GROTON UTILITIES

GROTON, CONNECTICUT

JUNE 2022

DRAFT Report

Groton Pollution Abatement Facility Wastewater Facilities Plan

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Engineering a Better Environment

Groton Pollution Abatement Facility
Wastewater Facilities Plan

Groton Utilities, Groton, Connecticut

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Section 1 Executive Summary

Groton Utilities (GU) owns and operates an extensive wastewater collection system and advanced pollution abatement facility (PAF) which handles wastewater from the City of Groton sewer service area. The PAF has a design annual average permitted flow rate of 3.1 million gallons per day (mgd) and currently processes an annual average flow rate of 1.63 mgd with peaks over 6.5 mgd. The PAF was originally constructed in 1955 and was expanded in 1964 and 1970 to meet the needs of a growing city and expansion of the sewer collection system. Additions were made in 2000 to improve biosolids management, disinfection, aeration, and automated plantwide controls. In 2015, upgrades were made to expand office space, the lunchroom, and the locker room in the Blower Building, and a new laboratory was constructed in the Operations Building. Other improvements included concrete coatings and repairs in various tanks, the replacement of the primary and secondary settling tank mechanisms and drives, and replacement of the digester boiler and heat exchanger.

In 2020, GU proactively elected to commission this Facility Plan to evaluate and plan for needed improvements to the PAF due to a variety of issues facing the city at that time including:

- Seasonal impacts on plant performance
- Maintaining stringent nitrogen removal and disinfection requirements with increasing operation and maintenance costs to achieve those limits
- Periodic nuisance odor problems
- Lack of automated instrumentation and controls
- Undersized, inoperable, or otherwise unreliable equipment including the screenings grinder, primary sludge pumps, primary effluent pumps, aeration blowers, thickened waste sludge pumps, digested sludge pumps, plant water system, odor control system and the operation's building HVAC system
- Aging, energy inefficient unit processes, equipment and building systems with increasing operating costs and increasing corrective maintenance requirements

The purpose of is facilities plan was to identify the problems and conduct an analysis of alternative solutions with associated budgetary costs. The plan also included the evaluation of a regional alternative that would eliminate the PAF and convert it to a pump station. The pump station would then convey all wastewater to the Town of Groton for treatment and disposal.

During the preparation of this plan, GU proactively decided to move forward with upgrades to the PAFs liquid disinfection storage and feed system, odor control system and Operations Building HVAC system. The replacement of the liquid disinfection storage tanks, feed pumps and controls are underway with an expected completion of Summer/Fall 2022. The odor control system and Operations Building HVAC project is currently in design with an anticipated construction start date of Fall/Winter 2022.

Following approval of this plan, detailed engineering analysis will be performed, and specific solutions will be refined.

1.1 Basis of Design

Based on discussions with the City of Groton, Town of Groton, and Groton Utilities, future flows and loads were developed for the PAF. These parameters are presented in Table 1-1 below for both the current year and design year (2045).

Table 1-1 Design Flows and Loads

Parameter	Current (2022)	Design Year (2045)
Average Daily Flow (mgd)	1.63	1.84
Peak Hour Flow (mgd)	6.50	7.15
Avg BOD^5 Load (lbs/day)	1,758	2,289
Avg TSS Load (lbs/day)	2,277	2,796
TKN Load (lbs/day)	389	495

1.2 Recommended Capital Improvements Plan

The evaluation of the PAF generally focused on developing recommended improvements related to process upgrades needed to accommodate growth, provide for effective nitrogen removal, comply with permit requirements, replace aging, inoperable and inefficient equipment, and to identify potential foreseeable changes in state regulations that may require additional unit processes in the future. The evaluation also included an overall review of all associated structures and buildings, building systems, instrumentation and control, electrical service and distribution, and site conditions.

Based on the results of the evaluation, a recommended Capital Improvement Plan (CIP) was developed that includes immediate (years 0-5) and future (years 6-20) projected upgrade needs to assist GU is budgeting and planning for these capital expenditures. The CIP should be considered a working document. The planning level budgetary cost estimates will need to be reviewed and updated annually, or as needed, by the city over the course of the upgrade program. It is recommended that each proposed improvement project be reevaluated before beginning the design, as changes in scope, available technologies, and site conditions can occur over the course of the plan.

The total cost of the 20-year CIP is estimated to be $12.6 million in 2022 dollars with an Engineering News-Record (ENR) Index of 12684 (February 2022). This includes $9.0 million for immediate improvements through 2026 and $3.6 million for future capital projects through 2042.

1.2.1 Immediate Improvements Project

This facility plan was conducted utilizing a 55% planning grant through the State of Connecticut Department of Energy and Environmental Protection (DEEP) Clean Water fund (CWF) Program. The design and construction phases may also be eligible for CWF financing based on priority points and funding availability. To maximize potential grant funding, the immediate improvements should be constructed as one comprehensive project. Typically, CWF eligible projects can qualify a 20% grant/80% loan. Although currently presented as one project, GU may consider breaking the work up into multiple phases over the course of the five-year period prioritized by work area. Our preliminary opinion of probable project costs for the immediate improvements project are summarized in Table 1-2.

Table 1-2 Project Cost Estimate – PAF Immediate Improvements

Project Work Area	Cost
Site Work	$160,000
Architectural Improvements	$280,000
Structural Improvements	$670,000
Demolition	$170,000
Operation Building Improvements	$1,800,000
Blower Building/Aeration Tank Improvements	$2,260,000
Digester And Sludge Storage Building Improvements	$220,000
Miscellaneous Site Structure Improvement	$200,000
HVAC/Plumbing	$50,000
Instrumentation	$470,000
Electrical	$780,000
Bypass Pumping/Specials	$40,000
Construction Subtotal[2]	**$7,090,000**
Construction Contingency (5%)	$350,000
Technical Services (18%)	$1,274,000
Materials Testing (0.5%)	$35,000
Hazardous Materials Abatement	$50,000
Legal/Administrative (2%)	$140,000
Financing (1%)	$90,000
Total Project Cost[3]	$9,030,000

Notes:

1. Cost estimate is based on ENR Index 12684 (February 2022).
2. Includes OH&P, contractor markups, general conditions, design contingencies, and inflation.
3. Does not include any costs for flood protection at this time.

Major components of immediate improvements project include:

1. Conversion of the aeration system to an MLE process with three new hybrid screw compressor hybrid blowers, automated DO control system, diffusers, anoxic zone mixers and internal recycle pumps.
2. Replace the following inoperable or aging equipment: mechanical bar screen, screenings washpress/compactor/grinder, primary sludge pumps, primary effluent pumps, thickened waste sludge transfer pumps, digested sludge pumps, grit blowers, and digested sludge recirculation pumps.
3. Repair interior concrete walls and covers on digester tanks.
4. Construct upgrades to the aerated grit system for more efficient grit collection and disposal.
5. Install pumps, piping and valving to allow for thickened waste sludge to be pumped to the primary digester tank and secondary scum to be pumped to the head of the primary settling tanks.
6. Install of a spray water system for foam suppression in the aeration tanks and final settling tanks.
7. Upgrade the plantwide SCADA system, control panels, PLCs, alarming and reporting software, and replace any instrument that is over 10 years old.
8. Install an influent flowmeter for process control.
9. Retrofit or replace all fluorescent lighting to LED bulbs or fixtures throughout the facility.
10. Retrofit manual scum skimmers on the Primary Settling Tanks.
11. Install a new properly sized emergency generator.

1.2.2 Future Improvements Projects

The following major improvements have been identified and deferred to years 6 through 20, with anticipated larger projects to be completed every 5 years or so.

1. Routine SCADA hardware and software upgrades (year 10, 15 & 20)
2. Install launder covers in final settling tanks (Re-evaluate after immediate improvements work)
3. Replace rotary drum thickener (year 10)
4. Replace waste sludge polymer blending system (year 20)
5. Replace primary settling tank drives and internals (year 20)
6. Replace final settling tank drives and internals (year 20)
7. Replace chemical feed pumps (year 15)
8. Reevaluate solids handling operations and ether replace the digester tank covers, boiler, heat exchanger and gas system or convert digester building to a dewatering facility (year 15)
9. Miscellaneous building improvements: HVAC, doors, windows, sealants (years 10 and 20)
10. Demolish/clean up old and decommissioned equipment and electrical (yearly)
11. Repave bituminous parking area and drives (year 10)

1.2.3 Other Noteworthy Findings

Other noteworthy findings of this facilities plan evaluation include:

1. The Groton PAF has sufficient hydraulic and treatment capacity over the full range of future projected flows and loadings.
2. For the regional alternative, converting the PAF into a pump station and conveying flows approximately 2 miles to the Town of Groton's collection system for treatment and disposal is not favorable with a 20-year life cycle cost of $55.0 million compared to $45.5 million for maintaining full operation of the PAF.
3. Based on discussions with the CT DEEP during this facility plan, there are no plans to add any limits for phosphorus or de-chlorination at the City of Groton PAF in the near future.
4. Upgrades to the aeration equipment and controls to forego the current cyclic mode of operation in the aeration tanks and upgrading to operate as a more continuous "MLE" process results in an estimated 11.5-year payback on reduced energy consumption alone. This upgrade will also allow the plant to automatically control the disinfection system and pace the return sludge flow by eliminating "spiking" at the effluent flowmeter every time the blowers turn on/off.
5. Life cycle cost analysis of continuing to anaerobically digest sludge versus eliminating digestion favored maintaining anaerobic digestion. The main driving factor of this finding was that major equipment replacements and upgrades to the digestion process were recently conducted in 2015. It is recommended that GU revisit this evaluation periodically as the liquid sludge disposal market continues to be more stringent. Currently, most local incineration facilities do not prefer anaerobically digested sludge as it does not dewater as well or burn as efficiently as undigested sludge.
6. Installing dedicated waste sludge pump and automating the rotary drum thickener will provide for better process control and flexibility at the plant.
7. The plant water system at the PAF has not been in use for several years and city water is used for all process control needs. The life cycle cost analysis to maintain city water versus installing a new plant water system for process needs at the PAF favors the continued use of city water, mainly because there is no initial capital cost.
8. The Groton PAF site is split by two Special Flood Hazard Area 100-year Base Flood Elevations (Zone VE at EL 14.00 and Zone AE at EL 11.00 both in NGVD 88 datum). The resiliency evaluation in Section 7 suggests that the entire site may need to be protected to EL 17.0 (NGVD 88), well above any finished floor or top of tank elevation. Protection of the entire site to EL 17.0 may not be feasible and additional detailed discussions are recommended with FEMA and the CT DEEP prior to any major plant upgrades that would require flood protection upgrades as part of their scope. In either case, it is anticipated that some level of protection will be required. Costs for flood protection measures are not included at this time.
9. As part of this plan, an inventory of all major assets at the PAF was entered into an asset management database. The condition of each asset was assessed, and a criticality/risk analysis performed. The findings of the asset management evaluation are incorporated into the overall CIP. The findings are in Microsoft Excel format so that Groton Utilities can use it to populate a Computerized Maintenance Management System (CMMS) in the future.
10. Using the cost of service and financial model completed for GU in January 2022 by Utility Financial Solutions, LLC (UFS), the previously published long term rate track was smoothed out to account for the actual cost and timing of capital expenditures at the PAF and within the sewer collection system to help ensure future planned upgrades to the wastewater system can be funded with limited to no impacts to customers. Refer to Appendix I for a copy of the updated May 2022 cost of service study.

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Section 2 Introduction

2.1 Background

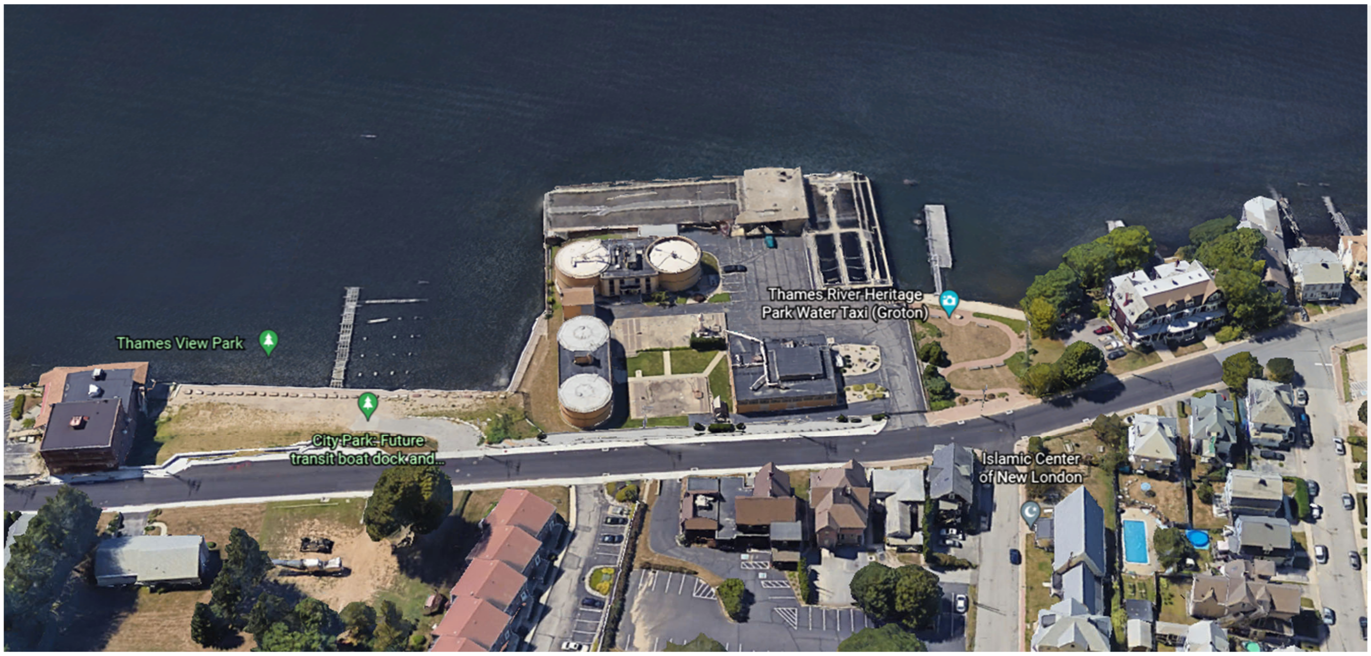
The City of Groton Fort Street Pollution Abatement Facility (PAF) is located at 311 Thames Street. The PAF receives wastewater flows from the City of Groton (including Electric Boat, Pfizer and UCONN at Avery Point) as well as from a portion of the Town of Groton north of I-95. The PAF has a design annual average flow rate of 3.1 million gallons per day (mgd) and peak hour flow rate of 6.5 mgd and currently processes an annual average flow rate of 1.63 mgd with peaks over 6.5 mgd, or the maximum flow capable of being recorded at the effluent Parshall flume. The plant has received flows in excess of this peak but the flowrate is not measured above this value. Treated effluent from the plant is discharged to the Thames River.

The PAF was originally constructed in 1955 to achieve preliminary and primary treatment for collected sewage flows from the city. Sludge digestion tanks were also constructed for sludge processing. The plant was expanded in 1964 to meet the needs of a growing city by constructing two additional primary settling tanks. In 1970, the plant was expanded to provide for secondary treatment through the addition of aeration tanks, final settling tanks, a chorine contact chamber, Blower Building and a second set of sludge digestion tanks. Major improvements and equipment replacements also occurred in 2000 and 2015. In 2000, the improvements included conversion from chlorine gas to liquid sodium hypochlorite for disinfection, new sludge pumps, new aeration blowers, new building HVAC, and a plantwide control and SCADA system. The most recent upgrade to the PAF was completed in 2015 and included full equipment replacement and interior concrete coatings to the primary settling tanks and final settling tanks, relocation of the laboratory to the Operations Building, replacement of the heat exchanger and HVAC equipment in the Digester Building, and construction of office space, a lunch room and locker rooms in the Blower Building. Figure 2-1 is an aerial view of the current treatment facility.

Wastewater is conveyed to the plant from the north and south sides of Thames Street. The two main lines combine outside of the Operations Building into one 18-inch diameter influent pipe. Preliminary treatment at the plant includes mechanical screening and grit removal. Screenings are compacted, washed, and ground prior to disposal. Grit is pumped out of the aerated grit tank once to twice per year for off-site disposal as a Special Waste. Flow is split between four primary settling tanks in the primary distribution box before leaving the Operations Building. After primary sedimentation, flow is conveyed to the primary effluent wetwell where it is lifted to the sludge mixing chamber by three primary effluent pumps and then flows by gravity to two aeration tanks. After biological treatment, the mixed liquor flows to two final settling tanks. Secondary effluent is then disinfected in the chlorine contact chamber and discharged to the Thames River.

Primary and secondary sludges are separated at the Groton PAF. Primary sludge is pumped to the primary digester where it is anaerobically digested. The digested sludge from the primary digester overflows to the secondary digester. Sludge is pumped from the secondary digester directly to hauler trucks for off-site disposal. Waste activated sludge is pumped to a rotary drum thickener, thickened, and then pumped to a sludge storage tank where it is periodically pumped to a hauler truck for off-site disposal.

Figure 2-1 Groton Pollution Abatement Facility – Aerial View



Source: Google Earth

The Groton PAF is well operated and maintained and has an excellent regulatory compliance record. However, the PAF has recently faced a variety of challenges including stringent nitrogen removal requirements, disinfection requirements, nuisance odor problems, oversized aeration blowers, lack of automated control systems (most noteworthy are aeration system controls and monitoring), reliability and efficiency of solids handling facilities, and aging unit processes and equipment.

2.2 Purpose of Evaluation

A partial Facilities Plan was completed in 2013, resulting in the improvements made to the facility in the 2015 upgrade. This Facilities Plan builds upon the previously completed 2013 report to develop a comprehensive evaluation of the PAF, with the goal of identifying the upgrade needs to meet current and future projected requirements and identifying opportunities to increase the facility's efficiency in order to control operating costs. The evaluation included inspections of the PAF to evaluate each unit process and process support systems, building systems (structural; architectural; heating, ventilation, and air conditioning systems; and electrical) and instrumentation and control systems. These evaluation efforts were utilized to develop a comprehensive facility upgrade plan and meet Connecticut DEEP requirements to be eligible for a 55% Planning Grant through the Clean Water Fund (CWF) program.

The Facility Plan follows industry standards and incorporates Federal and State recommendations and guidelines where appropriate to maintain present day regulatory compliance and future anticipated changes to regulatory requirements. The Facility Plan will also assist Groton Utilities (GU) in its goal of maintaining financial stability by managing a positive balance of revenue to expense.

The Facility Plan lists plant equipment in an asset management format with condition assessment, predictive dates for repair / replacement, and allocated costs utilizing industry established metrics. The overall recommended plan focuses on comprehensive improvements for the years 2022 – 2027. The Capital Improvements Plan also includes potential projects over the full 20-year planning period.

2.2.1 Report Organization

This Facilities Plan is divided into the following sections:

- Section 1: Executive Summary
- Section 2: Introduction
- Section 3: Basis of Design
- Section 4: Evaluation of Liquid Processes
- Section 5: Evaluation of Solids Processes
- Section 6: Evaluation of Plantwide Support Systems
- Section 7: Flood Protection & Resiliency Evaluation
- Section 8: Energy Evaluation
- Section 9: Regional Alternative Evaluation
- Section 10: Asset Management Evaluation
- Section 11: Recommended Plan
- Section 12: Environmental Impact Assessment

A variety of efforts were performed to develop the components of the plan listed above. An evaluation of the plant was conducted by all building service disciplines (i.e., civil, architectural, structural, process, mechanical, electrical, and instrumentation engineers). This was accomplished through on-site observations and interviews with plant staff. The interviews aided in evaluating both the current conditions as well as the anticipated future needs of the facility. The plant personnel were key participants in the evaluation, and they were instrumental in providing insight into current operations and assessment of possible alternatives to improve operations.

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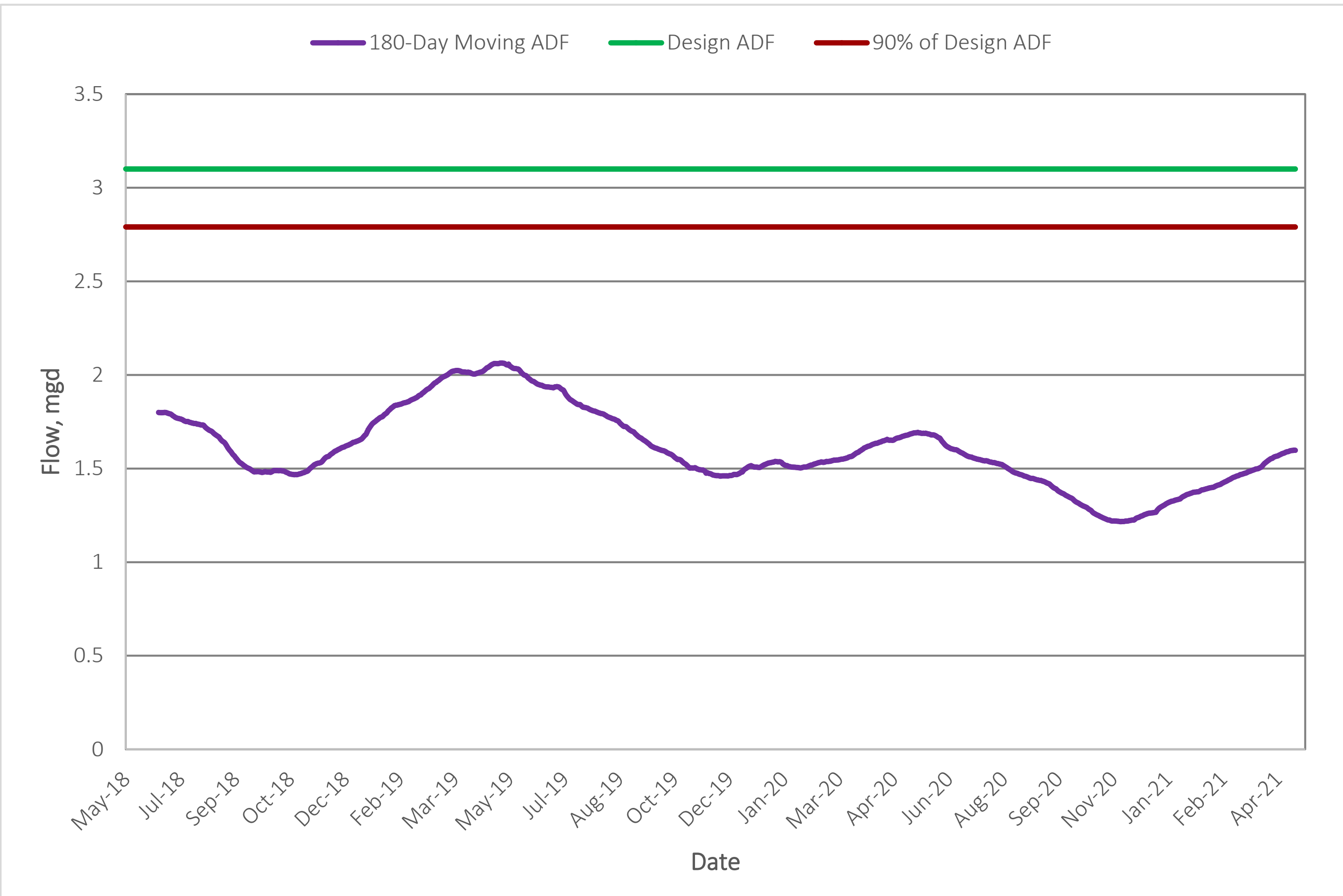
Section 3 Basis of Design

3.1 Introduction

To establish the basis for evaluation of the Groton Fort Point Pollution Abatement Facility (PAF), projections of future wastewater flows and loadings were determined based on population projections for the 20-year planning period as well as planned residential, commercial, industrial and institutional growth within the sewer service area. The design-year wastewater flow and load projections are based on the historical wastewater flows and loadings plus estimated increases in each of the components that contribute flow to the PAF. The PAF currently receives and treats wastewater flows below 90% of their design flow rate of 3.1 million gallons per day (mgd). As shown in Figure 3-1, the 180-day moving average of the total daily flows are consistently below 90% of the design flow (2.79 mgd).

Figure 3-1 180 Day Moving Average of Total Daily Flow – January 2018 Through April 2021



Census Data was used to estimate population projections which were coordinated with the City's Plan of Development Report and Sewer Service Area (SSA). The draft SSA for the City of Groton is presented in Figure 3-2. This proposed SSA map was developed as part of the Facilities Plan through various workshops with city staff and represents the areas within the City of Groton that are currently sewered or are planned to be sewered.

3.2 State Plan of Conservation and Development

The State of Connecticut General Statutes 16a-24 through 16a-30 requires that the Office of Policy and Management (OPM) prepare a Conservation and Development Policies Plan (C&D Plan). The C&D Plan is intended to serve as the framework for resource management and development for the State, with the goal of balancing growth while protecting the State's environmental resources. The statutes require that state agencies consult the C&D Plan when regulating their respective agencies to ensure that there is conformity to the intent of the Plan. This, in turn, is required for the allocation of state funding.

As part of this facilities plan, the City of Groton has developed a DRAFT Sanitary Sewer Service Area (SSA) map which includes existing public sewers, parcels and an indication of which parcels are within the Sewer Service Area, which parcels are within the Sewer Avoidance Area and which parcels are Open Space. The 2018-2023 C&D Plan Locational Guide Map (LGM) for the Groton area is presented in Figure 3-3. The new LGM classifications are intended to help state agencies comply with the administrative requirements of CGS Section 16a-35d and be used for general planning purposes. The following summary table is from page 32 of the current C&D plan and summarizes the LGM:

Priority Funding Areas	Balanced Priority Funding Areas	Village Priority Funding Areas	Conservation Areas	Undesignated Areas
Growth-related projects may proceed without an exception	Growth-related projects may proceed without an exception, if the sponsoring agency documents how it will address any potential policy	Growth-related projects may proceed without an exception, if the sponsoring agency documents how it will help sustain village character	Growth-related projects may proceed with an exception*	Growth-related projects may proceed with an exception*

* <u>Note</u>: In order for a growth-related project to be funded outside of a PFA, CGS Section 16a-35d requires the project to be supported by the municipal plan of conservation and Development and to be approved by OPM.

Proposed Sewer Service Area Map

Groton, CT

PROJ NO: 20653	DATE: 8/25/2021	FIGURE: 3-2

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Office of Policy and Management, 2021;
National Hydrography Dataset, 2021;
Map Developed by Wright-Pierce, 2021.
Gravity Main
Force Main
Sewer Service Area (SSA)
Sewer Avoidance Area (SAA)
Local Historic District
Protected Lands
Village Priority Funding Area
Balanced Priority Funding Area
Conservation Area
1-3 Conservation Factors
4-5 Conservation Factors
6-7 Conservation Factors
Priority Funding Area
Priority Funding Area — 1-2 Criteria
Priority Funding Area — 3-4 Criteria
Priority Funding Area — 5 Criteria
N
0 300 600 1,200
Feet
OPM Map
Conservation and
Development
Groton, CT
PROJ NO: 20653
DATE: 11/10/2021
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FIGURE: 3-3

Based on the revised 2018-2023 State Plan of Conservation and Development Policies Plan Update, the LGM will be used to determine whether a growth-related project is located within a Priority Funding Area (PFA). If a project is not located in a PFA, there is now an exception process that is weighted towards determining the project's consistency with the local municipal plan of conservation of development. In summary, no state agency shall provide funding of a "growth-related project" unless the project is either located in a PFA or has fully complied with the exception process if not within a PFA (CGS Sec. 16a-35c).

For Clean Water Funded Projects, these PFAs fall into two of six Growth Management Principles (GMP's):

- GMP #1 – Redevelop and Revitalize Regional Centers and Areas with Existing or Currently Planned Physical Infrastructure
- GMP #5 – Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety

The DRAFT SSA, presented in Figure 3-2 is in conformance with the 2018-2023 OPM C&D Plan Map. As shown in Figure 3-3, there are 12 parcels designated by OPM as protected lands in the City of Groton. Of these 12 parcels, three house sewer pump stations and two are part of the Fort Griswold Museum. The remaining seven are vacant parcels the City has identified for potential future growth. The currently sewered parcels identified in Figure 3-2 fall within a Priority Funding Area (PFA) or a Balanced Priority Funding Area (BPFA), which may remain without exception.

3.3 Current Flows and Loads

Current influent wastewater flows and loads have been established based on facility operating data for the 39-month period from January 2018 through April 2021 (Analysis Period). The specific waste streams that make up the City of Groton PAF influent include the following:

- Sanitary flows within the City of Groton
- Sanitary flows from a portion of the Town of Groton
- Sanitary and process flows from Pfizer
- Sanitary and process flows from Electric Boat
- Sanitary flows from the UCONN Avery Point Campus
- Trucked-in septage
- Internal recycle streams at the facility including filtrate from the rotary drum thickener as well as supernatant from the secondary digester

Only effluent flow is measured at the facility. Effluent flow is measured via an ultrasonic level transducer and Parshall flume downstream of the Chlorine Contact Chamber. Flow from the effluent meter is reported to the Connecticut Department of Energy and Environmental Protection (DEEP). The effluent flow meter has a maximum reading of 6.5 mgd which was exceeded four times over the analysis period. Influent flow is currently not measured at the facility. Influent flow metering alternatives were evaluated as part of the facilities plan for process control use only. The total influent load received at the City of Groton PAF is determined by sampling the influent wastewater immediately upstream of the grit chamber. Filtrate from the rotary drum thickener discharges into the aerated grit tank downstream of this sampling point. Overflow from the digestors flow by gravity to the primary settling tank influent flow distribution box also downstream of the influent sampling point. The frequency distribution of total daily flows, BOD5 loading, and TSS loading have been determined for the period January 2018 through April 2021 and are presented in Figure 3-4. The influent BOD5 and TSS concentration data for the period

January 2018 through April 2021 are presented in Figure 3-5. The monthly average flows are presented in Figure 3-6.

Figure 3-4 Influent Flow and Loading Frequency Distribution – January 2018 Through April 2021

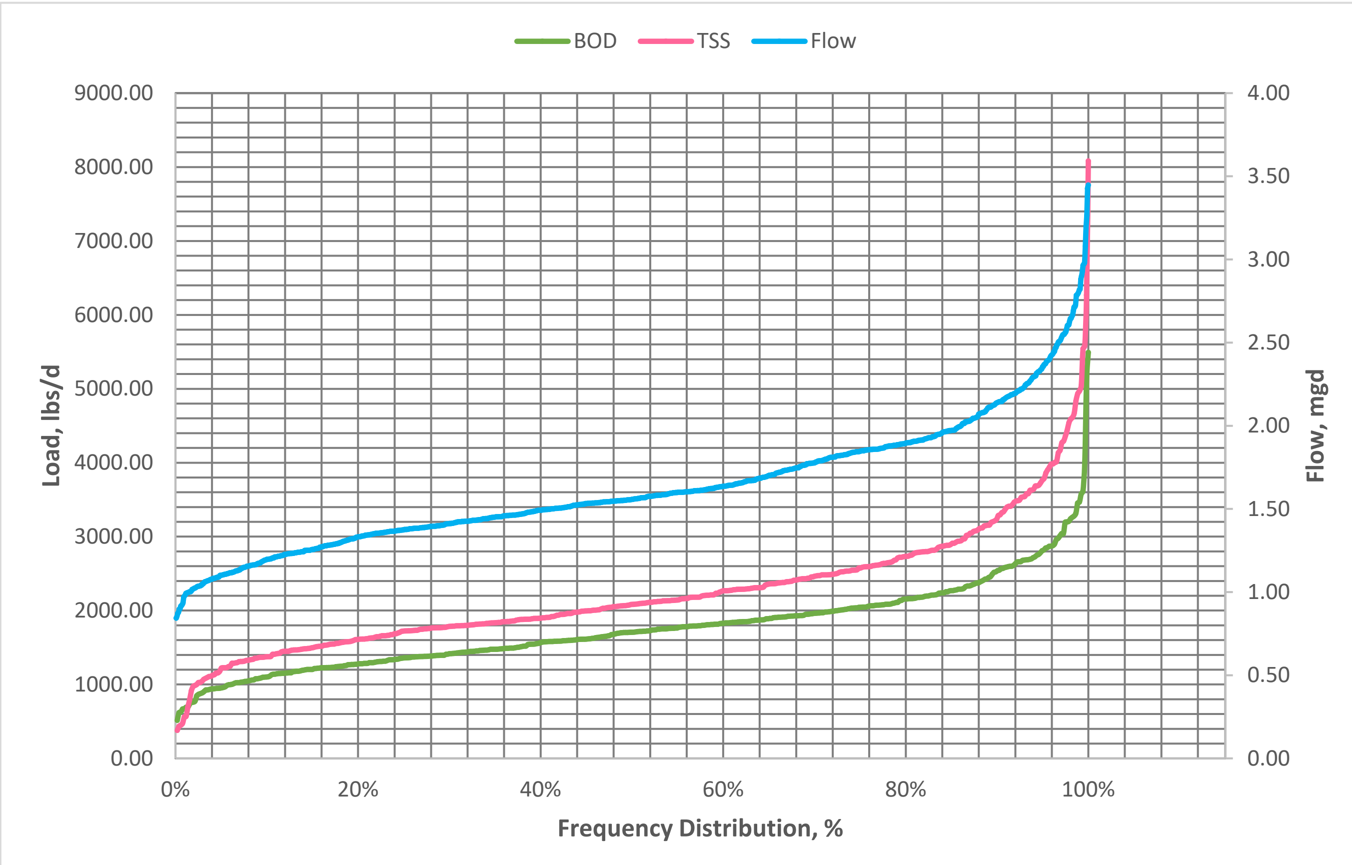
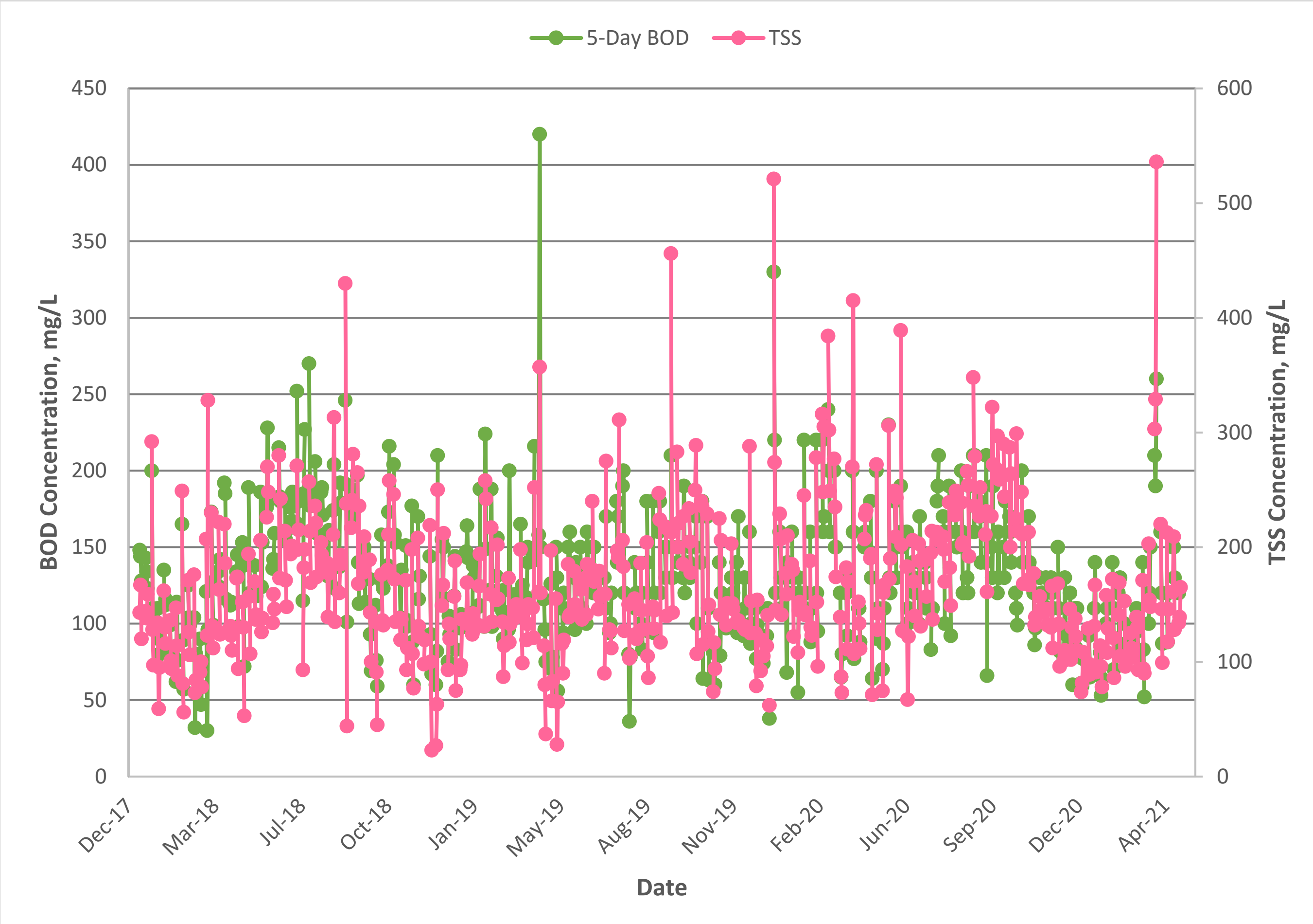


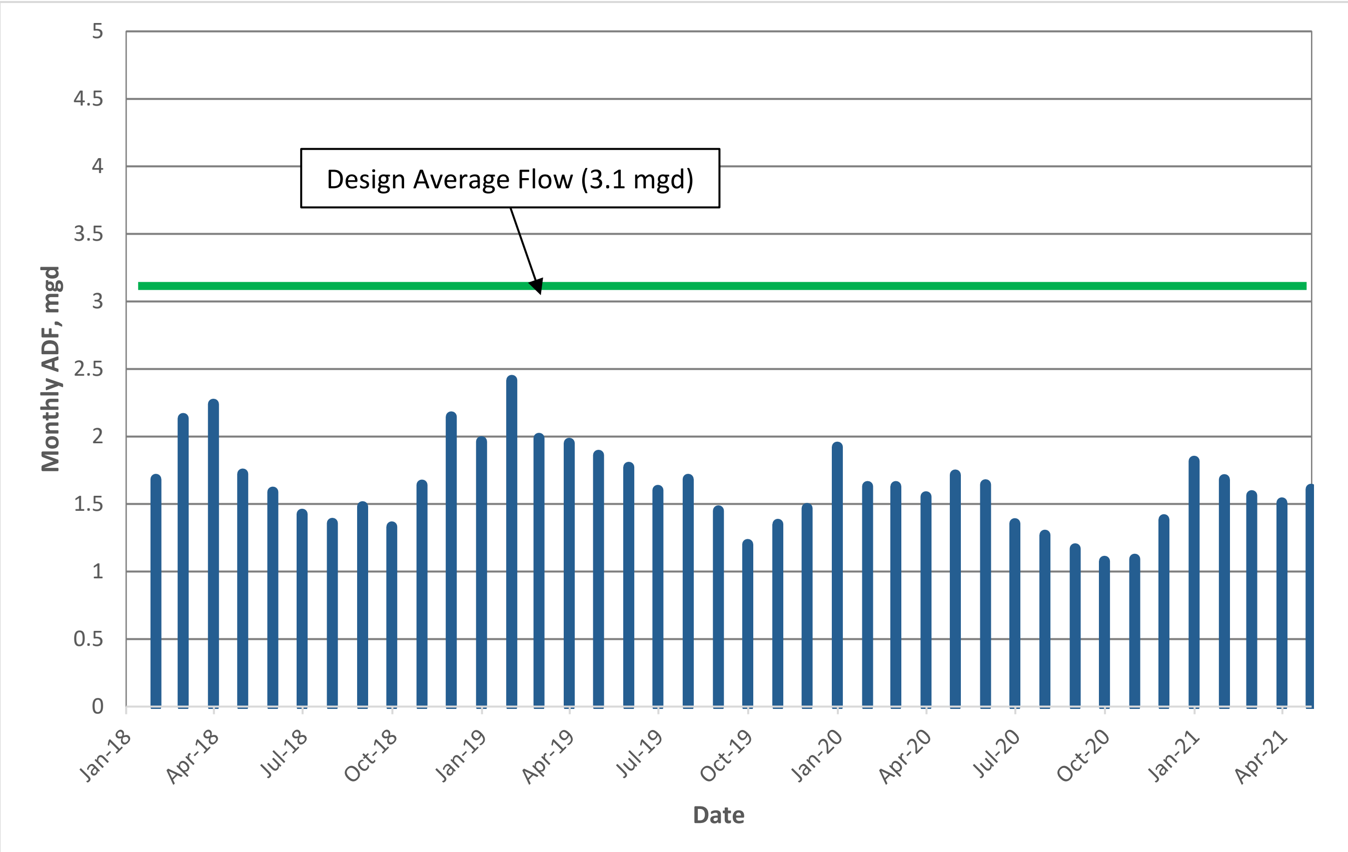
Figure 3-5 Influent BOD5 and TSS 7-Day Average Concentrations – January Through April 2021



3.3.1 Influent Flow, BOD5, and TSS Loadings

As seen in Figure 3-5, the average influent BOD5 and TSS loading are approximately 1,760 lb/d and 2,230 lb/d respectively. The 98th percentile BOD5 loading was around 3,232 lb/d and the 98th percentile TSS loading was around 4,573 lb/d. As seen in Figure 3-65, the influent BOD5 and TSS loading have an average value of 130 mg/L and 170 mg/L respectively.

Figure 3-6 Monthly Average Daily Flows – January 2018 Through April 2021



3.3.2 Current Influent Flows and Loadings

The current influent wastewater characteristics were developed by evaluating the historic operating data over the analysis period for annual average, maximum month and maximum day flows and loads (BOD5, TSS and TKN) and for peak-hour flows. The key flow and load conditions that are utilized as the basis of design for specific unit processes are summarized as follows:

- **Annual Average:** This is the average of all daily data for the entire study period. The average flow and loadings are important benchmarks, but capacity is typically controlled by other design criteria.
- **Maximum Month**: This is the maximum 30-day running average during the study period which is calculated for each parameter independently (i.e. the maximum TSS loading condition may not have occurred at the same time as the maximum month BOD5 loading condition). The maximum monthly conditions are an important measure of sustained capacity.
- **Maximum Day**: The maximum daily flow is typically the shortest time frame used to assess loadings and is an important measure of peak capacity. The single maximum day value for the data set is reported along with the 98th percentile maximum value. Hydraulic capacity is provided for the 100th percentile value but frequently, unit processes are sized for the 98th percentile value to avoid sizing processes for unusually high conditions.
- **Peak Hourly**: Peak hourly is typically used only to determine hydraulic capacity for flows, not loadings, and is an important hydraulic consideration for the design of unit processes at the PAF. As with the maximum day value,

both the instantaneous maximum value recorded (the 100th percentile value) and the 98th percentile values are presented. Hydraulic capacity is provided for the 100th percentile value. However, unit processes would be typically sized for process conditions based on the 98th percentile value.

A summary of the existing influent characteristics is summarized in Table 3-1.

3.3.3 Nitrogen and Phosphorus Loading

The PAF also monitors influent ammonia, TKN, nitrite and nitrate on a once per month basis. Data have been provided for the period January 2018 through April 2021. Influent orthophosphate and total phosphorus concentrations as well as effluent phosphorus are measured once per month. Typically, TKN concentration are approximately 20% of the influent BOD5 loading and ammonia is typically about 60% of the TKN loading and phosphorus is typically calculated by multiplying the existing BOD5 loadings by 3.5%. From Table 3-1, the annual average influent TKN is around 22% of BOD5 and had an average concentration of 28.7 mg/l.

As shown in Table 3-1, the current arithmetic mean of the average daily flow (ADF) from the PAF is 1.63 mgd, or approximately 52.7% of the permitted flow of 3.1 mgd. The 180-day moving average of the ADF was 1.61 mgd.

Table 3-1 Current Influent Wastewater Flows & Loads

Parameter	Flow		BOD			TSS			TKN[1]		
	mgd	P.F.	mg/L	lb/day	P.F.	mg/L	lb/day	P.F.	mg/L	lb/day	P.F.
Minimum Day	0.84	0.52	73	515	0.29	54	379	0.17	34	240	0.62
Annual Average	1.63	-	130	1,758	-	164	2,227	-	29	389	-
Maximum Month [2,3]	2.44	1.50	124	2,522	1.43	152	3,104	1.39	26	530	1.36
Maximum Day [4] (100th%)	3.45	2.12	191	5,492	3.12	281	8,082	3.63	18	530	1.36
Maximum Day[5] (98th%)	2.64	1.62	147	3,232	1.84	208	4,573	2.05	23	516	1.33
Peak Hour[6] (100th%)	6.50	4.00	-	-	-	-	-	-	-	-	-
Peak Hour[7] (98th%)	4.40	2.71	-	-	-	-	-	-	-	-	-

Parameter	NH3-N1			TP[8]			Ortho-P[8]		
	mg/L	lb/day	P.F.	mg/L	lb/day	P.F.	mg/L	lb/day	P.F.
Minimum Day	22	157	0.62	3	18	0.29	1	5	0.29
Annual Average	18	251	-	5	62	-	1	18	-
Maximum Month [2,3]	18	360	1.43	4	88	1.43	1	26	1.43
Maximum Day [4] (100th%)	13	360	1.43	7	192	3.12	2	58	3.12
Maximum Day[5] (98th%)	15	338	1.35	5	113	1.84	2	34	1.84
Peak Hour[6] (100th%)	-	-	-	-	-	-	-	-	-
Peak Hour[7] (98th%)	-	-	-	-	-	-	-	-	-

1. Ammonia, TKN, Nitrate, Nitrite, Total Nitrogen, Total Phosphate, and Total Orthophosphate are based on once per month influent sampling data (January 2018 through April 2021)
2. Maximum Month values are based on a maximum 30-Day moving average
3. Maximum Month TKN and Ammonia are based on 99th percentile data or max day. TKN is only sampled once per month.
4. Maximum Day is based on the actual maximum measured value during the data period
5. Maximum Day is based on 98th percentile data
6. Peak Hour is actual peak hour measured value during the data period. Actual reading may be higher. Effluent meter cannot read above 6.5 mgd.
7. Peak Hour is the 98th percentile
8. Total Phosphate is assumed to be 3.5% of the influent BOD5; Orthophosphate is assumed to be 30% of Total Phosphate

3.4 Future Flows and Loads

The City of Groton published and adopted a Plan of Conservation and Development in February 2019 which was used as a reference in this evaluation. The City of Groton is located in southeast Connecticut and is fronted by Long Island Sound and the Thames River. The City of Groton shares a border with the Town of Groton to its north and east. Three highways serve the City: State Highway Route 184, U.S. Route 1, and Interstate I-95, as well as two rail lines that have limited rail service. The main Amtrak northeast rail corridor runs through the City, but the nearest stations are in New London, CT and Stonington, CT. The City is home to two major industrial facilities for Electric Boat and Pfizer. Along the coastline at the center-west part of the City is the Electric Boat shipyard where submarines are designed and constructed. Pfizer's Research and Development facility is located south of Electric Boat, but further east. The University of Connecticut's (UCONN) Avery Point Campus is located at the southern end of the City. The City's current population is approximately 40,000, dispersed throughout the City's 6.8 square miles. The community is diverse with housing types ranging from multi-family dwellings to large single-family homes. According to the City's 2019 C&D Plan, 58% of the residential units are renter-occupied while the remaining 42% are owner occupied.

The City of Groton is a predominately residential community with significant commercial and industrial corridors. Commercial uses are concentrated along the U.S. Route 1 and Interstate I-95 corridors at the north end of the City, along Thames Street, and by the Thames Street and Poquonnock Road intersection area. Industrial uses are concentrated along the western-central coast of the City and up to the north end of the Shennecossett Road area.

Future flow and load projections were developed based on the summary of the current conditions presented in Table 3-1 and adding flows and loads associated with projected growth within the City of Groton. A discussion of the specific components that are anticipated to contribute future flows and loads to the City of Groton PAF are presented below:

- Population Projections
- Residential Flows within the City of Groton
- Inter-municipal Flows
- Institutional Flows
- Industrial, Commercial and Large Residential Flows within the City of Groton

As discussed above, projections have been made for a design year of 2045.

3.4.1 Population Projections

Two sources of data were utilized to obtain population projections for both the City and Town of Groton. The first is the Connecticut State Data Center, University of Connecticut, August 31st, 2017 updated Groton Population projections from 2015 to 2040. The second is from the December 2012 Connecticut Population Change: 1990-2010 Report by the Connecticut General Assembly. As discussed above, future wastewater flows and loads were estimated for a design year of 2045. Therefore, the available population projections were extrapolated to 2045 and presented in Table 3-2.

Based on review of the projections by both sources, as well as follow-up discussion with the City of Groton Planning and Zoning Department, the population of the City of Groton is expected to remain consistent between 38,000 and 40,000 people, of which approximately 90% are sewered. The City expects to see mainly residential and industrial development with some commercial growth, keeping the population in the range as stated above. To be conservative and based on the residential and commercial growth projections presented below, an additional increase of 500 people in the sewer service area is projected for the year 2045. Any flow increases associated with this population increase have been accounted for in residential in-fill development.

Table 3-2 Groton (City and Town) Population Projections

Year	CT State Data
1990	45,144[2]
2000	39,907[2]
2010	40,115[2]
2015	39,900[1]
2020	40,326[1]
2025	*40,640*[1]
2030	*40,334*[1]
2035	*39,763*[1]
2040	*38,622*[1]
2045	*38,300*

Note: Italicized values are projected.

[1]Source: CTData.org, 2015-2040 Population Projections - Town Level | Connecticut Data

[2]Source: Connecticut Population Change: 1990-2010

3.4.2 Residential Flows

The majority of future potential residential flows from the City of Groton will occur in areas that are currently sewered. These potential additional residential flows are primarily from vacant parcels with direct frontage to an existing gravity sewer main or re-development of an existing sewered parcel(s), such as the conversion/renovation of existing buildings on Thames Street into apartments or high-density residential development in the Thames Street/Bridge Street area.

There are 57 residentially zoned parcels (R5.2, R5.1, R8, R12, and RM) in the City of Groton that are currently vacant with direct frontage, or in close proximity, to the existing sewer system. These include parcels that can be developed into both single-family units and/or multi-family units. There is no ordinance in the City of Groton requiring these parcels to connect to the sewer. By the year 2045, working with the city planner we have assumed that 20% of these parcels will have been connected to the sewer system at full parcel build out based on current zoning, resulting in a projected residential flow increase of 27,260 gpd.

In addition to vacant "in-fill" parcels, the following planned residential development was discussed with the City of Groton Building, Zoning, Planning and Economic Development departments and are accounted for during the planning period:

- 120 West Street – Re-develop abandoned School into 60 residential units;
- Five Corners – Development of 80 residential units;

3.4.3 Inter-Municipal Flows

The City of Groton currently has a formal inter-municipal agreement (IMA) in place to treat a portion of the Town of Groton's wastewater conveyed to the City of Groton. The IMA has been in place since June 1979 and states that sewerage can be accepted from three areas: The William Seeley School area, the Grove Avenue area and the Starr Hill area. The IMA includes a peak daily flow greater than 800,000 gpd from the North Slope Pumping Station, requiring the Town to divert flows from the Starr Hill area. Based on preliminary discussions with the Town and City, there are plans to redevelop the Seely School Property into 280 apartments within the planning period, resulting in a projected flow increase of 41,580 gpd.

3.4.4 Institutional Flows

The University of Connecticut's (UCONN) Avery Point Campus is the only institution that was considered as part of the Flows and Loads evaluation. The UCONN Avery Point Campus is currently in the study phase of the possible addition of dormitory buildings and a floor in one of the buildings dedicated to laboratory space for the students but is also in the process of demolishing structures on site. Based on preliminary discussions with the City, no additional net flow increases will be accounted for from UCONN at Avery Point.

3.4.5 Commercial and Industrial Flows

There are 47 commercial zoned parcels in the City of Groton that are currently vacant, abandoned, or serve as parking lots with direct frontage or are in close proximity to the existing sewer system. Of these 47 parcels, 26 parcels are classified by the Town as either Commercial, Vacant, or Exempt, but fall under residential zoning codes (i.e., R5.2, R5.1, R8, R12, and RM); the remaining 21 parcels are classified by the Town as either Commercial, Vacant, or Exempt, but fall under business / technology zoning codes (i.e., WBC, FC, GC, and TC). There is no ordinance in the City of Groton requiring these parcels to connect to the sewer. By the year 2045, we have assumed that 20% of these parcels will have been developed and connected to the sewer system at full parcel build out based on current zoning, resulting in a projected commercial flow increase of 8,414 gpd.

There are also two major industrial facilities that discharge wastewater to the PAF, Pfizer and General Dynamics Electrics Boat. Vacant lots and parking lots owned by both facilities were assumed to remain; therefore, no additional flow was accounted for those parcels.

3.4.5.1 Pfizer

Pfizer is a major pharmaceutical Company located primarily along Eastern Point Road in the City of Groton. Over the past several years, Pfizer has been downsizing. Although they are amid building renovations and miscellaneous development at their facility, there is no known planned growth reported for the planning period that will increase wastewater flows discharged from the facility. For purposes of this facilities plan, no additional net flow increases will be accounted for from Pfizer-owned parcels.

3.4.5.2 General Dynamics Electric Boat

General Dynamics Electric Boat (EB) is a subsidiary of General Dynamics Corporation and is the primary builder of submarines for the Unites States Navy. EB occupies a large area in the City along Thames Street and Eastern Point Road. The facility currently discharges an average daily flow of 450,000 gpd to the City of Groton for treatment at their PAF. During this facility planning effort, EB was under construction for a major expansion to their facility as part of the South Yard Assembly Building (SYAB) project. As part of this project, additional sanitary flows will be generated from the SYAB, Building 61 and CCSM Trades Building. In anticipation of these additional flows, the City of Groton hired Fuss & O'Neill to evaluate the additional flows from the SYAB project. In an October 19th, 2019 memorandum from Fuss & O'Neill to Groton Utilities, an additional flow contribution of 116,400 gpd was projected from the SYAB expansion project. This number will be caried forward in the 2045 flow projections for the PAF.

Future flow projections for the planning period are summarized in Table 3-3. If not specifically known, the following assumptions were utilized to generate these flow projections from Metcalf and Eddy, Wastewater Engineering Treatment and Reuse, 4th Edition:

- 1,500 gal / acres / day for commercial development in >1-acre parcels
- 800 gal / acres / day for light commercial or retail development <1-acre parcels
- 3.3 people / apartment unit
- 70 gpd per capita for single-family units
- 45 gal / unit / day for multi-family units

Table 3-3 City of Groton Commercial/Industrial/Large Residential Flow Projections Summary – 2045

Parcel	Full Build Out ADF (gpd)	% Probability of Full Build Out by 2045	2045 Projected ADF (gpd)
Projected Residential (in-fills)	136,290	20%	27,260
Projected Residential (120 West St. & 5 Corners)	20,790	100%	20,790
Town of Groton (Seely School)	41,580	100%	41,580
UCONN - Avery Point	0	NA	0
Projected Commercial and Industrial (in-fills & redevelopment)	42,070	20%	8,140
General Dynamics – Electric Boat	116,400	100%	116,400
Pfizer	0	NA	0
Total	357,130		214,170

3.4.6 Summary of the Future Flows and Loads

Table 3-3 summarizes future average daily flows from the projected future sewered residential population, institutional, commercial and industrial sources in the City of Groton. For the planned residential growth within the City of Groton, estimates of population served were developed and it was assumed that a BOD5 loading of 0.17 lb/capita-day would be generated. In addition, it was assumed that the TKN loadings would be 20% of the BOD5 loading and the TP loading would be 3.5% of the BOD5 loading. For the remaining categories of future flows including commercial, industrial, institutional and large residential growth, TSS and BOD5 wastewater loadings of 300 mg/l were used with TKN loadings being 20% of the BOD5 loading. Note that max month, max day and peak hour are based on peaking factors from Table 3-1.

Based on the estimated future flows presented in this section, along with the assumptions for calculating wastewater loadings, the projected future Basis of Design flows and loadings for the Groton PAF are presented in Table 3-4. As shown in Table 3-4 the City of Groton is projected to see a minor increase in wastewater flows and loadings by the year 2045 while still remaining below their permitted capacity of 3.1 mgd.

Table 3-4 Groton PAF Basis of Design – 2045 Future Flow and Load Projections

Parameter	Minimum Day	Annual Average	Maximum Month	Peak Day	Peak Hour (98th%)	Peak Hour (100%)
Existing Influent Totals (Sanitary)						
Flow, mgd	0.84	1.63	2.44	3.45	4.40	6.50
BOD5, lb/d	515	1,758	2,522	5,492	-	-
TSS, lb/d	379	2,227	3,104	8,082	-	-
TKN, lb/d	240	389	530	530		
Projected Increase in Future Residential Flows						
Flow, mgd	0.05	0.09	0.11	0.18	0.26	0.27
BOD, lb/d	64	219	314	683	-	-
TSS, lb/d	44	257	358	933	-	-
TKN, lb/d	27	44	60	60	-	-
Projected Increase in Industrial/Commercial Flow						
Flow, mgd	0.065	0.13	0.150	0.250	0.37	0.38
BOD5, lb/d	162	313	375	626	-	-
TSS, lb/d	162	313	375	125	-	-
TKN, lb/d	32	63	75	125	-	-
Design Year Flows						
Flow, mgd	0.95	1.84	2.70	3.88	5.03	7.15
BOD5, lb/d	741	2,289	3,211	6,801	-	-
TSS, lb/d	584	2,796	3,838	9,641	-	-
TKN, lb/d	299	495	665	715	-	-

3.5 Current Effluent Discharge Limitations

The City of Groton Water Pollution Control Facility (PAF) discharges to the Thames River estuary under a National Pollutant Discharge Elimination System (NPDES) permit administered by the State of Connecticut Department of Energy and Environmental Protection (DEEP). The current permit was last renewed on August 1st, 2018 and expires on July 31st, 2023. It allows the discharge of 3.1 million gallons per day (mgd) of flow on an average daily basis (Permit CT0101184). A copy of the current permit is included in Appendix A.

Discharge limitations in the current NPDES discharge permit are provided to maintain the present and future water quality of the Thames River. The NPDES discharge permit requires that the PAF meet specific discharge requirements for a number of parameters, which are summarized in Table 3-5.

Table 3-5 City of Groton PAF Facilities Plan – NPDES Effluent Discharge Limitations

Parameter	Limitation	Sample Type/Frequency of Collection
Flow[1]	3.1 mgd Average Daily	Measured daily
BOD^5	30 mg/l Average Monthly[2] 50 mg/l Maximum Daily	3 per week/daily composite
TSS	30 mg/l Average Monthly[2] 50 mg/l Maximum Daily	3 per week/daily composite
pH	6 - 9 S.U.	Work Day
Fecal Coliform	<88/100 ml 30-day geometric mean ≤10 for percent samples >260/100 ml	3 per week/grab
Enterococci Bacteria	< 35/100 ml 30-day geometric mean 500/100 ml Maximum Instantaneous	3 per week/grab

Notes:

1. Minimum, maximum, and total flow for each day of discharge and the average daily flow for each sampling month shall be recorded and reported.
2. Limit shall be the more stringent of the average monthly influent BOD and TSS> Minimum average monthly percentage removal is 85%. The average weekly discharge limitation for BOSD and TSS shall be 1.5 times the average monthly limit listed above.

3.5.1 Nitrogen Discharge Limitations

To reduce the occurrence of hypoxia (low dissolved oxygen conditions) in Long Island Sound, Connecticut and New York have established a Total Maximum Daily Load (TMDL) for nitrogen. The TMDL quantifies the maximum amount of nitrogen that can be discharged to Long Island Sound to meet water quality goals within the Sound.

Each Water Pollution Control Facility in Connecticut has been assigned a Waste Load Allocation (WLA) as part of the General Permit for Nitrogen Discharges (Nitrogen General Permit). The Nitrogen General Permit specifies how much total nitrogen each facility is permitted to discharge. The WLA is an annual mass loading of total nitrogen expressed in pounds per day. To achieve the goals of the TMDL, approximately a 64% reduction in the total nitrogen discharged from Publicly Owned Treatment Works (POTWs) is necessary. The TMDL for nitrogen entering Long Island Sound was to be achieved by 2014. Discharge limits have been included for each facility in the Nitrogen General Permit. These limits are reduced annually until the final limit in 2014, which was developed based on each facility's proportionate share of the TMDL nitrogen loading based on their 1997 to 1999 average daily flow rate. Currently the total nitrogen discharge limit for the Groton PAF has been maintained at 99 lbs/day as per the General Permit for Nitrogen Discharges expiring December 31st, 2023.

As part of the Nitrogen General Permit development, a baseline for nitrogen loading of 272 lbs/day was established for the City of Groton PAF. Based on a nitrogen reduction of approximately 64% of the baseline, the fully implemented WLA or Nitrogen cap for City of Groton PAF is 99 lbs/day. The WLA implementation schedule and limits for the Groton PAF, as included in the Nitrogen General Permit are presented in Table 3-6.

Table 3-6 City of Groton PAF Facilities Plan – Discharge Limits for Total Nitrogen

Year	2002	2003	2004	2005	2006	2014	2019-2023
Total Nitrogen (lbs/day)	198	184	168	146	121	99	99

Facilities covered by the Nitrogen General Permit are considered in compliance if:

- the facility's annual mass loading of total nitrogen is less than or equal to the discharge limit set forth in the permit; or
- the facility has secured equivalent nitrogen credits equal to the amount the facility exceeded the permitted annual discharge limit.

The equivalent nitrogen credits generated by a POTW are determined by applying an equivalency factor to the actual differential between the facility's annual mass loading of total nitrogen and the discharge limit. The equivalency factor takes into account the attenuation of nitrogen within the receiving waters before it reaches Long Island Sound and the distance from the western end of the sound. The Groton PAF has an equivalency factor of 0.18. Therefore, for every pound of nitrogen below or above the discharge limit, 0.18 pounds of equivalent nitrogen credits would be bought or sold.

With respect to nitrogen, the Groton PAF is required to meet an end of pipe nitrogen discharge limit of 99 lbs/day for 2019-2023 permit period based on the General Permit for Nitrogen Discharges. Currently, they are achieving 78.14 lbs/day, and have sold credits every year since 2002.

3.5.2 Saltwater-Water Quality Based Limits

The Groton PAF currently has no water quality-based limits in the permit, nor are any anticipated. The most significant inclusion in the 2018 permit is the revised bacteria monitoring requirements (fecal coliform and enterococci). Based on discussions with the CT DEEP during this facility plan, there are no plans to add any limits for phosphorus or de-chlorination at the City of Groton PAF.

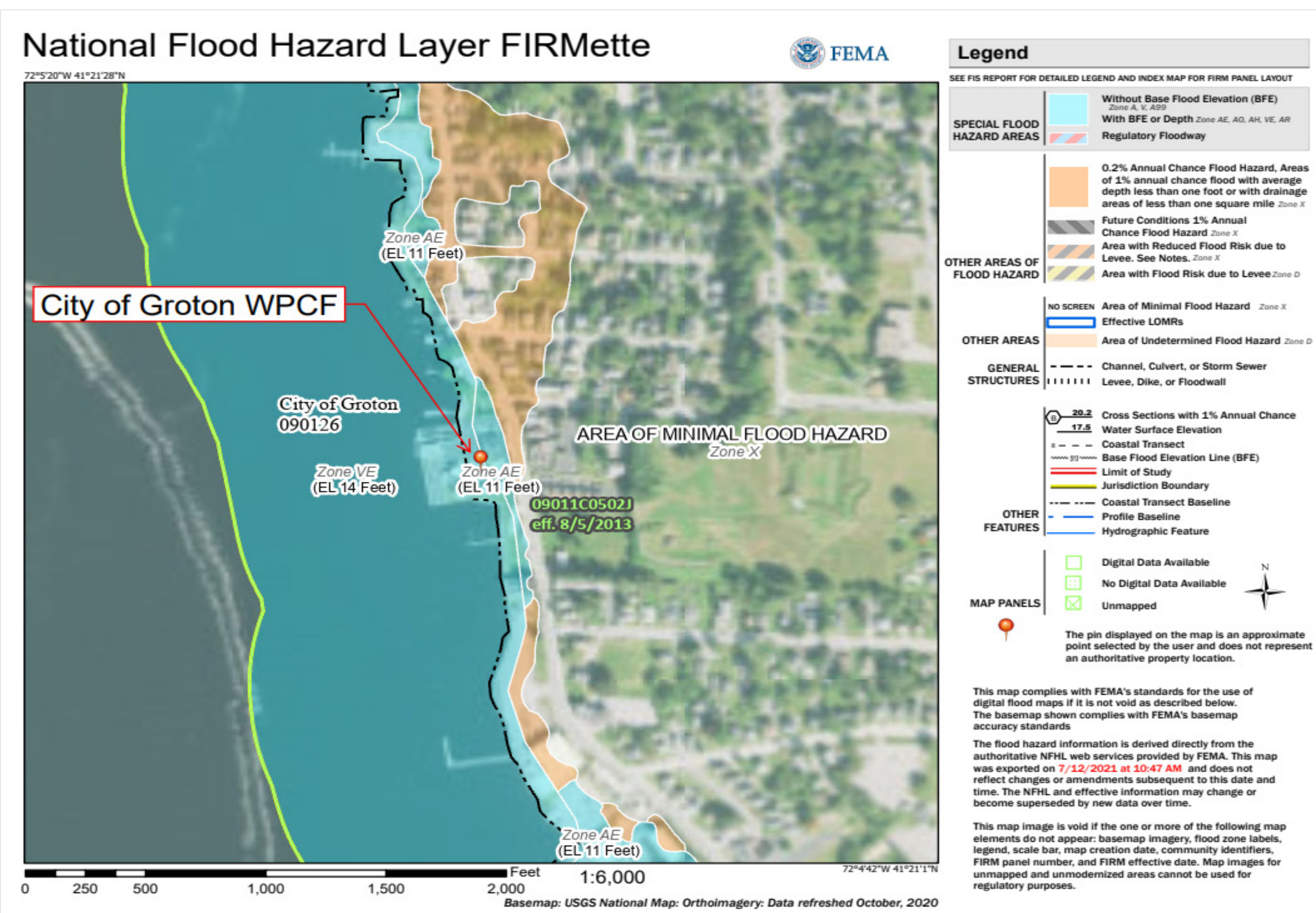
3.5.3 Compliance With Existing Discharge Limitations

The Groton PAF has operated in compliance with the current discharge permit limits during the period analyzed (January 2018 through April 2021). There have been no violations over the last three years that resulted in the need for any regulatory action.

3.6 Hydraulic Evaluation

The Groton PAF passes a current design peak hour flow rate of 6.5 mgd. As presented in this Section, the projected future design peak hour flow rate is 7.15 mgd. To assess the capacity of the existing plant tankage and piping to pass this increased flow, a preliminary hydraulic profile was developed. The hydraulic evaluation was performed considering the full range of flows, from the current minimum of 0.10 MGD to the future peak hour flow of 7.15 MGD. The Groton PAF site is split by two Special Flood Hazard Area 100-year Base Flood Elevations (Zone VE at EL 14.00 and Zone AE at EL 11.00, both in NAVD88 as published by FEMA by VertCon) as shown in Table 3-7.

Figure 3-7 PAF Base Flood Elevations



It should be noted that FEMA updated the base flood elevation from elevations 11.0 and 9.0 to 14.0 and 11.0 respectively in 2020. Elevations taken from available record drawings are based on Mean Low Water (MLW) Datum as shown in Table 3-7. Discussions with GU confirmed that that MLW is the same as NGVD 29 at the PAF facility. PAF flows were evaluated against the 100-year base flood elevation of the Thames River, mean high water, and mean sea level to determine the impacts from both "normal" and worst-case hydraulic constraints. The Groton PAF hydraulic evaluation assessed all the existing unit processes from the influent step screen to the outfall in the Thames River. In addition to preventing overtopping of tanks, the goal of good treatment plant design and operation is to maintain a stable water surface elevation under a wide range of flows. This treatment plant has a variety of control devices in place to maintain water levels, helping to produce equal flow splits. The hydraulic evaluation predicts the response of these unit processes to the anticipated range of flows.

Table 3-7 Hydraulic Controls

Location	Control Device	Elevation (MLW)
Chlorine Contact Chamber	Rectangular Weir	9.00
Final Settling Tanks	V-Notch Weir	12.40
Aeration Tanks	Rectangular Weir	13.85
Primary Effluent Pump Station	Pumps	--
Primary Settling Tanks (Effluent)	Rectangular Weir	5.70
Flow Distribution Box	Rectangular Weir	6.65
Thames River		
Mean Low Water (1,2,3)	--	0.00
Mean Sea Level (1,2,3)	--	1.35
Mean High Water (1,2,3)	--	2.57
100-Year Base Flood (1,2,3)	--	15

Note:

1. Sea level elevations were taken from NOAA, Station 8461490, Thames River, New London, CT in MLW datum from www.tidesandcurrents.noaa.gov.
2. No additional predicted sea level rise was assumed for this iteration of the hydraulic model for the PAF. Additional predicted sea level rise for the design year may be added during preliminary design efforts.
3. 100 Year Base Flood elevation with wave action was assumed to be 14.00 feet NAVD88 and converted to MLW (Refer to FEMA FIRM panel 502 of 554 for New London County, Map Number 09011C0502J, revised August 5, 2013).

3.6.1 Confirmation of Existing 1998 Hydraulic Profile

To confirm that the developed hydraulic model is accurately predicting the water surface elevations calculated by the original designers, the hydraulic profile developed for the 1998 PAF Improvements project was recreated at the flow rates and assumed units in service identified on Drawing G-1 of the **City of Groton, CT WPCA, Fort Street Pollution Abatement Facility Improvements** (Montgomery Watson, June 1998). No field measurements or surveys were conducted during this preliminary evaluation to compare calculated water surface elevations with field conditions at known flow rates. For the purposes of this evaluation, the hydraulic profile was checked at the Mean Low Water (EL 0.0), Mean High Water (EL 2.6), and the 1998 Design Water Surface (EL 6.1) under the existing plant configuration at 2.5 mgd (Design Flow) and 6.5 mgd (Peak Flow).

Overall, there is good correlation of the two models throughout the PAF and the profile appears to behave similar to current plant operations and all hydraulic grades are within +/- 0.1-feet of one another. Modeling of the plant under the Mean Low Water, Mean High Water and Design Water Surface elevations resulted in no submerged weirs and no overtopping of tanks/structures. However, when modeled with a 100-year base flood elevation in the Thames River of 15 (MLW), the better part of the facility would be completely submerged inclusive of a portion of Thames Street and the surrounding area. Although the published FEMA flood elevation was increased from 11.0 to 14.0 (NAVD88) in 2020, a review of historical data indicates that the maximum reported storm surge at the PAF was during Superstorm Sandy in Late October/Early November 2012 where the water reached to about 1-inch up the sidewalls of the Primary Settling tanks, or about elevation 8.8 (MLW).

3.6.2 Hydraulic Profile Under Future Flows

In addition to the 1998 hydraulic profile flows, a model of the existing PAF configuration was developed for the future flows as projected in this Section. Those flows are as follows:

- Minimum Day = 0.95 mgd
- Annual Average = 1.84 mgd
- Peak Day = 3.88 mgd
- Peak Hour (100th Percentile) = 7.15 mgd
- Peak Hour (100th Percentile) with 1 train off-line = 7.15 mgd

The hydraulic model was run using the above flows under Mean Sea Level, Mean High Tide and 100-Year High Tide conditions. Similar to the evaluation above, modeling of the plant under the Mean Low Water and Mean High Water Surface elevations resulted in no submerged weirs and no overtopping of tanks/structures. However, when modeled with a base flood elevation in the Thames River of 15 (MLW), the better part of the facility would be completely submerged inclusive of a portion of Thames Street and the surrounding area.

3.6.3 Summary of Findings

The existing Groton PAF has adequate hydraulic capacity to handle current and future flow conditions through the plant. However, at a water surface elevation of 9.0 (MLW) or greater in the Thames River, the existing weir in the CCT will become submerged and begin to surcharge the facility. As previously mentioned, during Storm Sandy in October 2012, the storm surge was 6-feet and water reached about 1-foot below the tops of the Primary Settling Tanks, or EL 8.8 (MLW). The peak storm tide elevation during Sandy was 6.55 feet. As a point of reference, the highest recorded tide record by NOAA was EL 10.65 (MLW) on September 21, 1938, significantly less than the FEMA 100-year flood elevation of 15 (MLW).

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4

Section 4 Evaluation of Liquid Process Units and Operations

4.1 Introduction

The Groton Pollution Abatement Facility (PAF) provides primary and secondary treatment for municipal wastewater generated in the City of Groton and portions of the Town of Groton. The WPCF also receives and treats industrial, commercial, and institutional wastewater that is discharged to the existing collection system.

