a G&L Aquaforce package booster system comprised of two 90 gpm/5 HP vertical close coupled centrifugal pumps each with a discharge pressure rating of 40 psi. The system pumps plant water to the following pieces of equipment:

- Seal water for influent wet well pumps (4), denitrification filter pumps (2), backwash pumps (2), and the waste sludge pump.
- Wash hose stations at the headworks screening channel, influent wet well, and Sludge Processing Building.
- Influent fine screening.
- Somat sludge hopper.
- Polymer blend unit.
- Odor control unit.
- Plant spray hydrants.

4.10.2 Evaluation

The low-pressure system located in the basement of the Operations Building is reportedly no longer in use and once verified in design phase, it can be demolished. The high-pressure system in the SBR Building is adequately sized for the design flows defined in Section 2. While the system functions adequately, as it is 15 years old it will likely require replacement at some point in the future due to age or increased capacity needs as the plant expands.

4.10.3 Operational Issues

There were no additional operational issues noted.

4.10.4 Recommendations

Table 4.18 Plant Water System Recommendations

Issues	Recommended Improvements
Low Pressure Plant Water System No Longer in Use	Demolish low pressure plant water system, including all equipment, pads, and piping in its entirety, once verified that it is not needed.
High Pressure Plant Water System Age	Consider replacement soon due to age.

4.11 Chemical Feed Systems

4.11.1 Description

The Falmouth WWTF has two chemical feed systems. Sodium hydroxide is added to increase the alkalinity levels of the raw wastewater. Methanol is available in the event the filter needs to be used as a denitrification filter.

Sodium Hydroxide

Sodium hydroxide (NaOH) is supplied to help buffer the wastewater against drops in pH that result from the treatment process. Since the nitrification process consumes alkalinity, supplemental alkalinity addition is required at the plant. A new caustic feed building and new pipes were installed in 2016 to supply NaOH to the influent wet well. The Caustic Building contains an 8-foot diameter, 4,000 gallon storage tank.

The sodium hydroxide parameters are shown in Table 4.19.

Methanol

The denitrification filter requires supplemental carbon due to a lack of carbon in the secondary effluent. The original intent was to use methanol to provide this. The methanol feed system is located behind the SBR Building and consists of a 3,000 gallon steel concrete encased bulk storage tank and two feed pumps (MFP-1 and MFP-2) to supply methanol to the denitrification filters. The methanol feed system was modified in 2016 to include a constant supply of dilution water to the methanol to avoid fire risk issues. In addition, the location of the methanol addition was modified to ensure proper mixing and better denitrification.

The chemical feed pump parameters are indicated in the following table.

Table 4.19 Chemical System Parameters

Pump	Type	Chemical Name (Strength)	Capacity (Per Pump)	Manufacturer (Model)
CFP 100, CFP 101, CFP 102	Simplex	Sodium Hydroxide (25%)	0.013-50.21 gph	Flowmotion (2001H Series Variable Speed Peristaltic Pump)
MFP-1, MFP-2	Simplex	Methanol (0-100%)	0.004-20.54 gph	Flowmotion (2001V Series Variable Speed Peristaltic Pump)

4.11.2 Evaluation

The sodium hydroxide storage and feed system was replaced in its entirety with new equipment including a new tank, pumps, piping, and accessories. In addition, the feed rate for the sodium hydroxide was made to be flow paced in order to control alkalinity addition. The facility currently receives a 25% concentration sodium hydroxide delivery every 2 to 3 weeks. TR-16 indicates that a 30 day supply of chemical should be provided under average conditions, where appropriate. While the existing system is adequately sized to handle the design flow, at the current chemical concentration the delivery frequency will be increased to every 2 weeks. In order to maintain the recommended 30 day storage, a higher concentration of the chemical would be required for monthly deliveries in the future. However, for future flows beyond this design, or if the facility wants to maintain a 25% concentration and reduce their frequency of chemical delivery, the sodium hydroxide storage system will need to be expanded and a new tank added.

The methanol system is adequate to handle the design flows indicated in Section 2.

4.11.3 Operational Issues

There were no operational issues identified with either of the chemical systems.

4.11.4 Recommendations

Based on the evaluation of the existing facility and no additional issues noted, there are no further recommendations to the chemical systems for the design flows as defined in Section 2. As discussed in the evaluation, the chemical deliveries are reliable for average flow conditions at the facility. At this time an additional tank is not needed.

4.12 Non-Treatment Facilities

4.12.1 Operations Building

The Operations Building was constructed as part of the original 1986 plant. Originally, the building housed the majority of process equipment along with the plant's administrative facilities. Over the years many of the original processes were replaced and the equipment abandoned, resulting in unused space. Currently, the septage system pneumatic ejectors and the plant water system are the remaining processes housed in this building. Over the years the building façade began to fail, and the HVAC became obsolete. The evaluation addresses these issues along with the condition and use of the building.

4.12.1.1 Evaluation and Recommendations

Architectural

<u>Exterior</u>

Updates to the existing administration building exterior will include replacing all exterior façade roofing material on flat and sloped roofs, and windows and doors throughout the building including the access hatch located in the work bay. The mezzanine solar wall will be replaced to accommodate the HVAC system upgrade.

<u>Upper Level Interior</u>

Recommendations include converting the existing shop in the northeast corner of the building into a new operator's office, work bay into a lunchroom, electrical room into a conference room, and generator room into a storage room to serve both the lunch and conference rooms. The existing locker room will expand to the west to make room for more lockers and the existing control area will be modified to make room for more staff. The lab and women's locker room will generally remain the same.

<u>Basement Interior</u>

The basement is to be separated into rated and non-rated space. The rated area, in the northeast corner, will be separated with CMU partitions and will have a vestibule between it and the exit stairway. Accommodations will be made to allow safe equipment removal from the rated area through the non-rated area and out of the building. The remaining portions of the basement will be non-rated and will contain a new electrical room as well as a file/storage room.

HVAC

Existing System

The existing heating system consists of an oil-fired hot water boiler located in the basement. There are 2-inch hot water supply and return mains. The pump capacity is 30 gpm. The piping serves horizontal flow unit heaters, cabinet unit heaters, and supply duct reheat coils. The boiler capacity is not noted on the original drawings, but it is likely to be 300,000 btu/h based on terminal unit and pump capacity. The existing ventilation system consists of two fan units connected to outdoor air louvers. These units provide outdoor air to the blower room. The air delivered to this space is then transferred with fans to the adjacent process space. There are also several exhaust fans that provide exhaust air for the bathrooms, lab, electrical room, and the attic space. The existing air conditioning system consists of a ducted fan-coil unit located in the mezzanine level. Original drawings indicate that this system is a self-contained unit with a water-cooled condenser utilizing domestic water for the heat rejection. There is also a solar heat re-claim system in the mezzanine. The laboratory has a ductless split air conditioning system.

Proposed Renovations

Re-use the existing oil-fired hot water boiler, pump, and hot water supply and return piping mains. Remove the terminal units for the spaces that are to be renovated. Remove the existing mezzanine system and all ductwork in the mezzanine level. Remove the solar heat re-claim system. Remove the existing oil tank and provide an above-ground oil storage tank. Provide new fan-coil unit with refrigerant cooling coil to be located in the basement that shall serve the first-floor spaces. Air conditioning shall be provided to all the renovated spaces. Provide air-cooled condensing unit on the exterior of the building. Capacity shall be approximately 3,000 cfm with 7.5 ton air-cooled condensing unit. Re-connect to existing ductwork and hot water reheat coils. Provide new hot water reheat coils for the renovated spaces on the north end of the building. Extend new supply and return ductwork to the renovated areas from the basement level. Provide new make-up air unit and exhaust fan to support renovated process space in the basement. This equipment shall be explosion-proof. Provide air pressurization design for the two adjacent vestibules to maintain negative pressure in the process space and positive pressure in the vestibules.

Electrical

The Falmouth WWTF is presently equipped with two stand-by emergency generators:

- 500kW / 625kVA generator located in the Sequencing Batch Reactor (SBR) Building, installed circa 2013.
- 300kW / 375kVA generator located in the Operations Building, installed circa 1983.

Given its age, the 300kW / 375kVA generator located in the Operations Building is nearing the end of its useful life. Additionally, fuel for this generator is fed from a day tank, which in turn is fed via an existing underground storage tank (UST) that also provides fuel for the Operations Building heating systems. The Town will be replacing this UST in the near future.

The possibility that the 500kW / 625kVA generator located in the SBR Building would be capable of providing adequate emergency stand-by power for both the SBR Building and the Operations Building was evaluated.

Data provided on the April 2020 Eversource electric bill for the WWTF (account number 4000-246-7401, meter number 5119548) shows that the peak demand for the entire WWTF over the previous 13-month period was 307 kVA, which occurred in September of 2019. The average peak demand over the previous 13-month period was 256.1 kVA. It is understood that this electric meter captures the energy usage of the entire WWTF.

The following figure shows a 13-month billing history.

13-MONTH BILL HISTORY				
5119548	Peak	Low A	Low B	Dmd
4/28	24,831	14,967	46,602	226.6
3/27	18,956	19,433	41,531	216.9
2/27	12,478	26,425	43,297	248.8
1/28	13,448	29,418	50,614	222.5
12/27	12,386	27,495	43,519	217.7
11/27	16,163	25,708	43,689	253.5
10/28	25,614	15,246	49,860	231.9
9/26	29,920	16,337	48,663	307.0
8/27	29,828	17,492	52,520	294.9
7/29	31,795	18,596	60,969	279.4
6/27	26,721	15,426	45,213	290.3
5/29	26,396	15,709	45,135	268.6
4/29	23,130	13,823	44,167	271.2

Figure 4.7 Monthly Bill History

Billing data shows that the peak demand from April 2019 back to May 2018 was never higher than 300 kVA.

The Town has indicated that energy usage/demand for the Operations Building and the SBR building were previously separately metered by the local electric utility. Based on the historical peak electrical demand data, the maximum monthly demand for the Operations Building was 88.8 kVA while the maximum monthly demand for the SBR Building was 269 kVA. These max peak demands did not occur in the same month, but if they had, the total peak demand would have been 357.8 kVA. The historical data provided was from 2007.

The highest overall metered peak load of 307 kVA, as well as the worst-case scenario of the historical peak demand of both the Operations and SBR Buildings occurring at the same time, is significantly lower that the nameplate capacity of the 500kW / 625kVA generator located in the SBR Building.

Thus, the existing 500kW / 625kVA generator located in the SBR Building would be capable of providing adequate emergency stand-by power for both the Operations Building and SBR Building provided that:

- A load test be conducted on the existing 500kW / 625kVA generator located in the SBR Building to determine that it is still capable of producing its nameplate power output.
- A procedure is adapted, (either manually or automatically via interlocks with SCADA), to stage the starting of large equipment such that motors over 20 HP are not permitted to be started simultaneously when operating on generator power.

In order to connect the emergency generator in the SBR Building to the electrical distribution in the Operations Building, the following additional infrastructure is required:

- Additional lugs on the existing 500kW / 625kVA generator to accommodate a tap to feed the Operations Building.
- A new circuit breaker to be located in the Generator Room in the SBR Building.
- Conduit and conductors between the Generator Room in the SBR Building and the Electric Room in the Operations Building. Conductors would be provided for emergency power delivery as well as generator start signal from the existing Automatic Transfer Switches (ATSs) located in the Operations Building. This will require the installation of an underground duct bank run between the two buildings. The length of this run is approximately 400 feet.
- A new disconnect switch to be located in the Operations Building.

A cost assessment was done for interconnecting the SBR generator to the Operations Building. This assessment indicated that replacing the existing 300kW / 375kVA generator located in the Operations Building with a new generator should be pursued. The new generator would be located outside of the Operations Building and provided with its own skid-mounted fuel tank and sound attenuated, weather-proof enclosure.

4.12.2 Sludge Processing Building

The sludge processing building currently houses the Somat thickening unit. The existing HVAC system is not functional in the building. Additionally, there are process modifications that are recommended for the building, which will likely reconfigure the layout of the rooms in the building including that of the electrical room.

HVAC

Existing System

The heating system for the sludge processing building is served by 2-inch hot water supply and return piping. The boiler system and pump for this system is located in the SBR Building. The design flow rate for sludge processing building is 25 gpm. The boiler system in the SBR Building provides 250,000 btu/h of heating capacity to the sludge processing building. The hot water supply and return is piped to horizontal flow unit heaters, cabinet unit heaters, and a make-up air unit. There is a rooftop exhaust fan with a coil run-around loop heat recovery system.

Proposed Renovations

Re-use the existing oil-fired boiler in the SBR Building to provide the heating source for the sludge processing building. In order to support increased spatial requirements for the process equipment, it is proposed to remove the heating-ventilating unit that serves the building and provide a new unit in a new location. One option would be to make the H-V unit a rooftop unit. A second option would be to create a small building addition to house indoor equipment. Remove and replace hot water unit heaters as required for the process equipment changes. Provide new exhaust fan. Revise ductwork, grilles, registers, and diffusers as required in coordination with process equipment changes. Provide ventilation system that is arranged for continuous ventilation at six air changes per hour in order to electrically de-rate the process space. Provide ventilation system monitoring and failure alarms.

Electrical

The recommended process modifications to the Sludge Processing Building will likely require the existing electrical room to be relocated outside of the Sludge Processing Building. The existing electrical room serves equipment both on the main floor and in the basement of the Sludge Processing Building.

4.12.3 SCADA

4.12.3.1 Evaluation and Recommendations

The SCADA system at the Falmouth WWTF consists of multiple components dating back to the 2005 upgrade of the facility as well as newer components from subsequent upgrades to the facility. This system will be further evaluated during design, especially the main part of the SCADA system located in the Operations Building, which is slated for major modifications in the next upgrade project.

One item that was noted with this system is that a number of the equipment control panels utilize PLC processors that are no longer supported by Allen Bradley SLC 505 model. Consideration should be given to replace these processors with more modern processors. These will be considered as part of the preliminary design of the next upgrade.

4.13 Criticality Matrix – A Summary of Evaluations

The following table provides a summary of the assets and projects identified and assigned a risk rating from Low to Very High as a function of the probability the equipment will fail (LoF) and the consequence of it failing (CoF). This risk assessment matrix allows the Town to develop a plan to prioritize projects by the risk they pose. The prioritization of the projects identified in Table 4.20 are ranked from Very High priority to Low priority. Within each priority category, they are ranked by condition (CA Rating) from worst condition (5) to best condition (1). Also included in the table are projects that the Town has indicated they will pursue and address.

Table 4.20 Summary of Evaluations

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix Risk Category
New Operations Building Generator	4	4	4	4	(4) Very High
Operations Building HVAC Modifications	5	5	5	3	(4) Very High
Sludge Processing Building HVAC Modifications	5	5	5	3	(4) Very High
Solids Treatment Odor-Control System	5	5	5	4	(4) Very High
Ultraviolet Disinfection Modifications	4	4	4	4	(4) Very High
Septage Odor Control Blower and Biofilter Replacement	4	4	4	4	(4) Very High
Influent Equalization Basin Addition	4	3	4	3	(4) Very High
Influent Wet Well Pump 3	4	3	4	3	(4) Very High
Denitrification Filter Pump 2	4	3	4	3	(4) Very High

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix Risk Category
SBR 2 Diffusers Replacement (includes diffuser rack, lifting mechanism {rail, cable, hoist}, and membranes)	4	3	4	3	(4) Very High
SBR Blower 1 Replacement	4	2	4	3	(4) Very High
Additional SBR Tank (including equipment and accessories)	3	5	5	4	(4) Very High
Somat Thickener Replacement	3	5	5	3	(4) Very High
RTU-1 - In Operations Building Control Room	3	2	3	4	(4) Very High
RTU-4 - In Dry Side of Influent Wet Well	3	2	3	4	(4) Very High
RTU-6 - In SBR Building Electrical Room	3	2	3	4	(4) Very High
Additional Thickened Sludge Tank	2	5	5	3	(4) Very High
Additional Blended Sludge Tank and pumps	2	5	5	3	(4) Very High
Operations Building Electrical Modifications	3	3	3	3	(3) High
Operations Building Structural/Architectural Modifications	3	3	3	3	(3) High
Sludge Processing Building Electrical Modifications	3	2	3	3	(3) High
Sludge Processing Building Structural/Architectural Modifications	3	2	3	3	(3) High
SBR Blower Room Expansion	2	3	3	3	(3) High
Septage Aeration Blower 3 Replacement	4	4	4	2	(3) High
SBR Building Fuel Tank Shelter Addition	4	3	4	2	(3) High
Septage Diffuser System Replacement	4	3	4	2	(3) High
RTU-13 In Sludge Building on SOMAT Platform	4	3	4	2	(3) High
Septage Aeration Blower 2 Replacement	3	4	4	2	(3) High
RTU-11 Outdoors at Effluent Distribution Structure	3	4	4	2	(3) High
Influent Wet Well Pump 1 Replacement	3	3	3	3	(3) High
Influent Wet Well Pump 2 Replacement	3	3	3	3	(3) High
Influent Wet Well Pump 4 Replacement	3	3	3	3	(3) High
Denitrification Filter Backwash Pump 2 Replacement	3	3	3	3	(3) High
RTU-8 - Outdoors at UV Sends UV Intensity Info to SCADA	3	3	3	3	(3) High
SBR Blower 2 Replacement	3	2	3	3	(3) High
SBR Blower 3 Replacement	3	2	3	3	(3) High
SBR Blower VFD 1 Replacement	3	2	3	3	(3) High
SBR Blower VFD 2 Replacement	3	2	3	3	(3) High
SBR Blower VFD 3 Replacement	3	2	3	3	(3) High
RTU-12 In Sludge Building Electrical Room	3	2	3	3	(3) High
Denitrification Filter Pump 1 Replacement	3		3	3	(3) High
Denitrification Filter Backwash Pump 1 Replacement	3		3	3	(3) High
RTU 3 - In Preliminary Treatment Building	3		3	3	(3) High

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix Risk Category
SBR 1 Diffusers Replacement	2	3	3	3	(3) High
Mechanical Fine Screen Replacement	3	3	3	3	(3) High
RTU-7 - In SBR Building Opposite Boiler Room	2	2	2	4	(3) High
RTU-5 - In SBR Building Electrical Room	1	2	2	4	(3) High
Aerated Grit Chamber (including blowers and grit equipment)	5	5	5	1	(2) Medium
Submersible Mixers	3	3	3	2	(2) Medium
SBR Building Plant Water Systems	3	3	3	2	(2) Medium
Septage Ejector 1	3	2	3	2	(2) Medium
Septage Ejector 2	3	2	3	2	(2) Medium
Gravity Line	2	1	2	3	(2) Medium
Sodium Hydroxide Storage Tank	1	2	2	3	(2) Medium
Operations Building Biofilter	1	2	2	3	(2) Medium
Effluent Distribution Weirs	1	1	1	3	(2) Medium
Beds 9-13	1	1	1	3	(2) Medium
Beds 14-15	1	1	1	3	(2) Medium
WAS Pump	3	3	3	1	(1) Low
SBR 2 Mixer	3	3	3	1	(1) Low
Beds 1-5	3	3	3	1	(1) Low
Beds 6-8	3	3	3	1	(1) Low
Preliminary Treatment Building HVAC	3	3	3	1	(1) Low
Preliminary Treatment Building Electrical	3	3	3	1	(1) Low
Preliminary Treatment Building Structural/Architectural	3	3	3	1	(1) Low
Lagoon Basin - Leave as Existing	2	2	2	2	(1) Low
Denitrification Filter Capacity	2	2	2	2	(1) Low
Denitrification Filter Media	2	2	2	2	(1) Low
Denitrification Filter Underdrain	2	2	2	2	(1) Low
Coarse Bar Rack	2	2	2	2	(1) Low
Influent Wet well	2	2	2	2	(1) Low
SBR 1 Tank	2	2	2	2	(1) Low
SBR 1 Mixer	2	2	2	2	(1) Low
SBR 1 Decanter	2	2	2	2	(1) Low
Post EQ basin	2	2	2	2	(1) Low
SBR Building Generator	2	2	2	2	(1) Low
SBR Building Generator Room Fan	2	2	2	2	(1) Low
SBR Building Electrical	2	2	2	2	(1) Low
SBR Building Boiler and 6-8 Boiler Circulator Pumps	2	2	2	2	(1) Low
SBR Building Boiler Room Fan	2	2	2	2	(1) Low
Denitrification Filter Backwash Blower 1	2	2	2	2	(1) Low
Denitrification Filter Backwash Blower 2	2	2	2	2	(1) Low
Automatic Sampling Stations	2	2	2	2	(1) Low

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix Risk Category
SBR 2 Tank	1	1	1	2	(1) Low
SBR 2 Decanter	1	1	1	2	(1) Low
Blended Sludge Transfer Pump (for WAS and septage)	1	1	1	2	(1) Low
Thickened Sludge Pumps	1	1	1	2	(1) Low
Biofilter at Sludge Processing Building	1	1	1	1	(1) Low
Septage Air Compressors	1	1	1	2	(1) Low
Former RTU-10 (junction box outside back door of SBR Building)	NA	NA	NA	NA	Town
There is no RTU-2	NA	NA	NA	NA	Town
There is no RTU-9	NA	NA	NA	NA	Town
Pneumatic Valve System	4	3	4	2	Town
SBR Building Fuel Tank (fuel for generator)	3	2	3	2	Town
SBR Building Fuel Tank (fuel for boiler)	3	2	3	2	Town
Septage Holding Tanks - 4	3	2	3	2	Town
Septage Receiving Fine Screen	2	5	5	1	Town
Nitrate Analyzers	2	3	3	1	Town
SBR Building Structural/Architectural	2	2	2	3	Town
Blended Sludge Storage Tank #1 (and covers)	2	2	2	3	Town
Thickened Sludge Storage Tank #1 (and covers)	2	2	2	3	Town
Thickened Sludge Storage Tank #2 (and covers)	2	2	2	3	Town
Methanol Storage Tank	2	1	2	1	Town
Sodium Hydroxide Feed Pumps	1	2	2	3	Town
Fire Booster Pumps	1	1	1	4	Town
Blended Sludge Storage Tank #2 (and covers)	1	1	1	3	Town
Sodium Hydroxide Building HVAC	1	1	1	3	Town
Sodium Hydroxide Building Electrical	1	1	1	3	Town
Sodium Hydroxide Building Structural/Architectural	1	1	1	3	Town
SBR Building Electrical Room HVAC	1	1	1	2	Town
Methanol Feed Pumps 1 and 2	1	1	1	1	Town

5. Facility Expansion

Beyond the TASA and ESRA expansions, the Falmouth WWTF is expected to grow in capacity. While the future expansions are not defined, a conceptual layout plan for future expansions of the facility is shown below.