The PAF currently consists of the following liquid treatment processes:

- Pretreatment Facilities including grit removal, screening, screenings washing/compaction and grinding
- Primary treatment
- Primary effluent pumping
- Secondary treatment / activated sludge
- Disinfection using sodium hypochlorite
- Plant Water System

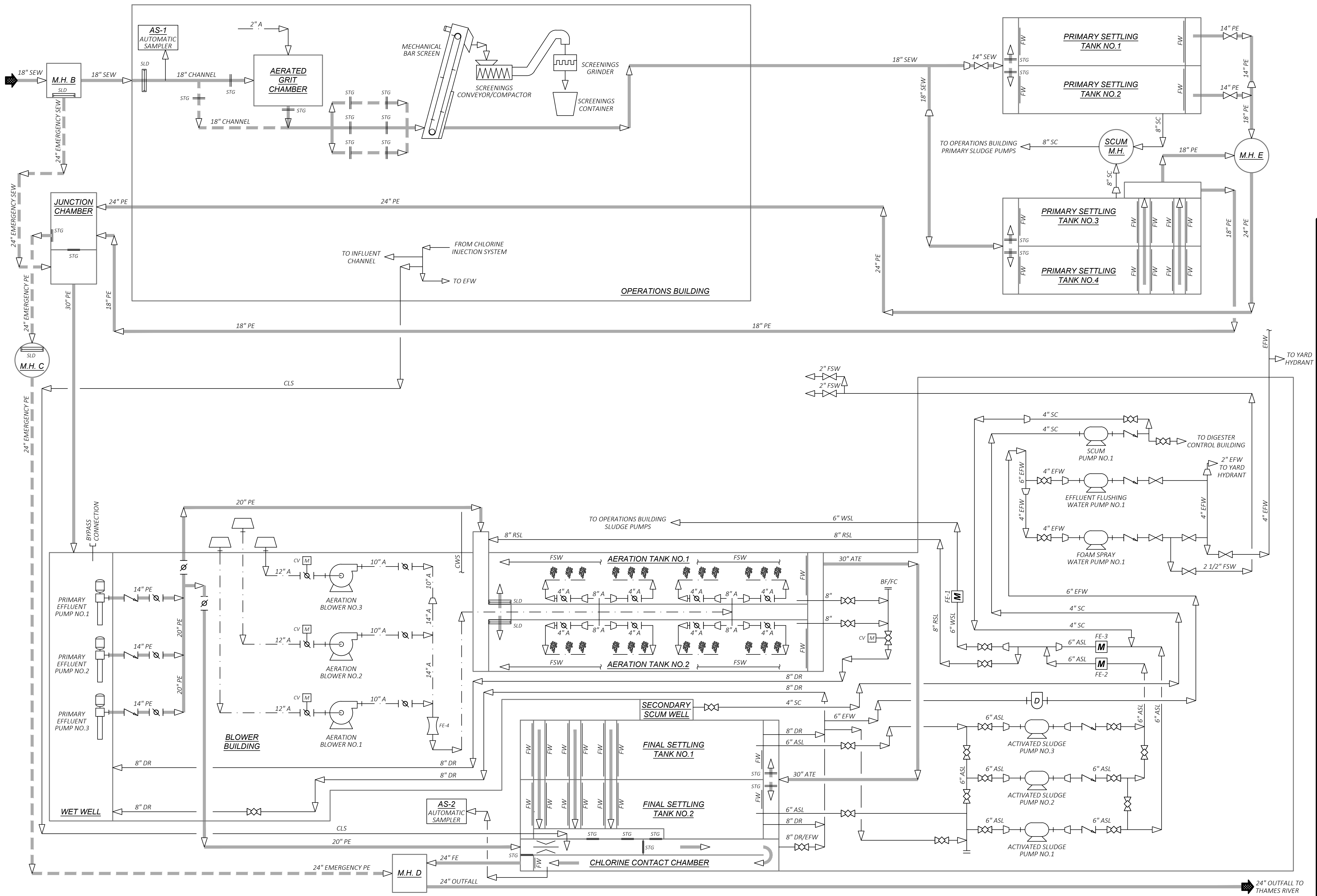
Each liquid treatment process and associated components were evaluated with regards to the existing condition, capacity, and performance to meet regulatory and operational requirements at the projected flows and loads for the planning period. A basic process flow schematic of the liquid stream process is shown in Figure 4-1. This section describes the alternatives evaluated and recommended improvements to meet the above stated requirements. Each of these processes are described herein.

4.2 Septage Receiving

The City of Groton PAF receives little to no septage and does not anticipate an increase in septage volume in the future. Any septage received at the plant is discharged from septage trucks into a sewer manhole outside of the Operation Building where it is combined with the plant influent. This operation does not require frequent operator attention and there are no operation and maintenance concerns. Since the amount of septage received is minimal, there is no significant flow or loading increase to the plant. Therefore, it is recommended to maintain the existing system as-is.

4.3 Influent Flow Metering

Flow is conveyed to the treatment facility through an 18-inch influent sewer and enters the Operations Building though an 18-inch influent channel. There are currently no means to measure influent flow to the facility. Previously, a Parshall flume was located in the Operations Building up stream of the aerated grit removal system, but the flume was removed due to hydraulic issues it created upstream of the facility. In periods of elevated flow, the flume acted as a hydraulic bottleneck, causing the influent sewer to surcharge and overflow into Thames Street. The PAF is only required by permit to monitor effluent flow, however TR-16 guidelines recommend influent flow monitoring to assist in optimizing downstream treatment processes. This section reviews the influent flow monitoring deficiencies and discusses the alternatives that were reviewed.



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NO.	REVISIONS	DRAWN BY	APP'D
1		APC	
2			
3			

CITY OF GROTON, CONNECTICUT
GROTON UTILITIES
WASTEWATER TREATMENT FACILITY
FACILITIES PLAN

PROJ NO: 20653
DATE: MARCH 2022

WRIGHT-PIERCE

EXISTING LIQUID STREAM PROCESS FLOW SCHEMATIC

FIGURE: 4-1

4.3.1 Performance Evaluation

There is currently no means of influent flow metering. While influent flow metering is not required by permit, it is generally recommended by current wastewater design standards. Benefits to influent flow metering include the use of influent flow data to optimize a treatment, to verify effluent flows and to allow for fine tuning of the various treatment processes.

4.3.2 Operations and Maintenance Evaluation

The treatment facility previously had a Parshall flume in the influent channel up stream of the aerated grit system, however it was removed due to hydraulic issues it created upstream in the influent sewer. Following the removal of the Parshall flume, a Flo-Dar unit was installed in an influent manhole outside of the Operations Building. This meter has since been removed.

4.3.3 Process Alternatives Evaluation

The following influent flow metering alternatives were reviewed:

- Installation of a radar flow meter (Flo-Dar) at the influent channel in the Operations Building
- Installation of Flo-Dar meter within Influent Manhole C
- Installation of a Parshall Flume

4.3.3.1 Installation of Radar Flowmeter at Influent Channel

Flo-Dar units utilize doppler radar and ultrasonic level measurement to accurately calculate flows through open channels. A Hach Flo-Dar unit would be mounted above the influent channel within the Operations Building to measure influent flows to the facility. The unit would be hardwired to a wall mounted controller unit, that would allow for reporting of influent flows to SCADA. The benefit of installing the unit within the Operations Building is that it is easily visible and accessible for maintenance and calibration, and the unit will not contact the wastewater stream under most flow conditions.

The Flo-Dar unit requires a constant channel width and depth in order to accurately measure flow through an open channel. The 1998 record drawings show that the previously existing parshall flume and sluice gate were demolished, and a new 18-inch ductile iron pipe was run from the sluice gate thimble to the aerated grit influent channel. However, it appears that this pipe was not installed and instead the flume was partially demolished to create a gradually tapering channel from the sluice gate to the aerated grit influent channel. This influent channel would need to be modified to create a uniform rectangular channel from the sluice gate to the aerated grit influent for the Flo-Dar unit to measure accurately.

Figure 4-2 Influent Channel

4.3.3.2 Installation of Flo-Dar Unit Within Influent Manhole C

Following the removal of the Parshall flume after the 1998 upgrade, Manhole C was installed on the influent sewer upstream of the Operations Building to provide a location to install an area-velocity flow meter. Our understanding is this meter was removed in the early 2000s due to accuracy issues. Area velocity flow meters measure the cross-sectional area and velocities of channelized flow to compute the flows. When installed in sewers these flow meters are typically installed in the sewer pipe with the instrument located at the invert of the sewer. This leads to ragging issues and requires confined space entry to remove or replace the instrument.

For this alternative, the Flo-Dar unit would be installed in Manhole C upstream of the Operations Building to measure influent flows. The advantages of this unit being installed above the flow stream include the elimination of rag build up on the instrument, and confined space entries are not required to access the instrument for maintenance.

While this instrument is designed to continue operating during surcharge events, it is unclear how the accuracy is impacted when the flow stream surcharges above the pipe invert and onto the structure bench. The instrument relies on the known pipe diameter to calculate a flow depth, and a change in the measured channel dimensions during surcharge events would disrupt measurement accuracy. In addition, Manhole C acts as a junction point where flow from two separate pipes merge inside the structure. When installed at a junction point, the Hach installation manual requires upstream instruments to be installed at each upstream pipe, and a downstream instrument to be installed 10 pipe diameters downstream of the junction. These constraints increase the difficulty of installation to a point where it is no longer feasible.

4.3.3.3 Installation of a Parshall Flume

The reinstallation of a Parshall flume within the influent channel of the Operations Building was investigated. A flume with a wider throat would be installed to reduce the potential for a hydraulic bottleneck to be created by the flume. However, a wider throated flume would be less accurate during lower flow periods. Due to potential inaccuracies during low flow periods and the potential for a bottleneck in the system that would create sanitary sewer overflows (SSO's) in the influent sewer, this alternative was not considered any further.

4.3.4 Recommendations

The installation of a radar flowmeter at the influent channel inside of the Operations Building provides the most accurate and reliable means of flow metering, while locating the instrument in an environment that is easily accessible for maintenance. For these reasons, it is recommended that the influent channel be modified for the installation of a radar type influent flow meter.

The influent channel will need to be modified in order to provide a consistently uniform rectangular channel for flow measurement. To modify the channel, influent flows will need to be bypassed from an influent manhole upstream and directly to the aerated grit process. Under bypass, the concrete channel would be saw-cut and re-formed as necessary to provide uniform dimensions for the Flo-Dar unit.

Figure 4-3 Open Channel Flow Meter Installation Example

4.4 Aerated Grit Removal

Grit removal is located in the Operations Building. Raw influent wastewater enters the Operations Building via an 18-inch influent channel and enters a single aerated grit tank. A single blower conveys air into the grit tank through a stainless-steel air pipe header, which promotes the separation of organics from the grit in the wastewater stream. The grit particles settle to the bottom of the tank, and the wastewater continues to the screening process.

4.4.1 Performance Evaluation

Discussions with operations staff indicated that the aerated grit system does well at removing coarse grit, and they do not see accelerated wear issues in any downstream treatment equipment. Grit that is not removed in the aerated grit tank or during grit tank bypass typically settles out in the primary sludge. This material is transferred to the anaerobic digesters and may reduce the active volume of the process as grit accumulates over time.

The 2013 Facilities Plan indicated that the aerated grit tank was undersized based on current TR-16 design standards. The existing aerated grit tank was evaluated, and it was confirmed that it is undersized at current peak hourly flows per TR-16 standards as shown in Table 4-1. Specifically, the existing layout does not meet recommended length to width ratio, width to depth ratio, and hydraulic retention time guidelines.

Figure 4-4 Aerated Grit Tank

Table 4-1 Grit Removal Basis of Design

Parameter	Current Value	Typical Standard (TR-16)
Grit Channel		
Number of Channels	1	
Type	Aerated Grit	
Length, ft	9	
Top Width, ft	7	
Bottom Width, ft	3	
Depth, ft	10	
Length to Width Ratio	1.29:1	3:1 - 8:1
Width to Depth Ratio	1.43:1	0.8:1 - 0.9:1
Detention Time, minutes		
2.7 mgd (Design Max Month)	2.5	> 3
7.15 mgd (Design Peak Hour)	0.95	> 3
Grit Blower		
Number of Blowers	1	
Type	Rotary Lobe	
Manufacturer	Roots	
Motor HP	2	
Drive Type	Constant Speed	Variable Speed
Air Flow Rate, SCFM/ft of tank length	3.5	3.0 - 8.0

4.4.2 Operations and Maintenance Evaluation

Currently there is no automated grit disposal system or equipment. Settled grit is removed periodically and requires the tank to be bypassed and dewatered for removal. The grit tank is bypassed by installing a series of slide gates to divert flow around the tank. The tank is then dewatered by operations staff using portable submersible pumps, and the remaining grit slurry is removed by a local vendor with a vac truck. This method of grit disposal requires a significant amount of effort from plant staff and requires bypassing of the grit tank which allows coarse grit to travel to downstream equipment.

There is no redundancy in the grit removal process, with only one aerated grit tank and one blower. Operations staff have indicated that the blower needs replacement, and a second blower is desired to provide redundancy. The existing positive displacement grit blower operates at a constant speed and is not equipped with an air flow meter. TR-16 recommends that aerated grit facilities be provided with a combination of variable speed blowers, valving, and flow meters to adjust air flow during variations in influent flow.

4.4.3 Process Alternatives Evaluation

The following grit removal and disposal alternatives were evaluated:

- Install a tank sump and submersible grit pump
- Mechanical Vortex grit removal
- Keep aerated grit tank as-is and install two new blowers

4.4.3.1 Submersible Grit Pump and Grit Collector Installation

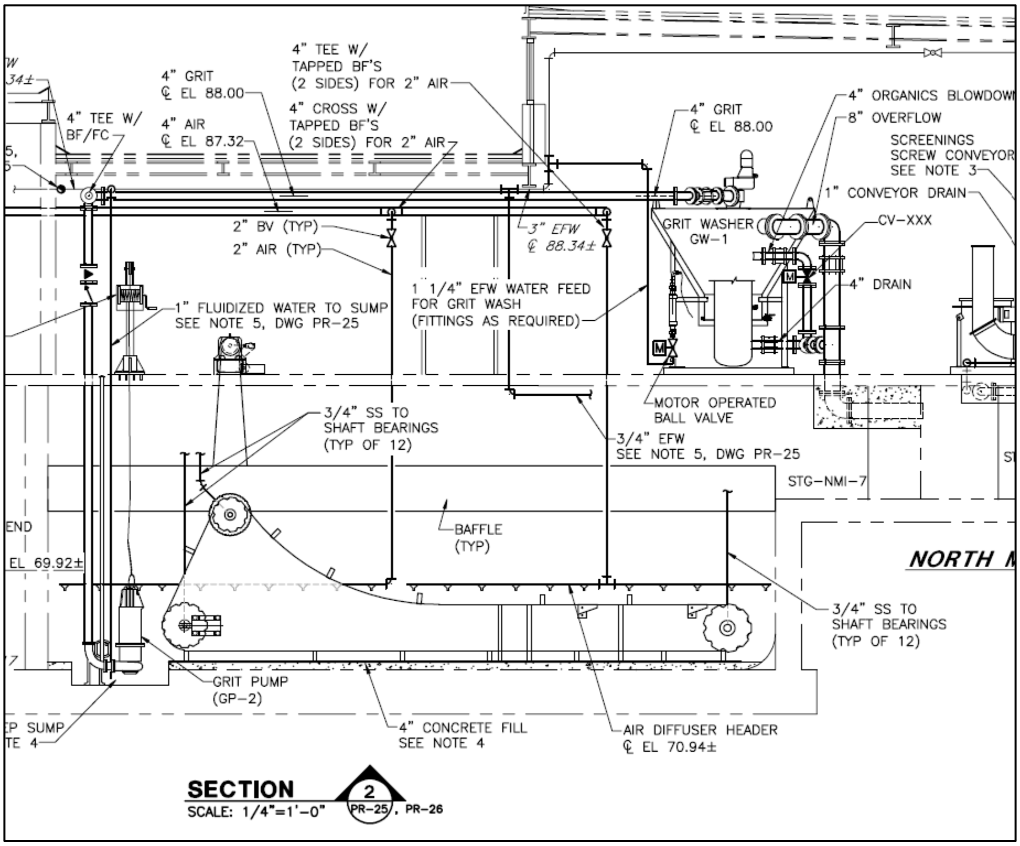
The existing grit removal system is required to be taken offline in order to drain and remove the settled grit. This alternative consists of the installation of a sump and submersible grit pump in the bottom of the existing aerated grit chamber. The new sump would be approximately 12-inches deep, and the tank bottom would be sloped in order to direct settled grit towards the sump via a new collector mechanism. Guide rails would be provided with the new pump to assist with removal for maintenance.

A Wemco model CE submersible torque flow centrifugal pump was investigated, which is constructed of durable metals that are resistant to corrosion from grit. A small diameter plant water line would be run down to the grit sump to assist with fluidizing the grit when pumping out the sump. New grit discharge piping would extend up from the tank, run overhead within the Operations Building ground floor, and terminate at a discharge location. There is currently no location for grit to be pumped, so alternative discharge locations could include:

- A quick connect camlock fitting located either inside or outside the building. Settled grit would be pumped from the sump to hauler trucks connected to the camlock fitting for disposal.
- A grit dumping bay. A covered retaining bay with underdrain could be installed to store removed grit, and liquids would drain out of the grit and flow by gravity to the influent stream.
- Installation of a Grit Classifier/Washer for grit handling. This would require the construction of a pre-engineered metal building addition at the Operations Building to house the equipment and roll-off grit cart.

The benefit to this alternative is the aerated grit tank would no longer need to be taken fully offline and dewatered to remove grit, minimizing the amount of grit being transported to downstream processes. One issue with this proposed alternative is the constructability of adding a sump to the existing tank base slab. The existing slab appears to be 12-inches thick and would require either excavation below the existing base slab or additional grout fill in the tank to achieve the required sump depth.

Figure 4-5 Submersible Grit Pump/Sump/Collector & Washer – Manchester, CT WPCF



4.4.3.2 Mechanical Vortex Grit Removal

The replacement of the aerated grit system with a Smith & Loveless Pista-grit vortex system was investigated for grit removal. The vortex system would be installed within the existing footprint of the aerated grit tank and would be provided with a new grit pump to remove settled grit.

The existing influent channel would be maintained, and then transition down on a 25-degree angle to the vortex tank inlet. The hydraulic vortex created by the axial flow propeller pulls grit down to a central hopper, and the wastewater stream flows in a rotational pattern out of the grit chamber and on to the mechanical screen. The suction lift pump system provided with the vortex unit would convey grit slurry from the grit hopper out of the building to hauling trucks, to grit bay, or to grit classifier equipment.

The vortex grit system would be sized for the 98th % peak hourly design flow of 5.03 MGD, with the hydraulic capacity to handle influent flows up to 7.15 MGD.

4.4.3.3 Keep Aerated Grit and Install Two Grit Blowers

The existing aerated grit system is undersized per TR-16 standards. However, the fine grit that passes through the system to downstream processes has not caused damage to equipment, piping or concrete surfaces to the plants knowledge. The existing aerated system does not have a second blower for redundancy, which does present a small level of risk for operations staff in the event that the existing aging blower fails.

Operations staff have indicated that they would like a second blower installed if the aerated system were to remain. The existing blower would be removed and replaced with two new variable speed positive displacement blowers. The common air discharge header would be fitted with a thermal air flow meter to optimize air supply as the influent flow varies. These measures would follow the good engineering practices recommended by TR-16 and may provide an opportunity for energy cost savings to the facility over time.

Figure 4-6 Aerated Grit Blower

4.4.4 Recommendations

While the aerated grit removal system is currently undersized and less efficient at higher flows, operations staff have indicated that grit that passes through preliminary treatment settles within the primary sludge and does not create equipment wear or downstream issues. The construction of an aerated grit tank expansion or vortex grit removal system will be a significant capital cost with little additional benefit. This alternative has been eliminated based solely on cost.

To provide aeration redundancy, it is recommended that the existing blower be replaced, and a second blower be installed in the Storage Room. To install two blowers, the Blower Closet will need to be expanded by removing and extending interior CMU walls to close off a new space within the Storage Room. In addition, it is recommended that a grit sump and collection mechanism be constructed for the installation of a submersible grit pump to allow for grit to be removed without taking the tank off-line. The disposal location will be further evaluated with the GU and determined during final design.

4.5 Screenings Removal and Disposal

The wastewater stream exits the aerated grit tank and flows through one of three channels to a single mechanical step screen. The step screen and washpress/compactor were installed by Groton Utilities as a capital improvements project in 2005. Th screen is still functioning well but the washpress has been problematic at times when it plugs up with wipes. The step screen operates based on a differential level measured between and upstream and downstream ultrasonic level sensor. The screen removes rags and other debris in the influent stream and discharges the solids into a compactor. The compactor auger transports screenings through flexible hosing to a Franklin-Miller grinder. Ground screenings are discharged to a small trash can below, which is emptied daily.

Figure 4-7 Mechanical Step-Screen

4.5.1 Performance Evaluation

The mechanical step screen and washpress/compactor are in good condition, and operations staff are generally happy with screen operations. Staff have indicated that the mechanical screen generally does a good job at removing flushable wipes, and there have been minimal issues with wipes jamming the compactor or grinder. The compactor and grinder are approaching the end of their useful life and need replacement.

Step screens are considered a fine screen technology, with bar spacings between 1/8 to 1/4-inches. The technology uses stepped plates that gradually lift screenings out of the wastewater stream and up to a discharge point. The mat of screened material that builds up on the screen helps to catch finer debris such as hair, and fibrous materials. They are also lower profile and require a minimal amount of headroom for installation. However, the mat of material that builds up on the screen creates a higher chance for binding, and also increases head losses through the screen. Higher headloss raises water levels in the influent channel, which reduces the effectiveness of the screen and can lead to surcharging. Step screens generally have a lower capture rate than other screen types and the components that require maintenance are located below the water line.

4.5.2 Operations and Maintenance Evaluation

The mechanical bar screen has been generally reliable. The Rotary Drum Thickener filtrate line discharges into the wastewater flow upstream of the mechanical screen, and the residual polymer can sometimes cause debris to stick together and bind the screen. However, there is currently no manual bar rack or means of bypassing the mechanical screen. Staff can raise the mechanical screen rack out of the flow stream when the equipment is taken offline for maintenance. This method of bypass is acceptable only for short periods of time.

The screenings compactor consistently transports screenings to the grinder with minimal issues. The auger occasionally jams when large slugs of grease pass through the system, which requires the system to be taken offline and repaired.

The ground screenings garbage bin is filled approximately halfway each day, and the bin is emptied daily. A larger screenings container for disposal would allow staff to dispose of screenings less frequently.

Figure 4-8 Screenings Grinder

4.5.3 Process Alternatives Evaluation

The following screenings removal and disposal alternatives were evaluated:

- Installation of a manual bar rack
- Replacement of the screenings washer/compactor and grinder and keeping screenings inside
- Installation of a conveyor to transport washed, ground and compacted screenings outside to a canopy covered dumpster
- Replacement of the step-screen

4.5.3.1 Manual Bar Rack

There is currently no screening redundancy at the influent channel when the existing mechanical bar screen is taken out of service for maintenance, or in the event of equipment failure. In order to provide redundancy a manual bar rack could be installed within one of the three existing channels upstream of the mechanical screen, where the old comminutors were located. Flow would be bypassed around the manual rack using the available existing stop gates and comminutor channels. When in use, operations staff would need to periodically rake screenings off the bar rack and transfer them to the screenings grinder or disposal bin. This alternative provides a low-cost backup plan for screenings removal at the facility.

4.5.3.2 Screenings Compactor and Grinder Replacement In-Kind

The existing screenings grinder is past its useful life and in need of replacement. When replaced, a new washpress compactor should also be provided. A new washer compactor can be installed on the discharge end of the mechanical screen to wash and convey screenings through a stainless-steel chute discharging to a stanchion mounted heavy duty grinder similar to the existing configuration. Alternatively, a shaftless screw conveyor can be installed to convey screenings from the discharger hopper to a new all-in-one screenings grinder/washer compactor.

4.5.3.3 Installation of Screenings Conveyor, Dumpster, and Exterior Canopy

The existing screenings disposal bin is small and is emptied daily. To increase screenings storage and reduce the frequency of emptying the screenings bin, a new conveyor would be installed to convey screenings outside to a large roll-off dumpster. The dumpster would be located beneath a canopy structure to prevent rainwater from accumulating in the screenings dumpster.

The screenings dumpster would be located outside of the eastern face of the Operations Building, where there is currently a paved access drive. A new dumpster pad would be installed to prevent the pavement from being damaged during dumpster removal and replacement. The canopy structure could be a free-standing structure, or partially fixed to the Operations Building. The height of the canopy will be coordinated with maintenance vehicle clearance so that access can be maintained to the southeastern corner of the facility. Due to the limited amount of screenings generated a the Groton PAF, and the potential to introduce an additional exterior odor source, this alternative was not considered any further.

4.5.3.4 Replacement of the Step Screen

The current Huber step screen was installed in 2005 and should be able to continue operating for another 5-10 years before requiring replacement. While this equipment does not currently need to be replaced, Groton Utilities should plan to replace the screen as a future capital improvement in the five to ten years or re-evaluate and include it in the immediate improvement project during the preliminary design phase. At that time, alternative technologies should be evaluated to optimize capture rate and head losses through the screen.

4.5.4 Recommendations

In order to provide screening redundancy during emergencies or equipment maintenance, it is recommended that a manual bar rack be installed in one of three channels up stream of the mechanical screen. Flow can be diverted towards or around the manual rack using the existing channel stop gates.

In addition, it is recommended that the aging step screen, screenings grinder, and compactor equipment be replaced with a new screen and shaftless screw conveyor discharging to a new all-in-one grinder/washpress/compactor to improve the screenings handling process. Grinding ahead of compaction will also decrease the volume of material generated for disposal.

Figure 4-9 Screenings Conveyor & Combined Grinder/Washpress/Compactor

4.6 Primary Treatment

After flow passes through the mechanical step screen, it is distributed to up to four primary settling tanks across two treatment trains. Distribution is accomplished via the Flow Distribution Box located in the Operations Building. Two pipes exit the bottom of the distribution structure; an 18-inch diameter line that flows to Primary Settling Tanks 1 and 2, and a 24-inch diameter line that flows to Primary Settling Tanks 3 and 4. Flow is directed to the two lines by the use of stop gates located at the distribution structure. Plug valves are also located on each of the Primary Influent lines in the yard.

Primary Settling Tanks 1 and 2 were constructed in 1952 and are 54-feet long by 16-feet wide, with a side water depth of 8.5-ft. Primary Settling Tanks 3 and 4 were constructed in 1964 and are 78-feet long by 16-feet wide, with a side water depth of 11 feet. All tanks were recently rehabilitated in 2015 which included replacement of scum and sludge collector mechanisms, and the application of a protective epoxy coating to all interior tank surfaces. Flow exiting the Operations Building flows through the two primary influent pipes, and up into an influent distribution box at each primary settling treatment train. Stop gates are located at each influent distribution box to distribute flow to the primary settling tank influent channels. Wastewater then flows from the influent channels into each settling tank. Primary scum floats to the surface and is skimmed and removed with helical skimmer blades. Grit and the remaining solids settle to the bottom of the tanks as Primary Sludge. Chain and flight collectors scrape and convey settled solids to a hopper located at the influent end of each tank. Primary effluent exits each of the tanks by spilling over v-notch weirs into inboard launders and is conveyed to the Primary Effluent Junction Structure. Primary Effluent then continues on to the Primary Effluent Pump Station before being lifted up to the Aeration Tanks.

Primary scum is collected at the effluent end of the settling tanks ahead of the effluent launders, using helical skimmers that scrape scum into a scum trough. Scum exits the tanks through the trough and flows by gravity through the Scum Manhole to the Operations Building. Primary Scum is pumped from the basement of the Operations Building to the Thickened Sludge Storage Tank where it is mixed with thickened secondary sludge prior to disposal.

Primary sludge is withdrawn from the bottom of each of the four primary settling tanks by two Primary Sludge Pumps located in the basement of the Operations Building. Motorized valve operators control which tank is drawn from and the sludge pumps run on operator adjusted timed cycles. The primary pumps run intermittently. Primary sludge is drawn from the settling tanks into the Operations Building through four dedicated 8-inch ductile iron pipes. Sludge is then pumped through one of two primary sludge piston pumps and is conveyed through an 8-inch force main to the Primary Digester. The design characteristics of the Primary Settling tanks are presented in Table 4-2 along with TR-16 guidelines.

Figure 4-10 Primary Settling Tanks

Table 4-2 Primary Settling Tanks Basis of Design

Parameter	Current Value	Typical Standard (TR-16)
Rectangular Primary Settling		
Tanks		
Total Number of Tanks	4	
Primary Settling Tanks 1&2		
Length, ft	54	50 - 300
Width, ft	16	
Side water Depth, ft	8.5	10 - 12 minimum
Surface Area, sf (per clarifier)	864	
Volume, million gallons (per clarifier)	0.055	
Primary Settling Tanks 3&4		
Length, ft	78	50 - 300
Width, ft	16	
Side water Depth, ft	11	10 - 12 minimum
Surface Area, sf (per clarifier)	1,248	
Volume, million gallons (per clarifier)	0.103	
Surface Overflow Rate, gpd/sf	**(with one of the large tank out of service)**	
Design Max Month (2.7 mgd)	900	<1,200 gpd/sf
(one large tank out of service)		
Design Peak Hour (7.15 mgd)	2,400	<3,000 gpd/sf

4.6.1 Performance Evaluation

The plant typically operates with one or two settling tanks, and rarely needs to operate three or more tanks at once. Staff have indicated that they primarily operate Primary Tanks 3 and 4 because they are the larger and newer set of tanks. Based on TR-16 standards, with one of the larger tanks out of service the facility has adequate capacity at average and peak flows.

Treatment plant staff have indicated that flow splitting to the two treatment trains is not even, and more flow appears to split to Tanks 3 and 4.

4.6.2 Operations and Maintenance

The Primary Settling Tanks were recently rehabilitated in 2015. This included the installation of new helical scum skimmers, primary collector chain and flight, and primary sludge cross collector equipment. This equipment is new and are not experiencing issues at this time, other than the automated scum tube actuators which skip a tooth periodically.

4.6.3 Process Alternatives Evaluation

Due to the recent upgrades at the settling tanks, no alternatives were evaluated other than converting the scum skimmers to a manual operation. Mechanism replacement should be accounted for on the overall asset management plan in the next 20 to 25 years.

4.6.4 Recommendations

It is recommended that the elevations of the weirs in the flow distribution structure as well as the influent weirs in tanks be surveyed and perhaps reset improve flow splitting between primary settling trains. Based on surface area, the flow split should be 60/40 favoring tanks 3 and 4. It is also recommended that the scum tube actuators be removed, and manual skimming arms be installed.

4.7 Primary Effluent Pumping

Primary effluent exiting the two primary settling tank trains is either combined in Manhole E and conveyed through a 24-inch primary effluent pipe or is conveyed separately from the two trains through dual 18-inch primary effluent pipes to the Primary Effluent Junction Chamber. From this structure, primary effluent can be bypassed directly to the outfall (emergency scenario) or conveyed to the Primary Effluent Wetwell. Primary Effluent is then pumped by vertical turbine pumps to the Sludge Mixing Chamber ahead of the aeration tanks. Three vertical turbine pumps are located within the Primary Effluent Wetwell.

4.7.1 Performance Evaluation

The vertical turbine pumps and motors were rebuilt in 2010 and a new motor installed on one of the pumps in 2021. The pumps appear to operate satisfactorily, and operators have not indicated that there are any clogging or performance issues with the pumps, but they are approaching the end of their useful life. The turbine pumps require seal water. The issues with these pumps are predominantly related to the challenges associated with preventative maintenance and inefficient operation.

Table 4-3 Primary Effluent Pumps Basis of Design

Parameter	Current Value	Typical Standard (TR-16)
Primary Effluent Pumps		
Number of Pumps	3	
Type	Vertical Turbine	
Manufacturer	Fairbanks-Morse	
Operating Point (1 pump)	2700 gpm @ 14-ft TDH	Meet peak hour flow with largest pump out of service
Operating Point (2 pumps)	2,250 gpm @ 22-ft TDH (each pump)	
Impeller Diameter	-	
Suction/Discharge Size	14" x 14"	
Motor Size	20 HP	
Motor Speed	1170	
Drive Type	VFD	

Figure 4-11 Primary Effluent Pumps

4.7.2 Operations and Maintenance Evaluation

One of the major challenges is accessing and removing the pumps for maintenance and replacement. While the motors are located above grade, the turbine shafts are long and require a crane to be mobilized to the site to remove the entire pump apparatus from the wetwell. In addition, staff must make confined space entries into the wetwell to facilitate the removal of the equipment. These two factors present additional costs and safety liabilities when performing maintenance on the pumps.

Another challenge noted by operations staff is the difficulty to locate replacement parts for the pumps and motors, and the long lead times associated with ordering new parts. Previous repairs have taken as long as one to two years to complete.

4.7.3 Process Alternatives Evaluation

The following primary effluent pumping alternatives were evaluated:

- Replacement of turbine pumps in kind
- Installation of submersible pumps

4.7.3.1 Replacement of Turbine Pumps In-Kind

The existing Fairbanks-Morse vertical turbine pumps are past their useful life and are in need of replacement. This alternative consists of the replacement of the pumps in-kind with new vertical turbine pumps. A Goulds model VIT vertical turbine pump matching the existing pump operating points was investigated. It was noted in the 2013 facilities plan as well as by the manufacturer’s representative, that the selected vertical turbine pumps are not efficient when operating at the current design points. The pumps also do not appear to be capable of handing peak hour flows with one pump out of service.

This alternative requires the least number of modifications at the Primary Effluent Pump Station, as the pump style is being replaced in-kind. In addition, our understanding is the existing pumps have operated reliably without any major performance concerns. However, the issues related to pump capacity, maintenance, and removal will not be resolved. Confined space entries would still be required to perform maintenance on the pump impeller and piping. Any future pump removal would continue to require outsourcing of a crane.

4.7.3.2 Installation of Submersible Pumps

To address the difficulties with pump access and removal for maintenance, Flygt model NP submersible pumps were evaluated. Three new submersible pumps with elbows would be installed within the Primary Effluent Wetwell and would be provided with new variable frequency drives. The existing wetwell would need to be modified and intermediate interior platform removed, and all valving would remain in the Blower Building basement. The submersible style pumps will also operate more efficiently due to their non-clog design.

The proposed pumps weigh approximately 1,100 pounds each and require a minimum overhead clearance of approximately 60-inches for removal. Based on the pump weight and available overhead space at the existing canopy over the Primary Effluent Pump Station, a portable davit crane rated for 1,200 pounds could be provided to remove the submersible pumps for maintenance. Conversely, a motorized hoist and monorail could be installed on the underside of the canopy for pump removal. A detailed structural evaluation would be required during design to determine whether the existing canopy could support a new beam and hoist or if a stand-alone structure would be required.

The benefits of installing submersible pumps in this location include the elimination of pump seal water, the elimination of confined space entries for pump maintenance, and improvements in the ease of pump removal for inspection and maintenance.

4.7.4 Recommendations

Replace the vertical turbine pumps with new submersible pumps sized to meet design peak hour flows with one pump out of service and modify the Primary Effluent Lift Station and canopy as necessary to accommodate installation and removals. The change to submersible pumps will improve the ease and cost of pump removal, improve safety when accessing and maintaining pumps, and eliminate the need for seal water.

4.8 Secondary Treatment System – Activated Sludge Process

The secondary biological treatment system utilized at the City of Groton PAF is an extended aeration activated sludge process configured for biological nitrogen removal. The activated sludge process consists of the following unit processes and components:

- Aeration Tanks – including reactor tanks, aeration system (blowers, diffusers, aeration piping and mixers).
- Final Settling Tanks – including settling tanks, recycle and waste sludge pumping, scum and solids removal internal mechanisms.

These two-unit processes work together to provide biological treatment and solids removal for secondary treatment at the PAF. Effluent from the primary settling tanks is pumped from the Primary Effluent Pump Station to the Sludge Mixing Chamber. In this chamber, return activated sludge (RAS) from the final settling tanks combines with the primary effluent. The combined flows are distributed to two aeration trains through a channel with isolation slide gates. The effluent from each aeration train flows over a rectangular weir to a common effluent channel where it is conveyed to the final settling tanks through the 30-inch ATE pipe.

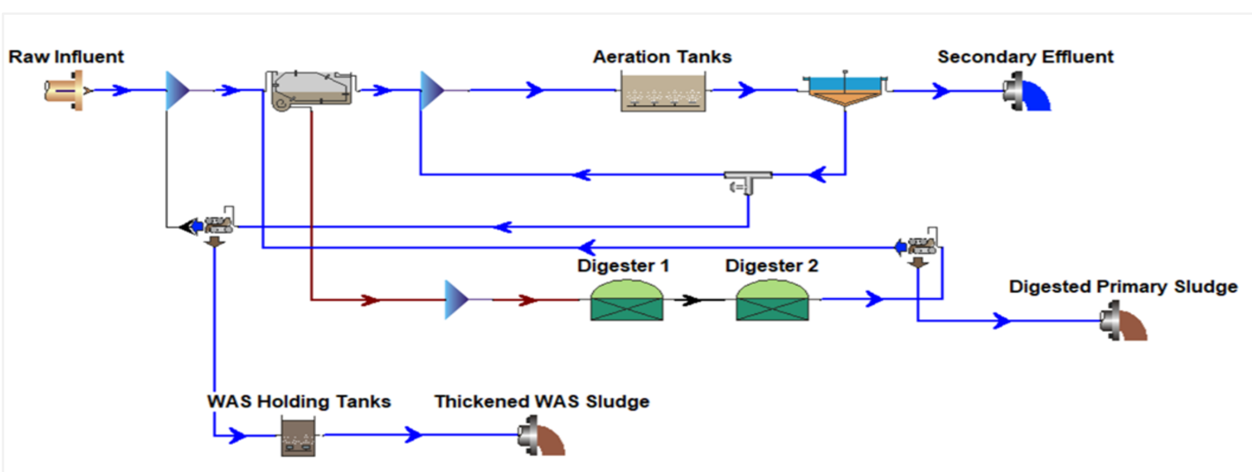
4.9 Process Modeling

Prior to evaluating the secondary treatment and solids handling systems, a process model of the Groton PAF was developed using BioWIN®. The model was calibrated using available plant operating data supplemented with additional wastewater characterization data collected in August and September 2021. For the purposes of the process alternatives analysis, a steady-state model was developed and calibrated to an extended period (typically for a duration of several solids residence times) to simulate sustained process performance. Once the model was calibrated and validated using available data, it was used to simulate the existing process under current and future design flows and loadings, as well as several process alternatives under design conditions for nutrient removal. Refer to Appendix B for model results.

4.9.1 Model Calibration and Verification

The flow schematic of the model is shown in Figure 4-12. Note the number of primary clarifiers, aeration tanks, and secondary clarifiers were consolidated into one representative unit each for simplicity.

Figure 4-12 BioWIN Model Process Flow Diagram



The model was calibrated and validated using plant operating data and BioWIN® default parameters. The key calibration criterion was to verify that the plant effluent quality predicted by the model matched plant operating data (within 10%), the MLSS concentration, and the amount of waste activated sludge (WAS) produced by using a combination of BioWin default values and adjusted stoichiometric coefficients. MLSS concentrations, waste activated sludge flow volumes, and WAS concentrations are measured and recorded five days per week.

4.9.2 Design Capacity Analysis

The calibrated model was used to evaluate the activated sludge system in the existing two train configuration with continued cyclic aeration, and with the Modified Ludzack Ettinger (MLE) process. The operation of the activated sludge process was adjusted (number of anoxic zones on-line, recycle rates, etc.) for each modeled condition to maximize the nitrogen removal performance of the process. Process modeling was completed for the current and future design flows and loads as presented in Section 3, assuming a total recycled nitrogen load of approximately 10% of the total influent nitrogen load.

A summary of the flows and loads used for the BioWin model including results of the BioWIN model showing actual oxygen requirement (AOR) and standard oxygen requirement (SOR) for varying plant conditions are shown in Table 4-5. The AOR values from the BioWin modelling were used to calculate the standard oxygen requirement (SOR). The AOR to SOR conversion utilizes the existing field conditions at the Groton PAF and considers site elevation, wastewater temperature, working DO level, fine bubble diffuser submergence and alpha and beta factors. The transfer efficiency of new fine bubble diffusers was used to calculate the required air flow rate to the tanks at varying influent loads as shown in Table 4-4. The maximum day scenario was calculated utilizing the peak day influent flow and loadings to the plant.

Table 4-4 Model Results for Design Year Flows and Loads

Basis Of Design	Current Conditions (2022)				Design Year Conditions (2042)			
	Min. Day	Annual Avg.	Max. Month	Max Day	Min. Day	Annual Avg.	Max. Month	Max Day
Raw Influent								
Average Flow (mgd)	0.84	1.57	2.44	3.45	0.96	1.79	2.70	3.88
BOD (mg/L)	515	1,742	2,522	3,456	747	2,273	3,214	4,780
TSS (mg/l)	379	2,196	3,104	4,919	591	2,766	3,843	6,491
TKN (mg/L)	240	390	530	530	300	497	665	715
Cyclic Aeration Process								
SCFM[1]	632	1,546	2,218	3,592	1,271	2,650	3,030	4,080
ICFM[1]	716	1,592	2,284	3,699	1,309	2,728	3,120	4,201
MLE Process								
AOR lbs/d	1,315	2,719	3,791	6,468	1,711	3,505	4,801	7,295
SOR lbs/d	2,376	5,520	7,720	11,702	4,618	9,460	9,868	13,186
MLE Process								
SCFM	316	773	1,109	1,796	636	1,325	1,515	2,040
ICFM	358	796	1,142	1,850	655	1,364	1,560	2,102

Notes:

1. Air Quantities for cyclic aeration was developed showing that the blower size will need to be twice the size of MLE process because the air needs to be supplied during a shorter timeframe to meet the oxygen demand.

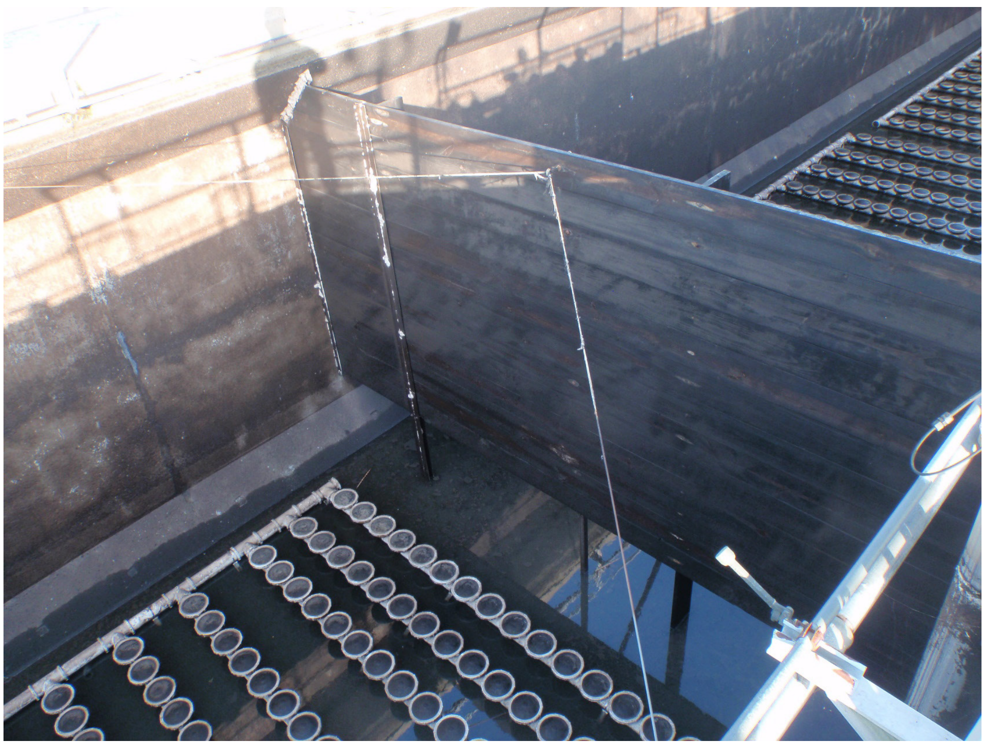
4.10 Aeration Tanks

4.10.1 Performance Evaluation

Aeration tanks 1 and 2 were constructed as part of the 1969 Upgrade. Each aeration tank is 106-feet-long and 24-feet-wide. Plant staff typically operate both tanks for treatment. A distribution structure and influent channel with slide gates allows plant staff to convey wastewater into either Tank 1, Tank 2, or both.

The aeration system initially operated as an extended aeration system with diffusers along the entire length of the tank floor. A wooden baffle was installed in 1996 to allow the activated sludge system to operate as a Modified-Ludzack Ettinger (MLE) process to achieve nitrification and denitrification. The wooden baffle includes a port located at the bottom along its entire length to allow wastewater to flow over and under the baffle to the downstream portion of the aeration tanks.

Figure 4-13 Aeration Tank Baffle Wall



Three aeration blowers located in the Blower Building supply diffused air to the aeration tank via a network of stainless-steel and ductile iron piping. The 1999 upgrade replaced the existing blowers with new blowers and included modifications to portions of the suction and discharge air piping including air filters to accommodate the new blowers. In 2016, a portion of the aeration blower's exterior header pipe was modified and replaced with stainless steel piping. The blowers discharge into a 14-inch common header that runs along the entire length of the tanks. The header pipe branches off to the drop legs for each of the eight diffuser grids. Each diffuser grid is connected to a 4 or 6-inch drop leg. The diffusers were replaced around 2010 and are in good condition.

Each drop leg includes air butterfly valves which allow plant staff to adjust the amount of air provided to each grid. Plant staff initially adjusted these valves to maintain a 2.0 mg/l dissolved oxygen (DO) setpoint in the aeration tanks since the original blowers were oversized for this application. After the blowers were upgraded to include variable frequency drives, plant staff maintained the butterfly valves in the fully open position and used the drives to reduce the speed of the blowers to supply the needed air for treatment. There are currently no automated valves in the air piping system.

The original tanks included coarse bubble diffusers to provide diffused air to the tanks. To enhance overall oxygen transfer efficiency, plant staff replaced these diffusers with fine bubble diffusers in 1999. The fine bubble diffusers are 9-inch diameter diffuser disks with rubber membranes. Each tank has four diffuser grids and air to these grids are manually controlled via a butterfly valve located on the tank walkway.

The plant has been operating the aeration tanks cyclically since 2004 due to the inability to achieve the required turndown of the aeration blowers. Typically, in a cyclic operation the aeration blowers are operational to attain nitrification and when blowers are turned off, the mixers are operated to minimize settling of activated sludge and enhance denitrification. Current operation is 30 min of air on/50 min of air off.

Plant staff installed two mixers per tank, one at the influent and the other at the effluent end suspended by rope to allow operation of the aeration tanks in a cyclic fashion in lieu of operating as an MLE process. The mixers used at the facility are 1 HP D-Icer mixers. The mixers used at the facility are typically not installed in wastewater applications and plant staff replace them annually. Each mixer is less than $1,000 each. With cyclic operation, the aeration blowers are operational to attain nitrification and when blowers are turned off, the mixers are operated to minimize settling of activated sludge and enhance denitrification. Typically, mixing needed to maintain the solids in suspension requires that it be sized to meet the 0.12 scfm/sq-ft. Sufficient information is not available from the mixer manufacturer to verify that the mixers used are operating as intended to meet the above standard.

4.10.2 Operations and Maintenance

The existing activated sludge system is generally operating as intended with some noted modifications and plant staff have been successful in meeting the Total Nitrogen Limit for the facility.

The existing blowers are oversized and a consistent DO setpoint of 2 mg/l is not attainable in the aeration tanks due to excess process air from the blowers, even with turning the blower speed down at the variable frequency drives. Dissolved oxygen probes located at the downstream end of each tank are not operational. Plant staff currently utilize a portable DO measuring device to measure the DO levels in the aeration tanks and adjust the speed of the blowers manually for treatment. Additional instruments for continuous monitoring located on the aeration tank include a pH and ORP meter, which are also not functional.

Discussions with plant staff also indicated that with the cyclic operation of the blowers, the effluent flow meter spikes. When the blowers are turned ON, wastewater initially flows over the weir at a higher rate which results in the nuisance spiking of the effluent flow meter which is not representative of the actual facility flows.

Table 4-5 Activated Sludge System Basis of Design

Parameter	Current Value	Typical Standard (TR-16)
Aeration Tanks		
Number of Tanks	2	
Tank dimensions, ft		
Length	106	
Width	24	
Side water depth	13.85	
Total Volume (Mgal per tank)	0.52	
Total hydraulic detention time, hours		
Average flow (@ 1.57 mgd)	8	8 to 16 hrs.
Max Day Flow (@3.45 mgd)	3.6	
Aerobic MCRT, days	9 days	6-12 days
MLSS concentration, mg/l	1,793	2000 to 4000
Aeration Equipment		
Number of blowers (including standby)	3	
Type	Multistage Centrifugal Type	
Capacity, scfm	3,000 +/-	
Motor HP	Two 75 HP, One 100 HP	
Submersible Mixers		
Number of Mixers	2 per tank	
Motor HP	1 HP	
Diffusers		
Diffuser Type	Fine Bubble	
Location	Aeration Tanks	
No of Diffusers (Tank 1), Qty.	792	
No of Diffusers (Tank 2), Qty.	792	

4.10.3 Process Alternatives Evaluation

The following process alternatives were evaluated for the aeration system:

- Replace Equipment In-Kind
- Convert existing activated system to operate as an MLE process

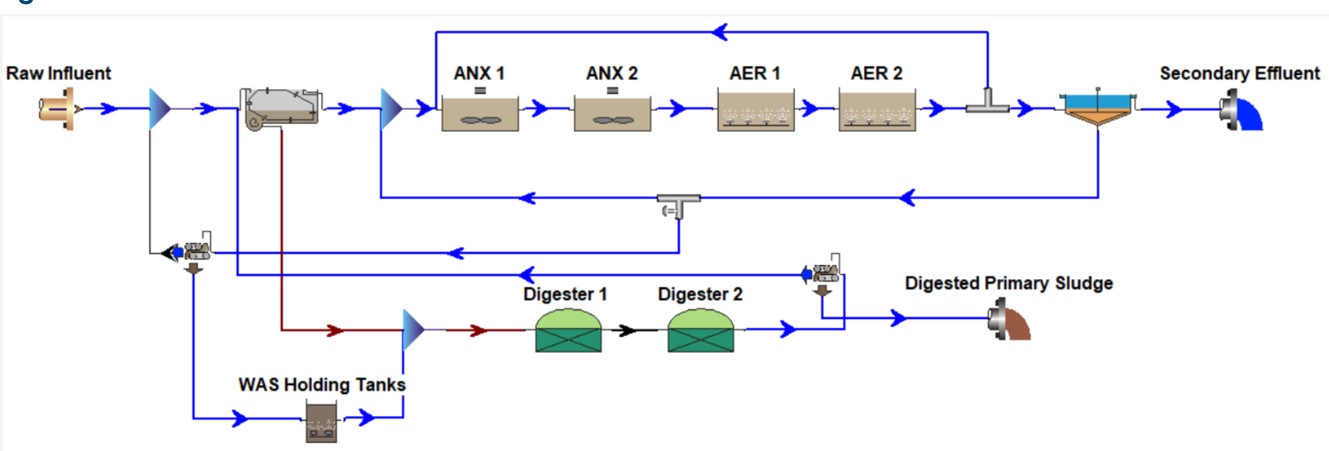
4.10.3.1 Replace Equipment In-Kind

The replace in-kind alternative would allow for the activated sludge system to continue to operate in a cyclic fashion; however, the existing aeration tank equipment including blowers, diffusers, air piping, butterfly valves, mixers, instruments and controls would be replaced. Most of the equipment listed above are nearing their design life or are no longer functional. The diffusers would be replaced in-kind, and the air piping would be modified to include automated valve actuators to control the opening of the butterfly valves based on the DO set point. The existing mixers would be replaced with submersible mixers.

4.10.3.2 Convert Existing Activated System to MLE Process

The MLE process is a single stage system, consisting of an anoxic zone for denitrification, and an aerobic zone for carbon oxidation and nitrification. The denitrification anoxic zone is located at the influent end and typically occupies 30% of the total tank volume. Nitrification occurs in the aerobic portion of the tank, downstream of the anoxic section. A nitrate recycle system is used to return the high nitrate mixed liquor from the aerobic zone to the anoxic zone. The MLE process is an extensively used process for the biological removal of nitrogen and is often considered the "baseline" alternative when evaluating nitrogen removal facilities. This MLE process is simplest and lowest cost for total nitrogen removal. A limitation of the MLE process is that the aeration tank effluent contains some portion of nitrate that is not recycled back from the aeration zone to the anoxic zone, and therefore cannot be removed. This process can generally achieve an effluent total nitrogen concentration of approximately 5.0 to 6.0 mg/l. It can achieve lower effluent total nitrogen levels depending on the site-specific conditions (high influent carbon to nitrogen ratio, low influent nitrogen concentration, etc.). A basic MLE process flow schematic for the Groton PAF is shown in Figure 4-14 with each tank having an anoxic and aerobic zone with internal recycle.

Figure 4-14 MLE Process Flow Schematic



In addition to new blowers, diffusers, select air piping, valves, mixers, instruments and controls, converting the existing system to a MLE process would require modification/relocation or replacement of the wooden baffle walls to create a properly sized anoxic zone upstream of the aerobic zone. Submersible internal recycle pumps would also be installed to return MLSS from the aerobic zone to the head of the anoxic zone where it will be mixed with the influent.

4.10.4 Recommendations

It is recommended to convert the existing tanks to operate as a MLE process. This recommendation is supported in the Section 4.11 below, as well as in Section 7 where payback to convert the aeration system to an MLE process is estimated to be 11.5 years.

4.11 Aeration System Blowers

The blowers for the facility were upgraded in 1999 and utilize multi-stage type centrifugal blowers manufactured by Spencer. Originally these blowers were installed with constant speed motors and later upgraded to include variable frequency drives to provide adequate turndown of the blowers.

Figure 4-15 Aeration Blowers

Two blowers have a motor rating of 75 HP with a rated capacity of 1,000 scfm and one blower has a motor rating of 100 HP with a rated capacity of 2,100 scfm. Typically, multi-stage centrifugal blowers are able to be turned dsown to approximately 60% of their design capacity. The existing blowers are not capable of being turned down below 750 scfm. A flow meter located inside the blower building room provide plant staff with the total air supplied to the tanks. Inlet throttling valves were added to the blowers as part of the 1999 upgrade. Plant staff no longer utilize the valves since the blowers would go into surge when operating at lower speeds. The blowers and associated equipment are approximately 22 years old and have exceeded their design life. Based on discussions with plant staff, the existing inlet filter to the blowers is not operating as intended and the air header piping is leaking.

The existing aeration equipment has been operating satisfactorily and meeting the needs of the facility. However, even with installation of the variable frequency drives, plant staff have not been able to maintain the desired dissolved oxygen in the aeration tanks due to its inability to turn the blowers down to operate at a lower speed.

As part of this study, an evaluation was conducted to utilize the existing blowers by retrofitting them with smaller impellers/internals to operate at a lower output, or to replace them with a newer more efficient blower technology. WP contacted the blower manufacturer, Spencer, to evaluate the condition of the existing blowers. The evaluation of the existing blowers included visual inspections and field testing to verify the vibration, temperature and shaft alignment of the existing blower motors and to determine if the existing blowers could be downsized in place to supply a reduced output.

Spencer conducted a site visit, visual inspections, and field testing on November 2nd, 2021. Originally because the blowers were sized for constant speed application, the blower curve provided did not have sufficient information on how it would operate at various speeds. As part of the site visit, Spencer utilized existing data to prepare variable frequency curves for all three blowers. The curves were generated for various inlet temperatures to simulate the seasonal temperature from winter to summer months. Based on the curves provided by the manufacturer, the blowers are not capable of turning down below 750 scfm. On occasion, the 750 scfm air flow rate would still be too high especially at night when the flows and loads to the plant are low and would still result in the aeration tanks to be over aerated. This impacts the performance of the denitrification process. A copy of Spencer's field report is included in Appendix C.

4.11.1 Operations and Maintenance

The existing blower have been operating as intended to meet the plant staff's needs and plant staff conduct ongoing maintenance on the blowers to keep them operational. The following observations were made by Spencer as part of their evaluation:

- All blowers are VFD driven and have vibration and bearing temperature probes tied to the blower control panel that was installed in 1999
- The control panel has stopped working due to multiple shutdowns and provides a tripping alarm. A potential cause for the panel not working was that the blowers were operating at critical speed when operating in VFD mode
- The blowers are operated with the inlet and discharge control valves wide open during the evaluation
- Pressure transmitter gauge on the discharge piping was not operational. A Spencer issued pressure gauge was used to measure pressure during the evaluation
- There were no means to record the inlet pressure of the blowers
- VFD performance curves were generated by Spencer for each blower

- The maximum allowable vibration (vertical, horizontal and axial) was all below the recommended 0.19 in/sec. threshold
- Spencer recommended maintenance procedures on the coupling for one of the blowers to reduce vibration in the vertical direction

4.11.2 Process Alternatives Evaluation

The following process alternatives were evaluated for aeration blower replacement based on the current and future required air demands presented in Table 4-4:

- Rebuild existing blowers
- Install blowers with newer technology

4.11.2.1 Rebuild Existing Blowers

The existing blowers are approximately 22 years old and have reached their design life which is typically 20 years for most wastewater process equipment. Based on discussions with the manufacturer, rebuilding these blowers to meet the smaller air flow range would be expensive and the cost to rebuild them is similar or greater than to purchase new blowers. In addition, rebuilding the blowers may still limit the plant to cyclic operation only during certain times of the year. For these reasons, the option to rebuild was eliminated.

4.11.2.2 Install Blowers with Newer Technology

Three blower technologies were considered for this project and are listed below along with the pros and cons of each technology.

- Multi-Stage Centrifugal Blowers
  - Wider operating range (50 to 80%)
  - Typically requires more than one blower to achieve full range of air requirements
  - Larger Footprint
  - 50% turndown but poor efficiency at lower range
  - Complicated controls
  - Higher overhead costs
- High-Speed Turbo Blowers
  - High operating efficiencies (70 to 80%)
  - Smaller footprint
  - Poor turndown capabilities (typically 45%)
  - Higher capital cost
  - Complex electrical design
  - Typically serviced/maintained only by the manufacturer due to complexity
- Rotary Screw Compressor Blowers (Hybrid Blowers)
  - Higher operating efficiencies (80-85%) than standard PD blower but less than turbo
  - blower
  - Smaller footprint than standard PD blower but larger than turbo blower
  - Good turndown capabilities (70%)
- Standard PD Style Blowers (Tri-Lobe Blowers)
  - Lowest operating efficiencies (45 to 65%)
  - Good turndown capabilities (75%)

- Largest footprint

4.11.3 Recommendations

For the Groton PAF, screw compressor-hybrid blowers were selected for further evaluation as part of the facilities planning effort due to their footprint and blend of efficiency and turndown capability at the air flow ranges required. Example manufactures of this blower type are Aerzen and Atlas Copco. These blowers are sold as a "packaged" system with all mechanical components and control panels. The blower, motor, and associated mechanical devices are located in a sound dampening enclosure. Air is pulled into the enclosure through the blower and into the discharge piping system. The blower uses a standard motor on a variable frequency drive.

Three new screw compressor-hybrid blowers are recommended (2 active and 1 standby). Each blower will be rated for 1,150 icfm with the ability to turn down to meet the full range of current and future airflow demands presented in Table 4-4. The system would be designed so that one blower is operational during current annual average conditions, and two blowers would be operational at 60% capacity each to meet future max month and peak airflow demands. The third blower would serve as a dedicated stand-by.

To further justify this recommendation, an evaluation of the energy savings associated with installing new aeration blowers and operating the aeration tanks in the MLE mode results in an energy savings of approximately $13,000/year, with an investment payback of 11.5 years.

Figure 4-16 Atlas Copco Screw Compressor Hybrid Blower Installation – Farmington, CT WPCF

4.12 Final Settling Tanks

Aeration Tank effluent is conveyed by gravity through a 30-inch diameter ductile iron pipe through the Blower Building basement and up into the Final Settling Tank influent channel. Two stop gates are located at the influent channels to distribute flow to each of the two settling tanks. The two settling tanks were constructed in 1969 and are 112-feet long by 20-feet wide, with a side water depth of 12.25-feet. The two tanks were recently rehabilitated in 2015 which included a full replacement of the activated sludge collector and cross collector chains, flights, and drives.

The chain and flight collectors scrape settled activated sludge along the bottom of the tanks to an activated sludge hopper at the influent end of each tank. Cross collector chain and flights scrape the settled sludge across the hopper to a sump for removal. Activated sludge is withdrawn from each settling tank sludge hopper by one of three activated sludge pumps. Activated sludge is drawn through two 8-inch ductile iron pipes into the Blower Building Basement and pumped by horizontal end suction centrifugal pumps to either the Return Activated Sludge Mixing chamber for recycle, or to the Rotary Drum Thickener for thickening through a dedicated waste sludge line.

Figure 4-17 Final Settling Tanks

Secondary scum is skimmed off the surface approximately halfway down the length of each tank by manually actuated skimmer pipes. Secondary scum is conveyed by the pipes to a Secondary Scum Well located to the south of the two tanks. Secondary scum is then manually pumped from the Scum Well by a centrifugal secondary scum pump located in the Blower Building basement, to the Primary Effluent Pump Station.

Secondary effluent spills over dual v-notch weirs fixed to three inboard launders in each tank and is conveyed through the launders directly to the influent end of the Chlorine Contact Chamber for disinfection. The design characteristics of the final settling tanks along with TR-16 guidelines is presented in Table 4-6.

Table 4-6 Final Settling Tanks Basis of Design

Parameter	Current Value	Typical Standard (TR-16)
Number of Tanks	2	
Length, ft	125	
Width, ft	20	
Side water Depth, ft	11.0	12 minimum
Surface Area, sf (per tank)	2,500	
Volume, (Mgal per tank)	0.206	
Mechanism Manufacturer	Viking	
Sludge Collection	Chain and Flight	
Motor HP	0.5	
Surface Overflow Rate, gpd/sf (both tanks on-line)		
Design Max Month (2.7 mgd)	540	
Design Peak Hour 98th percentile (5.03 mgd)	1,006	
Design Peak Hour (7.15 mgd)	1,430	<1,200 gpd/sf

4.12.1 Performance Evaluation

The plant typically operates with both settling tanks online. Staff maintain the activated sludge blanket at an average of 3-feet and typically have good suspend solids removal. The final settling tanks can pass 7.15 mgd hydraulically but for performance, it is typical to use the 98th percentile so the tanks are not oversized. There are no concerns with clarifier performance at this time.

4.12.2 Operations and Maintenance

The collector and cross collector mechanisms were installed in 2015 and are relatively new. However, staff experience seasonal issues with the settling tanks.

In the winter the settling tank surfaces can ice over, straining the collector chains and causing the shear pins to break at the drives due to an over torque condition. The drives are covered with heated enclosures; however, the heaters were not properly rated for the space and have since stopped working. As a result, the shear pins tend to get stuck when they break in the cold due to ice formation. When the pins break, they fuse to the stainless-steel sleeve, and have to be drilled out by operations staff. In warmer weather, they experience algae issues in the tanks.

4.12.3 Process Alternatives Evaluation

The following final settling tank equipment alternatives were evaluated:

- Collector Equipment Drive Modifications
- Install launder covers for algae control

4.12.3.1 Collector Equipment Drive Modifications

There are multiple methods that can be used to provide additional protection to the clarifier drives to automatically shut down the equipment before a shear pin breaks. The first option is to install an adjustable torque switch at the drives. The torque switch trip setting would be set at a value less than the torque required to break a shear pin. In the event the settling tank chain and flight mechanisms become jammed, the collector drive should shut down and alarm staff.

Another alternative is to install a current monitoring sensor at each mechanism MCC breaker. The sensor monitors the current draw to the settling tank collector drives. In the event the collector equipment becomes jammed, the device would sense the spike in current draw from the equipment and shut the equipment down. The sensors would need to be set such that the equipment would be shut down prior to the shear pins breaking.

In either case, the heaters in the drive enclosures should be replaced with properly rated units.

4.12.3.2 Install Launder Covers for Algae Control

Each final settling tank has three inboard launders with dual v-notch weirs. During warmer weather, algae will grow and build up on the effluent launders and weirs, which requires operations staff to hose down the weirs daily. Circular clarifiers are commonly outfitted with algae brush mechanisms fixed to the rotating mechanism arms to control algae, however there is not an equivalent brush technology for rectangular settling tanks.

Flat covers can be installed over rectangular launders to shield the weirs and launders from sunlight and inhibit algae growth. Launder covers would be fabricated of FRP and would be provided with hatched covers to inspect the protected launders. The covers are supported off brackets fixed to the tank walls and effluent launder. Each launder would be provided with two hinged hatches, that could be opened from the walkways on either side of the tanks for access and inspection.

4.12.4 Recommendations

In order to prevent shear pin issues during cold weather it is recommended that either an adjustable torque switch be installed at the drives, or a current monitoring sensor be installed at the equipment breakers to provide additional means to protect the equipment and provide for alarming or tank shut-down. The alarm set points would coordinate such that equipment shut down would occur before the torque exceeds the shear pin break point. New heaters should also be installed in each drive enclosure.

In addition, if the city were to conduct a comprehensive upgrade of the treatment facility, it is recommended that the installation of effluent launder covers be considered to minimize algae build up. However, this is a low priority upgrade to be included at the City's discretion and may be a good candidate for consideration as a Bid Alternate.

4.13 Secondary Scum

Scum from the secondary settling tanks is skimmed from the tank surfaces and transported to a secondary scum well located to the south of Final Settling Tank No.1. The scum well is approximately 2’-2” wide, by 5’-7” long, by 10’-8” deep. Scum is pumped from the bottom of the secondary scum well to the Primary Effluent Wetwell by the secondary scum pump, located in the basement of the Blower Building.

The secondary scum pump is an Ebara end suction centrifugal pump. The pump is 7.5-hp, with 2-inch suction and discharge outlets. The secondary scum well is pumped down manually by operations staff as needed. The scum pump was replaced in 2020 and is in good operating condition.

Figure 4-18 Secondary Scum Pump

4.13.1 Performance Evaluation

The existing scum pump is new and is in good operating condition.

4.13.2 Operations and Maintenance Evaluation

The current configuration sends secondary scum to the Primary Effluent Wetwell where it is then pumped back to the aeration tanks, and effectively recycles the scum through the activated sludge process. The ideal means of scum handling is to convey it back to the head of the plant or to remove it from the wastewater stream.

The secondary scum pump is operated manually by operations staff to draw down the secondary scum well manually as needed. The scum pumping system is currently not automated by timer or level setpoint.

4.13.3 Alternatives Evaluation

The following secondary scum handling alternatives were evaluated:

- Install a submersible recirculating chopper pump at the secondary scum well
- Pump secondary scum to Primary Flow Distribution Box

4.13.3.1 Submersible Recirculating Chopper Pump Installation

The replacement of the existing dry pit scum pump with a Vaughan submersible recirculating chopper pump was evaluated. A submersible recirculating chopper pump and nozzle mixing assembly would be installed within the existing secondary scum well to mix and convey secondary scum. The typical means of operation consists of first recirculating and mixing secondary scum within the scum well by pumping through a nozzle fixture for a period of time, followed by pumping down the mixed liquid within the scum well. The system can be designed to automatically actuate between operating modes or be manually actuated to switch between operating modes.

The dimensions of the secondary scum well are 2’-2” wide, by 5’-7” long, by 10’-8” deep. The 2-2” width is very narrow and will make it difficult to install equipment within the structure. Vaughan was contacted to discuss the feasibility of installing a recirculating system, and there is a system available that would fit within the scum well. However, there would be minimal clearance between the equipment and well walls, and access for installation and maintenance would be difficult.

Expansion of the scum well is necessary to properly install a submersible recirculating scum pump and nozzle system. However, extending the width of the scum well would conflict with the Blower Building garage bay door opening. For this reason, widening of the scum well and installation of a submersible recirculating chopper pump is not feasible.

4.13.3.2 Secondary Scum to Primary Flow Distribution Box

As previously discussed, the current secondary scum handling system recirculates the scum within the activated sludge process. This can impact the biological process, especially if there are filamentous problems and filaments are recirculated back to the aeration tanks. The concept of pumping secondary scum to the influent Flow Distribution Box downstream of the mechanical bar screen was investigated. This would allow secondary scum to be collected and removed within the Primary Settling Tanks along with the primary scum.

Approximately 300 linear feet of new 4-inch secondary scum forcemain piping would be run from the Blower Building and discharge into the center chamber of the influent Flow Distribution Box in the Operations Building.

Pipe routing from the Blower Building to the Flow Distribution Box will need to be evaluated; there is a significant amount of site piping at the southwest corner of the Operations Building that will cause conflicts and increase the difficulty of installation. Routing the piping through the basement of the Operations Building may reduce the amount of trench excavation required.

Relocation of the secondary scum discharge point would require the installation of a newer larger secondary scum pump, to account for the increased forcemain length. Additional piping and valves will be installed at the pump to allow operators to mix the contents of the scum well prior to pumping.

4.13.4 Recommendations

Ideally, secondary scum should be removed to upstream of the primary settling tanks. For these reasons it is recommended that a centrifugal secondary scum pump be installed within the Blower Building basement, and a new forcemain be installed to discharge secondary scum at the Flow Distribution Box at the Operations Building with additional piping and valving to allow operators to mix the contents of the scum well prior to pumping. Secondary scum will be conveyed ahead of the Primary Settling process and provides the means for secondary scum to be skimmed from the Primary Settling Tank surface and removed to the digesters.

A new 4-inch glass-lined forcemain would be routed from the Blower Building basement through the Operations Building Basement and cored into the Flow Distribution Box. A new secondary scum pump will need to be installed at the Blower Building sized for the additional head conditions from the new discharge location and additional forcemain length. Automatic controls would also be installed to drawdown the secondary scum well based on level set points to automate scum handling.

4.14 Return Activated Sludge Pumping

Three Return Activated Sludge (RAS) pumps located in the Blower Building Basement convey sludge from Final Settling Tanks 1 and 2, to the Sludge Mixing Chamber upstream of the Aeration Tanks. In this chamber, RAS is mixed with primary effluent before entering one of two Aeration Tanks. The pumps are Vaughan centrifugal chopper pumps, rated for 1,390 gpm at 47 feet of total dynamic head with 40 Hp motors on VFDs. Staff have been replacing one pump each over a three-year period as capital improvements. The last new pump is scheduled to be installed in 2022.

Figure 4-19 Return Activated Sludge Pumps

There are two separate 8-inch suction headers, one from each Final Settling Tank, that allows one pump to be dedicated to each tank with 3rd standby pump. The pumps discharge into two 6-inch forcemains that are each outfitted with magnetic flow meters. The forcemains combine into one 8-inch line downstream of the flow meters. From there, a motor operated valve typically directs RAS to the Sludge Mixing Chamber. The RAS Pumps are also used to waste sludge from the system as the plant does not have dedicated waste sludge pumps. The motor operated valve can also direct RAS sludge to the Rotary Drum Thickener in the Operations Building when staff needs to waste secondary sludge.

Each pump is equipped with a variable frequency drive, where the speed is set manually by operators at the VFD. The pumps are not currently flow paced based on influent flows to the plant as there is no influent flow meter or flow signal available.

4.14.1 Performance Evaluation

The return sludge pumps are typically operated to provide a return rate of 110% of influent flows, or approximately 550 gpm for each pump. Two of the three pumps have recently been replaced, and the third pump is scheduled to be replaced this year. These pumps are new and are anticipated to last for another 25 to 30 years.

4.14.2 Operations and Maintenance

The existing pumps are equipped with VFDs; however, they are not set up with programming for flow pacing. Pump speeds are set manually at the VFDs. Staff indicate that return flows are adequate during the day, however return flows can be high overnight during low flow periods.

4.14.3 Process Alternatives Evaluation

The following Return Activated Sludge pumping alternatives were evaluated:

- Installation of flow pacing capabilities
- Continue to use RAS pumps to waste to Rotary Drum Thickener

4.14.3.1 Installation of Flow Pacing Capabilities

The treatment facility is not staffed 24-hours per day, and RAS pump speeds are manually set at the VFD. When influent flows drop overnight, operators cannot adjust the return rates which results in excess return flows during these periods. In order to provide flow pacing capabilities a programmable logic controller (PLC) will need to be installed, as well as proportional integral derivative (PID) controller software for each return sludge pump.

When operated in an “automatic” mode the pumps will be called to run, and the pump speeds will be controlled by the PID controllers. The controller receives an automatically generated or manually selected setpoint and uses this input to generate an output that manipulates the RAS pump speed to maintain the setpoint. Programming could be setup to provide multiple operation modes; one where the VFD would scale the pump speed to maintain a constant return flowrate in gpm, or a second where the VFD would scale the pump speed to maintain a percentage of the influent flowrate.

These improvements will require the modification of existing control panels on site, or the installation of a new control panel at the Blower Building.

4.14.3.2 Continue to Utilize RAS Pumps to Waste Activated Sludge to Rotary Drum Thickener

Refer to discussions in Section 5 – Solids Handling, and Section 8 – Energy Evaluation, for recommendations and justification for installing dedicated waste sludge pumps to feed the Rotary Drum Thickener.

4.14.4 Recommendations

Flow pacing capabilities should be installed to optimize the return sludge pumping rates to the activated sludge process. A programmable logic controller (PLC) will need to be installed, as well as proportional integral derivative (PID) controller software for each return sludge pump. Return sludge pumping should be paced from the effluent flow meter. This will allow return rates to be automatically adjusted overnight, during low flow periods.