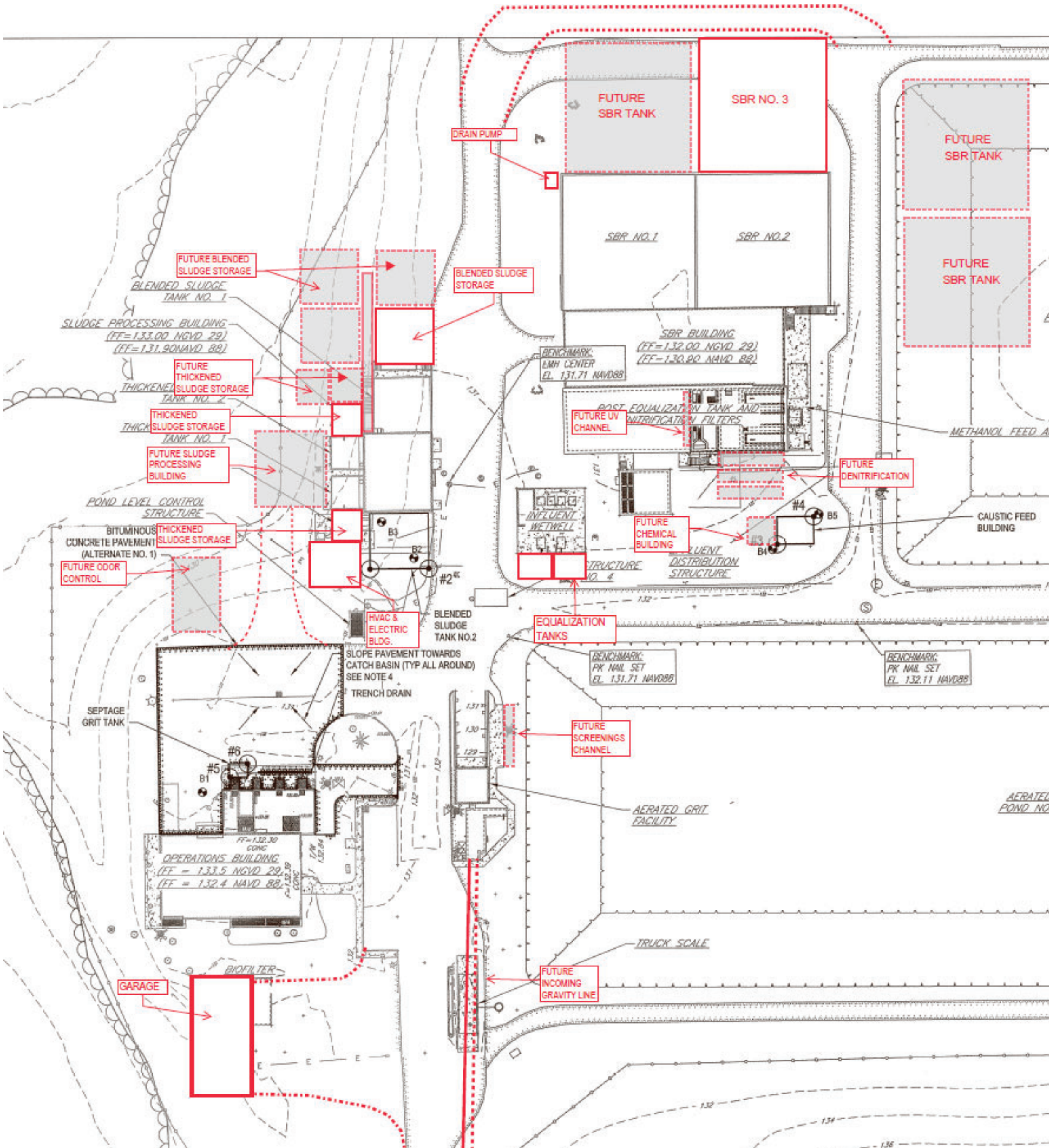

Figure 5.1 Future Expansion Layout

This layout is intended to show adequate space exists at the facility for doubling of the existing treatment facilities outlined in this report. This layout should be revisited once a complete treatment capacity analysis is done for all future stages of anticipated collection system buildout.

5.1 Preliminary Treatment

The evaluation in Section 5 indicated that the screen is at 90 percent capacity and a future upgrade would increase flows that might exceed the mechanical fine screen capacity. If future peak hour flows increase beyond the current mechanical fine screen's capacity, modifications will be required to increase the capacity of the equipment. Options for increasing screenings capacity with an increased peak hour flow include the following (and as indicated in the following table):

- Replacement of the existing screen with another type of mechanical fine screen that can accommodate a larger peak hour flow but can fit within the existing channel.
- Increasing the width of the existing screenings channel to accommodate a larger capacity screen.
- Adding a second primary screenings channel.

Table 5.1 Fine Screening Future Expansion

Fine Screening Expansion
Replacement of the existing screen with another type of mechanical fine screen that can accommodate a larger peak hour flow but can fit within the existing channel.
Increasing the width of the existing screenings channel to accommodate a larger capacity screen.
Increasing grade around the channel to allow for larger flows through the screenings channel.
Adding a second primary screenings channel.

The grit removal system is not currently operating, however grit accumulation in the secondary treatment system has not been a problem. If the secondary treatment is expanded with an additional SBR no changes to the preliminary treatment process would be required. If grit accumulation becomes an issue with increased flows, the following expansion could be considered:

Table 5.2 Grit Removal Future Expansion

Grit Removal System Expansion
Monitor grit accumulation in the processes or pumps and consider addition of a grit removal system.

If the secondary treatment process is converted to a MBR system in the expansion, then the preliminary treatment system should be updated. To protect the membranes in the MBR a screen with smaller openings is recommended. A screen opening size of 2 mm is recommended by most MBR manufacturers. Additionally, to protect the membranes in the MBR a functioning grit removal system is usually recommended by manufacturers. Rehabilitating or replacing the existing vortex grit removal system would be recommended. Lastly, if the secondary treatment system is updated to an MBR it may be wise to reconfigure the liquid flow byproduct from the solid treatment process to go through the preliminary treatment process before going to the secondary treatment process. Currently the solid treatment byproduct is rejoined with the main flow after the preliminary treatment process.

Table 5.3 Preliminary Treatment Future Expansion

	Future Expansion
Fine Screenings Expansion with Increased Future Flows	Replacement of the existing screen with another type of mechanical fine screen that can accommodate a larger peak hour flow but can fit within the existing channel.
	Increasing the width of the existing screenings channel to accommodate a larger capacity screen.
	Increasing grade around the channel to allow for larger flows through the screenings channel.
	Adding a second primary screenings channel.
Grit Removal System Modifications with Increased Future Flows	Monitor grit accumulation in the processes or pumps and consider addition of a grit removal system.
Preliminary Treatment Modifications with Conversion to MBR for Secondary Treatment	Add a mechanical fine screen with 2 mm opening to protect membranes.
	Install grit removal system to protect membranes.
	Redirect sludge processing liquid decant to go through Preliminary Treatment prior to entering the MBR system.

5.2 Secondary Treatment

As indicated previously, it is recommended that the facility maintain their SBR process for secondary treatment. A third SBR tank will be required to accommodate the additional flows with TASA and ESRA expansion. In the future, increased flows and loads would require increasing the SBR capacity, at which point additional tanks could be added north of the existing tanks.

Table 5.4 Secondary Treatment Future Expansion

	Future Expansion
SBR Expansion with Increased Future Flows	Additional SBR tanks can be added north of the existing tanks.
Conversion to MBR System for Secondary Treatment	Additional membrane cassettes can be added to the system.

5.3 Denitrification Filters

As indicated in Section 4 the current denitrification system, which contains three denitrification filters, should be able to handle the peak flow from the TASA and ESRA expansion. If a MBR is used for secondary treatment in the future, then denitrification filters are not needed. For future expansions of the SBR system additional denitrification filters should be added.

Table 5.5 Denitrification Future Expansion

	Future Expansion
Denitrification Filter Expansion with Increased Future Flows	Additional denitrification filters can be added next to existing filters.
	Mud well and wet well tanks can be expanded.

5.4 Ultraviolet Disinfection

For future expansions with additional flow increased UV capacity will be needed. At that point a second UV channel would be installed per TR-16 guidelines and can be hung over the equalization tank wall.

Table 5.6 UV Future Expansion

	Future Expansion
Ultraviolet Disinfection Filter Expansion with Increased Future Flows	Additional channel can be hung over the equalization channel and will be outfitted with UV modules.

5.5 Effluent Distribution and Monitoring

The effluent distribution structure and the open sand beds are not sized to handle the TASA, ESRA, or future flows. A separate study is currently being conducted to determine additional disposal capacity. Construction of additional open sand beds may be necessary in the future.

Table 5.7 Effluent Distribution Future Expansion

	Future Expansion
Effluent Distribution and Monitoring Expansion with Increased Future Flows	Additional infiltration beds and further studies of nitrogen loads on watersheds.

5.6 Septage Receiving

The septage receiving at the plant is not expected to increase in the future. In fact, as more of the Town is sewered the demand for septage that needs to be delivered to the WWTF should decrease. The septage receiving area was last updated in 2016; as the system ages, individual equipment (such as the screen) may need to be replaced.

5.7 Sludge Processing

As indicated in Section 4.9 the current sludge thickening equipment has operational issues and is undersized for the design flows. In addition, the blended and thickened sludge storage tanks do not have enough capacity for a long weekend's storage volume (3-day weekend). With increased future flows, the existing Sludge Processing Building could be expanded by adding a second building adjacent to the existing Blended Sludge Tank No. 2.

A second sludge processing building can be built to the west of the existing sludge processing building. Additional gravity belt thickeners can be incorporated into the new building to expand the processing capacity. Figure 5.1 shows how the facility can expand its sludge processing capacity with future flow increases and upgrades.

Table 5.8 Sludge Processing Future Expansion

	Future Expansion
Sludge Thickening Process Expansion with Increased Future Flows	Add a second building west of the thickened sludge tanks to contain more sludge processing equipment and increase the thickened sludge tank size.
	Add additional blended sludge tanks adjacent to existing Blended Sludge Tank No. 1. Addition of a pipe gallery is recommended for pumping blended sludge to the processing equipment in the Sludge Processing Building.
	Add additional thickened sludge tanks as shown in Figure 5.1.

6. Sustainable Design

There are many opportunities to incorporate sustainability considerations into the wastewater treatment process, thereby reducing the carbon footprint of the facility and realizing operational savings through the minimization of wasted power.

The sustainability alternatives discussed in this section are considered either good practice, or better than standard practice. The alternatives have been evaluated and categorized as one of the following options:

- Measure to be considered in preliminary and final design—more analysis is required on these items to determine whether these are recommended items.
- Not recommended measure—these items are not recommended for implementation.

6.1 Greenhouse Gas Evaluation

The Falmouth CWMP provided an evaluation of the facility's greenhouse gas (GHG) emissions using the USEPA's Portfolio Manager. The EPA Portfolio is an online tool designed to assess energy and water consumption at a facility. The tool provides a benchmark score which compares the performance of the facility analyzed with similar facilities. The tool also calculates GHG emissions for the facility based on the data entered. The GHG analysis is included in Appendix D.

For a municipal wastewater treatment plant, the following inputs are used to determine energy consumption at a facility:

- Zip code
- Average influent flow
- Average influent biological oxygen demand (BOD_5)
- Average effluent biological oxygen demand (BOD_5)
- Plant design flow rate
- Presence of fixed film trickling filtration process

- Presence of nutrient removal process
- Annual electricity and fuel usage

At the time this analysis was done, existing flows were 0.78 mgd with the expectation of expansion to a flow of 1.12 mgd with TASA and ESRA flows. The present facility score—as established in the CWMP—was a score of 21 (with 0.78 mgd). Based on the EPA Portfolio Manager Analysis below, the increased capacity of 1.12 mgd raises the utility benchmark score from 21 to 31.

Table 6.1 GHG Evaluation

Scenario	Utility Benchmark Score	Site kBTU/gpd	Source kBTU/gpd	CO2 Emissions (short tons/yr)
Present Facility	21	5	12	325.2
Future	31	4	10	316.5

Computer output from this evaluation is provided in Appendix D. The EPA Portfolio includes only purchased fuel. Power generated by the facility is not included.

6.2 Water Conservation

Installation of Reduced Flow Plumbing

Water usage can be minimized through the installation of reduced flow plumbing such as water-saving toilets, reduced flush devices, and restricted shower heads. **This is an item to be considered in final design.**

Reduced Infiltration and Inflow

Locating and repairing sources of inflow and infiltration in the collection system helps minimize the amount of water that needs to be pumped to and treated by the Facility. An Infiltration and Inflow (I/I) study was previously conducted for the Woods Hole area. It is recommended that an I/I study be conducted on the remainder of the system in order to identify whether there are cost-effective reduction measures that could be done within the existing collection system.

Reclaimed Wastewater Reuse

Potable water usage can be minimized through the reuse of effluent water (plant water) for non-potable purposes. The facility currently uses plant water for spray wash in the screenings channel and influent wet well, for the Polymer blend unit, for the plant spray hydrants, and pump seal system. An assessment should be conducted to determine where there are any other economic effluent reuse opportunities at the facility. **This is an item to be considered in final design.**

Landscaping

Landscaping water conservation measures can be accomplished through the planting of native species to eliminate supplementary watering needs and use of landscaping features, such as open-grid pavers. **This is an item to be considered in final design.**

6.3 Energy Efficiency

Energy Audit

An energy audit is used to determine if the equipment at a facility is properly sized for a process. There is some existing mechanical equipment at the facility that is past its useful life and in need of replacement. In addition, the secondary and sludge thickening processes are being modified or expanded with new equipment and tanks. **Because of the volume of equipment replacement and process modifications, it is not recommended that an energy audit of existing equipment be conducted at this time.**

Optimizing Existing Infrastructure

It is possible that existing infrastructure can be reused in future construction. **This is an item to be considered in preliminary and final design.**

Sub Metering

Energy usage can be minimized through system monitoring. Sub-metering will allow the facility to track the energy usage of individual processes and equipment. Installing dissolved oxygen (DO) probes in aeration systems allows operators to closely match the air supplied by the blowers to the system's need, thereby reducing excess energy consumption. **This is an item to be considered in final design.**

Energy Management System

Energy management systems are used to lock out specified process operations during periods of peak energy demand in order to minimize demand charges from the local utility. **It is recommended that this be considered in preliminary and final design.**

Upgrade Existing Motors to Variable Frequency Drives

Variable frequency drives (VFDs) should be considered for all major equipment and process modifications at the facility. **This is an item to be considered in final design.**

Process Optimization

Most WWTFs are designed with oversized equipment in order to account for uncertainty in influent variations, to provide additional capacity for future growth and to meet State and local regulatory criteria. Probes and the use of up-to-date electronic equipment for use in SCADA controls can help with process optimization. **This is an item to be considered in final design.**

Reduce Ventilation and Heating Requirements

Codes should be examined for provisions that allow for lower heating requirements and fewer air changes when an area is unoccupied in order to reduce energy consumption for ventilation and heating. The Operations and Sludge Processing Buildings HVAC systems will be redone with consideration for high-efficiency HVAC equipment. **This is an item to be considered in final design.**

Implementation of Instrumentation and Control Systems

Instrumentation and control systems, such as Supervisory Control and Data Acquisition (SCADA), are used to help match supply with demand. SCADA can be used to monitor energy usage trends and to remotely optimize process control through the measurement of variables such as liquid and gas flow rates, chemical residual and dissolved oxygen concentrations. The Falmouth WWTF has a SCADA control system that will be analyzed for process control optimization as part of the next upgrade. **This is an item to be considered in final design.**

Optimize Lighting

Energy efficiency measures to be considered for the lighting system include adding motion sensors on lights in non-process buildings, using high-efficiency fixtures and maximizing the use of natural light through the use of windows, translucent panels, skylights, etc., to reduce reliance on artificial lighting. In order to limit light pollution, light sensors or light timers should be considered and exterior lighting should be limited to what is required by local codes or for safety. **For any processes and buildings that will be upgraded, this is an item to be considered in final design.**

Optimize Building Envelope

Upgrading building envelope requirements, through the use of upgraded insulation and window requirements, should be considered at the facility. **This is an item to be considered in final design for any new or modified buildings.**

6.4 Energy Recovery

Hydroelectric Potential

If adequate head is present in an effluent pipe, a hydro-turbine could be utilized to recover a portion of the potential energy in the flow with a low head generation device. **This is an item to be considered in preliminary and final design.**

Anaerobic Sludge Digestion

Anaerobic sludge digestion is a process in which microorganisms break down organic materials in the absence of oxygen. A by-product of the process is the production of methane gas, which can be harvested and used as a biogas. The biogas can be used to power boilers, generators, pumps, or blowers. **Due to the high infrastructure costs of anaerobic digestion, it is not recommended that anaerobic digestion be retained for further evaluation as part of this project.**

Effluent Heat Recovery

Typical wastewater effluent contains enough heat, extractable through a heat exchanger, to be considered as a building heating source. Effluent heat pumps have a relatively low impact on energy consumption at a facility. **This is an item to be considered in preliminary and final design.**

6.5 Alternative Energy

Solar

The Town could consider solar photovoltaic (PV) systems to produce renewable energy onsite. The feasibility of solar in place of the existing decommissioned wind turbines was evaluated.

The wind turbines are located in a clearing that is approximately 80 feet wide and 200 feet long (16,000 square feet). Once the wind turbines are removed this area will be cleared and be an open space that sits at an angle approximately 10 degrees from due south, which is near ideal for the orientation of a solar array. Out of the 16,000 square feet available, 65 percent (10,400 square feet) would be usable for solar panel installation, allowing for spacing between rows of solar panels to prevent each row from casting shadows on the rows behind them. Each solar panel is assumed to be an average of 5.4-feet x 3.25-feet (17.55 square feet) with a nameplate rating of 315 watts. Thus, an estimated 600 panels could be installed in the available area. The overall solar array nameplate rating for this area is approximately 190 kW.

Based on solar data obtained from a weather station 1.2 miles from Falmouth, the area receives an average of 4.86 sun hours per day of solar energy (the amount varies depending on the time of year). The standard modules, if mounted in a fixed tilt position of 41 degrees with the entire array in the southernmost alignment (about 10 degrees off due south at this location), the Town could expect to produce an average of 270,000 kWh per year. At an estimated utility cost per kWh of $0.13, the value of the offset energy that would have otherwise been purchased if a solar array was not installed would be approximately $35,000.

Presently, the cost of installing a solar array on the Cape is approximately $3.35 per watt. The estimated installation cost for a 190 kW array would be approximately $635,000. Given the value of the solar electricity produced of $35,000 per year, the simple payback period, without taking any potential grants or incentives into account, would be approximately 18 years.

The panels require little to no maintenance and have a life cycle of approximately 30 to 40 years. The system inverters (the devices that convert direct current (dc) to alternating current (ac)) can be expected to last between 15 and 20 years.

This analysis was conducted using the National Renewable Energy Lab's online software and solar data. The results are provided in Appendix E (see the PVWatts Calculator printout).

Wind

The Town currently has a wind turbine installed onsite that has been decommissioned. **Due to the decommissioning of the existing turbines, it is not recommended that wind energy is pursued further at this time.**

Geothermal

Geothermal systems use the nearly constant temperature of the earth to act as a heat source and heat sink to heat and cool building through a heat pump and a heat exchanger. A heat exchanger is a system of pipes buried in the shallow ground near the building. **This is an item that could be considered in preliminary and final design.**

6.6 Site Considerations

Low Pollution Generator

The Town should consider the installation of a low-polluting emergency generator at the facility. **This is an item to be considered in preliminary and final design.**

6.7 Summary

Table 6.2 summarizes the sustainability considerations that are recommended to be considered during preliminary and final design.

Table 6.2 Summary of Sustainable Design Considerations

Water Conservation	Energy Efficiency	Energy Recovery	Alternative Energy	Site Considerations
Installation of reduced flow plumbing	Optimizing existing infrastructure	Hydroelectric potential	Solar	Low-polluting generator
Reduced I/I	Sub-metering	Effluent heat recovery	Geothermal	
Reclaimed WW reuse	Energy management systems			
Landscaping	Upgrade existing motors to VFDs			
	Process Optimization			
	Reduce ventilation and heating requirements			
	Implement instrumentation and control systems			
	Optimize lighting			
	Building envelope upgrade			

7. Capital Improvement Costs

7.1 Overview

The capital improvement plan (CIP) includes the planning and design (if applicable) phases of several important capital projects, with the goal of timely replacement of existing aged infrastructure. The CIP can be used as a tool to allow the facility to spend less time on reactive maintenance and more time on preventative maintenance. Anticipated planning level project costs were determined using GHD cost estimating experience. Costs are presented as total capital cost in ENR index year of 2020.

7.2 Planning Level Capital Improvement Costs

Capital projects were evaluated to estimate the anticipated costs necessary to upgrade the facility's capacity and treat expanded flows from the TASA and ESRA expansions (as noted in Section 2). No costs were carried for potential improvements at the WWTF that may be required to meet future, more stringent permit requirements, or for upgrades required to meet future updated codes. Using the analysis conducted in this report and shown in the criticality matrix, two separate upgrades we considered for the WWTF. The first upgrade is that of the new Operations Building Generator; the second upgrade is that of the most critical improvements for the WWTF. The planning level engineers' opinion of probable costs for this upgrade are outlined in Table 7.2.

Table 7.1 Engineers' Estimate of Probable Costs

Lump Sum Work	Conceptual Design
Equalization Tank	$ 674,000
SBR	$ 3,156,000
Denitrification Pumps and UV	$ 779,000
Sludge Processing	
– Blended Sludge Tank	$ 1,532,000
– Sludge Processing	$ 1,228,000
– Thickened Sludge Tank	$ 806,000
Sludge Processing Building HVAC	$ 213,000
New Electrical and HVAC Building	$ 270,000
Operations Building	
– Architectural Modifications	$ 2,030,000
– HVAC	$ 269,000
– Garage	$ 887,000
Generator Modifications	$ 311,000
Subtotal of Project Cost Estimate	$ 12,200,000
Contingency	$ 3,050,000
TOTAL CONSTRUCTION	$ 15,300,000
Construction Engineering	$ 2,300,000
TOTAL CAPITAL COSTS (ENR - January 2020 = 11392)	$ 17,600,000
"TOTAL CAPITAL COSTS TO MIDPOINT OF CONSTRUCTION (ENR - June 2023 = 12562)"	$ 19,000,000
Design Engineering	$ 1,700,000
Total Project Costs	$ 20,700,000
Alternate No. 1 – Odor Control	$ 690,000

The implementation schedule is based on the criticality of the facility's infrastructure and the projects required for expansion of treatment at the facility. Table 7.2 lists each project, estimated project cost, and the timeframe in which the project may occur. Further description and justification of the various equipment ratings can be found in the full criticality matrix in Appendix C. The projected year of investment for the projects is based on age, condition, and remaining life data provided for the Town's infrastructure. It is recommended that the Town consider potential upgrades when implementing this schedule, in order to identify whether cost savings measures exist in the timing of implementing the schedule.

This implementation schedule provides a basis for planning for future project costs and establishing an Asset Management and Fiscal Sustainability Plan.

Table 7.2 Criticality Matrix Project Costs and Timeframe

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix	Total Project Costs (2020 $)	Year 0 (2022 $)	Year 1 (2023 $)	Year 5 (2027 $)	Year 10 (2032 $)	Year 15 (2037 $)	Notes
New Operations Building Generator	4	4	4	4	(4) Very High	$17,600,000		$19,000,000				
Operations Building HVAC Modifications	5	5	5	3	(4) Very High							
Sludge Processing Building HVAC Modifications	5	5	5	3	(4) Very High							
Ultraviolet Disinfection Modifications	4	4	4	4	(4) Very High							
Influent Equalization Basin Addition	4	3	4	3	(4) Very High							
Additional SBR Tank (including equipment and accessories)	3	5	5	4	(4) Very High							
Somat Thickener Replacement	3	5	5	3	(4) Very High							
RTU-1 - In Operations Building Control Room	3	2	3	4	(4) Very High							
RTU-4 - In dry side of Influent Wet Well	3	2	3	4	(4) Very High							
RTU-6 - In SBR Building Electrical Room	3	2	3	4	(4) Very High							
Additional Thickened Sludge Tank	2	5	5	3	(4) Very High							
Additional Blended Sludge Tank and Pumps	2	5	5	3	(4) Very High							
Operations Building Electrical Modifications	3	3	3	3	(3) High							
Operations Building Structural/Architectural Modifications	3	3	3	3	(3) High							
Sludge Processing Building Electrical Modifications	3	2	3	3	(3) High							
Sludge Processing Building Structural/Architectural Modifications	3	2	3	3	(3) High							
SBR Blower Room Expansion	2	3	3	3	(3) High							
Septage Odor Control Blower and Biofilter Replacement	4	4	4	4	(4) Very High	$690,000		$754,000				
Solids Treatment Odor-Control System	5	5	5	4	(4) Very High							
Influent Wet Well Pump 3	4	3	4	3	(4) Very High	$85,600	$90,800					
SBR 2 Diffusers Replacement	4	3	4	3	(4) Very High	$22,800	$24,300					Cost for membrane replacement.
SBR Blower 1 Replacement	4	2	4	3	(4) Very High	$123,600	$131,100					
Denitrification Filter Pump 2	4	3	4	3	(4) Very High	$85,600	$90,800					
Septage Aeration Blower 3 Replacement	4	4	4	2	(3) High	$37,600			$46,000			

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix	Total Project Costs (2020 $)	Year 0 (2022 $)	Year 1 (2023 $)	Year 5 (2027 $)	Year 10 (2032 $)	Year 15 (2037 $)	Notes
SBR Building Fuel Tank Shelter Addition	4	3	4	2	(3) High	$17,200			$21,000			
Septage Diffuser System Replacement	4	3	4	2	(3) High	$87,600			$108,000			Cost for replacement for piping and valves in 4 Septage Tanks.
RTU-13 In Sludge Building on SOMAT Platform.	4	3	4	2	(3) High				$0			
Septage Aeration Blower 2 Replacement	3	4	4	2	(3) High	$37,600			$46,000			
RTU-11 Outdoors at Effluent Distribution Structure	3	4	4	2	(3) High				$0			
Mechanical Fine Screen Replacement	3	3	3	3	(3) High	$409,600			$504,000			
Influent Wet Well Pump 1 Replacement	3	3	3	3	(3) High	$85,600			$105,000			
Influent Wet Well Pump 2 Replacement	3	3	3	3	(3) High	$85,600			$105,000			
Influent Wet Well Pump 4 Replacement	3	3	3	3	(3) High	$85,600			$105,000			
Denitrification Filter Backwash Pump 2 Replacement	3	3	3	3	(3) High	$85,600			$105,000			
RTU-8 - Outdoors at UV. Sends UV Intensity Info to SCADA.	3	3	3	3	(3) High							
SBR Blower 2 Replacement	3	2	3	3	(3) High	$123,600			$152,000			
SBR Blower 3 Replacement	3	2	3	3	(3) High	$123,600			$152,000			
SBR Blower VFD 1 Replacement	3	2	3	3	(3) High	$59,200			$73,000			
SBR Blower VFD 2 Replacement	3	2	3	3	(3) High	$59,200			$73,000			
SBR Blower VFD 3 Replacement	3	2	3	3	(3) High	$59,200			$73,000			
RTU-12 In Sludge Building Electrical Room	3	2	3	3	(3) High				$0			
Denitrification Filter Pump 1 Replacement	3		3	3	(3) High	$85,600			$105,000			
Denitrification Filter Backwash Pump 1 Replacement	3		3	3	(3) High	$85,600			$105,000			
RTU 3 - In Preliminary Treatment Building	3		3	3	(3) High				$0			
SBR 1 Diffusers Replacement	2	3	3	3	(3) High	$25,000			$31,000			Cost for membrane replacement.
RTU-7 - in SBR Building opposite boiler room	2	2	2	4	(3) High				$0			
RTU-5 - In SBR Building Electrical Room	1	2	2	4	(3) High				$0			

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix	Total Project Costs (2020 $)	Year 0 (2022 $)	Year 1 (2023 $)	Year 5 (2027 $)	Year 10 (2032 $)	Year 15 (2037 $)	Notes
Aerated Grit Chamber (including Blowers and Grit Equipment)	5	5	5	1	(2) Medium	$12,000				$17,000		Cost includes decommissioning equipment in building.
Submersible Mixers	3	3	3	2	(2) Medium	$38,300				$55,000		
SBR Building Plant Water Systems	3	3	3	2	(2) Medium	$91,000				$130,000		
Septage Ejector 1	3	2	3	2	(2) Medium	$49,000				$70,000		
Septage Ejector 2	3	2	3	2	(2) Medium	$49,000				$70,000		
Gravity Line	2	1	2	3	(2) Medium	$100,000				$143,000		Allowance for manhole modifications.
Sodium Hydroxide Storage Tank	1	2	2	3	(2) Medium	$786,000				$1,121,000		Cost includes a new building with a new tank and piping system.
Operations Building Biofilter	1	2	2	3	(2) Medium	$163,000				$232,000		
Effluent Distribution Weirs	1	1	1	3	(2) Medium	$10,000				$14,000		Allowance for replacement of only fiberglass weirs.
Beds 9-13	1	1	1	3	(2) Medium	$0				$0		No capital costs. This item only requires maintenance.
Beds 14-15	1	1	1	3	(2) Medium	$0				$0		No capital costs. This item only requires maintenance.
WAS Pump	3	3	3	1	(1) Low	$70,000					$116,000	
SBR 2 Mixer	3	3	3	1	(1) Low	$38,000					$65,000	
Beds 1-5	3	3	3	1	(1) Low	$0					$0	No longer in use; these have been decommissioned.
Beds 6-8	3	3	3	1	(1) Low	$300,000					$511,000	Long term backup to Beds 9-13. Allowance for rehabilitation of beds.
Preliminary Treatment Building HVAC	3	3	3	1	(1) Low	$50,000					$85,000	Allowance for HVAC for storage as grit removal is no longer used.
Preliminary Treatment Building Electrical	3	3	3	1	(1) Low	$40,000					$68,000	Allowance for updated lighting and miscellaneous electrical work.
Preliminary Treatment Building Structural/Architectural	3	3	3	1	(1) Low	$20,000					$34,000	Allowance for door replacements.
Lagoon Basin - Leave as Existing	2	2	2	2	(1) Low	$500,000					$851,000	Allowance for unknown sludge remediation.
Denitrification Filter Capacity	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
Denitrification Filter Media	2	2	2	2	(1) Low	$100,000					$170,000	Allowance for media replacement.
Denitrification Filter Underdrain	2	2	2	2	(1) Low	$100,000					$170,000	Allowance for underdrain replacement.
Coarse Bar Rack	2	2	2	2	(1) Low	$7,000					$12,000	
Influent Wet Well	2	2	2	2	(1) Low	$100,000					$170,000	Allowance for controls upgrade, floats replacement, and concrete repair.
SBR 1 Tank	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
SBR 1 Mixer	2	2	2	2	(1) Low	$38,300					$65,000	
SBR 1 Decanter	2	2	2	2	(1) Low	$44,000					$75,000	
Post EQ Basin	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix	Total Project Costs (2020 $)	Year 0 (2022 $)	Year 1 (2023 $)	Year 5 (2027 $)	Year 10 (2032 $)	Year 15 (2037 $)	Notes
SBR Building Generator	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
SBR Building Generator Room Fan	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
SBR Building Electrical	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
SBR Building Boiler and 6-8 Boiler Circulator Pumps	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
SBR Building Boiler Room Fan	2	2	2	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
Denitrification Filter Backwash Blower 1	2	2	2	2	(1) Low	$124,000					$211,000	
Denitrification Filter Backwash Blower 2	2	2	2	2	(1) Low	$124,000					$211,000	
Automatic Sampling Stations	2	2	2	2	(1) Low	$38,000					$65,000	Cost for 2 sampling stations.
SBR 2 Tank	1	1	1	2	(1) Low	$0					$0	There is no need to address this in the next 20 years.
SBR 2 Decanter	1	1	1	2	(1) Low	$44,000					$75,000	
Blended Sludge Transfer Pump (for WAS and Septage)	1	1	1	2	(1) Low	$0					$0	Replacement planned in next upgrade. There is no need to address this further in next 20 years.
Thickened Sludge Pumps	1	1	1	2	(1) Low	$140,000					$238,000	
Biofilter	1	1	1	1	(1) Low	$13,000					$22,000	
Septage Air Compressors	1	1	1	2	(1) Low	$10,000					$17,000	Allowance for air compressor replacement.
RTU-10 was the RTU-10 by the back door of SBR building, near door to fuel tanks. Now it's just a junction box.	NA	NA	NA	NA	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
There is no RTU-2.	NA	NA	NA	NA	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
There is no RTU-9	NA	NA	NA	NA	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Pneumatic Valve System	4	3	4	2	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
SBR Building Fuel Tank (fuel for generator)	3	2	3	2	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
SBR Building Fuel Tank (fuel for boiler)	3	2	3	2	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Septage Holding Tanks - 4	3	2	3	2	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Septage Receiving Fine Screen	2	5	5	1	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Nitrate Analyzers	2	3	3	1	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
SBR Building Structural/Architectural	2	2	2	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.

Process	CA Rating	PA Rating	LoF Rating	CoF Rating	Rating Matrix	Total Project Costs (2020 $)	Year 0 (2022 $)	Year 1 (2023 $)	Year 5 (2027 $)	Year 10 (2032 $)	Year 15 (2037 $)	Notes
Blended Sludge Storage Tank #1 (and covers)	2	2	2	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Thickened Sludge Storage Tank #1 (and covers)	2	2	2	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Thickened Sludge Storage Tank #2 (and covers)	2	2	2	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Methanol Storage Tank	2	1	2	1	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Sodium Hydroxide Feed Pumps	1	2	2	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Fire Booster Pumps	1	1	1	4	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Blended Sludge Storage Tank #2 (and covers)	1	1	1	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Sodium Hydroxide Building HVAC	1	1	1	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Sodium Hydroxide Building Electrical	1	1	1	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Sodium Hydroxide Building Structural/Architectural	1	1	1	3	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
SBR Building Electrical Room HVAC	1	1	1	2	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.
Methanol Feed Pumps 1 and 2	1	1	1	1	Town							Nothing anticipated to be done in next 20 years or Town will address immediately and is not included.

8. Conclusion

8.1 Current Issues Summary

In summary, the TASA and ESRA flows will require process updates and modification to the Falmouth WWTF. The following table summarizes the process modifications that should be included in the next design project.

Table 8.1 Summary of TASA and ESRA Flow Expansion Recommendations

Item	Recommendation
Secondary Treatment	• Addition of one SBR tank, including all equipment
Sludge Processing	• Addition of one blended sludge tank. • Addition of two thickened sludge tanks. • Addition of two new gravity belt thickeners. • Modifications of Sludge Processing Building to accommodate sludge processing equipment. • Addition of a new pipe and pump gallery for sludge processing and storage.
Equalization Volume	• Addition of two equalization tanks (the size of two additional influent wet wells).
UV Disinfection	• Replacement of the UV system.

8.2 Next Steps

The next steps following the conclusion of this report are summarized in the schedule below.

Table 8.2 Schedule

Task	Estimated Date
Submit SRF Project Evaluation Form (PEF)	August 14, 2020
Appropriate money for design	Fall Town Meeting 2020
Design	December 2020 – October 2021
Release of the Intended Use Plan (DEP)	February 2021
Appropriate money for construction and CPS	Spring Town Meeting 2021
Funding appropriation in place	July 1, 2021
Submit DEP Application	October 15, 2021
Receive approval from DEP to Bid	February 1, 2022
Bid Phase	Feb 1 – March 15, 2022
Notice to Proceed	June 1, 2022
Construction	June 1, 2022 – June 1, 2024

about GHD

GHD is one of the world's leading professional services companies operating in the global markets of water, energy and resources, environment, property and buildings, and transportation. We provide engineering, environmental, and construction services to private and public sector clients.

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Appendices

Appendix A
Meeting Minutes

Minutes

April 17, 2020

Subject/Client:	Kickoff Meeting/Falmouth	Ref. No.	11210942
From:	Sara Greenberg Lenna Quackenbush	Tel:	774-470-1655 774-470-1654
Venue/Date/Time:	WebEx; March 24, 2020 @ 9:30 a.m.		
Copies To:	All attendees		
Attendees:	Amy Lowell—Town of Falmouth Charlie Pires—Town of Falmouth Marc Drainville—GHD Sara Greenberg—GHD Lenna Quackenbush—GHD	Absent:	

Action Item	Responsibility
Send Falmouth WWTF Flows and Loads Data	Amy Lowell
Follow up on/revisit electrical assessment of SBR Building Generator to power the Operations Buidling	GHD
Complete desktop analysis of WWTF flows and loads analysis	GHD
Assess existing secondary and sludge processes as well as modification options	GHD

A. INTRODUCTION OF ATTENDEES

1. Attendees were introduced; see list above.

B. GHD PROJECT TEAM AND ROLES

1. Mr. Drainville explained the project team as follows:
    a. Marc Drainville (Technical Lead)
    b. Sara Greenberg (Project Manager)
    c. Lenna Quackenbush (Project Engineer)
    d. Discipline Support
        i. Esten Rusten (Arch)
        ii. Tom Devine (Electrical)

C. PROJECT BACKGROUND

1. The project background was discussed as follows:

   a. Mr. Drainville noted that the Notice of Project Change (NPC) for Teaticket Acapesket Sewer Service Area (TASSA) (previously TASA Study Area) was just completed. A Targeted Watershed Management Plan (TWMP) for TASSA will be initiated in 2020. The goal is to initiate WWTF improvements for the TASSA area (and perhaps more) prior to TASSA sewering. This will allow the size of TASSA to be maximized with upcoming debt drop-off.

D. SCOPE OF SERVICES

1. The scope of services in the project agreement was reviewed.
2. The group had a discussion about membrane bioreactor (MBR) facilities. Ms. Lowell requested that wastewater operators in Falmouth get a chance to visit a MBR facility.
3. Mr. Dainville explained that the team would evaluate future needs and options for solids treatment. He gave examples for some treatment equipment options including the following:

   a. A gravity belt thickener and rotary drum for sludge thickening.

   b. A belt-filter press, Fournier press, screw press or centrifuge for dewatering of sludge.

   c. The group also discussed some of the market considerations and concerns for future solids removal, including concerns of PFAS contamination. Mr. Drainville mentioned that some towns have been looking into combined solids treatment equipment that offers the flexibility to thicken or dewater sludge.

4. The group reviewed the list of non-treatment facilities that would be evaluated in this project. Ms. Lowell pointed out that these were listed in approximate order of priority in the scope of services.
5. The group discussed that a preliminary assessment had been done to determine if the Operations Building could be powered from the backup generator located in the SBR Building. GHD would follow up on this initial assessment.
6. The group discussed the effort to evaluate sustainable design features. Mr. Drainville noted that sustainability considerations would be taken into account for the intended use plan (IUP). Ms. Lowell noted that Falmouth does have a part-time energy coordinator but for this purpose she advised that work be conducted with the Town managers office.

E. SCHEDULE

1. Mr. Drainville reviewed the schedule for this project as follows:

   a. Tentative monthly progress meetings:

      i. Process Review including flows and loads; options for major process changes (Secondary Treatment, Sludge Processing); preliminary plant evaluation – April

      ii. Preliminary cost review and process selection – May

      iii. Reserved – June

iv. Report review – July

b. Draft Report by July 15, 2020

c. Final Report by August 15, 2020

d. Submit IUP application by deadline (August 2020)

F. NEXT MEETING

1. The next meeting will be held the week of April 20, 2020.

G. ITEMS NEEDED

1. Mr. Drainville and Ms. Lowell discussed the data files that were needed from Falmouth. Ms. Lowell said that she would send over the wastewater and solids data for the facility as follows:

   a. Excel data files (all)

      i. Wastewater data

      ii. Sludge data

H. SITE VISITS

1. The group discussed site visits with the WWTF operation staff to see examples of membranes and sludge processing systems. Site visits will be discussed in greater detail at the next meeting.

I. ASSET MANAGEMENT PLAN

1. Mr. Drainville noted that the IUP requires an asset management (or fiscal sustainability) plan. Mr. Drainville inquired if the Town had any current asset management systems or software in place that were being used and could be built off of. Ms. Lowell noted that there is no current software being used. Mr. Drainville explained that the report could include items to fulfill the assest management requirement and that these would be discussed further.

☐ Attachments: ______________________________

This confirms and records GHD's interpretation of the discussions which occurred and our understanding reached during this meeting. Unless notified in writing within 7 days of the date issued, we will assume that this recorded interpretation or description is complete and accurate.

Minutes

June 11, 2020

Subject/Client:	WWTF Evaluation/	Ref. No.	11210942
From:	Lenna Quackenbush LQ	Tel:	774-470-1654
Venue/Date/Time:	Falmouth WWTF; April 17, 2020 @ 10:00 a.m.		
Copies To:	All Attendees, Absentees, and file		
Attendees:	Amy Lowell (Falmouth) Charlie Pires (Falmouth) March Drainville (GHD) Sara Greenberg (GHD) Lenna Quackenbush (GHD)	Absent:	

Item Description	Action
Think over Process condition and performance and email any additional thoughts	CP
Schedule Next Meeting	SG

A. MINUTES OF LAST MEETING

1. Kickoff meeting minutes were distributed on April 17, 2020. If comments are received, the minutes will be revised and reissued and accepted at next meeting.

B. EXISTING FACILITIES CONDITION AND PERFORMANCE

1. Service Road Odor Control Station/Gravity Influent Pipe issues were discussed, and the Town indicated the following:
    a. There are no existing/ongoing problems to report.
    b. The Town indicated they had problems in the past with solids settling out in the line and possibly an incorrect pump capacity. The pumps were updated and the problem has not occurred since.
    c. There had been some odor complaints about the service road vent over the previous summer.
2. Preliminary Treatment
    a. Screenings—The Town indicated the following:
        i. The fine screen works well, however the screen's brushes have worn down and there are occasional problems with the sonar before and after the screen.
        ii. The screen parts were rebuilt in 2018 when there was an oil leak in the gear box.

iii. Typically the collection bags are changed every two to three days.

b. Grit Removal—The Town indicated the following:

   i. The grit removal does not function.

   ii. Stop blocks are used in the channel to collect grit.

   iii. They have not had trouble getting spare parts for the grit removal system.

3. Influent Pumping Station—The Town indicated the following:

   a. The influent pump station has two wet wells with an open gate valve between the wet wells.

      i. The backwash is sent into one wet well and return flow from sludge press is sent into the other.

   b. Sampling in influent pump station is in one wet well, therefore it could include liquid byproduct from solid treatment or backwash in the sample.

   c. The pumps started running in 2005.

   d. There have been problems with fixing and getting parts for pumps. The pump supplier and parts suppliers are not the same company. The pump supplier is Aqua Solutions.

   e. There have been issues with the PLC, requiring upgrades and new I/O cards.

   f. No visible corrosion in wet well was reported.

4. SBR—The Town indicated the following:

   a. Waste Sludge Pump

      i. Nothing specific was noted about the waste sludge pumps during the meeting.

   b. SBR Equipment

      i. There have been some issues with wiring to mixer rubbing and wearing. These problems seem to have been fixed.

      ii. There were past issues with the flex joint of the decanter. The decanter in SBR 2 was replaced in 2015, and parts for the decanter in SBR 1 were replaced in 2016.

      iii. The diffusers are hard to maintain. RBO replaced diffusers in SBR 2 while it was drained. The diffusers are difficult to lift out of the tank for maintenance.

      iv. Mr. Pires asked GHD to investigate whether improvements have been made to Aqua Aerobics diffuser system or if other manufactures have an easier maintenance setup.

5. Blowers—The Town indicated the following:

      i. The blowers are narrowly spaced in the blower room and cannot be easily removed from the room. This makes major maintenance or replacement of the blowers difficult.

      ii. The VFDs on the blowers have been replaced during the last 15 years. Multiple types of VFDs are now used for the blowers.

6. Post-EQ—The Town indicated the following:
   a. The Post-EQ flow is pumped into the denitrification filter. The same issue fixing and finding parts for the denitrification/post-EQ pumps exists as for the influent pumps. The pump supplier and parts suppliers are not the same company. The pump supplier is Aqua Solutions.
   b. There is no slope on floor, causing solids to collect in the EQ basin.
   c. The inflow and outflow are on the same side of the tank.
7. Denitrification Filters—The Town indicated the following:
      i. The methanol system is not used.
      ii. There are inline nitrate sensors before and after filters.
      iii. The nitrate concentration measured coming out of SBR is usually "no detect".
8. UV Disinfection—The Town indicated the following:
   a. It is hard to get parts for the UV system.
   b. The intensity measurement is not reliable.
   c. The control panel is outside and exposed to the weather which has caused damage/aging.
   d. The chemical dip tank is often not used as manually wiping the bulbs is found to be sufficient to clean the system.
9. Ancillary Systems—The Town indicated the following:
   a. Plant water
      i. The plant water supplies seal water, hose down water, and water for polymer system.
      ii. The plant water system is 15 year old but operates satisfactorily.
   b. Methanol
      i. The methanol system is not used.
   c. Sodium Hydroxide
      i. The peristaltic pumps had to be replaced sooner than anticipated.
      ii. The facility receives a load of sodium hydroxide every two weeks.
10. Effluent Distribution—The Town indicated the following:
   a. The effluent distribution system functions well.
   b. The Gate 3 valve is broken.
11. Sand Beds—The Town indicated the following:
   a. Currently, beds 9 through 13, and 14 and 15 are being used for effluent disposal.
   b. Beds 1 through 8 are currently not in use and need to be rehabilitated (they have a large amount of growth).

12. Sludge Storage—The Town indicated the following:
    a. The blended and thickened sludge storage tanks and mixers function adequately and are in working condition.
13. Sludge Processing—The Town indicated the following:
    a. The blended and thickened sludge pumps are all Penn Valley Pumps that are in good working condition. The dampeners on the pump lose air quickly and the Operators have to frequently refill the dampeners.
    b. The polymer system functions adequately.
    c. The Somat Unit is not designed correctly for its function. There have been problems with the equipment in the past. The unit is currently functioning adequately.
    d. The HVAC system in the solids building is not functioning, GHD plans to further investigate the air exchange and heating in the building.
14. Septage Receiving—The Town indicated the following:
    a. The septage receiving equipment works.
    b. The grit collected from septage is disposed of on site (after washing and dewatering).
    c. No specific comments on the weighing station were discussed.
    d. No specific comments on the receiving area were discussed.
    e. Mr. Pires mentioned that the storage tank is small and requires weekly cleaning.
    f. The septage pumps have been rehabilitated, they continue to work well and are reliable.
15. Buildings (Architectural, HVAC, Electrical, Plumbing)—The Town indicated the following:
    a. Preliminary Treatment
        i. The building is not used often.
    b. Influent Pumping
        i. There used to be water issues, but the leaks have been fixed.
    c. SBR Complex
        i. Mr. Pires mentioned a desire for new AC system.
    d. Sludge Processing
        i. There is no working HVAC system in this building and only one remote heating blower which does not work.
    e. Sodium Hydroxide
        i. The sodium hydroxide building is new and functioning well.
    f. Operations Building

i. Mr. Pires mentioned a desire for new AC system.

ii. Ms. Lowell mentioned issues with the siding and functionality of the building.

g. Odor control was not discussed during the meeting, it will be discussed in future meetings.

16. Controls/SCADA

a. SCADA will be further discussed in future meetings.

C. NEXT MEETING

1. Next meeting will be scheduled and conducted over MS Teams
2. Meeting will show examples of solid treatment and secondary treatment.

☒ Attachments: Charlie Pires' notes on processes

This confirms and records GHD's interpretation of the discussions which occurred and our understanding reached during this meeting. Unless notified in writing within 7 days of the date issued, we will assume that this recorded interpretation or description is complete and accurate.

Fine Screen:
Occasional problems with sonar, before/after screen
Screen Brush's wear
Comb weld
Oil leak on gear box, seals, rebuilt in 2018

Grit Removal
Not functioning
Aeration blowers, not functioning

Hydroxide 25% caustic addition
3 pumps work adequately
Tank functioning
Piping to/from pumps function adequate, occasional leaks?
Piping to wet-well adequate

Influent Pump Station
New 2 piece fiberglass wet-well hatch's
Problem getting parts for 4 Flowserve pumps (2 low flow, 2 high flow)
Cannot buy seal parts and pump parts from same company
Need upgrade to PLC, I/O cards
Check valve?
Limit switch?
Seal water pressure switch, out of range? Should be 0-25 psi
Influent Valve Leak rebuild difficult while using, no isolation valve
Pneumatic Control parts?

SBR 1 and 2
Pressure Transducers? SBR Volume need new Aqua Aerobics mount
Blower maintenance/rebuild problems?
Hach LDO meter adequate
ORP meter?
HL Float, works
Flex Joint?
Spare SBR?
Floating Decant Actuator mechanism, adequate
SBR plan to restart after major part failure?
Loss of MLSS, minimal grit and solids removal
Diffuser, install of tube replacement, problem with pull
Size of pull wire, pull wire snap
Should pull from middle of diffuser, rear diffuser slide/lubrication, slide-track?
Remove hanging debris?
Waste Sludge Pump, not used?
Aeration, more efficient way to aerate/mix? Air-lift water

Aqua-Aerobic RTU5: Recent PLC and I/O card change
6-8 additional RTU PLC's and I/O card change outs in WWTF
Dual Boiler system more efficient?
Valve/Circulator Pump change?

Post EQ
Denite Pumps seal and pump part problem?
HL Float Logic
Solids accumulation?
Ammonia, Nitrate, Nitrite Analyzer

Denite Filters
Question can DF polish low Nitrate numbers/how much carbon addition
Influent DO high with cascade fall effect
Denite filters don't see same amount of water
Misconception that the Denitrification Filter ensures low N numbers?
Valves adequate
Pneumatic control adequate parts for rebuild?
Air Solonoid's occasional problem

UV Disinfection System?
Accurate Intensity measure/data recording?
UV Bulbs?
Ballast?
Crustal tubes?
UV auto wipe?