4.15 Effluent Disinfection

Liquid sodium hypochlorite is used for effluent disinfection at the Groton PAF. As part of the PAF's discharge permit, plant effluent is required to be disinfected 365 days per year/24 hours per day prior to being conveyed to the Thames River. Currently, disinfection is accomplished with 12.5% liquid sodium hypochlorite. There are two 2,300-gallon storage tanks and two metering pumps in the basement of the Operations Building installed in 2000. One storage tank has failed and has been taken out of service. The second tank is suspected to be leaking.

Figure 4-20 Proposed Location of New Sodium Hypochlorite Storage Tanks

During the preparation of this facilities plan, GU proceeded forward with an upgrade to the existing sodium hypochlorite storage and feed system including full replacements. Due to numerous building code changes since the original installation 2000, replacing the existing tanks in-kind would require extensive building upgrades and the installation of a fire suppression system. It was decided that the most feasible, cost effective and least disruptive solution would be to install two new 1,550-gallon tanks outside of the Operations Building on a concrete pad, while utilizing the existing hypochlorite room in the basement for a day tank and new metering pumps. The tanks will be set where an existing 1,000-gallon fuel oil tank is located. The existing 1,000-gallon fuel tank will be relocated elsewhere in the City to make room for the new tanks. The project design was completed in December 2021 and is construction is expected to be completed in late 2022. A summary of the upgrade includes:

1. Removal of existing exterior 1,000-gallon fuel storage tank and concrete pad and construct new concrete pad to house two new double-walled 1,550-gallon chemical storage tanks.
2. Demolition of exiting storage tanks and pumps in the Operations Building Basement to make room for the installation of two new chemical metering pumps and a 250-gallon day tank.

3. Installation of leak detection and heat tracing instruments.
4. Control panel upgrades to incorporate the new tanks and pumps into the plant's SCADA system.

4.15.1 Recommendations

Although the upgrade will replace the sodium hypochlorite storage and feed systems major equipment and controls, the PAF is still unable to flow pace the disinfection system due to the spikes at the effluent flow meter as a result of operating the aeration system in a cyclic mode. The new controls will be programmed to allow for flow pacing if the aeration blowers are replaced and cyclic operation is discontinued. This will also require replacement of the existing Hach CL-17 chlorine residual analyzer that is not functioning properly and has been problematic. This work is all being conducted under a separate project.

4.16 Effluent Flow Metering

Secondary effluent from the Final Settling Tanks is conveyed into a common secondary effluent channel, where sodium hypochlorite is added to the flow upstream of the Chlorine Contact Tank. Chlorinated secondary effluent then flows through the effluent Parshall flume before entering the Chlorine Contact Tank. Prior to the treatment plant upgrade in 1998, plant flows were measured by the influent Parshall flume located upstream of the aerated grit chamber in the Operations Building. As part of the 1998 upgrades, the influent flume was removed due to surcharging issues, and a new effluent Parshall flume was constructed upstream of the Chlorine Contact Chamber.

The effluent Parshall flume consists of an FRP insert that was cast into the effluent channel with concrete fill. The existing flume has a throat width of 12-inches. The current maximum reading from the system is 6.5 MGD. The treatment plant is required by permit to measure and record effluent flows.

Figure 4-21 Effluent Parshall Flume

4.16.1 Performance Evaluation

Plant staff did not indicate any hydraulic issues with the flume. However, the flume has a current capacity of approximately 6.50 mgd, which can be exceeded during periods of high flows. Staff are interested in increasing the flumes capacity to be able to measure peak flows either by installing a later flume or an ultrasonic level instrument with an increased readability range.

The meter is calibrated and checked annually to comply with permit requirements.

4.16.2 Operations and Maintenance

Staff have noted that the effluent flow meter tends to spike at points in time. This spiking appears to be correlated to the cyclical operation of the aeration tanks. This spiking prevents the facility from being able to control equipment through flow pacing.

Flow is measured using an ultrasonic level element at the Parshall flume. The ultrasonic instrument was installed in 1995, is approaching the end of its useful life, and is in need of replacement.

4.16.3 Process Alternatives Evaluation

The following effluent flow metering alternatives were evaluated:

- Modify Parshall Flume
- Replace Ultrasonic Level Element

4.16.3.1 Modify Parshall Flume

The hydraulic capacity of a parshall flume is governed by the throat width dimension. The existing flume has a throat width of 12-inches, which equates to a textbook published capacity between 0.4 cfs (0.26 mgd) and 16.0 cfs (10.4 mgd) assuming there is no surcharging of the flume. The next larger standard flume size is a throat width of 18-inches, which equates to a textbook published capacity range of 0.5 cfs (0.32 mgd) to 24.0 cfs (15.5 mgd).

Our understanding is that the existing flume and metering instruments has an approximate capacity of 6.5 mgd, and fails to record flows over this threshold. With the theoretical capacity of the existing flume calculated at up to 10.4 mgd per textbook values, the current hydraulic capacity exceeds the expected flows to the treatment facility. It appears that the outdated ultrasonic instruments may be limiting flow measurement at the higher end flow range. For this reason, the existing flume should have sufficient capacity and does not need to be replaced.

In addition, based on the anticipated changes to the aeration system operation, we expect that the slugs of flow exiting the aeration tanks to be eliminated, resulting in steadier flows through the flume.

4.16.3.2 Replace Ultrasonic Level Element

Flow is measured at the effluent Parshall flume by a Milltronic ultrasonic level instrument. This instrument was installed in the 1995 upgrades, and the installed model has been discontinued. This instrument would be replaced with a modern ultrasonic element to provide increased accuracy and range.

4.16.4 Recommendations

The existing ultrasonic element at the effluent flume should be replaced with modern ultrasonic element(s) with an extended maximum flow measurement range, to be able to measure the full range of flows through the facility.

The existing flume and upstream/downstream channels and weirs should also be surveyed to determine if there is an impact to the flume due to surcharging at peak flows. The flume may also need to be raised or reset to an appropriate elevation before replacing just the instrument. Alternatively, a second ultrasonic instrument may be able to be added downstream to account for any submerged flow through the flume and adjust the reported flow accordingly.

4.17 Plant Water System

Plant water is drawn from the bottom of the Chlorine Contact Chamber through an 8-inch drain line to a manual twin basket strainer in the basement of the Blower Building. The common discharge pipe from the strainer is connected to one effluent flushing water (EFW) pump and one foam spray water (FSW) pump. There is limited information on the strainer and pumps. The EFW pump was installed in 1970. It is a 15-HP Ebara Model A3U-40-280A150TC3 designed to provide flushing water to several exterior yard hydrants and interior hose stations in the Blower and Digester Buildings. The FSW pump was also installed in 1970. It is a 5-HP Ebara Model A30-40-125A50TC3 designed to provide effluent flushing water to a series of nozzles suspended over the water surface of the Aeration Tanks for foam suppression and process control. Plant water is not currently available in the Operations Building or Sludge Storage Building.

Use of the plant water system was discontinued years ago and the PAF now uses city water for all potable and process needs. As a whole, the plant water system is no longer functional.

4.17.1 Process Alternatives Evaluation

Currently, the PAF uses city water for process needs. Water is provided to the PAF from the City of Groton Utilities Water Department. The following alternatives were evaluated for the plant water system:

- Effluent Flushing Water
  - Continue to use city water for all potable and process needs
  - Install a new basket strainer, EFW pump, hydropneumatic tank and interior and exterior piping to allow for use of plant water throughout the facility
- Foam Spray Water
  - Install a new Foam Spray Water pump with simplex strainer and replace all foam spray water piping and nozzles on the aeration ands final settling tanks

4.17.1.1 Effluent Flushing Water

In order to use plant water for process needs, a full sitewide commitment would need to be made. In addition to replacing the basket strainer and EFW pump, this alternative would also include the installation of a plant water feed line to the Operations Building and Sludge Storage Building. A 20-year life cycle cost analysis was completed comparing continued City water use versus installing a new plant water system. As shown in Table 4-7, maintaining city water use represents the least costly alternative because there is no capital cost, and the water is provided by Groton Utilities.

Table 4-7 Effluent Flushing Water Alternatives – Life Cycle Cost Evaluation

Parameter	Maintain City Water Use	Replace System Equipment
Capital Cost	$0	$262,000
Annual O&M Costs	$20,800[1]	$9,500
Total Present Worth	$283,000	$350,000

Notes: 1. Annual city water bill averages $26,000. Assume only 80% of that water is used in the process.

4.17.1.2 Foam Spray Water

The foam spray water system can be managed separately from the effluent flushing water. PAF operators have expressed an interest in bringing this system back on-line to help control foam on the surface of the Aeration tanks and final settling tanks as witnessed during several site visits to the plant in 2021. Currently, operators have no means to suppress foam. Regardless of if a new plant water system is installed, the foam spray water pump should be replaced with a new simplex basket strainer and two new centrifugal pumps with all new distribution piping and nozzles to allow for intermittent foam suppression of the aeration tank surface on an as-needed basis.

4.17.2 Recommendations

Although it is not typical to use city water for process control, it is less costly for Groton Utilities who has their own water treatment and distribution system. Based on the current water demands of the facility, it is recommended to maintain city water use for all process control areas and to install a new standalone foam spray water system with a new strainer, pumps, piping and spray nozzles. Installing a full systemwide plant water system should be evaluated further during the design phase to provide the pant with additional flexibility and redundancy.

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5

Section 5 Evaluation of Solids Process Units and Operations

5.1 Introduction

The solids handling facilities at the City of Groton PAF processes primary and secondary treatment sludges separately. A flow schematic of the solids handling process is shown in Figure 5-2. Primary sludge is thickened in the primary clarifiers and then pumped directly to the primary anaerobic digester. Anaerobically digested primary sludge is transferred to tanker trucks for off-site disposal. Waste activated sludge (WAS) is thickened using a rotary drum thickener (RDT) and stored in a sludge storage tank prior to being transferred to tanker trucks for off-site disposal. An evaluation of the available plant operating data for the period January 2019 through May 2021 was done to determine the volume and mass of both primary and secondary sludge handled at the Groton PAF. These values were then checked against the values predicted using the BioWin® model for primary and secondary solids. A discussion of this evaluation is presented below for both primary and secondary solids.

5.1.1 Primary Sludge

Primary sludge is currently determined based on the volume of primary sludge pumped and the concentration of the sludge. The volume pumped is estimated based on the runtime of the primary sludge pumps and the number of minutes the pumps are operating. The mass of primary sludge pumped is determined based on the measured solids concentration. Based on the available MOR data, an average of 3,060 gpd of primary sludge is sent to the digesters at an average solids concentration of 3.2 percent. This is equivalent to approximately 820 lb/d of primary sludge. For comparison, the raw wastewater TSS concentration averaged 169 mg/L and the primary effluent concentration averaged approximately 46 mg/L with an average flow rate of 1.6 mgd. This results in a TSS removal of approximately 73% in the primary clarifiers. This is slightly higher than typical removal efficiencies of 40% to 70%. Based on an assumed 60% removal efficiency, approximately 1,350 lb/d of primary sludge would be generated. Based on this, it appears that the volume and mass of primary sludge determined by the pump flow rate and runtime data underestimates to quantity of primary sludge. For the purposes of this evaluation, we have assumed a primary solids removal percentage of 60% and estimated the quantity of primary sludge based on the BioWin® model output.

5.1.2 Waste Activated Sludge

The current MORs include data for the quantity of waste activated sludge (WAS) being sent to the RDT based on the sludge flow meter data and sampling of the solids concentration in the Return Activated Sludge. Based on this information, the plant sends approximately 40,300 gpd to the RDTs at an average RAS concentration of approximately 0.42%. This is equivalent to approximately 1,400 lb/d of WAS. The plant also reports the total volume of thickened waste activated sludge that is hauled off site in tanker trucks. Based on these data, the Groton PAF disposes of approximately 65,800 gallons per month of thickened sludge at approximately 4% solids. This is equivalent to approximately 21,950 lb/month or 730 lb/d. Assuming a 90% capture rate in the RDT, the amount of secondary sludge wasted is estimated to be approximately 815 lb/d. This discrepancy may be due to changes in the RAS concentration throughout the day and may indicate the actual WAS concentration is lower. As an alternate check on these values, the current primary effluent BOD5 concentration is reported to average 78 mg/L. At the average daily flow of 1.6 mgd, the organic loading on the aeration tanks is approximately 1,145 lb/d. Typically for activated sludge systems following primary clarifiers, a rough estimate of the sludge yield is approximately 0.6 to 0.8 lb WAS per lb of BOD. At a BOD loading of 1,145 lb/d, the WAS quantity is estimate as approximately 800 lb/d assuming a yield of 0.7 lb WAS/lb BOD. This is more in line with the volume of sludge reported to be hauled off site.

The BioWin model also predicts approximately 815 lb/d of WAS under current conditions. Therefore, for the purposes of this evaluation, we have assumed a secondary sludge quantity of 815 lb/d under average conditions based on the model output.

5.1.3 Current and Future Sludge Production

Table 5-1 presents current and design-year solids production rates prior to digestion and thickening. Current average and maximum month sludge production is taken from plant operating data from 2018 to 2021. Average design sludge production was simulated with the BIOWIN® model using the projected design flows and loadings presented in Section 3 along with the simulated process changes. Maximum month design solids production is calculated using peaking factors from current maximum month sludge production. It is important to note that the design waste sludge production is reported to be less than the current waste sludge production in Table 5-1 due to overestimations of actual, current sludge production from an overall solids balance. Similarly, the design primary sludge production is reported to be greater than the current primary sludge production in Table 5-1 due to underestimations of actual, current sludge production from an overall solids balance. Review of the current operating data indicates that the sum of the primary sludge (lb/d) and the waste sludge(lb/d) was greater than the total influent TSS (lb/day) to the plant, indicating an overestimation of primary and/or waste sludge production at the facility. For example, waste sludge could easily be overestimated if its concentration is not measured accurately. Waste sludge concentration tends to vary over time during a sludge wasting event if the sludge blanket becomes thin. As a result, we did not calibrate BIOWIN® with the current sludge production values and used typical default parameters.

Table 5-1 Current and Future Sludge Production

Loading Condition		Solids Quantity (lbs/day)		Hydraulic Loading (gpd)	
Annual Average		Primary	Secondary	Primary	Secondary
	Current (MOR)	820	1,360	3,280	40,820
	Current (BIOWIN®)	1,350	815	5,400	24,460
	Design (BIOWIN®)	1,560	796	6,240	23,890
Maximum Month	Current (MOR)	1,770	1,904	7,080	57,140
	Current (BIOWIN®)	1,870	1,090	7,483	32,710
	Design (BIOWIN®)	2,165	1,064	8,660	31,930

Note: Primary Solids at 3% TS and Secondary Solids at 0.4% TS.

5.2 Primary Sludge Pumping

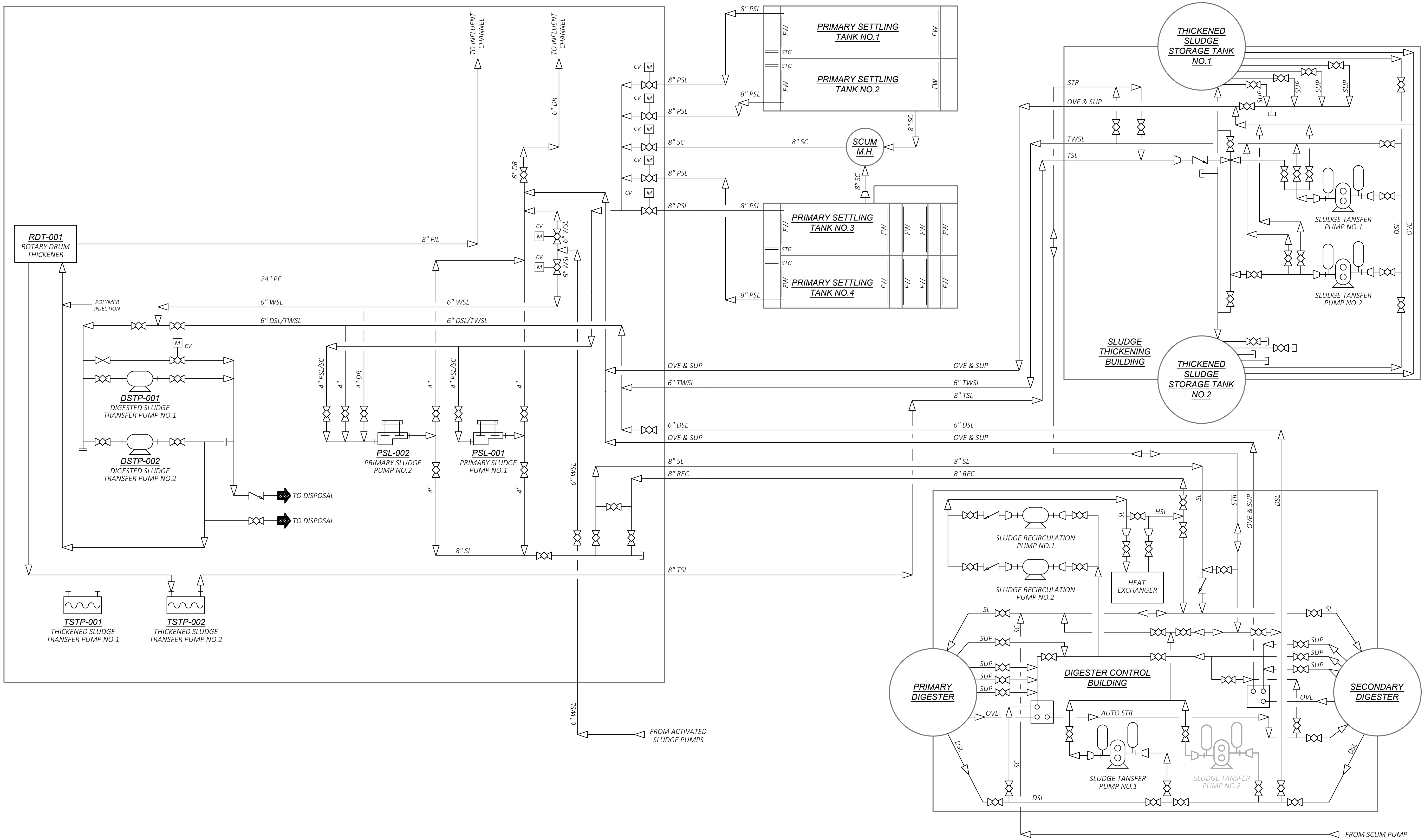
Primary sludge in the primary settling tanks is maintained in a blanket of around 2-feet or less at a solids concentration of 2-4% total solids. Operators monitor the blankets with sludge judges throughout the day to monitor blanket depth. The sludge is withdrawn from each settling tank sludge hopper through four dedicated 8-inch pipes by one of two Primary Sludge Pumps in the Operations Building. The existing pumps are 5Hp piston pumps manufactured by Waste Corp that were installed in 1996. They are each rated for 70-gpm with constant speed motors.

The primary sludge pumps operate at 15-minute intervals periodically during the day to maintain primary sludge blankets. The primary sludge suction header within the Operations Building basement is set up with four motor actuated valves that control which tank is pumped from. Sludge is pumped directly to the digestors and undergoes primary and secondary digestion. Digested sludge is then pumped directly from the secondary digester to hauling trucks for disposal.

5.2.1 Performance Evaluation

Staff have not indicated issues with removing primary sludge from the system. The tanks would turn septic before the settled sludge becomes too thick to pump. Approximately 3,000 gallons per day of primary sludge is transferred to the primary digester at 2-4% solids. The current capacity of 70-gpm is sufficient although the ability to control the speed of the pumps through VFDs is desired to better control the amount and frequency of primary sludge pumped.

Figure 5-1 Primary Sludge Pumps



NO.	REVISIONS	DRAWN BY	APP'D
1		APC	
2			
3			

CITY OF GROTON, CONNECTICUT
GROTON UTILITIES
WASTEWATER TREATMENT FACILITY
FACILITIES PLAN

PROJ NO: 20653
DATE: MARCH 2022

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EXISTING SOLIDS HANDLING PROCESS FLOW SCHEMATIC

FIGURE: 5-1

5.2.2 Operations and Maintenance Evaluation

These pumps are approaching the end of their useful life and are in need of replacement. There is currently no flow meter on the primary sludge pump discharge piping to track flow rates to the digester. Volumes are estimated based on pump run times.

5.2.3 Process Alternatives Evaluation

The following primary sludge pumping alternatives were evaluated in addition to replacing in-kind with new piston pumps:

- Installation of rotary lobe pumps
- Installation of recessed impeller centrifugal pumps
- Install a flow meter on discharge piping

5.2.3.1 Install New Rotary Lobe Pumps

The two existing plunger pumps would be replaced with new rotary lobe primary sludge pumps rated for 150 gpm. The plunger pumps would be removed, and the new pumps would be installed on the existing concrete pedestals. The pedestals would be expanded as needed to accommodate the new pumps. The suction and discharge piping will be modified as needed to connect to the pump inlets and outlet flanges.

Rotary lobe pumps are positive displacement pumps, that draw the conveyed liquid into the pump chamber. Two interlocked rotors located within the pump chamber pull and convey liquid past the pump chamber and through the discharge forcemain. Depending on the application, the rotors can be steel or polyurethane coated steel. These pumps provide a smooth flow with minimal pulsation and are able to run dry for a short period of time without damaging the pumps.

However, due to the close tolerances between the two lobes, grit can cause excessive wear and reduce pump efficiency. The excessive wear can also lead to increased maintenance and pump down time. In addition, rotary lobe pumps require a high starting torque that is generally two to three times the running torque, so larger horsepower motors are often required as well as in-line grinders on the suction side of the pumps.

Our understanding is the existing aerated grit system does allow finer grit to pass through to the primary settling process. Staff have indicated that the grit typically settles with the primary sludge but does not cause excessive or noticeable wear on equipment downstream. The grit that accumulates in the primary sludge may impact the operating efficiency and cause excessive wear on the proposed pumps.

5.2.3.2 Install New Recessed Impeller Centrifugal Pumps

The two existing plunger pumps could be replaced with new recessed impeller centrifugal primary sludge pumps rated for 150 gpm. The plunger pumps would be removed, and the new pumps would be installed on the existing concrete pedestals. The pedestals would be expanded as needed to accommodate the new pumps. The suction and discharge piping will be modified as needed to connect to the pump inlet and outlet flanges.

Recessed impeller pumps are horizontal or vertical centrifugal pumps that rely on the recessed impeller to create a vortex that draws material into and out of the pump. The recessed impeller design allows the pump to pass larger solids and grit with less wear. The pump casing and impellers are typically constructed of hardened metals that are abrasion resistant, making the pumps well suited for conveying fluids with grit or other fibers. However, these pumps are generally hydraulically less efficient as a result of the recessed impeller (generally 5 to 20% less efficient that standard non clog pumps). These pumps are also not suited for conditions that require a suction lift.

5.2.3.3 Install Flow Meter on Discharge Piping

A new 6-inch magnetic flow meter will be installed on the primary sludge pump discharge piping in the basement of the Operations Building. These flow meters are required to be installed in straight runs of piping with a minimum of five diameters upstream and three diameters downstream of the meter. It appears there is a suitable location to install the meter on the section of piping that runs parallel to the west face of the Operations Building.

5.2.4 Recommendations

Due to their age and condition, the primary sludge pumps should be replaced with pumps on VFD's with a design capacity of 150 gpm at full speed. The pump type will need to be further evaluated during the preliminary design phase as it relates to any improvement to the aerated grit tank. It is also recommended that a magnetic flow meter be installed on the discharge piping in basement of the Operations Building and monitored and trended through SCADA.

5.3 Waste Activated Sludge Pumping

The facility has three activated sludge pumps that are located in the Blower Building basement. The pumps are primarily operated as return sludge pumps, but they are also configured to waste activated sludge. When the plant is staffed, operators waste activated sludge with the return sludge pumps through a 6-inch force main to the Rotary Drum Thickener (RDT) in the Operations Building. After thickening, waste activated sludge is pumped to Sludge Storage Tank No.2 in the Sludge Thickening Building for holding until disposal.

The return sludge pumps are used to pump approximately 150 to 180 gallons per minute of activated sludge to the RDT. The operation of each return sludge pump is controlled by a VFD, and speeds are manually set by operators at the VFD. A separate flow meter is installed on the force main to the Operations Building to measure the waste sludge flow rate to the RDT.

5.3.1 Performance Evaluation

Using the Return Sludge Pumps, staff currently pump approximately 50,000 gallons per day to the RDT on weekdays, and approximately 30,000 gallons per day on weekends. The plant typically wastes 7 days per week. Staff would like a dedicated set of waste sludge pumps installed to separate return and wasting.

5.3.2 Operations and Maintenance Evaluation

The current return sludge pumps are new and were installed in 2020/2021, however staff would like to install a dedicated set of waste sludge pumps to minimize the attention that is required to manually waste during the workday. Installing new pumps and dedicated piping for wasting sludge will minimize staff time by automating wasting over a set period of time.

5.3.3 Process Alternatives Evaluation

The following waste sludge pumping alternatives were evaluated:

- Maintain RSL pumps for wasting
- Install dedicated WSL pumps in basement of the blower building
- Automate wasting sludge to the RDT's

5.3.3.1 Maintain Return Sludge Pumps for Wasting

The existing Return Sludge Pumps would remain as currently configured to waste activated sludge to the RDT. A motor operated ball valve could be installed upstream of the waste sludge flowmeter and be programmed to be interlocked with the operation of the RDT so that it is only called to open when the RDT is in operation and send a specified sludge flow to the RDT for processing.

5.3.3.2 Install Dedicated Waste Sludge Pumps in the Blower Building Basement

Two new dedicated Waste Sludge Pumps would be installed in the basement of the blower building for wasting activated sludge. The new sludge pumps would be either rotary lobe, or recessed impeller centrifugal pumps and be coordinated with the selection of the new primary sludge pumps for consistency. New suction piping will be tapped off of the existing activated sludge suction header and routed to the two new waste sludge pumps. Potential locations for the two new pumps in the Blower Building basement include adjacent to the secondary scum pump or within the polymer containment area.

With the current Return Sludge Pumps, operators can waste approximately 150 to 180 gpm of activated sludge. The new pumps would be sized for up to 300 gpm and provided with VFDs, to allow operators to adjust the desired waste rates depending on if the system is operated automatically or manually and to be capable of utilizing the full design capacity of the rotary drum thickener equipment.

5.3.3.3 Automate Wasting and RDT Operation

Whether the PAF continues to waste using the return sludge pumps or installs two new waste sludge pumps, programming of the waste sludge thickening system can be implemented to allow for extended operation of the wasting and RDT system to waste for up to 24 hours per day instead of only during the times when the plant is staffed.

5.3.4 Recommendations

Two new dedicated rotary lobe or centrifugal waste sludge pumps are recommended to be installed in the basement of the Blower Building with a design capacity of 300 gpm at full speed. The pump type will need to be further evaluated during the preliminary design phase to be consistent with other solids handling pumps being provided. It is also recommended that additional programming, controls and alarming to be implemented to allow for the capability of 24/7 wasting and thickening. In all cases, these recommendations should be coordinated with the overall recommendations for Solids Handling at the PAF.

5.4 Secondary Sludge Thickening

Secondary sludge is mechanically thickened in a Rotary Drum Thickener (RDT). There is a single RDT at the Groton PAF installed in 2003. The unit is manufactured by Ipec and has a rated hydraulic capacity of 300 gpm. The RDT is fed by the return sludge pumps and the thickened waste sludge produced is pumped by one of two thickened waste sludge transfer pumps to Sludge Storage Tank No. 2 where it is stored until it is pumped onto hauler trucks for off-site disposal. The thickened waste sludge transfer pumps are 15 HP progressive cavity Flygt pumps installed in 2003 with an unknown rated capacity, however they are large enough to keep up with the discharged sludge from the RDT.

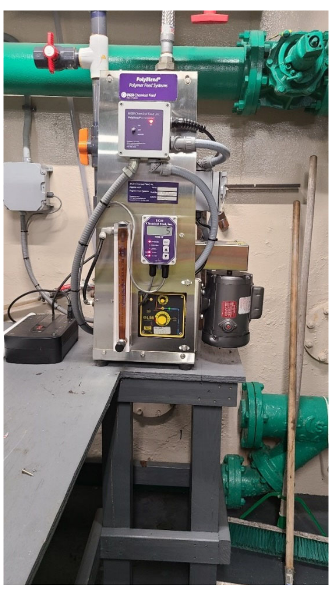
Waste activated sludge is conditioned with an emulsion polymer prior to being thickened in the RDT. Polymer is diluted, activated and blended with the unthickened waste sludge in a flocculation tank prior to thickening. A new Polyblend packaged polymer feed skid was installed in 2020 and operates with no issues.

Figure 5-3 Rotary Drum Thickener

5.4.1 Performance Evaluation

The RDT performs as intended with a thickened waste sludge product averaging 4% solids. It should be noted that the RDT can produce an even thicker sludge, but the plant is currently limited by the ability to transfer sludge over 4% to SST No. 2 with the thickened waste sludge transfer pumps.

Figure 5-4 Polymer Blending Unit



5.4.2 Operations and Maintenance Evaluation

The RDT operates well with minimal maintenance. Only one of the thickened sludge transfer pumps is operational. The on-line pump is functional but is undersized for the application and does not allow for the RDT to thicken waste sludge to greater than 4% solids. There is also no redundancy for the RDT. When it is down for maintenance, the PAF has the ability to send waste activated sludge to the primary clarifiers where it can be co-settled with the primary sludge prior to anaerobic digestion.

5.4.3 Process Alternatives Evaluation

The following waste sludge thickening alternatives were evaluated:

- Replace thickened waste transfer pumps
- Automate RDT operation

Figure 5-5 Thickened Waste Sludge Transfer Pumps

5.4.3.1 Replace Thickened Waste Sludge Pumps

The two existing progressing cavity pumps would be replaced with new rotary lobe or progressing cavity sludge pumps with a design capacity of 100 gpm. The existing pumps would be removed, and the new pumps would be installed on the existing/modified concrete pedestals. The pedestals would be expanded as needed to accommodate the new pumps. The suction and discharge piping will be modified as needed to connect to the pump inlets and outlet flanges.

5.4.3.2 Automate Wasting and RDT Operation

Programming of the waste sludge thickening system can be implemented to allow for extended operation of the wasting and RDT system to waste for up to 24 hours per day instead of only during the times when the plant is staffed.

5.4.4 Recommendations

Thickening waste sludge in the RDT is recommended to continue at the Groton PAF. The RDT is currently 19 years old and should be rebuilt or replaced in the next 5-10 years. System automation should also be considered to allow for continuous waste sludge thickening 24/7 in lieu of only during the workday. The PAF has operated well with only one RDT. Installing a second unit will be costly and will require significant modifications to the Operation Building first floor. As noted above, waste sludge can be cossetted in the primary settling tanks for periods of time when the RDT is down for maintenance.

Two new thickened waste sludge pumps are recommended to be installed in the basement of the Operations Building with a rated design capacity of 100 gpm each. The pump type will need to be further evaluated during the preliminary design phase to be consistent with other solids handling pumps being provided. It is also recommended that additional programming, controls and alarming at the RDT be implemented to allow for the capability of 24/7 wasting and thickening. In all cases, these recommendations should be coordinated with the overall recommendations for Solids Handling of the PAF.

5.5 Sludge Storage

There are two 35-foot diameter sludge storage tanks at the Groton PAF. The tanks were originally constructed in the 1950's as anaerobic digesters until the new anaerobic digester tanks and digester building was constructed during the 1970's upgrade. Each tank has a working volume of 180,000 gallons, for a total available storage volume of 360,000 gallons. Currently only Sludge Storage Tank (SST) No. 2 is in service to store thickened waste activated sludge produced by the Rotary Drum Thickener (RDT). The tanks were retrofit with new aluminum dome covers in 2000 and both tanks are in good condition internally and externally. The building space between the two tanks is mostly unused with the exception of a truck loading pump, used to pump thickened waste sludge from SST No. 2 to hauler trucks. The truck loading pump is a 7.5 HP Vaughn centrifugal chopper pump installed in 2004 with a rated capacity of 300 gpm.

Figure 5-6 Sludge Truck Loading Pump

5.5.1 Performance Evaluation
The sludge storage tank and truck loading pump perform as intended and there are there are no known issues.

5.5.2 Operations and Maintenance Evaluation
The sludge storage tank and truck loading pump operate as intended and there are there are no known issues.

5.5.3 Process Alternatives Evaluation
As part of the overall solids handling evaluation, one or both of these tanks will continue to be utilized for sludge storage whether anaerobic digestion is continued or not. Any alternatives evaluated for these tanks are discussed in further detail in coordination with the solids stabilization and disposal portion of this section.

5.6 Solids Stabilization and Disposal
Primary solids are digested using mesophilic anaerobic digestion. At the Groton PAF, this process consists of a primary digester and a secondary digester with an intermediate building that houses digester mixing pumps, digester sludge boiler, heat exchanger and sludge recirculation pumps.

5.6.1 Primary Digester
Approximately 3,000 gpd of 2-4% thickened primary sludge from the primary settling tanks is pumped to the primary digester. The sludge temperature in the digester is maintained at 100°F on average by a heating system consisting of recirculation pumps, a boiler, and a heat exchanger. The heat exchanger is fueled by digester gas with an exterior propane tank as backup. Digested sludge in the primary digester is mixed by one of two Vaughn centrifugal pumps installed in 2020 (1,390 gpm) and 2022 (1,000 gpm), respectively. The tank has a fixed cover that is uninsulated and replaced in 2000. The design residence time in the digesters is 20 days. Excess gas that is not utilized by the heating system is flared off.

Figure 5-7 Digester Mixing Pump

5.6.2 Secondary Digester

Primary digested sludge from the primary digester overflows to the secondary digester where it is stored prior to disposal. This tank is neither heated nor mixed. However, the new mixing pumps recently installed by PAF staff have piping and valving to allow for mixing of the secondary digester tank during times where it becomes too thick to move product. The tank has a floating cover which provides for the storage of biogas. Liquid primary digested sludge was designed to be loaded onto hauler trucks by one of two Digested Sludge Transfer pumps in the basement of the Operations Building. The majority of the time, these pumps are unable to load trucks from the Secondary Digester. Currently, digested sludge is loaded onto hauler trucks by gravity from the Secondary Digester. The floating cover was replaced in 2000.

Plant staff decant the primary digester during the weekends by about 1 to 3 feet which helps with the process ahead of when Electric Boat pumps on Mondays. There is no basis for how much decant is removed from the tanks, Plant staff currently visually estimate the quantity decanted.

The anaerobic digestion system basis of design is presented in Table 5-2.

Table 5-2 Anaerobic Digesters Basis of Design

Treatment Process	Design Criteria		Typical Standard1
Digester Tanks			
Type	Two-Stage High-Rate Digestion		
Number of Tanks	2		
SRT, days[2]	26		15 - 30
Target Temperature, 0F	100 (mesophilic)		95 - 100
Feed Solids, %	2-4		4-6
	Primary Digester Tank	**Secondary Digester Tank**	
Diameter, ft	40	40	
Max Water Depth, ft	21	21	
Volume, gal	260,000	260,000	
Digester Heating Recirculation Pumps			
Number	2		
Capacity, gpm	350		
Motor HP	7.5		
Heat Exchanger			
Number	1		
Capacity	560 MBTU/hr		
Boiler			
Number	1		
Capacity	560 MBTU/hr		
Digester Mixing Pumps			
Number	2		
Capacity, gpm	1,900 & 1,000		
Motor HP	20 & 15		
Digested Sludge Transfer Pumps			
Number	2		
Capacity, gpm	250		
Motor HP	20		

1. Technical Resource (TR-16) Guides for the Design of Wastewater Treatment Facilities. 2016.
2. Estimated based on maximum month flows, primary digester only.

5.6.3 Performance Evaluation

The digesters have performed as designed, with average digester volatile solids destruction (50%+) typical of mesophilic digestion with 20-day residence time. The primary digester tank is currently mixed with a Vaughn chopper pump that simply recirculates/turns over the contents of the tank by drawing off the tank bottom and discharging through the top of the fixed cover. The primary digester is mixed continuously. The Secondary Digester is currently not mixed. However, the PAF is currently making provisions to allow for use of the Vaughn mixing pumps to mix the contents of the Secondary Digester if the contents become too thick to pump to hauler trucks. The new mixing pumps work well to keep the tank sufficiently mixed.

The primary digester recirculation pumps are 7.5 HP Vaughn centrifugal pumps installed in 1993 with a design capacity of 300 gpm each. The pumps work well but are approaching the end of their useful life.

The heating system including boiler and heat exchanger were replaced in 2015 and provide enough capacity to keep the primary digester at proper temperature.

Digested sludge is removed from the Secondary Digester and loaded onto a 6,500-gallon tanker truck by one of two digested sludge transfer pumps in the basement of the Operations Building one to three times per month on average. These pumps were originally used to transfer sludge from the digester and to load thickened digested sludge onto hauler trucks for off-site disposal. The pumps are currently old and don’t perform well. Most of the time sludge is drained by gravity which is problematic due to the extended time it takes to load a truck.

5.6.4 Operations and Maintenance Evaluation

Digester maintenance and operation is often tedious and time consuming when the tanks are not running efficiently and often times requires assistance of a 3rd party vendor. Although the gas and heating systems were installed in 2015, regular maintenance is paramount to maintain efficient and safe operation of the digestion system.

The tank covers were installed in 2000 but several welds have failed on the Secondary Cover requiring repairs. It was also reported in the 2013 Facilities Plan that the interior concrete walls are beginning to deteriorate and will require rehabilitation in the future if digestion is continued.

The waste gas flare works well and has no reported issues.

5.6.5 Process Alternatives Evaluation

Anaerobic digestion is currently effective in conditioning and reducing the volume of primary biosolids prior to disposal at the Groton PAF. With a recommended design loading criteria (TR-16, 2016 Edition) of 0.12 to 0.16 lb volatile solids per cubic foot (lb VS/ft3), and assuming 90% volatile fraction, the maximum digester solids feed is 3,600 to 4,800 lb/day. To ensure sufficient stabilization of biosolids, it is necessary to maintain a solids residence time in the primary digester or at least 20 days on average. The primary digester has a volume of 260,000 gallons, and the original design criteria for the residence time in the digesters was 20-days, which limits feed to the digester to 13,000 gpd.

Current and design year average and maximum month solids production is presented in Table 5-1. These values were used to determine hydraulic and solids loading rates if digestion was continued, and to determine the number of days of available sludge storage in existing converted tankage if digestion was eliminated.

5.6.5.1 Alternative 1A – Continue Anaerobic Digestion of Primary Sludge

Alternative No. 1A would continue to anaerobically digest primary sludge, thicken waste sludge, and dispose of each product separately. This alternative will serve as the baseline for the present worth evaluation. Over the 20-year planning period, the following improvements are recommended:

- Repair deteriorating concrete on interior walls of the Digester Tanks
- Rehabilitate the Primary Digester Fixed Cover and Secondary Digester Floating Cover
- Maintain the Heat Exchanger and Gas System
- Replace the heated sludge recirculation mixing pumps
- Replace the digested sludge transfer pumps or install piping and valving to allow for the existing mixing pumps to be used to load hauler trucks

5.6.5.2 Alternative 1B – Anaerobic Digestion of Combined Primary and Thickened Waste Sludge

Alternative No. 1B would anaerobically digest combined primary and thickened waste sludge and disposing of one combined product. To determine if this option is viable, an evaluation was conducted to determine if there is sufficient digester capacity to handle both primary and waste sludge while maintain a 20-day residence time at design year conditions. The RDT produces a solids concentration of 4.0% on average, although it can potentially produce up to 6% if new thickened waste sludge pumps are installed to transfer sludge to Sludge Storage Tank No. 2 or some other location. Assuming new pumps will be installed, a thickened waste sludge concentration of 5% TS was assumed, resulting in an additional 1,920 gpd (or 800 lbs/day) of waste sludge fed to the Primary Digester at design average conditions. The combined design average hydraulic loading of 8,160 gpd (6,240 gpd primary + 1,920 gpd waste) and design average solids loading of 2,360 lbs/day (1,560 lbs/day primary + 800 lbs/day waste) are within the system's capacity of 12,500 gpd and 3,100 lbs/day respectively. Alternative 1B is feasible if anerobic digestion is continued. This alternative will also significantly reduce sludge disposal costs by reducing the total volume of sludge to be disposed.

Over the 20-year planning period, the following improvements are recommended:

- Repair deteriorating concrete on interior walls of the Digester Tanks
- Rehabilitate the Primary Digester Fixed Cover and Secondary Digester Floating Cover
- Maintain the Heat Exchanger and Gas System
- Replace the heated sludge recirculation mixing pumps
- Replace the digested sludge transfer pumps or install piping and valving to allow for the existing mixing pumps to load hauler trucks
- Install piping and valving to allow for thickened waste sludge to be fed directly to the primary digester
- Install new sludge transfer pumps to pump thickened waste sludge from the sludge storage tanks to the primary digester

5.6.5.3 Alternative 2A – Eliminate Anaerobic Digestion and Dispose of Liquid Sludge

Alternative No. 2A would eliminate the use of the anaerobic digesters and allow for the disposal of blended thickened liquid sludge at 5% TS on average. To achieve a 5% TS blend, primary sludge would need to be further thickened prior to blending with thickened waste sludge for off-site disposal. Primary and waste sludges will be stored separately to minimize odor generation and high strength recycle streams and will only be blended prior to disposal. One driving factor in evaluating the elimination of anaerobic digestion is to determine if there is enough available storage volume on site for at least 3-days at design maximum month conditions in any combination of available tankage. The number of days of storage at design max month conditions for Alternative 2A and 2B are presented in Table 5-3. As shown in Table 5-3, there is sufficient capacity in the existing Sludge Storage and Digester Tanks in multiple combination of uses when considering the elimination of digestion as an alternative. However, the sludge storage tanks and digesters are too large to properly mix the contents of the tank. As a result, the tanks will be partitioned off to store and mix a sludge volume equivalent to 5-days of storage.

Table 5-3 Available Sludge Storage Volumes – No Digestion

Tank	Available Volume (Gallons)	Thickened Primary Sludge (gal/day)	Storage (days)	Thickened Waste Sludge (gal/day)	Storage (days)
Sludge Storage Tank No. 1	180,000	5,200	34	2,550	70
Sludge Storage Tank No. 2	180,000	5,200	34	2,550	70
Primary Digester	Converted to Gravity Thickener				
Secondary Digester	250,000	5,200	48	2,550	98

Note: Assumes thickened primary sludge at 5% TS and thickened waste sludge at 5% TS.

Over the 20-year planning period, the following improvements are recommended:

- Rehabilitate and convert either the Primary Digester Tank or Sludge Storage and No. 2 to a Gravity Thickener with odor control to thicken primary sludge to 5% TS.
- Rehabilitate and convert a portion of the Secondary Digester to a thickened primary sludge storage tank with a concrete divider wall. Odor control and mixing will also be provided
- Repurpose the digester mixing pumps to not only be used for mixing, but also to be used for transferring thickened primary sludge from the gravity thickened to the thickened sludge storage tank or for transferring thickened primary sludge from the thickened sludge storage tank to the sludge blend tank
- Convert Sludge Storage Tank No. 1 to a blended sludge storage tank with a concrete divider wall. Odor control and mixing will also be provided
- Install transfer pumps to transfer thickened waste sludge from Sludge Storage tank No. 2 to the Blended Sludge Storage Tank
- Utilize the existing thickened waste sludge transfer pump, with minor piping modifications, to load blended liquid sludge onto trucks. Install a 2nd back-up truck loading pump

5.6.5.4 Alternative 2B – Eliminate Anaerobic Digestion and Dispose of Dewatered Sludge

Alternative No. 2B would eliminate the use of the anaerobic digesters and install dewatering equipment to produce a sludge cake of approximately 22% prior to disposal. There is no available space on the Groton PAF site for a new Dewatering Building. If dewatering equipment is installed, one option is to convert the Secondary Digester Tank to a dewatering facility. Primary and waste sludges will be stored separately to minimize odor generation and high strength recycle streams and will only be blended prior to dewatering.

Over the 20-year planning period, the following improvements are recommended:

- Rehabilitate and Convert the Digester Building to a dewatering building with a container bay, dumpster, and overhead door at grade with a 2nd elevated floor/platform housing dewatering equipment, polymer and electrical and control equipment. For purposes of this evaluation, two screw presses were assumed.
- Repurpose the digester mixing pumps and install new pumps for mixing, sludge transfer, and dewatered sludge feed
- Convert one of the sludge storage tanks to a gravity thickener and the other to a combined thickened waste, thickened primary sludge and sludge blend tank with concrete partition wall. Odor control and mixing will also be provided

5.6.6 Combined Heat and Power System

The PAF has considered installing Combined Heat & Power (CHP) systems for cogeneration on the existing digesters to utilize the methane in the biogas and produce energy in the past. GU staff reported that a feasibility study was conducted by Fuss & O'Neill several years ago concluding that the installation a CHP system had no financial benefit. This result is typical for treatment plants with existing anaerobic digesters and an average daily flow of less than 9.0 mgd.

5.6.7 Sludge Disposal and Truck Loading

Primary and waster sludges are disposed of separately at the Groton PAF as discussed throughout this section. There is a common truck loading station and spill containment area along the eastern exterior wall of the Operations Building. Currently, thickened waste sludge is loaded onto hauler trucks at 300 gpm, filling a 6,500-gallon tanker in approximately 20 to 30 minutes. Digested primary sludge is loaded onto hauler trucks one to three times per month by gravity which is not desirable and limited by the level in the Secondary Digester. Upgrades or replacements to the existing sludge loading equipment and operations are included as part of the overall solids handling recommendation. At a minimum, if liquid sludge disposal is maintained, the truck loading station will remain, and a new odor control connection will be provided. Truck access is problematic, requiring cars to be moved when a truck is on-site to load sludge. However, the PAF is very tight and relocation of the truck loading area is not feasible.

Figure 5-8 Sludge Truck Loading Area

5.6.8 Life Cycle Cost Analysis

A 20-year life-cycle cost analysis for each of the four alternatives above was completed including capital, operation, maintenance, and sludge disposal costs. The results are presented in Table 5-4.

Table 5-4 Sludge Stabilization and Disposal Alternatives – Life Cycle Costs

Cost Item	Alternative 1A Baseline – Digestion of Primary Sludge	Alternative 1B Digestion of Primary and Waste Sludge	Alternative 2A Eliminate Digestion & Dispose of Liquid Sludge	Alternative 2B Eliminate Digestion & Dispose of Sludge Cake
Total Project Cost	$1,779,000	$2,068,000	$4,026,000	$6,557,000
Construction Loan Rate	2.0%	2.0%	2.0%	2.0%
Loan Term, years	20	20	20	20
Capital Recovery (A/P, i%, n)	0.061	0.061	0.061	0.061
Annual Debt Payment	$109,000	$126,000	$246,000	$402,000
Operation/Maintenance Costs				
Operating/Maint. Cost ($/yr)	$76,900	$69,400	$37,500	$91,300
Sludge Disposal ($/yr)	$274,400	$222,500	$308,500	$140,000
Total Annual O&M Cost ($/yr)	$351,300	$291,900	$346,000	$231,300
Net Present Worth O&M ($)	$5,744,300	$4,772,600	$5,657,600	$3,782,100
Total Net Present Worth	$7,523,300	$6,840,600	$9,683,600	$10,359,100

Note: Operations costs include liquid sludge disposal at $0.15/gallon, cake solids disposal at $350/dry ton and electricity at $0.15/kW-hr.

5.6.9 Recommendations

As show in Table 5-4, Alternative 1B, Digestion of Primary and Waste Sludge, is the most cost-effective solids handling alternative over the 20-year planning period. Due to site limitations and the recent replacement of sludge mixing pumps, boiler and heat exchanger, controls, and building HVAC equipment in 2015, it is not economically feasible to discontinue anaerobic digestion at this time. However, another study is recommended prior to the next scheduled replacement of major digester equipment.

In summary, the following immediate improvements are recommended to the solids handing process at the Groton PAF:

- Repair deteriorating concrete on interior walls of the Digester Tanks
- Rehabilitate the Primary Digester Fixed Cover and Secondary Digester Floating Cover
- Replace the heated sludge recirculation mixing pumps

- Replace the digested sludge transfer pumps or install piping and valving to allow for the existing mixing pumps to load hauler trucks
- Install piping and valving to allow for thickened waste sludge to be fed directly to the primary digester
- Install sludge transfer pumps to pump thickened waste sludge from Sludge Storage Tank No. 2 to the primary digester

It is also important to note that Alternative 1B will reduce the amount of liquid sludge hauler trucks in/out of the facility from 280 to 230 trucks per year.

6

Wright-Pierce
Engineering a Better Environment

Section 6 Plantwide Support Systems

An evaluation was performed on the odor control system, on-site buildings, structures and process tankage by architectural, structural, process, mechanical, instrumentation and electrical engineers in October of 2021. This section of the report will serve to summarize the results of those evaluations and present recommended immediate improvements (0-5 years) and future improvements (6+ years). Refer to Appendix D for detailed site visit evaluation memorandums from each building discipline and Section 11 for a summary of the timing to implement the recommend improvements as part of the overall capital improvements plan.

6.1 Odor Control

Odor control at the GU PAF is provided by a single-stage vertical packed bed chemical scrubber system installed in 1985. The scrubber system was originally designed to exhaust odorous air from the preliminary treatment area (grit and screenings) and the control room (vacuum filter) in the Operations Building. Over time, the ductwork for the scrubber system was modified by capping areas from less odorous spaces in the Operations Building and new ductwork was added to exhaust odorous air from the rotary drum thickener, sludge hauling truck vent, Sludge Storage Tank No. 2 and the primary settling tanks. The system does not currently function per the original design, and plant staff currently add chlorine tablets on a weekly basis in an attempt to maintain the required chemistry to scrub the odors from the air stream.

Numerous odor complaints, typically limited to one neighbor who resides across the street from the facility, have been recorded and logged by GU since July 2019. GU has been proactive in investigating the source of the suspected odors. In June 2020, GU hired Hazen and Sawyer to evaluate the existing facility and operations towards understanding potential odor sources and mitigation measures. The findings from the Hazen and Sawyer report indicated that on the day of the site visit detectable odors were generally low and operational practices at the facility which may have been exacerbating odor generation was not observed. GU also had the CT DEEP visit the site in September of 2020. The DEEP report summarized that the odor control and plant process systems appeared to be operating properly with no odors noted beyond the plant boundaries based on a walkthrough of each process area including the remote pump stations.

At the request of GU, the odor control evaluation portion of the facilities plan was expedited and completed in October 2021, resulting in the recommendation of complete replacement of the existing odor control system with a newer more efficient technology as an immediate improvement. The project is currently in the design phase with an expected construction start date in late 2022. The following alternatives are under consideration to provide odor control of the preliminary treatment area, rotary drum thickener and truck loading areas with room for expansion:

- Alternative No.1: Reuse existing scrubber followed by a carbon system
- Alternative No. 2: New Packed Bed Wet Chemical Scrubber System
- Alternative No. 3: New Carbon System

Refer to Appendix E for additional information on the findings and recommendations of the October 2021 evaluation. In addition to treatment of process air streams, the project will evaluate the need for odor control or containment for the dumpster located at the northwest corner of the Operations Building. This dumpster can either be retrofitted with a removable odor control connection or it can be installed inside of an existing or new building addition that is odor controlled.

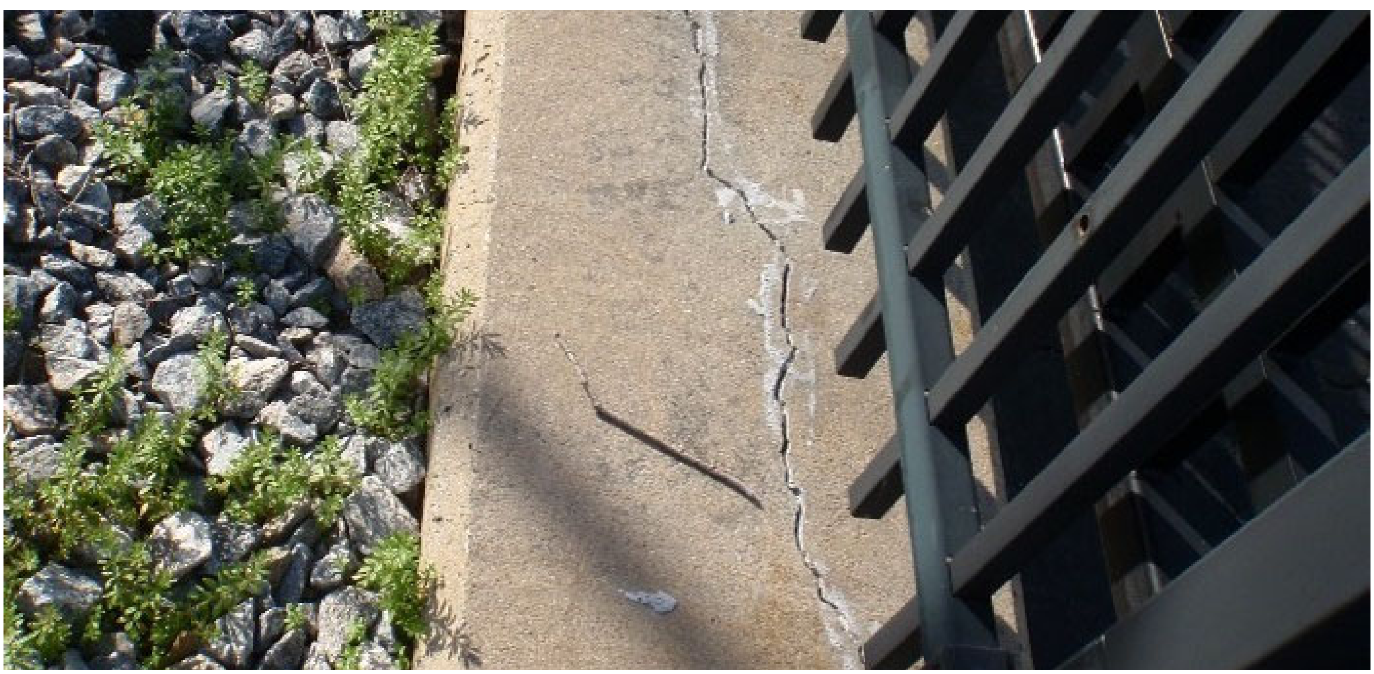
6.2 Civil/Site Evaluation

The Groton PAF is located on a low lying 1.96-acre parcel at 311 Thames Street. The site is bound by Thames Street to the east and the Thames River to the west, north and south. In the 1970s, the plant was expanded to include secondary treatment. The expansion required construction of tankage and buildings in the Thames River, supported on piles. The site is split by the VE and AE FEMA flood zones. A cursory review of the site's storm drainage, paved parking areas, retaining wall and fencing/site security was conducted.

6.3 Retaining Wall

Along the east side of the plant a concrete retaining wall of varying height separates the higher sidewalk and roadway from the lower plant site. The retaining wall is in fair to poor condition considering its age. The face of the wall shows map cracking throughout its entirety and wide longitudinal cracks observed along and near the top of the wall. These are telltale signs of what is probably alkali-silica reactivity (ASR). This is a chemical reaction between reactive aggregate and alkalis present in the concrete that creates an expansive gel causing the concrete to deteriorate internally. To attempt to reduce accelerated deterioration, longitudinal cracks along and near the top of the wall should be routed and sealed to prevent precipitation from direct entry into the interior of the wall. A new concrete cap on top of the wall, connected by drilling and epoxy grouting rebar, is another possible repair - though more costly and difficult given the existing fence mounted into the top of the wall. There are some remnants of previous repairs at the top longitudinal cracks. ASR requires moisture, so the drier the concrete can be kept, the slower any additional reaction will be. Unfortunately, the retained soil is expected to be a continual source of moisture. The exposed face of the wall could be sealed, but if the interior of the wall is already saturated, and because the exposed face of the wall isn't expected to be the primary source of water, it may be of little benefit. ASR will also stop once the alkalis available in the concrete are used up in the associated chemical reactions.

Figure 6-1 Retaining Wall Longitudinal Cracking



The metal fence along the top of the wall is significantly leaning and needs to be replaced or reset. A vertical steel strap fastened to the face of the wall and the fence has been installed. The strap was likely installed straight, but it is bent, which could indicate further displacement of the fence since its installation. Any displacement of the wall due to ASR will also affect the fence because it is directly connected into the top of the wall.

Figure 6-2 Perimeter Fencing

6.4 Site Storm Drainage

There is a series of catch basins and drain manholes that are used to collect stormwater from the site and convey it to the Thames River at the southern end of the plant behind the Generator Building. There is a catch basin in front of the Operations Building Garage that discharges back to the influent of the plant. There is also a catch basin in the paved area off the northeast corner of the Final Settling Tanks at a low spot where the majority of the site drainage sheet flows to. There is a very short concrete wall that is effectively the north edge of the treatment plant site. The wall has a small slide gate used to accelerate drainage of surface water after flooding if the catch basin cannot keep up. In this area, there are sizable holes in the pavement and severe soil erosion below. This indicates that a drainage path developed independent of those provided by the catch basin and the slide gate. This area is expected to continue to erode, especially with future flood events and should be excavated and stabilized. This location is in proximity to the transition between the ground-supported part of the plant to the east and the pile-supported part of the plant to the west.

Figure 6-3 PAF Site Stormwater Outfall

6.5 Parking Areas & Pavement Condition

Parking for employee vehicles and visitors is limited at the facility and is available on the east side of the Blower Building and north side of Primary Settling Tanks 3 & 4. There are also 4-5 visitor parking spots along the east side of the Final Settling Tanks. However, any cars that are parked there need to be moved if the PAF is accepting any deliveries or if sludge trucks are on-site to haul away liquid sludge. The pavement throughout the facility is in fair condition with many surface cracks present through all areas of the facility. These cracks will continue to grow and break up the pavement through freeze thaw cycles and winter plowing. Resurfacing of the entire parking area and replacement of the subbase material is recommended. Thickened pavement areas are also recommended for high truck traffic and turning areas to extend the life of the pavement. There is little opportunity to add parking spaces and every effort should be made to maintain the current number of parking spaces at the facility.

6.6 Architectural

The Groton Utilities PAF consists of multiple buildings and structures required to treat wastewater for the City of Groton. The Operations Building and adjacent Sludge Digester Building were constructed in 1955 as part of the original treatment plant. The Blower Building and Digester Building were constructed in 1972 as part of the secondary treatment facilities. With the exception of a metal storage building adjacent to the Digester Building, the buildings are all of steel and concrete framing, with masonry walls of concrete block and brick veneer, with flat roofs. Any work in existing buildings is governed by the International Existing Building Code.

6.6.1 Operations Building

The Operations Building is a 74’ long by 61’ wide 1-story, flat roofed building completed in 1955. It is about 15’ tall, with an additional 5’ tall roof monitor over a portion of the building. The roof is EPDM on concrete decking. The site inspections yielded the following immediate and future improvements.

6.6.1.1 Immediate Improvements

- Replace EPDM Roof and trim

6.6.1.2 Future Improvements

- Clean the brick veneer. Repoint a percentage of the masonry joints. Replace all sealants at control joints and openings. Repair/Reconstruct brick corners where there is brick cracking and evidence of settlement in the corners
- Replace window sealants
- Replace exterior doors, frames and hardware
- Caulk and paint louvers
- Miscellaneous interior painting

6.6.2 Blower Building

The Blower Building is a 64’ long by 42’ wide 1-story, flat roofed building completed in 1972. It is about 14’ tall. The roof is ballasted EPDM on concrete decking. The site inspections yielded the following immediate and future improvements.

6.6.2.1 Immediate Improvements

- None

6.6.2.2 Future Improvements

- Clean the brick veneer. Repoint a percentage of the masonry joints. Replace all sealants at control joints and openings
- Replace windows and integral window/louvers with new thermally broken aluminum windows with appropriate hurricane rating
- Replace exterior doors, frames and hardware including the overhead door
- Miscellaneous interior painting

6.6.3 Digester Building

The Digester Building is a 110’ long by 43’ wide 2-story, flat roofed building completed in 1972 as part of the Secondary Treatment project, and shares many characteristics with the Blower Building. It is about 25’ tall. The roof is EPDM on concrete decking.

6.6.3.1 Immediate Improvements

- Replace EPDM roofing. In addition, the east curtainwall has a projecting roof where the soffit shows significant rusting, indicating a roof leak that should be located and repaired. Replace lower roof soffit

6.6.3.2 Future Improvements

- Clean the brick veneer and cast stone belt coursing. Repoint a percentage of the masonry joints. Replace all sealants at control joints and openings. Inspect roof coping stones and flashings, reset selected stones and replace joint sealants. Repair cracks in walls at roof bulkhead. Investigate rust visible at steel angles supporting roof bulkhead walls
- Replace windows and integral window/louvers with new thermally broken aluminum curtain wall assemblies with appropriate hurricane rating. Replace window at roof bulkhead and inspect lintel for rust and decomposition
- Replace doors and hardware with new thermally broken aluminum doors.
- Miscellaneous interior door replacements and interior painting.

6.6.4 Sludge Storage Building

The Sludge Thickening Building is a 96’ long by 36’ wide 2-story, flat roofed building completed in 1955 as part of the Operations Building construction, and shares many of its characteristics. It is about 18’ tall. The roof is EPDM on concrete decking.

6.6.4.1 Immediate Improvements

- Replace EPDM roofing and canopy soffit

6.6.4.2 Future Improvements

- Clean the brick veneer and cast stone belt coursing. Repoint a percentage of the masonry joints. Replace all sealants at control joints and openings. Inspect roof copings and flashings, reset selected stones and replace joint sealants
- Replace windows with new thermally broken aluminum windows
- Replace exterior doors with new thermally broken aluminum doors and new hardware
- Miscellaneous interior door replacements and interior painting

6.6.5 Generator Building

The Generator is an approximately 25’ long by 15’ wide 1-story, flat roofed building constructed in 1993. There are no available drawings on the building, but it is in fair to poor condition. The site inspections yielded the following immediate and future improvements.

6.6.5.1 Immediate Improvements

- Replace roof and siding

6.6.5.2 Future Improvements

- Miscellaneous interior painting

6.7 Structural

The Groton PAF underwent an upgrade in 2015 that focuses on concrete repair and coatings in the Primary Settling tanks, Final Settling Tanks, Primary Effluent Pump Station wetwell, Digester overflow boxes and Sludge Mixing Chamber. A cursory look at these structures was conducted to evaluate how the tanks have held up over 5 years’ time. The PAF staff also drained the west aeration tank for a more detailed inspection during the visit. All repair and coatings work has held up with the following additional items noted:

6.7.1 Immediate Improvements

- Remove vegetation in below grade channel of the Aeration Tanks to prevent roots from penetrating the concrete
- Repair or replace primary and secondary digester covers if digestion is continued
- Repair interior walls of primary and secondary digester and consider concrete coatings if digestion is continued

6.7.2 Future Improvements

- Replace 36” high guardrails with OSHA required 42” high guardrails on two aeration tanks when tanks undergo renovations
- Remove and replace sealant in cracks along walkways and walls of aeration tanks
- Miscellaneous minor grout and concrete infills/repairs sitewide

6.7.3 Review of 2020 Pile Inspection Report

The Secondary Treatment Facilities were constructed in the 1970s on a 2'-6" thick reinforced concrete slab supported on approximately 530 concrete-filled steel pipe piles. In 2020, Groton Utilities hired divers to inspect the condition of the piles and a report was provided. The report noted that although the piles appear to be in good condition, there are eight piles along the north end that are not coated, or the coating has failed with about ½" loss of thickness. It is unclear if the loss is typical throughout each pile or is the maximum. Also, such estimated loss exceeds the wall thickness indicated on the typical pile detail on the design drawings of 5/16". It is possible that the design pipe thickness was changed if pressure-injected footings were used instead of the closed-ended driven piles shown on the plan. Regardless, such significant section loss is of concern because the steel pipe and concrete function compositely to resist loads, and the steel pipe also confines the concrete from failing. The report recommends another inspection in 5 years. During the next inspection, these items should be further investigated, and photographs provided and compared to the baseline measurements in the 2020 report. The diameter of the piles should also be verified.

6.8 HVAC and Plumbing

A site visit was conducted at the Groton, CT Wastewater Treatment Facility on October 19, 2021 in order to perform a facility walk-through and an evaluation of the facility's HVAC and plumbing systems. Based on these observations, immediate and future improvement recommendations regarding the existing heating, cooling, and air handling systems have been made including recommendations for upgrades, maintenance, and other restorative measures. It is noted that a comprehensive HAVC upgrade was conducted in the Blower Building & Digester Building in 2016.

6.8.1 Immediate Improvements

- Replace all old, inoperable or inefficient heating and ventilation equipment in the Operations Building complete. During the preparation of this facilities plan, design of this work is underway
- Reroute Operations Building Electrical Room AC duct to building exterior. Currently, the duct is connected to the odor control system which can create a potential hazard if the odor control system is shut down.
- Install functioning heating and ventilation in the Sludge Storage Building to maintain code compliance. Systems TBD depending on what that building's future use
- Provide new fresh air intake, damper, and supply fan at end of pipe gallery in the Blower Building Basement.
- Install two new electric unit heaters in the Maintenance Building and add ventilation to provide 0.75 cfm/sqft in accordance with vehicle repair garage requirements of mechanical code
- Add level and interstitial space leak monitoring at the 3,000-gallon diesel fuel tank and report it back to SCADA

6.9 Instrumentation and Controls

A meeting was held on site with Groton Utility Staff on October 5th, 2021. Following the meeting a site investigation was completed. Plant instrumentation and equipment were evaluated for the following metrics: general condition, obsolescence, maintenance, calibration, and its ability to provide accurate and actionable information to the plant SCADA system.

The last major instrumentation upgrade was completed in 1998. Many of the systems replaced or installed at that time are now defunct, obsolete, or abandoned in place. Most of the systems installed in the 2016 upgrade appear to be in a reasonable state. Discussions with GU staff indicate that a comprehensive SCADA upgrade for the PAF is being planned for.

The plant SCADA system is maintained under a separate contract by Woodard and Curran Inc. This includes a schedule of hardware replacements as well as periodic software updates and PLC and SCADA programming changes. In general, the SCADA system screens were adequate graphical representations of plant systems. However, there are numerous screen functions that no longer work due to defunct or removed field instruments and/or systems. Controls for those defunct systems should be either hidden from view or deleted, for clarity of system functions. SCADA access is only available in the Operations Building and the Blower Building. Installation of additional client terminals in strategic locations would optimize access to relevant information while staff is evaluating individual systems throughout the plant. Plant staff maintain individual logons with varying staff permission levels as is recommended by current cyber security guidelines.

The main SCADA server is a workstation type machine installed on a desk in the operations building. Prior to WP's visit the server had crashed due to overloading on the UPS that was shared with another PC system. The SCADA contractor installed a separate UPS exclusively for the SCADA server.

The plant wide network consists of the following network types; 900 MHz instrument radios, intra building radio links and a star fiber optic network connecting three of the buildings. It is recommended that the fiber optic network be reconfigured in a ring star topology with redundant links on the main loop. The odor control system, which is being evaluated for replacement, is using a 900MHz instrument transmitter attached to an H_2S sensor. The replacement system should utilize standard hardwired 4-20mA instruments connected to the Operations Building PLC directly.

Numerous pieces of equipment and instruments did not have the recommend stainless steel identification tags. Other instruments were labeled with sharpie marker. Clear and concise labeling of equipment, as it is identified in operations & maintenance manuals, aids in diagnostic troubleshooting and maintenance. Identification tags are of paramount importance for the purposes of reading the correct instrument and recording results. All equipment should be labeled with its corresponding ISA tag information.

Upgrading the existing plantwide SCADA system including control panels, PLCs, alarming and reporting system software including replacement of all site instruments pre-2016 upgrade is recommended as an immediate improvement, although phasing should be considered to coordinate with other plant improvements. A summary of major instrument replacements include:

- Gas Detection System in Headworks
- Influent flow meter
- Chlorine and pH analyzers
- Emergency shower flow switches
- Thermal mass air flow meters and motor operated valves on air piping
- Process line magnetic flowmeters
- Motor actuated valves
- Tank level instruments and back-up floats sitewide
- DO, ORP, pH and ammonia probes in the aeration tanks
- Effluent flow meter transducer and chlorine analyzer

6.10 Electrical

The existing service into the facility consists of an overhead medium voltage riser pole that connects underground to a pad mounted NEMA 3R enclosed transformer. The utility service transformer is 480/277VAC secondary and connects to a main 800 amp rated disconnect located in the Operations Building electrical room. There is an automatic transfer switch, and main distribution panel labelled MDP. From this panel, the 480 Volt power is fed to the Blower Building, Digester Building and Operations Building Motor Control Centers (MCCs). Listed below are the respective MCC's that are powered by the switchgear and building locations:

1. MCC-1A Operational Building
2. MCC-3 Blower Building
3. MCC-4 Digester Building

Figure 6-4 600kW Emergency Generator

All of the facilities are provided back-up power by a 600-kW diesel generator located in the Generator Building. As mentioned, there is an automatic transfer switch (ATS) that provides back up power to the entire plant. The generator was installed in 2003, is over 17 years old, and oversized for the plant. A load bank was installed for the generator, but it is no longer functioning.

A meeting was held on site with Groton Utility Staff on October 5th, 2021. Wright-Pierce staff also walked through the WPCF and took note of areas that would require improvements or should be upgraded in the near future.

6.10.1 Immediate Improvements

- Replace 600-kW generator with smaller, properly sized unit
- Replace all existing fluorescent lighting fixtures with LED fixtures or bulbs in the Blower Building, Operations Building, Generator Building and site lighting fixtures
- Replace corroded conduit supports in Headworks area
- Install door with labeling on Operations Building Electrical Room
- Investigate VFD programming on the Rotary Drum Thickener and Digester Heat Exchanger pump to allow for auto-restart of the equipment upon a power failure
- Remove/relocate locker cabinet from Operations Building Electrical Room to allow for proper clearance requirements

6.10.2 Future Improvements

- Replace Lighting Panel No. 1 in Blower Building garage
- Disconnect/remove any electrical panels or equipment no longer used or slated for re-use.
- Install E-stops on any pumps or equipment that do not have one
- Eliminate older MCC-1A and install smaller MCC
- Investigate and tie-in Digester and Sludge Storage Buildings to the sitewide fire alarm system depending on the future use of those spaces

7

Section 7 Flood Protection & Resiliency

7.1 Introduction

This section summarizes the storm resiliency measures for consideration at the Groton Utilities PAF. The evaluation includes:

- Establishing critical flood protection elevation(s) for the PAF Site based on regulatory standards
- Identifying equipment and structures that are located below the critical flood protection elevation that are vulnerable to flood and can be impacted due to a hazardous weather event
- Establishing resiliency and flood proofing measures that can be implemented to anticipate, absorb, accommodate, and recover from the effects of a potential storm in a timely and efficient manner thus allowing for the facilities continuous operation following a flood event.

7.2 Flood Protection Criteria

"Storm Resiliency of Municipal Wastewater Infrastructure: Sea Level Rise Change Scenario and Designing for Flood Levels Above BFE" memorandums in Appendix F, issued by the Connecticut Department of Energy and Environmental Protection (DEEP), serve as a guide for municipalities to prepare existing and proposed wastewater infrastructure to be resilient and better withstand the effects of severe weather events and impacts from climate change.

The "Storm Resiliency of Municipal Wastewater Infrastructure" memo indicates that all state funded wastewater projects must adhere to the minimum flood protection levels in "TR-16 – Guides for the Design of Wastewater Treatment Works" and the Flood Management Act (FMA). A summary of the various governing authorities dictating the flood elevation protection criteria for wastewater infrastructure in addition to TR-16 and FMA requirements were discussed with the DEEP and summarized below.

- **TR-16:** This guidance document requires all critical wastewater equipment and structures to be flood protected to withstand a 100-year BFE + 3-feet of freeboard at a minimum. All non-critical wastewater equipment shall be flood protected to 100-year BFE + 2 feet of freeboard. TR-16 defines critical equipment as conveyance and treatment system components identified for protection including, but not limited to, all electrical, mechanical, and control systems associated with pump stations and treatment facilities that are responsible for conveyance of wastewater to and through the treatment facility to maintain primary treatment and disinfection during the flood event.
- **FMA Requirements:** The FMA requirements pursuant to Connecticut General Statues (CGS) Section 25-68 requires the following protection criteria for facilities located in a coastal or inland boundary as listed below. The Act requires that state agencies proposing an activity within or affecting the flood plain or natural or man-made storm drainage facility must submit a flood management certification.
    - Critical Activity within Coastal Boundary – Storage of Chemicals – 500-year flood elevation+2 ft
    - Critical Activity within Inland Boundary – Storage of Chemicals – 500-year flood elevation
    - Non-Critical Activity within Coastal Boundary – Plants, facilities, pump stations – 100-year + 2 ft flood elevation
    - Non-Critical Activity Inland – Plants, facilities, pump stations – 100-year +1 ft flood elevation
- **Public Act 18-82:** "Sea Level Rise Change Scenario" memo issued by the DEEP states that municipalities need to account for sea level rise from climate change. The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) at UCONN which helps communities identify critical infrastructure at risk; measures the vulnerability

and identifies ways to reduce the vulnerability; prepared a report which predicted a static sea level rise of a 0.5 m (1 foot 8 inches) higher than the national tidal datum by 2050. The sea level rise requirements as suggested in the DEEP memo are stated in Public Act 18-82 and codified in CGS 25-68. Public Act 18-82 is a new updated statue related to climate change planning and resiliency, mainly targeting the reduction of greenhouse gas emissions, requires that all state funded critical activities be protected up to a design elevation of 500-Yr BFE plus a freeboard of 2 feet. The definition for critical activities is similar to that defined in the FMA requirements.

- **Connecticut State Building Code:** The State Building Code which references ASCE-24 considers all pump stations under a Flood Design Class 4 rating and structures/equipment will need to be protected to 100-year BFE elevation + 2ft or 500-year BFE, whichever is higher.

7.3 Establishing Base Flood Elevations

The following section describe the procedure used to establish the 100-year and 500-year flood elevations for the Groton PAF and in turn determine the criteria needed to protect the facility from impacts related to riverine and coastal flooding including flood protection criteria for sea level rise and associated impacts from limits of moderate wave action.

7.3.1 FEMA Mapping

Flood Insurance Rate Maps (FIRMs) which are official flood maps used in the National Flood Insurance Program, were downloaded from FEMA's website for the PAF site and are shown in Figure 7-1. FEMA typically establishes BFE's in the following zones:

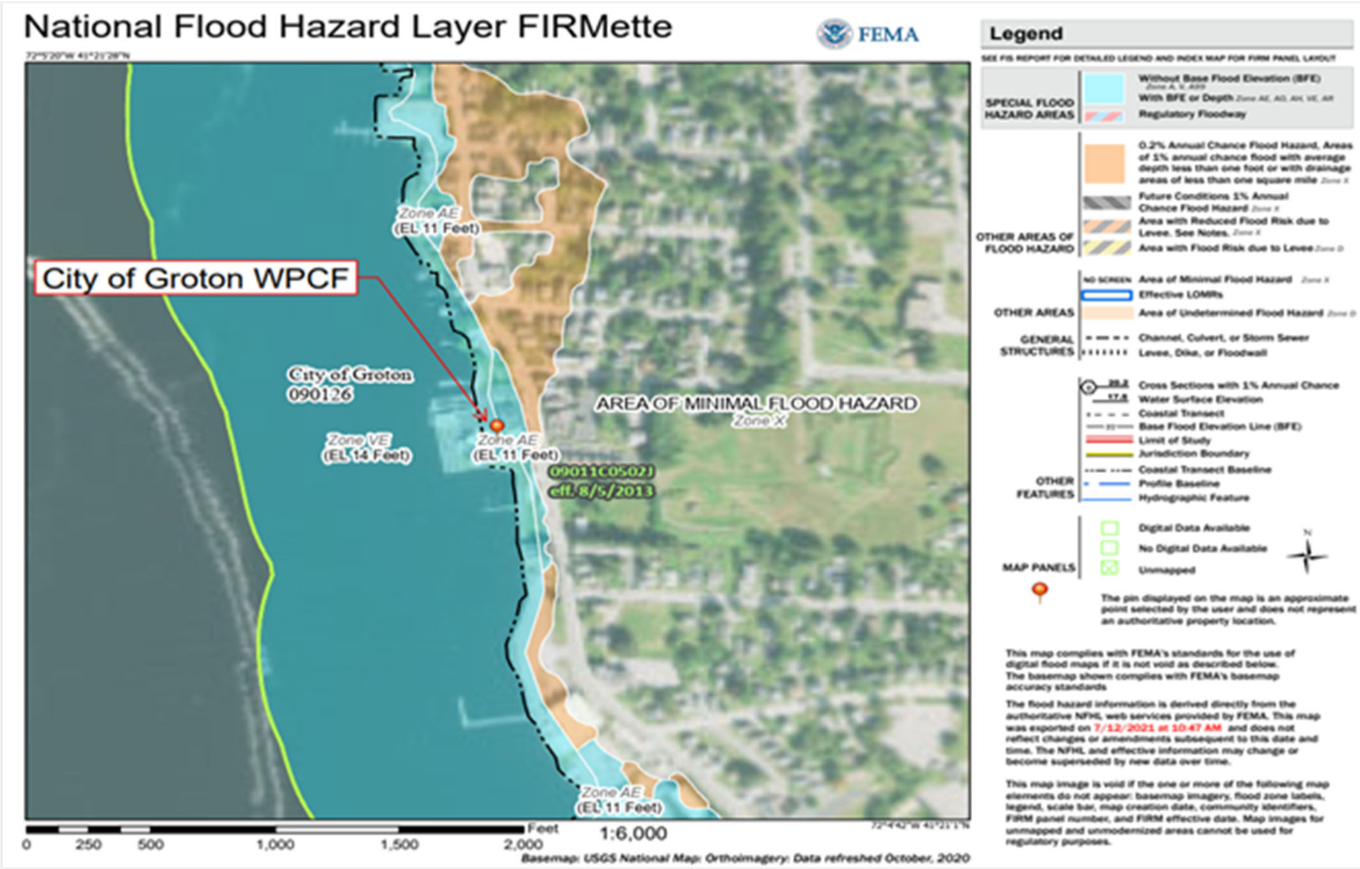
- Zone A: 1% (100-year) annual chance of floods with no BFE determined
- Zone AE: 1% (100-year) annual chance of floods with BFE determined
- Zone VE: 1% (100 year) annual chance of flooding with an additional hazard associated with storm waves. BFE is determined
- Zone X: Areas determined to be outside the flood zone
- Zone X500: Area with 0.2% (500-year) annual chance of flood

As defined above, Zones AE and VE have BFE's readily available and determined by FEMA and listed on the FIRMs. It should be noted that when FEMA prepares flood maps for an area, impacts from wave velocity and hurricane surge are typically included in the BFE's.

To establish 500-year flood elevations in coastal areas, the DEEP suggests estimating the 500-year flood as the 100-year base flood elevation multiplied by a factor of 1.25. The calculation is supported by FEMA technical fact sheet 1.6 "Designing for Flood Levels Above BFE".

As shown in Figure 7-1, the Groton PAF site is split by two Special Flood Hazard Area 100-year Base Flood Elevations (Zone VE at EL 14.00 and Zone AE at EL 11.00, both in NAVD88 as published by FEMA by VertCon). It should be noted that FEMA updated the base flood elevation from elevations 11.0 and 9.0 to 14.0 and 11.0 respectively in 2020. Elevations taken from available record drawings are based on Mean Low Water (MLW) Datum. Discussions with GU confirmed that that MLW is the same at NGVD 29 at the PAF facility. It was determined that a -1.0 ft factor is needed to convert the from MLW to the NAVD 88 datum. For purposes of this evaluation, we will use a BFE of 14.0 (NAVD 88) for the entire site.

Figure 7-1 PAF Base Flood Elevations



7.3.2 Sea Level Rise Mapping

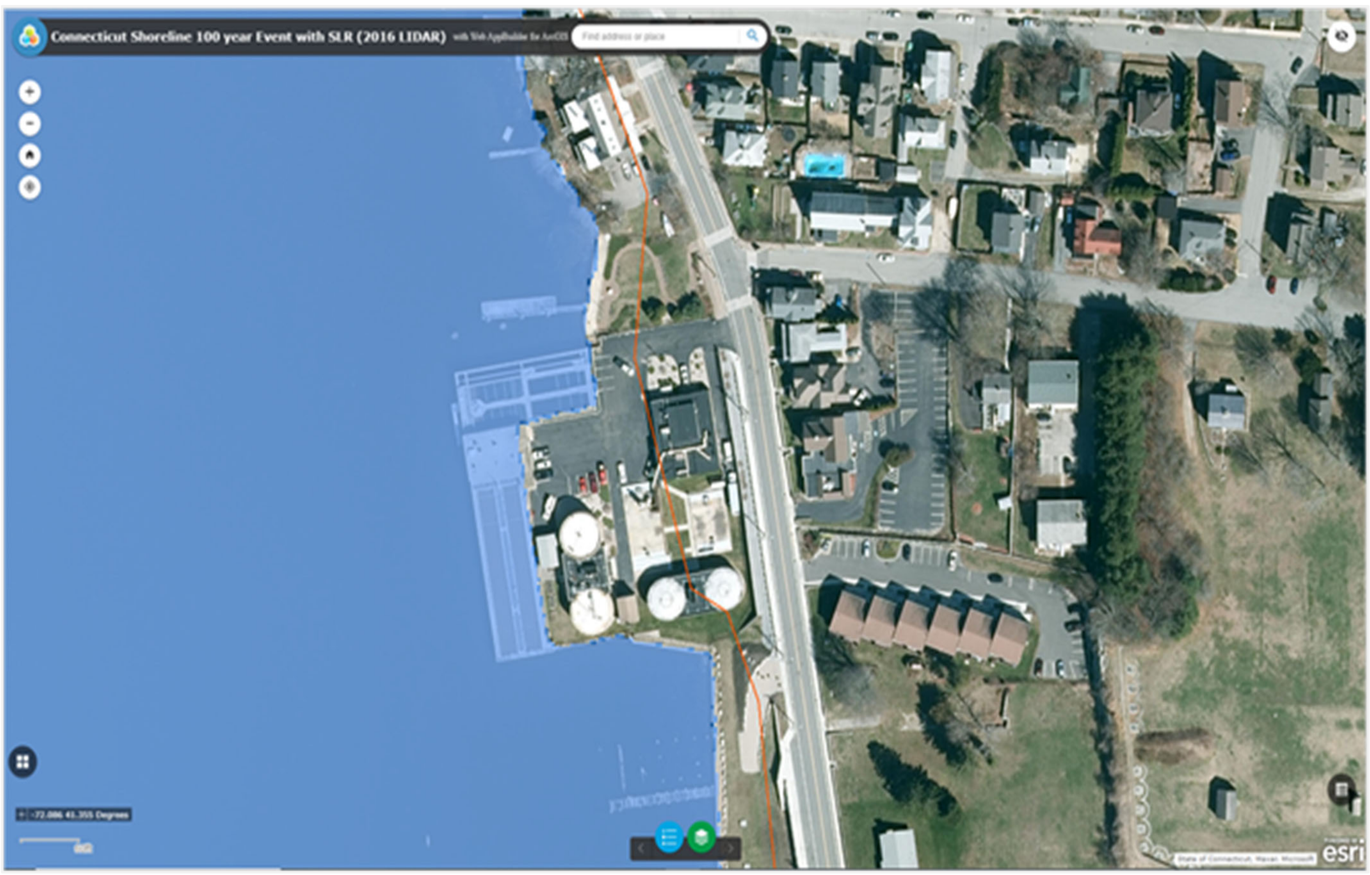
FEMA flood maps do not currently account for sea level rise. Climate change and sea level rise tend to also impact future flooding and a greater level of flood protection is warranted. CIRCA research recommends anticipating sea level up to 20 inches higher than the national tidal datum in Long Island Sound by 2050. CIRCA's report on Connecticut sea level rise provided the basis for projections in Bill S.B. 7, which was introduced into the 2018 legislative session and was enacted into law as Public Act 18-82.

An on-line Sea Level Rise Viewer by CIRCA was used to evaluate if the PAF will be impacted by sea level rise (i.e., 20 inches above the mean higher high water (MHHW)). The Sea Level Rise Map for the PAF is shown in Figure 7-2 which shows the impact of the 20-inch sea level rise above the MHHW. Low-lying areas displayed in yellow, are considered hydrologically "unconnected" areas that may flood. Blue areas denote a high confidence of inundation. It should be noted that sea level rise requirements as suggested in the DEEP memo are stated in Public Act 18-82 and codified in CGS 25-68. The Public Act 18-82 requires that all state funded critical activities to be protected up to a design elevation of 500-Yr BFE plus a freeboard of 2 feet.

FEMA's Limit of Moderate Wave Action (LIMWA) boundary is also shown on the Sea Level Rise maps as a continuous red line. The LiMWA line in the CIRCA viewer was updated in December 2021 to reflect FEMA's LiMWA Viewer release for New England states, including Connecticut. The coastal AE Zone is depicted on current effective flood insurance rate maps (FIRMs) with the landward limit of the zone labeled "Limit of Moderate Wave Action".

FEMA's Limit of Moderate Wave Action (LIMWA) boundary is also shown on the Sea Level Rise maps as a continuous red line. The LiMWA line in the CIRCA viewer was updated in December 2021 to reflect FEMA's LiMWA Viewer release for New England states, including Connecticut. The coastal AE Zone is depicted on current effective flood insurance rate maps (FIRMs) with the landward limit of the zone labeled "Limit of Moderate Wave Action". Any area seaward of the red LiMWA line is either coastal AE or VE zone must meet new construction requirements outlined in the updated state building codes. Based on discussion with the DEEP, if a site is located on the seaward side of the LiMWA and categorized to be in an AE flood zone, should be considered as a VE flood zone to protect it to issues related to wave action. This is the case with the Groton PAF. As shown in Figure 7-2, the Aeration Tanks, Blower Building, Final Settling Tanks and Chlorine Contact Chamber are located in an area with a high confidence of inundation. However, these structures have concrete walls that are higher than the surrounding areas of the PAF that are not shown subject to inundation due to seal level rise.

Figure 7-2 CIRCA Sea Level Rise Viewer



7.3.3 Groton PAF Flood Elevations

A summary of the flood elevations for each building/structure at the Groton PAF is summarized in Table 7-1 along with the various protection requirements for each regulatory standard. Based on correspondence with the CTDEEP, the "flood protection design elevation" listed in Table 7-1 must be the most conservative elevation when compared to all regulatory standards. It is also dependent upon the funding source utilized.

As shown in Table 7-1, every building and structure at the Groton PAF is below the "flood protection design elevation" by anywhere from 3.5 to 10-feet. If using FEMA or State of CT funding sources for any facility upgrades, it is recommended that FEMA and the CTDEEP be engaged very early on in the process to determine if the facility does in fact need to be protected to a flood protection design elevation as shown in Table 7-1 and if any requirements have changed since the writing of this report. During these discussions, it is important to note that during Storm Sandy in October 2012, the storm surge was 6-feet and water reached about 1-foot below the tops of the Primary Settling Tanks, or EL 8.8. The peak storm tide elevation during Sandy was 6.55 feet. As a point of reference, the highest tide recorded by NOAA was EL 10.65 on September 21, 1938, significantly less than the FEMA 100-year flood elevation of 14.0.

The next section evaluates the various types of flood protection measures available for implementation at the Groton PAF.

7.4 Mitigation Options

In order to fully comply with the TR-16 guidance, critical equipment/infrastructure should be protected to the 100-year BFE plus three feet. Our study did not evaluate the structural integrity or water-tightness of the structures other than the need to close up large opening or voids. Some reinforcement or water-tight coatings may be required.

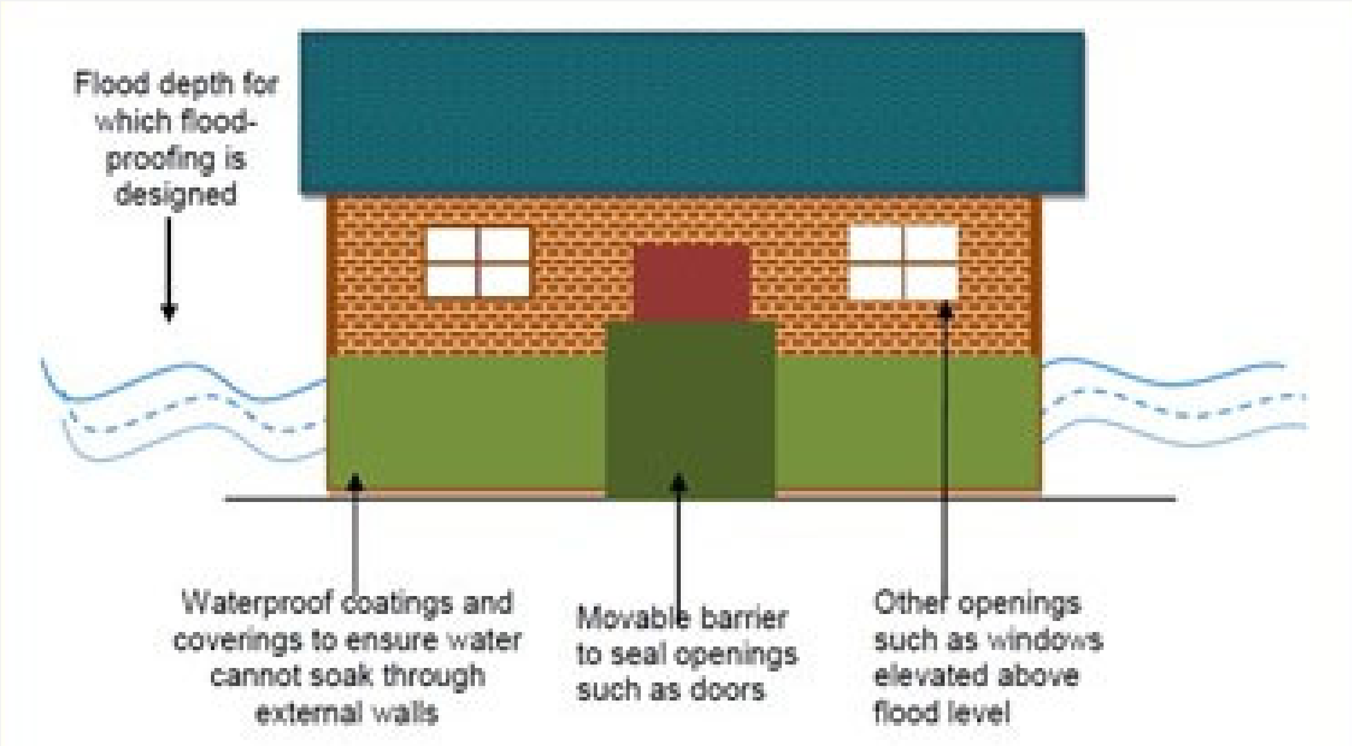
7.4.1 Floodproofing

Wastewater treatment plants should be protected from damage during a flood event. Floodproofing a structure is defined as a combination of structural and non-structural additions, changes, and adjustments to structures to reduce or eliminate flood damage. Dry floodproofing a structure can be a cost-effective alternative solution to constructing a new facility outside of the floodplain or elevating the building or structure above flood elevations. The structure itself should be made floodproof to the recommended protection elevations. With existing structures, impermeable membrane materials or waterproofing coating systems can be used on the surfaces of the structure. Additional courses of concrete or masonry may also be an appropriate solution to strengthen existing walls or provide an additional barrier for flood waters.

Structural openings, (i.e.: doors, windows, louvers, vents, pipe penetrations) should be watertight to prevent water from entering the building through the use of shields or barriers. More simple solutions for flood protection may include raising the elevations of vent pipes and fill pipes, replacement of standard manhole covers with watertight covers, and anchoring fuel tanks and chemical tanks to prevent flotation.

Floodproofing measures will require the facility to mobilize personnel with adequate warning of an impending flood event. Some measures will also require ongoing maintenance.

Figure 7-3 Typical Flood Proofing Measures



Note: Source: ClimateTech Wiki

Table 7-1 Flood Protection Design Elevations

Structure	Actual EL in MLW from As-Builts	Actual EL in NAVD 88	Flood Zone[1]	Impact form Limit of Moderate Wave Action	FEMA BFE EL[1] NAVD 88	500-YR Flood EL (1.25 x BFE)[2] NAVD 88	TR-16 Guidance (100-YR BFE + 3-FT) NAVD 88	Coastal Boundary: Non-Critical Activity FMA/Public Act 18-82 (100-YR BFE+ 2 ft)[3]	Coastal Boundary: Critical Activity FMA/Public Act 18-82 (500-YR BFE+ 2 ft)[3]	Selected Flood Protection Design Elevation[4] NAVD 88
Operation Building										
First Floor	10.55	9.55	AE	No	11.0	13.75	14.0	13.0	15.75	17.0
Headworks	9.0	8.0	AE	No	11.0	13.75	14.0	13.0	15.75	17.0
Garage Bay	9.78	8.78	AE	No	11.0	13.75	14.0	13.0	15.75	17.0
Primary Settling Tanks	9.78	8.78	AE/VE	Yes (3&4 only)	14.0	17.50	17.0	16.0	19.5	17.0
Sludge Thickening Building										
First Floor	15.5	14.5	AE/VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Digester Control Building										
First Floor	11.22	10.22	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Primary Effluent Wetwell	10.55	9.55	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Sludge Mixing Chamber	15.5	14.5	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Aeration Tanks	15.15	14.15	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Final Settling Tanks	14.0	13.0	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Blower Building										
First Floor	12.45	11.45	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Garage Bay	9.78	8.78	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Chlorine Contact Chamber	14.0	13.0	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0
Generator Building	13.5	12.5	VE	Yes	14.0	17.50	17.0	16.0	19.5	17.0

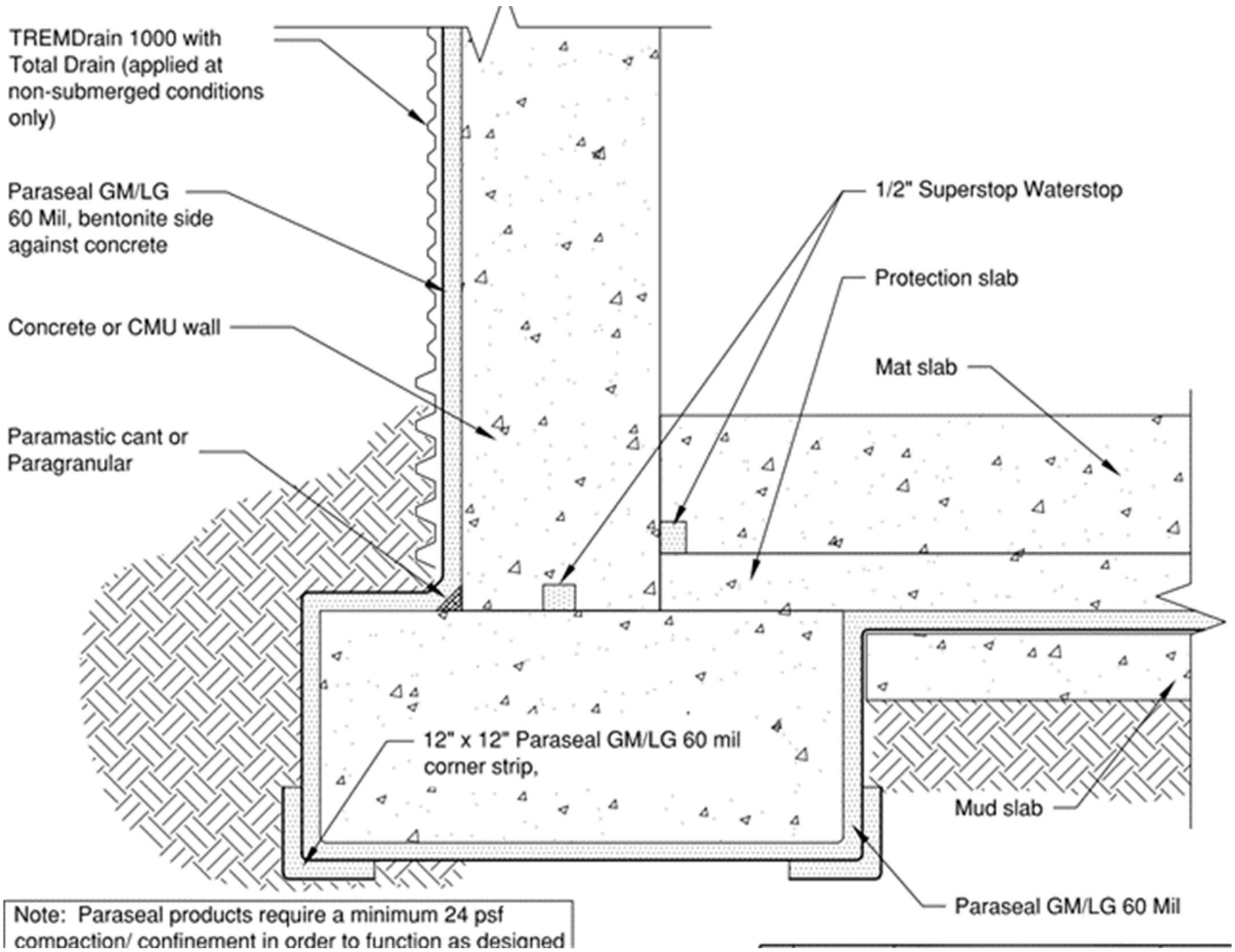
Notes:

1. Flood Zone and FEMA BFE were taken from FEMA FIRMs for the Groton PAF.
2. The DEEP designates the calculation of the 500-year flood elevation in coastal areas as the 100-year base flood elevation multiplied by a factor of 1.25.
3. CGS-98 provides definition of the coastal boundary, Town GIS map was used to confirm PAF is in a coastal management area and work will required a Flood Management Certification.
4. Maximum elevation of TR-16, FMA and Public Act 18-82 selected as the entire PAF is within the coastal boundary. Any chemical storage needs to be protected to EL 19.5.

7.4.1.1 Floodproofing Solutions – Impermeable Membrane and Coatings

Impermeable membranes and coatings can be used to seal walls to reduce or prevent the penetration of floodwater. Membranes and coatings are typically applied to exterior wall faces, making them cost-effective options for retrofitting existing buildings. The following is an example of membrane and coating systems that can be used on existing structures for those areas above grade and above the elevation of the structural concrete. The detail shown is for new construction, but the same principals apply.

Figure 7-4 Exterior Floodproofing Coatings



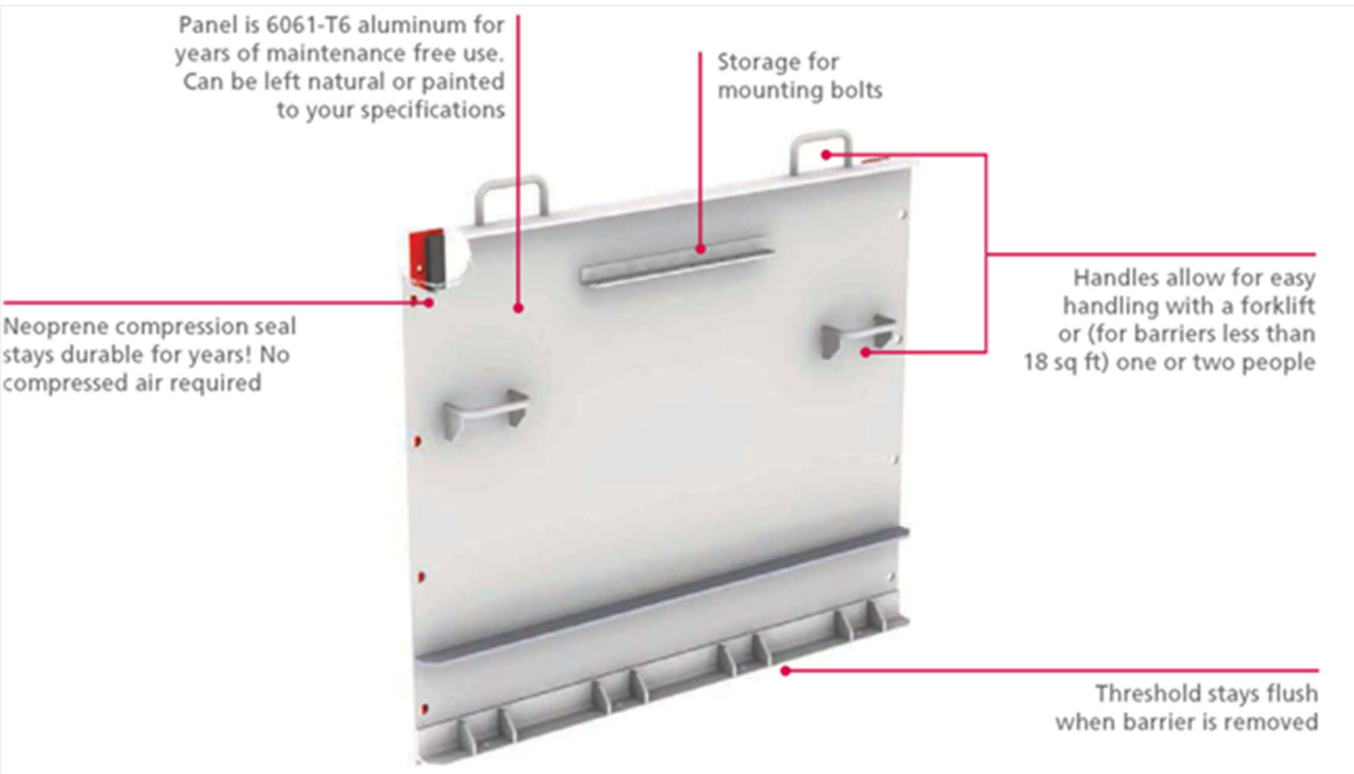
Source: Tremco Products

7.4.1.2 Flood Doors/Barriers

Facilities with FFE's below the flood design elevation, should be equipped with flood doors or temporary barriers that can be manually installed in preparation for a flood event. Flood doors may be required under extreme conditions where flood event and elevations are well above the FFE of the building such as the case at the Groton PAF. Flood doors can be a costly option and can become a burden to operators under normal operation and maintenance. When flood elevations are a few feet above the FFE, a temporary barrier that is manually installed prior to a flood event may be a preferable option. An example of temporary barriers includes the following:

Mechanical Seal Barrier: Mechanical barriers require installation by an operator prior to a flood event where the barrier is compressed against a mechanical seal. Similar system can be installed on window openings as well.

Figure 7-5 Mechanical Seal Barrier



Source: Presray Products

Pneumatic Seal Barrier: Pneumatic barriers require installation by an operator prior to a flood event where the barrier is compressed against a frame by inflation of a gasket with air (hand pump or portable compressors).

Figure 7-6 Pneumatic Seal Barrier

Source: Presray Products

In the case where the top of a tank is below the BFE exposing mechanical and electrical components to flooding, a removable or permanent flood barrier surrounding the entire tank, or just the mechanical and electrical equipment can be installed to keep it from being submerged during a flood event. Once the flood waters recede, the equipment would be able to be started back up and be operational.

7.5 Flood Protection Recommendations

The Groton PAF site is split by two Special Flood Hazard Area 100-year Base Flood Elevations (Zone VE at EL 14.00 and Zone AE at EL 11.00). As noted in this section, storm surges have historically not reached any higher than EL 8.8. Protection of the entire site to EL 17.0 does not seem reasonable and additional detailed discussions are recommended with FEMA and the CT DEEP prior to any major plant upgrades that would require flood protection. In either case, it is anticipated that some level of protection will be required. Assuming the worst-case scenario that the entire site would require protection to the design flood elevation of 17.0, the following measures would be required at a minimum:

- Operations Building – Install temporary or permanent flood doors on all opening to EL 17.0.
- Primary Clarifiers – Install temporary or permanent flood walls/barriers around all tank perimeter to EL 17.0.
- Sludge Storage Building – Install temporary or permanent flood doors on all opening to EL 17.0.
- Generator Building – Install temporary or permanent flood doors on all opening to EL 17.0.
- Digester Building – Install temporary or permanent flood doors on all opening to EL 17.0.
- Primary Effluent Wetwell – Install temporary or permanent flood walls around the wetwell and pump motors to EL 17.0.
- Blower Building - Install temporary or permanent flood doors on all opening to EL 17.0.
- Aeration Tanks/Sludge Mixing Chamber – Install temporary or permanent flood walls/barriers around all electrical and control equipment or raise all equipment to above EL 17.0.
- Final Settling Tanks/Chlorine Contact Chamber - Install temporary or permanent flood walls/barriers around all tank drive assemblies or raise all equipment to above EL 17.0.

Installing individual flood doors at each building opening may not be feasible. Alternatively, the feasibility of installing a flood wall around the entire perimeter of the site to EL 17.0, in lieu of individual structures, could also be considered if it is determined that protection to EL 17.0 is required. For reference, the pavement elevation in Thames Street at the plant entrance drive is EL 15.0 +/-.

8

Section 8 Energy Evaluation

An energy evaluation of the Groton PAF was conducted in order to assess the current energy use at the facility and identify opportunities for energy cost savings, efficiency and renewable energy applications. This section of the report summarizes the results of energy efficiency and renewable energy evaluations and alternatives assessments performed for the plant buildings and process systems. The evaluation included an energy audit of the PAF which was performed through the following tasks:

- A review of the energy usage of the facility through electrical and fuel oil bills
- Development of an energy balance for select processes to justify current energy use and costs
- Calculation of energy cost savings through various operational and equipment modifications

Potential energy efficiency projects that were discovered as a direct result of the tasks mentioned above have been presented in this section under two categories:

- Short Term (ST) Solutions
- Long Term (LT) Solutions

Each of these two categories contains the following types of recommended measures:

- Operational measures (OMs)
- Energy conservation measures (ECMs)

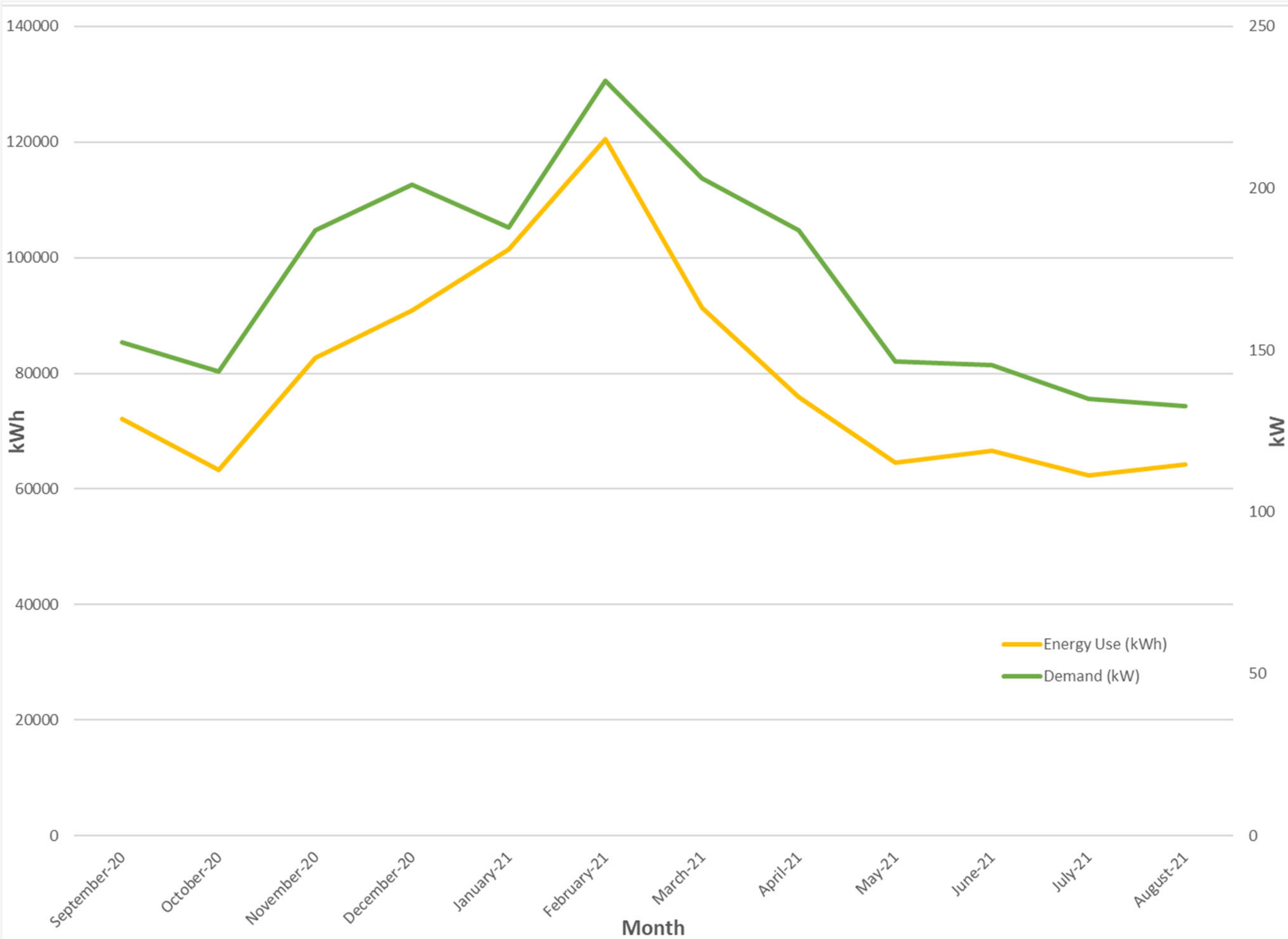
8.1 Current Facility Energy Use

To determine the current energy use and the cost of the existing WPCF a review of the electrical billing history was performed from September 2020 to August 2021. A summary of the overall annual energy use at the facility is shown in Table 8-1. The monthly breakdown of energy usage (kWh) and peak demand (kW) is presented in Figure 8-1 below. As shown in Figure 8-1, energy usage at the PAF doubles in the winter months. The majority of this demand increase is due to the use of plantwide heating systems. An increase in the colder winter months is expected, but can be reduced by installing newer, more energy efficient heating and ventilation building control systems.

Table 8-1 2020/2021 Groton PAF Energy Usage

Facility	Annual Use (kWhs)	Average Monthly Cost	Annual Cost	Total Unit Cost
Groton PAF	956,000	$9,580	$115,000	$0.12

Figure 8-1 2020/2021 Groton PAF Electrical Energy Use



8.1.1 Groton Utilities Rate Structure

Groton Utilities (GU) is a municipally owned and operated utility providing electric, water and sewer services. The GU bills their PAF according to the basic rate structure provided in Table 8-2, effective as of April 2021.

Table 8-2 Groton Utilities PAF Electric Rate Structure

Item	Cost
Monthly Service Charge (flat)	$210.00
Metered Energy Charge ($/kWh)	$0.075
Billed Demand ($/kW)	$15.01
State Mandated Conservation Charge ($/kWh)	$0.0025

One of the ways to assess whether there are opportunities to reduce energy consumption is to "benchmark" energy usage against other similarly sized wastewater treatment facilities. At a calculated total of approximately 510 million gallons (MG) of wastewater treated in 2021, and the energy usage above, the plant consumes approximately 1,874 kWh per MG of wastewater treated, this energy usage is average when compared to other similarly sized plants ranging between 1,200 and 3,200 kWh per MG of wastewater treated.

8.2 Short-Term Efficiency Improvements

A desktop facility energy audit of the PAF was conducted resulting in several potential energy efficiency improvements, or energy control measures (ECMs). The potential improvements were divided into short-term and long-term upgrades based on their payback period and the integration and timing of other proposed plant upgrades and asset replacements. The short-term recommended improvements are summarized in Table 8-3 below and are consistent with the recommendations made in other sections of this report. It should be noted that the costs (reported in 2022 dollars) and simple payback analysis are based on providing the minimum necessary improvements to realize the cost savings and do not include the cost of additional features that the city may wish to incorporate into any short-term improvements. These additional features would increase the cost of specific measures and affect the payback period and should be considered prior to moving forward with any specific improvement. It should also be noted that while some of these short-term efficiency improvements could be implemented in the near future, it may be more feasible logistically to implement during the initial comprehensive PAF upgrade project.

Table 8-3 Groton Utilities PAF Short-Term Efficiency Improvements

Cost Savings Measure	Annual Energy Savings (kWh)	First Year Annual Savings	Initial Capital Cost	Simple Payback (years)
ECM #1 - Add Flow Pacing to Return Sludge Pumps	35,200	$4,200	$25,000	6
ECM #2 - Replace Boiler in Operations Building (1)	$6,000 (fuel oil)	$6,000	$50,000	8
Potential Cost Savings	35,200	$10,200	$75,000	7

1. Includes Electricity and Fuel Oil Savings

8.2.1 ECM #1 – Add Flow Pacing to Return Sludge Pumps

Return activated sludge (RAS) is pumped back to the aeration tanks by three 15 hp units controlled manually through VFDs. The RAS pumps were replaced in 2020, 2021 and 2022 (scheduled) respectively and are designed to discharge 1,390 gpm at a TDH of 47 feet. The pump speeds are currently set manually at the VFD to achieve 550 gpm each for a total of 1,100 gpm, or 110% of the total average daily flow. Typically, there are two pumps in service, one dedicated to each final settling tank.

Utilizing the vendor pump and motor data, the existing RAS pumps operating continuously at 550 gpm results in an annual energy use of (2 pumps x 12kW x 8,760 hrs/year) = 210,240 kWh/year, or $25,230/year. It is typical to see an energy use reduction of about 20% when a facility's return sludge system is programmed to pace off of a percentage of plant flow due to a decreased power demand during low flow times of the day. In addition to programming and integration, a new transducer will need to be installed and calibrated at the effluent Parshall flume to allow for reading flows above 6.5 MGD. The programming will also need to include a time delay to dampen the effects of the flow spikes associated with cyclic aeration.

8.2.2 ECM #2 – Replace Boiler in Operations Building

The existing boiler in the Operation Building was installed prior to and relocated during the 1998 upgrade and is in poor condition. It is corroded, and the flue piping and chimney door are leaking. The expansion tank is in poor condition, and its supports are corroded. The air separator as well as the exposed piping are corroded and in poor condition. The circulator pumps are in fair condition, but the flanges are leaking and in poor condition. The boiler serves five finned tube radiators, six unit heaters, and two air handling units in the Operations Building. The unit is reported to burn in excess of 500 gallons per month of fuel during the colder winter months and is noticeably inefficient overall.

During the preparation of this facilities plan, GU hired Wright-Pierce to replace the boiler and associated heating system in the Operation Building with a more modern, energy efficient heating system and controls. This project is currently in design and a significant cost savings will be realized. Simply assuming the elimination of the need for fuel oil, and a no cost in power usage from the new heating system, an annual savings of $6,000 is anticipated.

8.3 Long-Term Efficiency Improvements

The long term recommended improvements are summarized in Table 8-4 and are consistent with the other recommendations in this report. It should be noted that the costs (reported in 2022 dollars) and simple payback analysis are based on providing the necessary improvements to realize the cost savings through direct equipment replacement or rehabilitation and do not include the cost of additional features that the city may wish to incorporate. It should also be noted these long-term efficiency improvements would be implemented during the initial comprehensive PAF upgrade project.

Table 8-4 Groton Utilities PAF Long-Term Efficiency Improvements

Cost Savings Measure	Annual Energy Savings (kWh)	First Year Annual Savings	Initial Capital Cost	Simple Payback (years)
ECM #3 - Aeration Blower Replacement / Automated DO Control	108,000	$13,000	$150,000[2]	11.5
ECM #4 - Install Waste Sludge Pump[1]	8,865	$1,063	$20,000	19
ECM #5 - HVAC System Upgrades	Additional investigation recommended at time of upgrade (see below)			
ECM #6 - Lighting System Upgrades	Additional investigation recommended at time of upgrade (see below)			
ECM #7 – Demand Reduction Program	Additional investigation recommended at time of upgrade (see below)			
Potential Cost Savings	175,865	$21,063	$170,000	13.25

1. Assumes one new pump with RAS pumps as a back-up.
2. Capital cost includes difference in additional capital for new blowers and controls versus upgrading the existing and does not represent the entire cost of new blowers and controls.

8.3.1 ECM #3 – Aeration Blower Replacement/Automated DO Control

The blowers at the Groton PAF were replaced in 1999 and are multi-stage type centrifugal blowers manufactured by Spencer. Two blowers have a motor rating of 75 HP with a rated capacity of 1,000 scfm and one blower has a motor rating of 100 HP with a rated capacity of 2,100 scfm. Typically, one 100 HP blower runs during the week and one 75 HP blower is in service on weekends. Originally these blowers were installed with constant speed motors and later upgraded to include variable frequency drives to provide manual turndown of the blowers. However, even with installation of the variable frequency drives, plant staff have not been able to maintain the desired dissolved oxygen in the aeration tanks due to its inability to turn the blowers down to operate at a lower speed, requiring the plant to run in a cyclic mode of aeration, created by turning blowers on and off for fixed periods of time between cycles.

This mode of operation is very inefficient and uses excess power during the initial inrush every time a blower turns on, rather than running continuously at a lower, steadier demand. The inability to turn the blowers down, coupled with the lack of dissolved oxygen (DO) control and monitoring on the aeration tanks to automatically adjust the speed of the blowers based on the actual air demand in the tanks limits process control and is inefficient. Upgrading the blowers and providing for automated DO control will provide for energy savings opportunities. Based on discussions with the manufacturer, rebuilding the existing blowers to meet the smaller air flow range would be expensive and will still limit the plant to cyclic operation the majority of the time.

To determine the energy saving that can be realized by replacing the existing aeration blowers with smaller units, and installing a fully automated DO control system on the aeration tanks, a comparison of horsepower draw was used for a new blower that will operate continuously at 75% speed on average off of a 75 HP motor, versus one 100 HP blower turning on and off 5 days per week and a 75 HP blower turning on and off 2 days per week (both 30 minutes on/50 minutes off). The payback for this measure was calculated by assuming that the existing aeration blowers operating cyclically utilize 475,000 kWh/year; while new blowers operating continuously would utilize only 367,000 kWh/year.

Based on this high-level analysis, replacing the existing blowers with smaller units to achieve the minimum and maximum airflow requirements of the Groton PAF without cycling; and operating the new blowers on a new automated DO control and monitoring system, would provide approximately 167,000 kWh/year in savings.

8.3.2 ECM #4 – Install Waste Sludge Pump

The Groton PAF does not have a dedicated waste sludge (WAS) pump. Sludge is wasted directly to the Rotary Drum Thickener (RDT) manually during the workday with the RAS pumps operating at about 150 to 180 gpm. A total of 50,000 gallons is wasted during the workweek and 25,000 gpd on weekend days. This corresponds to a RAS pump run time of 30 hours per week to process 300,000 gallons of waste sludge. As noted above, the RAS pumps are 15 hp. Dedicated WAS pumps sized for this application would be in the range of 100 to 150 gpm and in the 5hp range and be designed to waste off of an operator adjustable timer at X-min ON per hour.

It is difficult to determine the energy demand on the RAS pumps during wasting as it is a manual operation done while continuing to return RAS back to the Aeration Tanks. Installing a dedicated WAS pump will allow for better process control and consistency. The payback for this measure was calculated by assuming that the RAS pumps utilize (12kW x 1,560 hrs/year) = 18,720 kWh/year pumping WAS to the RDTs while new dedicated WAS pump would utilize (4.5kW x 2,190 hrs/year) = 9,855 kWh/year.

8.3.3 ECM #5 – HVAC System Upgrades

The current HVAC systems throughout the plant are mostly new and consist of a combination of heat pumps and electric unit heaters. As noted above, improvements to the heating system in the Operations Building is in the design phase. As part of the current Operations Building HVAC upgrade, or any other future upgrades at the PAF, GU has a commercial Air Conditioning/Heat Pump Program that provides cash incentives for new or replacement roof-top, split systems, terminal A/C units, and heat pumps that meet or exceed program efficiency standards by filling out a simple rebate application form. Because this would involve an interdepartmental exchange of funds, it should be discussed with GU first to determine if this program is applicable to the PAF.

8.3.4 ECM #6 – Lighting System Upgrades

GU has a commercial lighting program that provides cash incentives for new or retrofit lighting fixtures to energy efficient systems. New lighting systems provides fixed per-unit rebates on eligible materials. Existing lighting system retrofits provide rebates based on a fixed cents per kWh saved. The program also provides rebates for installation of lighting occupancy controls. In either case, rebates shall not exceed 40% or 30 cents per annual kWh saved with a maximum annual rebate not to exceed $100,000. Similar to the heating and ventilation program, a series of simple application forms need to be filled out and submitted. Because this would involve an interdepartmental exchange of funds, it should be discussed with GU first to determine if this program is applicable to the PAF.

Regardless of if a rebate is obtained or not, it is recommended that the following lighting system upgrades be completed during the next upgrade project to reduce consumption:

- Replace fluorescent fixtures with LED fixtures throughout the Blower Building, Operations Building, Generator Building and Sludge Storage Building
- Replace fluorescent or metal halide site lighting fixtures with LED fixtures

8.3.5 Demand Reduction Program

The increase in transmission demand may be due to a change in flow and loads experienced at the plant or the simultaneous operation of multiple unit processes. The plant may wish to reduce excess operation of equipment, on a consistent basis, to reduce the billed demand on a monthly basis. GU does offer a Demand Response Program that the PAF should look into. A Demand Monitoring Program may alert the operators when specific (high hp/high demand) equipment is in operation, or when the plant is reaching a certain electrical (kW) load. This would allow for automated or manual demand reduction. Specifically, the operators could select equipment or systems to temporarily take off-line to control peak demand and the associated demand charge.

Automated systems that monitor and control demand may be eligible for incentives. Alternatively, these modifications can be made manually. The current demand monitoring system could be modified to incorporate the large energy users in the process including blowers and pumps. There is also a potential to incorporate control strategies into the existing system at a lower cost to assist in monitoring and reducing energy use during the on-peak hours during the summer months. Because this would involve an interdepartmental exchange of funds, it should be discussed with GU first to determine if this program is even applicable to the PAF., or if the program can be implemented with the absence of any incentives to simply reduce demand.

8.3.6 Other Programs Offered by Groton Utilities

Any equipment that is replaced at the Groton PAF will be supplied with premium efficient motors if available. GU has a 3-phase motor replacement program that provides cash incentives for new or replacement 3-phase premium efficient motors by filling out and submitting a simple application form. Because this would involve an interdepartmental exchange of funds, it should be discussed with GU first to determine if this program is even applicable to the PAF.

8.4 Green Design Standards

In addition to the energy efficiency improvements and possible renewable energy technologies that can be incorporated at the PAF, any new and retrofitted facilities can also be designed using sustainable practices and incorporate applicable LEED design and construction standards. Some of the proposed green and LEED design principles that can be incorporated at the PAF include the following:

- Reusing existing buildings and structures can provide an economic benefit but also limits the environmental impact of the project. Upgrading the existing buildings wherever it is feasible will greatly reduce construction waste, as well as reduce expended energy and pollutants generated in the manufacturing and transportation of new materials. Existing building improvements should include improvements to the energy performance as well as water efficiency.
- Low emitting materials such as paints, coatings, wood and sealants can be used wherever possible.
- Minimizing the use of potable water for any processes that do not require it or replacing potable water with plant water supply if practical. See Section 3.
- New and renovated bathroom facilities, showers, break room, and lab can include high efficiency fixtures. This may include instantaneous hot water heaters if appropriate to meet the hot water demand.
- Maximize energy performance of new/retrofitted building envelope, HVAC systems, and lighting.
- Daylighting through use of skylights can be maintained and employed in new structures. Other options for daylighting can be investigated as part of the design effort to select appropriate alternatives for each building. New lighting controls can utilize occupancy sensors and HVAC systems can incorporate thermostats and adequate controls for providing efficient comfort.

- Minimize heating requirements and utilize heat recovery in ventilation systems.

These concepts can be included in the final structures and buildings and can reduce the environmental impact of the facility over the long term. The construction work itself can also be done in a sustainable manner, minimizing pollution and conserving resources. By including these standards in the construction documents the contractors will be required to employ these sustainable strategies as part of their work and in their purchase and procurement methods, creating benefit for both the local community and the environment. Some of the construction requirements that can be included in the final specifications include:

- Manage construction waste to maximize recycling, minimize landfill disposal, and improve opportunities to salvage materials.
- Allow for the use of salvaged or refurbished materials that are in acceptable condition, but do not require new resources.
- Use building materials with recycled content. Specific goals for the percentage of recycled content can be established.
- To the extent possible, incorporate materials and products that have been extracted, produced, or manufactured locally (within 500 miles of the site). Coordination of this requirement with the State's Clean Water Fund procurement requirements will be necessary if State funding is utilized.
- Incorporate materials that are considered rapidly renewable (i.e., specific types of wood). Require environmentally responsible wood products and consider species and harvesting technique.
- Manage indoor and outdoor air quality during construction by specifying low VOC materials (adhesives, paint, sealants, caulking), implementing dust control, controlling equipment exhaust, and avoiding contamination of porous material.

9

Section 9 Regionalization Alternative

As part of the Facility plan, regionalization alternatives were evaluated to eliminate the Groton Pollution Abatement Facility (PAF) and pump all flow to the Town of Groton's Water Pollution Control Facility (WPCF) for treatment and disposal through a new force main and gravity pipe system. This section reviews the routing options and costs associated with transporting the flows to the Town of Groton WPCF.

9.1 Routing Options

The City of Groton Utilities and the Town of Groton discussed three potential routing alternatives during the scoping phase of this facilities plan. Two of the routes require that a new pumping station be constructed at the existing City of Groton PAF to convey the flow to the nearest location within the Town of Groton Sewer system that could hydraulically accept the flow. This location was identified to be a manhole on the Town of Groton Northwest Interceptor near the intersection of Poquonnock Road and Long Hill Road (US Route 1). Both routing options appear to be feasible to convey the flows from the existing PAF to this point. These alternative routes are illustrated in Figure 9-1. A third alternative was initially evaluated but was determined to not be feasible. This option would not only require that a new pumping station be constructed at the PAF site to convey a portion of wastewater back to the West Side Pump Station, but would also include a major capacity upgrade to the West Side Pump Station including a larger parcel of land to construct it. The West Side pump station force main would also need to be upsized and routed parallel to the Town of Groton's 24-inch outfall pipe through Birch Plain Creek and the Sparkle Lake Conservation Area. It is our understanding that this pipe was installed in 1987, took more than 5 years to get permitted, and carried a total project cost of $7.7M at that time.

The two potentially viable routes were viewed on various online "street view" software applications to look for obstacles or other significant items that might impact the design or construction of the pipe routing that should be included into the route selection and evaluation process at this planning level.

9.1.1 Meridian Street Route

The routing for this alternative would leave the PAF heading north along Thames Street to School Street. The route then heads west along School Street to Monument Street. The route continues one block north along Monument Street turning east onto Meridian Road. The route follows Meridian Road past the intersection with Clarence B Sharp Highway (State Route 349) and onto Meridian Street Extension into the Town of Groton to Long Hill Road. The route then turns to the Southeast along Long Hill Road to the connection point to the Northwest Interceptor.

This route is approximately 11,500 feet in total length. There are no intermediate pumping stations along the route. There are two localized high points along the route, however. The first one is located on Meridian Road near Monument Street and Cottage Street (elevation near 100 ft compared to the elevation on Thames Street near the WPCF of around 10 ft). The other high point has an elevation of around 90 ft and is located along Meriden Street Extension near the entrance to the Country Glen Apartments. In between there is a local low point with an elevation near 50 feett along Meridian Street between Washington Park and the crossing with route 349. These localized high and low points would either require a transition to gravity flow with a pumping station to continue conveying the flow, or the installation of air release valves and drain or flushing valves to allow for the proper operation of a force main through these areas. For purposes of this evaluation, we have assumed that it would be cost prohibitive to install additional pump stations and have carried costs for extending the force main as far as possible before transitioning to gravity. The rough elevation profile utilized to identify these locations and approximate elevation was created utilizing Google Earth as shown in Figure 9-2.

Sewer Route Options
Groton, CT

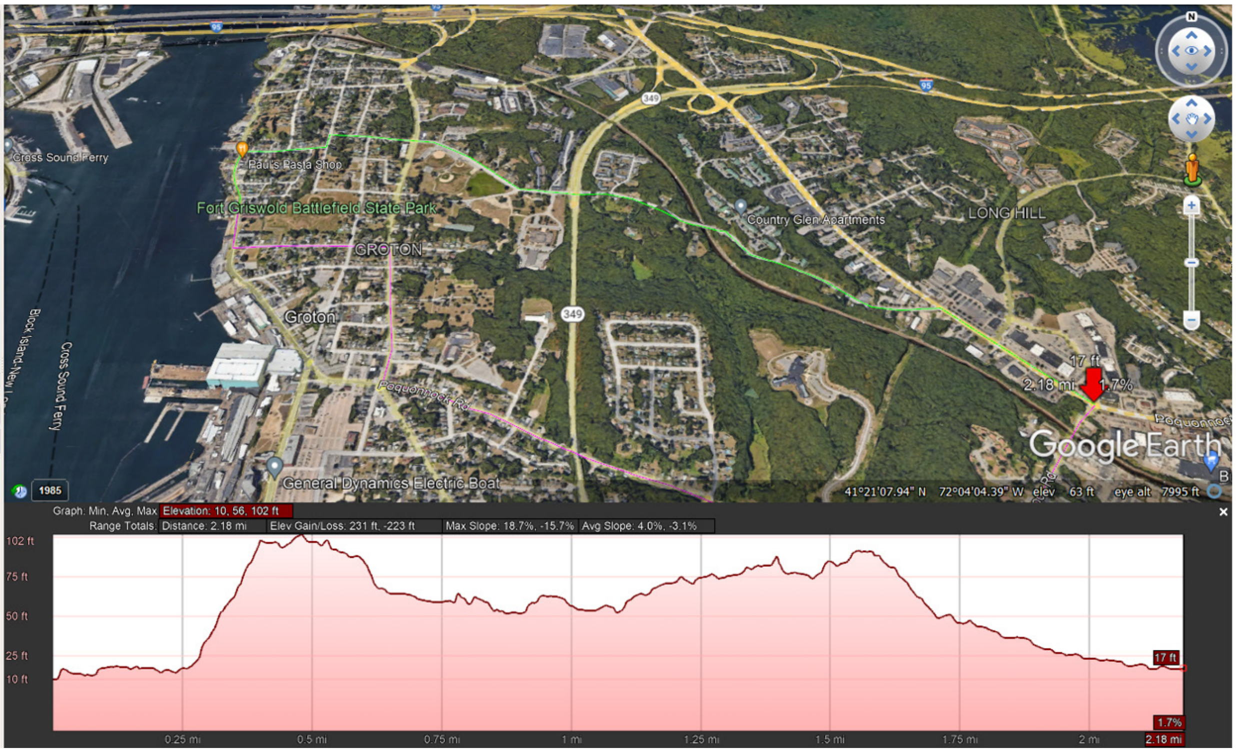
PROJ NO: 20653	DATE: 3/9/2022
WRIGHT-PIERCE Engineering a Better Environment	FIGURE: 9-1

JMN W:\GIS_Development\Projects\CT\Groton\20653_WWTP_FacPlan\MXDs\RoutingOptions.aprx - 8x11-Portrait

9.1.1.1 Meridian Street Route Challenges

There are a few sections of this route that will increase the cost and constructability of the route. Along Thames Street near Fort Street, there appears to be brick or concrete pavers in the roadway instead of asphalt paving, which are more labor intensive, time consuming and costly to repair/replace following the sewer installation efforts.

Figure 9-2 Meridian Street Route Profile



Source: Google Earth

This route appears to cross through six intersections that are controlled by traffic lights. Installation of the new sewer through each of these intersections will include significant traffic control measures and perhaps repair of loop detectors or similar features that control the timing of these lights.

This route includes the crossing of the railroad at the border of the Town of Groton with the City of Groton. The roadway crosses over the railroad on a bridge. Any means of hanging a new sewer beneath the bridge would require significant coordination and permitting approvals with the railroad company for clearance from trains and protection of what appear to be electrical utilities for the railroad in the area of the bridge. The railroad was not engaged as part of this planning level effort.

This route also crosses State Route 349 at a lighted intersection and runs along, within or parallel to US route 1 for around 1,700 linear feet. This route would therefore require significant coordination with the State Department of Transportation regarding work in the state rights-of-way and might include more extensive paving requirements than Town or City maintained roads.

This route also appears to cross a stream, within the City of Groton limits. Just east of Route 349 / Clarence Sharp Highway, Meridian Street Extension appears to cross over an unnamed stream. This crossing could involve additional permitting efforts, construction mitigation techniques or other factors that could complicate the design or construction efforts.

9.1.2 Poquonnock Road Route

This route leaves the existing PAF and heads south along Thames Street to Baker Avenue. Heading east on Baker Avenue, the route continues until it turns to the south along Mitchell Street. The route follows Mitchell Street until it turns to the east once more along Poquonnock Road. The route follows Poquonnock Road across the municipal boundary between the Town and City of Groton to its connection point with the northwest interceptor at US Route 1. Part of this section of Poquonnock Road is also labeled as State Route 649 on some mapping.

This route is slightly longer, measuring about 13,000 linear feet. This route also runs past two existing pumping stations: the City of Groton maintained Twin Hills pumping station near the municipal boundary, and the Town of Groton maintained Trails Corner pumping station, both along Poquonnock Road. If these stations were used as an intermittent pumping site, they would need to each be upgraded to handle an additional 7.15 MGD. For purposes of this evaluation, we have assumed that that would be cost prohibitive and have carried costs for extending the force main as far as possible before transitioning to gravity.

The first high point after leaving the PAF site (approx. elevation 10 ft) along this route is approx. elevation 115 ft near the intersection of Baker Avenue and Mitchell Street. From there the elevation drops to a localized low point of around elevation 80 ft near the intersection of Mitchell Street and Poquonnock Road. The elevation then rises again to a localized high point of around elevation 110 ft a quarter-mile down Poquonnock Road (between West and High Streets) before once again trending downwards. The next low point of approximately elevation 5 ft is near the Twin Hill Pumping station. The grade along the route stays relatively low and flat between the Twin Hill Pumping station and the Trails Corner pumping station (staying between elevation 0 to 10 ft). Once the route hits the intersection of Poquonnock Road and High Rock Road (where it turns Northeast to head towards US Route 1), the grade trends upwards with undulations to an elevation of around 30 ft between Loraine Road and Ginger Drive. Then the grade slopes slowly downward towards the connection point to the Northwest Interceptor at US Route 1. The rough elevation profile utilized to identify these locations and approximate elevation was created utilizing Google Earth as shown in Figure 9-3.

9.1.2.1 Poquonnock Road Route Challenges

There are a few sections of this route that increase the cost or difficulty of the route. This route appears to cross through four intersections that are controlled by streetlights. Installation of the new sewer through each of these intersections will include significant traffic control measures and perhaps repair of loop detectors or similar features that control the timing of these lights.

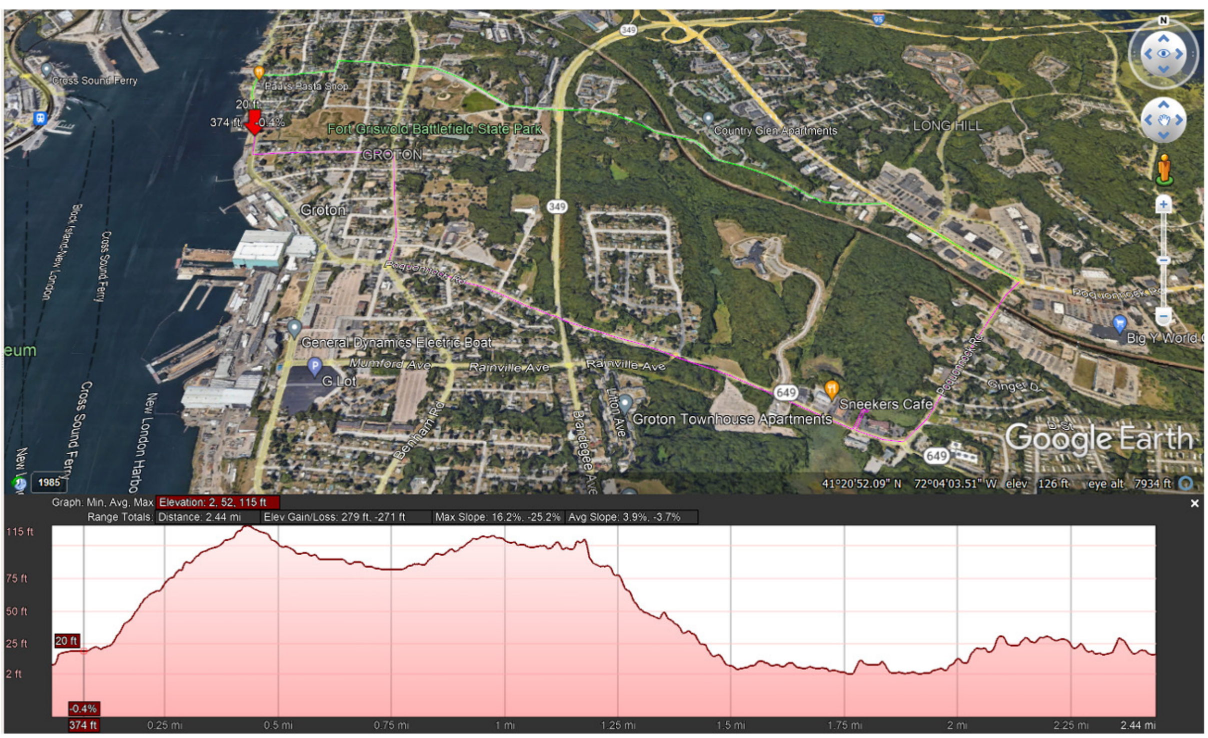
This route includes the crossing of the railroad within the Town of Groton near US Route 1. The roadway crosses underneath the railroad utilizing a bridge. Based on past experience, excavation beneath the road in the vicinity of the bridge would likely require review and approval of the railroad company, as well as potential construction inspection by the railroad and depending on the owner, potentially limiting additional construction method requirements.

This route also crosses beneath State Route 349, with the limited clearance under the bridge, a construction contractor would be limited in his means and methods to work in this area due to the height restriction.

This route runs for a significant length along what appears to be a state-delineated highway (Route 649), although this route does not appear to be signed as such along the roadway. Depending on the state's jurisdiction and the controlling pavement depth, this work could require significant coordination with the State Department of Transportation regarding work in the state rights-of-way and might include more extensive paving requirements than Town or City maintained roads. It is unclear exactly what portions of Poquonnock Road are part of State Route 649, but it appears to be from Rainville Ave to High Rock Road, approximately 2,900 LF.

This route also appears to cross two streams, both within the Town of Groton limits. One crossing is with Plain Creek, near the large "M Lot" private parking area and the Catherine Kolnaski Magnet School. The other crossing is of a stream that does not appear to be named approximately 850ft southwest of Route 1 (400 ft southwest of the RR bridge These crossings could involve additional permitting efforts, construction mitigation techniques or other factors that could complicate design and construction efforts.

Figure 9-3 Poquonnock Route Profile



Source: Google Earth

9.2 Routing Alternative Analysis

Both of these routes were evaluated for feasibility to determine which one might be preferable for future regionalization. Any interconnection with the Town of Groton would require Town of Groton approval and cooperation, as well as a formal intermunicipal agreement defining items such as a term period, allowable daily flow and loading limits, cost to treat, limits of operational responsibilities, and the financial responsibilities of Groton Utilities for future upgrades or expenditures required at the Town of Groton WPCF and in the collection system. As part of the initial discussions with the Town of Groton, they indicated a preference for the Poquonnock Road Route. The town of Groton has also confirmed that the existing Northwest interceptor and WPCF can handle the additional flows but that their Poquonnock River Pump Station would require an upgrade.

9.2.1 Force Main & Gravity Main Project Costs

Based on the available information, we generated a Planning Level Opinion of Probable Cost for the two routes. This estimate is based primarily on the estimated linear footage of gravity and force main piping required, the estimated needs for upgrading pumping stations, and cost additions for identified areas along the route that might increase design or construction costs beyond the typical price per linear foot of pipe. In general, with the length of the routes being similar, the undulations of the routes being similar, the cost of the piping and the associated complexities (streetlights, stream crossings, railroad crossings, etc), at this stage of the project there does not appear to be a large cost difference between the two routes.

The estimated opinion of probably cost for each route is summarized in Table 9-1 and Table 9-2. These estimates have been developed for planning purposes and are considered to be Association for the Advancement of Cost Engineering (AACE) Class 3 estimates, reflecting a maturity level of the project definition of deliverables in the range of 10% to 40%.

Table 9-1 Summary of Opinion of Probable Cost – Meridian Route

Item Description	Quantity	Unit Price	Line-Item Price
Force Main Pipe	8,200 LF	$400/LF	$3,280,000
Gravity Pipe	3,300 LF	$600/LF	$1,980,000
Paver Replacement (Thames St)	2,500 SF	$25/SF	$62,500
Town/City Road Trench Paving[1]	9,000 SY	$45/SY	$405,000
State Route Trench Paving[1]	2,000 SY	$100/SY	$200,000
Final 2” Mill & Overlay[2]	32,000 SY	$30/SY	$960,000
Lighted Intersection Crossings[3]	6 EA	$75,000 / EA	$450,000
Bridge Crossings[4]	1 EA	$100,000 / EA	$100,000
Railroad Crossings[5]	1 EA	$250,000 / EA	$250,000
Stream Crossings[6]	1 EA	$150,000 / EA	$150,000
Traffic Control	1 EA	$500,000/ EA	$500,000
Soils Management	1 EA	$500,000/ EA	$500,000
		Construction Subtotal	$8,837,500
		Contingency (25%)	$2,209,000
		Design & Construction Engineering Services (20%)	$1,768,000
Total Project Cost			$12,815,000

Notes:

1. Trench paving cost assumes 8' width and 4" thickness on most streets, 10-wide and 9" thick on route 1 and 649. $200/ton, 0.055 ton per SY-IN.
2. Mill and overlay assumed for one travel lane only along entire route.
3. Cost for lighted intersection crossing assumes added traffic control as well as additional utility crossings and potential loop detector adjustments.
4. Cost for Bridge Crossings assumes added coordination and modified procedures due to lower clearance or pipe hanging, etc.
5. Cost for Railroad Crossings assumes alternate construction methods to be coordinated with railroad company
6. Cost for Stream Crossings assumes permitting efforts, potential alternate construction methods or timing restrictions

Table 9-2 Summary of Opinion of Probable Cost – Poquonnock Route

Item Description	Quantity	Unit Price	Line-Item Price
Force Main Pipe	9,500 LF	$400/LF	$3,760,000
Gravity Pipe	3,500 LF	$600/LF	$2,100,000
Town/City Road Trench Paving[1]	11,500 SY	$45/SY	$517,500
State Route Trench Paving[1]	100 SY	$100/SY	$10,000
Final 2" Mill & Overlay[2]	36,000 SY	$30/SY	$1,080,000
Lighted Intersection Crossings[3]	4 EA	$75,000 / EA	$300,000
Bridge Crossings[4]	1 EA	$100,000 / EA	$100,000
Railroad Crossing[5]	1 EA	$250,000 / EA	$250,000
Stream Crossings[6]	2 EA	$150,000 / EA	$300,000
Traffic Control	1 EA	$500,000/ EA	$500,000
Soils Management	1 EA	$500,000/ EA	$500,000
		Construction Subtotal	$9,417,500
		Contingency (25%)	$2,354,000
		Design & Construction Engineering Services (20%)	$1,884,000
Total Project Cost			$13,655,000

Notes:

1. Trench paving cost assumes 8' width and 4" thickness on most streets, 10-wide and 9" thick on route 1 and 649. $200/ton, 0.055 ton per SY-IN.
2. Mill and overlay assumed for one travel lane only along entire route.
3. Cost for lighted intersection crossing assumes added traffic control as well as additional utility crossings and potential loop detector adjustments.
4. Cost for Bridge Crossings assumes added coordination and modified procedures due to lower clearance or pipe hanging, etc.
5. Cost for Railroad Crossings assumes alternate construction methods to be coordinated with railroad company
6. Cost for Stream Crossings assumes permitting efforts, potential alternate construction methods or timing restrictions

9.3 Convert Groton PAF to Pump Station

With either alternative, the Groton PAF site would be converted to a pump station to convey flow to the Town of Groton WPCF for treatment and disposal. The Town of Groton's Poquonnnock Road Pump Station will also need to be upgraded. The PAF site remains the low point in the city's collection system. All wastewater flow generated in the City of Groton will continue to be directed to this site. The pump station design requirements are summarized in Table 9-3. The pump station will be designed to convey the future peak hour flow of 7.15 MGD. The force main will be 14-inches in diameter to maintain proper scouring velocities above 3.0 ft/s.

Table 9-3 Pump Station Design Parameters

Item	Value
Station Type	Drywell/Wetwell
Station Design Capacity	7.15 MGD
Number of Pumps	3 (2 duty, 1 stand-by)
Pump Type	Dry-pit Submersible
Individual Pump Design Capacity	2,500 gpm each
Force Main Diameter & Material	14-inch C-900 or Ductile Iron
Design Finished Floor Elevation	18.0

One of the costliest components of pump station construction is the excavation and installation of the wetwell. A cursory review of the existing structures and building on site concluded that one set of the existing primary settling tanks could be converted into a wetwell with approximately 7-feet of vertical working volume. None of the other tankage on site is deep enough to serve as a wetwell and provide enough storage volume. With respect to constructability and sequencing, the following general assumptions were made:

- Maintain Operations Building, or a portion there of, to house all pump station electrical infrastructure, controls and mechanical bar screen(s) or, construct a new building
- Convert existing primary settling tanks into a wetwell/drywell
- Install three new dry-pit submersible pumps in the drywell
- Install wetwell level control and wetwell grease control/mixing system in the wetwell
- Extend wetwell walls to EL 18.0 and add stairwell access to the drywell and hatch access to the wetwell to meet Resiliency requirements
- Repurpose existing odor control system or install new odor control system to treat exhaust air from the wetwell
- Demolish or repurpose remaining structures and building on-site to site GU operational needs

The majority of this work can be conducted while the existing PAF remains operational with limited shut-downs and bypass pumping. Once the new station is constructed and started up, the remainder of the PAF can be taken off-line, demolished, abandoned or repurposed for other GU needs.