Plant water system
VFD's work but will not switch automatic if pump fail and shows low pressure
2 functioning pumps

Methanol Feed
Part of Denite system, working adequately
NO3?
Pumps work
Misconception that this ensures low N numbers

Effluent Distribution
Beds 1-5 growth/not in use
Beds 6-8 growth/not in use
Beds 9-13 clean/in use
Beds 14 and 15 clean/in use

Sludge Process
Blend/Sludge thick tank mixers? 1 mixer in sludge thick tank needs replacement
Blend Tank Sonar/volume?
Penn-Valley Pumps, 4 each, function great
Dampeners require air often or pumps rattle
Polymer Feed system? Future change dependent on sludge thickening system upgrade
Future thicken sludge endpoint location
Somat units require often auger/brush change
Somat units require set of 4 screen change often/expensive
No RTU logic?
Gas Detection mechanism?
Efficient building air exchange and heat system (hydrogen sulfide/methane corrosion)
MCC room

?Addition of Pre-Equalization Tank: Possible mix and/or aeration needed, takes BW water from denite filters, MLSS settled solids when having to take an SBR off-line, Pressate from sludge/septic dewater/thickening system, feed into SBR system slowly

Minutes

June 23, 2020

Subject/Client:	WWTF Evaluation Town of Falmouth, MA	Ref. No.	11210942
From:	LQ Lenna Quackenbush	Tel:	774-470-1654
Venue/Date/Time:	MS Teams Video Conference; May 1, 2020 @ 10:00 a.m.		
Copies To:	All Attendees, Absent, and File		
Attendees:	Amy Lowell (Falmouth) Charlie Pires (Falmouth) March Drainville (GHD) Sara Greenberg (GHD) Lenna Quackenbush (GHD)	Absent:	

Item Description	Action
Send Veolia contact information to Ms. Lowell	SG

A. LAST MEETING

1. WWTF Meeting (April 17, 2020) – Minutes will be issued soon.

B. VIRTUAL WORKSHOP PROCESS

1. Mr. Drainville asks for patience as the group adjusts to having meetings through video services.
2. The team will plan to do site visits to view specific equipment installations, the specific dates for site visits will have to be determined depending on State, Town, and industry regulations.

C. EXISTING WWTF EVALUATION

1. The group discussed current and expanded flows and loads.
   a. Ms. Lowell told the group that LPSA parcels are almost all tied in, five residential properties have not connected. No parcels have connected in the last six months.
   b. Mr. Drainville explained that data from the past three to five years is usually analyzed to calculate flows and loads, however with LPSA being tied in over this time range the values are not steady. Instead calculations from past reports and industry guidelines were used to determine the future flows and loads.
   c. Ms. Lowell asked that GHD present the concentrations of loads in the final report.

D. SECONDARY TREATMENT

1. The group discussed the layout for the expanded SBR system. The SBR would require a third SBR tank.
2. A drain box was shown on the layout for a controlled draining of tanks. The drain box was not shown to scale.
3. Space was shown on the layout for more blowers and equipment.
4. The group discussed the MBR process and layout.
5. A fine (2mm) screen would most likely be needed for an MBR system.
6. The liquid from solids would also need to be screened for the MBR process and piping would need to be installed to allow this.
7. Mr. Drainville explained that an MBR often is less costly when you don't need to build additional tanks to hold the system.
8. Mr. Drainville explained the next steps for the secondary treatment analysis.
9. GHD will do a cost analysis for the MBR and SBR options.
10. The team will organize a time to visit a MBR installation.

E. SLUDGE PROCESSES

1. Ms. Greenberg displayed a cost comparison for the lifecycle costs for thickened and dewatered sludge disposal.
    a. Ms. Lowell asked whether GHD had any insight on how disposal costs might change over time. Mr. Drainville explained that sludge disposal is mostly privatized. He expects that costs may go up due to uncertainty in testing, treating, and disposing of PFAS and other contaminants.
2. Mr. Drainville recommended not treating sludge into a class A biosolid (composting or drying).
3. Ms. Lowell shared that the Falmouth contract needs to renew in 2020.
4. GHD will continue to investigate PFAS concerns.
5. Ms. Lowell asks for Veolia contact info from Ms. Greenberg.
6. Mr. Drainville suggests only thickening or dewatering, does not suggest further treatment.
7. The group discussed the redundancy of solids treatment. Mr. Drainville explained that many small plants do not have redundant systems.
    a. The Somat unit currently has redundancy, it has three units (two duty and one spare).
8. Mr. Pires and Ms. Lowell voiced that they would prefer to have redundancy.
9. Mr. Pires asked whether the facility would continue to treat septage. Currently, septage goes to solid thickening unit and then the pressate goes to SBR. Mr. Drainville suggested continuing to use this process.

10. Mr. Pires shared that there is a large percentage of grit and inorganic material in thickened sludge currently from septage.

11. Thickening

    a. Gravity belt thickener

        i. The Team showed a video of the equipment.

        ii. Mr. Drainville explained that the equipment can achieve solids of 6%.

        iii. Ms. Lowell asked how often the belt needed to be replaced; GHD will look into that.

        iv. Mr. Drainville explained that polymer is added ahead of equipment; that gravity removes free water in the equipment; and showed the legs on the belt, which bump the sludge to dislodge free water.

    b. Rotary drum

        i. The Team showed a video of the equipment.

        ii. Mr. Drainville explained that the equipment can achieve solids of 6%; that polymer is added ahead of equipment; that gravity removes free water in the equipment; and showed that the drum rotates with helical screw, the sludge slowly rotates, and the free water drops through the surrounding screen.

    c. Dewatering

        i. Belt filter press

            - The Team showed a video of the equipment.
            - Mr. Drainville showed how flow enters into floc tank, where polymer is added. He also pointed out that the first stage is thickening, similar to a gravity belt thickener. Then the sludge is pressed between two belts

        ii. Screw press

            - The Team showed a video of the equipment.
            - The video showed that a helical screw pushes sludge up, as the sludge gets closer to the top of the screw the pressure increases as it pushes against a top plate.
            - The video also showed how water is released from screen surrounding screw.

        iii. Fournier press

            - The Team showed a video of the equipment.
            - Mr. Drainville explained that sludge first enters floc tank with polymer. The sludge is then pumped into the press.
            - The video showed how the rotating disc presses liquid out.
            - Mr. Drainville explained that some redundancy is built into equipment allowing multiple discs to be connected to the same power source.

iv. Centrifuge

- The Team showed a video of the equipment.
- Mr. Drainville mentioned that the centrifuge technology has been updated.
- The video showed that the centrifuge spins quickly.
- Mr. Drainville explained that the centrifuge uses more energy to spin compared to other dewatering equipment; that the centrifuge is loud; and that the centrifuge can achieve higher solids concentration than other dewatering equipment.

12. Ms. Lowell asked whether the companies that supply the equipment provide the maintenance. GHD will follow up with the companies.
13. Ms. Lowell and Mr. Pires discussed that the Somat screen needs to be replaced each year, which is costly. They asked that the expected replacement and maintenance required be checked for all solids equipment.
14. Ms. Lowell asked if brushes are required to clean screen.
15. Mr. Drainville explain that GHD will review the capture rate of the equipment, which describes the amount of solids being released into water.
16. The group discussed that the next steps will be for GHD to go through and review solids equipment for any "deal-breakers" that would make the equipment not desirable for Falmouth.

F. UV DISINFECTION

1. Ms. Greenberg presented three configurations for UV treatment: inclined, vertical, and horizontal systems.
2. Mr. Drainville explained a potential flaw in horizontal systems that when a bulb burns out some of the water column is not treated.
3. GHD will get proposals from manufacturers to see if the existing channel can be retrofitted to hold a new UV system.

G. FISCAL SUSTAINABILITY

1. Mr. Drainville explained that GHD will create a fiscal sustainability matrix of the existing processes to rank necessary upgrades. The fiscal sustainability analysis includes:
    a. Consequence and likelihood of failure.
    b. Likelihood of failure – condition assessment.
    c. Likelihood of failure – performance assessment.

H. NEXT MEETING

1. The next meeting will be scheduled to discuss Cost Comparison (end of May 2020).
2. The team will explore the option of seeing a MBR installation for next meeting.

3. GHD will continue to investigate disposal options to be further discussed in future meetings.

☒ Attachments: Meeting Presentation

This confirms and records GHD's interpretation of the discussions which occurred and our understanding reached during this meeting. Unless notified in writing within 7 days of the date issued, we will assume that this recorded interpretation or description is complete and accurate.

Minutes

June 23, 2020

Subject/Client:	WWTF Evaluation Town of Falmouth, MA	Ref. No.	11210942
	LQ		
From:	Lenna Quackenbush	Tel:	774-470-1654
Venue/Date/Time:	MS Teams Video Conference; May 21, 2020 @ 10:00 a.m.		
Copies To:	All Attendees, Absent, and File		
Attendees:	Amy Lowell (Falmouth) Charlie Pires (Falmouth) March Drainville (GHD) Sara Greenberg (GHD) Lenna Quackenbush (GHD)	Absent:	

Item Description	Action
Update criticality matrix per meeting discussion and send to Town for review	GHD
Send building layout options (Operations Building) to Town	GHD

A. LAST MEETING

1. Meeting minutes from the last meeting on May 1, 2020 will be distributed.

B. OPERATIONS BUILDING

1. Mr. Rusten went through layout options, the layout are attached:
    a. Option 5 – Kitchen placed between conference room and lunchroom.
    b. Option 6 – Storage room between conference room and lunchroom.
    c. Option 7 – Larger women's restroom between conference room and lunchroom, with kitchen in the lunchroom.
    d. Option 8 – Combined conference room and lunchroom.
2. The group discussed the first floor layouts:
    a. Mr. Drainville introduced the idea to remove the generator and move the workshop and garage to a separate new three bay garage. This would allow more space in the operations building for personel and administration.

b. Ms. Lowell and Mr. Pires were okay with moving the workshop and garage to another building as long as there is heat and enough space for tools and workspace.

c. Ms. Lowell asked that the control room is expanded if possible. Remove the wall separating the SCADA room from the control room. Ms. Lowell recommends placing the computers along the outside edge of the room. Computers needed in the room include:

    i. Scale computer

    ii. SCADA computer

    iii. RTU 1 computer

    iv. Two operator computers

    v. Printer

d. Ms. Lowell and Mr. Pires liked Option 6 the best, with some changes. They were in favor of having the kitchen area in the lunchroom instead of in a separate space.

e. Mr. Pires will go over drawing layouts with operators.

f. GHD will look at laying out garage/workshop building.

3. The group discussed the basement:

    a. Mr. Drainville explained that the septage ejector pumps and septage intake blower creates an electrically rated Division 2 area. The layout showed how walls could segment the basement into a Division 2 area and a lower electrical rating

    b. The group went through the equipment in the basement and discussed equipment that will need to be kept and the equipment that can be removed. A general sketch of the basement locations and equipment is attached.

    c. Equipment to keep in the basement:

        i. Equipment in the small room near the stairs (booster pumps, water heater (boiler), air compressor that supplies air to ejector pumps)

        ii. Ejector pumps (2)

        iii. Sump pumps for building

        iv. Blowers (3)

        v. Compressors (2)

        vi. Level sensor for septic tank

    d. Equipment to be removed from the basement:

        i. Plant water

        ii. Other pumps and blowers

        iii. Carbon filter for odor control (2)

e. Ms. Lowell commented that she likes having the electrical room in the basement, but is worried about the cost of moving it there.

f. Ms. Lowell and Mr. Pires both said that they were fine with placing the file room in the basement. Mr. Pires explained that they already store older files in the basement.

4. The group discussed the hatch to raise equipment from the basement.
   a. The current location of the hatch would now be in the lunchroom.
      i. Hatch is currently 4-feet x 4-feet.
      ii. Hatch winch is placed over the hatch on the first floor ceiling.
      iii. The hatch is falling apart and needs to be rehabbed.
   b. If the hatch continues to be in the lunchroom, Mr. Esten mentioned that the hatch could be covered to better match the floor. Mr. Esten also mentioned placing double doors in the lunchroom to remove equipment to outside.
   c. Mr. Rusten discussed moving the hatch into the main hallway and expanding the entrance door to a double door.
   d. Mr. Pires explained that the hatch is not used often (less than once per year) but is necessary.
   e. GHD can look into hatches that blend into flooring.
   f. GHD will also look into getting equipment out of Division 2 rated area in the basement to hatch.
5. The group discussed the odor control unit near the operations building.
   a. Mr. Pires shared that the wood chips in biofilter were replaced a few months ago.
   b. Ms. Lowell mentioned that she is not sure if odor control is functioning.
   c. Ms. Lowell voiced a desire to have a functioning odor control for the septage system and tanks.
   d. Ms. Lowell would like to replace wood chips, underdrain, and blower for odor control; she asked GHD to plan to cost out the upgrades in the future.
   e. Ms. Lowell noted that the blowers that pull air from the septage tank to the biofilter needs to be replaced.
6. The group discussed the septage tanks.
   a. Mr. Pires shared that the diffuser system is 30 years old.
   b. Ms. Lowell asked how much it would cost to replace a blower and motor.
7. The group discussed the operations building HVAC system:
   a. Ms. Lowell asked for demolition drawings for the HVAC system; she shared that there is some HVAC on the basement ceiling and some in the attic area.

C. FISCAL SUSTAINABILITY

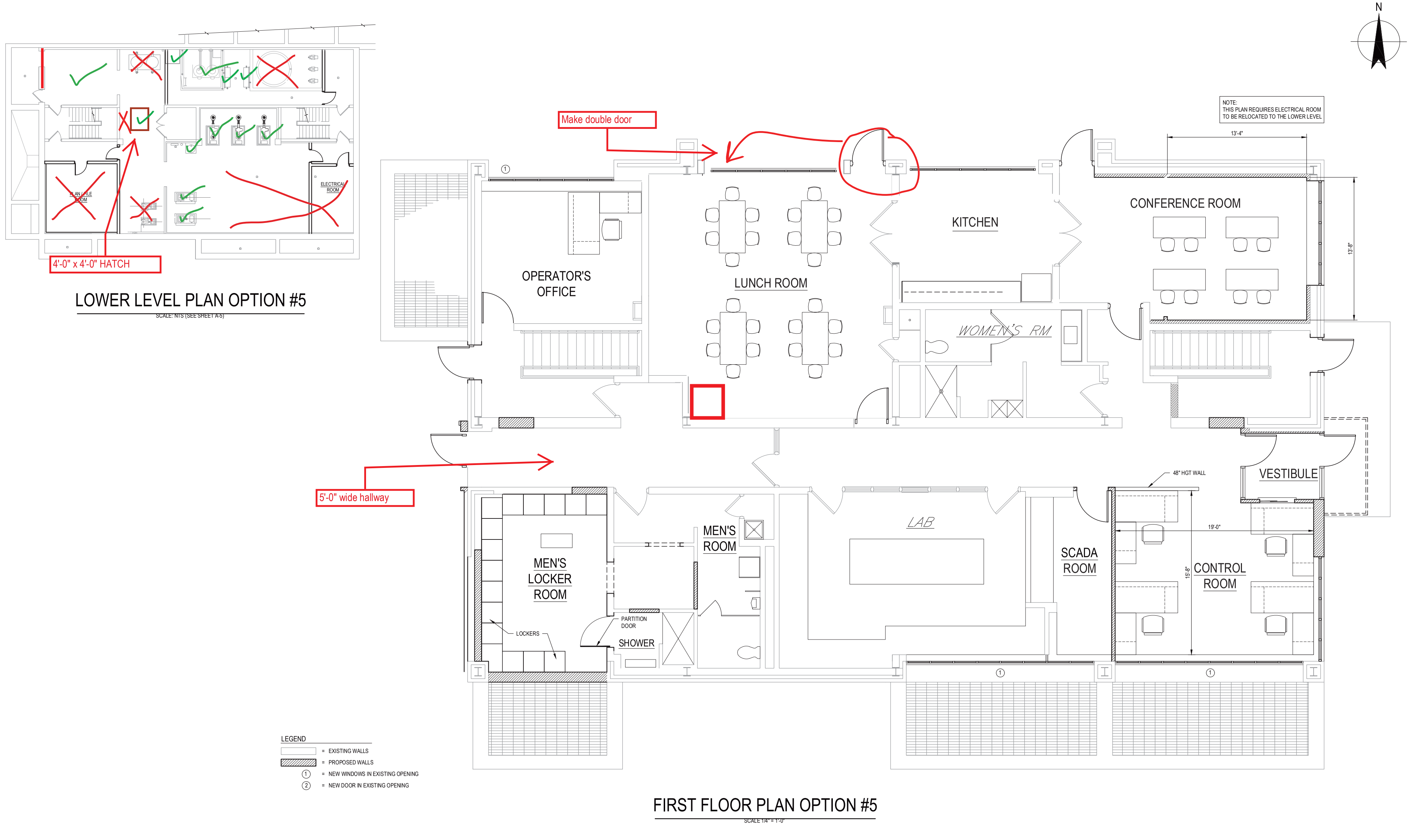
1. Mr. Drainville explained ranges and parameters of the Consequence and Likelihood of Failure Matrix:
   a. Likelihood of Failure – the maximum of the condition assessment and the performance assessment.
   b. Condition assessment – what is the condition of the equipment, age, etc.
   c. Performance assessment – how does the equipment perform.
   d. Consequence of Failure – if the equipment were to fail what would be the consequence to personel and ability for the facility to function.
   e. Matrix Rating – Consequence of failure rating and likelihood of failure rating create a rating from Very High (4) to Low (1).
2. Mr. Drainville walked through example in the WWTF evaluation matrix.
3. GHD will add items pertaining to the items discussed in this meeting.

D. NEXT MEETING

1. Mr. Drainville outlined the next meeting which is planned for Friday, June 5, 2020. The following will be discussed in the meeting:
   a. Solids treatment options discussion.
   b. Process discussion.
   c. Criticality matrix discussion. The matrix will be sent ahead of time for review and discussed during the meeting.

[x] Attachments: Layouts

This confirms and records GHD's interpretation of the discussions which occurred and our understanding reached during this meeting. Unless notified in writing within 7 days of the date issued, we will assume that this recorded interpretation or description is complete and accurate.



NOTES: UNDERGROUND FACILITIES, STRUCTURES, AND UTILITIES HAVE BEEN PLOTTED FROM AVAILABLE SURVEYS AND RECORDS, AND THEREFORE THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. THERE MAY BE OTHERS, THE EXISTENCE OF WHICH IS PRESENTLY NOT KNOWN. ANYONE USING UTILITY INFORMATION AND DATA PROVIDED HEREIN SHALL CALL DIG SAFE AT 811 SEVENTY TWO (72) HOURS, 3 BUSINESS DAYS IN ADVANCE TO VERIFY THE LOCATION OF UTILITIES PRIOR TO START OF CONSTRUCTION.

No	Revision	Drawn	Job Manager	Project Director	Date
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Note: * indicates signatures on original issue of drawing or last revision of drawing

Plot Date: 18 July 2018 - 8:46 AM Plotted by: Mike Simizon Cad File No: N:\US\Hyannis\Projects\111\11153041 Town of Falmouth South Coast CWMP Update\CADD\Drawings\Architectural\111-53041-A01.dwg

GHD Inc.
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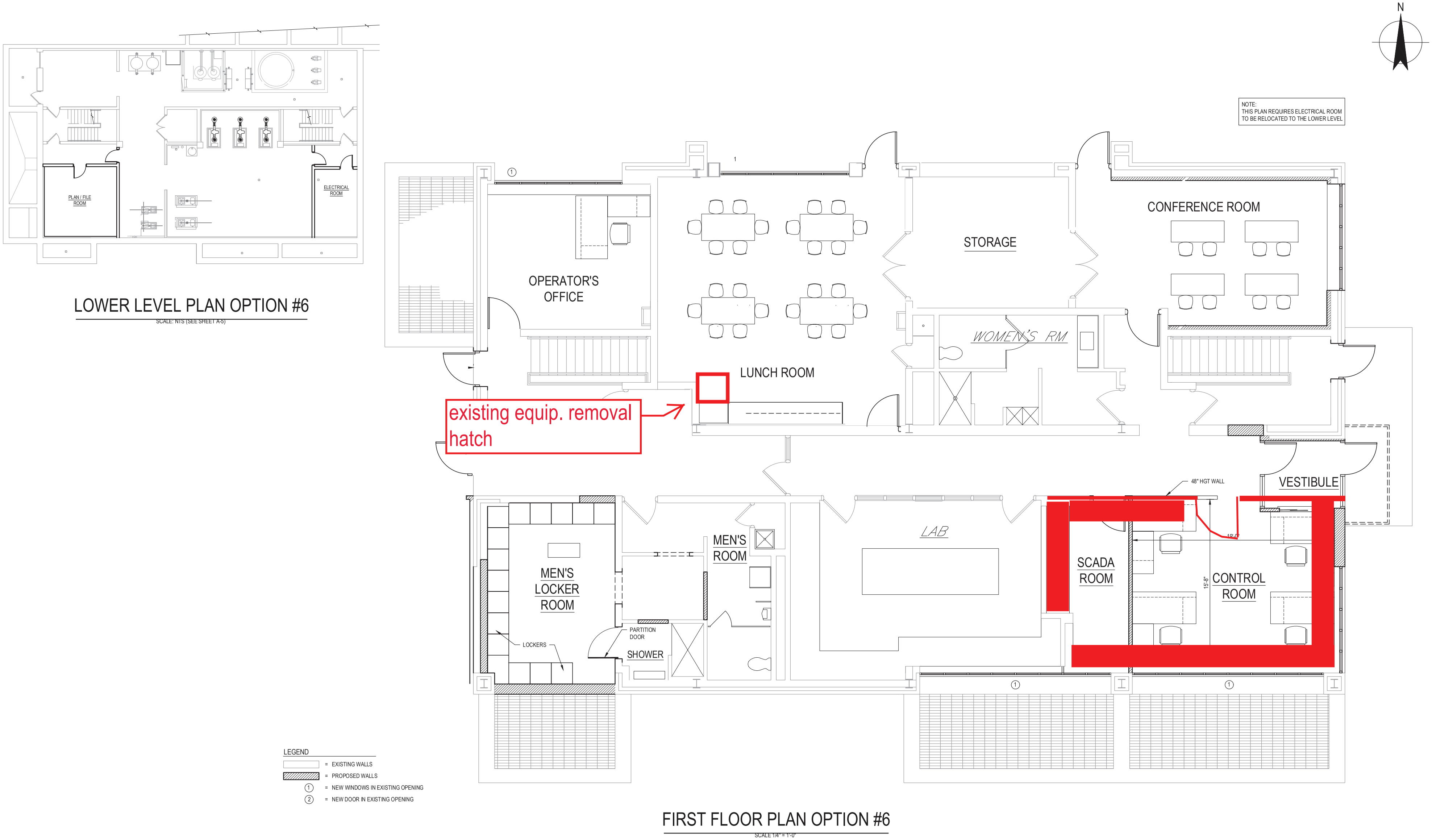
Drawn MJS | Designer MJS
Drafting Check | Design Check
Approved (Project Director)
Date
Scale AS SHOWN

This Drawing shall not be used for Construction unless Signed and Sealed For Construction

Client **TOWN OF FALMOUTH, MA**
Project **OPERATIONS BUILDING ADDITIONS AND ALTERATIONS**
Title **FIRST FLOOR PLAN OPTION #5**
Contract No.
Original Size Arch D
Drawing No: **111-53041-A5**
Rev:



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No	Revision	Drawn	Job Manager	Project Director	Date
1					
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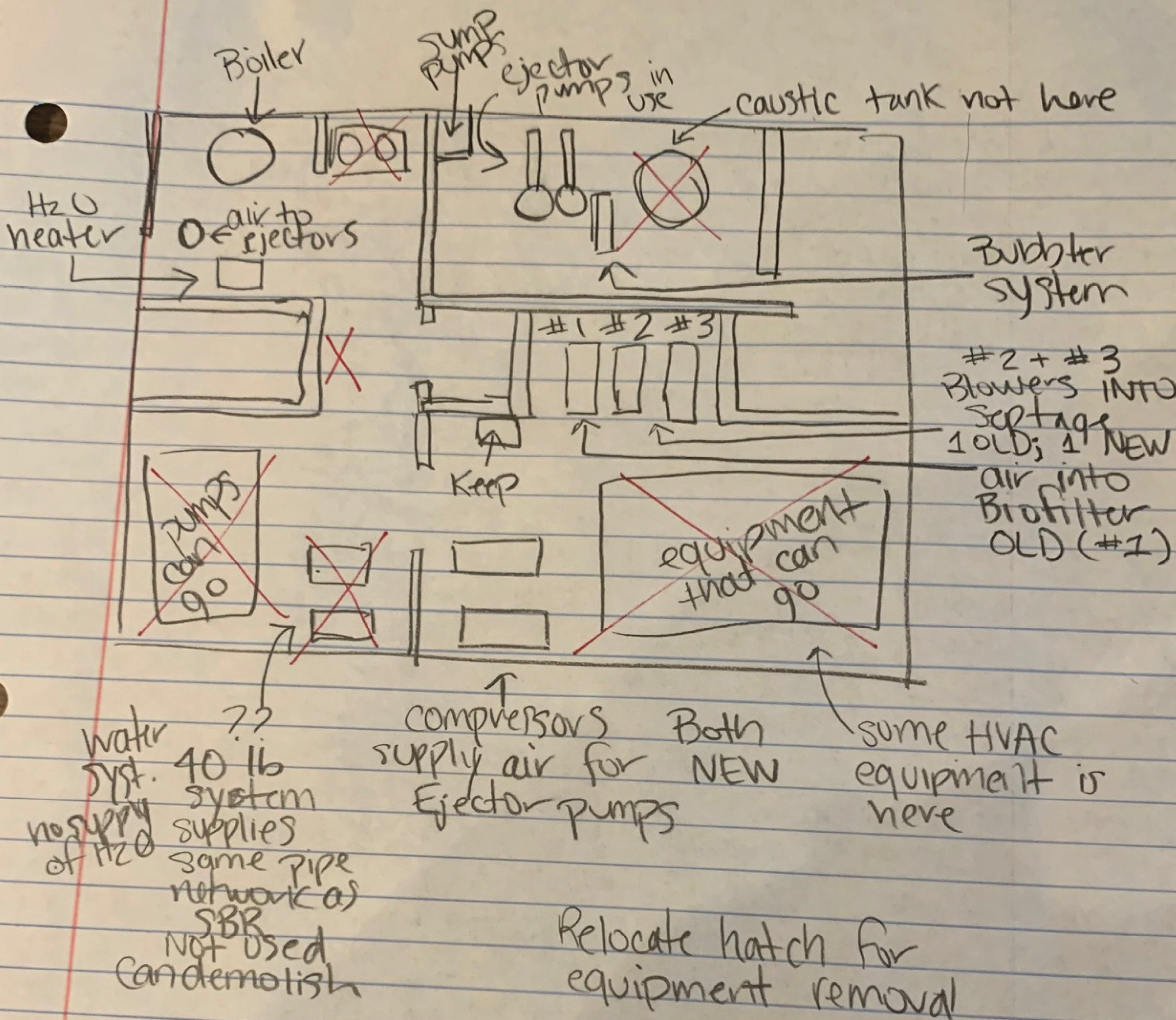
Drawn MJS | Designer MJS
Drafting Check | Design Check
Approved (Project Director)
Date
Scale AS SHOWN

This Drawing shall not be used for Construction unless Signed and Sealed For Construction

Client: **TOWN OF FALMOUTH, MA**
Project: **OPERATIONS BUILDING ADDITIONS AND ALTERATIONS**
Title: **FIRST FLOOR PLAN OPTION #6**
Contract No.
Original Size: Arch D
Drawing No: **111-53041-A6**
Rev:

Plot Date: 18 July 2018 - 8:46 AM Plotted by: Mike Simizon Cad File No: N:\US\Hyannis\Projects\111\11153041 Town of Falmouth South Coast CWMP Update\CADD\Drawings\Architectural\111-53041-A01.dwg


Boiler
sump pumps
ejector pumps in use
caustic tank not here
H2O heater
air to ejectors
Bubbler system
#1 #2 #3
#2 + #3 Blowers INTO Septage 1 OLD; 1 NEW
air into Biofilter OLD (#1)
Keep
pumps can go
equipment that can go
??
compressors supply air for Ejector pumps
Both NEW
some HVAC equipment is here
water syst. no supply of H2O
40 lb system supplies same pipe network as SBR
Not used can demolish
Relocate hatch for equipment removal

Minutes

June 23, 2020

Subject/Client:	Falmouth WWTF Evaluation	Ref. No.	11210942
	LQ		
From:	Lenna Quackenbush	Tel:	774-470-1654
Venue/Date/Time:	MS Teams Video Conference; June 5, 2020 @ 10:00 a.m.		
Copies To:	All Attendees, Absent, and File		
Attendees:	Amy Lowell (Falmouth) Charlie Pires (Falmouth) Kruser Keller (Falmouth) March Drainville (GHD) Sara Greenberg (GHD) Lenna Quackenbush (GHD)	Absent:	

A. LAST MEETING

1. A previous meeting was held on May 21, 2020.

B. OPERATIONS BUILDING

1. Mr. Drainville reviewed the layout options for the Operations Building.
    a. Ms. Lowell noted that the HVAC should be reviewed.
2. Mr. Drainville reviewed the layout options for the addition of a new Garage.

C. SLUDGE PROCESSING

1. Mr. Drainville reviewed the various sludge processing layout options as follows. The processing options discussed were those that fit in the existing building with minor modifications.
    a. Centrifuge
    b. Rotary Drum Thickener
        i. Ms. Lowell inquired if the units could be moved downstairs, but noted that would require a larger hatch being installed.
        ii. Mr. Pires inquired if the thickened sludge could directly discharge into the holding tanks in lieu of needing a pump that discharged sludge from the unit to the tanks. GHD would follow up and look into rearranging the equipment to accommodate this option. Even further, Mr. Pires noted that if the electrical room were removed then one of the RDT units could be moved

south in the building to directly discharge into tank 2 – allowing each of one unit to discharge into each tank.

   iii. Mr. Pires inquired how the RDT processing equipment can handle septage. Mr. Drainville noted that handling of septage was a consideration in all processing equipment analyses.

c. Gravity Belt Thickener

   i. The group discussed looking at putting in two (2) 1-meter units instead of one 2-meter unit. Eliminate the Electrical room.

d. There was discussion on expansion of the building versus using the existing space. In order to make use of the existing space, one option to pursue is to move the electrical room to create more space in the building. The electrical room could be moved into the basement or as an added room on the exterior of the building.

   i. Mr. Drainville noted that the easiest way to expand the building is to add on to the west and remove the existing holding tanks. Ms. Lowell noted that the total future buildout should be considered such that if a new building will eventually be required, building expansion should be considered now.

D. FISCAL SUSTAINABILITY

1. Mr. Drainville reviewed the Falmouth WWTF criticality matrix. The team focused on the (4) Very High items in the matrix.
2. Preliminary Treatment Building
   a. Ms. Lowell noted that the Preliminary Treatment Building should not be considered (4) Very High in the criticality matrix. The HVAC and electrical equipment in that building does not need to be modified. The majority of the equipment in the building could be demolished, but is not a high priority. Mr. Drainville noted that the priority would be lowered on this line item.
3. Septage Receiving
   a. Ms. Lowell inquired if there was a way to eliminate the duplicative storage for the Septage. Would it be feasible to pump directly from the four septage holding tanks to sludge processing equipment? Mr. Pires noted that polymer injection would need to be included.
4. Flow Equalization
   a. There was discussion on the flow equalization basin and capacity at the WWTF. Mr. Pires and Mr. Keller noted that the influent wet well was not large enough to contain the capacity of the collection system and side streams. Mr. Drainville noted that the equalization basins could be used to store side streams (decant and filter backwash) to alleviate the strain on the wet well. In addition, a more controlled emptying of the SBR tanks could be considered as well.
5. SBRs
   a. Ms. Lowell noted that item 5.5 should indicate SBR No. 2 membranes. The replacement of these membranes would likely be done through the Town as a maintenance item.

6. Generator
    a. Mr. Drainville noted that an outside generator might be more cost-effective than a ductbank from the existing generator in the SBR building to the Operations Building. However, it was noted that the existing generator in the SBR building could handle the Operations Building, allowing the underground fuel storage tank at the Operations building to be demolished (including the Operations Building generator).
7. Fire Booster pumps
    a. Mr. Drainville noted that these pumps were new and installed as support of the potable water system. However, there would be no cost associated with this item and it would fall off the list of priorities for replacement (even though it appears as (3) High).

E. NEXT MEETING

1. Review solids processing options in more detail.
2. Show secondary process.
3. Review Town’s comments on Criticality Matrix.

☐ Attachments: ______________________________

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Appendix B
Presentations

Secondary Treatment and Sludge Treatment Options:

Equipment Options and Installations

May 1, 2020

Outline

- Flows and Loads
- Secondary Treatment
- Solids Treatment
- UV Disinfection
- Fiscal Sustainability

Flows and Loads

Summary of Flows

	WWTF - Pre-LPSA (mgd) 1	LPSA (mgd) 2	TASA (mgd) 3	ESRA (mgd) 4	Total Future Flow (mgd)
Average Day	0.36	0.26	0.36	0.14	1.12
Maximum Month	0.65	0.47	0.59	0.26	1.97
Maximum Day	0.68	0.47	0.61	0.27	2.03
Peak Hour	1.22	1.08	1.04	0.48	3.82

Flows and Loads

Average Loads

Influent Characteristic	WWTF (lb/day)	LPSA (lb/day)	TASSA (lb/day)	ESRA (lb/day)	Total (lb/day)
BOD5	618	631	683	208	2140
TSS	643	743	803	217	2406
TN	89	149	161	34	432
TP	13.35	22	24	5	65

Max Day Loads

Influent Characteristic	WWTF (lb/day)	LPSA (lb/day)	TASSA (lb/day)	ESRA (lb/day)	Total (lb/day)
BOD5	2478	1,010	1,092	570	5150
TSS	3914	1,411	1,526	1046	7897
TN	332	149	225	104	809
TP	50	22	33	16	120

Flows and Loads

Max Month Loads

Influent Characteristic	WWTF (lb/day)	LPSA (lb/day)	TASSA (lb/day)	ESRA (lb/day)	Total (lb/day)
BOD5	1717	796	860	543	3916
TSS	2534	966	1,044	1046	5589
TN	218	184	199	65	667
TP	33	27	29	10	98

Secondary Treatment

- Sequencing Batch Reactor (SBR)
- Membrane Bioreactor (MBR)

General wastewater process

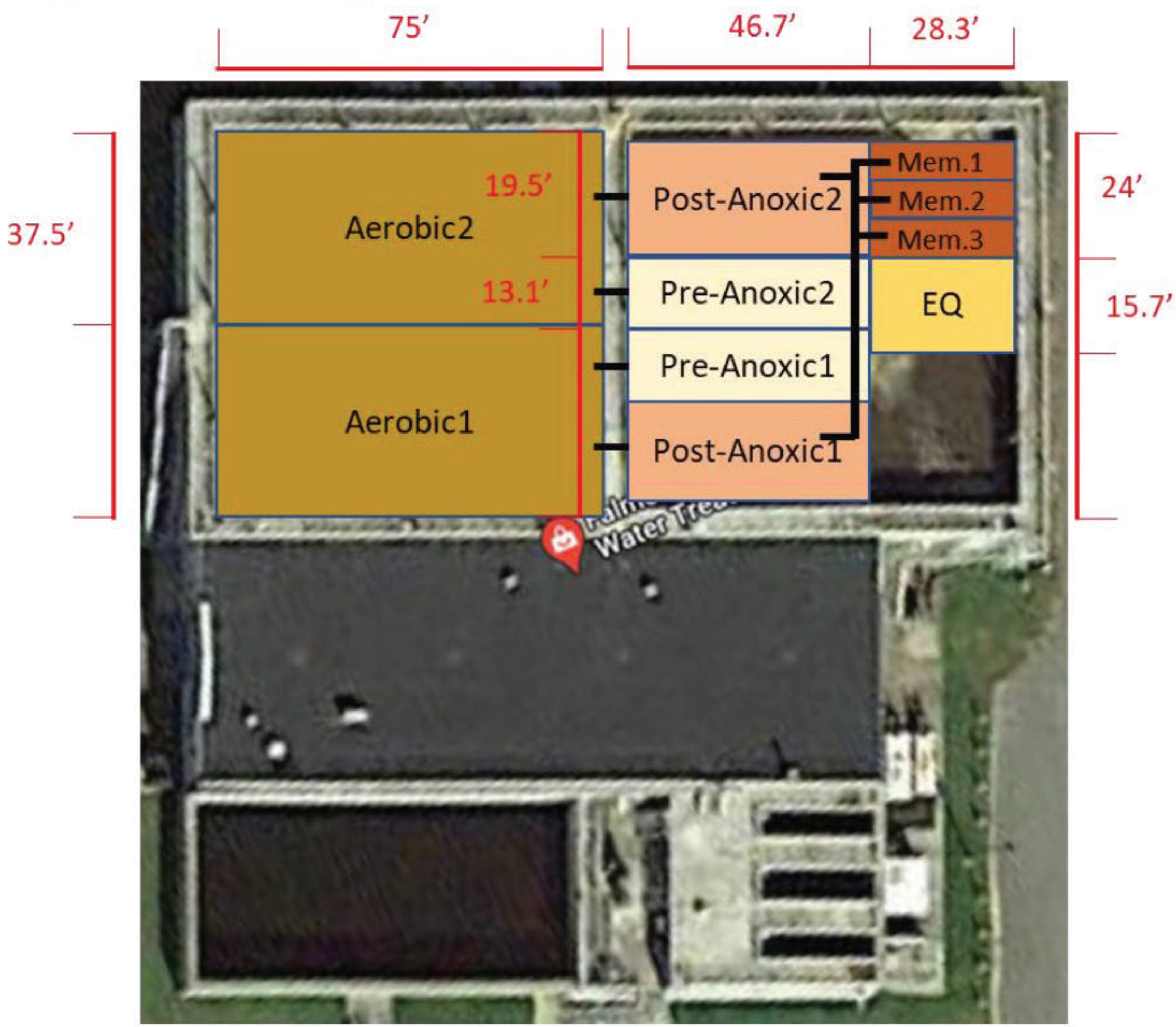
With Sequencing Batch Reactor (SBR)	With Membrane Bioreactor (MBR)

• Preliminary Treatment
  • Screening (6 mm)
  • Grit Removal
• Secondary Treatment
  • SBR
• Tertiary Treatment
  • Denitrification Filter
• UV Disinfection
	• Preliminary Treatment
	  • Screening (1 to 3 mm)
	  • Grit Removal
	• Secondary/Tertiary Treatment
	  • MBR
	• UV Disinfection

SBR - Layout

Membrane Bioreactor (MBR) How it Works

MBR - Layout



75’
46.7’
28.3’
37.5’
24’
15.7’
19.5’
13.1’
Aerobic2
Aerobic1
Post-Anoxic2
Pre-Anoxic2
Pre-Anoxic1
Post-Anoxic1
Mem.1
Mem.2
Mem.3
EQ

Solids Treatment – Overview

- Cost Comparison
- Redundancy Preference
- Treatment Options
  - Thickening
  - Dewatering

Solids Treatment – Cost Comparison

Sludge Hauling Costs Until 2030	
Dewatered Sludge Hauling Costs	$ 500,000.00
Thickened Sludge Hauling Costs	$ 1,600,000.00
Dewatered Hauling - $$ Savings	**$ 1,100,000.00**

Sludge Hauling Costs Until 2040	
Dewatered Sludge Hauling Costs	$ 900,000.00
Thickened Sludge Hauling Costs	$ 2,700,000.00
Dewatered Hauling - $$ Savings	**$ 1,800,000.00**

Solids Treatment – Options

Thickening

- Gravity Belt Thickener
- Rotary Drum

Dewatering

- Belt Filter Press
- Screw Press
- Centrifuge
- Fournier Press

Sludge Processing Technologies

- Thickening
  - Gravity Belt Thickener
  - Rotary Drum
- Dewatering
  - Belt Filter Press
  - Screw Press
  - Fournier Press
  - Centrifuge

Sludge Processing Technologies

- Thickening
  - Gravity Belt Thickener
  - Rotary Drum
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  - Gravity Belt Thickener
  - Rotary Drum
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  - Belt Filter Press
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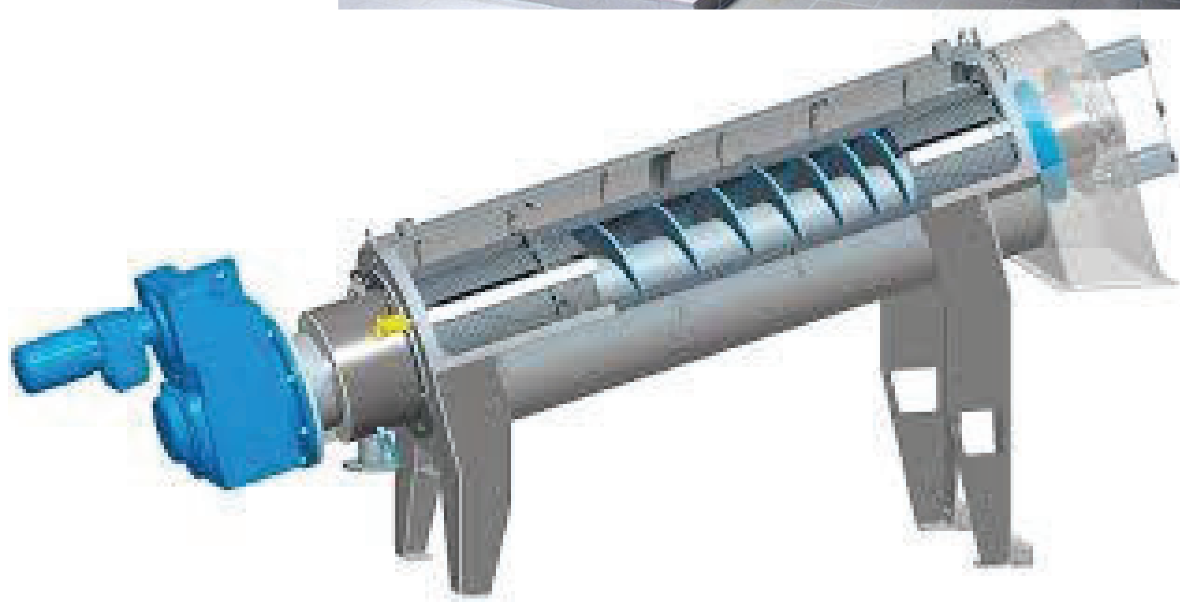
  - Centrifuge



Sludge Processing Technologies

- Thickening
  - Gravity Belt Thickener
  - Rotary Drum
- Dewatering
  - Belt Filter Press
  - Screw Press
  - Fournier Press
  - Centrifuge

Sludge Processing Technologies

- Thickening
  - Gravity Belt Thickener
  - Rotary Drum
- Dewatering
  - Belt Filter Press
  - Screw Press
  - Fournier Press
  - Centrifuge

Installation Locations

- Thickening
  - Gravity Belt Thickener – *Wareham, MA and Hyannis, MA (Chatham, MA and Edgartown, MA)*
  - Rotary Drum
- Dewatering
  - Belt Filter Press – *Chatham, MA and Edgartown, MA*
  - Screw Press
  - Fournier Press
  - Centrifuge – *Tisbury, MA*

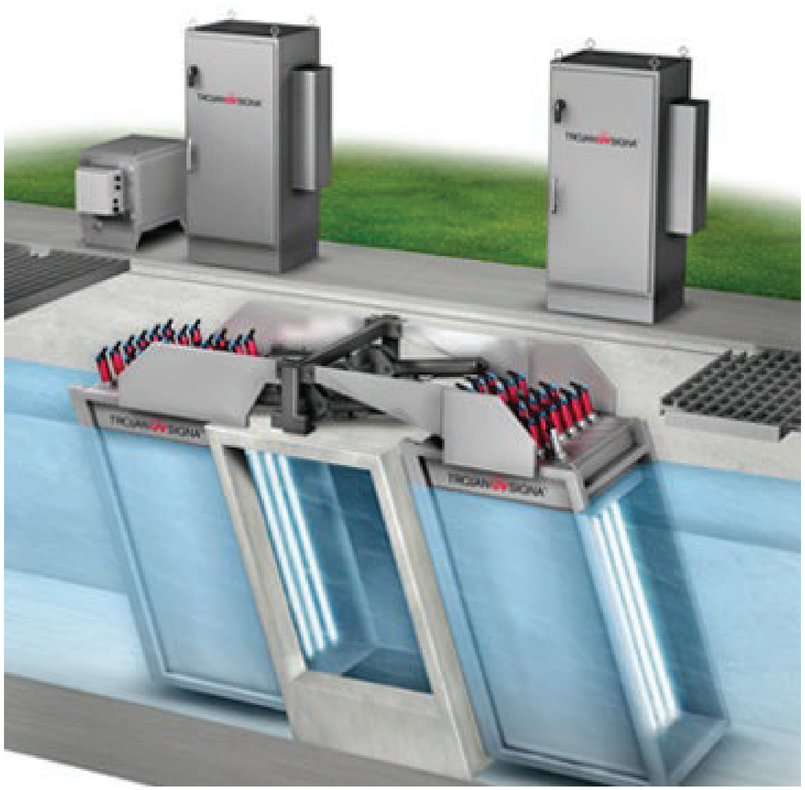
Installation Locations

Secondary	SBR	SBR	Falmouth, MA
	MBR	Suez MBR	Nantucket, MA; Mashpee, MA
Solids	Thickening	Gravity Belt Thickener	Wareham, MA; Hyannis, MA
		Rotary Drum	**TBD**
	Dewatering	Belt Filter Press	Chatham, MA; Edgartown, MA
		Screw Press	Lebanon, NH
		Fournier Press	Billerica, MA
		Centrifuge	Tisbury, MA
Disinfection	UV	Ultratech UV	Chatham, MA

UV Disinfection

UV Systems

Inclined



Trojan

Vertical

Ultratech

Horizontal

Trojan

GHD

Fiscal Sustainability

- Likelihood of Failure
  - Condition Assessment
  - Performance Assessment
- Consequence of Failure
- Risk Matrix

Condition Assessment

Rating Guidelines		
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1 – Excellent	Asset is like new, fully operable, and well maintained.	80 to 100% remaining life left
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Consequence of Failure

Rating	Guidelines	WWTF Examples
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4 - Catastrophic	Failure of asset likely to cause serious injury or loss of life, long-term environmental damage, or sudden failure of other significant assets.	Failure of the main power distribution system, resulting in loss of entire treatment facility operation; or failure of gaseous chlorination system which could cause serious injury or loss of life.