9.3.1 Pump Station Upgrade Project Costs

Based on the available information and assumptions, we generated a Planning Level Opinion of Probable Cost for constructing a pump station on the existing PAF site, and to upgrade the Towns Poquonnock Road Pump Station. This estimate is based primarily on the actual construction costs of similarly sized stations in CT over the last 5 years. The estimated opinion of probable cost for upgrading two pump stations is shown in Table 9-4. This estimate have been developed for planning purposes and is considered to be Association for the Advancement of Cost Engineering (AACE) Class 4 estimates, reflecting a maturity level of the project definition of deliverables in the range of 1% to 15% and a range of estimate between -30% to 50%.

Table 9-4 Summary of Opinion of Probable Cost – Pump Station

Item Description	Quantity	Unit Price	Line-Item Price
Convert Primary Settling tanks to Wetwell/Drywell & Extend Walls	1 LS	$500,000	$500,000
Furnish and Install Pumps	3 EA	$125,000	$375,000
Furnish and Install Piping and Valving	1 LS	$250,000	$250,000
Furnish and Install New Mechanical Bar Screen & Washer/Compactor/Grinder	1 LS	$350,000	$350,000
Convert Operations Building to Pump Station Building or Build New	1 LS	$1,500,000	$1,500,000
Electrical and Controls Allowance	1 LS	$750,000	$750,000
Odor Control & HVAC Allowance	1 LS	$300,000	$300,000
Bypass Pumping/Temporary Facilities	1 LS	$250,000	$250,000
Demolition & Site Work	1 LS	$500,000	$500,000
Upgrade Town of Groton Poquonnock Pump Station	1 LS	$3,000,000	$3,000,000
		Construction Subtotal	$7,775,000
		Contingency (25%)	$1,944,000
		Design & Construction Engineering Services (20%)	$1,555,000
Total Project Cost			$11,274,000

9.4 Regional Alternative Operation and Maintenance Costs

Although the Groton PAF will be eliminated as part of this regional alternative, it will be replaced with infrastructure that will need to be operated and maintained. Operation and Maintenance (O&M) costs required for the existing and new pump stations and force mains are estimated in Table 9-5, including a yearly cash reserve budget of $50,000 for small parts replacements and to budget for future upgrades and larger replacements/repairs at the pump station or within the Town of Groton collection system and WPCF. This value is dependent upon the terms and condition of the intermunicipal agreement. The pump station will need to be visited at least once per day, and force main air/vacuum release structures inspected quarterly. There are also other administrative tasks that will be required. It was estimated that two full-time equivalent staff persons per year will be required to properly operate and maintain the systemwide collection system.

Table 9-5 Operation and Maintenance Costs

Item Description	Quantity	Unit Price	Cost/Year
Electricity	400,000 kW-hr/yr	$0.12/kW-hr	$48,000/yr
City Water	1	Allowance	$500/yr
Telephone/Internet/Alarm & SCADA Software	12 months	$250/month	$3,000/yr
2 employees	2	$70,000/yr	$140,000/yr
Insurance/Site Management	1	Allowance	$50,000/yr
Cash Reserve	1	$50,000	$50,000/yr
Cost to treat	1,830,000 gpd	$0.90/gpd	$1,647,000
Total O&M Costs			$1,940,000/year

9.5 Conclusions and Recommendations

The regional alternative will require the construction of over 2 miles of underground pipe installed in a combination of local and state roadways. It will also require that the existing PAF site be converted to a pump station and that the town of Groton's Poquonnock Road Pump Station be upgraded. The total estimated project cost for these upgrades is $25.0 million, with a yearly associated O&M cost of $1.94 million in 2022 dollars. Again, this estimate has been developed for planning purposes and is considered to be Association for the Advancement of Cost Engineering (AACE) Class 4 estimate at the Study/Feasibility level, reflecting a maturity level of the project definition of deliverables in the range of 1% to 15%.

Refer to Section 11 for a life cycle cost analysis of this regional alternative versus a comprehensive upgrade to the PAF.

10

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Engineering a Better Environment

Section 10 Asset Management Evaluation

10.1 Goals and Objectives of Evaluation

This report section summarizes the asset management work completed for the Groton Utilities Pollution Abatement Facility (PAF). The purpose of this evaluation is to meet the following objectives:

- Create an asset hierarchy for the PAF's assets.
- Conduct condition assessment of assets.
- Perform criticality/risk analysis of significant assets.
- Identify best practices and management strategies for implementing the City's asset management program.
- Develop a Capital Improvement Plan focusing on comprehensive improvements in years 0-5 and be predictive for years 6-20.
- Provide evaluation findings in Microsoft Excel format so that Groton Utilities can use it to populate a Computerized Maintenance Management System (CMMS) in the future if desired.

10.2 Asset Evaluation Procedures

Asset condition assessments are based on information provided by the City, interviews with operations staff, and field observations by Wright-Pierce personnel. During the site visits:

- Basic testing was performed with commonly available tools. The results were used to identify assets performing outside the expected range.
- The Wright-Pierce team spoke with GU personnel to verify performance history and learn about the reliability of each asset.
- Data was collected by the Wright-Pierce team using Fulcrum, a cloud-based data collection software, on tablets and smartphones.
- The condition assessment was limited to readily accessible areas. No confined space entry was performed.
- No destructive testing of construction materials (concrete, paint, metal, insulation, etc.) was performed to determine the condition of assets.

Refer to the evaluation user guide in Appendix G for the methodology and details on which data was to be collected in the field. The overall asset inventory spreadsheet and detailed evaluation forms for each asset collected as part of this study are also included in Appendix G. An electronic copy of the working asset registry for the PAF is also available to the city as a tool for their use moving forward with future CMMS software packages.

10.3 Basis for Estimates of Probable Costs

Planning-level costs have been estimated for recommended PAF improvements. These planning-level costs were estimated using standard cost estimating procedures consistent with industry standards utilizing unit cost information. Total capital cost estimates include an allowance of the estimated construction costs to account for construction contingency, design and construction phase, engineering, permitting, materials testing, as well as financing, administrative and legal expenses. The planning cost information presented herein is in current dollars and is based on an ENR Index of 12684 (February 2022).

These estimates were primarily developed for planning level budgeting and are generally reliable for determining the relative costs associated with equipment replacement. To group proposed improvements into biddable projects, additional factors not easily defined for this planning level report would need to be considered during preliminary and final design (e.g., foundation conditions, owner selected features and amenities, building code issues, bypass pumping, etc.). Contingency was included in the estimates to account for unknown design conditions. However, this contingency allowance may not be adequate in all circumstances.

10.4 Risk Analysis/Modeling and Management Strategies

All assets are not equally important to a wastewater utility's operation. Some assets are critical to operations and others are not critical. Some assets can easily be repaired or replaced with minimal operational impact. Other assets are difficult to repair or replace and cause major service disruptions upon failure. A community must examine its own wastewater system assets to determine which assets are critical and why.

Analyzing existing wastewater system assets to determine the probability of failure (PoF) and the consequence of failure (CoF) provides valuable information about assets in the system. This risk analysis is the foundation for developing cost-effective asset management strategies. Risk-based asset management planning allows the city to allocate money to best reduce risk and maintain service.

10.5 Asset Registry

An asset registry is a list of items identified as assets to be evaluated and maintained. The registry includes what is owned by the City and where it is located. An asset is a maintenance managed item (MMI). A MMI is an asset that is maintained, parts are identified, decisions are made to repair, refurbish, or replace.

To develop the asset registry for the PAF, the City provided Wright-Pierce with the following data sources:

- As-built drawings
- Design drawings
- O&M Manuals
- Staff Input

10.6 Risk Analysis Model

10.6.1 Probability of Failure

The first step to determine risk is to find the Probability of Failure (PoF). PoF is the probability that an asset is subject to failing. To determine the PoF, a condition assessment is performed. An asset is more likely to fail if it is old, has a history of failure, has a known failure record in other locations, or has a poor condition rating. An asset is less likely to fail if it is newer, has little to no history of failure, and has a good to excellent condition assessment rating. The categories used in analyzing facility assets for the PoF condition assessment are physical condition, reliability, performance, and maintainability.

Physical Condition rating is based off several tests and questions including vibration, noise, temperature, coating condition, wear or corrosion, and leakage. The following are the possible condition ratings:

- 1-New or Excellent Condition
- 2-Very Good Condition
- 3-Minor Defects Only
- 4-Some Defects and Deterioration
- 5-Moderate Deterioration
- 6-Moderate to Significant Deterioration
- 7-Significant Deterioration
- 8-Significant Deterioration w/ Major Repairs Performed on Equipment
- 9-Virtually Unserviceable
- 10-Unserviceable

Reliability rating is based on the history of the asset. It relates the number of reported breakdowns or unplanned maintenance calls and potential downtime related to the availability of parts and service for the asset. The following are the possible reliability ratings:

- 1-Exceptional (No Problems)
- 2-Random Breakdown (Every 5 Years)
- 3-Occasional Breakdown (Every 2 Years)
- 4-Periodic Breakdown (Once per Year)
- 5-Continuous Breakdown (Multiple Times per Year)

Current Performance rating is based on efficiency, attention required, and the asset's ability to meet required demands. The following are the possible performance ratings:

- 1-Meets or Exceeds all Performance Targets
- 2-Minor Performance Deficiencies
- 3-Considerable Performance Deficiencies
- 4-Major Performance Deficiencies
- 5-Does not meet any Performance Targets

Maintainability rating is based on the level and frequency of maintenance and monitoring required to keep the asset operational. The following are the possible maintainability ratings:

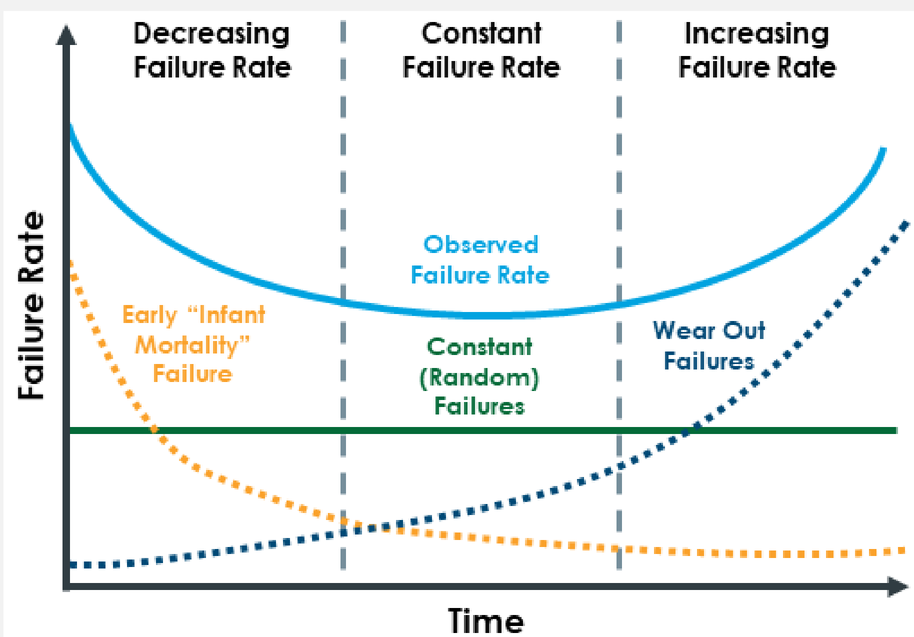
- 1-Easily Maintained
- 2-Largely Preventative Maintenance
- 3-Periodic Corrective Maintenance
- 4-More Frequent Corrective Maintenance
- 5-Work Orders Well Above Average
- 6-Corrective Maintenance has become Routine

Once the condition assessment is complete, the PoF score is determined. Using the condition and reliability ratings, the remaining life of the asset is determined. The remaining life is used to perform a Weibull analysis and produce the probability of failure. The Weibull analysis is based off the bathtub curve in Figure 10-1 below. The Weibull curve has three distinct zones:

- Decreasing Failure Rate – When an asset first starts, early Infant Mortality (defective equipment, poor installation, for example) is the primary mode of failure.
- Constant Failure Rate – Over time, random failures are the primary mode of failure.
- Increasing Failure Rate – As an asset ages and parts wear out, the failure rate increases.

A failure rate is found using the Weibull curve. The failure rate is adjusted based on the performance and maintainability ratings found during the inspection to determine a final PoF.

Figure 10-1 Bathtub Curve



10.6.2 Consequence of Failure

The second step to determine risk is to find the Consequence of Failure (CoF). PoF tells us how often a failure might occur. CoF considers the cost and impacts when a failure does occur. The cost of failure could include loss of fire protection, public health impacts, social costs, collateral damage caused by asset failure, legal costs related to damage caused by the failure, environmental cost. The CoF score is calculated using the triple bottom line concept. The triple bottom line approach considers social, economic, and environmental impacts of asset failure. Wright-Pierce also includes replacement time and redundancy when calculating the final CoF score.

The Social/Community factor gives weight to the social/community consequences that would occur if an asset failed. Potential consequences included in this factor are shown in Table 10-1.

The Economic/Financial Scoring factor gives weight to the economic and financial consequences that would occur if an asset failed. Potential consequences included in this factor are shown in Table 10-2.

The Environmental factor gives weight to the environmental consequences that would occur if an asset fails. Potential consequences included in this factor are shown in Table 10-3.

Potential Consequences	Score					
	1	**3**	**5**	**7**	**9**	**10**
Spill/ Flood	No Impact	Short duration, small quantity	Moderate flooding, some offsite spillage	Many inconvenienced; moderate health and habitat issues	Severe health and habitat issues; some mandatory vacation of premises	Large areas vacated and closed to public access; extensive specialized containment cleanup required
Permit Compliance	No consequence	Minor violation - reporting only	Regulatory sanction possible	Regulatory sanction likely; Damage reversible less than one year	Extensive regulatory sanction virtually assured; damage reversible in one to five years	Severe sanctions; damage reversible in five years or more

Table 10-1 Social/Community Scoring

Potential Consequences	Score					
	1	**3**	**5**	**7**	**9**	**10**
Loss of Service	Can be out of service indefinitely	Cannot be down a month	Cannot be down a week	Cannot be down a day	Cannot be down 8 hours	Cannot be down one hour

Potential Consequences	Score					
	1	**3**	**5**	**7**	**9**	**10**
Safety	No impact	Minimal Impact	Minor injury	Moderate Impact on Public Safety	Significant Impact to Public Safety	Significant and Immediate Impact to Public Safety
Agency's Image	No media or no consequence	Neutral coverage	Adverse media	Widely adverse media	Continual; political opposition	Nationally adverse media

Table 10-2 Economic/Financial Scoring

Potential Consequences	Score					
	1	**3**	**5**	**7**	**9**	**10**
Economic Impact	Low cost	Moderate cost	High cost	High cost; diverts $	Painful change of priorities	Likely to trigger rate increase, staff changes
Financial Impact	Insignificant	<$10k	<$50k	<$100K	<$1 million	>$1 million

Table 10-3 Environmental Scoring

Potential Consequences	Score					
	1	**3**	**5**	**7**	**9**	**10**
Spill/ Flood	No Impact	Short duration, small quantity	Moderate flooding, some offsite spillage	Many inconvenienced; moderate health and habitat issues	Severe health and habitat issues; some mandatory vacation of premises	Large areas vacated and closed to public access; extensive specialized containment cleanup required
Permit Compliance	No consequence	Minor violation - reporting only	Regulatory sanction possible	Regulatory sanction likely; Damage reversible less than one year	Extensive regulatory sanction virtually assured; damage reversible in one to five years	Severe sanctions; damage reversible in five years or more

The CoF score is a sum of the factors listed below normalized to a 1-10 scale. The weighting factors were selected to reflect the potential risk for each factor in Groton.

Table 10-4 Consequence of Failure Factor Weighting

Factor	Weighting
Social/Community	35%
Economic/Financial	30%
Environmental	35%

After the CoF is determined, replacement time and redundancy factors are incorporated into the calculation. These two factors increase or decrease the score based on the replacement time and level of redundancy for each asset.

10.6.3 Final Score

After final scores for PoF and CoF are determined, a management strategy can be assigned to each asset based on the risk matrix in Figure 10-2. Management strategies are selected to maximize cost-effective maintenance practices and reduce the risk associated with the asset.

Figure 10-2 Risk Matrix

Probability of Failure	Consequence of Failure									
	1	2	3	4	5	6	7	8	9	10
10	D	D	B	B	A	A	A	A	A	A
9	D	D	B	B	A	A	A	A	A	A
8	D	D	C	B	B	B	A	A	A	A
7	D	D	C	B	B	B	B	B	A	A
6	F	F	C	C	C	B	B	B	B	B
5	F	F	F	C	C	C	C	C	C	C
4	F	F	F	E	C	C	C	C	C	C
3	F	F	F	E	E	E	E	C	C	C
2	F	F	F	E	E	E	E	E	E	E
1	F	F	F	E	E	E	E	E	E	E

Management strategies include:

- **Group A** – Critical Renew & Replace (R&R) – (High PoF, High CoF). Asset has reached the end of its useful life or is near the end of its useful life but has high consequence of failure. Asset should be replaced within the year.
- **Group B** – Priority Renew & Replace (R&R) – (High PoF, High CoF). Asset is nearing the end of its useful life. Asset should be put on the 5-year CIP to be replaced.
- **Group C** – Add Predictive Maintenance Schedule – (Mid PoF, High CoF). Asset is about halfway through its useful life and parts will begin to wear out. A predictive maintenance schedule should be implemented.
- **Group D** – Opportunistic Renew & Replace – (High PoF, Low CoF). Asset has a low consequence of failure and is considered acceptable to fail. Replace as it fails.
- **Group E** – Routine Maintenance or Preventative Maintenance Schedule – (Low PoF, High CoF). Asset is new or early in its useful life. A routine or preventative maintenance schedule needs to be implemented.
- **Group F** – Run to Fail – (Low PoF, Low CoF). Asset has low consequence of failure and is considered acceptable to fail. No preventative or predictive maintenance should be scheduled for these assets.

Figure 10-3 shows a summary of management strategies for the Groton PAF assets.

Figure 10-3 Summary of Assets by Strategy

Group	Strategy	Count	% Assets
A	Critical R&R	2	1%
B	Priority R&R	8	5%
C	Add PdM Schedule	15	9%
D	Opportunistic R&R	9	5%
E	Rt or PM Schedule	26	16%
F	Run to Fail	106	64%
G	(undefined)	0	0%
	Total	166	

Risk can be reduced by decreasing the PoF by repair, replacement, or refurbishment of an asset. Risk can also be reduced by decreasing the CoF through redundancy, relocation, insurance, or alarms. Typically, the most cost-effective means of reducing risk for aging assets is to reduce the PoF through infrastructure replacement projects. The assets with the greatest PoF and CoF are the assets with the greatest risk. These assets should be further evaluated to determine the best way to reduce the risk.

10.7 Asset Registry

The asset registry is the backbone of an effective CMMS program. If an asset is not in the asset registry, it cannot be managed or tracked very easily. The asset registry lists assets and important asset information. A well-developed asset registry will include the following (if applicable):

- Asset ID number
- Asset description
- Serial number
- Model number
- Equipment class
- Manufacturer
- Material
- Size and Capacity
- Installation Date
- Service life
- Replacement cost
- Criticality ranking
- Warranty begin and end date
- Equipment condition rating

The asset registry should be organized in a hierarchy that allows staff to report on the performance and cost impacts of assets quickly and effectively.

10.8 Asset Hierarchy

An asset hierarchy is the logical organization of assets that supports effective condition and cost analyses for groups of assets. The asset hierarchy is typically built upon a series of ‘parent/child’ relationships. Asset hierarchies are set up to support both high-level CMMS decision-making and more immediate maintenance management decision-making.

Wright-Pierce has developed an asset hierarchy that encompasses the City’s assets.

The purpose of the asset hierarchy is to:

- Support CMMS reporting.
- Support maintenance cost reporting.
- Support related CMMS functionality, such as the ability to assign assets to work orders.
- Capture all wastewater assets.
- Provide flexibility to add new assets in the future.

The asset numbering convention uses a series of codes that provide useful information about the asset. The asset number structure includes a facility number, a location number, a room number, an asset classification, and an identifying asset number. An example asset ID is 100-110-01-PP-01:

100 = Pollution Abatement Facility ID
110 = Building/Structure (Operations Building)
01 = Room Number (Basement)
PP = Asset Classification (Pump)
01 = Asset Number (Pump No. 1)

This example (100-110-01-PP-01) is the asset ID for Pump No. 1 located in the Basement of the Operations Building. The complete asset hierarchy for the Groton PAF is in Appendix G.

10.9 Observations and Recommendations

The observations and recommendations have been broken out by area of the plant and have been coordinated with the observations and recommendations made throughout other sections of this report and combined into one comprehensive recommended capital improvements plan in Section 11. Each recommendation has a year that the work should be completed attached to it, while many of the items listed below can be completed by PAF staff as routine preventative maintenance. Each asset also had its replacement time estimated based on age, current condition, reliability, performance, and maintainability. Any asset that was predicted to require replacement in the next ten years had an observation of “Predicted replacement year”.

Table 10-5 Aeration Tanks

Asset Description	Room/Area	Observation	Recommendation	Year
Submersible Mixers	-	Attached using ropes.	Recommend a more permanent attachment if they will be reused in new aeration process.	2024

Table 10-6 Blower Building

Asset Description	Room/Area	Observation	Recommendation	Year
Old Chemical Feed System	Basement	No bellows on tank outlet piping.	If there are plans to reuse in the future, then bellows should be installed on both tanks. If no plans to reuse, then system should be removed.	2022
Electric Unit Heater	Basement	Thermostat set to 65, all other unit heaters are on standby, and temperature is well above 65 but this heater is still running at max.	Check thermostat, it may not be sending the signal to the heater to turn off. Consider removal of abandoned hydronic piping.	2022
Foam Spray Pump	Basement	Decommissioned. Predicted replacement year.	Replace in kind.	2022
Plant Water Pump	Basement	Decommissioned for years. City water used instead.	If the cost of city water is more than running the plant water system, then this system should be brought back online.	2025
(General)	Basement	There is no mechanical ventilation provided in the Pipe Gallery, manual damper to intake hood at end of gallery is closed.	Provide new fresh air intake, damper, and supply fan at end of pipe gallery. Evaluate ventilation requirements to comply with NFPA 820 requirements. Confirm capacity of exhaust fan serving basement and replace as necessary to provide adequate ventilation.	2022
Emergency Eyewash/Shower	Basement	Existing emergency shower/eyewash station at polymer storage area is supplied with cold water only.	Remove existing emergency shower (not required for polymer); add new emergency shower with an emergency thermostatic tankless water heater.	2023
Aeration Blower No. 1	Blower Room	Blower is oversized and difficult to control.	Replace with properly sized blower.	2025
Aeration Blower No. 2	Blower Room	Blower is oversized and difficult to control.	Replace with properly sized blower.	2025
Aeration Blower No. 3	Blower Room	Air leak on the discharge.	Seal air leak.	2022
Aeration Blower No. 3	Blower Room	Blower is oversized and difficult to control.	Replace with properly sized blower.	2025

Asset Description	Room/Area	Observation	Recommendation	Year
Heat Pump	Break Room	Ceiling cassette units are in good condition; the filters are dirty to a point which may affect the efficiency of the system.	Clean ductless heat pump indoor unit filters to restore full airflow and add filter cleaning to maintenance schedule (3 months recommended).	2022
Primary Effluent Pump No. 1	Exterior	Water leaking at seal.	Fix seal leak.	2022
Primary Effluent Pump No. 1	Exterior	Pump is problematic, reduced flow, hard to get in/out for maintenance.	Replace pump with submersible style and install a gantry and crane above for removal.	2025
Primary Effluent Pump No. 2	Exterior	Pump is problematic, reduced flow, hard to get in/out for maintenance.	Replace pump with submersible style and install a gantry and crane above for removal.	2025
Primary Effluent Pump No. 3	Exterior	Pump is problematic, reduced flow, hard to get in/out for maintenance.	Replace pump with submersible style and install a gantry and crane above for removal.	2025

Table 10-7 Digester Building

Asset Description	Room/Area	Observation	Recommendation	Year
Circulating Pump No. 1	Boiler Room	Exposed wires, junction box needs to be installed.	Install junction box to cover exposed wires.	2022
Digester Heat Exchanger/Boiler System	Boiler Room	Predicted replacement year.	Replace in kind.	2031
Air Handling Unit	Gas Gallery	Water dripping from cleanout on return heating water pipe.	Replace cleanout.	2022
Digester Mixing Pump No. 1	Pump Room	The digesters are designed for mesophillic anaerobic digestion and temperatures should typically range from 86-100 degrees F. The thermophilic anaerobic digestion typical temperature range is 122-140 degrees F. This pump is running hotter than expected at 124 degrees F.	First check to make sure it's not an issue with the pumps, check to make sure the pump is not losing prime, there are no clogs, and that the motor isn't drawing too much current. If those items are normal, then the pump should still be monitored to make sure the temperature doesn't increase any more. If the pump is fine then operation of the digester should be confirmed because it appears they are operating thermophilic digestion instead of mesophillic.	2040
Digester Mixing Pump No. 2 Motor	Pump Room	Exposed wires, no cover on junction box.	Install junction box cover.	2022
Digester Recirculation Pump No. 1	Pump Room	The digesters are designed for mesophillic anaerobic digestion and temperatures should typically range from 86-100 degrees F. The thermophilic anaerobic digestion typical temperature range is 122-140 degrees F. This pump is running hotter than expected at 125 degrees F.	First check to make sure it's not an issue with the pumps, check to make sure the pump is not losing prime, there are no clogs, and that the motor isn't drawing to much current. If those items are normal, then the pump should still be monitored to make sure the temperature doesn't increase any more. If the pump is fine then operation of the digester should be confirmed because it appears they are operating thermophilic digestion instead of mesophillic.	2022

Asset Description	Room/Area	Observation	Recommendation	Year
Digester Recirculation Pump No. 2	Pump Room	The digesters are designed for mesophillic anaerobic digestion and temperatures should typically range from 86-100 degrees F. The thermophilic anaerobic digestion typical temperature range is 122-140 degrees F. This pump is running hotter than expected at 125 degrees F.	First check to make sure it's not an issue with the pumps, check to make sure the pump is not losing prime, there are no clogs, and that the motor isn't drawing to much current. If those items are normal, then the pump should still be monitored to make sure the temperature doesn't increase any more. If the pump is fine then operation of the digester should be confirmed because it appears they are operating thermophilic digestion instead of mesophillic.	2022
Digester Recirculation Pump No. 1 Motor	Pump Room	Temperature is higher than expected but still within acceptable range.	Check motor current because pump is overheating and motor is hotter than expected.	2022
Digester Recirculation Pump No. 1 Motor	Pump Room	Predicted replacement year.	Replace in kind.	2024
Digester Recirculation Pump No. 2 Motor	Pump Room	Predicted replacement year.	Replace in kind.	2024
Exhaust Fan	Roof	Temperature is higher than expected but still within acceptable range.	Monitor to see if temperature increases any more.	-
Building	-	2015 upgrade plans list the space as Class 1, Division 1 which appears to be appropriate. Some equipment and accessories in the space appear to be correctly rated for the application but others, including the motor operated damper actuator serving the roof mounted exhaust fan, are not appropriately rated for the space.	Evaluate ventilation requirements in accordance with NFPA 820; identify and replace all electrical and control components that do not meet the NEMA classification of the space.	2023

10.9.1 Final Settling Tanks

No observations or recommendations noted for the final settling tanks other than those noted in Section 4..

Table 10-8 Generator Building

Asset Description	Room/Area	Observation	Recommendation	Year
Engine Generator	-	Generator is oversized, a load bank had to be installed.	Replace generator with properly sized one.	2029
Resistive Load Bank	-	Reported to not work.	Remove, will not be required with new generator.	2029
Fuel Day Tank	-	Predicted replacement year.	Replace in kind with generator.	2029

Table 10-9 Grounds

Asset Description	Room/Area	Observation	Recommendation	Year
Fuel Oil Storage Tank	-	Double walled - No leak detection system.	Install leak detection system.	2022
Odor Control System	-	Recirculation pump is missing. Fan is still running but odor control is not functional.	Replace odor control system with either carbon or in-kind scrubber.	2022

Table 10-10 Maintenance Building

Asset Description	Room/Area	Observation	Recommendation	Year
Electric Unit Heater No. 1	-	Predicted replacement year.	Replace in kind.	2024
Electric Unit Heater No. 2	-	Predicted replacement year.	Replace in kind.	2024
Building	-	No mechanical ventilation is provided.	Recommend adding ventilation to provide 0.75 cfm/sqft in accordance with vehicle repair garage requirements of mechanical code.	2024

Table 10-11 Operations Building

Asset Description	Room/Area	Observation	Recommendation	Year
Air Handling Unit	Basement	Linkages are showing corrosion. Associated ductwork is in fair condition with some minor surface corrosion, supply ductwork near chemical storage area shows more significant signs of corrosion. The exhaust ductwork is in fair condition and shows signs of minor surface corrosion. Two of the three exhaust inlets are blocked off, leaving a significant area of the space without air circulation. Predicted replacement year.	Replace unit.	2022
Boiler System	Basement	Originally told it is not working but the unit itself has temperature and water pressure. Existing Boiler, which serves the Operations Building was installed prior to and relocated during the 1998 upgrade and is in poor condition. It is corroded, and the flue piping and chimney door are leaking. The expansion tank is in poor condition, and its supports are corroded. The air separator as well as the exposed piping are corroded and in poor condition. The circulator pumps are in fair condition, but the flanges are leaking and in poor condition. The boiler serves 5 finned tube radiators, 6 unit heaters, and two air handling units. The desire to remove the hydronic heating system in its entirety was noted.	Schedule for demolition/replacement with newer technology. Demolish and reconfigure existing exhaust ductwork as necessary to better circulate air throughout the space.	2022
Chlorine Booster Pump No. 2 Motor	Basement	Temperature is a little warmer than expected but still within the acceptable range.	Monitor to see if temperature increases any more.	-
Digested Sludge Transfer Pump No. 1	Basement	Pump does not have the capacity required to transfer sludge, so pump is not used. They have to drain the digesters by gravity in most cases.	No recommendation currently. Need to determine future use of digesters first before recommending removal, reuse, or replacement of pump.	-
Digested Sludge Transfer Pump No. 2	Basement	Pump does not have the capacity required to transfer sludge, so pump is not used. They have to drain the digesters by gravity in most cases.	No recommendation currently. Need to determine future use of digesters first before recommending removal, reuse, or replacement of pump.	-
Emergency Eyewash/Shower	Basement	Showing signs of corrosion and is located too far from point of potential exposure in sodium hypochlorite room with obstructions and restrictions to movement limiting the ability to reach the unit in an acceptable time. There is no recirculating pump to limit stagnation of water in pipe.	Demolish existing emergency shower/ eyewash unit and provide new PVC unit closer to possible point of chemical exposure to minimize obstructions and limit travel time required to less than 10 seconds. Consider addition of a recirculating pump to reduce stagnation and microbial growth in tepid water piping.	2023
Old RDT Polymer Feed System	Basement	No longer required.	Remove.	2022
Primary Sludge Pump No. 1	Basement	Predicted replacement year.	Replace with either double disc, rotary lobe, or recessed impeller type pump. Further evaluation required to determine the correct pump type for this application.	2025
Primary Sludge Pump No. 2	Basement	Friction noise. Bearings appear to be misaligned, could be what is creating friction noise.	Properly align bearings.	2022
Primary Sludge Pump No. 2	Basement	Predicted replacement year.	Replace with either double disc, rotary lobe, or recessed impeller type pump. Further evaluation required to determine the correct pump type for this application.	2025
RDT Polymer Feed System	Basement	Predicted replacement year.	Replace in kind.	2030
RPZ Backflow Preventer	Basement	Installed in the vertical orientation. Typically, this equipment is approved only for horizontal installation	Confirm if model installed is approved for vertical installation	2022
Sodium Hypochlorite Pump No. 1	Basement	Predicted replacement year.	Scheduled for replacement.	2022
Sodium Hypochlorite Pump No. 2	Basement	Predicted replacement year.	Scheduled for replacement.	2022

Asset Description	Room/Area	Observation	Recommendation	Year
Sodium Hypochlorite Tank No. 1	Basement	No bellows on tank outlet pipe.	Tank scheduled for replacement. Install bellows on new tank.	2022
Sodium Hypochlorite Tank No. 2	Basement	No bellows on tank outlet pipe.	Tank scheduled for replacement. Install bellows on new tank.	2022
Thickened Waste Sludge Transfer Pump No. 1	Basement	Not connected to power or piped in.	Make operational for redundancy.	2022
Thickened Waste Sludge Transfer Pump No. 2	Basement	Minor seal leak.	Replace seal.	2022
Grit Blower Motor	Blower Room	Temperature is high but still within the acceptable range.	Monitor to see if temperature increases any more.	-
Air Conditioner	Electric Room	Discharges into the exhaust ductwork running through the space which is connected to the odor control system on the roof above. This means of connection creates a potential hazard if the odor control system is shutdown explosive gases could be introduced into the unit and space.	Provide new ductless split system heat pump to serve the Electrical Room. Remove the floor air conditioning unit and repair the basement exhaust ductwork.	2022
Emergency Eyewash	Lab Room	A deck mounted face/eye wash is provided but no emergency shower is provided.	Evaluate chemicals used to ensure deck mounted eye/face wash is appropriate. If required add emergency shower and associated piping.	2022
Influent Sluice Gate	Preliminary Treatment Area	Gate does not operate, but not really needed.	Remove gate.	2029
Influent Step Screen	Preliminary Treatment Area	Predicted replacement year.	Replace in kind.	2029
Screenings Grinder	Preliminary Treatment Area	Heavy surface corrosion under peeling paint. Cutters are reported to be worn and in need of replacement.	Replace cutters.	2022
Screenings Grinder	Preliminary Treatment Area	Predicted replacement year.	Replace in kind.	2029
Screenings Grinder Motor	Preliminary Treatment Area	Motor is not explosion proof, located in class 1 div 1 space.	Install an explosion proof motor.	2022
Screenings Washpress	Preliminary Treatment Area	Predicted replacement year.	Replace in kind.	2029
Unit Heater No. 1	Preliminary Treatment Area	Predicted replacement year.	Replace in kind.	2022
Unit Heater No. 2	Preliminary Treatment Area	Fan running but no heat because boiler does not work. Predicted replacement year.	Boiler being replaced with newer technology. Replace in kind same time as boiler.	2022
Air Conditioner	Roof	Predicted replacement year. Existing air conditioning unit (**AC-2**), which was installed in 1998 and replaced in approximately 2015 is not operating properly, provides no heating and insufficient cooling to the lab and office area. Associated ductwork and grilles are in good condition. This unit provides cooling and ventilation air to the Lab, Office, and Shop. The Process equipment located in the Shop space causes the space to be rated Class 1, Division 2, air from this space should not be returned and recirculated through unclassified spaces as the current duct arrangement allows.	Replace unit. Provide new ductless split system heat pumps to serve the Office and Lab areas. Ceiling cassette indoor units and either roof or wall mounted outdoor units sized to provide heating and cooling to these spaces are recommended. Individual units would be provided to allow for independent control of the Lab and Office zones. Electric baseboard heating elements could be added at the	2022

Asset Description	Room/Area	Observation	Recommendation	Year
			owner's option, to provide additional comfort heating in these spaces. A small, dedicated energy recovery ventilator to supply tempered ventilation air to these spaces is recommended.	
Air Handling Unit	Roof	Predicted replacement year.	Demolish existing roof mounted AHU-2 serving the Grit Chamber and adjacent process areas. Replace unit with new roof mounted makeup air unit and connect to existing ductwork. Replace corroded supply and exhaust grilles in the Grit Chamber. This equipment would need to be rated for use with Class 1, Division 1 spaces or the duct system modified to allow for protecting the unit from the migration of explosive vapors into the unit in the event that the unit is off.	2022
Roof	-	Equipment is too close to the roof's edge for safe maintenance and requires climbing over obstructions to access.	Add guard rails at roof edge where equipment is mounted less than 15' from roof edge to comply with OSHA safety requirements. Provide crossover bridge/stairs to allow for passing over odor control ductwork to access roof mounted equipment.	2022
(General)	Shop	Grilles are showing significant signs of corrosion, and duct insulation is in poor condition.	Replace corroded supply and return grilles and damaged duct insulation. Evaluate NFPA classification and ventilation requirements for the space. Add dedicated exhaust fan as necessary sizes to match the airflow of the makeup air unit.	2023
(General)	Shop	Drain piping appears to reduce from 4" CI to 3" PVC in the direction of flow.	Replace 3" PVC drain pipe with 4" to match cast iron to comply with plumbing code requirements.	2023
Rotary Drum Thickener	Shop	Predicted replacement year.	Replace in kind.	2032
Unit Heater No. 1	Shop	Predicted replacement year.	Boiler being replaced with newer technology, replace unit heater as required with new technology.	2022
Unit Heater No. 2	Shop	Predicted replacement year.	Boiler being replaced with newer technology, replace unit heater as required with new technology.	2022
Unit Heater	Storage Room #1	Fan running but no heat. Predicted replacement year.	Boiler being replaced with newer technology, replace unit heater as required with new technology.	2032
Unit Heater	Truckway	Does not work. Predicted replacement year.	Boiler being replaced with newer technology, replace unit heater as required with new technology.	2022
(General)	Truckway	The Truckway is not ventilated and has a door that opens into the adjacent Grit Chamber likely making the space Class 1, Division 2; the equipment in the space does not appear to be properly rated given this classification. The two unit heaters (one hydronic, one electric) are not functioning properly.	Evaluate the ventilation requirements and provide new intake louver with motor operated damper and exhaust fan as necessary. Heating to be provided by unit heater with heat source dependent on option chosen.	2022

Table 10-12 Primary Settling Tanks

Asset Description	Room/Area	Observation	Recommendation	Year
Tank 3/4 Sludge Collector	-	Heavy surface corrosion under peeled paint.	Gearbox and pillow blocks need to be cleaned, prepped, and recoated.	2022

Table 10-13 Sludge Storage Building

Asset Description	Room/Area	Observation	Recommendation	Year
Boiler	Basement	Not functional - Requires replacement. The unit is corroded, not functional, and the associated piping is not insulated. No dedicated combustion or ventilation air is provided in the Boiler Room.	Demolish existing boiler and all associated appurtenances and replace.	2022
Hydronic Unit Heater	Basement	Missing Damper Blades.	Replace with electric heater.	2022
Sludge Mixing Pump	Basement	Pump not used or needed.	Remove pump.	2022
(General)	Building	No mechanical ventilation is provided in the building.	Evaluate ventilation requirements and NFPA classification for the space. Add makeup air unit and exhaust fans as necessary to meet requirements. New packaged makeup air unit mounted outside at grade (or supported above grade on structural steel if required for flood protection) and ducted into the building.	2025
(General)	Roof	Roof drain is damaged. Drain piping is reduced in size in the direction of flow.	Replace damaged roof drain with proper size to comply with plumbing code requirements.	2022
Hydronic Unit Heater	Upper Level	Boiler does not work so this can't run. Missing damper blades.	Replace with Electric heater.	2022

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11

Section 11 Recommended Plan

11.1 Introduction

The City of Groton is facing some challenges at their pollution abatement facility (PAF) including:

- Maintaining stringent nitrogen removal and disinfection requirements with increasing operation and maintenance costs to achieve those limits
- Periodic nuisance odor problems
- Aging/obsolete/inoperable equipment and instruments

The purpose of this facilities plan is to identify the issues and conduct an analysis of alternative solutions with associated budgetary costs. Following approval of this plan, detailed engineering analysis will be performed, and specific solutions will be refined during any subsequent preliminary and final design phase(s).

11.2 Description of the Recommended Plan

The recommendations are outlined below and are generally organized by process area by immediate needs (years 0-5) and future needs (years 6-20) based on the evaluations conducted throughout the various sections of this facilities plan. Routine maintenance items such as cleaning, painting, lubricating, etc. are not included in these lists and should be monitored and scheduled separately by PAF staff as part of routine operations and maintenance (O&M). The specific recommendations for the immediate and future improvements are presented below.

11.2.1 Immediate Improvements (Years 0-5)

The following immediate improvements are recommended to be completed as part of one comprehensive project.

11.2.1.1 Operations Building

- Modify influent channel and install radar flowmeter
- Replace aerated grit blower and provide standby unit
- Construct sump in grit tank, install submersible pump and mechanism for grit removal
- Install new mechanical screen and combination screenings washpress/compactor/grinder
- Replace primary sludge pumps with new larger units and install primary sludge flow meter
- Replace thickened waste sludge pumps
- Replace the digested sludge transfer pumps or install piping and valving to allow for the existing mixing pumps to load hauler trucks
- Install piping and valving to allow for thickened waste sludge to be fed directly to the primary digester
- Upgrade odor control system, operations building HVAC and roof (in design)

11.2.1.2 Blower Building/Aeration Tanks

- Replace primary effluent pumps with three new submersible pumps
- Convert aeration system to an MLE process with three new screw compressor hybrid blowers, automated DO control system, diffusers, mixers, internal recycle pumps
- Install torque switches or a current monitoring system on final settling tank drives
- Replace secondary scum pump with larger unit and route new discharge force main to primary settling tank flow distribution box
- Add programming to flow pace the return activated sludge pumps
- Replace effluent flow meter transducer and calibrate for full range of PAF flows

- Install two new aeration tank foam spray water pumps, strainer, piping and nozzles
- Replace supply fan in blower building basement

11.2.1.3 Digester and Sludge Storage Buildings

- Repair interior walls and covers on both digester tanks
- Replace the heated sludge recirculation pumps
- Install piping and valving to allow for the existing mixing pumps to load hauler trucks
- Install transfer pumps to pump thickened waste sludge from the sludge storage tank to the primary digester
- Install piping and valving to allow for thickened waste sludge to be fed directly to the primary digester
- Replace EPDM roofing on the digester and sludge storage buildings

11.2.1.4 Site/Miscellaneous Structures

- Remove actuator on primary settling tank scum tubes and replace with manual arm
- Survey and adjust weirs as primary settling tank flow distribution structure to obtain a 60/40 split
- Replace emergency generator with a smaller unit
- Make repairs to retaining wall and replace/repair section of perimeter fence
- Repair site drainage outfall catch basin and slide gate erosion/settlement
- Replace electric unit heaters in maintenance building
- Add level and leak monitoring at 3,000-gallon fuel tank and report to SCADA
- Upgrade the plantwide SCADA system, control panels, PLCs, alarming and reporting software, and replace any instrument that is over 10 years old
- Retrofit or replace all fluorescent lighting to LED bulbs or fixtures
- Engage FEMA and DEEP to select final flood protection design elevation during preliminary design and incorporate requirements into the project

11.2.2 Future Improvements (Years 6-20)

The following major improvements have been identified and deferred to years 6 through 20, with anticipated larger projects to be completed every 5 years or so.

- Routine SCADA hardware and software upgrades (year 10, 15 & 20)
- Install launder covers in final settling tanks (Re-evaluate after immediate improvements work)
- Replace rotary drum thickener (year 10)
- Replace waste sludge polymer blending system (year 20)
- Replace primary settling tank drives and internals (year 20)
- Replace final settling tank drives and internals (year 20)
- Replace chemical feed pumps (year 15)
- Reevaluate solids handling operations and ether replace the digester tank covers, boiler, heat exchanger and gas system or convert digester building to a dewatering facility (year 15)
- Miscellaneous building improvements: HVAC, doors, windows, sealants (years 10 and 20)
- Demolish/clean up old and decommissioned equipment and electrical (yearly)
- Repave bituminous parking area and drives (year 10)

11.3 Preliminary Layouts of Proposed Immediate Improvements

The following figures are provided at the end of this section to generally illustrate the proposed immediate improvements recommendations.

- Figure 11-1: Operation Building First Floor
- Figure 11-2: Operation Building Basement
- Figure 11-3: Primary Effluent Pump Station
- Figure 11-4: Blower Building Basement
- Figure 11-5: Aeration Tanks

11.4 Planning Level Project Costs

Planning level opinion of probable construction costs (OPCC) have been prepared for the recommended facilities upgrades/improvements. The total preliminary project cost for the immediate improvements project is presented in Table 11-1. The planning-level costs were developed using standard cost estimating procedures consistent with industry standards utilizing concept layouts, unit cost information, and planning-level cost curves, as necessary. Total project costs include estimated construction costs to account for construction contingency, design, and construction engineering, permitting, as well as financing, administrative, and legal expenses. The project cost information presented herein is in current dollars and is based on ENR Construction Cost Index 12684 (February 2022). The detailed construction cost estimate is provided in Appendix G.

These estimates have been developed for planning purposes and are considered to be Association for the Advancement of Cost Engineering (AACE) Class 4 estimates, reflecting a maturity level of the project definition of deliverables in the range of 1% to 15%. Many factors arise during preliminary and final design (e.g., foundation conditions, owner-selected-features and amenities, code issues, etc.) that cannot be definitively identified and estimated at this time. These factors are typically covered by allowances, which may not be adequate for all circumstances.

For this planning level cost estimate, the following allowance assumptions and values were made:

- Administrative and Legal Costs – The administrative and legal costs are estimated to be approximately 2% of the total construction cost. This includes Town costs such as bond council and accounting services that are associated with the project.
- Financing – The Town will likely incur interim financing costs until the final loan is closed. 1% of the total project cost has been carried for interim financing costs.
- Engineering Services – The engineering services cost is estimated to be approximately 18% of the construction cost and is for all phases of engineering services associated with the project. The services include design, permitting, bidding, construction administration, onsite field observation (resident project representative), development of record drawings, development of the operation and maintenance manual, and commissioning phase services.
- Construction Contingency Costs – There is a construction contingency (5%) to account for unexpected conditions in the field identified once construction starts. The contingency costs are a percentage of the total construction cost associated with the project.
- Materials Testing Costs – The materials testing costs are estimated to be approximately 0.5% of the total construction cost. This cost is for miscellaneous materials testing such as soils and concrete testing associated with the project.

Given the current market fluctuations due to the ongoing Covid-19 pandemic, supply chain issues and many other unknowns in the next 12-24 months, budgetary proposals received are subject to change and it is recommended to solicit updated pricing as the project advances to preliminary design.

Table 11-1 Project Cost Estimate – PAF Immediate Improvements

Project Work Area	Cost
Site Work	$160,000
Architectural Improvements	$280,000
Structural Improvements	$672,000
Demolition	$164,000
Operation Building Improvements	$1,800,000
Blower Building/Aeration Tank Improvements	$2,260,000
Digester And Sludge Storage Building Improvements	$214,000
Miscellaneous Site Structure Improvement	$203,000
HVAC/Plumbing	$47,000
Instrumentation	$468,000
Electrical	$781,000
Bypass Pumping/Specials	$40,000
Construction Subtotal[2]	**$7,090,000**
Construction Contingency (5%)	$350,000
Technical Services (18%)	$1,274,000
Materials Testing (0.5%)	$35,000
Hazardous Materials Abatement	$50,000
Legal/Administrative (2%)	$142,000
Financing (1%)	$89,000
Total Project Cost	$9,030,000

Notes:

1. Cost estimate is based on ENR Index 12684 (February 2022).
2. Includes OH&P, contractor markups, general conditions, design contingencies, and inflation.

11.5 Recommended Capital Improvement Plan

A 20-year Capital Improvements Plan (CIP) for the Groton PAF was also developed. It includes both the immediate and future recommended improvements, assuming the immediate improvements will be constructed as one project.

The CIP should be considered a working document. The planning level budgetary cost estimates will need to be reviewed and updated annually, or as needed, by GU over the course of the upgrade program. It is recommended that each proposed improvement project be reevaluated before beginning the design, as changes in scope, available technologies, and site conditions can occur over the course of the plan.

The timing of the improvements in the CIP is based mainly on our review of the probability of failure, consequence of failure, and the risk matrix developed in Section 10. This represents an appropriate process to prioritize the projects in the plan. This CIP should be coordinated with other ongoing work. The proposed 20 Year Capital Improvement Plan is shown in Table 11-2.

11.6 Estimated PAF Operations and Maintenance Costs

The budget to operate and maintain sewer operations for the 2022 fiscal year was approximately $2.23 million. Because the majority of the recommended improvements are direct equipment replacements or improvements, it was assumed that there would be no change in the budget line items other than to account for a 5% yearly increase due to inflation.

11.7 Life Cycle Cost Comparison – Maintain PAF or Pump to Town of Groton

Section 9 of this report evaluated one regionalization alternative that would send all current and future wastewater flows generated in the City of Groton to the Town of Groton. In order to convey the flow to the town of Groton, a new pump station would be constructed on the existing PAF site and up to 13,000-feet of a force main and gravity sewer main would be installed conveying the pump station discharge to the Town of Groton's northwest interceptor in the manhole at the intersection of Poquonnock Road and Long Hill Road (US Route 1). Once in the northwest interceptor, it will be pumped again by the Town of Groton's Poquonnock Road Pump Station. Preliminary discussions with the Town of Groton indicate that their collection system and WPCF can handle the additional flow. However, their Poquonnock Road Pump Station is undersized and will also require a capacity upgrade.

Wright-Pierce performed a 20-year present worth life cycle cost analysis (LCCA) to maintain the PAF versus decommissioning it and pumping all flow to the Town of Groton for treatment. The results are shown in Table 11-2 and favor maintaining the operation of the PAF.

Table 11-2 20-year Capital Improvements Plan

Location	2022 Budget Cost	Plan Year										
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
		1	1.040	1.082	1.125	1.170	1.217	1.265	1.316	1.369	1.423	1.480
Immediate Improvements Comprehensive Upgrade	$9,030,000		$500,000	$1,030,000	$3,500,000	$4,000,000						
Replace Rotary Drum Thickener	$400,000											$592,000
Replace Waste Sludge Polymer Blending System	$50,000											
Replace Final Settling Tank Drives and Internals	$500,000											
Replace Primary Settling Tank Drives and Internals (2 Lg. Tanks)	$400,000											
Replace Hypochlorite Chemical Feed Pumps	$30,000											
Replace Digester Heat Exchanger, Boiler, Covers, Mixing Pumps or Convert to Sludge Dewatering (Study Required)	$1,500,000											
SCADA System Equipment Upgrades & Instrument Replacements	$150,000	$50,000										$74,000
Miscellaneous Building Improvements (HVAC, Doors, Windows,etc.)	$200,000											$148,000
Repave Parking Lot and Drive	$50,000											$74,000
Grand Total	$12,310,000	$50,000	$500,000	$1,030,000	$3,500,000	$4,000,000						$888,000

Table 11-3 20-year Capital Improvements Plan

Location	2022 Budget Cost	Plan Year									
		2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
		1.539	1.601	1.665	1.723	1.801	1.873	1.948	2.026	2.107	2.191
Immediate Improvements Comprehensive Upgrade	$9,030,000										
Replace Rotary Drum Thickener	$400,000										
Replace Waste Sludge Polymer Blending System	$50,000										$110,000
Replace Final Settling Tank Drives and Internals	$500,000										$1,096,000
Replace Primary Settling Tank Drives and Internals (2 Lg. Tanks)	$400,000										$876,000
Replace Hypochlorite Chemical Feed Pumps	$30,000					$54,000					
Replace Digester Heat Exchanger, Boiler, Covers, Mixing Pumps or Convert to Sludge Dewatering (Study Required)	$1,500,000					$2,701,000					
SCADA System Equipment Upgrades & Instrument Replacements	$150,000										$109,667
Miscellaneous Building Improvements (HVAC, Doors, Windows,etc.)	$200,000										$219,000
Repave Parking Lot and Drive	$50,000										
Grand Total	$12,310,000					$2,755,000					$2,411,000

Table 11-4 LCCA Comparison – Maintain PAF or Pump to Town of Groton

Project Component	Maintain PAF	Pump to Town of Groton
Total Project Cost Immediate Improvements	$9.03 million	$25.0 million
Annual O&M Cost	$2.23 million	$1.94 million
20-year Present Worth	$45.5 million	$56.7 million

11.8 Implementation Plan and Schedule

It is recommended that the immediate improvements be constructed as a single comprehensive upgrade at the PAF. This approach would offer several benefits to GU including the economy of scale of having a single construction contract with a general contractor and maximizing any potential funding sources that may be available. A preliminary schedule noting key milestones has been developed. Should GU desire to move forward with the implementation of the immediate recommended improvements project, the anticipated schedule is outlined in Table 11-6. The schedule has been prepared assuming that the project will receive funding and approvals through the CWF program. However, CWF funding is based on assigned priority points and funding availability. There is no guarantee that CWF funding will be available for the Immediate Improvements Project. Should GU decide to fund the project by an alternate means, the timeline of this schedule could potentially be reduced by as much as three to six months.

Table 11-5 Projected Milestone Schedule – Facilities Plan

Wastewater Facilities Plan	Date
Submit DRAFT Plan to GU	March 2022
Submit Revised DRAFT Plan to GU & CTDEEP	June 2022
Public Hearing on Plan	June 2022
Finalize Report and Obtain DEEP Approval	August 2022

Table 11-6 Projected Milestone Schedule – Immediate Improvements

Potential Design and Construction Timeline	Date
DEEP CWF review and approval for Design Scope and Fee	September - November 2022
Draft Preliminary Design Report	May 2023
Preliminary Design Report - Submit to DEEP	June 2023
30% Value Engineering Review	September 2023
60% Design Submittal	February 2024
60% Value Engineering Review	March 2024
90% Design Submittal	June 2024
Client/DEEP Review	July - August 2024
100% Design Submittal	October 2024
Bidding / Award	January 2025
Construction	April 2025 – September 2026

11.9 Funding Options

Most of the recommended improvements may not be reflected within the City's current rate structure and options for additional funding will need to be investigated. Some potential means of funding the CIP include the following:

11.9.1 CT DEEP Clean Water Fund

As discussed above, the immediate improvements project may qualify for funding through the State of Connecticut's Clean Water Fund. The majority of improvements would likely qualify for a 20% grant while those related to nutrient removal may qualify for a 30% grant, but considerations should be given where the Groton PAF will be ranked on the CWF priority list. The remaining portion of the project would be funded through a 2% loan over 20 years.

11.9.2 User Rates

Although not popular, a rate increase is a potential means of raising additional funds for capital improvements. For this facilities plan, a planning level study of Groton Utilities existing rate structure was performed in coordination with Utility Financial Solutions, LLC (UFS) taking the increased budget into account. Using the cost of service and financial model UFS completed for GU in January 2022, the previously published long term rate track was adjusted to account for the actual cost and timing of capital expenditures at the PAF and within the sewer collection system to help ensure future planned upgrades to the wastewater system can be funded with limited to no impacts to customers. Refer to Appendix I for a copy of the updated May 2022 cost of service study.

11.9.3 Debt Service Charge
This is a newer revenue stream that other wastewater departments are beginning to implement for the principal and interest of specific debt that can then be eliminated once the particular debt is retired. This set up is similar to a debt exclusion on a Town's property tax.

11.9.4 Bonding
In general, bonding of improvements over a specified period of time will decrease the annual outlay so that more improvements can be completed annually. Bonding caps should be considered so that repayment is limited to the available budget (this would allow new debt to be taken on as older debt is paid off).

In general, there are many financing opportunities that could be taken into consideration depending on amounts and timing. Ultimately, the City of Groton Utilities will need to review and adjust the CIP as required to meet the City's priorities and desired rate structure.

11.10 Staffing Assessment
11.10.1 Current Staffing and WPCF Classification Requirements
As in any sewered community, the PAF represents a significant investment by ratepayers and proper operation and maintenance is the direct responsibility of plant personnel. As regulatory requirements increase the minimum effluent quality standards, the sophistication of wastewater treatment processes and equipment increase as well. It is important that sufficient qualified personnel be provided for the efficient operation and maintenance of the plant. It should be noted that there must be flexibility and some degree of overlapping of duties for efficient operation.

The Groton PAF is currently staffed by a total of 7 full-time employees with various levels of responsibility and expertise. The specific positions include:

- 1 – Class IV Superintendent
- 1 – Class IV Lab Analyst
- 1 - Class III Operators
- 3 - Class II Operators
- 1 - Class I Operators

All listed operators also dedicate a portion of their time to maintaining the wastewater collection system and remote pumping stations.

11.10.2 Future Staffing and PAF Classification Requirements
Future staffing requirements for the Groton PAF were developed using the methodology found in the New England Interstate Water Pollution Control Commissions' (NEIWPCC), *Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants*, which was published in 2008. The NEIWPCC developed this process based on EPA's 1973 guide, Estimating Staffing for Municipal Wastewater Treatment Facilities. New treatment technologies, improvements in SCADA systems, and new computer software programs have made EPA's guide less relevant.

NEIWPCC surveyed and collected information from 50 wastewater treatment plants in New England and New York State. NEIWPCC created charts for various tasks based on the number of staff hours per year. NEIWPCC tested these charts by conducting pilot studies at 25 plants which had a range of flow from 0.25 MGD to 56 MGD. The final product consists of a group of seven charts that are used to estimate staffing requirements.

The first step in estimating the staffing requirements is to input two parameters into the model, which in turn select the correct set of charts for the particular size of the facility. The plant's future design flow rate (1.84 MGD) and its number of personnel shifts per day (one shift a day, seven days a week) are used to make this determination.

The City of Groton WPCF will use the chart for one plus shift plant with design flows between 1.0 MGD to 5.0 MGD. The plant has approximately 365 working days based on the operators working seven days a week. Currently, plant staff receives 12-13 holidays per year. In addition, due to the varied years of service and level of experience of the PAF staff, approx. 10-20 days a year are for sick days or vacation time per employee, averaging to approx. 15 days per year per employee. Based on these numbers, it was assumed that the average staff person will have 23 days of off time based on sick, vacation and holiday time. This results in the average employee having 1,896 productive work hours per year.

To determine the staffing required, each task associated with the operation of a typical treatment facility is assigned an equivalent staffing hour required per day which is multiplied by the number of working days and by the number of units of the task. For example, the PAF has four primary settling tanks, which each are estimated to require 1 hour of work per day. Therefore, based on this analysis method, the plant would require 1,460 staffing hours annually to operate the primary settling tanks (4 primary clarifiers x 1 hr/day/clarifier x 365 days/yr = 1,460 hours/yr).

The staffing analysis guide includes seven specific areas of analysis including:

1. Basic and Advanced Operations & Processes
2. Maintenance
3. Laboratory Operations
4. Biosolids/Sludge Handling
5. Yard Work
6. Automation/SCADA
7. Considerations for Additional Plant Staffing

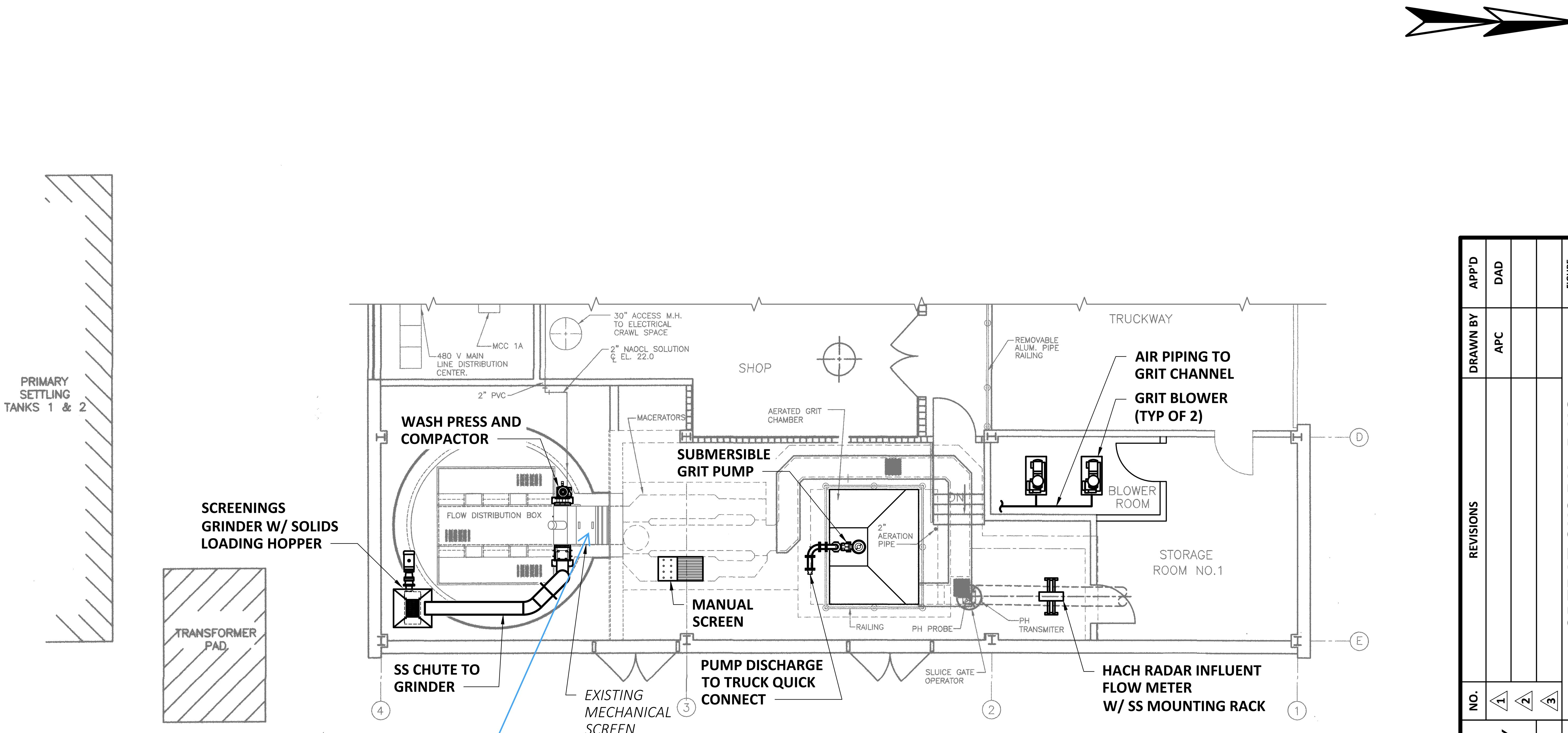
The first item represents the time staff dedicated to all of the operations and processes conducted at the PAF. The second item corresponds to the time operators spend maintaining the processes and systems at the PAF. The third item considers the time spent sampling and running laboratory tests at the facility. The fourth item focuses on the time associated with biosolids handling. The fifth item represents time the staff spends doing yard work such as mowing and snow removal. Item 6 does not impact the staffing hours and is intended to show the level of automation present at the PAF. The last item's purpose is to take into consideration other tasks and responsibilities not covered in items 1-5, such as management responsibilities, clerical duties, and off-site duties such as pump station operation and maintenance. This item is used to identify staffing effort necessary to cover these additional tasks. A summary of the final staffing estimate using the NEIWPCC guidelines for the future projected upgraded facilities is presented in Table 11-7 below.

Table 11-7 City of Groton WPCF, Future Staffing Estimates

Chart Number and Description	Annual Hours (Upgraded WPCF)
Chart 1 – Basic and Advanced Operations and Processes	3,872
Chart 2 – Maintenance	2,586
Chart 3 – Laboratory Operations	1,318
Chart 4 – Biosolids/Sludge Handling	320
Chart 5 – Yard Work	75
Estimated Operation and Maintenance Hours	**8,171**
Estimated Operation and Maintenance Staff	**6.0**
Estimated Additional Staff from Chart 7	**3.00**
Total Staffing Estimate	9.0

The estimated hours for the upgraded facility, as shown in Table 11-5 above and as determined from Charts 1 through 5, are 8,171 hours. This corresponds to a staffing need of 6.0. Answering the questions for Chart No's 6 and 7, there is the need for a minimum of three additional employees. Considering that most of the administrative work for the plant is completed by staff at Groton Utilities main office, an additional two staff members is reasonable. Hence, the total recommended number of employees to be staffed at the Groton PAF is 8.0.

Based on this evaluation, the City of Groton PAF should consider hiring one additional employee to assist in facility O&M in accordance with the NEIWPCC guidelines.



FIRST FLOOR PLAN

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CITY OF GROTON, CONNECTICUT
GROTON UTILITIES
WASTEWATER TREATMENT FACILITY
FACILITIES PLAN

PROJ NO: 20653

DATE: MARCH 2022

OPERATIONS BUILDING FIRST FLOOR

FIGURE: 11-1

WRIGHT-PIERCE

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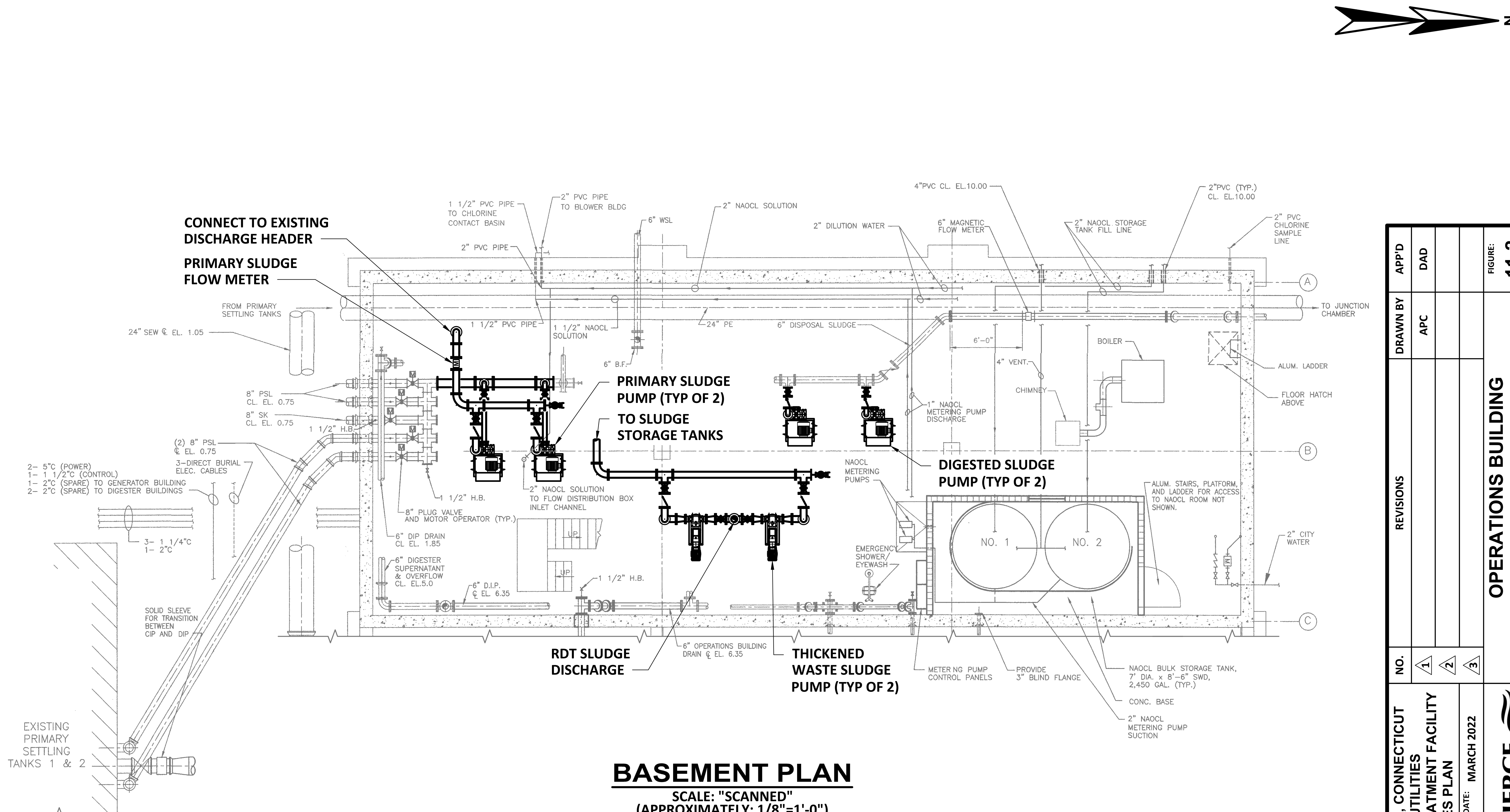

BASEMENT PLAN

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CITY OF GROTON, CONNECTICUT
GROTON UTILITIES
WASTEWATER TREATMENT FACILITY
FACILITIES PLAN

PROJ NO: 20653
DATE: MARCH 2022

WRIGHT-PIERCE

OPERATIONS BUILDING
BASEMENT

FIGURE: 11-2

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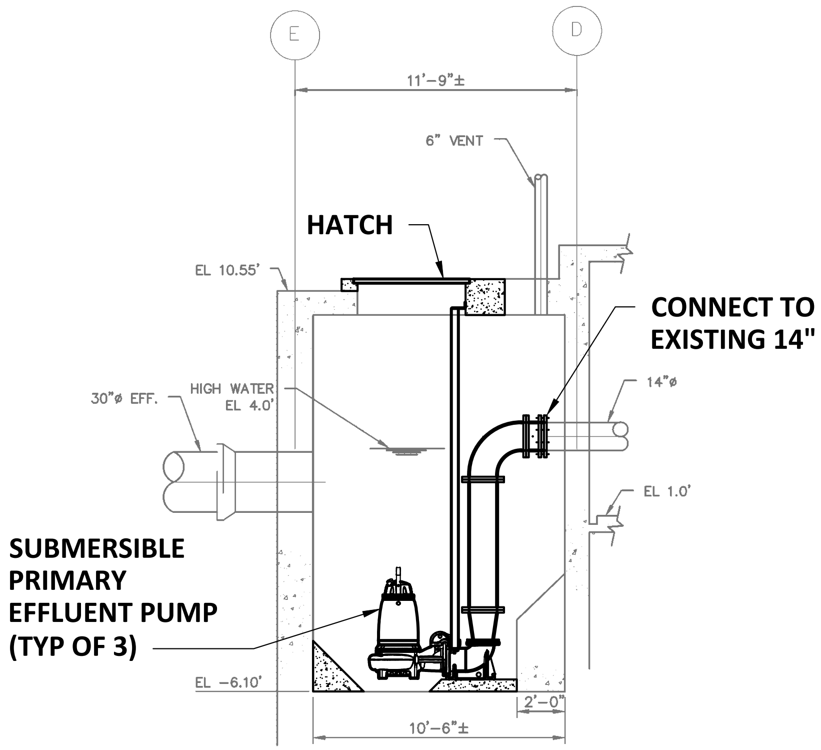

2 SECTION 11-4
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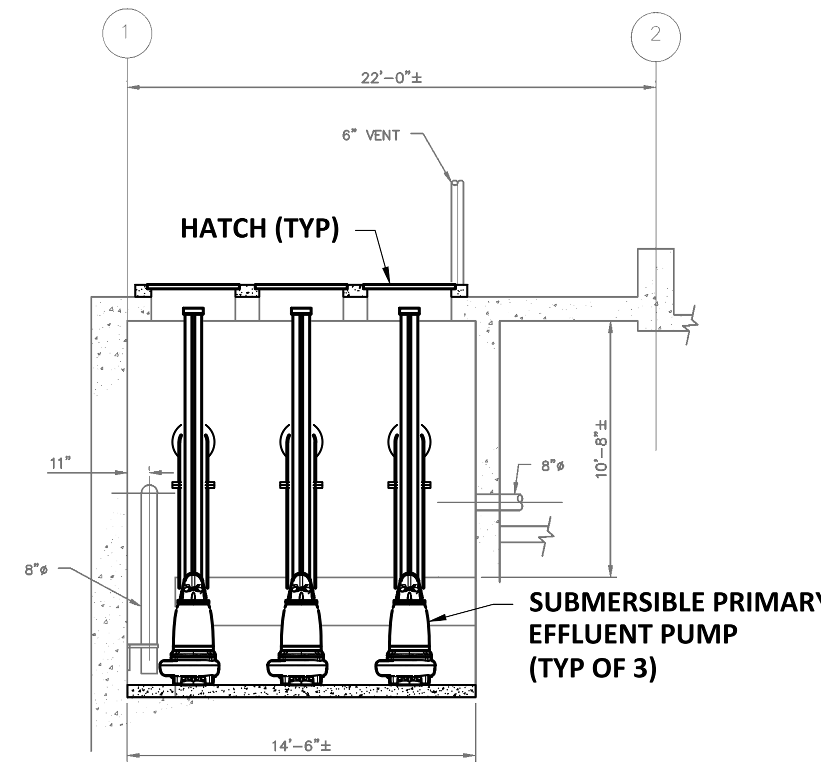

3 SECTION 11-4
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CITY OF GROTON, CONNECTICUT
GROTON UTILITIES
WASTEWATER TREATMENT FACILITY
FACILITIES PLAN

PROJ NO: 20653 DATE: MARCH 2022

WRIGHT-PIERCE

PRIMARY EFFLUENT PUMP STATION

FIGURE: 11-3

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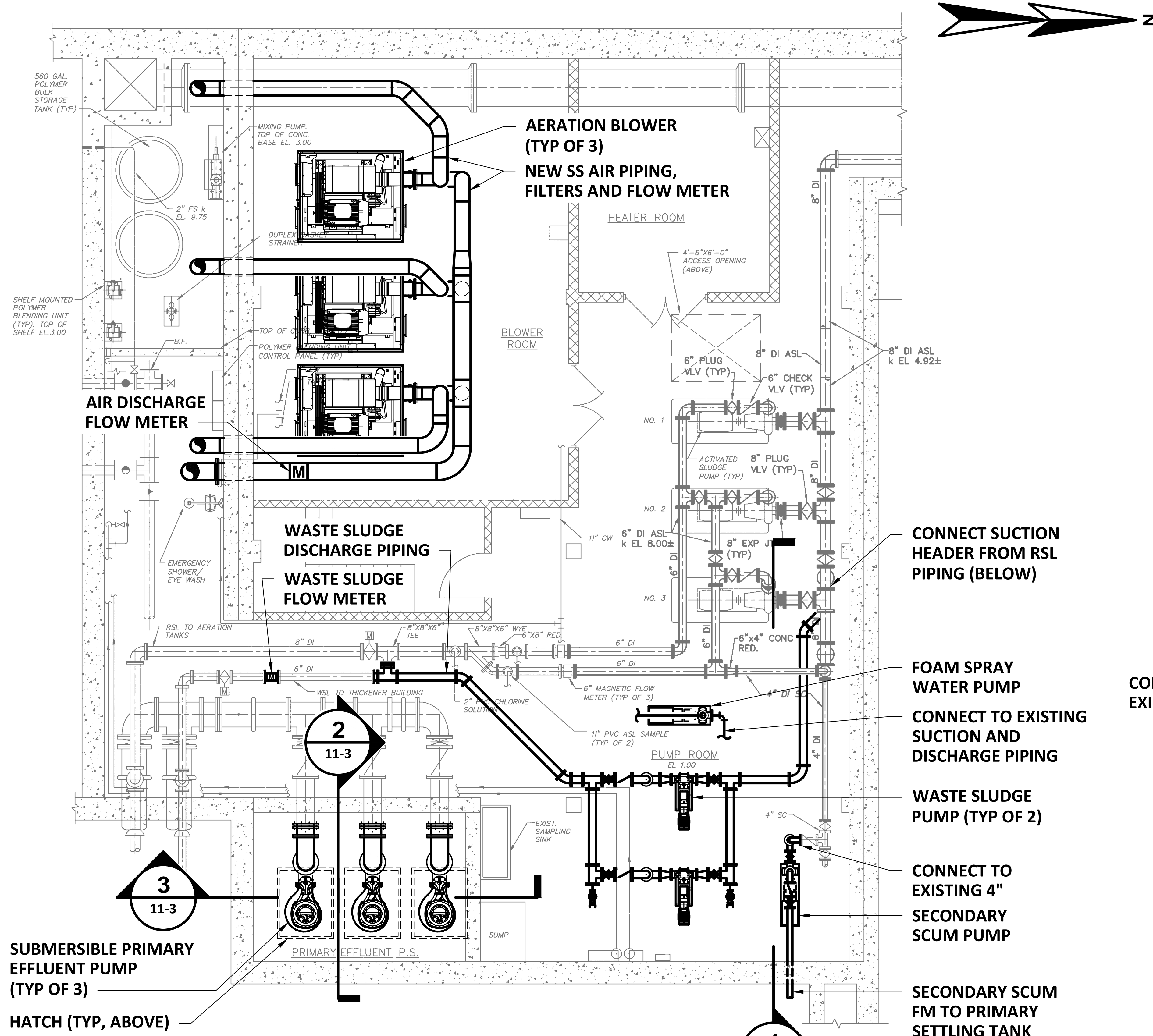

BASEMENT PLAN

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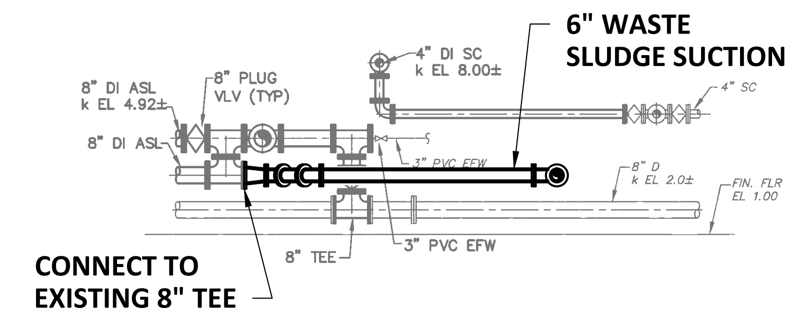

1 SECTION

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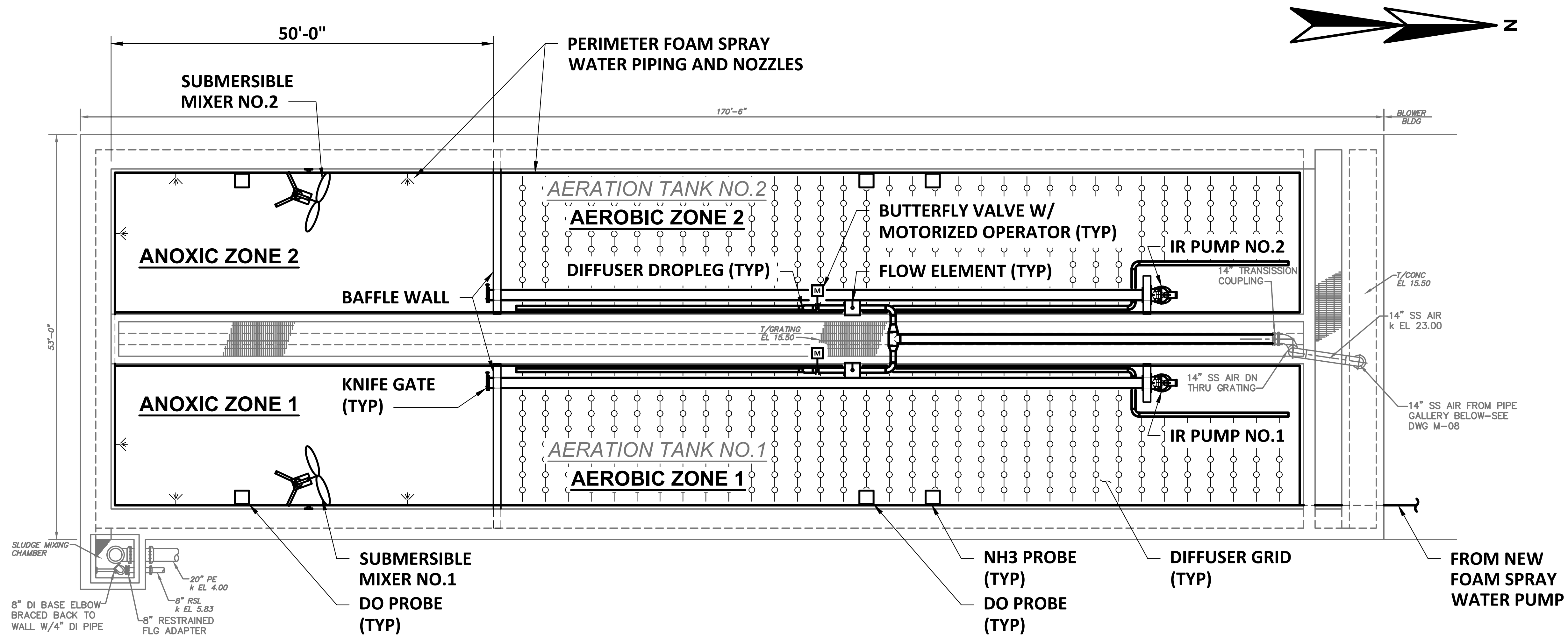
CITY OF GROTON, CONNECTICUT
GROTON UTILITIES
WASTEWATER TREATMENT FACILITY
FACILITIES PLAN

PROJ NO: 20653 DATE: MARCH 2022

WRIGHT-PIERCE

BLOWER BUILDING
BASEMENT

FIGURE: 11-4



AERATION TANKS

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CITY OF GROTON, CONNECTICUT
GROTON UTILITIES
WASTEWATER TREATMENT FACILITY
FACILITIES PLAN

PROJ NO: 20653
DATE: MARCH 2022

WRIGHT-PIERCE

AERATION TANKS

FIGURE: 11-5

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Wright-Pierce
Engineering a Better Environment

12

Section 12 Environmental Impact Evaluation

12.1 Introduction

As indicated in the DEEP's Clean Water Fund Checklist, direct impacts of the recommended plan to air and water quality, floodplains, coastal zones, wetlands, farmlands, aquifer protection zones, historical and archaeological areas, and endangered species must be assessed. The recommended plan includes improvements to the existing Pollution Abatement Facility (PAF) with minimal anticipated growth within the sewer service area. Therefore, the direct environmental impacts would be limited to activities on the existing PAF site during construction of the improvements or upgrades. The direct and indirect environmental impacts of the recommended plan were assessed along with potential mitigation of adverse impacts. These impacts and potential mitigation are discussed below.