Risk Matrix

CoF Rating → ↓ LoF Rating	Negligible (1)	Marginal (2)	Critical (3)	Catastrophic (4)
Failing (5)	Medium	High	Very High	Very High
Poor (4)	Medium	High	Very High	Very High
Moderate (3)	Low	Medium	High	Very High
Good (2)	Low	Low	Medium	High
Excellent (1)	Low	Low	Medium	High

Questions

Falmouth WWTF Evaluation Progress Meeting

June 24, 2020

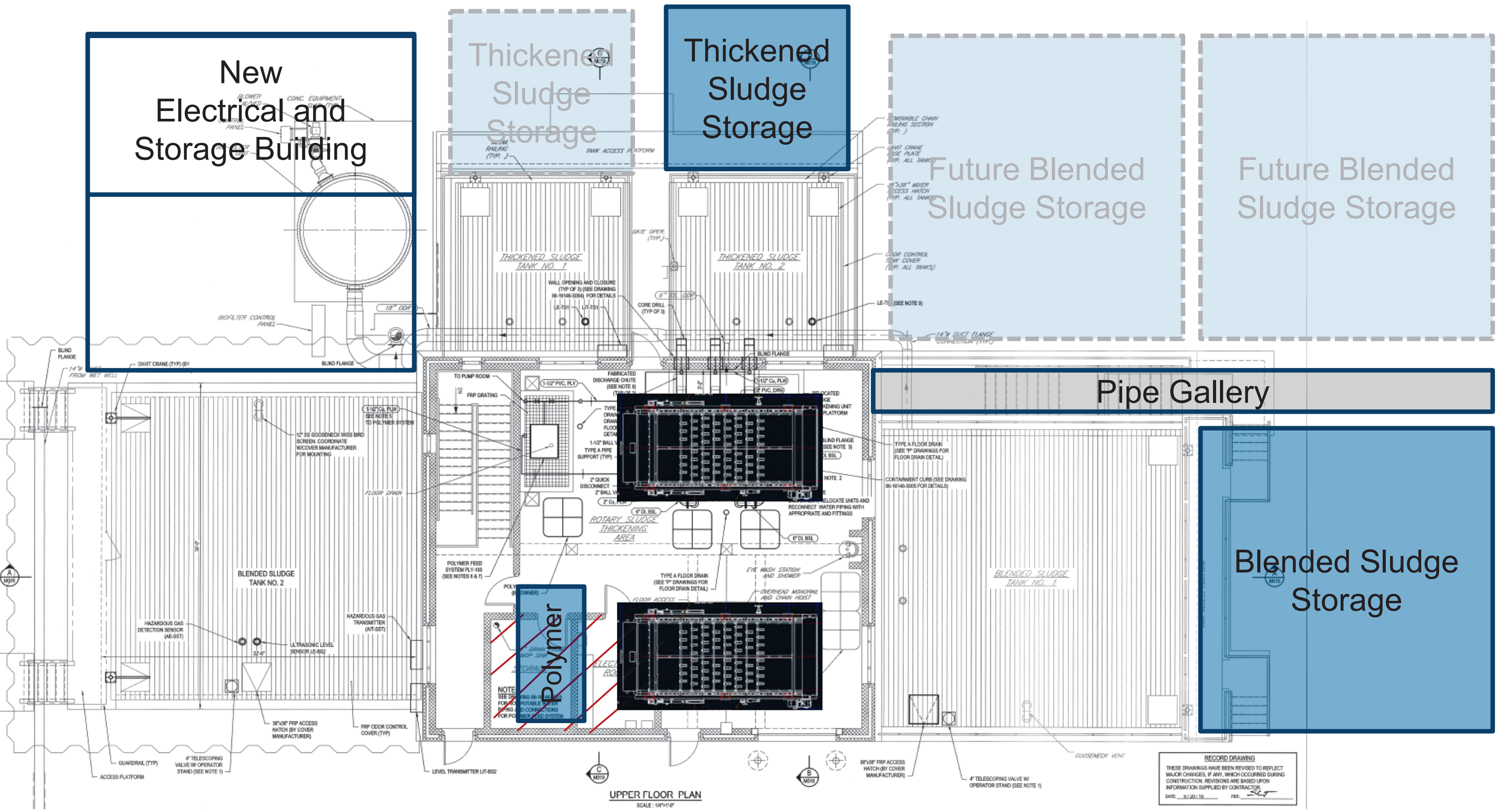
Outline

- Sludge Processing Building
- Secondary Treatment
- HVAC
- Generator
- Fiscal Sustainability

Sludge Processing Building

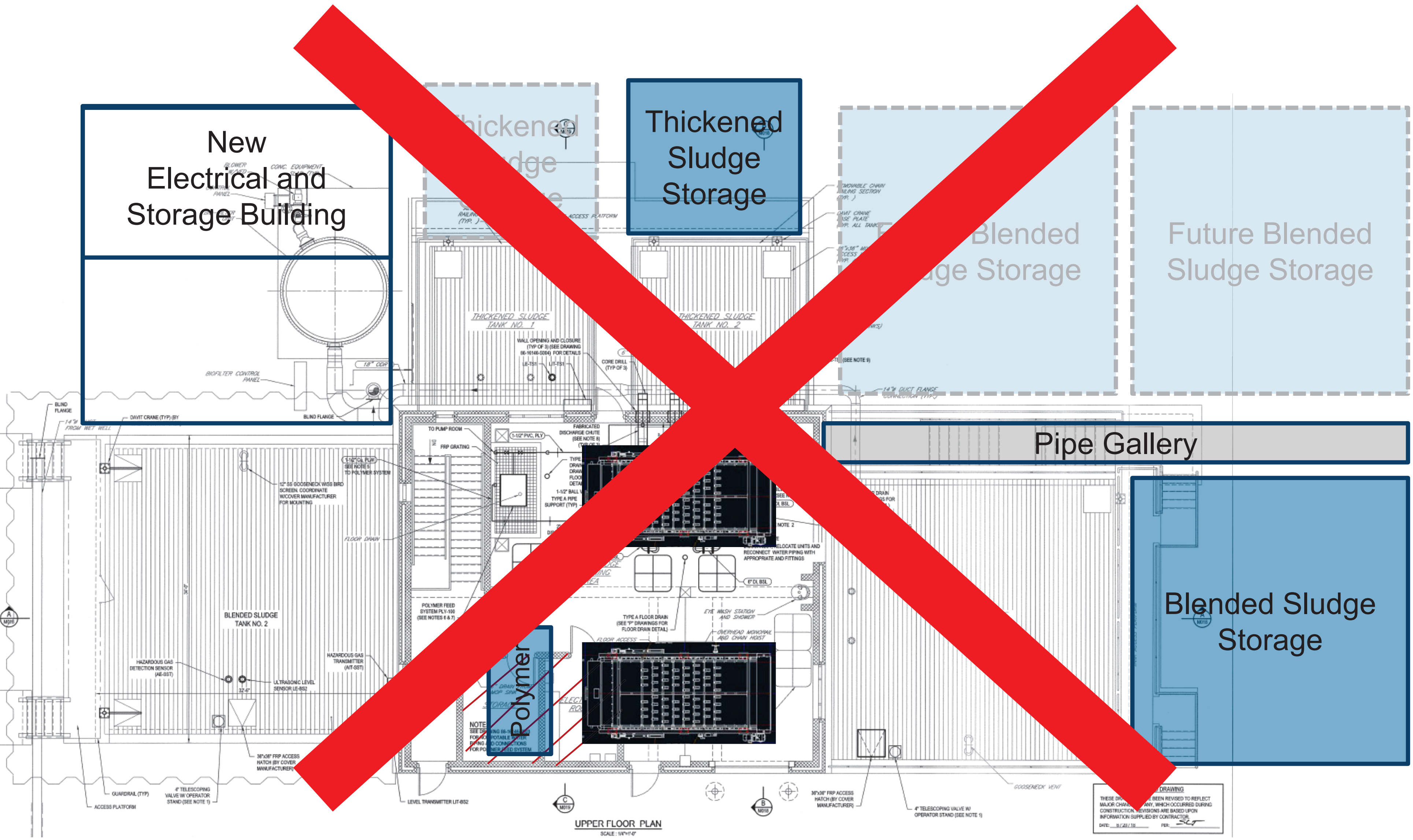
- Layouts
- EQ Liquid Storage

Layout 1

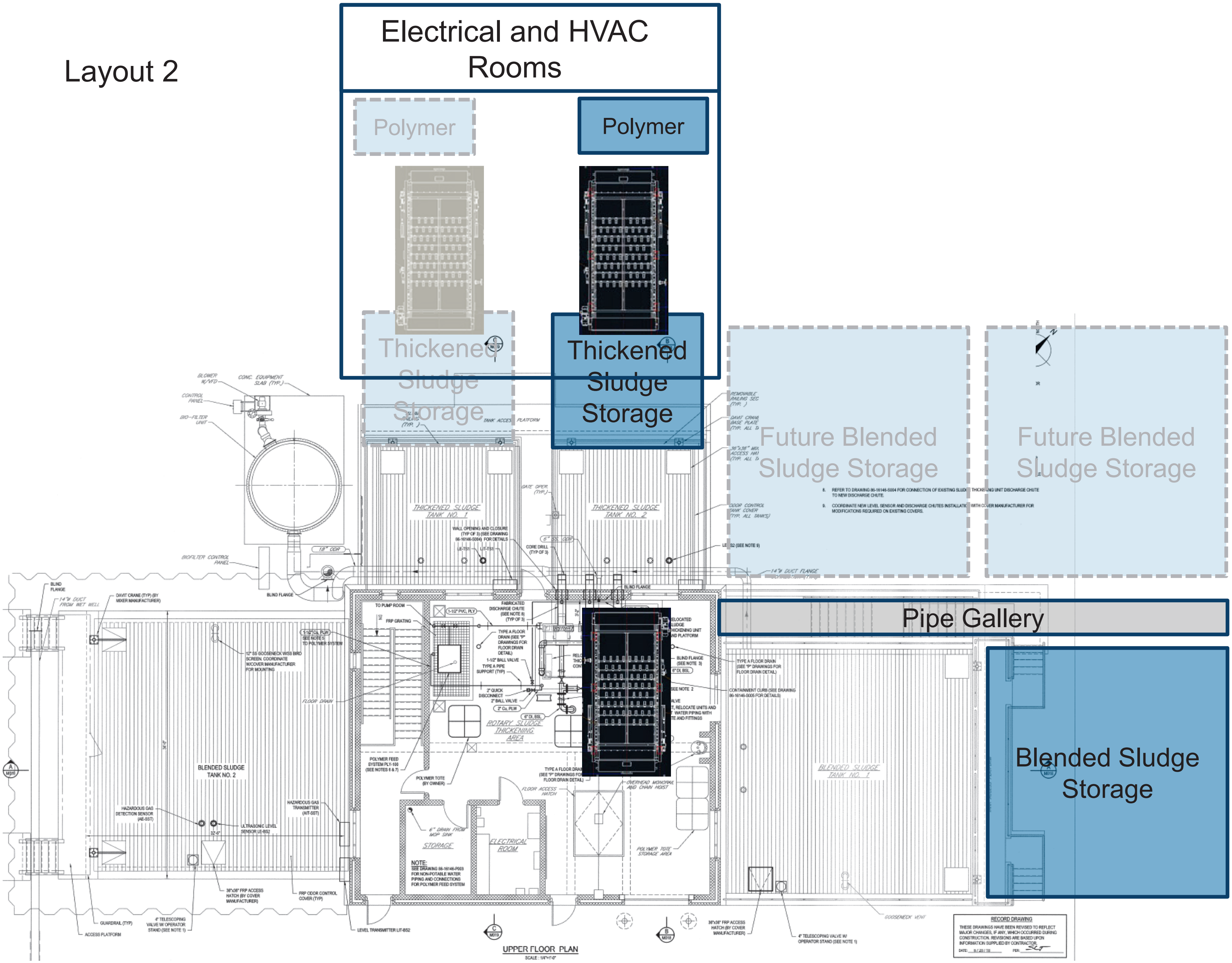


New Electrical and Storage Building
Thickened Sludge Storage
Thickened Sludge Storage
Future Blended Sludge Storage
Future Blended Sludge Storage
Pipe Gallery
Blended Sludge Storage
Polymer
BLENDED SLUDGE TANK NO. 2
BLENDED SLUDGE TANK NO. 1
THICKENED SLUDGE TANK NO. 1
THICKENED SLUDGE TANK NO. 2
ROTARY SLUDGE THICKENING AREA
UPPER FLOOR PLAN
RECORD DRAWING

Layout 1


New Electrical and Storage Building
Thickened Sludge Storage
Future Blended Sludge Storage
Pipe Gallery
Blended Sludge Storage
Polymer
BLENDED SLUDGE TANK NO. 2
THICKENED SLUDGE TANK NO. 1
THICKENED SLUDGE TANK NO. 2
UPPER FLOOR PLAN

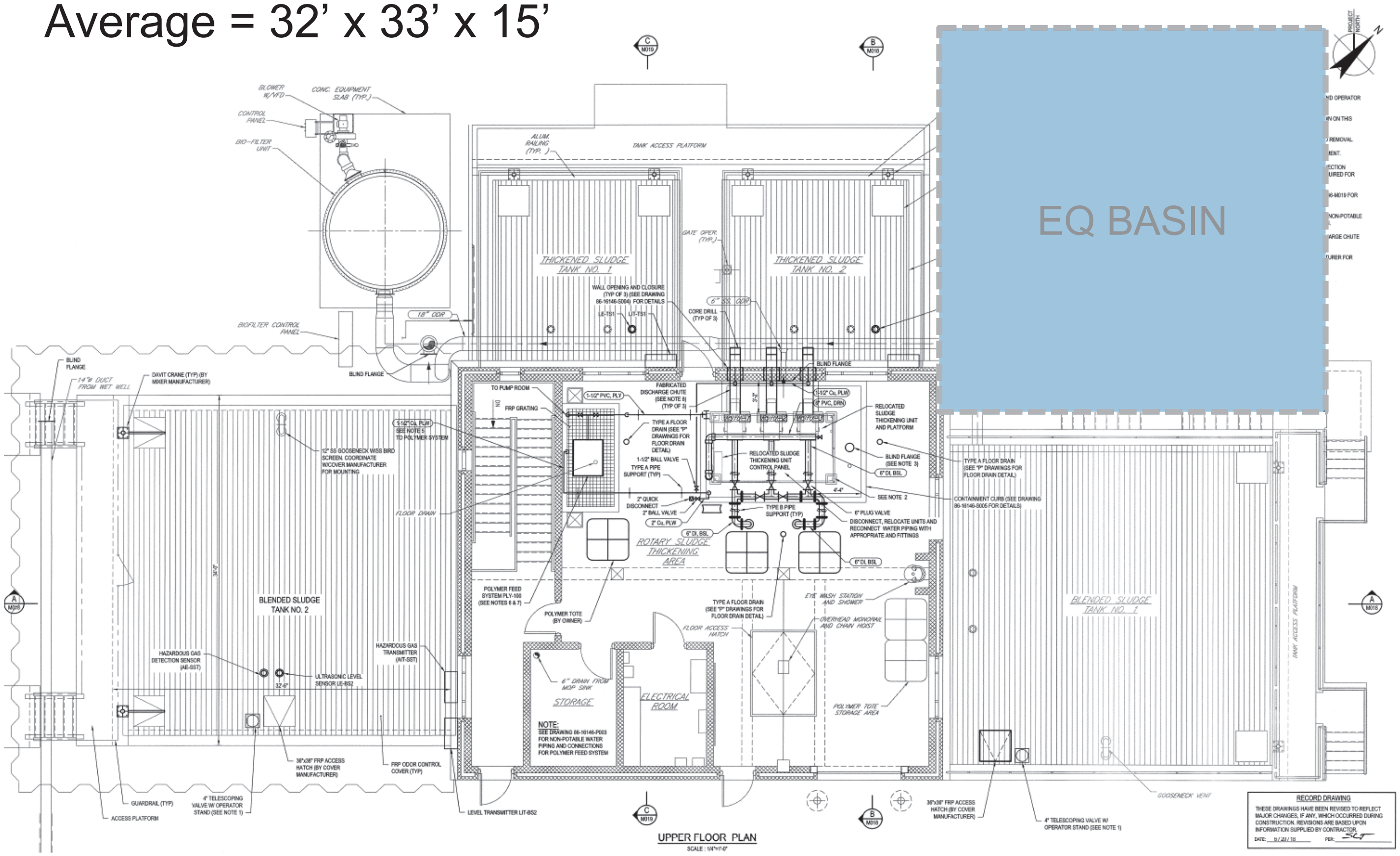
Layout 2



Electrical and HVAC Rooms
Polymer
Polymer
Thickened Sludge Storage
Thickened Sludge Storage
Future Blended Sludge Storage
Future Blended Sludge Storage
Pipe Gallery
Blended Sludge Storage
THICKENED SLUDGE TANK NO. 1
THICKENED SLUDGE TANK NO. 2
BLENDED SLUDGE TANK NO. 2
BLENDED SLUDGE TANK NO. 1
ROTARY SLUDGE THICKENING AREA
ELECTRICAL ROOM
STORAGE
POLYMER TOTE STORAGE AREA
UPPER FLOOR PLAN
RECORD DRAWING

EQ Basin

- Size of a Blended Sludge Tank
  - 1 backwash cycle + 1 day of thickening process decant
    - Max Month = 37' x 37' x 15'
    - Average = 32' x 33' x 15'



Secondary Treatment

- Sequencing Batch Reactor (SBR)
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- UV Disinfection

General wastewater process

With Sequencing Batch Reactor (SBR)	With Membrane Bioreactor (MBR)

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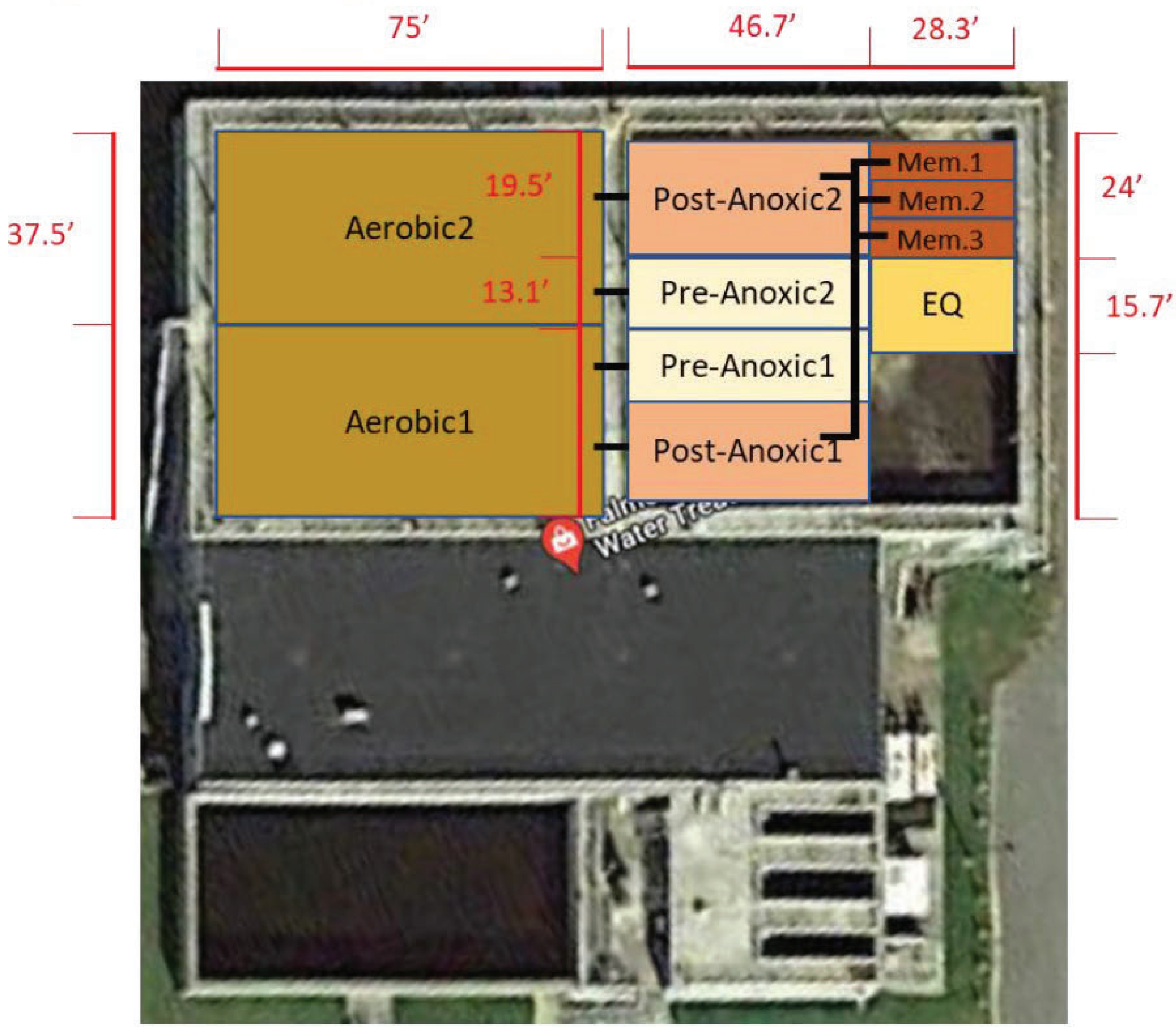
SBR - Layout

MBR - Layout



75’
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13.1’
Aerobic2
Aerobic1
Post-Anoxic2
Pre-Anoxic2
Pre-Anoxic1
Post-Anoxic1
Mem.1
Mem.2
Mem.3
EQ

MBR vs. SBR

- Cost Comparison
  - MBR more expensive than SBR

Denitrification Filter

Do you feel you need another denitrification filter?

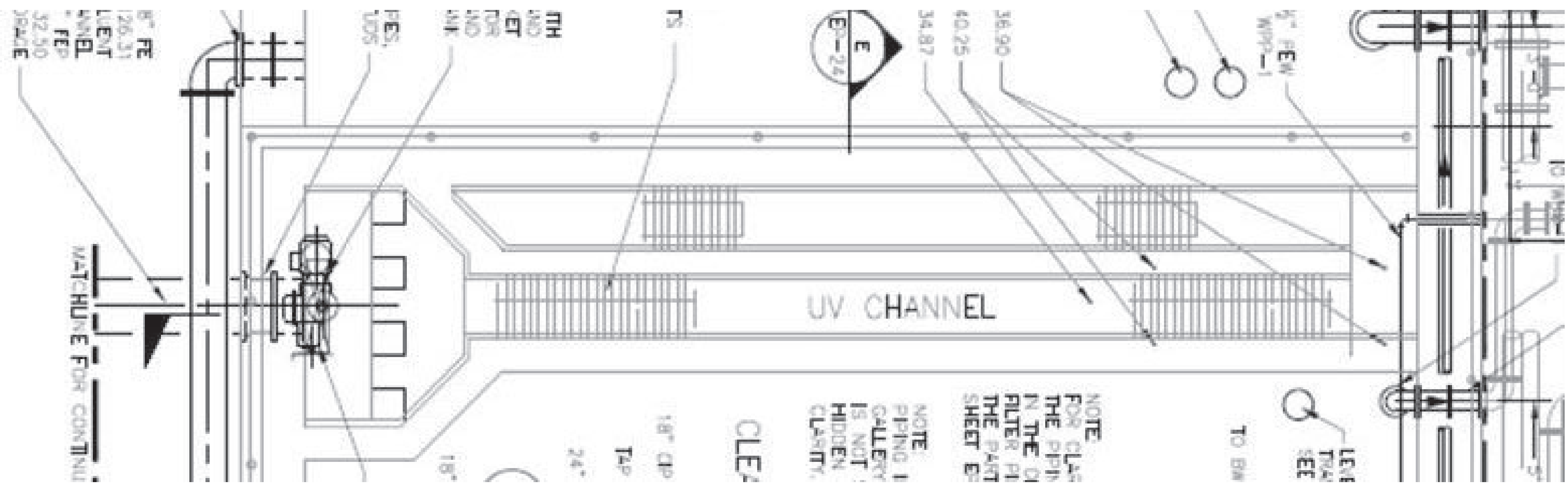
- Process flow
- 1 unit out of service

  AND
- 1 unit in backwash

UV Disinfection

Equipment Replacement
- Single Channel

Redundancy
- Double Channel



GHD

Fiscal Sustainability

- Likelihood of Failure
    - Condition Assessment
    - Performance Assessment
- Consequence of Failure
- Risk Matrix

Condition Assessment

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Risk Matrix

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Questions

Falmouth WWTF Evaluation Progress Meeting

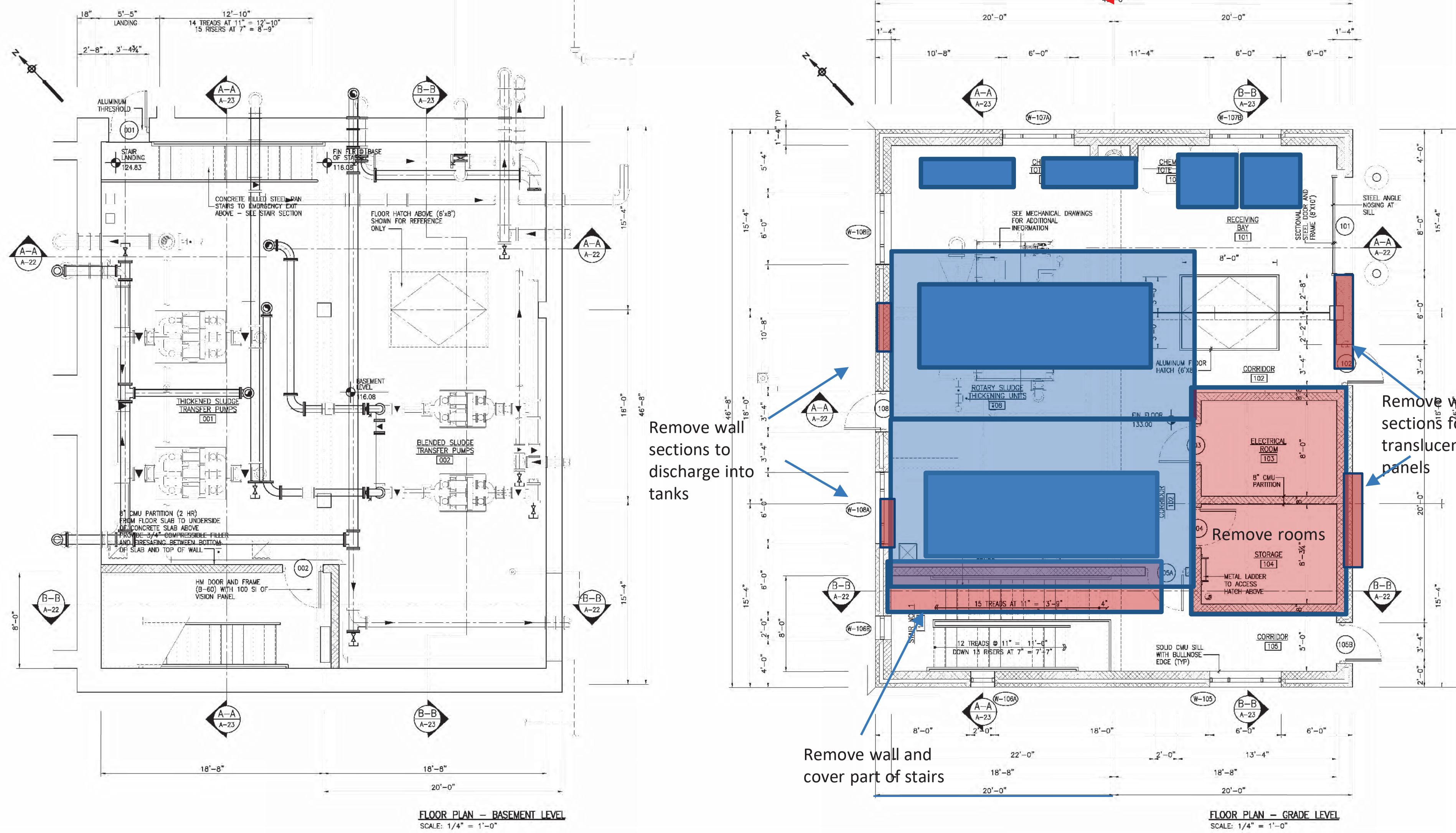
July 7, 2020

Outline

- Sludge Processing Building
- Equalization Volume
- Fiscal Sustainability
- Future Expansion Layout