12.2 Background

There is little room for expansion on the existing PAF site. Most improvements will occur within existing buildings and structures. There are only minor site-work improvements recommended in Section 11 that include:

1. Repair of retaining wall and perimeter fence
2. Repairs to eroded soils at stormwater outfall catch basin and slide gate
3. Installation of small diameter (4" or less) suite piping between existing buildings
4. Flood protection walls/barriers installed to a design flood elevation TBD

12.3 Exceptions

This section lists exceptions identified as part of the preliminary permitting review conducted for the project.

- The site is partially within a FEMA mapped limit of moderate wave action area (LiMWA)
- The site does not appear to lie below the Coastal Jurisdiction Line which is elevation 2.1' NAVD 88 for the City of Groton
- The site does not appear to contain any prime farmland soils
- Though the WPCF is on the coast of the Thames River, i.e., a Wild or Scenic River, improvements at the plant will not affect the River
- It appears no tidal wetlands will be affected by the project
- There are no Aquifer Protection Areas (APAs) in the City of Groton
- Currently, it appears the project will have no impacts on historical or archaeological resources

12.4 Air Quality Impacts

Short-term air quality impacts will occur during construction due to dust and emissions from construction equipment and vehicles. The construction contractor will be required to implement dust control and mitigation measures during construction. In addition, contractor working hours would be limited. There may be the potential for short-term odors from sewer work; however, once construction is complete odor control systems would provide a long-term improvement in local air quality.

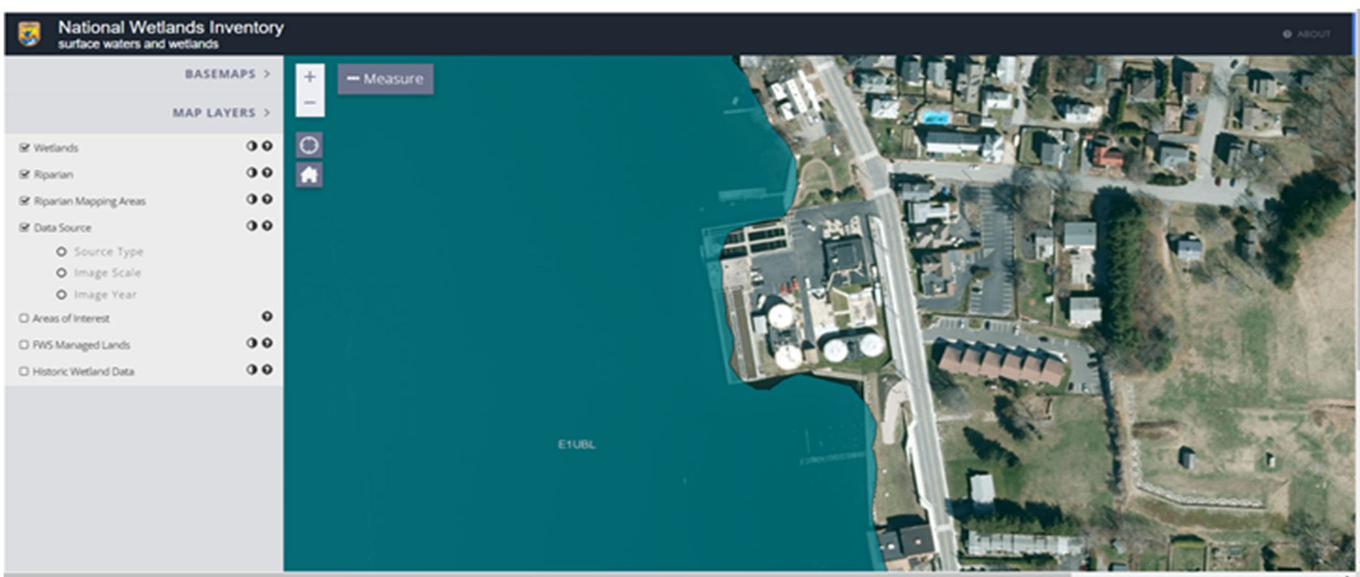
12.5 Water Quality Impacts

The improvements at the treatment facilities will have an overall positive impact on water quality as a result of improved and upgraded facilities. Continued operation of the existing facilities during construction is required and the new facilities will enhance nitrogen removal and water quality discharge in general while providing more reliable equipment. Some short-term adverse impacts upon the water quality may result from construction activities. The effects of erosion and siltation will be mitigated by erosion and sedimentation (E&S) control measures to be incorporated into final plans and specifications and as required under applicable permits. Permits and project specifications will also require proper handling of discharges from dewatering systems and management of stormwater during construction.

12.6 Wetlands Impacts

Based on a preliminary review of available wetlands mapping, it appears that the east and part of the north side of the site may fall within mapped riverine wetlands. Note, however, that detailed wetlands mapping would be delineated by a soil scientist during the preliminary design phase to properly locate any wetlands within the WPCF boundaries. Impacts to any wetlands would be temporary due to construction activities. As described above, the contractor will be required to implement and maintain proper erosion and sediment control procedures during construction. Portions of the work may fall within the local 200-foot setback review area for the Billings Avery Pond and diversion channel, Morgan Reservoir and Ledyard Reservoir watershed. Applicable permits would be obtained, and any requirements followed.

Figure 12-1 Wetlands Mapping



12.7 Flood Plain Impacts

About half of the WPCF itself falls within the 100-year floodplain Zone AE with a BFE of 11 feet NAVD 88, with the other half of the facility within the 100-year floodplain Zone VE with a BFE of 14 feet NAV88. For planning and design purposes, consideration will be made to protect plant assets from the 100-year flood, but to an elevation TBD. A CTDEEP Flood Management Certification (FMC) Approval will be required for future upgrades that receive state funding.

All work will also need to comply with local floodplain requirements and applicable City of Groton permits or variances will be necessary. Floodplain compensatory storage will need to be addressed through the permitting process and variances may be necessary.

12.8 Storm Resiliency Requirements

The plant upgrades will be designed to comply with the NEIWPCC TR-16 Guidelines. Recently, NEIWPCC updated its "TR-16 Guide for the Design of Wastewater Treatment Works" to include storm resiliency considerations and to address requirements of Executive Order No. 13690. Refer to Section 7 for additional discussion.

12.9 Other Direct Impacts

The recommended plan will take place within the existing boundaries of the PAF. Other direct impacts from this project would be temporary due to construction activities including noise and traffic impacts. These issues would be mitigated to the extent possible by requiring construction activities to occur during a normal weekday schedule.

The City of Groton is located within the Coastal Area and the PAF site is located within the Coastal Boundary of the Thames River. As such, all work will need to obtain the required local Coastal Site Plan Review and any necessary State permits and comply with all applicable requirements for coastal zone management.

Portions of the work area and the plant are located within shaded CTDEEP Natural Diversity Data Base (NDDB) areas. The project will need to undergo an NDDB review with CTDEEP and follow any seasonal or temporal or other work restrictions determined appropriate by CTDEEP.

12.10 Indirect Impacts

Indirect impacts from the wastewater facilities projects can include items such as induced growth. Construction of new sewer lines to serve an existing area with failing septic systems or no existing sewer line can induce denser residential development in areas because of the availability of a public sewer. This growth can place a burden on other town services such as the school system and public water supply system. This project does not include any significant planned expansion of the sewer service area and anticipates very little growth over the planning period. Therefore, no indirect impacts from induced growth or increased demand on the water supply system are anticipated.

12.11 Permits and Approvals

A preliminary review of the permits and approvals that will likely be required for this project was completed. A listing of the anticipated or potential permits and approvals is presented below.

- Local City of Groton Planning & Zoning Commission Approvals, including Coastal Site Plan Review.
- Any necessary CTDEEP OLISP or Coastal Zone approvals.
- Local City of Groton Floodplain Permit, including any potential variances necessary.
- Local City of Groton Inland Wetlands Commission Approval.
- Currently, it appears there will be no direct impacts to Army Corps wetlands and, therefore, no Army Corps permits needed; however, this will need to be verified when detailed wetlands mapping, and delineations are conducted during design.
- Local Building Permits.
- Fire Marshall Approval.
- CTDEEP Flood Management Certification Approval.
- General Permit for the Discharge of Stormwater Associated with Construction Activities.
- Conformance with NEIWPCC TR-16 and Executive Order 13690.

12.12 Conservation and Development

The City of Groton WPCF has a current design rated permit capacity of 3.1 mgd. It is expected that the next permit renewal or permit modification will reflect no increase in its design rated permit capacity.

The Sewer Service Area is described in greater detail in Section 3 of this plan. The development of conservation areas (sewer avoidance areas), sewer expansion areas and planned sanitary sewer projects under construction are also discussed in Section 3. Development of the sewer service area boundaries was performed in consultation with other city departments including Planning and was developed to be consistent with the City's plan of conservation and development as well as with the State's Plan of Conservation and Development map.

The Sewer Service Area Map was then coordinated with the population projects for the City of Groton and used to develop the future flows for the 20-year planning period.

Appendix A
Groton Utilities Pollution Abatement Facility – Current NPDES Permit

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

79 Elm Street • Hartford, CT 06106-5127 www.ct.gov/deep Affirmative Action/Equal Opportunity Employer

NPDES-PERMIT

issued to

Permittee:
City of Groton
295 Meridian Street
Groton, Connecticut 06340

Location Address:
311 Thames Street
Groton, Connecticut 06340

Permit ID: CT0101184 **Design Flow Rate:** 3.1 MGD **Effective Date: August 01, 2018**

Receiving Stream: Thames River **Permit Expires: July 31, 2023**

SECTION 1: GENERAL PROVISIONS

(A) This permit is reissued in accordance with Section 22a-430 of Chapter 446k, Connecticut General Statutes ("CGS"), and Regulations of Connecticut State Agencies ("RCSA") adopted thereunder, as amended, and Section 402(b) of the Clean Water Act, as amended, 33 USC 1251, et. seq., and pursuant to an approval dated September 26, 1973, by the Administrator of the United States Environmental Protection Agency for the State of Connecticut to administer a N.P.D.E.S. permit program.

(B) The City of Groton, ("Permittee"), shall comply with all conditions of this permit including the following sections of the RCSA which have been adopted pursuant to Section 22a-430 of the CGS and are hereby incorporated into this permit. **Your attention is especially drawn to the notification requirements of subsection (i)(2), (i)(3), (j)(1), (j)(6), (j)(8), (j)(9)(C), (j)(10)(C), (j)(11)(C), (D), (E), and (F), (k)(3) and (4) and (l)(2) of Section 22a-430-3.** To the extent this permit imposes conditions more stringent than those found in the regulations, this permit shall apply.

Section 22a-430-3 General Conditions
(a) Definitions
(b) General
(c) Inspection and Entry
(d) Effect of a Permit
(e) Duty to Comply
(f) Proper Operation and Maintenance
(g) Sludge Disposal
(h) Duty to Mitigate
(i) Facility Modifications; Notification
(j) Monitoring, Records and Reporting Requirements
(k) Bypass
(l) Conditions Applicable to POTWs
(m) Effluent Limitation Violations
(n) Enforcement
(o) Resource Conservation
(p) Spill Prevention and Control
(q) Instrumentation, Alarms, Flow Recorders
(r) Equalization

Section 22a-430-4 Procedures and Criteria
(a) Duty to Apply
(b) Duty to Reapply
(c) Application Requirements
(d) Preliminary Review
(e) Tentative Determination

(f) Draft Permits, Fact Sheets
(g) Public Notice, Notice of Hearing
(h) Public Comments
(i) Final Determination
(j) Public Hearings
(k) Submission of Plans and Specifications. Approval.
(l) Establishing Effluent Limitations and Conditions
(m) Case-by-Case Determinations
(n) Permit Issuance or Renewal
(o) Permit or Application Transfer
(p) Permit Revocation, Denial or Modification
(q) Variances
(r) Secondary Treatment Requirements
(s) Treatment Requirements
(t) Discharges to POTWs - Prohibitions

(C) Violations of any of the terms, conditions, or limitations contained in this permit may subject the Permittee to enforcement action including, but not limited to, seeking penalties, injunctions and/or forfeitures pursuant to applicable sections of the CGS and RCSA.

(D) Any false statement in any information submitted pursuant to this Section of the permit may be punishable as a criminal offense under Section 22a-438 or 22a-131a of the CGS or in accordance with Section 22a-6, under Section 53a-157b of the CGS.

(E) The Permittee shall comply with Section 22a-416-1 through Section 22a-416-10 of the RCSA concerning operator certification.

(F) No provision of this permit and no action or inaction by the Commissioner shall be construed to constitute an assurance by the Commissioner that the actions taken by the Permittee pursuant to this permit will result in compliance or prevent or abate pollution.

(G) Nothing in this permit shall relieve the Permittee of other obligations under applicable federal, state and local law.

(H) An annual fee shall be paid for each year this permit is in effect as set forth in Section 22a-430-7 of the RCSA. As of October 1, 2009 the annual fee is $2367.50.

SECTION 2: DEFINITIONS

(A) The definitions of the terms used in this permit shall be the same as the definitions contained in Section 22a-423 of the CGS and Section 22a-430-3(a) and 22a-430-6 of the RCSA, except for "Composite" and "No Observable Acute Effect Level (NOAEL)" which are redefined below.

(B) In addition to the above, the following definitions shall apply to this permit:

"------" in the limits column on the monitoring tables in Attachment 1 means a limit is not specified but a value must be reported on the DMR, MOR, and/or the ATMR.

"Annual" in the context of any sampling frequency, shall mean the sample must be collected in the months of July, August or September of each year.

"Average Monthly Limit" means the maximum allowable "Average Monthly Concentration" as defined in Section 22a-430-3(a) of the RCSA when expressed as a concentration (e.g. mg/l); otherwise, it means "Average Monthly Discharge Limitation" as defined in Section 22a-430-3(a) of the RCSA.

"Bi-Weekly" in the context of any sampling frequency, shall mean once every two weeks.

"Composite" or **"(C)"** means a sample consisting of a minimum of eight aliquot samples collected at equal intervals of no less than 30 minutes and no more than 60 minutes and combined proportionally to flow over the sampling period provided that during the sampling period the peak hourly flow is experienced.

"Critical Test Concentration" or **"(CTC)"** means the specified effluent dilution at which the Permittee is to conduct a single-concentration Aquatic Toxicity Test.

"Daily Composite" or **"(DC)"** means a composite sample taken over a full operating day consisting of grab samples collected at equal intervals of no more than sixty (60) minutes and combined proportionally to flow; or, a composite sample continuously collected over a full operating day proportionally to flow.

"Daily Concentration" means the concentration of a substance as measured in a daily composite sample, or, arithmetic average of all grab sample results defining a grab sample average.

"Daily Quantity" means the quantity of waste discharged during an operating day.

"Geometric Mean" is the "n"th root of the product of "n" observations.

"Infiltration" means water other than wastewater that enters a sewer system (including sewer system and foundation drains) from the ground through such means as defective pipes, pipe joints, connections, or manholes. Infiltration does not include, and is distinguished from, inflow.

"Inflow" means water other than wastewater that enters a sewer system (including sewer service connections) from sources such as, but not limited to, roof leaders, cellar drains, yard drains, area drains, drains from springs and swampy areas, cross connections between storm sewers and sanitary sewers, catch basins, cooling towers, storm waters, surface runoff, street wash waters, or drainage. Inflow does not include, and is distinguished from, infiltration.

"Instantaneous Limit" means the highest allowable concentration of a substance as measured by a grab sample, or the highest allowable measurement of a parameter as obtained through instantaneous monitoring.

"In-stream Waste Concentration" or **"(IWC)"** means the concentration of a discharge in the receiving water after mixing has occurred in the allocated zone of influence.

"MGD" means million gallons per day.

"Maximum Daily Limit" means the maximum allowable "Daily Concentration" (defined above) when expressed as a concentration (e.g. mg/l), otherwise, it means the maximum allowable "Daily Quantity" as defined above, unless it is expressed as a flow quantity. If expressed as a flow quantity it means "Maximum Daily Flow" as defined in Section 22a-430-3(a) of the RCSA.

"Monthly Minimum Removal Efficiency" means the minimum reduction in the pollutant parameter specified when the effluent average monthly concentration for that parameter is compared to the influent average monthly concentration.

"NA" as a Monitoring Table abbreviation means "not applicable".

"NR" as a Monitoring Table abbreviation means "not required".

"No Observable Acute Effect Level" or **"(NOAEL)"** means any concentration equal to or less than the critical test concentration in a single concentration (pass/fail) toxicity test, conducted pursuant to Section 22a-430-3(j)(7)(A)(i) of the RCSA, demonstrating 90% or greater survival of test organisms at the CTC.

"Quarterly" in the context of any sampling frequency, shall mean sampling is required in the months of January, April, July, and October.

"Range During Sampling" or **"(RDS)"** as a sample type means the maximum and minimum of all values recorded as a result of analyzing each grab sample of; 1) a Composite Sample, or, 2) a Grab Sample Average. For those Permittee with pH meters that provide continuous monitoring and recording, Range During Sampling means the maximum and minimum readings recorded with the continuous monitoring device during the Composite or Grab Sample Average sample collection.

"Range During Month" or **"(RDM)"** as a sample type means the lowest and the highest values of all of the monitoring data for the reporting month.

"Sanitary Sewage" means wastewaters from residential, commercial and industrial sources introduced by direct connection to the sewerage collection system tributary to the treatment works including non-excessive inflow/infiltration sources.

"Twice per Month" in the context of any sampling frequency, mean two samples per calendar month collected no less than 12 days apart.

"ug/l" means micrograms per liter

"Work Day" in the context of a sampling frequency means, Monday through Friday excluding holidays.

SECTION 3: COMMISSIONER'S DECISION

(A) The Commissioner of Energy and Environmental Protection ("Commissioner") has issued a final decision and found continuance of the existing system to treat the discharge will protect the waters of the state from pollution. The Commissioner's decision is based on application #201710437 for permit reissuance received on December 1, 2017 and the administrative record established in the processing of that application.

(B) The Commissioner hereby authorizes the Permittee to discharge in accordance with the provisions of this permit, the above referenced application, and all approvals issued by the Commissioner or his authorized agent for the discharges and/or activities authorized by, or associated with, this permit.

(C) The Commissioner reserves the right to make appropriate revisions to the permit, if required after Public Notice, in order to establish any appropriate effluent limitations, schedules of compliance, or other provisions which may be authorized under the Federal Clean Water Act or the CGS or regulations adopted thereunder, as amended. The permit as modified or renewed under this paragraph may also contain any other requirements of the Federal Clean Water Act or CGS or regulations adopted thereunder which are then applicable.

SECTION 4: GENERAL LIMITATIONS AND OTHER CONDITIONS

(A) The Permittee shall not accept any new sources of non-domestic wastewater conveyed to its POTW through its sanitary sewerage system or by any means other than its sanitary sewage system unless the generator of such wastewater; (a) is authorized by a permit issued by the Commissioner under Section 22a-430 CGS (individual permit), or, (b) is authorized under Section 22a-430b (general permit), or, (c) has been issued an emergency or temporary authorization by the Commissioner under Section 22a-6k. All such non-domestic wastewaters shall be processed by the POTW via receiving facilities at a location and in a manner prescribed by the Permittee which are designed to contain and control any unplanned releases.

(B) No new discharge of domestic sewage from a single source to the POTW in excess of 50,000 gallons per day shall be allowed by the Permittee until the Permittee has notified in writing the Connecticut Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Water Planning and Management Division, Municipal Wastewater Section, 79 Elm Street, Hartford, CT 06106-5127 of said new discharge.

(C) The Permittee shall maintain a system of user charges based on user charge taxes sufficient to operate and maintain the POTW (including the collection system) and replace critical components.

(D) The Permittee shall maintain a sewer use ordinance that is consistent with the Model Sewer Ordinance for Connecticut Municipalities prepared by the Department of Energy and Environmental Protection. The Commissioner of Energy and Environmental Protection alone may authorize certain discharges which may not conform to the Model Sewer Ordinance.

(E) No discharge from the permitted facility beyond any zone of influence shall contain or cause in the receiving stream a visible oil sheen, floating solids, visible discoloration, or foaming beyond that which may result from a discharge from a permitted facility and none exceeding levels necessary to maintain all designated uses.

(F) No discharge from the permitted facility shall cause acute or chronic toxicity in the receiving water body beyond any Zone Of Influence (ZOI) specifically allocated to that discharge in this permit.

(G) The Permittee shall maintain an alternate power source adequate to provide full operation of all pump stations in the sewerage collection system and to provide a minimum of primary treatment and disinfection at the water pollution control facility to insure that no discharge of untreated wastewater will occur during a failure of a primary power source.

(H) The average monthly effluent concentration shall not exceed 15% of the average monthly influent concentration for BOD_5 and Total Suspended Solids for all daily composite samples taken in any calendar month.

(I) Any new or increased amount of sanitary sewage discharge to the sewer system is prohibited where it will cause a dry weather overflow or exacerbate an existing dry weather overflow.

(J) Sludge Conditions

(1) The Permittee shall comply with all existing federal and state laws and regulations that apply to sewage sludge use and disposal practices, including but not limited to 40 CFR Part 503.

(2) If an applicable management practice or numerical limitation for pollutants in sewage sludge more stringent than existing federal and state regulations is promulgated under Section 405(d) of the Clean Water Act (CWA), this permit shall be modified or revoked and reissued to conform to the promulgated regulations.

(3) The Permittee shall give prior notice to the Commissioner of any change(s) planned in the Permittee' sludge use or disposal practice. A change in the Permittee' sludge use or disposal practice may be a cause for modification of the permit.

(4) Testing for inorganic pollutants shall follow "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", EPA Publication SW-846 as updated and/or revised.

(K) This permit becomes effective on the 1st day of the month following the date of signature of the Commissioner or designee.

(L) When the arithmetic mean of the average daily flow from the POTW for the previous 180 days exceeds 90% of the design flow rate, the Permittee shall develop and submit within one year, for the review and approval of the Commissioner, a plan to accommodate future increases in flow to the plant. This plan shall include a schedule for completing any recommended improvements and a plan for financing the improvements.

(M) When the arithmetic mean of the average daily BOD_5 or TSS loading into the POTW for the previous 180 days exceeds 90% of the design load rate, the Permittee shall develop and submit for the review and approval of the Commissioner within one year, a plan to accommodate future increases in load to the plant. This plan shall include a schedule for completing any recommended improvements and a plan for financing the improvements.

(N) On or before July 31st of each calendar year the main flow meter shall be calibrated by an independent contractor in accordance with the manufacturer's specifications. The actual record of the calibration shall be retained onsite and, upon request, the Permittee shall submit to the Commissioner a copy of that record.

(O) The Permittee shall operate and maintain all processes as installed in accordance with the approved plans and specifications and as outlined in the associated operation and maintenance manual. This includes but is not limited to all preliminary treatment processes, primary treatment processes, recycle pumping processes, anaerobic treatment processes, anoxic treatment processes, aerobic treatment processes, flocculation processes, effluent filtration processes or any other processes necessary for the optimal removal of pollutants. The Permittee shall not bypass or fail to operate any of the aforementioned processes without the written approval of the Commissioner.

(P) On or before 2.5 years from effective date of this permit each anaerobic digester unit shall be sampled, in a manner approved in writing by the Commissioner, to determine the amount of grit and depth of scum blanket. The results of the sampling shall be maintained at the POTW and, upon request, the Permittee shall submit to the Commissioner a copy of the sampling data.

(Q) The Permittee is hereby authorized to accept septage at the treatment facility or other locations as approved by the Commissioner.

(R) The temperature of any discharge shall not increase the temperature of the receiving stream above 83°F, or, in any case, raise the temperature of the receiving stream by more than 4°F beyond the permitted zone of influence. The incremental temperature increase in coastal and marine waters is limited to 1.5°F during the period including July, August and September.

SECTION 5: SPECIFIC EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

(A) The discharge(s) shall not exceed and shall otherwise conform to the specific terms and conditions listed in this permit. The discharge is restricted by, and shall be monitored in accordance with Tables **A** through **G** incorporated in this permit as Attachment 1.

(B) The Permittee shall monitor the performance of the treatment process in accordance with the Monthly Operating Report (MOR) incorporated in this permit as Attachment 2.

SECTION 6: SAMPLE COLLECTION, HANDLING and ANALYTICAL TECHNIQUES

(A) Chemical Analysis

(1) Chemical analyses to determine compliance with effluent limits and conditions established in this permit shall be performed using the methods approved pursuant to the Code of Federal Regulations, Part 136 of Title 40 (40 CFR 136) unless an alternative method has been approved in writing pursuant to 40 CFR 136.4 or as provided in Section 22a-430-3-(j)(7) of the RCSA. Chemicals which do not

have methods of analysis defined in 40 CFR 136 or the RCSA shall be analyzed in accordance with methods specified in this permit.

(2) All metals analyses identified in this permit shall refer to analyses for Total Recoverable Metal, as defined in 40 CFR 136 unless otherwise specified.

(3) Grab samples shall be taken during the period of the day when the peak hourly flow is normally experienced.

(4) Samples collected for bacteriological examination shall be collected between the hours of 11 a.m. and 3 p.m. or at that time of day when the peak hourly flow is normally experienced. A chlorine residual sample must be taken at the same time and the results recorded.

(5) The Minimum Levels specified below represent the concentrations at which quantification must be achieved and verified during the chemical analyses for the parameters identified in Attachment 1, Tables A and C. Analyses for these parameters must include check standards within ten percent of the specified Minimum Level or calibration points equal to or less than the specified Minimum Level.

Parameter	**Minimum Level**
Arsenic, Total	0.005 mg/l
Mercury, Total	0.0002 mg/l

(6) The value of each parameter for which monitoring is required under this permit shall be reported to the maximum level of accuracy and precision possible consistent with the requirements of this Section of the permit.

(7) Effluent analyses for which quantification was verified during the analysis at or below the minimum levels specified in this Section and which indicate that a parameter was not detected shall be reported as "less than x" where 'x' is the numerical value equivalent to the analytical method detection limit for that analysis.

(8) Results of effluent analyses which indicate that a parameter was not present at a concentration greater than or equal to the Minimum Level specified for that analysis shall be considered equivalent to zero (0.0) for purposes of determining compliance with effluent limitations or conditions specified in this permit.

(B) Acute Aquatic Toxicity Test

(1) Samples for monitoring of Acute Aquatic Toxicity shall be collected and handled as prescribed in "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA-821-R-02-012).

(a) Composite samples shall be chilled as they are collected. Grab samples shall be chilled immediately following collection. Samples shall be held at 0 - 6°C until Acute Aquatic Toxicity testing is initiated.

(b) Effluent samples shall not be dechlorinated, filtered, or, modified in any way, prior to testing for Acute Aquatic Toxicity unless specifically approved in writing by the Commissioner for monitoring at this facility. Facilities with effluent dechlorination and/or filtration designed as part of the treatment process are not required to obtain approval from the Commissioner.

(c) Samples shall be taken at the final effluent prior to chlorination for Acute Aquatic Toxicity unless otherwise approved in writing by the Commissioner for monitoring at this facility.

(d) Chemical analyses of the parameters identified in Attachment 1, Table C shall be conducted on an aliquot of the same sample tested for Acute Aquatic Toxicity.

(i) At a minimum, pH, salinity, total alkalinity, total hardness, and total residual chlorine shall be measured in the effluent sample and, during Acute Aquatic Toxicity tests, in the highest concentration of the test and in the dilution (control) water at the beginning of the test and at test termination. If total residual chlorine is not detected at test initiation, it does not need to be measured at test termination. Dissolved oxygen, pH, and temperature shall be measured in the control and all test concentrations at the beginning of the test, daily thereafter, and at test termination. Salinity shall be measured in each test concentration at the beginning of the test and at test termination.

(e) Tests for Acute Aquatic Toxicity shall be initiated within 36 hours of sample collection.

(2) Monitoring for Acute Aquatic Toxicity to determine compliance with the permit condition on Acute Aquatic Toxicity (invertebrate) shall be conducted for 48 hours utilizing neonatal (less than 24 hours old) *Daphnia pulex*.

(3) Monitoring for Acute Aquatic Toxicity to determine compliance with the permit condition on Acute Aquatic Toxicity (vertebrate) shall be conducted for 48 hours utilizing larval (1 to 14-day old with no more than 24 hours range in age) *Pimephales promelas*.

(4) Tests for Acute Aquatic Toxicity shall be conducted as prescribed for static non-renewal acute tests in "Methods for measuring the Acute Aquatic Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms" (EPA/821-R-02-012), except as specified below.

(a) For Acute Aquatic Toxicity limits, and for monitoring only conditions, expressed as a NOAEL value, Pass/Fail (single concentration) tests shall be conducted at a specified Critical Test Concentration (CTC) equal to the Aquatic Toxicity limit, (100% in the case of monitoring only conditions), as prescribed in Section 22a-430-3(j)(7)(A)(i) of the RCSA.

(b) Organisms shall not be fed during the tests.

(c) Synthetic freshwater prepared with deionized water adjusted to a hardness of 50±5 mg/L as $CaCO_3$ shall be used as dilution water in the tests.

(d) Copper nitrate shall be used as the reference toxicant.

(5) For monitoring only conditions, toxicity shall be demonstrated when the results of a valid pass/fail Acute Aquatic Toxicity indicates less than 90% survival in the effluent at the CTC (100%).

(C) Chronic Aquatic Toxicity Test for Estuarine or Marine Discharges

(1) Chronic Aquatic Toxicity testing of the discharge shall be conducted annually during July, August, or September of each year.

(2) Chronic Aquatic Toxicity testing shall be performed on the discharge in accordance with the test methodology established in "Short-Term Methods for Estimating The Chronic Toxicity of Effluents and Receiving Water to Marine and Estuarine Organisms" (EPA-821-R-02-014) as referenced in 40 CFR 136 for sheepshead minnow, *Cyprinodon variegates*, survival and growth and mysid, *Mysidopsis bahia*, survival, growth and reproduction.

(a) Chronic Aquatic Toxicity tests shall utilize a minimum of five effluent dilutions prepared using a dilution factor of 0.5 (100% effluent, 50% effluent, 25% effluent, 12.5% effluent, 6.25% effluent).

(b) Thames River water collected immediately upstream of the area influenced by the discharge (with the outgoing tide) shall be used as control (0% effluent) and dilution water in the toxicity tests.

(c) A laboratory water control consisting of synthetic seawater prepared in accordance with EPA-821-R-02-014 shall be used as an additional control (0% effluent) in the toxicity tests.

(d) Daily composite samples of the discharge (final effluent following disinfection) and grab samples of the Thames River, for use as site water control and dilution water, shall be collected on day 0 for test solution renewal on day 1 and day 2 of the test; day 2, for test solution renewal on day 3 and day 4 of the test; and day 4, for test solution renewal for the remainder of the test. Samples shall not be pH or hardness adjusted, or chemically altered in any way.

(3) All samples of the discharge and Thames River water used in the Chronic Aquatic Toxicity test shall, at a minimum, be analyzed and results reported in accordance with the provisions listed in Section 6(A) of this permit for the parameters listed in Attachment 1, Table C included herein, excluding Acute Aquatic Toxicity organism testing.

SECTION 7: RECORDING AND REPORTING REQUIREMENTS

(A) The Permittee and/or the Signatory Authority shall continue to report the results of chemical analyses and any aquatic toxicity test required above in Section 5 and the referenced Attachment 1 by electronic submission of DMRs under this permit to the Department using NetDMR in satisfaction of the DMR submission requirement of this permit. The report shall include a detailed explanation of any violations of the limitations specified. DMRs shall be submitted electronically to the Department no later than the 15th day of the month following the month in which samples are collected.

(1) For composite samples, from other than automatic samplers, the instantaneous flow and the time of each aliquot sample collection shall be recorded and maintained at the POTW.

(B) Complete and accurate test data, including percent survival of test organisms in each replicate test chamber, LC_{50} values and 95% confidence intervals for definitive test protocols, and all supporting chemical/physical measurements performed in association with any aquatic toxicity test, shall be entered on the Aquatic Toxicity Monitoring Report form (ATMR) and sent to the Bureau of Water Protection and Land Reuse at the address specified below by the 15th day of the month following the month in which samples are collected:

ATTN: Municipal Wastewater Monitoring Coordinator
Connecticut Department of Energy and Environmental Protection
Bureau of Water Protection and Land Reuse
Water Planning and Management Division
79 Elm Street
Hartford, Connecticut 06106-5127

(C) The results of the process monitoring required above in Section 5 shall be entered on the Monthly Operating Report (MOR) form, included herein as Attachment 2, and reported to the Bureau of Water Protection and Land Reuse. The MOR report shall also be accompanied by a detailed explanation of any violations of the limitations specified. The MOR may be included as an attachment to the DMR in NetDMR or must be received at the address specified above in Section 7 (B) of this permit by the 15th day of the month following the month in which the data and samples are collected.

(D) A complete and thorough report of the results of the chronic toxicity monitoring outlined in Section 6(C) shall be prepared as outlined in Section 10 of EPA-821-R-02-014 for estuarine and marine waters and submitted to the Department for review on or before December 31 of each calendar year to the address specified above in Section 7 (B) of this permit.

SECTION 8: RECORDING AND REPORTING OF VIOLATIONS, ADDITIONAL TESTING REQUIREMENTS, BYPASSES, MECHANICAL FAILURES, AND MONITORING EQUIPMENT FAILURES

(A) If any Acute Aquatic Toxicity sample analysis indicates toxicity, or that the test was invalid, an additional sample of the effluent shall be collected and tested for Acute Aquatic Toxicity and associated chemical parameters, as described above in Section 5 and Section 6, and the results reported to the Bureau of Water Protection and Land Reuse (Attn: Aquatic Toxicity) via the ATMR form (see Section 7 (B)) within 30 days of the previous test. These test results shall also be reported on the next month's DMR report pursuant to Section 7 (A). The results of all toxicity tests and associated chemical parameters, valid and invalid, shall be reported.

(B) If any two consecutive Acute Aquatic Toxicity test results or any three Acute Aquatic Toxicity test results in a twelve month period indicates toxicity, the Permittee shall immediately take all reasonable steps to eliminate toxicity wherever possible and shall submit a report, to the Bureau of Water Protection and Land Reuse (Attn: Aquatic Toxicity), for the review and written approval of the Commissioner in accordance with Section 22a-430-3(j)(10)(c) of the RCSA describing proposed steps to eliminate the toxic impact of the discharge on the receiving water body. Such a report shall include a proposed time schedule to accomplish toxicity reduction and the Permittee shall comply with any schedule approved by the Commissioner.

(C) Sewage Right-to-Know Electronic Bypass Reporting

(1) Section 22a-430-3(k) of the RCSA shall apply in all instances of bypass including a bypass of the treatment plant or a component of the sewage collection system planned during required maintenance. The Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Water Planning and Management Division, Municipal Wastewater, the Department of Public Health, Water Supply Section and Recreation Section, and the local Director of Health shall be notified within 2 hours of the Permittee learning of the event via online reporting in a format approved by the Commissioner. A final incident report shall be submitted to the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Water Planning and Management Division, Municipal Wastewater within five days of the Permittee learning of each occurrence of a discharge or bypass of untreated or partially treated sewage via online reporting in a format approved by the Commissioner.

If the online reporting system is nonfunctional, then the Permittee shall notify DEEP via telephone during normal business hours (8:30 a.m. to 4:30 p.m. Monday through Friday) at (860) 424-3704 or after hours to the DEEP Emergency Response Unit at (860) 424-3338 and the Department of Public Health at (860) 509-8000 with the final incident report being submitted online.

(D) Section 22a-430-3(j) 11 (D) of the RCSA shall apply in the event of any noncompliance with a maximum daily limit and/or any noncompliance that is greater than two times any permit limit. The Permittee shall notify in the same manner as in paragraph C (1) of this Section, the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Water Planning and Management Division, Municipal Wastewater Section except, if the online reporting system is nonfunctional and the noncompliance occurs outside normal working hours (8:30 a.m. to 4:30 p.m. Monday through Friday) the Permittee may wait to make the verbal report until 10:30 am of the next business day after learning of the noncompliance.

(E) Section 22a-430-3(j) 8 of the RCSA shall apply in all instances of monitoring equipment failures that prevent meeting the requirements in this permit. In the event of any such failure of the monitoring equipment including, but not limited to, loss of refrigeration for an auto-sampler or lab refrigerator or loss of flow proportion sampling ability, the Permittee shall notify in the same manner as in paragraph C (1) of this Section, the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Water Planning and Management Division, Municipal Wastewater Section except, if the online reporting system is nonfunctional and the failure occurs outside normal working hours (8:30 a.m. to 4:30 p.m. Monday through Friday) the Permittee may wait to make the verbal report until 10:30 am of the next business day after learning of the failure.

(F) In addition to the reporting requirements contained in Section 22a-430-3(i), (j), and (k) of the Regulations of Connecticut State Agencies, the Permittee shall notify in the same manner as in paragraph C (1) of this Section, the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Water Planning and Management Division, Municipal Wastewater concerning the failure of any major component of the treatment facilities which the Permittee may have reason to believe would result in an effluent violation.

This permit is hereby issued on July 25, 2018.

Betsey Wingfield
Bureau Chief
Bureau of Water Protection and Land Reuse

ATTACHMENT 1

Tables A through G

TABLE A

Discharge Serial Number (DSN): **001-1**										Monitoring Location: 1
Wastewater Description: **Sanitary Sewage**										
Monitoring Location Description: **Final Effluent**										
Allocated Zone of Influence (ZOI): **473 cfs**					In-stream Waste Concentration (IWC): **1 %** (allocated)					
PARAMETER	**Units**	**FLOW/TIME BASED MONITORING**				**INSTANTANEOUS MONITORING**			**REPORT FORM**	**Minimum Level Analysis See Section 6**
		Average Monthly Limit	**Maximum Daily Limit**	**Sample Freq.**	**Sample type**	**Instantaneous Limit or Required Range[3]**	**Sample Freq.**	**Sample Type**		
Alkalinity	mg/l	NA	NA	NR	NA	------	Monthly	Grab	MOR	
Biochemical Oxygen Demand (5 day) [1] See remark C	mg/l	30	50	3/week	Daily Composite	NA	NR	NA	DMR/MOR	
Chlorine, Total Residual see remark A below.	mg/l	NA	NA	NR	NA	0.2 - 1.5	4/ Work Day	Grab	DMR/MOR	
Fecal coliform (year round)	Colonies per100 ml	NA	NA	NR	NA	see remark A below	3/Week	Grab	DMR/MOR	
Fecal coliform (year round)	Percent of samples exceeding 260 colonies per100 ml	NA	NA	NR	NA	≤10	3/Week	Grab	DMR/MOR	
Enterococci see remark B	Colonies per100 ml	NA	NA	NR	NA	500	3/Week	Grab	DMR/MOR	
Flow	MGD	------	——	Continuous[2]	Average Daily Flow	NA	NR	NA	DMR/MOR	
Nitrogen, Ammonia (total as N)	mg/l	NA	——	Monthly	Daily Composite	NA	NR	NA	MOR	
Nitrogen, Nitrate (total as N)	mg/l	NA	------	Monthly	Daily Composite	NA	NR	NA	MOR	
Nitrogen, Nitrite (total as N)	mg/l	NA	------	Monthly	Daily Composite	NA	NR	NA	MOR	
Nitrogen, Total Kjeldahl	mg/l	NA	------	Monthly	Daily Composite	NA	NR	NA	MOR	
Nitrogen, Total	mg/l	NA	------	Monthly	Daily Composite	NA	NR	NA	MOR	
Nitrogen, Total	lbs/day	NA	------	Monthly	Daily Composite	NA	NR	NA	MOR	
Oxygen, Dissolved	mg/l	NA	NA	NR	NA	------	Work Day	Grab	MOR	
pH	S.U.	NA	NA	NR	NA	6 - 9	Work Day	Grab	DMR/MOR	

Phosphate, Ortho	mg/l	NA	------	Monthly	Daily Composite	NA	NR	NA	MOR	
Phosphorus, Total	mg/l	NA	——	Monthly	Daily Composite	NA	NR	NA	MOR	
Solids, Settleable	ml/l	NA	NA	NR	NA	------	Work Day	Grab	MOR	
Solids, Total Suspended[1] See remark C	mg/l	30	50	3/week	Daily Composite	NA	NA	NA	DMR/MOR	
Temperature	°F	NA	NA	NR	NA	------	Work Day	Grab	MOR	
Turbidity	NTU	NA	NA	NR	NA	------	Work Day	Grab	MOR	

TABLE A – CONDITIONS

Footnotes:

[1] The discharge shall not exceed an average monthly 30 mg/l or a maximum 50 daily mg/l.

[2] The Permittee shall record and report on the monthly operating report the minimum, maximum and total flow for each day of discharge and the average daily flow for each sampling month. The Permittee shall report, on the discharge monitoring report, the average daily flow and maximum daily flow for each sampling month.

[3] The instantaneous limits in this column are maximum, except for total chlorine residual and pH which provide a minimum and maximum limit.

Remarks:

(A) The geometric mean of the Fecal coliform bacteria values for the effluent samples collected in a period of a calendar month shall not exceed 88 per 100 milliliters.

(B) The geometric mean of the Enterococci bacteria values for the effluent samples collected in a period of a calendar month shall not exceed 35 per 100 milliliters.

(C) The Average Weekly discharge Limitation for BOD_5 and Total Suspended Solids shall be 1.5 times the Average Monthly Limit listed above.

TABLE B

Discharge Serial Number (DSN): **001-1**			Monitoring Location: **K**		
Wastewater Description: **Sanitary Sewage**					
Monitoring Location Description: **Final Effluent**					
Allocated Zone of Influence (ZOI): **473 cfs**		In-stream Waste Concentration (IWC): **1 %**			
PARAMETER	**Units**	**FLOW/TIME BASED MONITORING**			**REPORT FORM**
		Average Monthly Minimum	**Sample Freq.**	**Sample type**	
Biochemical Oxygen Demand (5 day) Percent Removal[1]	% of Influent	85	3/Week	Calculated[2]	DMR
Solids, Total Suspended Percent Removal[1]	% of Influent	85	3/Week	Calculated[2]	DMR

TABLE B – CONDITIONS

Footnotes:

[1] The discharge shall be less than or equal to 15% of the average monthly influent BOD_5 and total suspended solids (Table E, Monitoring Location G).

[2] Calculated based on the average monthly results described in Table A. Removal efficiency = $\frac{\text{Inf.BOD or TSS} - \text{Effluent BOD or TSS}}{\text{Inf.BOD or TSS}} \times 100$

TABLE C

Discharge Serial Number (DSN): **001-1**					Monitoring Location: **T**	
Wastewater Description: **Sanitary Sewage**						
Monitoring Location Description: **Final Effluent prior to Chlorination**						
Allocated Zone of Influence (ZOI): **473 cfs**			In-stream Waste Concentration (IWC): **1 %**			
PARAMETER	**Units**	**Maximum Daily Limit**	**Sampling Frequency**	**Sample Type**	**Reporting form**	**Minimum Level Analysis See Section 6**
Aluminum, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Antimony, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
NOAEL Static 48Hr Acute D. Pulex[1]	% survival	------	Quarterly	Daily Composite	ATMR/DMR	
NOAEL Static 48Hr Acute Pimephales[1]	% survival	------	Quarterly	Daily Composite	ATMR/DMR	
Arsenic, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	*
Beryllium, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
BOD_5	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Cadmium, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Chromium, Hexavalent	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Chromium, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Chlorine, Total Residual	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Copper, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Cyanide, Amenable	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Cyanide, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Iron, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Lead, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Mercury, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	*
Nickel, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Nitrogen, Ammonia (total as N)	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Nitrogen, Nitrate, (total as N)	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Nitrogen, Nitrite, (total as N)	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Phenols, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Phosphorus, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Selenium, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Silver, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Suspended Solids, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Thallium, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	
Zinc, Total	mg/l	------	Quarterly	Daily Composite	ATMR/DMR	

TABLE C - CONDITIONS

Remarks:[1]The results of the Toxicity Tests are recorded in % survival. The Permittee shall report % survival on the DMR based on criteria in Section 6(B) of this permit.

ATMR – Aquatic Toxicity Monitoring Report

TABLE D

Discharge Serial Number: **001-1**		Monitoring Location: **N**		
Wastewater Description: **Activated Sludge**				
Monitoring Location Description: **Each Aeration Unit**				
PARAMETER	**REPORTING FORMAT**	**INSTANTANEOUS MONITORING**		**REPORTING FORM**
		Sample Frequency	Sample Type	
Oxygen, Dissolved	High & low for each WorkDay	2/WorkDay	Grab	MOR
Sludge Volume Index	WorkDay	WorkDay	Grab	MOR
Mixed Liquor Suspended Solids	WorkDay	WorkDay	Grab	MOR

TABLE E

Discharge Serial Number: **001-1**			Monitoring Location: **G**				
Wastewater Description: **Sanitary Sewage**							
Monitoring Location Description: **Influent**							
PARAMETER	**Units**	**DMR REPORTING FORMAT**	**FLOW/TIME BASED MONITORING**		**INSTANTANEOUS MONITORING**		**REPORTING FORM**
			Sample Frequency	**Sample Type**	**Sample Frequency**	**Sample Type**	
Biochemical Oxygen Demand (5 day)	mg/l	Monthly average	3/Week	Daily Composite	NA	NA	DMR/MOR
Nitrogen, Ammonia (total as N)	mg/l		Monthly	Daily Composite	NA	NA	MOR
Nitrogen, Nitrate (total as N)	mg/l		Monthly	Daily Composite	NA	NA	MOR
Nitrogen, Nitrite (total as N)	mg/l		Monthly	Daily Composite	NA	NA	MOR
Nitrogen, Total Kjeldahl	mg/l		Monthly	Daily Composite	NA	NA	MOR
Nitrogen, Total	mg/l		Monthly	Daily Composite	NA	NA	MOR
Phosphate, Ortho	mg/l		Monthly	Daily Composite	NA	NA	MOR
Phosphorus, Total	mg/l		Monthly	Daily Composite	NA	NA	MOR
pH	S.U.		NA	NA	Work Day	Grab	MOR
Solids, Total Suspended	mg/l	Monthly average	3/Week	Daily Composite	NA	NA	DMR/MOR
Temperature	°F		NA	NA	Work Day	Grab	MOR

TABLE F

Discharge Serial Number: **001-1**								Monitoring Location: **P**
Wastewater Description: **Primary Effluent**								
Monitoring Location Description: **Primary Sedimentation Basin Effluent**								
PARAMETER	**Units**	**REPORTING FORMAT**	**TIME/FLOW BASED MONITORING**		**INSTANTANEOUS MONITORING**		**REPORTING FORM**
			Sample Frequency	**Sample Type**	**Sample Frequency**	**Sample type**	
Alkalinity, Total	mg/l		NA	NA	Monthly	Grab	MOR
Biochemical Oxygen Demand (5 day)	mg/l	Monthly average	Weekly	Composite	NA	NA	MOR
Nitrogen, Ammonia (total as N)	mg/l		Monthly	Composite	NA	NA	MOR
Nitrogen, Nitrate (total as N)	mg/l		Monthly	Composite	NA	NA	MOR
Nitrogen, Nitrite (total as N)	mg/l		Monthly	Composite	NA	NA	MOR
Nitrogen, Total Kjeldahl	mg/l		Monthly	Composite	NA	NA	MOR
Nitrogen, Total	mg/l		Monthly	Composite	NA	NA	MOR
pH	S.U.		NA	NA	Monthly	Grab	MOR
Solids, Total Suspended	mg/l	Monthly average	Weekly	Composite	NA	NA	MOR

TABLE G

Discharge Serial Number: **001-1**	Monitoring Location: **SL**		
Wastewater Description: **Digester Sludge**			
Monitoring Location Description: **At sludge draw off**			
PARAMETER	**INSTANTANEOUS MONITORING**		**REPORTING FORM**
	Units	**Grab Sample Freq.**	
Arsenic, Total	mg/kg	Quarterly	DMR
Beryllium, Total	mg/kg	Quarterly	DMR
Cadmium, Total	mg/kg	Quarterly	DMR
Chromium, Total	mg/kg	Quarterly	DMR
Copper, Total	mg/kg	Quarterly	DMR
Lead, Total	mg/kg	Quarterly	DMR
Mercury, Total	mg/kg	Quarterly	DMR
Nickel, Total	mg/kg	Quarterly	DMR
Nitrogen, Ammonia *	mg/kg	Quarterly	DMR*
Nitrogen, Nitrate (total as N) *	mg/kg	Quarterly	DMR*
Nitrogen, Organic *	mg/kg	Quarterly	DMR*
Nitrogen, Nitrite (total as N) *	mg/kg	Quarterly	DMR*
Nitrogen, Total *	mg/kg	Quarterly	DMR*
pH *	S.U.	Quarterly	DMR*
Polychlorinated Biphenyls	mg/kg	Quarterly	DMR
Solids, Fixed	%	Quarterly	DMR
Solids, Total	%	Quarterly	DMR
Solids, Volatile	%	Quarterly	DMR
Zinc, Total	mg/kg	Quarterly	DMR
(*) required for composting or land application only			

ATTACHMENT 2

MONTHLY OPERATING REPORT FORM

ty of Groton Facility ID: 059-002 Chief Plant Operator: Phone: Date received: (stamped)

mple month/year: Page 1 of MOR for permit # CT0101184 Permit expiration date: 8/27/2008

	Daily Flow			Primary Sludge			Aeration Tank #1				Aeration Tank #2				Return sludge		Waste sludge	Dry solids		Anaerobic Digester								Waste accepted		BOD (5-day)		
	Max.	Min.	Total	Vol.	%	wt.	MLSS	SVI	high D.O.	low D.O.	MLSS	SVI	high D.O.	low D.O.	%flow	%solids		in	out	prim pH	sec pH	prim Alk.	sec Alk.	prim temp	sec temp	prim V.A.	sec V.A.	septic	indust	Inf.	Final Eff.	Prim. Eff.
its	mgd			gal.	solids	lbs.			mg/l				mg/l				lbs	lbs		S.U.	S.U.	mg/l	mg/l	°F	°F	mg/l	mg/l	gal	gal	mg/l		
eq	daily			work day			work day				work day				work day		work day	work day		weekly								work day		3/week		weekly
1																																
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uspended Solids			Settleable Solids	Turbidity	Chlorine Dose		Chlorine Residual		Chlorine Residual	Fecal Coliform	Entero Cocci	Lowest D.O.	pH			Temp.		Alkalinity	
Inf.	Final Eff.	Prim. Eff.	Eff.	Eff.			high	low	average			Eff.	Inf.	Eff.	Prim. Eff.	Inf.	Eff.	Eff.	Prim. Eff.
mg/l			ml/l	NTU	lbs	mg/l	mg/l		mg/l	#/100 ml	#/100 ml	mg/l	S.U.			°F		mg/l	
3/week		weekly	work day	work day	Daily		4/work day		4/work day	3/week	3/week	workday	work day		monthly	work day		monthly	

Sludge Disposal Location:

Please return forms to:
DEP - Water Management
ATTN: Municipal Wastewater Monitoring Coordinator
Municipal Facilities
79 Elm Street
Hartford, CT 06106-5127

Statement of Acknowledgement

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.

Authorized Official:

Title:

Signature: ____________________

Date: __________

DATA TRACKING AND TECHNICAL FACT SHEET

PERMITTEE: City of Groton

PERMIT, ADDRESS, AND FACILITY DATA

PERMIT #: CT01001184 **APPLICATION #:** 201710437 **FACILITY ID.** 059-002

Mailing Address:	Location Address:
Street: 311 Thames Street	Street: 311 Thames Street
City: Groton ST: CT Zip: 06340	City: Groton ST: CT Zip: 06340
Contact Name: Kevin Cini	Contact Name: Kevin Cini
Phone No.: (860)-441-6736	Phone No.: (860) 441-6736
	DMR Contact email address: cinik@cityofgroton-ct.gov

PERMIT INFORMATION

DURATION 5 YEAR X 10 YEAR ___ 30 YEAR ___

TYPE New __ Reissuance X Modification __

CATEGORIZATION POINT (X) NON-POINT ( ) GIS #

NPDES (X) PRETREAT () GROUND WATER(UIC) ( ) GROUND WATER (OTHER) ( )

NPDES MAJOR(**MA**) X
NPDES SIGNIFICANT MINOR or PRETREAT SIU **(SI)** ___
NPDES or PRETREATMENT MINOR **(MI)** ___

COMPLIANCE SCHEDULE YES__ NO X
POLLUTION PREVENTION __ TREATMENT REQUIREMENT__
WATER QUALITY REQUIREMENT __ OTHER ___

OWNERSHIP CODE
Private __ Federal __ State __ Municipal (town only) X Other public__

DEEP STAFF ENGINEER: Max Fan **DATE DRAFTED:** 1/13/18

PERMIT FEES

Discharge Code	DSN Number	Annual Fee
111000c	001-1	2,367.50

APPLICATION FEE PAID X YES 12/1/2017
PROCESSING FEE PAID X YES 1/22/2018
ANNUAL FEE PAID X YES Next fee due by 8/1/2018

PUBLIC NOTICE
Date of Public Notice: 6/13/18
Date Permit Cleared Public Notice: 7/13/18
Date Public Notice Fees Paid: 7/11/18

FOR NPDES DISCHARGES
Drainage Basin Code: 3000 Water Quality Classification Goal: **SB** Segment: Thames River-02

NATURE OF BUSINESS GENERATING DISCHARGE
Municipal Sanitary Sewage Treatment

PROCESS AND TREATMENT DESCRIPTION (by DSN)
Secondary treatment with biological nutrient removal and year round chlorine disinfection

RESOURCES USED TO DRAFT PERMIT

_X_ *Federal Effluent Limitation Guideline* _40CFR 133_ *Secondary Treatment Category*

__ *Performance Standards*

__ *Federal Development Document*
name of category

_X_ *Department File Information*

_X_ *Connecticut Water Quality Standards*

_X_ *Anti-degradation Policy*

__ *Coastal Management Consistency Review Form*

__ *Other - Explain*

BASIS FOR LIMITATIONS, STANDARDS OR CONDITIONS

_X_ *Secondary Treatment (Section 22a-430-4(r) of the Regulations of Connecticut State Agencies)*

__ *Case-by-Case Determination (See Other Comments)*

__ *In order to meet in-stream water quality (See General Comments)*

__ *Anti-degradation policy*

GENERAL COMMENTS
The City of Groton ("Permittee") operates a municipal water pollution control facility ("the facility") located at 311 Thames Street, Groton. The facility is designed to treat and discharge up to 3.1 million gallons a day of effluent into Thames River. The facility currently uses secondary treatment and chlorine disinfection to treat effluent before being discharged. Pursuant to Conn. Gen. Stat. § 22a-430, the Department of Energy and Environmental Protection has issued the City of Groton a permit for the discharge from this facility. The City of Groton has submitted an application to renew its permit. The Department has made a tentative determination to approve Groton's application and has prepared a draft permit consistent with that determination.

SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC NOTICE PERIOD AND THE DEPARTMENT'S RESPONSES

☒ *The Department has received no written comments on the proposed action. (REVIEW BY MANAGEMENT ONLY)*

☐ *Staff has reviewed the written comments and responded to the comments, no significant permit changes have been made. (REVIEW BY SUPERVISOR AND MANAGEMENT ONLY)*

☐ *The Department has received and Staff has reviewed written comments on the proposed action and made significant changes as follows: (ADD COMMENTS, RESPONSES AND PERMIT CHANGES) (REVIEW BY PERMIT STAFF, SUPERVISOR AND MANAGEMENT)*

SPECIFIC REQUIREMENTS OR REVISIONS
The Department reviewed the application for consistency with Connecticut's Water Quality Standards and determined that with the limits in the draft permit, including those discussed below, that the draft permit is consistent with maintenance and protection of water quality in accordance with the Tier I Anti-degradation Evaluation and Implementation Review provisions of such Standards.

The need for inclusion of water quality based discharge limitations in this permit was evaluated consistent with Connecticut Water Quality Standards and criteria, pursuant to 40 CFR 122.44(d). Discharge monitoring data was evaluated for consistency with the available aquatic life criteria (acute and chronic) and human health (fish consumption only) criteria, considering the zone of influence allocated to the facility where appropriate. In addition to this review, the statistical procedures outlined in the EPA Technical Support Document for Water Quality-based Toxics Control (EPA/505/2-90-001) were employed to calculate the need for such limits. Comparison of the attached monitoring data and its inherent variability with the calculated water quality based limits indicates a low statistical probability of exceeding such limits. Therefore, no water quality based were included in the permit at this time.

WATER QUALITY LIMIT CALCULATIONS
See attached

City of Groton

Discharger:	City of Groton			by: Fanma, 12/20/2017, 09:54	
Receiving Water:	Thames River		CURRENT CONDITIONS		
Design Flow:	3.100	MGD	Avg. Flow:	1.730	MGD
Allocated ZOI:	473.00	CFS	Max. Flow:	2.200	MGD
Samples/Month:	4		IWC:	1.00 %	

WQB Limits - **Saltwater**

Compound	C.V.	AML ug/l	MDL ug/l	AML kg/d	MDL kg/d	LIMIT? ML?
Aluminum	0.0	8.67E+03	8.67E+03	1.02E+02	1.02E+02	
Ammonia	1.0	5.42E+04	1.37E+05	6.36E+02	1.60E+03	
Antimony	0.1	2.79E+04	3.23E+04	3.28E+02	3.79E+02	
Arsenic	0.2	2.10E-02	2.78E-02	2.47E-04	3.27E-04	ML
Beryllium	0.0	1.30E+01	1.30E+01	1.52E-01	1.52E-01	
Cadmium	0.0	8.77E+02	8.77E+02	1.03E+01	1.03E+01	
Chlorine	0.6	6.12E+02	1.23E+03	7.18E+00	1.44E+01	
Chromium (hex)	0.0	4.98E+03	4.98E+03	5.85E+01	5.85E+01	
Chromium (tri)	0.3	1.01E+08	1.51E+08	1.18E+06	1.77E+06	
Copper	1.0	3.47E+02	8.74E+02	4.07E+00	1.03E+01	
Cyanide (amen)	0.0	9.96E+01	9.96E+01	1.17E+00	1.17E+00	
Lead	0.5	6.82E+02	1.26E+03	8.01E+00	1.48E+01	
Mercury	0.0	5.08E+00	5.08E+00	5.97E-02	5.97E-02	
Nickel	0.5	6.91E+02	1.27E+03	8.11E+00	1.50E+01	
Phenol	0.0	8.57E+07	8.57E+07	1.01E+06	1.01E+06	
Selenium	0.6	5.79E+03	1.16E+04	6.80E+01	1.36E+02	
Silver	0.0	1.89E+02	1.89E+02	2.22E+00	2.22E+00	
Thallium	1.1	4.68E+01	1.22E+02	5.50E-01	1.44E+00	
Zinc	0.2	8.38E+03	1.11E+04	9.84E+01	1.30E+02	

Current Conditions

Compound	# DETECTS	AMC ug/l	MMC ug/l	AMM kg/d	MMM kg/d
Aluminum	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ammonia	20	3.88E+00	1.87E+01	2.54E-02	1.56E-01
Antimony	0	4.80E+00	5.00E+00	3.15E-02	4.17E-02
Arsenic	0	3.80E+00	4.00E+00	2.49E-02	3.33E-02
Beryllium	0	1.00E+00	1.00E+00	6.55E-03	8.33E-03
Cadmium	0	1.00E+00	1.00E+00	6.55E-03	8.33E-03
Chlorine					
Chromium (hex)	0	1.00E+01	1.00E+01	6.55E-02	8.33E-02
Chromium (tri)	4	1.10E+00	2.00E+00	7.21E-03	1.67E-02
Copper	12	1.08E+01	5.10E+01	7.08E-02	4.25E-01
Cyanide (amen)	0	1.00E+01	1.00E+01	6.55E-02	8.33E-02
Lead	3	1.90E+00	5.00E+00	1.25E-02	4.17E-02
Mercury	1	2.00E-01	2.00E-01	1.31E-03	1.67E-03
Nickel	18	2.10E+00	5.00E+00	1.38E-02	4.17E-02
Phenol	0	1.50E+01	1.50E+01	9.83E-02	1.25E-01
Selenium	0	9.50E+00	1.00E+01	6.23E-02	8.33E-02
Silver	0	1.00E+00	1.00E+00	6.55E-03	8.33E-03
Thallium	0	1.80E+00	1.00E+01	1.18E-02	8.33E-02
Zinc	20	3.77E+01	5.50E+01	2.47E-01	4.58E-01

Final WQB Limits

	AML (kg/d)	MDL (kg/d)

Interim WQB Limits

	AML (kg/d)	MDL (kg/d)

Minimum Levels

Arsenic	0.005 mg/L

Effluent Chemistry: GROTON CITY WPCF

as of Tuesday, December 19, 2017 **Design Flow** 3.1 MGD **Avg. Monthly Flow :** MGD **Max. Monthly Flow :** MGD

Receiving Waterbody: Thames River
Allocated ZOI: 100:1 cfs
Database IWC: 1% (allocated)

Date	BOD	TSS	NH3	NO2	NO3	CNt	CNa	Be	As	Cd	Cr6	Cr3	Cu	Pb	Th	Ni	Ag	Zn	Sb	Se	Phen	Hg	Al	P	Fe
1/14/2013	23.00	13.00	2.48	0.230	1.45	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	12.0	< 2.0	< 2.0	2.0	< 1.0	45.0	< 5.0	< 10.0	< 15.0	< 0.2			
4/9/2013	7.50	< 5.00	2.49	0.130	0.41	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	< 1.0	< 2.0	1.0	< 1.0	36.0	< 5.0	< 10.0	< 15.0	< 0.2			
7/16/2013	12.00	16.00	4.92	0.590	0.10	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	2.0	51.0	< 2.0	< 2.0	3.0	< 1.0	55.0	< 5.0	< 10.0	< 15.0	< 0.2			
10/9/2013	9.30	8.00	4.39	1.020	0.20	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	< 1.0	< 2.0	2.0	< 1.0	30.0	< 5.0	< 10.0	< 15.0	0.2			
1/14/2014	13.00	11.00	1.16	0.960	0.17	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	1.0	9.0	< 2.0	< 2.0	2.0	< 1.0	44.0	< 5.0	< 10.0	< 15.0	< 0.2			
4/8/2014	14.00	< 5.00	1.85	0.450	1.71	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	< 2.0	< 2.0	2.0	< 1.0	36.0	< 5.0	< 10.0	< 15.0	< 0.2			
7/8/2014	17.00	13.00	2.15	0.440	1.14	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	1.0	14.0	< 1.0	< 2.0	2.0	< 1.0	32.0	< 5.0	< 10.0	< 15.0	< 0.2			
10/14/2014	12.00	15.00	8.50	0.340	1.30	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	5.0	< 1.0	< 2.0	< 1.0	< 1.0	36.0	< 5.0	< 10.0	< 15.0	< 0.2			
1/13/2015	7.10	< 5.00	1.78	0.240	1.72	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	8.0	< 2.0	< 10.0	3.0	< 1.0	39.0	< 5.0	< 10.0	< 15.0	< 0.2			
4/14/2015	5.60	< 5.00	4.88	0.470	0.16	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	< 2.0	< 1.0	2.0	< 1.0	28.0	< 5.0	< 10.0	< 15.0	< 0.2			
7/7/2015	19.00	23.00	1.91	1.570	0.15	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	2.0	18.0	< 2.0	< 1.0	3.0	< 1.0	38.0	< 5.0	< 10.0	< 15.0	< 0.2			
10/13/2015	25.00	11.00	18.70	0.190	0.02	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	2.0	< 1.0	< 1.0	< 1.0	34.0	< 5.0	< 10.0	< 15.0	< 0.2			
11/10/2015	28.00	17.00	4.82	1.070	0.07	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	12.0	4.0	< 1.0	3.0	< 1.0	54.0	< 5.0	< 10.0	< 15.0	< 0.2			
1/19/2016	31.00	23.00	5.25	2.070	0.29	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	19.0	5.0	< 1.0	1.0	< 1.0	46.0	< 5.0	< 10.0	< 15.0	< 0.2			
4/5/2016	5.60	< 5.00	2.16	0.570	2.14	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	< 2.0	< 1.0	2.0	< 1.0	31.0	< 5.0	< 10.0	< 15.0	< 0.2			

Date	BOD	TSS	NH3	NO2	NO3	CNt	CNa	Be	As	Cd	Cr6	Cr3	Cu	Pb	Th	Ni	Ag	Zn	Sb	Se	Phen	Hg	Al	P	Fe
7/17/2016	**4.70**	**8.00**	**3.59**	**0.271**	**0.06**	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	< 2.0	< 1.0	5.0	< 1.0	25.0	< 5.0	< 10.0	< 15.0	< 0.2			
10/18/2016	**8.60**	**< 5.00**	**1.38**	**0.664**	**0.07**	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	< 5.0	< 2.0	< 1.0	2.0	< 1.0	29.0	< 5.0	< 10.0	< 15.0	< 0.2			
1/17/2017	**8.30**	**6.00**	**0.73**	**0.530**	**2.49**	< 10.0	< 10.0	< 1.0	< 4.0	< 1.0	< 10.0	< 1.0	7.0	< 1.0	< 1.0	1.0	< 1.0	36.0	< 5.0	< 10.0	< 15.0	< 0.2			
4/25/2017	**8.50**	**< 5.00**	**2.26**	**0.325**	**0.75**	< 10.0	< 10.0	< 1.0	< 2.0	< 1.0	< 10.0	< 1.0	6.0	< 1.0	< 0.3	1.0	< 1.0	33.0	< 3.0	< 5.0	< 15.0	< 0.2			
7/18/2017	**< 4.00**	**< 5.00**	**2.27**	**0.386**	**0.55**	< 10.0	< 10.0	< 1.0	< 2.0	< 1.0	< 10.0	< 1.0	14.0	< 1.0	< 1.0	2.0	< 1.0	46.0	< 3.0	< 5.0	< 15.0	< 0.2			

1210

	BOD	TSS	NH3	NO2	NO3	CNt	CNa	Be	As	Cd	Cr6	Cr3	Cu	Pb	Th	Ni	Ag	Zn	Sb	Se	Phen	Hg	Al	P	Fe
Count	**20**	**20**	**20**	**20**	**20**	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	0	0	0
# Detected	**19**	**12**	**20**	**20**	**20**	0	0	0	0	0	0	4	12	3	0	18	0	20	0	0	0	1	0	0	0
Average	**13.21**	**10.20**	**3.88**	**0.626**	**0.75**	10.0	10.0	1.0	3.8	1.0	10.0	1.1	10.8	1.9	1.8	2.1	1.0	37.7	4.8	9.5	15.0	0.2			
Maximum	**31.00**	**23.00**	**18.70**	**2.070**	**2.49**	10.0	10.0	1.0	4.0	1.0	10.0	2.0	51.0	5.0	10.0	5.0	1.0	55.0	5.0	10.0	15.0	0.2			
CV	**0.6**	**0.6**	**1.0**	**0.8**	**1.1**	0.0	0.0	0.0	0.2	0.0	0.0	0.3	1.0	0.5	1.1	0.5	0.0	0.2	0.1	0.2	0.0	0.0			

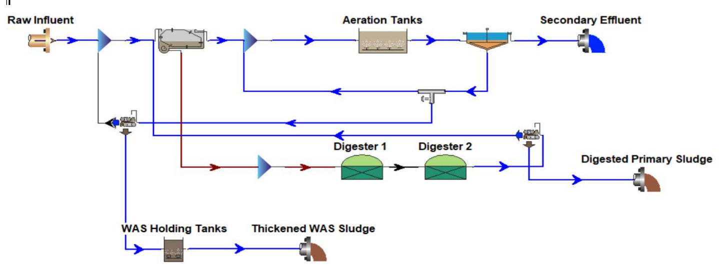
Bold => mg/L Normal => ug/L

Appendix B
Process Modeling Results

Groton Utilities CT
WWTF Facility Plan
Scenario No. 1 Existing Process - Design Max Month Condition
PROJECT # 20653

Process Model Results
2.7 MGD maximum month flows and loads condition
\\wright-pierce.com\wpmfs\vol4\ENG\CT\GrotonUtilities\20653-WWTP Facilities Plan\20653A\Technical\5-Process\Biowin\Scenarios_Options\Groton Utilities WWTF_SCN_1_Existing_AirCycling.bwc

Process Schematic



Basis of Design Information

Aeration 0.8106 MG

Secondary Clarifiers

No. Unit	2
L (ft)	138
W (ft)	20
A each (sf)	2760
A total (sf)	5520

Desired Effluent Quality

BOD and TSS
20 Monthly Ave. (mg/l)
20 Monthly Ave. (mg/l)

Total Nitrogen
min (mg/l)

Nitrate Nitrogen
min Single Sample (mg/l)

Descriptions of operating conditions
Primary Clarifier TSS removal: 55% (BioWin default)
18 day total SRT - 11˚C winter mixed liquor temperature within the existing aeration tanks volume 0.8106 MG
Aeration on off cycling - 45 min aeration-on (2 mg/L DO), 45 min aeration-off (30 min aeration on+45min aeration off is currently used. Aeration-on was increased to 50% for complete nitrification (Aerobic SRT approx 9 days)

Max MLSS: 3,600 mg/L based on the state point analysis at the design max day flow, max month loadings

Raw primary sludge is digested in the two stage anaerobic digestion (0.2 MG each, 0.4 MG total). 50% decanting in the second stage.
Raw WAS is thickened to 4%, stored in WAS holding tanks (0.18 MG).