Sludge Processing Building

1 Meter GBT Andritz



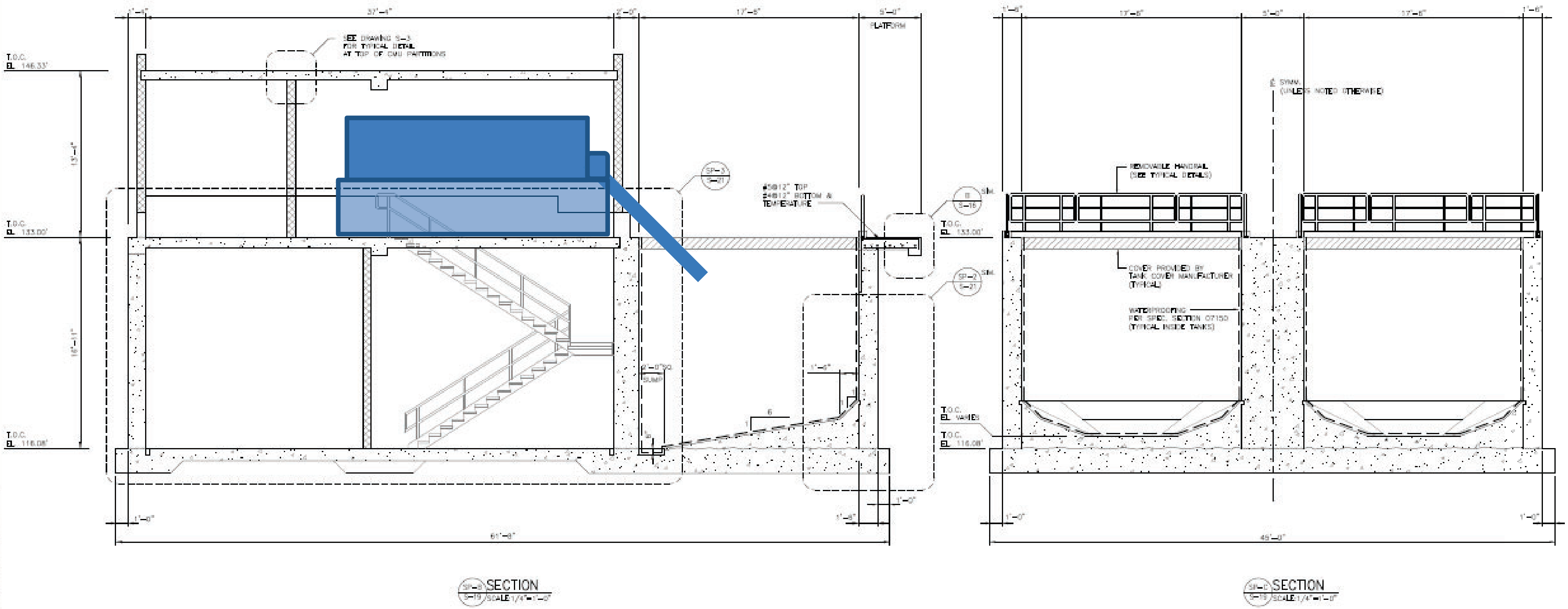
THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING	No As-built mark-ups were provided by contractor for this drawing.	Maguire Group Inc. Architects/Engineers/Planners 225 Foxborough Boulevard Foxborough, MA 02035	MARK DATE DESCRIPTION

Proj. Mgr.: S.L.
Designed: J.M.S.
Drawn: J.M.S.
Checked: –
Scale: AS NOTED
Date:

Town of Falmouth
Falmouth, MA
WWTF Improvements

SLUDGE PROCESSING BUILDING
ENLARGED FLOOR PLANS
BASEMENT LEVEL AND GRADE LEVEL

AS-BID
Proj. No. 16176
A–18



AS-BID

THIS LINE IS ONE INCH LONG WHEN PLOTTED AT FULL SCALE ON A 22" X 34" DRAWING

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Maguire Group Inc.
Architects/Engineers/Planners
225 Foxborough Boulevard
Foxborough, MA 02035

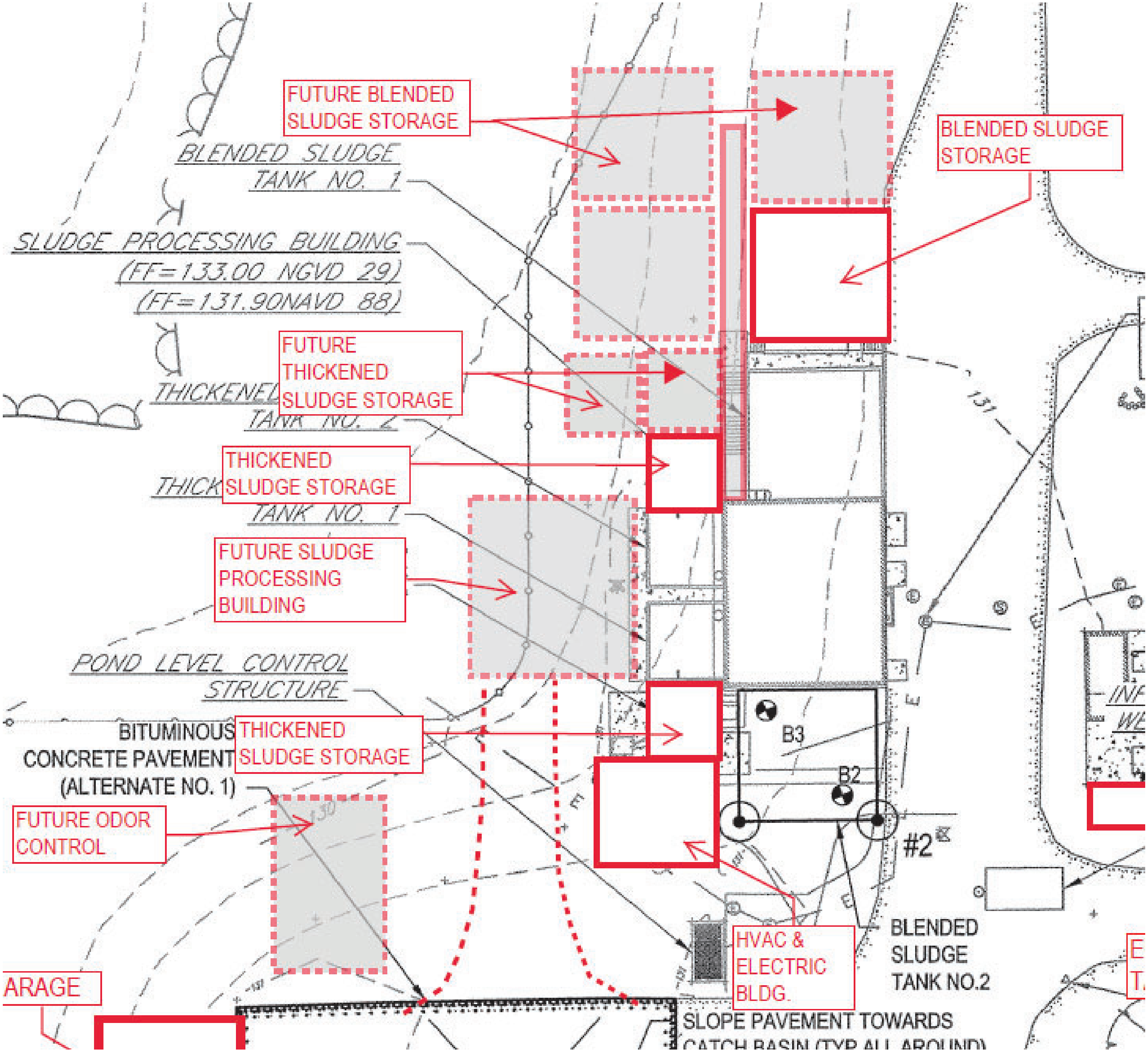
MARK	DATE	DESCRIPTION

Proj. Mgr.: S.L.
Designed: A.N.
Drawn: K.C.
Checked:
Scale: AS NOTED
Date:

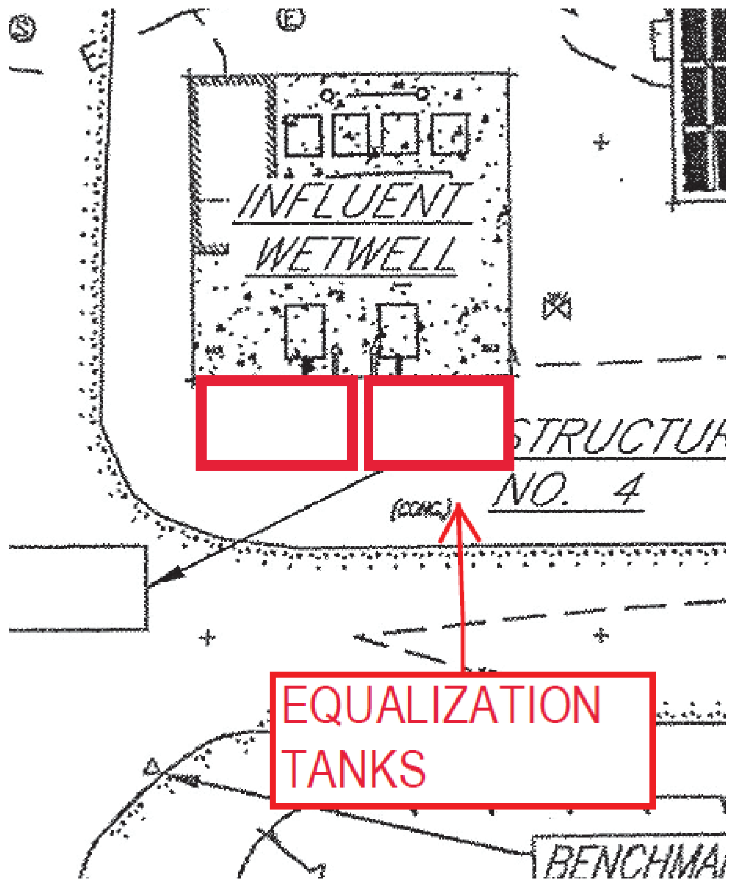
Town of Falmouth
Falmouth, MA
WWTF Improvements

SLUDGE PROCESSING BUILDING
SECTIONS – SHEET 2

Proj. No. 16176
Dwg. No.
S–19


FUTURE BLENDED SLUDGE STORAGE
BLENDED SLUDGE TANK NO. 1
BLENDED SLUDGE STORAGE
SLUDGE PROCESSING BUILDING (FF=133.00 NGVD 29) (FF=131.90NAVD 88)
FUTURE THICKENED SLUDGE STORAGE
TANK NO. 2
THICKENED SLUDGE STORAGE
TANK NO. 1
FUTURE SLUDGE PROCESSING BUILDING
POND LEVEL CONTROL STRUCTURE
BITUMINOUS CONCRETE PAVEMENT (ALTERNATE NO. 1)
THICKENED SLUDGE STORAGE
FUTURE ODOR CONTROL
ARAGE
131
130
B3
B2
#2
HVAC & ELECTRIC BLDG.
BLENDED SLUDGE TANK NO.2
SLOPE PAVEMENT TOWARDS

Equalization – Influent Wetwell



Equalization

Parameter	Volume (Gal)
Volume of 2 feet of SBR Tank	84,000
Skim Peak Hour Flow	78,000

Parameter	Volume (Gal)
Existing Wetwell Working Volume	60,000
Note: Split between two wetwells	

Parameter	Volume (Gal)
Future Total Volume (double one wetwell)	90,000
Note: existing wetwell capacity 60,000 gallons; new wetwell volume 30,000 gallons	

Three (3) SBRs will increase equalization flexibility

GHD

Fiscal Sustainability

- Likelihood of Failure
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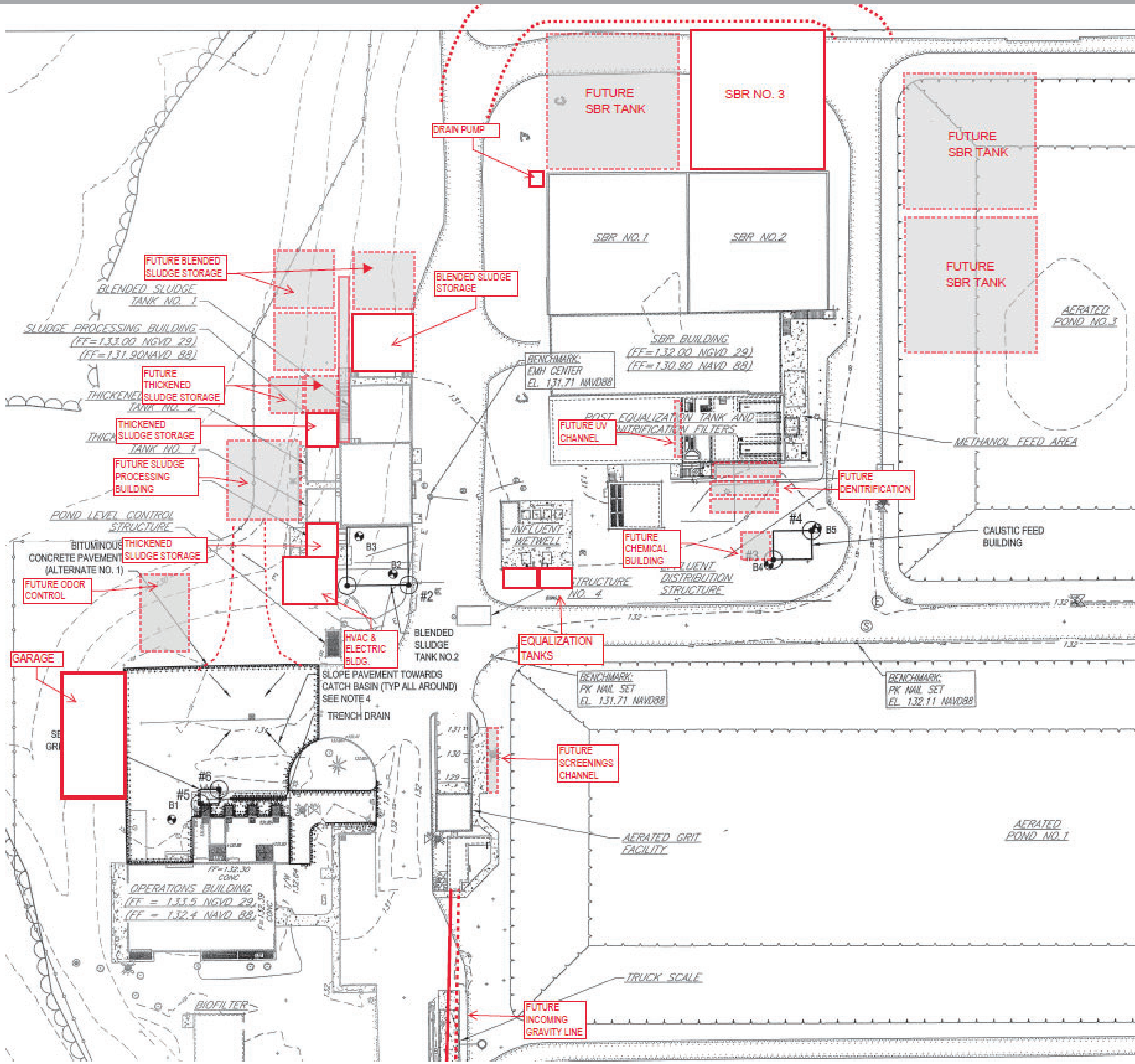
Moderate (3)	Low	Medium	High	Very High
Good (2)	Low	Low	Medium	High
Excellent (1)	Low	Low	Medium	High

Risk Matrix

ID Number	Process	CA Rating	ndition Assessment Descripti	PA Rating	formance Assessment Descrip	LoF Rating	CoF Rating	Rating Matrix
12.2	Odor- Control Blower	4	Does not meet code to have placed in the basement in un-rated area, pulls air out of septage tank into biofilter	4		4	4	(4) Very High
3.2	Influent equalization basin	4	sludge remaining in basin	3		4	3	(4) Very High
5.1	SBRs Capacity (including Blowers and Tank)	3		5	Need additional capacity for TASA and ESRA flows	5	4	(4) Very High
5.5	SBR 1 Fine Bubble Aerator	5	diffusers are difficult to service	4	Two diffusers added in 2015-2016	5	3	(4) Very High
8.1	Ultraviolet Disinfection	4	Difficulty replacing parts for UV system; control panel is outside and open to the elements	4	Intensity measurement is not reliable; not flow pacing properly; Average capacity 1.83 mgd, max capacity 2.2 mgd	4	4	(4) Very High
11.9	Somat Thickener	3		5	average capacity 150 gpm (216,000 gpd) and max capacity is 3,100 gpm (4.46 mgd)	5	3	(4) Very High
11.3	Thickened Sludge Capacity	2		5		5	3	(4) Very High
11.4	Blended Sludge Capacity	2		5		5	3	(4) Very High
16.1	Operations Building HVAC	5		5		5	3	(4) Very High
16.4	Generator	5	UST needs to be removed	4		5	4	(4) Very High
17.1	Preliminary Treatment Building HVAC	5		5		5	3	(4) Very High
17.2	Preliminary Treatment Building Electrical	5		5		5	3	(4) Very High
17.3	Preliminary Treatment Building Structural/Architectural	4		3		4	3	(4) Very High
19.1	Sludge Processing Building HVAC	5		5		5	3	(4) Very High

Future Expansion


FUTURE SBR TANK
SBR NO. 3
FUTURE SBR TANK
FUTURE SBR TANK
DRAIN PUMP
SBR NO.1
SBR NO.2
AERATED POND NO.3
SBR BUILDING (FF=132.00 NGVD 29) (FF=130.90 NAVD 88)
BENCHMARK: EMH CENTER EL. 131.71 NAVD88
POST EQUALIZATION TANK AND NITRIFICATION FILTERS
FUTURE UV CHANNEL
METHANOL FEED AREA
FUTURE DENITRIFICATION
CAUSTIC FEED BUILDING
FUTURE CHEMICAL BUILDING
INFLUENT WETWELL
EFFLUENT DISTRIBUTION STRUCTURE
STRUCTURE NO. 4
EQUALIZATION TANKS
BENCHMARK: PK NAIL SET EL. 131.71 NAVD88
BENCHMARK: PK NAIL SET EL. 132.11 NAVD88
FUTURE BLENDED SLUDGE STORAGE
BLENDED SLUDGE STORAGE
BLENDED SLUDGE TANK NO. 1
SLUDGE PROCESSING BUILDING (FF=133.00 NGVD 29) (FF=131.90NAVD 88)
FUTURE THICKENED SLUDGE STORAGE
THICKENED SLUDGE STORAGE
FUTURE SLUDGE PROCESSING BUILDING
POND LEVEL CONTROL STRUCTURE
BITUMINOUS CONCRETE PAVEMENT (ALTERNATE NO. 1)
FUTURE ODOR CONTROL
HVAC & ELECTRIC BLDG.
BLENDED SLUDGE TANK NO.2
GARAGE
SLOPE PAVEMENT TOWARDS CATCH BASIN (TYP ALL AROUND) SEE NOTE 4
TRENCH DRAIN
FUTURE SCREENINGS CHANNEL
AERATED GRIT FACILITY
AERATED POND NO.1
OPERATIONS BUILDING (FF = 133.5 NGVD 29) (FF = 132.4 NAVD 88)
TRUCK SCALE
BIOFILTER
FUTURE INCOMING GRAVITY LINE


GHD
Questions

Appendix C
Criticality Matrix

ID Number	Process	CA Rating	Condition Assessment Description	PA Rating	Performance Assessment Description	LoF Rating	CoF Rating	Rating Matrix
16.4	New Operations Building Generator	4	Generator sized for much larger load. UST needs to be removed. If leave existing generator, will need new fuel tank.	4	Evaluate which more cost effective: power ops building from SBR building generator or install new smaller ops building generator outdoors (?) with belly tank.	4	4	(4) Very High
16.1	Operations Building HVAC	5	Not operational	5		5	3	(4) Very High
19.1	Sludge Processing Building HVAC Modifications	5	Not operational	5		5	3	(4) Very High
12.2	Odor-Control System at Solids Treatment	5	never used, not functional	5		5	4	(4) Very High
8.1	Ultraviolet Disinfection	4	Difficulty replacing parts for UV system; control panel is outside and open to the elements	4	Intensity measurement is not reliable; not flow pacing properly; Average capacity 1.83 mgd, max capacity 2.2 mgd	4	4	(4) Very High
12.2	Odor Control Blower for in-ground biofilter (see biofilter notes)	4	Does not meet code to have placed in the basement in un-rated area, pulls air out of septage tank into biofilter. Location issue, not condition issue, and not essential.	4		4	4	(4) Very High
3.2	Influent equalization basin	4	Insufficient volume for storage/equalization of sludge pressate, backwash water, peak summer day flows. would be better to stabilize flow and load to SBRs more consistently. Issues: (1) Sludge pressate goes directly to IWW very high load when pressing. We press ~7 hrs/day 5 days a week so load to SBRs is highly variable. (2) When SBRs are having settling problems, that can cause excessive denit filter backwash; backwash water flows directly to IWW (no storage) and so back into SBRs, exacerbating settling problems. (3) peak day time summer influent flow - big SBR batches during the day, small at night.	3		4	3	(4) Very High
4.2	Influent wet well pump 3	4	bad seal - needs work	3	WWP-3 capacity is 2.2 mgd	4	3	(4) Very High
7.3	Denitrification Filter Pump 2	4	Issues replacing parts and seals for pumps. Pump 2 should be rehabbed or replaced.	3	2 Pumps designed for 1650 gpm (2.4 mgd) each; New max day flow is 2.0 mgd	4	3	(4) Very High
5.9	SBR 2 Diffusers (includes diffuser rack, lifting mechanism (rail, cable, hoist), and membranes)	4	SBR 2 - membranes are "sausaged" i.e. filled with sludge, possibly due to cracked diffuser hoses, or due to stretched or broken membranes or to leaks at fittings/grommets. This results in low DO transfer during peak load (summer day time). Need to replace all hoses with new hoses with SS camlocks, and replace all membranes and test. Town has bought all needed parts and has on hand. Need to rent a crane and replace membranes 2 diffusers at a time this fall? This "fine bubble system" is too difficult to install correctly, too difficult to maintain.	3	see SBR Diffusers 1	4	3	(4) Very High
6.2	SBR Blower 1	4	seal leak on blower 1. This is top priority for rehab. These blowers are critical equipment and operators have been servicing as they can. But the blowers are > 15 years old, Aerzen apparently doesn't do service on location, and blowers cannot be removed from the room as-is (no door).	2		4	3	(4) Very High
5.1	SBRs Capacity (including Blowers and Tank)	3		5	Need additional capacity for TASA and ESRA flows. Also need another tank to allow dual-tank operation while one tank (the 3rd) is down for maintenance	5	4	(4) Very High
11.9	Somat Thickener	3		5	average capacity 150 gpm (216,000 gpd) and max capacity is 3,100 gpm (4.46 mgd)	5	3	(4) Very High
21.1	RTU-1 - In Operations Building control room. Recieves info from all other RTUs at WWTF and from 11 remote lift stations, conveys info to SCADA system for monitoring, logging, initiating alarm calls, etc.	3	The PLC in this must be replaced - it's essential but old, potential for failure. Also, the communication equipment on both sides of the wall at RTU-1/lab should be reviewed for what can be demolished, and what can be consolidated, what should be replaced.	2		3	4	(4) Very High
21.4	RTU-4 - In dry side of Influent Wet Well - controls IWW pumps based on level in wet wells	3	PLC should be replaced	2		3	4	(4) Very High
21.6	RTU-6 - In SBR Building Electrical Room - Runs denit pumps based on Post EQ tank level; controls caustic dose based on calc infl flow from IWW level	3	no one seems certain what else this panel does. Functions should be documented and PLC replaced	2		3	4	(4) Very High