Influent Flows and Loads

Parameter	Flow	Temp	BOD_5		TSS		VSS		TKN		NH3-N		TP	
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day
Maximum Month	**2.70**	**11.00**	143	**3,211**	170	3838	136	3070	29	655	19	432	4.5	101
Maximum Day (100th %)	**3.88**													

Secondary Effluent Quality

Parameter	Flow	Temp	BOD_5		TSS		NH3-N		NOx		TN			
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day		
Annual Average														
Maximum Month	**2.70**	**11.00**	**4.8**	108	**14**	321	**2.3**	52	**5.30**	119	**9.60**			
Maximum Day (100th %)	**3.88**													
Peak Hour (100th %)														

Key Process Design Parameters

Parameter		Sludge Production (lbs/day)					Pumping Rates (MGD)			Aeration Requirements			
		Primary Sludge	Waste Activated Sludge	Digested Primary Sludge	Thickened WAS	Total Cake Disposed	Waste Activated Sludge	Return Activated Sludge	Internal Nitrate Recycle	Dissolved Oxygen Conc. (mg/l)	Actual Oxygen Required (lbs/day)	Air Flow Rate (scfm)	Assumed SOTE (%)
Annual Average													
Maximum Month		2148	1075	850	771		0.0147	1.84		2	3528	3200	
Maximum Day (100th %)								1.84					
Peak Hour (100th %)													

Activated Sludge Operation - Anaerobic/Aerobic

Parameter	Tank Volumes (mgal)					Mass		SRT (days		HRT (hrs)				
	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration	MLSS	MLVSS	Oxic	Total	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration
Annual Average														
Maximum Month		0.4053	0.4053			3568	2452	9.00	18.0		3.60	3.60		
Maximum Day (100th %)						3568								
Peak Hour (100th %)														

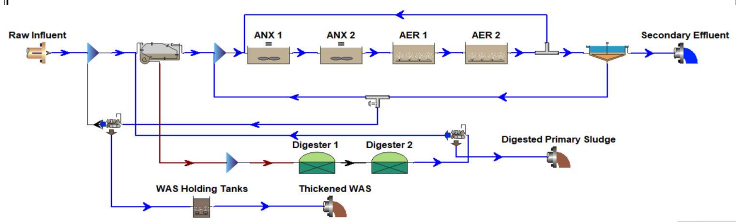
Secondary Clarifier Operation

Parameter	Design Parameters				
	# of Units Online	Total Surface Area (sf)	Surface Overflow Rate (gal/ft2/day)	Solids loading Rate (lbs/sf-day)	RAS Concentration (mg/l)
Annual Average					
Maximum Month	2	5520	489	24.47	8773
Maximum Day (100th %)				30.84	
Peak Hour (100th %)					

Groton Utilities CT
WWTF Facility Plan
Scenario No. 2 MLE modification within the existing volume - Design Max Month Condition
PROJECT # 20653

Process Model Results
2.7 MGD maximum month flows and loads condition
\\wright-pierce.com\wpmfs\vol4\ENG\CT\GrotonUtilities\20653-WWTP Facilities Plan\20653A\Technical\5-Process\Biowin\Scenarios_Options\Groton Utilities WWTF_SCN_2_MLE.bwc

Process Schematic



Basis of Design Information

Aeration 0.8106 MG

Secondary Clarifiers

No. Unit	2
L (ft)	138
W (ft)	20
A each (sf)	2760
A total (sf)	5520

Desired Effluent Quality

BOD and TSS
20 Monthly Ave. (mg/l)
20 Monthly Ave. (mg/l)

Total Nitrogen
min (mg/l)

Nitrate Nitrogen
min Single Sample (mg/l)

Descriptions of operating conditions
Primary Clarifier TSS removal: 55% (BioWin default)
18 day total SRT - 11˚C winter mixed liquor temperature within the existing aeration tanks volume 0.8106 MG
MLE conversion with 33% anoxic volume, 16% swing zone, and 50% aeration volume (2 mg/L DO). 50% anoxic SRT by utilizing swing zone with aeration-off.
300% IR
Max MLSS: 3,600 mg/L based on the state point analysis at the design max day flow, max month loadings

Raw primary sludge is digested in the two stage anaerobic digestion (0.2 MG each, 0.4 MG total). 50% decanting in the second stage.
Raw WAS is thickened to 4%, stored in WAS holding tanks (0.18 MG).

Influent Flows and Loads

Parameter	Flow	Temp	BOD_5		TSS		VSS		TKN		NH3-N		TP	
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day
Maximum Month	**2.70**	**11.00**	143	**3,211**	170	3838	136	3070	29	655	19	432	4.5	101
Maximum Day (100th %)	**3.88**													

Secondary Effluent Quality

Parameter	Flow	Temp	BOD_5		TSS		NH3-N		NOx		TN			
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day		
Annual Average														
Maximum Month	**2.70**	**11.00**	**4.5**	101	**12**	270	**0.8**	18	**5.80**	131	**8.40**			
Maximum Day (100th %)	**3.88**													
Peak Hour (100th %)														

Key Process Design Parameters

Parameter		Sludge Production (lbs/day)					Pumping Rates (MGD)				Aeration Requirements			
		Primary Sludge	Waste Activated Sludge	Digested Primary Sludge	Thickened WAS	Total Cake Disposed		Waste Activated Sludge	Return Activated Sludge	Internal Nitrate Recycle	Dissolved Oxygen Conc. (mg/l)	Actual Oxygen Required (lbs/day)	Air Flow Rate (scfm)	Assumed SOTE (%)
Annual Average														
Maximum Month		2164	1063	814	736			0.0147	1.84	8.1	2	3370	1400	
Maximum Day (100th %)									1.84					
Peak Hour (100th %)														

Activated Sludge Operation - Anaerobic/Aerobic

Parameter	Tank Volumes (mgal)					Mass		SRT (days		HRT (hrs)				
	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration	MLSS	MLVSS	Oxic	Total	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration
Annual Average														
Maximum Month		0.4053	0.4053			3526	2406	9.00	18.0		3.60	3.60		
Maximum Day (100th %)						3526								
Peak Hour (100th %)														

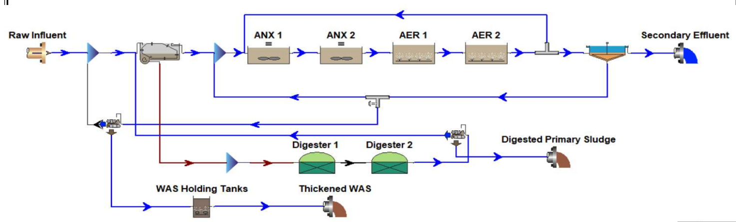
Secondary Clarifier Operation

Parameter	Design Parameters				
	# of Units Online	Total Surface Area (sf)	Surface Overflow Rate (gal/ft2/day)	Solids loading Rate (lbs/sf-day)	RAS Concentration (mg/l)
Annual Average					
Maximum Month	2	5520	489	24.19	8773
Maximum Day (100th %)				30.47	
Peak Hour (100th %)					

Groton Utilities CT
WWTF Facility Plan
Scenario No. 2-1 MLE modification within the existing volume - Design Max Month Condition, Summer
PROJECT # 20653

Process Model Results
2.7 MGD maximum month flows and loads condition
\\wright-pierce.com\wpmfs\vol4\ENG\CT\GrotonUtilities\20653-WWTP Facilities Plan\20653A\Technical\5-Process\Biowin\Scenarios_Options\Groton Utilities WWTF_SCN_2-1_MLE_Summer_AER.bwc

Process Schematic



Basis of Design Information

Aeration 0.8106 MG

Secondary Clarifiers

No. Unit	2
L (ft)	138
W (ft)	20
A each (sf)	2760
A total (sf)	5520

Desired Effluent Quality

BOD and TSS
20 Monthly Ave. (mg/l)
20 Monthly Ave. (mg/l)

Total Nitrogen
min (mg/l)

Nitrate Nitrogen
min Single Sample (mg/l)

Descriptions of operating conditions
Primary Clarifier TSS removal: 55% (BioWin default)
18 day total SRT - 20˚C winter mixed liquor temperature within the existing aeration tanks volume 0.8106 MG
MLE conversion with 33% anoxic volume, 16% swing zone, and 50% aeration volume (2 mg/L DO). 50% anoxic SRT by utilizing swing zone with aeration-off.
300% IR
Max MLSS: 3,600 mg/L based on the state point analysis at the design max day flow, max month loadings

Raw primary sludge is digested in the two stage anaerobic digestion (0.2 MG each, 0.4 MG total). 50% decanting in the second stage.
Raw WAS is thickened to 4%, stored in WAS holding tanks (0.18 MG).

Influent Flows and Loads

Parameter	Flow	Temp	BOD_5		TSS		VSS		TKN		NH3-N		TP	
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day
Maximum Month	**2.70**	**20.00**	143	**3,211**	170	3838	136	3070	29	655	19	432	4.5	101
Maximum Day (100th %)	**3.88**													

Secondary Effluent Quality

Parameter	Flow	Temp	BOD_5		TSS		NH3-N		NOx		TN			
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day		
Annual Average														
Maximum Month	**2.70**	**20.00**	**3.5**	79	**11**	254	**0.2**	4	**6.25**	141	**8.19**			
Maximum Day (100th %)	**3.88**													
Peak Hour (100th %)														

Key Process Design Parameters

Parameter		Sludge Production (lbs/day)					Pumping Rates (MGD)				Aeration Requirements			
		Primary Sludge	Waste Activated Sludge	Digested Primary Sludge	Thickened WAS	Total Cake Disposed		Waste Activated Sludge	Return Activated Sludge	Internal Nitrate Recycle	Dissolved Oxygen Conc. (mg/l)	Actual Oxygen Required (lbs/day)	Air Flow Rate (scfm)	Assumed SOTE (%)
Annual Average														
Maximum Month		2163	1010	819	727.69			0.0147	1.84	8.1	2	3533	1507	
Maximum Day (100th %)									1.84					
Peak Hour (100th %)														

Activated Sludge Operation - Anaerobic/Aerobic

Parameter	Tank Volumes (mgal)					Mass		SRT (days		HRT (hrs)				
	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration	MLSS	MLVSS	Oxic	Total	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration
Annual Average														
Maximum Month		0.4053	0.4053			3353	2251	9.00	18.0		3.60	3.60		
Maximum Day (100th %)						3353								
Peak Hour (100th %)														

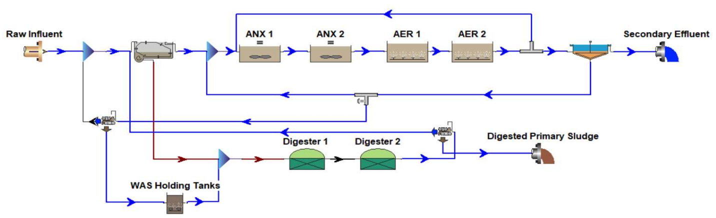
Secondary Clarifier Operation

Parameter	Design Parameters				
	# of Units Online	Total Surface Area (sf)	Surface Overflow Rate (gal/ft2/day)	Solids loading Rate (lbs/sf-day)	RAS Concentration (mg/l)
Annual Average					
Maximum Month	2	5520	489	23.00	8244
Maximum Day (100th %)				28.98	
Peak Hour (100th %)					

Groton Utilities CT
WWTF Facility Plan
MLE modification within the existing volume - Design Max Month Condition - Option No. 1-1 - Continued Anaerobic Digestion - Feed thickened waste activated sludge to primary digester along with un-thickened primary sludge.
PROJECT # 20653

Process Model Results
2.7 MGD maximum month flows and loads condition
\\wright-pierce.com\wpmfs\vol4\ENG\CT\GrotonUtilities\20653-WWTP Facilities Plan\20653A\Technical\5-Process\Biowin\Scenarios_Options\Groton Utilities WWTF_MLE_Opt1-1.bwc

Process Schematic



Basis of Design Information

Aeration 0.8106 MG

Secondary Clarifiers

No. Unit	2
L (ft)	138
W (ft)	20
A each (sf)	2760
A total (sf)	5520

Desired Effluent Quality

BOD and TSS
20 Monthly Ave. (mg/l)
20 Monthly Ave. (mg/l)

Total Nitrogen
min (mg/l)

Nitrate Nitrogen
min Single Sample (mg/l)

Descriptions of operating conditions
Primary Clarifier TSS removal: 55% (BioWin default)
18 day total SRT - 11˚C winter mixed liquor temperature within the existing aeration tanks volume 0.8106 MG
MLE conversion with 33% anoxic volume, 16% swing zone, and 50% aeration volume (2 mg/L DO). 50% anoxic SRT by utilizing swing zone with aeration-off.
300% IR
Max MLSS: 3,600 mg/L based on the state point analysis at the design max day flow, max month loadings

Raw WAS is thickened to 4%, stored in WAS holding tanks (0.18 MG) and digested with raw primary sludge in the two stage anaerobic digestion (0.2 MG each, 0.4 MG total). 50% decanting in the second stage.

Influent Flows and Loads

Parameter	Flow	Temp	BOD_5		TSS		VSS		TKN		NH3-N		TP	
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day
Maximum Month	**2.70**	**11.00**	143	**3,211**	170	3838	136	3070	29	655	19	432	4.5	101
Maximum Day (100th %)	**3.88**													

Secondary Effluent Quality

Parameter	Flow	Temp	BOD_5		TSS		NH3-N		NOx		TN			
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day		
Annual Average														
Maximum Month	**2.70**	**11.00**	**4.8**	108	**12**	270	**0.8**	18	**5.80**	131	**8.50**			
Maximum Day (100th %)	**3.88**													
Peak Hour (100th %)														

Key Process Design Parameters

Parameter		Sludge Production (lbs/day)					Pumping Rates (MGD)			Aeration Requirements			
		Primary Sludge	Waste Activated Sludge	Combined Digested Sludge			Waste Activated Sludge	Return Activated Sludge	Internal Nitrate Recycle	Dissolved Oxygen Conc. (mg/l)	Actual Oxygen Required (lbs/day)	Air Flow Rate (scfm)	Assumed SOTE (%)
Annual Average													
Maximum Month		2185	1076	1521			0.0147	1.84	8.1	2	3375	1400	
Maximum Day (100th %)								1.84					
Peak Hour (100th %)													

Activated Sludge Operation - Anaerobic/Aerobic

Parameter	Tank Volumes (mgal)					Mass		SRT (days		HRT (hrs)				
	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration	MLSS	MLVSS	Oxic	Total	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration
Annual Average														
Maximum Month		0.4053	0.4053			3571	2433	9.00	18.0		3.60	3.60		
Maximum Day (100th %)						3571								
Peak Hour (100th %)														

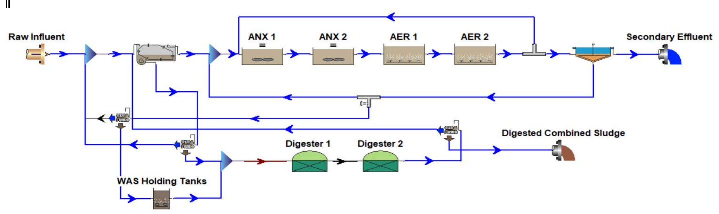
Secondary Clarifier Operation

Parameter	Design Parameters				
	# of Units Online	Total Surface Area (sf)	Surface Overflow Rate (gal/ft2/day)	Solids loading Rate (lbs/sf-day)	RAS Concentration (mg/l)
Annual Average					
Maximum Month	2	5520	489	24.49	8784
Maximum Day (100th %)				30.86	
Peak Hour (100th %)					

Groton Utilities CT
WWTF Facility Plan
MLE modification within the existing volume - Design Max Month Condition - Option No. 1-2 - Continued Anaerobic Digestion - Thicken primary sludge and waste activated sludge separately and feed to anaerobic digestion tanks.
PROJECT # 20653

Process Model Results
2.7 MGD maximum month flows and loads condition
\\wright-pierce.com\wpmfs\vol4\ENG\CT\GrotonUtilities\20653-WWTP Facilities Plan\20653A\Technical\5-Process\Biowin\Scenarios_Options\Groton Utilities WWTF_MLE_Opt1-2.bwc

Process Schematic



Basis of Design Information

Aeration 0.8106 MG

Secondary Clarifiers

No. Unit	2
L (ft)	138
W (ft)	20
A each (sf)	2760
A total (sf)	5520

Desired Effluent Quality

BOD and TSS
20 Monthly Ave. (mg/l)
20 Monthly Ave. (mg/l)

Total Nitrogen
min (mg/l)

Nitrate Nitrogen
min Single Sample (mg/l)

Descriptions of operating conditions
Primary Clarifier TSS removal: 55% (BioWin default)
18 day total SRT - 11˚C winter mixed liquor temperature within the existing aeration tanks volume 0.8106 MG
MLE conversion with 33% anoxic volume, 16% swing zone, and 50% aeration volume (2 mg/L DO). 50% anoxic SRT by utilizing swing zone with aeration-off.
300% IR
Max MLSS: 3,600 mg/L based on the state point analysis at the design max day flow, max month loadings

Raw WAS is thickened to 4%, stored in WAS holding tanks (0.18 MG) and digested with thickened primary sludge (7.5%) in the two stage anaerobic digestion (0.2 MG each, 0.4 MG total). 50% decanting in the second stage.

Influent Flows and Loads

Parameter	Flow	Temp	BOD_5		TSS		VSS		TKN		NH3-N		TP	
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day
Maximum Month	**2.70**	**11.00**	143	**3,211**	170	3838	136	3070	29	655	19	432	4.5	101
Maximum Day (100th %)	**3.88**													

Secondary Effluent Quality

Parameter	Flow	Temp	BOD_5		TSS		NH3-N		NOx		TN			
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day		
Annual Average														
Maximum Month	**2.70**	**11.00**	**4.0**	90	**12**	270	**0.8**	18	**5.80**	131	**8.44**			
Maximum Day (100th %)	**3.88**													
Peak Hour (100th %)														

Key Process Design Parameters

Parameter		Sludge Production (lbs/day)					Pumping Rates (MGD)				Aeration Requirements			
		Primary Sludge	Waste Activated Sludge	Combined Digested Sludge				Waste Activated Sludge	Return Activated Sludge	Internal Nitrate Recycle	Dissolved Oxygen Conc. (mg/l)	Actual Oxygen Required (lbs/day)	Air Flow Rate (scfm)	Assumed SOTE (%)
Annual Average														
Maximum Month		2185	1071	1514				0.0147	1.84	8.1	2	3385	1404	
Maximum Day (100th %)									1.84					
Peak Hour (100th %)														

Activated Sludge Operation - Anaerobic/Aerobic

Parameter	Tank Volumes (mgal)					Mass		SRT (days		HRT (hrs)				
	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration	MLSS	MLVSS	Oxic	Total	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration
Annual Average														
Maximum Month		0.4053	0.4053			3555	2427	9.00	18.0		3.60	3.60		
Maximum Day (100th %)						3555								
Peak Hour (100th %)														

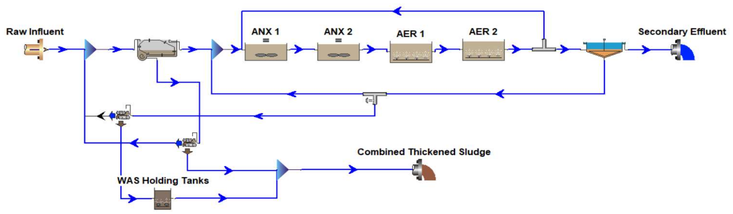
Secondary Clarifier Operation

Parameter	Design Parameters				
	# of Units Online	Total Surface Area (sf)	Surface Overflow Rate (gal/ft2/day)	Solids loading Rate (lbs/sf-day)	RAS Concentration (mg/l)
Annual Average					
Maximum Month	2	5520	489	24.38	8748
Maximum Day (100th %)				30.72	
Peak Hour (100th %)					

Groton Utilities CT
WWTF Facility Plan
MLE modification within the existing volume - Design Max Month Condition - Option No. 2-1 - Eliminate Anaerobic Digestion - Thicken primary sludge in new gravity thickener, continue thickening WAS in RDT and blend sludge prior to disposal.
PROJECT # 20653

Process Model Results
2.7 MGD maximum month flows and loads condition
\\wright-pierce.com\wpmfs\vol4\ENG\CT\GrotonUtilities\20653-WWTP Facilities Plan\20653A\Technical\5-Process\Biowin\Scenarios_Options\Groton Utilities WWTF_MLE_Opt2-1.bwc

Process Schematic



Basis of Design Information

Aeration 0.8106 MG

Secondary Clarifiers

No. Unit	2
L (ft)	138
W (ft)	20
A each (sf)	2760
A total (sf)	5520

Desired Effluent Quality

BOD and TSS
20 Monthly Ave. (mg/l)
20 Monthly Ave. (mg/l)

Total Nitrogen
min (mg/l)

Nitrate Nitrogen
min Single Sample (mg/l)

Descriptions of operating conditions
Primary Clarifier TSS removal: 55% (BioWin default)
18 day total SRT - 11˚C winter mixed liquor temperature within the existing aeration tanks volume 0.8106 MG
MLE conversion with 33% anoxic volume, 16% swing zone, and 50% aeration volume (2 mg/L DO). 50% anoxic SRT by utilizing swing zone with aeration-off.
300% IR
Max MLSS: 3,600 mg/L based on the state point analysis at the design max day flow, max month loadings

Raw WAS is thickened to 4%, stored in WAS holding tanks (0.18 MG). Raw primary sludge is digested to 7.5%. WAS and PS blended before disposal.

Influent Flows and Loads

Parameter	Flow	Temp	BOD_5		TSS		VSS		TKN		NH3-N		TP	
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day
Maximum Month	**2.70**	**11.00**	143	**3,211**	170	3838	136	3070	29	655	19	432	4.5	101
Maximum Day (100th %)	**3.88**													

Secondary Effluent Quality

Parameter	Flow	Temp	BOD_5		TSS		NH3-N		NOx		TN			
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day		
Annual Average														
Maximum Month	**2.70**	**11.00**	**4.0**	90	**12**	270	**0.82**	18	**4.90**	110	**7.55**			
Maximum Day (100th %)	**3.88**													
Peak Hour (100th %)														

Key Process Design Parameters

Parameter		Sludge Production (lbs/day)					Pumping Rates (MGD)				Aeration Requirements			
		Primary Sludge	Waste Activated Sludge	Combined Thickened Sludge				Waste Activated Sludge	Return Activated Sludge	Internal Nitrate Recycle	Dissolved Oxygen Conc. (mg/l)	Actual Oxygen Required (lbs/day)	Air Flow Rate (scfm)	Assumed SOTE (%)
Annual Average														
Maximum Month		2158	1051	2852				0.0147	1.84	8.1	2	3273	1352	
Maximum Day (100th %)									1.84					
Peak Hour (100th %)														

Activated Sludge Operation - Anaerobic/Aerobic

Parameter	Tank Volumes (mgal)					Mass		SRT (days		HRT (hrs)				
	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration	MLSS	MLVSS	Oxic	Total	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration
Annual Average														
Maximum Month		0.4053	0.4053			3489	2389	9.00	18.0		3.60	3.60		
Maximum Day (100th %)						3489								
Peak Hour (100th %)														

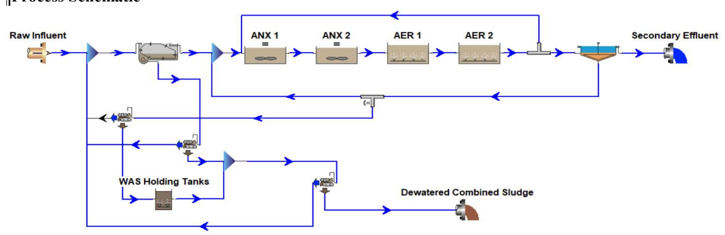
Secondary Clarifier Operation

Parameter	Design Parameters				
	# of Units Online	Total Surface Area (sf)	Surface Overflow Rate (gal/ft2/day)	Solids loading Rate (lbs/sf-day)	RAS Concentration (mg/l)
Annual Average					
Maximum Month	2	5520	489	23.93	8579
Maximum Day (100th %)				30.15	
Peak Hour (100th %)					

Groton Utilities CT
WWTF Facility Plan
MLE modification within the existing volume - Design Max Month Condition - Option No. 2-1 - Eliminate Anaerobic Digestion - Thicken primary sludge in new gravity thickener, continue thickening WAS in RDT and blend sludge, dewater prior to disposal.
PROJECT # 20653

Process Model Results
2.7 MGD maximum month flows and loads condition
\\wright-pierce.com\wpmfs\vol4\ENG\CT\GrotonUtilities\20653-WWTP Facilities Plan\20653A\Technical\5-Process\Biowin\Scenarios_Options\Groton Utilities WWTF_MLE_Opt2-2.bwc

Process Schematic



Basis of Design Information

Aeration 0.8106 MG

Secondary Clarifiers

No. Unit	2
L (ft)	138
W (ft)	20
A each (sf)	2760
A total (sf)	5520

Desired Effluent Quality

BOD and TSS
20 Monthly Ave. (mg/l)
20 Monthly Ave. (mg/l)

Total Nitrogen
min (mg/l)

Nitrate Nitrogen
min Single Sample (mg/l)

Descriptions of operating conditions
Primary Clarifier TSS removal: 55% (BioWin default)
18 day total SRT - 11˚C winter mixed liquor temperature within the existing aeration tanks volume 0.8106 MG
MLE conversion with 33% anoxic volume, 16% swing zone, and 50% aeration volume (2 mg/L DO). 50% anoxic SRT by utilizing swing zone with aeration-off.
300% IR
Max MLSS: 3,600 mg/L based on the state point analysis at the design max day flow, max month loadings

Raw WAS is thickened to 4%, stored in WAS holding tanks (0.18 MG). Raw primary sludge is digested to 7.5%. WAS and PS blended and dewaterd to 20% solids before disposal.

Influent Flows and Loads

Parameter	Flow	Temp	BOD_5		TSS		VSS		TKN		NH3-N		TP	
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day
Maximum Month	**2.70**	**11.00**	143	**3,211**	170	3838	136	3070	29	655	19	432	4.5	101
Maximum Day (100th %)	**3.88**													

Secondary Effluent Quality

Parameter	Flow	Temp	BOD_5		TSS		NH3-N		NOx		TN			
	MGD	C	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day	mg/L	lb/day		
Annual Average														
Maximum Month	**2.70**	**11.00**	**4.0**	90	**12**	270	**0.82**	18	**5.39**	121	**8.1**			
Maximum Day (100th %)	**3.88**													
Peak Hour (100th %)														

Key Process Design Parameters

Parameter		Sludge Production (lbs/day)					Pumping Rates (MGD)				Aeration Requirements			
		Primary Sludge	Waste Activated Sludge	Combined Dewatered Sludge				Waste Activated Sludge	Return Activated Sludge	Internal Nitrate Recycle	Dissolved Oxygen Conc. (mg/l)	Actual Oxygen Required (lbs/day)	Air Flow Rate (scfm)	Assumed SOTE (%)
Annual Average														
Maximum Month		2174	1059	2846				0.0147	1.84	8.1	2	3285	1357	
Maximum Day (100th %)									1.84					
Peak Hour (100th %)														

Activated Sludge Operation - Anaerobic/Aerobic

Parameter	Tank Volumes (mgal)					Mass		SRT (days		HRT (hrs)				
	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration	MLSS	MLVSS	Oxic	Total	Anaerobic	Anoxic	Oxic	Post Anoxic	Re-Aeration
Annual Average														
Maximum Month		0.4053	0.4053			3515	2405	9.00	18.0		3.60	3.60		
Maximum Day (100th %)						3515								
Peak Hour (100th %)														

Secondary Clarifier Operation

Parameter	Design Parameters				
	# of Units Online	Total Surface Area (sf)	Surface Overflow Rate (gal/ft2/day)	Solids loading Rate (lbs/sf-day)	RAS Concentration (mg/l)
Annual Average					
Maximum Month	2	5520	489	24.11	8653
Maximum Day (100th %)				30.38	
Peak Hour (100th %)					

Appendix C
November 2nd, 2021 Aeration Blower Field Report

Trip Report – City of Groton

Date: November 02, 2021
Time of Arrival: 8:10 am

Persons in attendance:
Joseph Pratt – Chief Plant Operator – City of Groton
Emmanuel Prashanth, PE – Project Manager, Wright-Pierce
Joe Damaso – Spencer Service Technician

Purpose of trip: Check coupling alignment, take vibration readings, and to record flow, pressure, ampere, and frequency reading. Visual Inspection.

The Blower room consist of (3) blowers, (1) C474, (2) 7075-HMOD. All Blowers are VFD driven. Blowers have Vibration / Bearing Temperature Probes tied to a Custom Design Electrical Control Panel. Date of Control Panel is 06-28-99. Plant Manager states Control Panel has stop working due to multiple shutdown - tripping alarm. The cause could be due to critical speed on the 4BOB when operating with VFD. Need to check critical speed for 7075-HMOD. The C474 blower ran smooth from start up to 3550 rpm. Blower C474 was Code Tested on 06-16-1999. Blower 7075-HMOD was Code Tested on 06-22-1999. VFD's were quoted on 09-19-2016.

Observations: Blowers are in the basement facility.

- **Control Panel – Low Load Safety Switch; Monitor Vibration plus Bearing Temperature Control.**
- **Inlet / Discharge Control Valves - wide open.**
- **All Blowers have Check Valves.**
- **Pressure Transmitter gauge on discharge piping is not working – Joe was able to tap into discharge pipe and mount Spencer issue pressure gauge.**
- **There was no half coupling on inlet piping to record inlet pressure.**
- **The flow and pressure are control with valves at the basin – discharge throttling. VFD'S are adjusted based on DO levels. Blowers are cycled every 30 minutes.**
- **DO is measured with a probe.**
- **Meter mounted on wall in the Blower room that reads SCFM and Blower discharge temperature – supplied by others.**
- **Pressure transmitter installed at discharge – supplied by others- is not functioning.**
- **Motor Amps and Frequency can be read from upstairs Control Panels.**

Flow Points:

It was not necessary to vary discharge valve position and record (5) flow points. The Blower valves were wide open; flow and pressure are controlled with the basin valves plus change in speed with VFD.

Machine No. 500454 – C474, Cast Blower, 100 Hp Motor, 109 FLA
Flow recorded at the meter: 1955 scfm
Discharge Temperature: 128.2 F.
Blower Inlet Temperature: 53 F., Barometric Pressure: 14.83 psia, 55% RH
Differential Pressure: 7.45 psig
Amps recorded at Control Panel: 69.7 amps
Frequency recorded at Control Panel: 51.97 Hz, 3075 rpm

Note: Performance Curve generated for 53 F. at 3075 rpm. Curve submitted to Joe Pratt, Chief Plant Operator – City of Groton.

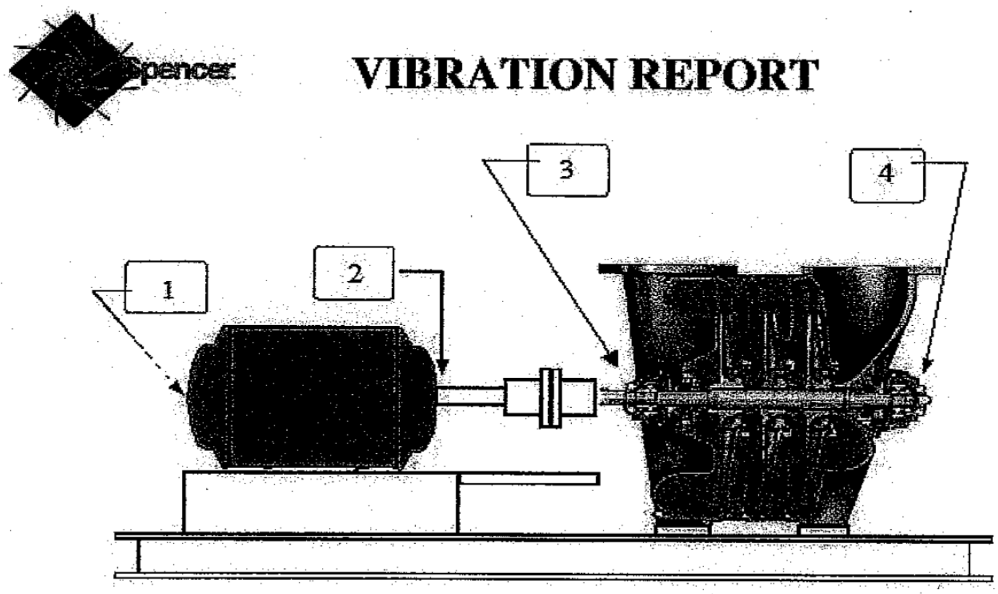
Machine No. 281133 – 7075-HMOD, 4BOB, 75 Hp Motor, 83 FLA
Flow recorded at the meter: 1865 scfm
Discharge Temperature: 166 F.
Blower Inlet Temperature: 53 F., Barometric Pressure: 14.83 psia, 55% RH
Differential Pressure: 7.37 psig
Amps recorded at Control Panel: 81.9 amps
Frequency recorded at Control Panel: 58.75 Hz, 3476 rpm

Machine No. 281134 – 7075-HMOD, 4BOB, 75 Hp Motor, 83 FLA
Flow recorded at the meter: 2050 scfm
Discharge Temperature: 172.2 F.
Blower Inlet Temperature: 53 F., Barometric Pressure: 14.83 psia, 55% RH
Differential Pressure: 7.48 psig
Amps recorded at Control Panel: 81.8 amps
Frequency recorded at Control Panel: 58.90 Hz, 3485 rpm

Note: Performance Curve generated for 53 F. at 3476 rpm. Curve submitted to Joe Pratt, Chief Plant Operator – City of Groton.

Vibration Data: Maximum Allowable is 0.19 in/sec Peak

Machine No. 500454, C474, 4000 Series Cast Blower



Vibration Data	1	2	3	4
Vertical	.03	.03	.05	.03
Horizontal	.05	.06	.06	.05
Axial	.03	.03	.04	.01

Machine No. 281133, 7075-HMOD, 4BOB

Vibration Data	1	2	3	4
Vertical	.03	.03	.05	.03
Horizontal	.05	.06	.06	.05
Axial	.03	.03	.04	.01

Machine No. 281134, 7075-HMOD, 4BOB

Vibration Data	1	2	3	4
Vertical	.12	.18/.19	.08	.19/.05
Horizontal	.06	.06	.11	.06
Axial	.04	.07	.09/.08	.05

Action Items:

- **Summitted new VFD Curves with varying blower inlet temperatures.**
- **Critical Speed for Machine No. 281133-134 is 2733 rpm and shown on the curves.**
- **Change out oil / replace hoses, gaskets, site glasses and oilers on C474 blower.**
- **Rotate coupling on Machine No. 281134 - to reduce vibration in the vertical direction.**
- **Electrical Panel is not in operation. Need Service call.**

Contact:

Joe Pratt – Chief Plant Operator – Groton Utilities
Office: 311 Thames Street, Groton, CT. 06340
T: 860-446-4085
C: 860-460-2793
e-mail: prattj@grotonutilities.com

Prashanth Emmanuel, PE – Project Manager – Wright Pierce
Office: 369 Main Street, 700 Plaza Middlesex, Middletown, CT. 06457
Direct: 860-852-1907
Office: 860-343-8297
e-mail: Prashanth.emmanuel@wright-pierce.com

Others:

Prashanth is the Project Manager evaluating new system requirement for the City of Groton. This will consist of new replacement blowers with up-to-date control features. Pressure – volume is unknown currently. Evaluation timeline is Summer 2021.

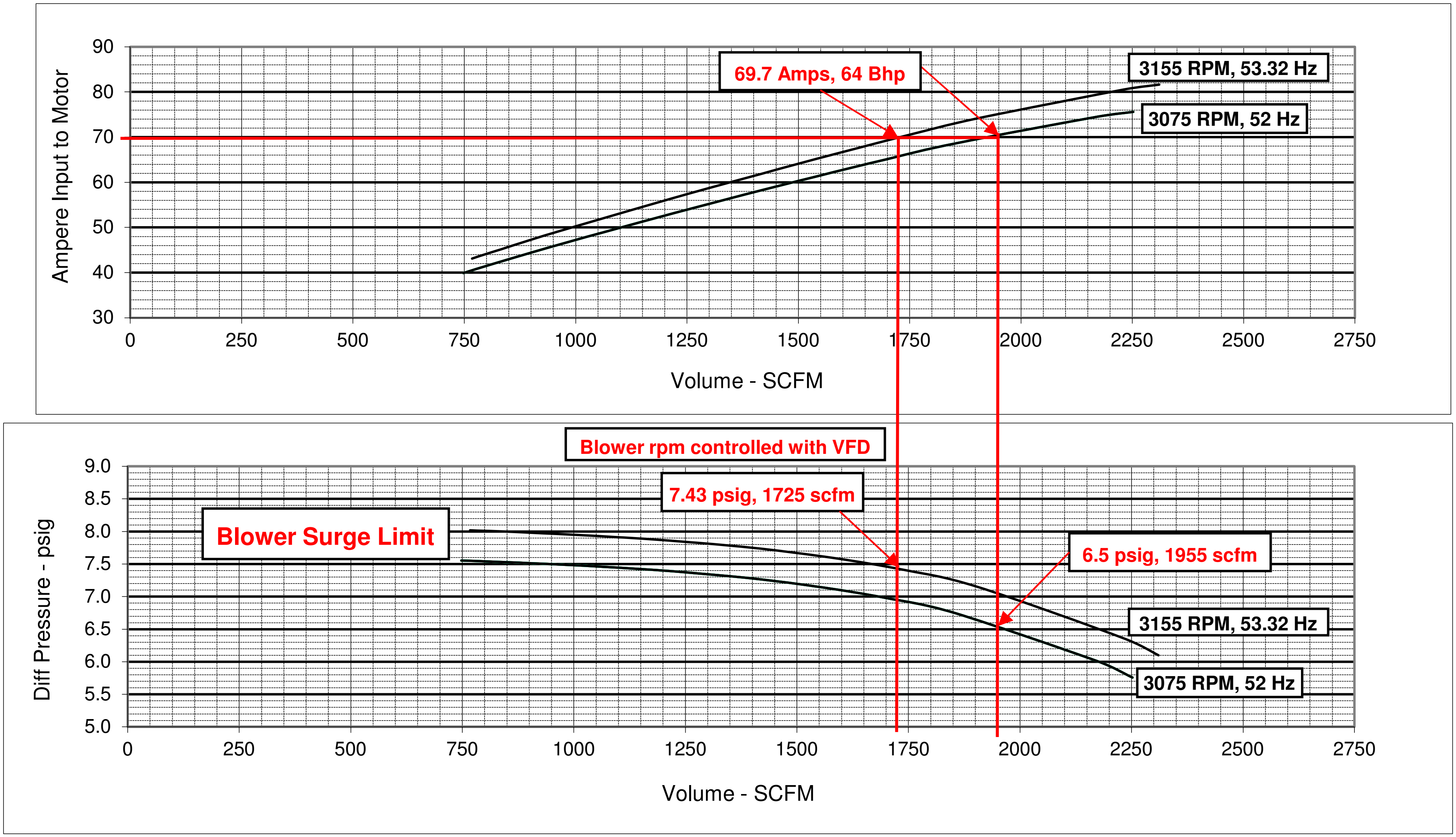
Jacques Heon
Mechanical Engineer
11-05-2021

The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # C474IA1

Rated	1725	SCFM	@	7.43	PSIG
Inlet Temperature	53	Deg. F	S.G.	1.000	
Inlet Pressure	14.49	PSIA	K-Value	1.395	

Motor			
100	HP	3550	RPM
460	Volts	3	Phase
109	F.L.A	60	Hertz



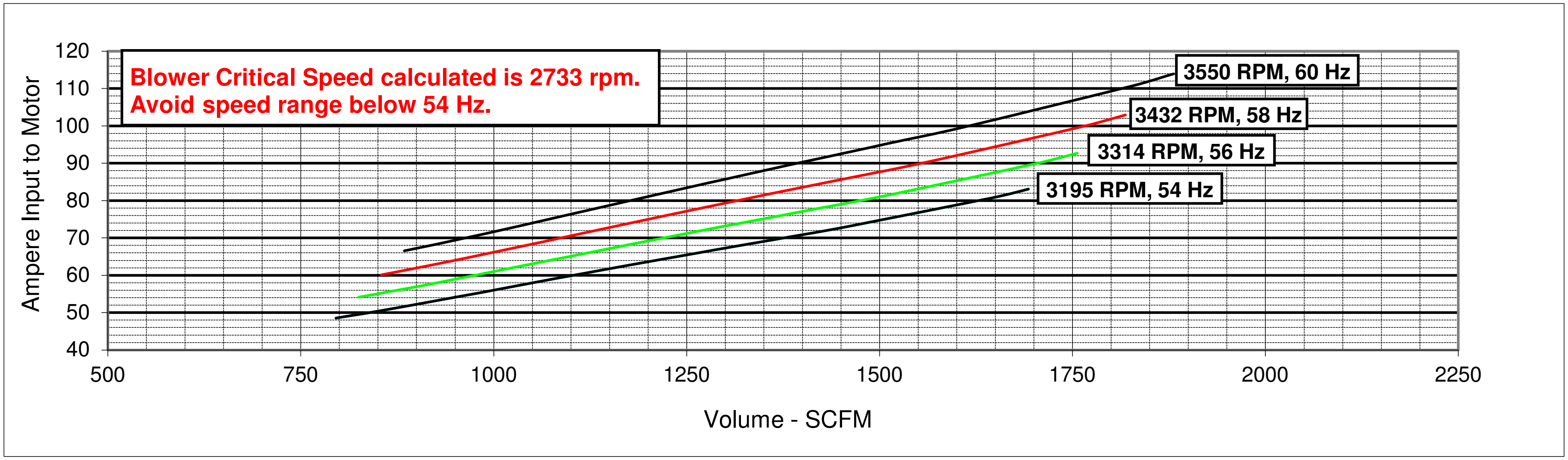
JRH 11/5/2021 MACHINE # 500454

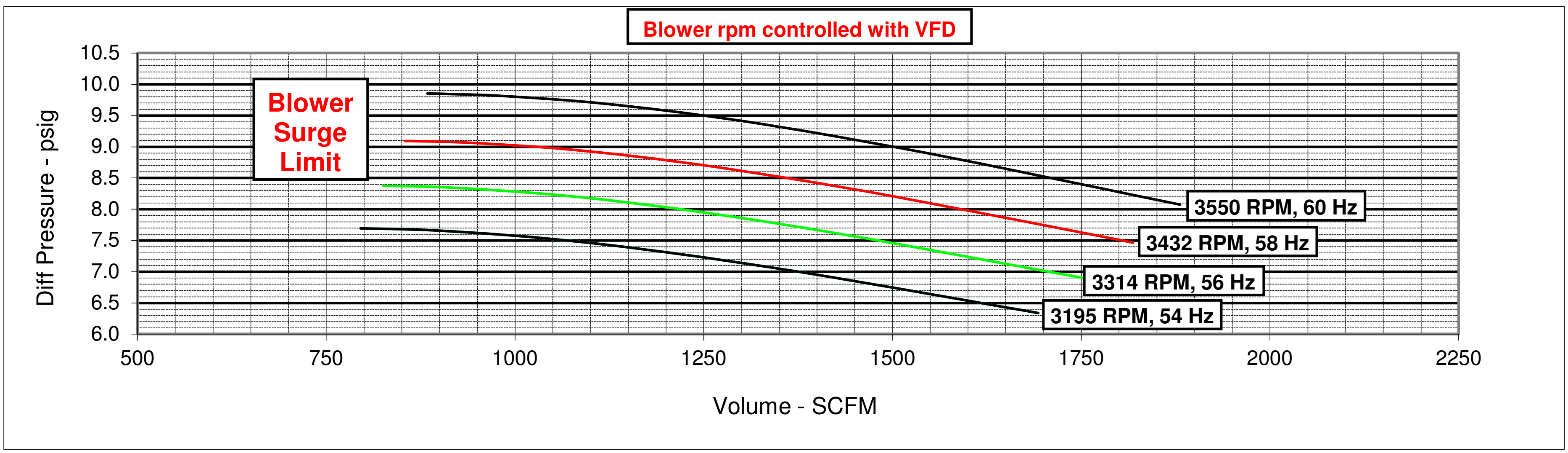
The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # 7075-HMOD

Rated	1000	SCFM	@	9.80	PSIG
Inlet Temperature	0	Deg. F	S.G.	1.003	
Inlet Pressure	14.49	PSIA	K-Value	1.396	

Motor			
75	HP	3550	RPM
460	Volts	3	Phase
83	F.L.A	60	Hertz





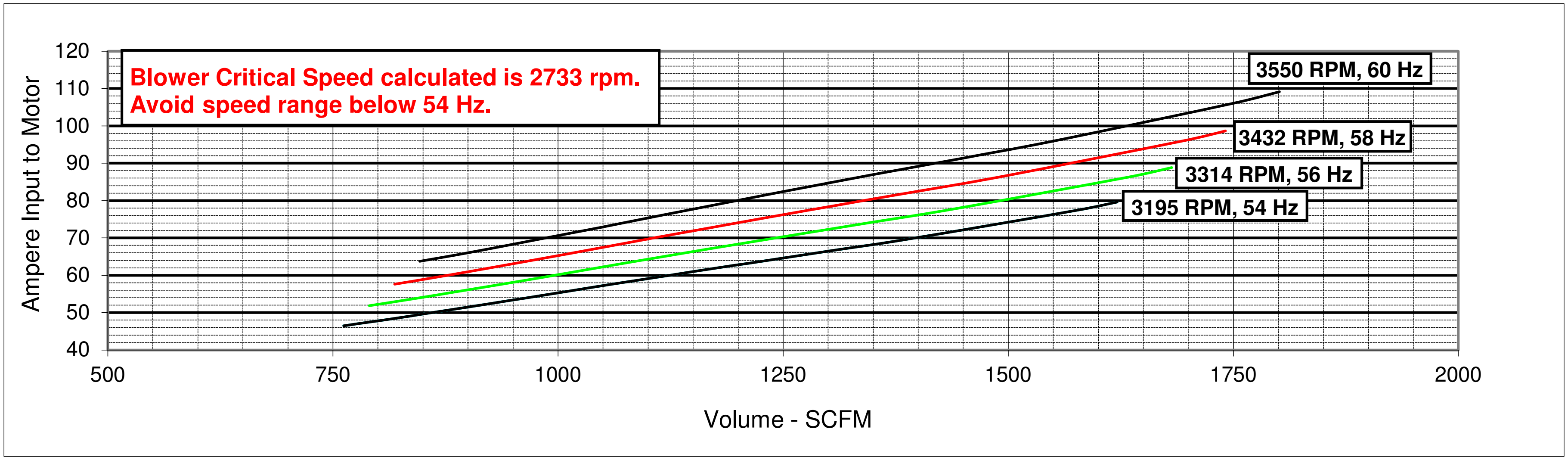
JRH 11/5/2021 MACHINE # 281133-134

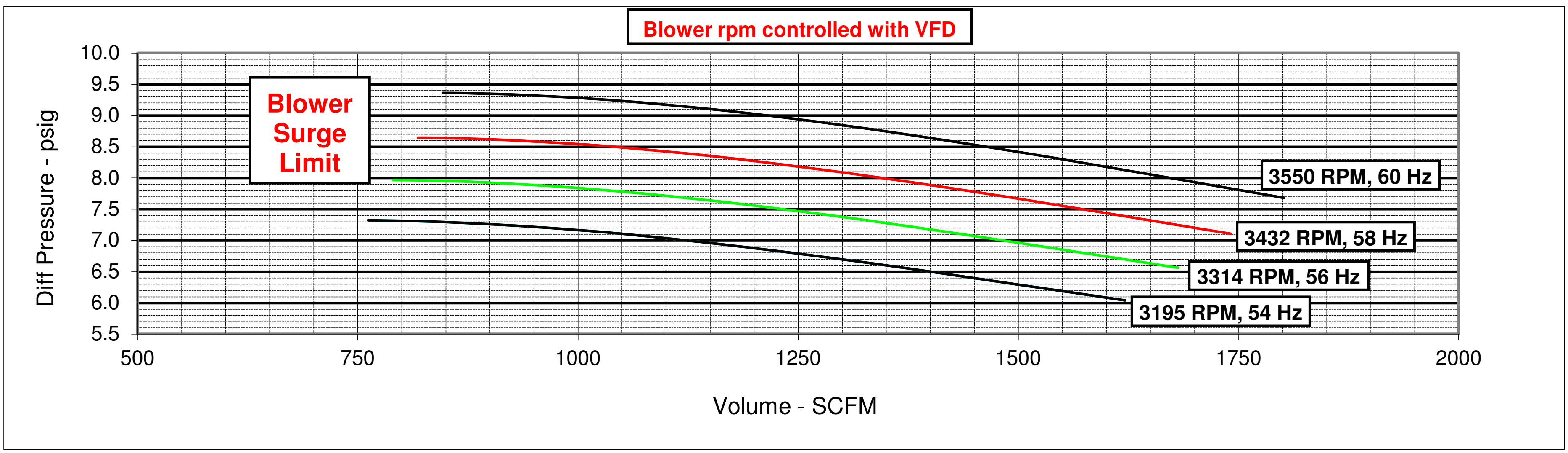
The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # 7075-HMOD

Rated	1000	SCFM	@	9.28	PSIG
Inlet Temperature	20	Deg. F	S.G.	1.003	
Inlet Pressure	14.49	PSIA	K-Value	1.396	

Motor			
75	HP	3550	RPM
460	Volts	3	Phase
83	F.L.A	60	Hertz





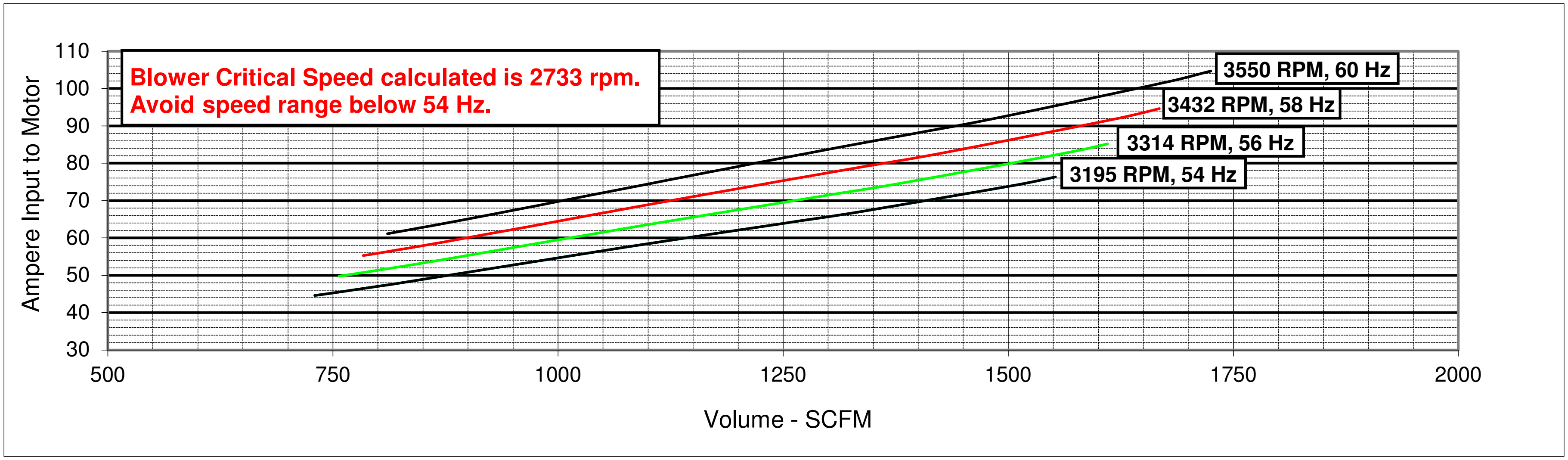
JRH 11/5/2021 MACHINE # 281133-134

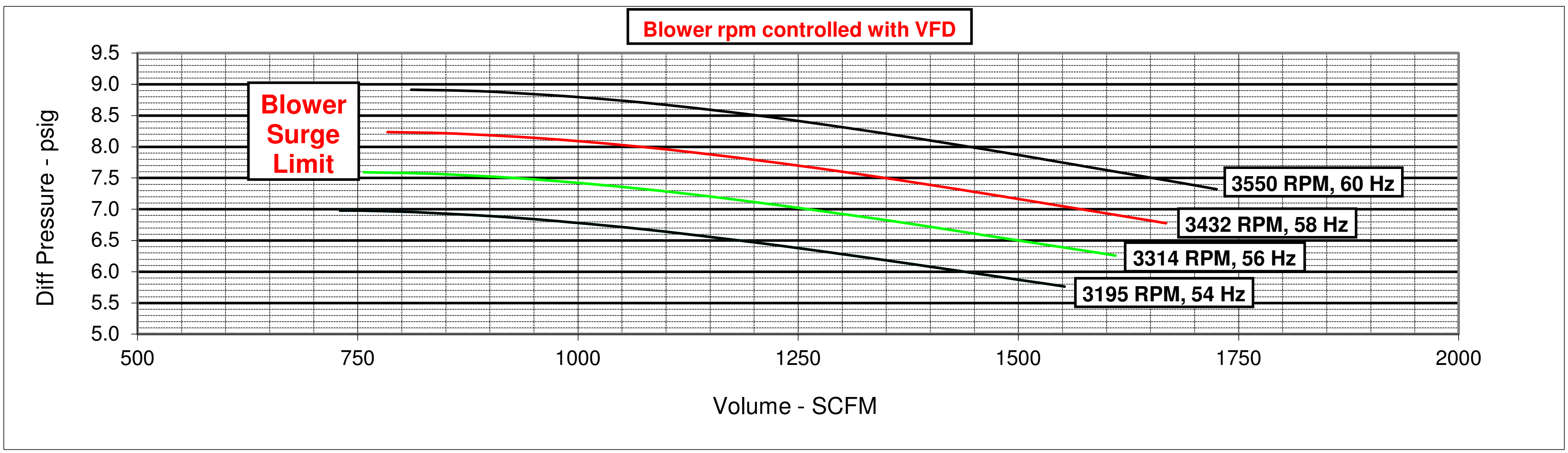
The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # 7075-HMOD

Rated	1000	SCFM	@	8.80	PSIG
Inlet Temperature	40	Deg. F	S.G.	1.002	
Inlet Pressure	14.49	PSIA	K-Value	1.395	

Motor			
75	HP	3550	RPM
460	Volts	3	Phase
83	F.L.A	60	Hertz





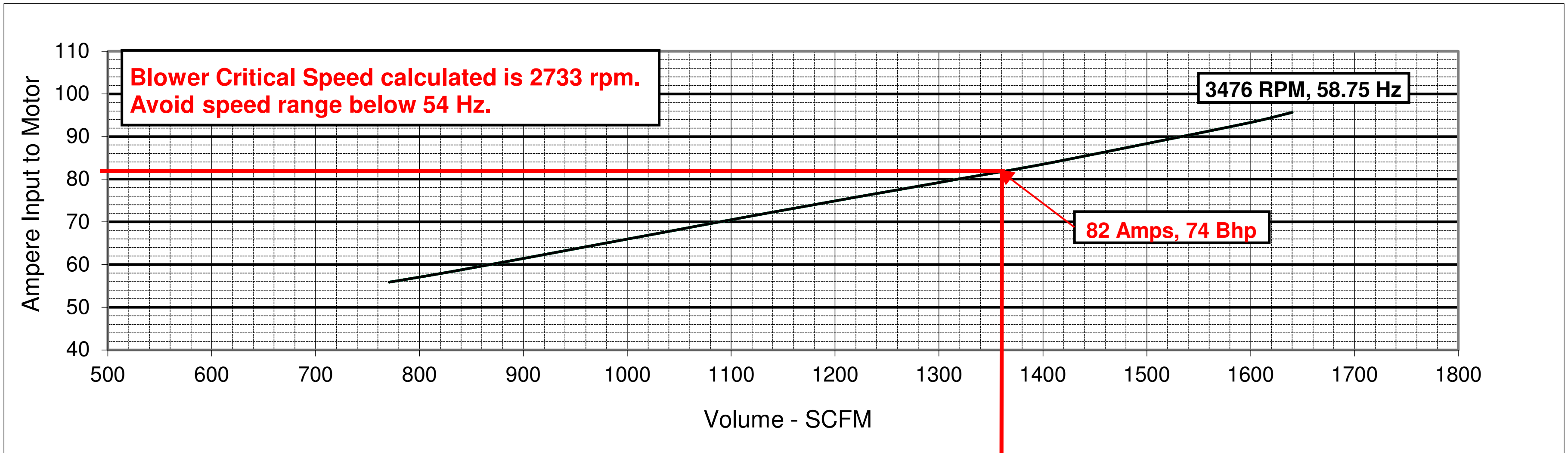
JRH 11/5/2021 MACHINE # 281133-134

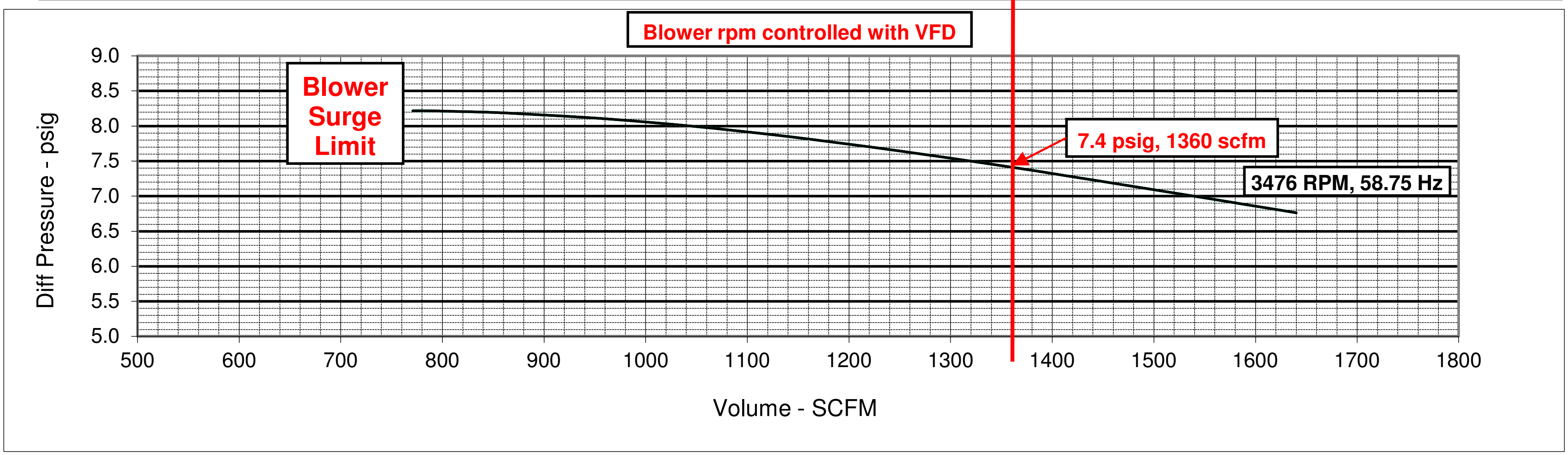
The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # 7075-HMOD

Rated	1000	SCFM	@	8.05	PSIG
Inlet Temperature	53	Deg. F	S.G.	1.000	
Inlet Pressure	14.49	PSIA	K-Value	1.395	

Motor			
75	HP	3550	RPM
460	Volts	3	Phase
83	F.L.A	60	Hertz





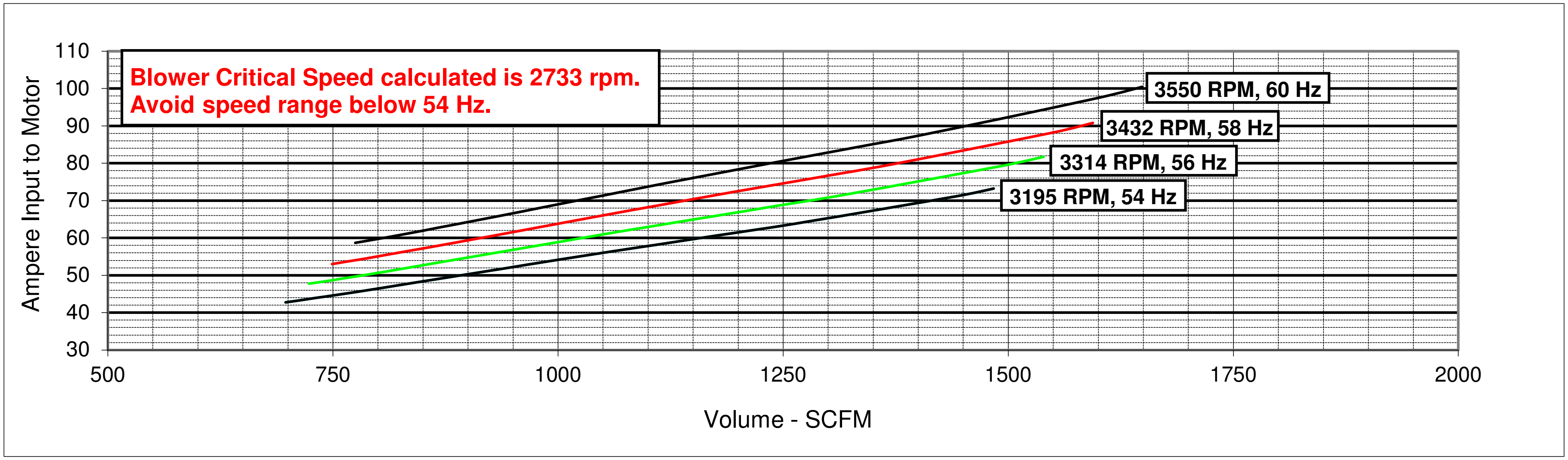
JRH 11/5/2021 MACHINE # 281133-134

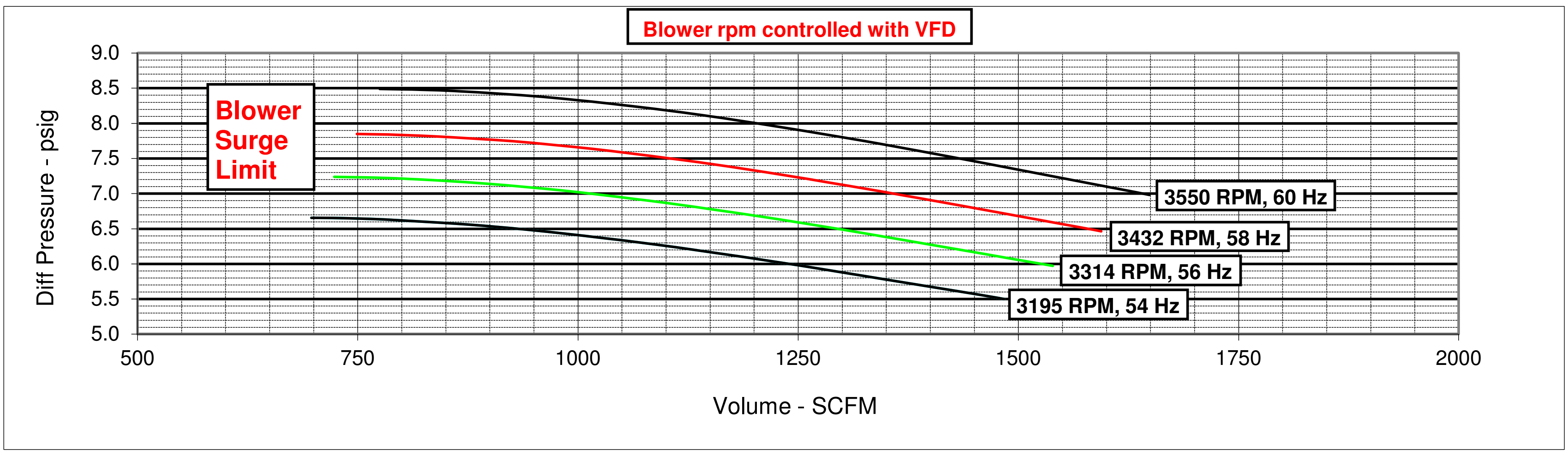
The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # 7075-HMOD

Rated	1000	SCFM	@	8.33	PSIG
Inlet Temperature	60	Deg. F	S.G.	0.999	
Inlet Pressure	14.49	PSIA	K-Value	1.395	

Motor			
75	HP	3550	RPM
460	Volts	3	Phase
83	F.L.A	60	Hertz





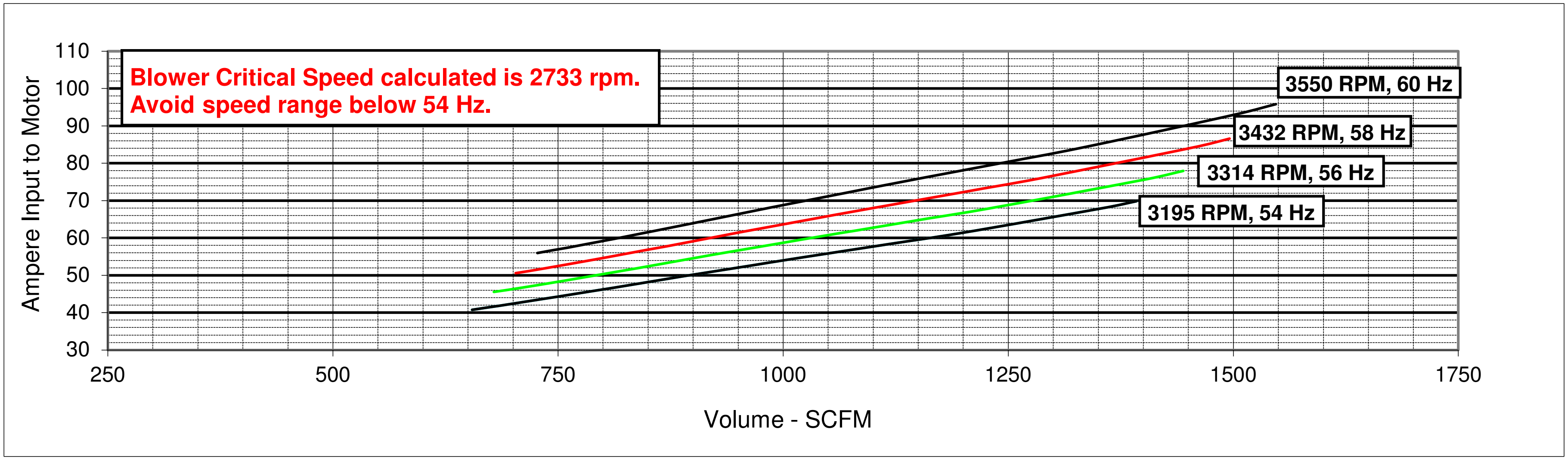
JRH 11/5/2021 MACHINE # 281133-134

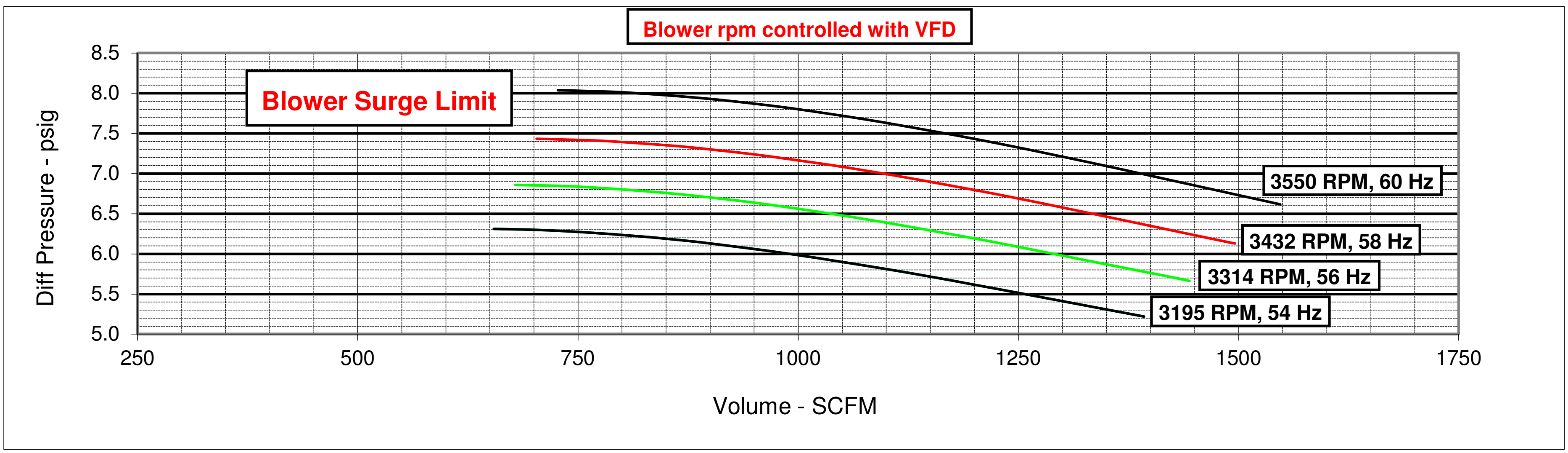
The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # 7075-HMOD

Rated	1000	SCFM	@	7.80	PSIG
Inlet Temperature	80	Deg. F	S.G.	0.990	
Inlet Pressure	14.49	PSIA	K-Value	1.392	

Motor			
75	HP	3550	RPM
460	Volts	3	Phase
83	F.L.A	60	Hertz





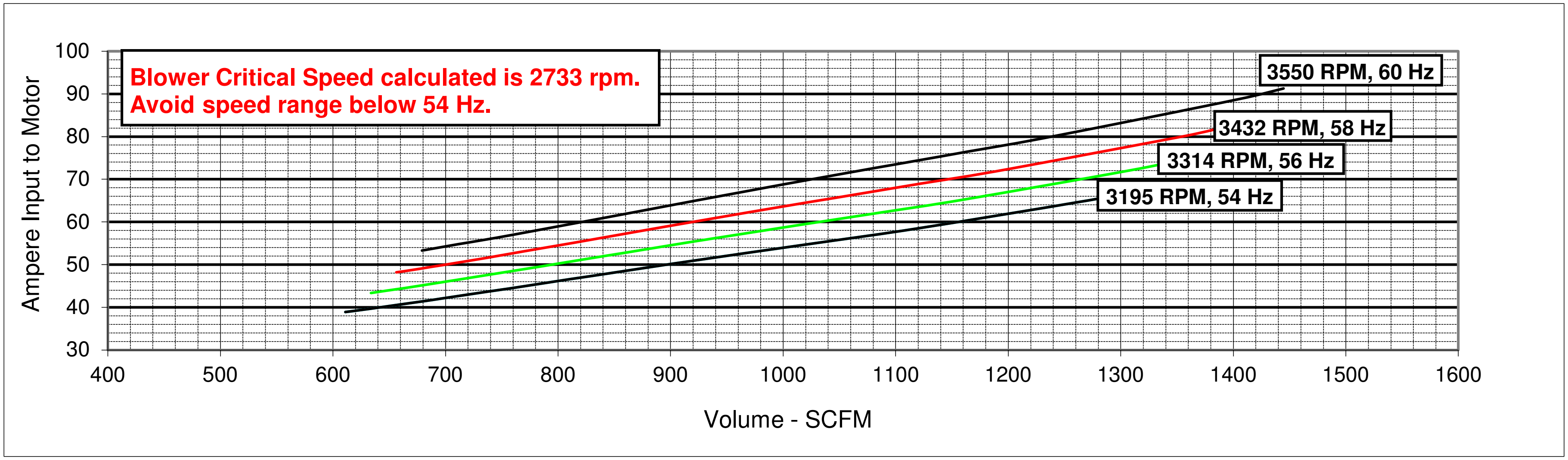
JRH 11/5/2021 MACHINE # 281133-134

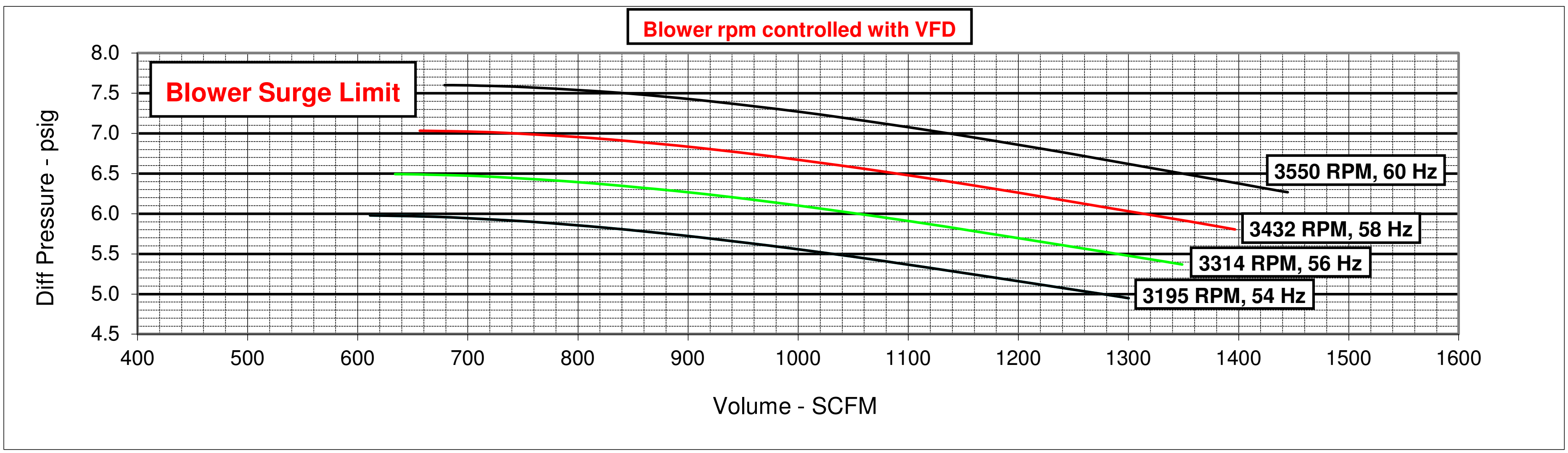
The Spencer Turbine Co., Windsor, CT, U.S.A.