ID Number	Process	CA Rating	Condition Assessment Description	PA Rating	Performance Assessment Description	LoF Rating	CoF Rating	Rating Matrix
11.3	Thickened Sludge Capacity	2		5		5	3	(4) Very High
11.4	Blended Sludge Capacity	2		5		5	3	(4) Very High
16.2	Operations Building Electrical	3		3		3	3	(3) High
16.3	Operations Building Structural/Architectural	3		3		3	3	(3) High
19.2	Sludge Processing Building Electrical	3		2		3	3	(3) High
19.3	Sludge Processing Building Structural/Architectural	3		2		3	3	(3) High
6.5	SBR Blower room	2	Blower room must be expanded for another blower, and must include way of removing blowers. Ventilation - there is no fan gets hot; louvers must be opened manually.	3		3	3	(3) High
10.8	Septage Aeration Blower 3	4	Older blower - replace	4		4	2	(3) High
6.13	SBR building fuel tank shelter	4	should have shelter	3		4	2	(3) High
10.5	Septage Diffuser System	4	Coarse Air diffuser - 30 years old 1 in each of 4 tanks	3		4	2	(3) High
21.13	RTU-13 In Sludge Building on SOMAT platform.	4	Does not work. SOMATs are run manually. Will be replaced when replace sludge thickening system	3		4	2	(3) High
10.7	Septage Aeration Blower 2	3	in better shape than blower 3 but should be replaced	4		4	2	(3) High
21.11	RTU-11 Outdoors at Effluent Distribution Structure? - sends flow info to SCADA from level transducers	3	PLC should be replaced	4		4	2	(3) High
4.2	Influent wet well pump 1	3	All IWWPs - 15 years old, need to plan to replace. WWP-3 in worst shape - seals. All - difficulty replacing parts and seals - AquaSolutions unsatisfactory service.	3	WWP-1 capacity is 1.2 mgd. Rated capacity of all WWP together is 4.6 mgd with largest unit out of service; New peak flow is 3.82 mgd. So sizing OK for future.	3	3	(3) High
4.2	Influent wet well pump 2	3	see WWP 1	3	WWP-2 capacity is 1.2 mgd	3	3	(3) High
4.2	Influent wet well pump 4	3	WWP-4 seal water pressure switch maybe out of range	3	WWP-4 capacity is 2.2 mgd.	3	3	(3) High
7.6	Denitrification Filter Backwash Pump 2	3		3	2 Pumps designed for 1410 gpm (2.0 mgd) each; New max day flow is 2.0 mgd	3	3	(3) High
21.8	RTU-8 - outdoors at UV. Sends UV intensity info to SCADA.	3	Originally, this was supposed to control UV system. UV system now runs all this time, not controlled by panel. Assume new UV will come with new intensity measurement and new CP.	3		3	3	(3) High
6.3	SBR Blower 2	3	see blower 1	2		3	3	(3) High
6.4	SBR Blower 3	3	see blower 1	2	Blower maintenance challenge: ACCESS. 3 blowers 1000 CFM and 2030 CFM	3	3	(3) High
6.6	SBR Blower VFD 1	3	each VFD has been rehabbed or replaced over time. They are all different. Working OK now but critical equipment, should consider phased replacement	2		3	3	(3) High
6.7	SBR Blower VFD 2	3	see VFD 1	2		3	3	(3) High
6.8	SBR Blower VFD 3	3	see VFD 1	2		3	3	(3) High
21.12	RTU-12 In Sludge Building Electrical Room - controls mixers, pumps, sends level info to SCADA	3	PLC should be replaced	2		3	3	(3) High
7.2	Denitrification Filter Pump 1	3	Pump 1 rehabbed 2019. Service from AquaSolutions was bad, not sure rehab will last long			3	3	(3) High
	Denitrification Filter Backwash Pump 1	3				3	3	(3) High
21.3	RTU 3 - In Preliminary Treatment Building - Controls Fine Screen	3				3	3	(3) High

ID Number	Process	CA Rating	Condition Assessment Description	PA Rating	Performance Assessment Description	LoF Rating	CoF Rating	Rating Matrix
5.8	SBR 1 Diffusers - includes diffuser rack, lifting mechanism (rail, cable, hoist), membranes etc	2	In 2015-2016 added two diffuser racks each tank and replaced all membranes both SBRs. In 2019 in SBR 1 only: replaced all membranes, replaced all air hoses (new hoses have SS fittings instead of plastic). See notes on SBR 2 Diffusers	3	Diffusers are very difficult to service when there is water in the SBR - they are heavy, lifting cable is attached at one end near wall and binds when try to lift diffuser. Have tried larger power cable, larger motor, lubricating cable. Have snapped at least one cable trying to lift. Also, membranes are difficult to install properly. Requires careful, knowledgeable oversight of bubble test, and many readjustments of grommets etc to get it right, so hard to imagine doing it properly with water in the tank. If membranes not correctly installed, sludge can get into them their function and making diffuser heavier to lift. Adding a 3rd SBR will help - won't have to run in single tank mode if take one SBR tank down for maintenance. But shouldn't have to tank whole tank out of service to replace membranes even every few years.	3	3	(3) High
2.2	Mechanical Fine Screen	2	Screen brush worn; rebuilt in 2018 due to oil leak	3	Existing design Peak flow is 4.3 mgd, new peak hour flow is 3.82 mgd. Average capacity is 1500 gpm (2.16 mgd) and max 3,100 gpm (4.46 mgd). Occasional problems with Sonar, Model XV-Cw Screw Screen.	3	3	(3) High
21.7	RTU-7 - in SBR Building opposite boiler room - Sevren Trent Control Panel - Denit filter input-output, including methanol, nitrate analyzers, initiates backwash based on level over filters?	2	RTU was moved indoors in ~2016. Got new HMI, new program, but still has original PLC. Matt (RE Erickson) said he does not have program for this panel. Need documentation. Replace PLC	2		2	4	(3) High
21.5	RTU-5 - In SBR Building Electrical Room - AquaAerobics - Controls SBRs (blowers, mixers, decanters, based on DO, time, level).	1	brand new (replaced by AquaAerobics in 2019)	2		2	4	(3) High
2.1	Aerated Grit Chamber (including Blowers and Grit Equipment)	5	17 (L) x 6 (W) x 12 (D)	5	Grit Chamber - Not functioning; Aeration blowers, not functioning. Average flow recirculation time 11 min,	5	1	(2) Medium
11.9	Submersible Mixers	3	one of the mixers is out of service	3		3	2	(2) Medium
6.9	SBR Building Plant Water Systems	3	System is 15 years old	3	System functions adequately; 2 WPP 250 gpm (360,000 gpd) and 180 gpm (259,000 gpd); originally supposed to be run based on water pressure (one come on when other low) but lead lag function didn't work.	3	2	(2) Medium
10.3	Septage Ejector 1	3	Replaced parts for the ejector pumps in XX year.	2	Ejector Pumps design (each): 50 gpm (at 40 ft TDH)	3	2	(2) Medium
10.4	Septage Ejector 2	3	Replaced parts for the ejector pumps in XX year.	2	Ejector Pumps design (each): 50 gpm (at 40 ft TDH)	3	2	(2) Medium
1.1	Gravity Line	2		1	Odor Complaints at Vent; 18" DIP; 2795 ft. length; full pipe capacity is 6.8 MGD; 56% capacity is 3.84 MGD.	2	3	(2) Medium
20.4	Sodium Hydroxide Storage Tank	1		2	May require frequent deliveries (once every 10 days)	2	3	(2) Medium
12.1	Operations Building Biofilter	1	old, unclear effectiveness, may need to be removed. Consider merging septage tank odor control and sludge building odor control. Like concept of biofilter in ground.	2	Have received odor complaints from one entity within the past few years	2	3	(2) Medium
15.1	Effluent Distribution Weirs	1		1		1	3	(2) Medium
15.4	Beds 9-13	1	Installed 2005	1		1	3	(2) Medium
15.5	Beds 14-15	1	Installed 2015	1		1	3	(2) Medium
6.1	WAS Pump	3	not in use - drain by gravity. Not needed (though make sure 3rd SBR doesn't require?)	3	1 WAS Pump 170 gpm (245,000 gal/day)	3	1	(1) Low
5.5	SBR 2 Mixer	3	see SBR Mixer 1	3	Two diffusers added in 2015-2016	3	1	(1) Low
15.2	Beds 1-5	3		3		3	1	(1) Low
15.3	Beds 6-8	3		3		3	1	(1) Low
17.1	Preliminary Treatment Building HVAC	3	not in use	3		3	1	(1) Low
17.2	Preliminary Treatment Building Electrical	3	minimal use	3		3	1	(1) Low
17.3	Preliminary Treatment Building Structural/Architectural	3	minimal use	3		3	1	(1) Low

ID Number	Process	CA Rating	Condition Assessment Description	PA Rating	Performance Assessment Description	LoF Rating	CoF Rating	Rating Matrix
3.1	Lagoon Basin - Leave as Existing	2	concrete sides, rubber liner, old piping etc remaining in basin. Sludge not removed 100% when last cleaned in ~ 2014.	2	Not in use. They collect rainwater which has to be discharged to effluent infiltration basins periodically.	2	2	(1) Low
7.1	Denitrification Filter Capacity	2		2	per Tr-16 one backwashing filter and one filter offline. Estimated per De Nora information: each filter backwashes for an average of once per day for 20-30. minutes.	2	2	(1) Low
7.4	Denitrification Filter Media	2	media is just sand/gravel. Used for solids removal.	2	Media typically good for at least 20 years	2	2	(1) Low
7.5	Denitrification Filter Underdrain	2		2	Underdrain typically good for at least 20 years	2	2	(1) Low
2.3	Coarse Bar Rack	2		2	1.25 inch openings	2	2	(1) Low
4.1	Influent Wet well	2	Fiberglass hatches are new and in good condition; No visible corrosion in wet well	2	Seal water pressure switch maybe out of range; no isolation valve for pneumatic control parts; PLC needs upgrade. Wet well Height 20.5 ft.	2	2	(1) Low
5.2	SBR 1 Tank	2	Concrete Basin	2		2	2	(1) Low
5.4	SBR 1 Mixer	2		2	Past issues with flex joint of decanter; decanter rehabbed in 2016	2	2	(1) Low
5.6	SBR 1 Decanter	2	Decanters appear to be in good condition at this time. See performance assessment for notes on maintenance. Have a spare decanter, decanter actuator, float and flex joint.	2	Replaced flex joint at wall in 2015; joint not broken at time. Rehabbed decanter in 2015.	2	2	(1) Low
6.1	Post EQ basin	2	Acceptable Condition	2	There is no slope on the bottom of the tank; EQ Basin designed to hold 163,000 gallons (Peak hour rate is 160,000 gal/hr.)	2	2	(1) Low
6.11	SBR Building Generator	2	just passed load test, all OK.	2		2	2	(1) Low
6.12	SBR Building Generator Room Fan	2		2		2	2	(1) Low
6.18	SBR Building Electrical	2	MCCs, ATS OK	2		2	2	(1) Low
6.16	SBR Building boiler and 6-8 boiler circulator pumps	2	some issues, will take care of outside this project	2		2	2	(1) Low
6.17	SBR Building boiler room fan	2		2		2	2	(1) Low
	Denitrification Filter Backwash Blower 1	2		2		2	2	(1) Low
	Denitrification Filter Backwash Blower 2	2		2	2 blowers 1175 CFM	2	2	(1) Low
13.1	Automatic Sampling Stations	2		2	Sampling at wet well does not measure pure influent	2	2	(1) Low
5.3	SBR 2 tank	1	Concrete Basin	1		1	2	(1) Low
5.7	SBR 2 Decanter	1	see SBR Decanter 1	1	Replaced flex joint at wall after it broke in ~2015-2016. Replaced decanter in kind in 2015-2016. Replaced flex joint under decanter after it broke in 2019.	1	2	(1) Low
11.1	Blended Sludge Transfer Pump (for WAS and Septage)	1	Penn Valley Pumps; 2015	1	2 pumps; 250 gpm (360,000gpd) each	1	2	(1) Low
11.2	Thickened Sludge Pumps	1	Penn Valley Pumps; 2015	1	2 pumps; 450 gpm (648,000gpd) each	1	2	(1) Low
1.2	Biofilter	1		1	May not be able to control odor completely at peak time (summer odor periodically? One odor compliant since installed.	1	1	(1) Low
10.6	Septage Air Compressors	1	newer	1		1	2	(1) Low
21.1	RTU-10 was the RTU-10 by the back door of SBR building, near door to fuel tanks. Now it's just a junction box.	NA	no action needed	NA		NA	NA	
21.2	There is no RTU-2.	NA		NA		NA	NA	
21.9	There is no RTU-9	NA		NA		NA	NA	
5.1	Pneumatic Valve System	4		3	Need ability to isolate denit area from SBR area for pneumatic troubleshooting	4	2	
6.14	SBR building fuel tank (fuel for generator)	3	paint peeling, some rust, no level indication - those things outside project	2		3	2	
6.15	SBR building fuel tank - (fuel for boiler)	3	paint peeling, some rust, no level indication - those things outside project	2		3	2	
10.2	Septage Holding Tanks - 4	3		2		3	2	
10.1	Septage Receiving Fine Screen	2	Removed. Not in use. Replaced by rock trap	5	Undersized rock trap	5	1	
9.3	Nitrate Analyzers	2	not in use	3		3	1	
6.2	SBR Building Structural/Architectural	2	fine	2		2	3	

ID Number	Process	CA Rating	Condition Assessment Description	PA Rating	Performance Assessment Description	LoF Rating	CoF Rating	Rating Matrix
11.5	Blended Sludge Storage Tank #1 (and covers)	2		2	105,000 gal	2	3	
11.7	Thickened Sludge Storage Tank #1 (and covers)	2		2	28,000 gal	2	3	
11.8	Thickened Sludge Storage Tank #2 (and covers)	2		2	28,000 gal	2	3	
9.1	Methanol Storage Tank	2		1		2	1	
14.1	Sodium Hydroxide Feed Pumps	1	Occasional leakage of piping to and from pumps	2	The three pumps function adequately; the tank functions; The piping to and from pumps function adequately with occasional leaks; Piping to wet-well functions adequately	2	3	
16.5	Fire Booster Pumps	1	brand new no issue	1		1	4	
11.6	Blended Sludge Storage Tank #2 (and covers)	1		1	103,000 gal	1	3	
20.1	Sodium Hydroxide Building HVAC	1		1		1	3	
20.2	Sodium Hydroxide Building Electrical	1		1		1	3	
20.3	Sodium Hydroxide Building Structural/Architectural	1		1		1	3	
6.19	SBR Building Electrical Room HVAC	1	Town replaced in 2019. Good condition.	1		1	2	
9.2	Methanol Feed Pumps 1 and 2	1		1		1	1	

Appendix D
Green House Gas Analysis

ENERGY STAR® PortfolioManager®

Portfolio Manager

Welcome liliapettit: Account Settings

- |
- Notifications
- |
- ENERGY STAR Notifications
-
- |
- Contacts
- |
- Help
- |
- Sign Out

- MyPortfolio
- Sharing
- Reporting
- Recognition

The History Log for "Building Use" has been corrected.
Which of the following trend charts would you like to display?

○ I don't want to see a chart
○ ENERGY STAR Score
◉ Source EUI (kBtu/ft²)
○ Site EUI (kBtu/ft²)
○ Weather Normalized Site EUI (kBtu/ft²)
○ Weather Normalized Source EUI (kBtu/ft²)
○ Water/Wastewater Site EUI (kBtu/gpd)
○ Water/Wastewater Source EUI (kBtu/gpd)
○ Source Energy Use (kBtu)
○ Water Use (All Water Sources) (kgal)
○ Total Waste (Disposed and Diverted) (Tons)
○ Energy Cost ($)
○ Total Water Cost (All Water Sources) ($)
○ Total Waste (Disposed and Diverted) - Cost ($)
○ Total GHG Emissions (Metric Tons CO2e)
○ Total GHG Emissions Intensity (kgCO2e/ft²)

*The chart will display up to 10 years of historical data. Each data point represents all of your properties that have a full calendar year of data for the selected metric.

Select Chart Cancel
Which of the following metrics would you like to display?

◉ ENERGY STAR Score
○ Source EUI (kBtu/ft²)
○ Site EUI (kBtu/ft²)
○ Weather Normalized Site EUI (kBtu/ft²)
○ Weather Normalized Source EUI (kBtu/ft²)
○ Water/Wastewater Site EUI (kBtu/gpd)
○ Water/Wastewater Source EUI (kBtu/gpd)
○ Source Energy Use (kBtu)
○ Water Use (All Water Sources) (kgal)
○ Total Waste (Disposed and Diverted) (Tons)
○ Energy Cost ($)
○ Total Water Cost (All Water Sources) ($)
○ Total Waste (Disposed and Diverted) - Cost ($)
○ Total GHG Emissions (Metric Tons CO2e)
○ Total GHG Emissions Intensity (kgCO2e/ft²)

Select Metric Cancel
Change Metric

Falmouth WWTF

154 Blacksmith Shop Road, Falmouth, MA 02540 | Map It

ENERGY STAR Not currently eligible for ENERGY STAR Certification

ENERGY STAR Score (1-100)

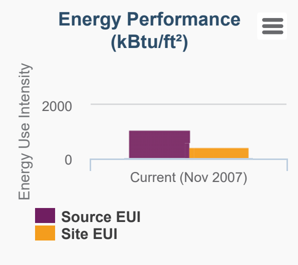
Why not score?
Current Score: 31
Baseline Score: N/A

Portfolio Manager Property ID: 11689755

Year Built: 2003

Edit

- Summary
- Details
- Energy
- Water
- Waste & Materials
- Goals
- Design



Generate & Download Performance Documents for this Property

Statement of Energy Performance (SEP)

ENERGY STAR Scorecard

Progress & Goals Report

Data Verification Checklist

Water Scorecard

Total Project Investment

$0.00

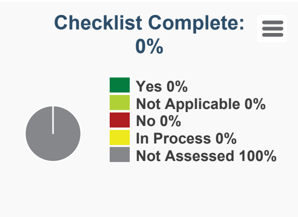
Total Estimated Savings

$0.00

Third Party Certifications

You can track your third party certifications, such as LEED and Green Globes. This information will automatically be included in your Sustainable Buildings Checklist.

Sustainable Buildings Checklist



Checklist completion percentage includes "Yes" and "Not Applicable" responses.

Metrics Comparison for Your Property & Your Target Change Time Period

Metric	Dec 31 2006 (Energy Baseline)	Nov 30 2007 (Energy Current)	Target*	Median Property*
ENERGY STAR score(1-100)	Not Available	31	Not Set	50
Source EUI(kBtu/ft²)	Not Available	1088.0	Not Set	895.2
Site EUI(kBtu/ft²)	Not Available	414.5	Not Set	341.1
Source Energy Use(kBtu)	1325145.4	11097396.2	Not Set	9131521.4
Site Energy Use(kBtu)	737930.5	4228020.1	Not Set	3479037.5
Energy Cost($)	Not Available	Not Available	Not Set	Not Available
Total GHG Emissions(Metric Tons CO2e)	55.0	316.5	Not Set	260.5

Select Time Periods for Metrics

Period 1:
- (●) Energy Baseline(Jan 1, 2006-Dec 31, 2006)
- ( ) Energy Current(Dec 1, 2006-Nov 30, 2007)
- ( ) Water Baseline(Not Available)
- ( ) Water Current(Not Available)
- ( ) Waste Baseline(Not Available)
- ( ) Waste Current(Not Available)
- ( ) Other Year

Period 2:
- ( ) Energy Baseline(Jan 1, 2006-Dec 31, 2006)
- (●) Energy Current(Dec 1, 2006-Nov 30, 2007)
- ( ) Water Baseline(Not Available)
- ( ) Water Current(Not Available)
- ( ) Waste Baseline(Not Available)
- ( ) Waste Current(Not Available)
- ( ) Other Year

Save Cancel

* To compute the metrics at the target and median levels of performance, we will use the fuel mix associated with your property's current energy use.

Baselines & Targets

	Baselines	Target
Energy	12/31/2006	Not Set
Water	Not Available	Not Available
Waste/Materials	Not Available	Not Available

Set Baselines or Target

Energy Projects (0)

Add Project

Name	Date Implemented	Estimated Savings	Action
Nothing to display			

Third Party Certifications

You have not added any third party certifications for this property.

Add or Edit Third Party Certifications

Sustainable Buildings Checklist

The Sustainable Buildings Checklist evaluates sustainability in existing buildings. It was first developed for US federal building managers to achieve the 2008 Federal Guiding Principles for High Performance Sustainable Buildings. It can also be used for non-government buildings. For guidance in using the 2008 Checklist, see How to Use the Sustainable Buildings Checklist. Updates to this Checklist to reflect the 2016 Guiding Principles are on hold. In the meantime, the 2016 Guiding Principles can be tracked in US federal buildings using this spreadsheet alternative.

Target Date of Compliance:
Not Set
Actual Date of Compliance:
Not Set
Start the Checklist

Continue Cancel
Selected items: 7 of 7 maximum (View Selection)

Select Information & Metrics

- Property Information
- Property ID Numbers
- Property Use Details
- Energy Use by Fuel Source
- Data Accuracy
- Energy Performance Metrics
- Water Performance Metrics
- Waste Performance Metrics
- Cost Performance Metrics
- Greenhouse Gas Emissions
- Renewable Energy & Green Power
- ENERGY STAR Certification
- Property Design
- Target Metrics
- Sustainable Buildings Checklist
- Data Center Metrics
-

☐ Property Name
☐ Parent Property Name
☐ Address 1
☐ Address 2
☐ City
☐ County
☐ State/Province
☐ Postal Code
☐ Country
☐ Property GFA - Self-Reported (ft²)
☐ Property GFA - Calculated (Buildings and Parking) (ft²)
☐ Property GFA - Calculated (Buildings) (ft²)
☐ Property GFA - Calculated (Parking) (ft²)
☐ Primary Property Type - Self Selected
☐ Primary Property Type - Portfolio Manager-Calculated
☐ National Median Reference Property Type
☐ List of All Property Use Types at Property
☐ Largest Property Use Type
☐ Largest Property Use Type - Gross Floor Area (ft²)
☐ 2nd Largest Property Use Type
☐ 2nd Largest Property Use - Gross Floor Area (ft²)
☐ 3rd Largest Property Use Type
☐ 3rd Largest Property Use Type - Gross Floor Area (ft²)
☐ Irrigated Area (ft²)
☐ Construction Status

Appendix E
Solar Analysis

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Caution: Photovoltaic system performance predictions calculated by PVWatts® include many inherent assumptions and uncertainties and do not reflect variations between PV technologies nor site-specific characteristics except as represented by PVWatts® inputs. For example, PV modules with better performance are not differentiated within PVWatts® from lesser performing modules. Both NREL and private companies provide more sophisticated PV modeling tools (such as the System Advisor Model at https://sam.nrel.gov) that allow for more precise and complex modeling of PV systems.

The expected range is based on 30 years of actual weather data at the given location and is intended to provide an indication of the variation you might see. For more information, please refer to this NREL report: The Error Report.

The energy output range is based on analysis of 30 years of historical weather data for nearby , and is intended to provide an indication of the possible interannual variability in generation for a Fixed (open rack) PV system at this location.

RESULTS

269,377 kWh/Year*

System output may range from 248,581 to 276,273 kWh per year near this location.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)	Value ($)
January	3.30	16,854	2,191
February	4.37	19,610	2,549
March	5.04	24,479	3,182
April	5.33	24,671	3,207
May	5.72	26,818	3,486
June	5.74	25,495	3,314
July	5.79	25,601	3,328
August	5.75	25,566	3,324
September	5.69	25,065	3,259
October	4.77	22,414	2,914
November	3.74	17,472	2,271
December	3.08	15,330	1,993
Annual	**4.86**	**269,375**	**$ 35,018**

Location and Station Identification

Requested Location	falmouth, ma
Weather Data Source	Lat, Lon: 41.57, -70.62 1.2 mi
Latitude	41.57° N
Longitude	70.62° W

PV System Specifications *(Commercial)*

DC System Size	190 kW
Module Type	Standard
Array Type	Fixed (open rack)
Array Tilt	41°
Array Azimuth	190°
System Losses	14.08%
Inverter Efficiency	96%
DC to AC Size Ratio	1.2

Economics

Average Retail Electricity Rate	0.130 $/kWh

Performance Metrics

Capacity Factor	16.2%