PERFORMANCE CURVE OF A SPENCER MODEL # 7075-HMOD

Rated	1000	SCFM	@	7.27	PSIG
Inlet Temperature	100	Deg. F	S.G.	0.978	
Inlet Pressure	14.49	PSIA	K-Value	1.389	

Motor			
75	HP	3550	RPM
460	Volts	3	Phase
83	F.L.A	60	Hertz





JRH 11/5/2021 MACHINE # 281133-134

Appendix D
Building Services On-Site Field Evaluation Memoranda

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	Dennis Dievert	**DATE:**	11/5/2021
FROM:	Dan Harazim	**PROJECT NO.:**	20653
SUBJECT:	Groton Utilities Wastewater Treatment Facility Plan, Groton, CT		

INTRODUCTION

The following write-up describes the architectural/building aspects of the Groton Utilities Wastewater Treatment Facility in Groton, CT.

GENERAL ARCHITECTURAL

General Description

The Groton Utilities Wastewater Treatment Facility consists of multiple buildings and structures required to treat wastewater for the City of Groton.

The Operations Building and adjacent Sludge Digester Building were constructed in 1955 as part of the original treatment plant. The Blower Building and Digester Building were constructed in 1972 as part of the secondary treatment facilities.

With the exception of a metal storage building adjacent to the Digester Building, the buildings are all of steel and concrete framing, with masonry walls of concrete block and brick veneer, with flat roofs.

Governing Codes

Connecticut State Building Code (CSBC):

2015 International Building Code (IBC)

2015 International Existing Building Code (IEBC)

2015 International Plumbing Code (IPC)

2015 International Mechanical Code (IMC)

2015 International Energy Conservation Code (IECC)

2017 National Electrical Code (NFPA 70) (IEC)

2009 ICC A117.1 Accessible and Usable Buildings & Facilities

Existing Code Implications

Work in existing buildings is governed by the International Existing Building Code. The existing building code classifies work in existing buildings in 6 categories; Repairs, Alteration – Level 1, Alteration – Level 2, Alteration – Level 3, Change of Occupancy and Additions. Following is a summary of how these classifications are defined and basic implications of each classification to the project:

Repairs: Fixing or replacing damaged materials. Replacement materials must comply with the building code.

Alteration – Level 1: Replacement of existing materials and equipment with new that serves the same purpose. New materials and equipment must comply with the building and energy codes.

Alteration – Level 2: Reconfiguration of space (where the Work Area is under 50%), addition/elimination of doors and windows, extension of existing systems or installing additional equipment. Modifications must comply with the building, energy and accessibility codes and cannot worsen means of egress. Other items required include:

> Providing automatic sprinkler systems where required by the building code for new buildings, including in windowless stories greater than 1500 sf.
>
> Providing guards at openings in work areas.

Alteration – Level 3: Where the Work Area is greater than 50%. Work Area is defined as the portion of the building where space is reconfigured. If other sections of the Existing Building Code requires reconfiguration of space, this reconfiguration does not count towards the Work Area. Modifications must comply with requirements for Level 2 Alterations plus additional items including:

> Enclosing stairs.
>
> Enclosing shafts and floor openings.
>
> Providing the number of exits required per current code.
>
> Providing doors that swing in the direction of travel for areas with an occupant load over 50.

Change of Use: Where the use or occupancy classification of a building is changed modifications must comply with requirements for Level 2 and 3 Alterations. If the new use is required to be accessible, the building must also be made accessible.

Generally, the energy code does not require updating existing buildings to current energy codes. New work and items must meet current energy codes if possible. If a building currently has a vestibule, the vestibule must remain or a new one provided. If any space changes from an unconditioned space to a conditioned space, the envelope of the space must be updated to meet the envelop requirements of the energy code.

OPERATIONS BUILDING

The Operations Building is a 74' long by 61' wide 1-story, flat roofed building completed in 1955. It is about 15' tall, with an additional 5' tall roof monitor over a portion of the building. The roof is EPDM on concrete decking.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Structure	The structure is a cast-in-place concrete foundation, and steel structural frame with cast-in-place concrete slabs.
Walls	The exterior walls consist of concrete block backup walls with exterior face brick. Based on the original construction drawings and in keeping with common practice of the time, there is no cavity space and the walls are uninsulated. The walls are in fair condition but require some repair work. **Clean** the brick veneer. **Repoint** a percentage of the masonry joints. **Replace** all sealants at control joints and openings. **Repair/Reconstruct** brick corners where there is brick cracking and evidence of settlement in the corners.
Windows	The original windows were replaced in the 2000 renovation and are aluminum with insulated glazing. They are in fair condition, but the sealants need **replacement**. Existing glass block windows are in fair condition, but need **new sealants and selective repointing.** Existing lintels show evidence of rust; lintels and flashings should be evaluated and replaced/repaired as necessary.
Doors	The existing doors and frames are aluminum at the headworks space and hollow metal in the office space. The doors and framing are in fair condition however there is some rust in the hardware and the doors should be **replaced** as part of any envelope renovations.
Hardware	The exterior doors have knobs and should be **replaced**.
Louvers	The louvers are painted metal and are in fair condition. **Repaint and recaulk.**
Roofing	The roofing is EPDM and should be reviewed for **replacement**. The metal wall flashings are original to the building and are built in. They were bent back and replaced with the last roofing replacement, and should be carefully **evaluated** as part of any roof replacement.
Edge Trim	The gravel stop/fascia is metal with a baked on, dark brown finish and is in good condition. It would be **replaced** as part of any reroofing project. **Prepare and paint** exposed concrete surfaces at walls and soffits.

Interior:

Walls	The interior partitions are a combination of glazed concrete block and painted concrete block. The walls currently painted will be **repainted**. Office spaces have painted gypsum board, which should be **repainted.**
Doors	Existing doors are a combination of painted hollow metal doors and frames and mill-finish aluminum doors and frames, and are in fair condition. The hollow metal doors and frames will be **repainted,** and the aluminum doors and frames will be **cleaned and repaired**. All sealants will be **replaced**.
Hardware	Door hardware is a mix of knob and lever handles, and is of varying states of repair. **Replace** all hardware.
Floors	The staff spaces have VCT flooring which is still serviceable. The wall base should be **replaced**. Floors in the workshop and pump spaces are concrete with a paint or epoxy finish. Existing concrete floors should be **prepared and refinished.**
Ceilings	The existing suspended acoustical tile in the office/lab area is aged. Tiles are sagging, some are missing and some are stained due to roof leaks. **Replace** with new tegular edged, second look acoustical ceiling tiles and new lighting. **Replace** ceiling registers. Existing concrete ceilings in shop/headworks spaces to be **prepared and painted.**

Space Improvements (TBD)

BLOWER BUILDING

The Blower Building is a 64' long by 42' wide 1-story, flat roofed building completed in 1972. It is about 14' tall. The roof is ballasted EPDM on concrete decking.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Structure	The structure is a cast-in-place concrete foundation, and steel structural frame with cast-in-place concrete slabs.
Walls	The exterior walls consist of concrete block backup walls with exterior face brick. Based on the original construction drawings and in keeping with common practice of the time, there is no cavity space and the walls are uninsulated. The walls are in fair condition but require some repair work. **Clean** the brick veneer. **Repoint** a percentage of the masonry joints. **Replace** all sealants at control joints and openings.
Windows	The windows are original to the building. They are single glazed, and showing signs of deterioration. Windows facing south have rolling storm shutters of

recent vintage. **Replace** windows with new thermally broken aluminum windows with appropriate hurricane rating.

Doors — The existing doors and frames are a variety of hollow metal and aluminum. The aluminum doors and frames are part of the window system. The hollow metal doors and framing are in fair condition, however there is some rust in the hardware and the doors should be **replaced** as part of any envelope renovations. Some existing steel lintels show evidence of rust; lintels and flashings should be evaluated and replaced/repaired as necessary. **Replace** overhead coiling door.

Hardware — The exterior doors have knobs and should be **replaced** with lever handle locksets.

Louvers — The louvers are integral to the window units and should be **replaced** as part of the window replacement.

Roofing — The roofing is ballasted EPDM and should be reviewed for **replacement**.

Edge Trim — The gravel stop/fascia is metal with a baked on, dark brown finish and is in fair condition. It would be **replaced** as part of any reroofing project. **Prepare and paint** exposed concrete surfaces at walls and soffits.

Interior:

Walls — The interior partitions are glazed or painted concrete block and are in fair condition. The inside of the exterior walls are painted CMU and in fair condition. Unglazed walls will be **repainted**. There is evidence of leakage on the basement walls and the basement CMU is unfinished.

Doors — Existing doors are painted hollow metal doors and frames and are in fair condition. The doors will be **repainted.**

Hardware — The bathrooms have pulls and the remaining doors have knobs. **Replace** door knobs with lever-handle hardware. **Review** all other hardware for replacement.

Floors — The offices and corridors are VCT and are still serviceable. The locker room and toilet areas are porcelain tile date to the 2016 renovations and are still serviceable.

Ceilings — The existing suspended acoustical tile is servicable. Some panels to be **replaced**. **Replace** lighting.

DIGESTER BUILDING

The Digester Building is a 110’ long by 43’ wide 2-story, flat roofed building completed in 1972 as part of the Blower Building project, and shares many of its characteristics. It is about 25’ tall. The roof is EPDM on concrete decking.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Structure	The structure is a cast-in-place concrete foundation, and steel structural frame with cast-in-place concrete slabs. The structural walls of the two digester tanks are of poured concrete.
Walls	The exterior walls of the digester tanks consist of poured concrete walls with exterior face brick. Based on the original construction drawings, the south tank is insulated and the north tank is not. The walls are in fair condition but require some repair work. **Clean** the brick veneer and cast stone belt coursing. **Repoint** a percentage of the masonry joints. **Replace** all sealants at control joints and openings. **Inspect** roof coping stones and flashings, **reset** selected stones and **replace** joint sealants. **Repair** cracks in walls at roof bulkhead. **Investigate** rust visible at steel angles supporting roof bulkhead walls.
Windows	The windows are original to the building and consist of two curtainwall assemblies with doors and louvers. They are single glazed with a mill-finish. The frames signs of wear and deterioration and sealant joints throughout are failing. **Replace** with new thermally broken aluminum curtain wall assemblies with appropriate hurricane rating. **Replace** window at roof bulkhead and **inspect** lintel for rust and decomposition.
Doors	The aluminum doors and frames are part of the curtainwall system. **Replace** doors with new thermally broken aluminum doors.
Hardware	New doors to receive new hardware.
Louvers	The louvers are integral to the window units and should be **replaced** as part of the curtainwall replacement.
Roofing	The roofing is EPDM and all roofing and flashings should be reviewed for **replacement**. The east curtainwall has a projecting roof where the soffit shows significant rusting, indicating a roof leak that should be located and repaired immediately. **Replace** lower roof soffit.
Edge Trim	The digester tanks have cast stone copings with metal flashing beneath (see Walls above). The gravel stop/fascia over the support section of the building is metal with a baked-on dark brown finish and is in fair condition. It would be **replaced** as part of any reroofing project. **Prepare and paint** exposed concrete surfaces at walls and soffits.

Interior:

Walls	Interior walls are exposed painted concrete or painted concrete block and are in good condition. All walls and exposed structural steel framing will be **repainted.**
Doors	**Replace** stair bulkhead door.
Hardware	**Replace** door hardware as part of door replacement.
Floors	Existing aluminum gratings and railings are in good condition. Concrete floor at basement level to be **prepared and recoated.**
Ceilings	**Prepare and paint** existing roof deck and steel framing.

SLUDGE STORAGE BUILDING

The Sludge Storage Building is a 96' long by 36' wide 2-story, flat roofed building completed in 1955 as part of the Operations Building project, and shares many of its characteristics. It is about 18' tall. The roof is EPDM on concrete decking.

Existing Materials/Conditions/Modifications/Repairs

Exterior:

Structure	The structure is a cast-in-place concrete foundation, and steel structural frame with cast-in-place concrete slabs. The structural walls of the two thickening tanks are of poured concrete.
Walls	The exterior walls of the digester tanks consist of poured concrete walls with exterior face brick. The walls are in fair condition but require some repair work. **Clean** the brick veneer and cast stone belt coursing. **Repoint** a percentage of the masonry joints. **Replace** all sealants at control joints and openings. **Inspect** roof copings and flashings, **reset** selected stones and **replace** joint sealants.
Windows	The windows are original to the building. They are single glazed aluminum with a mill-finish. The frames signs of wear and deterioration and sealant joints throughout are failing. The units at the roof bulkhead have been painted and 4 units on the south side have been boarded over. **Replace** with new thermally broken aluminum windows. **Inspect** lintels for rust and decomposition.
Doors	The existing doors are original to the building and show advanced aging. **Replace** doors with new thermally broken aluminum doors.
Hardware	New doors to receive new hardware.
Louvers	Louvers are should be **replaced** as part of the brick wall repairs.

Roofing	The roofing is EPDM and all roofing and flashings should be reviewed for **replacement**. On the day of WP's site visit, there were areas of exceptional bubbling in the roof membrane. The north entry has a roof canopy that is covered in moss and organic material. **Replace** roofing and canopy soffit.
Edge Trim	The straight parapets have cast stone copings with metal flashing beneath. Existing joints between stones should be replaced with new sealant. The gutters and drains at the holding tanks should be inspected for leakage.

<u>Interior</u>:

Walls	Interior walls are exposed painted concrete or exposed unpainted brick and are in good condition. All concrete walls and exposed structural steel framing will be **repainted.**
Doors	**Replace** stair bulkhead door.
Hardware	**Replace** door hardware as part of door replacement.
Floors	Existing aluminum gratings and railings are in good condition. **Repaint** all metal surfaces. Concrete floor at basement level to be **prepared and recoated.**
Ceilings	**Prepare and paint** existing roof deck and steel framing.

GENERATOR BUILDING

The Generator Building is a flat roofed, CMU building with a brick façade completed in 2003. There is limited information on this building. It is in good condition and the interior CMU walls are unfinished.

CODE SUMMARY

Use Group/Occupancy Classification/Construction Types/Heights and Areas

Operations Building

F-1, Moderate Hazard Factory Industrial (CSBC 306.2)

Industrial, Special Purpose Industrial Occupancy (NFPA 101 40.1.2.1.2)

II-B Construction Type (CSBC 602.2)

55-feet, 2-stories and 15,500 square feet allowed (CSBC Chapter 5)

<25-feet, 1-story and 4,500 square feet actual

Blower Building

F-1, Moderate Hazard Factory Industrial (CSBC 306.2)

Industrial, Special Purpose Industrial Occupancy (NFPA 101 40.1.2.1.2)

II-B Construction Type (CSBC 602.2)

55-feet, 2-stories and 15,500 square feet allowed (CSBC Chapter 5)

<25-feet, 1-story and 2,700 square feet actual

Digester Building

F-1, Moderate Hazard Factory Industrial (CSBC 306.2)

Industrial, Special Purpose Industrial Occupancy (NFPA 101 40.1.2.1.2)

II-B Construction Type (CSBC 602.2)

55-feet, 2-stories and 15,500 square feet allowed (CSBC Chapter 5)

<25-feet, 2-stories and 4,200 square feet actual

Sludge Storage Building

F-1, Moderate Hazard Factory Industrial (CSBC 306.2)

Industrial, Special Purpose Industrial Occupancy (NFPA 101 40.1.2.1.2)

II-B Construction Type (CSBC 602.2)

55-feet, 2-stories and 15,500 square feet allowed (CSBC Chapter 5)

<25-feet, 2-stories and 3,200 square feet actual

Generator Building

TBD - Original design drawings are needed to confirm.

Fire Resistance Requirements of Building Elements

For Construction Type II-B, Structural Elements, Walls and Roof Construction must be of noncombustible materials permitted by the code and is not required to have a fire rating (CSBC 602.2).

Fire Separation Distance

Buildings on the same lot which are considered separate buildings must meet CSBC Table 602, Fire-Resistance Rating Requirements for Exterior Walls Based on Fire Separation Distance. An imaginary lot line shall be designated between the two buildings (CSBC 705.3). When buildings of II-B Construction Type and F-1 occupancy are at least 10-feet from this line, walls can have a 0-hour rating and are limited to a total opening area of 15% of the wall area. (CSBC Tables 602 and 705.8).

Sprinklers

Sprinklers are not required in F-1 occupancies of 12,000 square feet or less (CSBC 903.2.4).

Fire Extinguishers

Fire Extinguishers will be provided in accordance with NFPA and CSBC 906.

Energy Conservation Climate Zone

The Energy Conservation Climate Zone of Connecticut is 5A (IECC Table C301.1).

Building Envelope Requirements for Conditioned Buildings

Any new building envelope work will be insulated in accordance with CSBC Tables C402.1.3 and C402.1.4. Fenestration U-factors and SHGC values for any new windows will be in accordance with CSBC Table C402.4. Any new air barriers will be in accordance with CSBC C204.5.

WRIGHT-PIERCE
Engineering a Better Environment

Memorandum

Date: **10/14/2021**

Project No.: **20653/A.11**

To: **Dennis Dievert, File**

From: **Mark W Cunningham**

Subject: **Groton Utilities WWTF Facility Plan Inspection – Structural**

Introduction

This memo describes structural issues observed at the WWTF during a site visit on October 12, 2021 and provides comments pertaining to the underwater pile inspection report by others. Attending the site visit were Will Edgerton and Dan Harazim. Some information in this memo was garnered from Joe Pratt, Plant Superintendent. [See corresponding photo file.]

Piles

WP was not involved with the pile inspection. In 2020 the piles were inspected by divers and a report was provided, "2020 PILE INSPECTION OF THE 1969 PAF PLANT EXTENSION INTO THE RIVER," dated June 12, 2020. W-P was asked to review and comment on the report.

Per the report, the east half of the site built in the early 1950's "…was constructed on an existing sloped surface extending into the river…[and]…extended mostly through hardpan soil down to a location within the hardpan that is assumed to be at a depth location where proper bearing strength was developed". The west half of the site, comprising the Secondary Treatment Facilities, was constructed around 1972 on a 2'-6" thick reinforced concrete slab supported on approximately 530 concrete-filled steel pipe piles. The pile report indicates that the pipe piles were installed as pressure-injected footings (i.e., Franki piles). However, the original project specifications indicate this pile type was an acceptable alternative to closed end, driven, concrete filled steel pipe piles that were also specified. The pile detail on the original drawings and included in the pile report indicates the latter type. Pressure injected footings are constructed by pounding concrete through an open-ended steel pipe, densifying the surrounding soil, and creating a bulb of concrete (i.e., the "pressure injected footing") at the tip. It is unknown if the existing piles are pressure-injected footings or closed end, driven, concrete filled steel pipe piles. This would be difficult to ascertain because in either case the ends of the piles are embedded in the soil at an unknown depth.

The report does not indicate that the diameter of the piles was measured. The diameter of the piles could be determined by measuring their circumference. The outside diameter shown on the plans is 14-inches.

At some piles, there was observed to be an approximate 2" high gap around the top of the pile beneath the concrete slab. "It was assumed that these small gaps were there from original casting of the pile cap and did not present any current structural issues." The detail on the drawings shows the top of the steel pipe to be embedded 4" into the bottom of the concrete slab. It is possible that the top of the pipe was cut off a few inches too low prior to placing the slab, and therefore required forming the concrete between the top of the pipe and the bottom of the slab, resulting in the gaps observed.

Except for eight of them, the piles were found to be coated and "…the coating was in overall good condition for the vast majority of piles". "Eight (8) piles along the north end of the building were not coated or the coating had failed with about ½" loss of thickness." It is unclear if the loss is typical throughout each pile or is the maximum. Also, such estimated loss exceeds the wall thickness indicated on the typical pile detail on the design drawings of 5/16". It is possible that the design pipe thickness was changed if pressure-injected footings were used instead of the closed-ended driven piles shown on the plan. Regardless, such significant section loss is of concern because the steel pipe and concrete function compositely to resist loads, and the steel pipe also confines the concrete from failing. The detail on the design drawing shows steel reinforcement dowels extending from the slab into the top of the pile about 3 feet, below which the concrete is unreinforced. The report indicates that at the northwest corner the piles extend only 76 inches (6'-4") from the bottom of the slab to the river bottom, and that for piles toward the east this dimension is reduced. It is good that the laterally unsupported length of the piles is quite short and given the large number of piles, lateral loading should not be of concern. However, the report recommends another inspection in 5 years, at which time these items should be further investigated and photographs provided.

Concrete Linings

Joe Pratt, Plant Superintendent, said that they aren't having any problems in areas where the concrete was lined in 2015: Aeration Tank Mix Chamber (at southeast corner of Aeration Tanks), Primary Settling Effluent Chamber (at Blower Building), Digester Overflow Boxes, and Primary Settling Tanks 1&2 and 3&4. Initially one location of Primary Settling Tank 2 failed by peeling away from the wall and was subsequently repaired. A few of the numerous Primary Settling Tank access plates were opened and no issues with the lining were observed. Joe Pratt said that personnel periodically clean these areas and would notice if there were any problems. Given this, and that all areas were in service and covered at the time of inspection, further inspections were considered unwarranted.

Aeration Tanks 1&2

The 2013 Phase I Improvement drawings by Tighe & Bond include some concrete repairs at the Aeration tanks. Some repairs weren't readily evident or were not performed. The west tank was drained for non-entry inspection and was viewed from above. There was standing water at the bottom of the tank around the diffusers. The east tank was full.

The weir plate at the north end is moderately corroded [photos 1, 2]. The aluminum guards around the tanks are approximately 36" high, and although they don't meet the current OSHA requirement of 3'-6", compliance through "grandfathering" is assumed. They also don't have a toe plate, which is typically desirable, although not a code requirement. The guards facing the river comprise large cast aluminum posts typically spaced 10-feet apart, with aluminum rails and mesh infill. These guards are approximately 3'-6" tall and without a toe plate, with a clear space of about 5.25-inches at the bottom.

The concrete walkways show moderate surface scaling throughout with exposed fine and some coarse aggregate [photo 3]. Much of the walkway shows discoloration at old fine map-cracking that appears dormant. A few wider cracks also appear to be dormant. The southwest corner of the walkway surface, an area of approximately 4-feet x 4-feet, is hollow and is expected to eventually spall. The 2013 drawings describe this as a spall to be repaired but it was clearly not repaired. Most sealant in walkway joints and cracks appears to have exceeded its service life, showing separation from concrete and some cracking [photos 4, 5]. Ideally, the sealant should be replaced. However, the potential for PCB contamination should be carefully considered before any testing, as it can have significant cost implications. (The 2013 drawings indicate replacement of the sealant, but it does not appear to have been done. It is notable that drawings S-3 and S-7 include: "REMOVE REQUIRED CAULK & SEALANT IN

ACCORDANCE WITH SPECIFICATION SECTION '13286 PCB CONTAMINATED BUILDING MATERIAL ABATEMENT." It is possible that replacement of the sealant was excluded from the contract due to cost implications.)

A large diameter pipe runs through the grating channel along the top of the tank divider wall. The channel has significant vegetation growth extending through the grating, which should be removed [photo 6]. In time roots can damage the concrete supporting their growth. Observed from above, the interior of the tank appeared to be in generally good condition. Most interior surfaces have a black coating, likely original coal tar epoxy, that is flaking off throughout [photos 7, 8]. However, it is not believed that the tanks require a protective coating.

The longitudinal tank divider wall joins the "influent conduit" vertical concrete box at the south end of the tanks. The inside dimensions of the box are 2'-6" x 2'-0", and its walls join the south endwall [photos 7, 8]. At the walkway level there are sealed joints and unsealed cracks [photos 9, 10]. Leakage was flowing through the upper part of the wall joint [photo 8]. It is unknown if the leakage is only at the upper location of the wall or along its entire height below the point where leakage is observed. The 1969 plans do not show construction joints where the walls of the influent conduit box join the south endwall, but they were likely provided during construction. The apparent gap in the wall at the joint appears to be too straight to be a crack that occurred without it being the location of a construction joint [photo 8]. Although the 1969 plans provide plan views of the reinforcement where walls intersect, such plan view was not provided at this location. It is possible that overstressing resulted in the cracks and separation observed.

At the walkway level an estimated displacement of 1/8" on opposite sides of the joint is evident at the corners of an embedded frame for an aluminum plate [photos 9, 10]. This location could have been overstressed when the tank was put into service resulting in the displacement and cracks observed. When overstresses occur, loads are commonly re-distributed and resisted at locations that have additional inherent capacity. In this case, if the horizontal strength of the wall was exceeded, more load could be resisted by additional vertical capacity until achieving equilibrium. The tank has been in service for about 50 years. The sealant appears very aged and the cracks very weathered. Obvious signs of recent movement are not apparent. Regardless, this location should be monitored closely over time for any additional movement or distress such as existing cracks becoming wider or separation at the sealed joints. The noted leakage should also be monitored. Worsening leakage or additional movement would be indicative of a continuing problem rather than a condition of dormant equilibrium, and additional structural analysis would be warranted. If leakage worsens at all while one tank is empty, personnel should not go inside the tank.

The top of the concrete steps from the parking area to the tank walkway show some minor shallow concrete spalling [photo 11] and one shallow rusted rebar. The embedded tread nosing plate on the bottom step was previously removed and the recess was grouted. The other embedded tread nosings have partially separated from the concrete and are expected to eventually fail by disengagement, which is common with such nosings on exterior stairs due to cyclic freezing and thawing. The top of the aeration tank east wall extends above grade and a few cracks were observed with heavy efflorescence that do not appear to be leaking [photo 12]. Three (3) cracks with active leakage were observed that should be repaired [photo 13].

Blower Building

Grout where the exterior top slab of the Aeration Tank meets the south side of the building [photo 14], and at the wall where the Final Settling Tank abuts the building on the north side [photo 15] is hollow with failure. On the north side attempted repairs using sealant is evident. At the exterior concrete stairs on the east side of the building, the embedded metal nosings on the bottom two steps were previously removed and the recesses grouted. The embedded nosing at the edge of the concrete landing may also eventually fail by detachment as described above. At the door at the landing at the top of the stairs the grout under the sill is spalling and should be removed and replaced [photo 16]. The grout beneath the sill of the door to the top slab of the Final Settling Tanks also shows some spalling (photo 17].

In the basement, it is possible that a previously repaired crack on the west wall near the north end is leaking behind the cementitious parging. The parging is mostly hollow, as observed by hammer sounding [photo 18]. Drawing D-06 of the 2013 plans provides a detail for crack injection, however the location for the repair/s is not identified. Crack injection could not be verified due to the cement parging. It was not readily evident that the floor slab had been injected. There is a puddle on the floor, and the slab at this location includes a very thick build-up of calcium carbonate, likely due to seepage through the slab since the time of its construction. There is also an unknown green matter [photo 19]. The pile report identifies underwater “marine growth” up to approximately 2-inches thick on the west side of the structure. It’s possible that seeping water is in this location is stained green, and it accumulates on the slab over time as the water evaporates. A ladder accesses a scuttle atop the final settling tank at this location. There is a functioning spigot connected to the exterior of the scuttle wall. Some dry water staining was observed around the slab below the scuttle and is not believed to be due to leakage at the scuttle, but this should be confirmed by plant personnel.

Diagonal steel bracing from the west wall of the building is attached to two piles extending out of the water. The north pile supports a hanging elevated gangway [photo 20]. Joe Pratt said the piles and bracing originally supported a floating dock that was used for unloading septage from boats. Rapidly passing of Navy vessels caused significant wake disturbance of the floating dock that created a safety concern and caused it to repeatedly bump against the piles and steel bracing, which transferred the impact into the structure’s wall. The plant asked if the Navy vessels could pass more slowly, but the Navy declined. Due to very infrequent use, the unloading dock was abandoned, and part of the gangway remains suspended from the north pile.

Final Settling Tank 1&2

The 2013 drawings do not include separate plans of the Final Settling Tanks but do indicate that cracks were to be repaired, without identifying any locations. Any evidence of such repairs was not obvious. The aluminum guards around the tanks and those facing the river are as described above for the Aeration Tanks. Concrete deterioration with surface spalling exists around the embedded aluminum grating support frames [photo 21]. Similar as described at the Aeration Tanks, much of the sealant in walkway joints and cracks appears to be at the end of its service life, showing separation from concrete and some cracking. Ideally, the sealant should be replaced. As described for the Aeration Tanks, any potential for PCB contamination should be carefully weighed before any testing, as it can have significant cost implications. The Chlorine Contact Chamber channel walls at the north-most side of the plant show light to moderate surface scaling extending an estimated 18-inches above the water surface [photo 22]. The condition below the water surface could not be observed. Given its approximate 50-year age, the amount of scaling isn’t of major concern, but is expected to worsen over time. Resurfacing with a cementitious repair mortar could be considered. The tank walls that extend above grade have some vertical cracks with heavy efflorescence, however leakage was not observed.

Primary Settling Tanks 1&2 and 3&4

The tanks are reported to have been repaired and fully lined in 2015. The tanks are covered with a concrete slab near grade, with numerous access plates [photo 23]. Much of the sloped grout transitions around the access plates are hollow with some spalling and are expected to continue to spall [photo 24]. The exposed top slabs appear to be in generally sound condition.

Transformer Platform

The transformer is mounted atop an elevated concrete pedestal that shows heavy efflorescence with concrete deterioration [photo 25]. The construction joint between the slab and the walls is partially open with some separation. A large area of the top slab on the north side is delaminated and hollow. There aren't any steps to access the top slab on the north side, and the south side is insufficiently wide for accessing the transformer at the slab level, if necessary – requiring access only from the ground unless a temporary means of higher access is used.

Digesters

The overflow boxes were repaired and lined in 2015. The concrete curb at the north (secondary) box shows concrete deterioration with heavy efflorescence and parallel cracking, primarily on one side [photo 26]. The primary digester with the fixed cover was over-pressurized in the Winter of 2017, and the cover was dislodged with anchorage failure. It was subsequently repaired. Joe Pratt said that the piping inside the digester was found to be severely corroded and was replaced when the cover was repaired. The interior of the secondary digester (with the floating cover) was found to have coating failure at that time, and the digester was properly prepared and recoated as well. The exterior surfaces of both digester steel covers show light surface rust and should be repainted to prevent more advanced corrosion [photo 27].

Retaining Wall

Along the east side of the plant a concrete retaining wall of varying height separates the higher sidewalk and roadway from the lower plant site. The face of the wall shows map cracking throughout its entirety [photo 28] and wide longitudinal cracks observed along and near the top of the wall [photos 29, 30]. These are telltale signs of what is probably alkali-silica reactivity (ASR). This is a chemical reaction between reactive aggregate and alkalis present in the concrete that creates an expansive gel causing the concrete to deteriorate internally. Signs of ASR normally manifest after about 15 years in service. The wall is believed to have been constructed when the plant was originally built in the early 1950's, so it's about 70 years old. The wall is not in good condition but given its age it could be expected to be much worse. To attempt to reduce accelerated deterioration, longitudinal cracks along and near the top of the wall should be routed and sealed to prevent precipitation from direct entry into the interior of the wall. A new concrete cap on top of the wall, connected by drilling and epoxy grouting rebar, is another possible repair - though more costly and difficult given the existing fence mounted into the top of the wall. There are some remnants of previous repairs at the top longitudinal cracks. ASR requires moisture, so the drier the concrete can be kept, the slower any additional reaction will be. Unfortunately, the retained soil is expected to be a continual source of moisture. The exposed face of the wall could be sealed, but if the interior of the wall is already saturated, and because the exposed face of the wall isn't expected to be the primary source of water, it may be of little benefit. ASR will also stop once the alkalis available in the concrete are used up in the associated chemical reactions.

The metal fence along the top of the wall is significantly leaning [photo 31]. A vertical steel strap fastened to the face of the wall and the fence has been installed [photo 32]. The strap was likely installed straight, but it is bent, which could indicate further displacement of the fence since its installation. Any displacement of the wall due to ASR will also affect the fence because it is directly connected into the top of the wall.

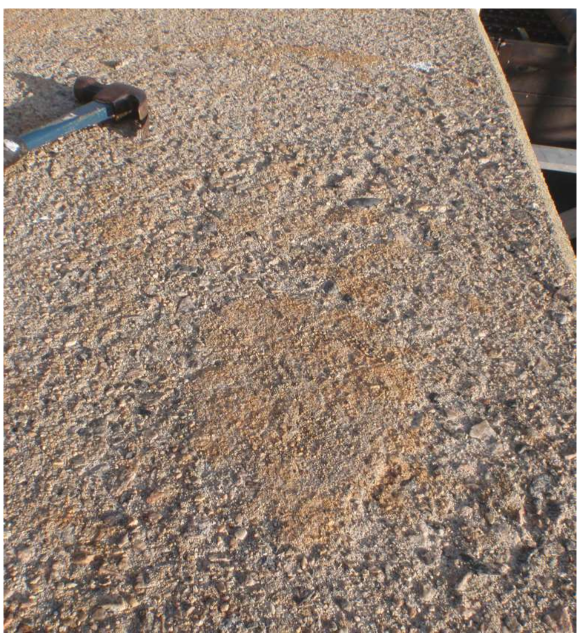
Miscellaneous Site Issue

There is a catch basin in the paved area off the northeast corner of the Final Settling Tanks. There is also a very short concrete wall that is effectively the north edge of the treatment plant site. The wall has a small slide gate believed to be used to accelerate drainage of surface water after flooding. In this area, there are sizable holes in the pavement and severe soil erosion below. This indicates that a drainage path developed independent of those provided by the catch basin and the slide gate [photos 33, 34]. This area is expected to continue to erode, especially with more flood events. This location is in proximity to the transition between the ground-supported part of the plant to the east and the pile-supported part of the plant to the west.

Groton Utilities WWTF Facility Plan Inspection – Structural Memo: photos

[1] Aeration Tank: corroded weir plate at north end.

[2] Aeration Tank: close-up of corroded weir plate at north end.



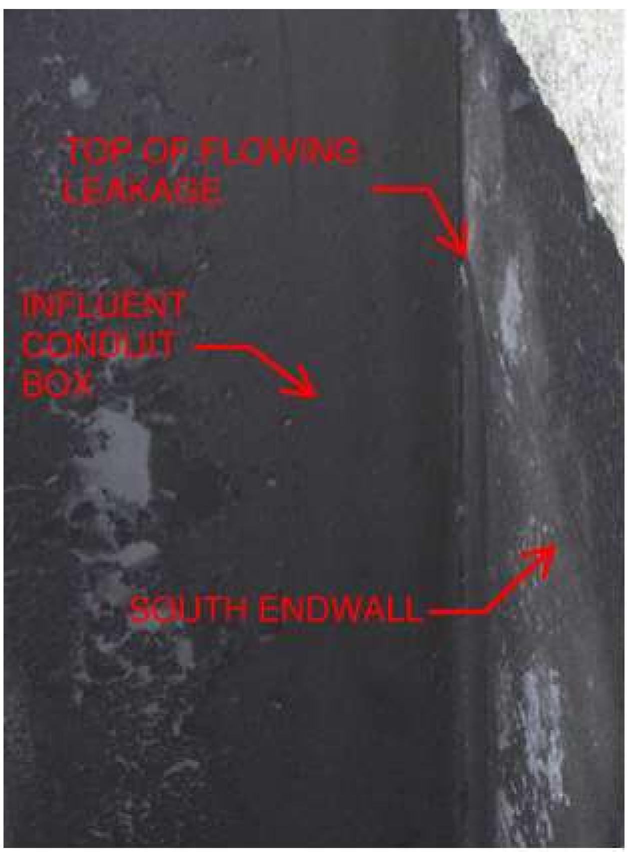
[3] Aeration Tank: typical walkway surface scaling.

[4] Aeration Tank: typical sealant.

[5] Aeration Tank: typical sealant.

[6] Aeration Tank: Vegetation.

[7] Aeration Tank: flaking coating and Influent Conduit Box at south end.



[8] Aeration Tank: flaking coating and leakage at Influent Conduit Box at south end.

[9] Aeration Tank: sealed joint and crack at Influent Conduit box and south endwall, west side.

[10] Aeration Tank: sealed joint and cracks at Influent Conduit box and south endwall, east side.

[11] Aeration Tank: spalling at top step.

[12] Aeration Tank: east Wall, typical vertical crack with heavy efflorescence.

[13] Aeration Tank: east wall, typical leaking crack.

[14] Blower Building: failing grout at south side of Blower Building at Aeration tank slab.

[15] Blower Building: failing grout at north side of Blower Building at Final Settling Tank wall.

[16] Blower Building: spalling grout at sill at east door.

[17] Blower Building: spalling grout at sill at north door.

[18] Blower Building: previously repaired crack in west wall toward north end in basement.

[19] Blower Building: the floor slab at the north end of the basement at the location of a puddle includes a very thick build-up of calcium carbonate. Green material is unknown and could be marine growth that leaked in from the underwater exterior.

[20] Blower Building: piles on the west side previously supported a floating dock.

[21] Final Settling Tank: concrete deterioration with spalling around grating.

[22] Final Settling Tank Chlorine Contact Chamber: scaling of concrete evident above waterline.

[23] Primary Settling Tanks: top slabs with numerous access plates.

[24] Primary Settling Tank: hollow and spalling grout transition around access plates.

[25] Transformer pedestal: heavy efflorescence and concrete deterioration.

[26] Digester: north overflow box concrete deterioration.

[27] Digester: cover showing typical surface rusting.

[28] Retaining wall: typical map cracking.

[29] Retaining wall: longitudinal cracking along top of wall.

[30] Retaining wall: longitudinal cracking near top of wall, and leaning fence.

[31] Retaining wall: leaning fence.

[32] Retaining wall: leaning fence with support strap.

[33] Holes in pavement with soil erosion on each side of curb, and flood slide gate in short wall.

[34] Holes in pavement with soil erosion on each side of curb, and flood slide gate in short wall.

[35] Summary.

WRIGHT-PIERCE
Engineering a Better Environment

Memorandum

Date: **11/11/2021**

Project No.: **20653**

To: **Dennis Dievert**

From: **Rodney Greene, Maggie Smith**

Subject: **Groton CT Wastewater Facility Plan Upgrade – Mechanical Evaluation**

INTRODUCTION

A site visit was conducted at the Groton, CT Wastewater Treatment Facility on October 19, 2021 in order to perform a facility walk-through and an evaluation of the facility's HVAC and plumbing systems.

This memorandum summarizes observations made during site visits and made through review of existing documentation provided by the facility. Based on these observations, finding and recommendations regarding the existing heating, cooling, and air handling systems have been made including recommendations for upgrades, maintenance, and other restorative measures.

GOVERNING CODES

- 2015 International Mechanical Code
- 2015 International Plumbing Code
- ASHRAE 62.1, Ventilation for Acceptable Indoor air Quality
- 2015 NFPA 1 – Fire Code
- 2015 NFPA 54 – National Fuel Gas Code
- 2016 NFPA 820 – Standard for Fire Protection in Wastewater Treatment and Collection Facilities

DESCRIPTION OF EXISTING FACILITIES

OPERATIONS BUILDING

Basement

- The RPZ backflow prevent located at the water service entrance is installed in the vertical orientation. Typically, this equipment is approved only for horizontal installation; confirm if model installed is approved for vertical installation.
- Existing air handling unit (AHU-1), which was installed in 1998 and serves the basement, appears to be in fair condition but is showing signs of corrosion. Associated ductwork is in fair condition with some minor surface corrosion, supply ductwork near chemical storage area shows more significant signs of corrosion. The exhaust ductwork is in fair condition and shows signs of minor surface corrosion. Two of the three exhaust inlets are blocked off, leaving a significant area of the space without air circulation.
- Existing Boiler, which serves the Operations Building was installed prior to and relocated during the 1998 upgrade and is in poor condition. It is corroded, and the flue piping and chimney door are leaking. The expansion tank is in poor condition, and its supports are corroded. The air separator as well as the exposed piping are corroded and in poor condition. The circulator pumps are in fair condition, but the flanges are leaking and in poor condition. The boiler serves 5 finned tube radiators, 6 unit heaters, and two air handling units. The desire to remove the hydronic heating system in its entirety was noted.

- An existing 120 gallon electric hot water heater (2015), emergency thermostatic mixing valve, and associated piping are located in the space to serve the basement and Lab emergency shower and eyewash units. The equipment appears to be in relatively good condition though showing some signs of corrosion.
- Exhaust air is provided by the odor control system for both the basement and Grit Chamber
- Sodium Hypochlorite Storage Room
    - The supply grille shows significant signs of corrosion.
    - The entry door to the space was held open at the time of observation; this door should be left closed to isolate the space from the rest of the basement.
    - Emergency shower/eyewash station (located centrally in the basement) is showing signs of corrosion and is located too far from point of potential exposure in sodium hypochlorite room with obstructions and restrictions to movement limiting the ability to reach the unit in an acceptable time.
    - Emergency showers are properly served with tepid water, but there is no recirculating pump to limit stagnation of water in pipe.
    - A sidewall mounted exhaust fan through the raised section of the roof is connected to the space via PVC ductwork.

First Floor

- Existing air conditioning unit (AC-2), which was installed in 1998 and replaced in approximately 2015 is not operating properly, provides no heating and insufficient cooling to the lab and office area. Associated ductwork and grilles are in good condition. This unit provides cooling and ventilation air to the Lab, Office, and Shop. The Process equipment located in the Shop space causes the space to be rated Class 1, Division 2, air from this space should not be returned and recirculated through unclassified spaces as the current duct arrangement allows.
- Chief Operator’s Office – Finned-tube radiators are in fair condition.
- Electrical Room - There is a small standalone air conditioner which discharges into the exhaust ductwork running through the space which is connected to the odor control system on the roof above. This means of connection creates a potential hazard if the odor control system is shutdown explosive gases could be introduced into the unit and space.
- Truckway – The Truckway is not ventilated and has a door that opens into the adjacent Grit Chamber likely making the space Class 1, Division 2; the equipment in the space does not appear to be properly rated given this classification. The two unit heaters (one hydronic, one electric) are not functioning properly.
- Storage Room No. 1 – Grilles and ductwork are in good condition. The hydronic unit heater is in poor condition; the fan functions but the heater is not operating. There is corrosion evident on the casing and fins.
- Blower Room – Ductwork and Grilles are in good condition. No heating is provided.
- Grit Chamber – The three intake louvers show significant signs of corrosion and do not appear to be operable. Hydronic unit heaters and associated piping are showing significant signs of corrosion. Exhaust ductwork is showing significant signs of corrosion. Supply registers show significant signs of corrosion, but ductwork appears to be in relatively good condition.
- Open Area – Grilles are showing significant signs of corrosion, and duct insulation is in poor condition. Unit heaters are in fair condition but show signs of corrosion. Drain piping appears to reduce from 4” CI to 3” PVC in the direction of flow.
- Toilet – The roof mounted exhaust fan is in good condition, but the roof curb shows signs of corrosion. No permanent means of heating is provided and the portable space heater in the space is insufficient for heating the space.

- Laboratory/Control Room – Grilles and finned tube radiators are in fair condition. A deck mounted face/eye wash is provided but no emergency shower is provided.

Roof

- Equipment is too close to the roof's edge for safe maintenance and requires climbing over obstructions to access.

SLUDGE THICKENING BUILDING

- An existing oil-fired boiler and associated appurtenances are located in the Boiler Room. The unit is corroded, not functional, and the associated piping is not insulated. No dedicated combustion or ventilation air is provided in the Boiler Room.
- There is a ductless split unit serving a converted office space off the Sludge Room which is in fair condition. Its supports are corroded, and the unit does not have seacoast protection.
- Two hydronic unit heaters in the Sludge Room are corroded and do not appear to be functioning.
- No mechanical ventilation is provided in the building. Due to lack of proper ventilation the space would be classified Class 1, Division 2; the equipment in the space is not rated for this classification.
- Roof drain is damaged.
- Drain piping is reduced in size in the direction of flow.
- Piping and sample sink appear to be in good condition.

GENERATOR BUILDING

- Two electric unit heaters provide heat.
- Louver/damper assemblies with motorized actuators and an exhaust fan provide ventilation.
- A packaged day tank supplies oil from the storage tank outside to the generator.
- All equipment and piping appears to be functional and in good condition.

DIGESTER CONTROL BUILDING

- 2015 upgrade plans list the space as Class 1, Division 1 which appears to be appropriate. Some equipment and accessories in the space appear to be correctly rated for the application but others, including the motor operated damper actuator serving the roof mounted exhaust fan, are not appropriately rated for the space.
- Existing air handling unit was installed in 2016 and appears to be in good condition.
- Existing roof mounted exhaust fan is in good condition.
- The Boiler is in fair condition, and the hydronic piping and insulation are in good condition. There are a strainer and balancing valve which show signs of corrosion.
- Hydronic unit heater is in good condition.
- Sample sinks and water supply piping are in good condition.

MAINTENANCE BUILDING

- Two electric unit heaters are in fair to poor condition.
- No mechanical ventilation is provided.

BLOWER BUILDING

The Mechanical systems throughout the building were replaced as part of the 2015 upgrade and generally appear to be in good condition.

Basement

- Electric unit heaters which replaced the original hydronic unit heaters.
- Hydronic piping which served the unit heaters has been abandoned in place.
- There is no mechanical ventilation provided in the Pipe Gallery, manual damper to intake hood at end of gallery is closed.
- Existing emergency shower/eyewash station at polymer storage area is supplied with cold water only.
- Domestic water heater located in Heater Room appears to be in good condition.

First Floor

- Ventilation is provided by an energy recovery ventilator located above the Break Room ceiling ducted to the ceiling cassettes and supply diffuser throughout the first floor.
- Ceiling cassette units are in good condition; the filters are dirty to a point which may affect the efficiency of the system.

SITE

- 3000-gallon diesel tank serving generator, located between the Sludge Thickening Building and Generator Building. Tank and accessories appear to be relatively new and in good condition; tank does not appear to be provided with means of monitoring leaks in the interstitial space.
- 1000-gallon fuel oil tank serving boilers is located adjacent to the Operations Building. Tank and accessories appear to be relatively new and in good condition.

RECOMMENDATIONS

OPERATIONS BUILDING

- A code analysis defining the ventilation requirements of all interior spaces will need to be performed as part of the design effort; once ventilation rates have been established the feasibility of heat pumps and/or electric heating equipment can be evaluated.
  - Option 1: New packaged makeup air equipment to be provided with indirect gas fired furnaces for heating of the outdoor air; spot heating in unclassified spaces by separated combustion gas unit heaters and in classified spaces by electric resistance unit heaters. New propane storage tank or tanks would need to be sited.
  - Option 2: Provide new high efficiency, direct vented, gas fired boiler and associated pumps, piping, and appurtenances. This option would eliminate the fuel oil storage, eliminate the natural draft chimney, and reduce the footprint required for the boiler and associated equipment. The existing hydronic heating system piping would be reused where appropriate, but the majority of the equipment replaced with new, properly sized equipment.
  - Option 3: All new equipment to be provided with heat pumps for cooling and heating of the incoming air and spaces; spot heating with electric resistance unit heaters as needed. A cursory review of these requirements indicates that dedicated outdoor air units with air source heat pumps may be available to provide the outside air required for the process areas but the equipment may be prohibitively large and/or costly.
  - Option 4: All heating throughout the building to be electric resistance heating. This would have a lesser capital cost but significantly higher ongoing operating costs.
  - Option 5: Replace the existing oil fired boiler and associated equipment in kind.
  - These options would include the following:

- Demolish existing AHU-1 in the basement and provide new packaged makeup air unit mounted outside at grade (or supported above grade on structural steel if required for flood protection) and ducted through the existing opening into the basement. The unit would be sized to provide 1 cfm/sqft to the chemical room and 6 ACH to the remainder of the basement to unclassify the space by ventilation in accordance with NFPA 820.
  - Option 1: Makeup air unit supplying heated outside air; heating provided by gas-fired furnace packaged with unit.
  - Option 2: Makeup air unit supplying heated outside air; heating provided by hydronic heating coil circulating glycol solution from boiler.
  - Option 3: Makeup air unit to be dedicated outside air unit with heating and cooling capability provided by air source heat pump.
  - Option 4: Makeup air unit supplying heated outside air; heating provided by electric resistance heat with SCR control.
  - Option 5: See Option 2 above.
- Demolish existing roof mounted AHU-2 serving the Grit Chamber and adjacent process areas. Replace unit with new roof mounted makeup air unit and connect to existing ductwork. Replace corroded supply and exhaust grilles in the Grit Chamber. This equipment would need to be rated for use with Class 1, Division 1 spaces or the duct system modified to allow for protecting the unit from the migration of explosive vapors into the unit in the event that the unit is off.
  - Option 1: Makeup air unit supplying heated outside air; heating provided by gas-fired furnace packaged with unit. This equipment is not available with Class 1, Division 1 rating, isolation from space during periods when unit is off would be required.
  - Option 2: Makeup air unit supplying heated outside air; heating provided by hydronic heating coil circulating glycol solution from boiler.
  - Option 3: Makeup air unit to be dedicated outside air unit with heating and cooling capability provided by air source heat pump.
  - Option 4: Makeup air unit supplying heated outside air; heating provided by electric resistance heat with SCR control.
  - Option 5: See Option 2 above.
- Demolish existing roof mounted AC-2 and provide new roof mounted makeup air unit. Modify the ductwork to isolate the office and lab spaces from the Shop/process space.
  - Option 1: Makeup air unit supplying heated outside air; heating provided by gas-fired furnace packaged with unit.
  - Option 2: Makeup air unit supplying heated outside air; heating provided by hydronic heating coil circulating glycol solution from boiler.
  - Option 3: Makeup air unit to be dedicated outside air unit with heating and cooling capability provided by air source heat pump.
  - Option 4: Makeup air unit supplying heated outside air; heating provided by electric resistance heat with SCR control.
  - Option 5: See Option 2 above.

The following modifications are recommended regardless of the option pursued above:

Basement

- Demolish and reconfigure existing exhaust ductwork as necessary to better circulate air throughout the space.

- Demolish the existing boiler and all associated equipment, piping, and appurtenances.
- Sodium Hypochlorite Storage Room
  - Replace corroded supply register with new aluminum supply register.
  - Demolish existing emergency shower/ eyewash unit and provide new PVC unit closer to possible point of chemical exposure to minimize obstructions and limit travel time required to less than 10 seconds.
  - Consider addition of a recirculating pump to reduce stagnation and microbial growth in tepid water piping.

First Floor

- Provide new ductless split system heat pumps to serve the Office and Lab areas. Ceiling cassette indoor units and either roof or wall mounted outdoor units sized to provide heating and cooling to these spaces are recommended. Individual units would be provided to allow for independent control of the Lab and Office zones. Electric baseboard heating elements could be added at the owners option, to provide additional comfort heating in these spaces. A small, dedicated energy recovery ventilator to supply tempered ventilation air to these spaces is recommended.
- Provide new ductless split system heat pump to serve the Electrical Room. Remove the floor air conditioning unit and repair the basement exhaust ductwork.
- Truckway – Evaluate the ventilation requirements and provide new intake louver with motor operated damper and exhaust fan as necessary. Heating to be provided by unit heater with heat source dependent on option chosen.
- Storage Room No. 1 – Replace existing unit heater with new electric unit heater.
- Shop / Process Area
  - Replace corroded supply and return grilles and damaged duct insulation. Evaluate NFPA classification and ventilation requirements for the space. Add dedicated exhaust fan as necessary sizes to match the airflow of the makeup air unit.
  - Replace 3" PVC drain pipe with 4" to match cast iron to comply with plumbing code requirements.
- Toilet – Provide electric cabinet heater sized to provide sufficient heating to the space.
- Laboratory/Control Room – Evaluate chemicals used to ensure deck mounted eye/face wash is appropriate. If required add emergency shower and associated piping.

Roof

  - Add a guard rails at roof edge where equipment is mounted less than 15' from roof edge to comply with OSHA safety requirements.
  - Provide crossover bridge/stairs to allow for passing over odor control ductwork to access roof mounted equipment.

SLUDGE THICKENING BUILDING

- Demolish existing boiler and all associated appurtenances.
- Demolish existing hydronic unit heaters and associated piping and appurtenances.
- Evaluate ventilation requirements and NFPA classification for the space. Add makeup air unit and exhaust fans as necessary to meet requirements. New packaged makeup air unit mounted outside at grade (or supported above grade on structural steel if required for flood protection) and ducted into the building:
  - Option 1: Makeup air unit supplying heated outside air; heating provided by gas-fired furnace packaged with unit.
  - Option 2: Makeup air unit supplying heated outside air; heating provided by hydronic heating coil circulating glycol solution from boiler.

  - Option 3: Makeup air unit to be dedicated outside air unit with heating and cooling capability provided by air source heat pump.
  - Option 4: Makeup air unit supplying heated outside air; heating provided by electric resistance heat with SCR control.
  - Option 5: See Option 2 above.
- Replace damaged roof drain.

MAINTENANCE BUILDING

- Replace existing electric unit heaters in kind.
- Recommend adding ventilation to provide 0.75 cfm/sqft in accordance with vehicle repair garage requirements of mechanical code.

DIGESTER CONTROL BUILDING

- Evaluate ventilation requirements in accordance with NFPA 820; identify and replace all electrical and control components that do not meet the NEMA classification of the space.

BLOWER BUILDING

Basement

- Consider removal of abandoned hydronic piping.
- Provide new fresh air intake, damper, and supply fan at end of pipe gallery. Evaluate ventilation requirements to comply with NFPA 820 requirements. Confirm capacity of exhaust fan serving basement and replace as necessary to provide adequate ventilation.
- Remove existing emergency shower (not required for polymer); add new emergency eyewash station with an emergency thermostatic tankless water heater.

First Floor

- Clean ductless heat pump indoor unit filters to restore full airflow and add filter cleaning to maintenance schedule (3 months recommended).

SITE

- Add leak detection system to monitor the interstitial space of the secondary containment area of the 3000-gallon diesel tank serving the generator.

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MEMORANDUM

TO:	Dennis Dievert, PE	**DATE:**	11/12/2021
FROM:	Ryan Mecham	**PROJECT NO.:**	20705A
SUBJECT:	Facilities Plan – Instrumentation Evaluation Groton, CT, Groton Utilities Water Pollution Control Facility		

INTRODUCTION

On October 5th, 2021, Ryan Mecham, Dennis Dievert and Steven LaPrise (WP Staff) visited the Groton WPCF located at 311 Thames St. Groton, CT. A meeting was held with the following WPCF staff; lead plant operator, facilities director, and the Groton Utilities project manager. Following the meeting a site investigation was completed. Plant instrumentation and equipment were evaluated for the following metrics: general condition, obsolescence, maintenance, calibration, and its ability to provide accurate and actionable information to the plant SCADA system. This document serves as a record of those findings and Wright-Pierce's recommendations for repair, replacement and/or the addition of new equipment. These recommendations are made in compliance with the following.

- TR-16 Guides for the Design of Wastewater Treatment Works
- National Electric Code (NFPA 70)
- NFPA 820.
- NFPA 70E.
- Connecticut State Building Code.

Notable Items during Site Investigation:

Existing conditions and general observations and recommendations.

The last complete instrumentation upgrade was completed in 1998. Many of the systems replaced or installed at that time are now defunct, obsolete or abandoned in place. Most of the systems installed in the 2016 upgrade appear to be in a reasonable state. Specific observations are included below and organized by building.

The plant SCADA system is maintained under a separate contract by Woodard and Curran INC. This includes a schedule of hardware replacements as well as periodic software updates and PLC and SCADA programming changes. In general, the SCADA system screens were adequate graphical representations of plants systems. However, there are numerous screen functions that no longer work due to defunct or removed field instruments and/or systems. Controls for those defunct systems should be either hidden from view or deleted, for clarity of system functions. SCADA access is only available in the Operations Building and the Blower Building. Installation of additional client terminals in strategic locations would optimize access to relevant information while staff is evaluating individual systems throughout the plant. Plant staff maintain individual logons with varying staff permission levels as is recommended by current cyber security guidelines.

The main SCADA server is a workstation type machine installed on a desk in the operations building. Prior to WP's visit the server had crashed due to overloading on the UPS that was shared with another PC system. The SCADA contractor installed a separate UPS exclusively for the SCADA server. However, during the visit it was observed that plant staff were plugging in phone chargers and other devices to the SCADA UPS. In compliance with industry physical/cyber security best practices, it is recommended that the Server and its associated subsystems be relocated to a secure network enclosure. This will provide additional protection from inadvertent and intentional harm.

The plant wide network consists of the following network types; 900 MHz instrument radios, intra building radio links and a star of stars fiber optic network connecting three of the buildings. It is recommended that the fiber optic network be reconfigured in a ring star topology with redundant links on the main loop. The odor control system, which is being evaluated for replacement, is using a 900MHz instrument transmitter attached to an H2S sensor. The replacement system should utilize standard hardwired 4-20mA instruments connected to the control building PLC directly.

Numerous pieces of equipment and instruments did not have the recommend stainless steel identification tags. Other instruments were labeled with sharpie marker. Clear and concise labeling of equipment, as it is identified in operations & maintenance manuals, aids in diagnostic troubleshooting and maintenance. Identification tags are of paramount importance for the purposes of reading the correct instrument and recording results. All equipment should be labeled with its corresponding ISA tag information.

Division 11 panels were reviewed during the site visit. It was noted that most if not all the panels were significantly undersized in their initial design and construction. As such maintenance and longevity suffers, in that maintenance cannot be completed properly due to lack of working and access space. As an example, cable covers are not replaced as there are too many wires. Over time, this can lead to damage to panel components and wiring. All new Division 11 control panels that are recommended in this upgrade should bear a UL508A label and have a minimum of 20% spare space for future component addition and wiring.

Notable Items during Walk Through:

Operations Building

- The headworks area gas detection is well past is usable life. The calibration stamp is unreadable and is only single gas detection. This monitoring equipment should be replaced with a tri-gas monitoring unit (H2S, LEL, O2) with a remote annunciation panel that is located outside the hazardous zone as well as monitored by SCADA and local Fire Alarm Control Panel.

- The Influent sampler (HACH AS950) is installed in the garage bay and the tubing is routed through a hole in the block wall and draped into the influent channel. This method of routing creates a connection between the hazardous space (Headworks) and the non-hazardous (garage bay) areas. This tubing should be removed, and permanent sample piping installed in a manner consistent with the manufactures recommendations and building code. This will ensure proper sampling, prevent dislodgement/damage to the tubing and eliminate the non-compliant link between the spaces.
- The plant's influent flowmeter (ultrasonic Parshall flume) was observed as defunct. A previous analysis (by others) suggested replacement to a radar type flowmeter. Wright-Pierce concurs with this recommendation by demolishing the existing ultrasonic unit and replacing it with a radar type open channel flow measurement in the headworks area.
- There is a Great Lakes International model 692P PH meter located in headworks that is defective reading 'Err4' and should be replaced.
- The Primary settling tank control panel should be labelled. Internal wiring should be neatened up and raceway covers replaced. Network cable in panel is unlabeled so it's source could not be identified.
- The backup Verbatim alarm dialer which is used by the SCADA system to dial out when no response is received on the primary SCADA alarming system. The alarming system should be considered for replacement with a dual-path digital communication for the SCADA alarm monitoring system.
- The existing hypochlorite storage and chemical metering systems were not evaluated at this time. However, operations staff indicated that the chemical feed control panel was inoperable. Based on this information, Wright-Pierce recommends replacement of instruments, chemical metering pumps, and associated control panel.
- The chlorine and pH analyzers in the basement should be replaced as they are no longer functional and have exceeded their useful life. Plant staff currently take readings and enter them in a logbook for comparison against the chlorine instrument which indicates wide swings in variation. The pH instrument is bypassed.
- PLC1 Control Panel:
    - The Cabinet is in disarray and has spare components in the base of the cabinet lying on top of wiring. Wires are draped and not secured. This will create long term maintenance issues as in addition to the added mechanical strain could result in cable and wire damage during maintenance and troubleshooting.
    - When the fiber optic cabling was installed at the facility it was not properly routed and is draped in the cabinet in an unsupported manner. This creates strain on the cables and will lead to premature fiber and communication failure.
    - The cabinet does not have sufficient space to be retrofitted and should be considered for replacement. Additionally, the door interlock on the disconnect has been disabled due to the fact that the panel was installed too close to the wall and the interlock cannot be accessed. This is a direct violation of the NFPA 70E arc flash protection requirements. Untrained staff can access the equipment without proper PPE and could suffer bodily injury as a result.

  - PLC1 is an Allen-Bradley SLC 5/05 that is nearing the end of its useful life. Availability of replacement components will become increasingly difficult and will lead to increased downtime and potential regulatory compliance issues if the system is operated in manual mode for a prolonged time period. As such it is recommended to be replaced. The PLC I/O is configured as follows.
    - 5 DC Digital input cards
    - 1 AC Digital input card
    - 3 Digital Output cards
    - 2 Analog Input cards
    - 1 Analog Output card
  - There is a secondary MicroLogix 1100 for which the purpose was not easily identifiable. The PLC was possibly used for radio communication. This is a recent generation PLC and is therefore still viable and does not need replacement at this time.
  - There is a MOXA 10 port switch (2 Fiberoptic ports) installed in the cabinet and none of the connected cables are labeled
  - Mounted adjacent to PLC 1 is a single instrument pen chart recorder that the plant currently still uses to monitor their effluent flow. Consideration should be given to replace this with a digital display chart recorder (with data logging and storage) or to eliminate it as the main SCADA display node is in the same room. Either replacement option will require that regulatory compliance is maintained for record keeping.
- The lab eyewash mounted at the sink does not have a flow switch that could be identified. This is a highly recommended safety device and should be installed per the state building code.
- The main utility entrance for phone and internet is in the room behind the PLC1 Cabinet. There are currently 2 cable modems one of which is a VOIP gateway facility phone lines, while the other provides the facility internet connection. One of the modems is installed on a shelf while the other is hanging loose from the wall supported by its RG6 cable. Unsupported devices are much more likely to suffer mechanical damage to their connection points which would lead in this case to an internet outage. Above the modems there is an 8U network rack with components haphazardly installed on Lexan shelving. The network enclosure should be replaced with an appropriately sized unit and all network equipment should be properly installed in the rack. Cyber security best practices indicate that the rack should be secured to prevent both inadvertent and intentional damage to the network infrastructure.

Blower Building

- PLC2 Control Panel is an Allen-Bradley SLC 5/05 that is nearing the end of its useful life. Availability of replacement components will become increasingly difficult and will lead to increased downtime and potential regulatory compliance issues if the system is operated

in manual mode for a prolonged time period. As such it is recommended to be replaced. The PLC I/O is located in both the primary rack and a secondary rack connected by a bus cable, it is configured as follows.
    - 5 (16 pt) DC Digital input cards
    - 1 (32 pt) DC Digital input card
    - 2 (16 pt) Relay output cards
    - 5 (8 pt) Analog input cards
    - 2 (8 pt) Analog output cards
- Similar to PLC1, the PLC2 cabinet wiring is not properly supported and wireway covers are not installed. General maintenance and upkeep should be performed to extend the longevity of the panel.
- There is a Bailey pressure transducer (PTSPAE1100001AD) installed in the blower main header which indicates a range of 0-30 psi with no visible calibration date. The NPT Weldolets on the piping are showing significant signs of corrosion. Given the instrument's age combined with being a discontinued model, WP recommends this instrument be replaced.
- There is an FCI thermal Mass flow meter (AF88-1AA2003CFC2) installed in the blower main air header that measures total supplied air to the aeration basin. Plant staff report significant discrepancies when blower flow capacity is compared to measured flow. This instrument should be replaced to accurately monitor flow.
- There are three (3) Bailey magnetic flow meters installed in the lower level that monitor the two return activated sludge lines and the waste activated sludge line. Plant staff indicated that they had no issues with them. They were installed in the 2016 upgrade and are not in need of replacement at this time.
- The plant water system was offline at the time of inspection. This is the normal condition as the facility uses primarily city water for its plant water needs. However, no method of control signal measurement was identified on the piping to the plant water system (Pressure transducer or flow meter). In the future if the plant wishes to utilize the plant water system, additional investigation should be undertaken to evaluate the plant water control system at that time.
- The existing blowers are to be evaluated by Spencer Turbine for sizing, control and mechanical condition. Until the completion of that evaluation Wright-Pierce Instrumentation will defer comment on the controls associated with those blowers.

Digester Control Building

- Digester Tank Levels are monitored by pressure transducers in the lower level. Only the instrument for tank 2 was functional at the time of evaluation. The although the tank 2 transducer was still functional, it shows significant surface corrosion. Both transducers should be replaced and optimally a redundant system installed.

- Two FCI AF88 gas flow meter displays are installed in the boiler room. They indicate the total gas flow and the used gas flow. There is no flow meter installed on the waste gas flare line. A flow meter should be installed on this line to ensure that waste gas flow can be accurately tracked and to measure leakage to the stack.
- The waste gas flare does not currently have a flame detector installed to confirm that it is lit. Plant staff currently confirm this manually. It was also indicated by the plant staff that the ignitor does always successfully light the flare. This would cause unburned fuel to be vented to the atmosphere. The plant is located in a residential setting and could create undue nuisance as well has a potential hazard. A flame sensor instrument should be installed to better manage this process and to prevent atmospheric venting of unburned fuel. Automatic actuation of the flare should be evaluated as it is the method used to reduce the head gas pressures when they exceed allowable limits.
- Head gas pressure instrument in tank 1 is not properly installed and or rated for the outdoor environment and is subject to freezing. To mitigate this, a heater circuit wire is wrapped around the instrument and connected to an unprotected extension cord that runs through a window and is plugged in inside the building. The instrument should be replaced with one that is rated for the environmental conditions in which it is installed. Alternatively, a permanent installation of a small, heated enclosure could be evaluated. Either option will need to include permanent wiring and the elimination of the extension cord.
- Two (2) MSA TriGuard gas detection monitors are installed in the entryway to the building with one measuring the boiler room and the other measuring the pump room. Due to the design of the space, there is no classification separations between the entry way and the hazardous monitored spaces. The indicators for the gas monitors should be moved outside and a second set of indicators installed at the second entrance. The units had current calibration dates and appear to be in good repair.
- The SCADA panel houses a MicroLogix 1400 and is in generally good condition at the time of the inspection. The MOXA radio communicator was still powered so it is unclear if it is still in use or if a separate CAT 5/6 feed has been supplied from an adjoining building for communication to this panel. As per the general comment the SCADA fiber network should be upgraded to a ring that connects all buildings.

Sludge Thickening Building

- The in-use sludge tank has a submersible pressure transducer installed. Specific identification of the device was not possible given site conditions. The device was not included in the most recent update and likely dates to the 1998 upgrade as such it will have exceeded its useful life and should be replaced. The requirement for intrinsic safety should be established and if lacking installed as part of the replacement.
- There is a backup float indicator on the in-use sludge well. The float is connected to a cable and pulley system that raises and lowers an indicator on the side of the building.

- A new redundant level monitoring system including a redundant level transmitter/monitor and a high float system is recommended to be installed in the sludge well.

Generator Building

- The existing control panel in the generator building houses a Micrologix 1400 PLC. This is a recent generation PLC and is therefore still viable and does not need replacement at this time.
- The previous radio communication system that was replaced by the interbuilding fiber was never fully decommissioned and removed from the panel. Defective equipment should be removed.

Outdoor Areas:

Primary Settling Tanks

- The Primary Settling tank flights have sensors to detect and control sequencing of the flights. However, the plant staff indicated that the system never worked even after installation during the plant upgrade in 1998. The sensors are still wired but mechanically disconnected and tied out of the way. Further evaluation would be needed to determine if the system could be made operational. If the system is truly defunct the sensors should either be replaced or be removed and the programing updated to allow operation without the sensors.

Final Settling Tanks

- The flight sensor system on the final settling tanks is deactivated in the same manner as the Primary settling tanks. Actions taken on the Primary Settling Tank should be carried forward to the Final Settling tanks as well.

Aeration Tanks

- All existing instruments are defective and non-functional. Plant staff currently perform grab samples for analysis in the lab.
- Recommend the installation of the following instruments
    - DO in all zones.
    - ORP in oxic zones
    - pH at reaeration zone.
    - Ammonia in anoxic zone.
- It is recommended to install thermal mass flow meters and MOV’s on each of the aeration (oxic) zones. Which, when coupled with the feedback from new dissolved oxygen metering equipment can be used to optimize aeration and substantially lower energy costs.

Outfall

- The existing chlorine meter is a ProMinent Dulcometer and has been recently calibrated. The unit is a current model for the manufacture and meets its design intent. Its age was not identifiable as the unit could not be directly accessed. The cabling for the instrument probe was exposed and zip tied to the handrails. Permanent installation and wiring protection should be installed.
- The outfall flow is measured using a Milltronic ST-25C in a Parshall flume. Calibration was current on the unit. However, the ST-25C series of instruments is discontinued and the device was installed during the 1995 upgrade. Given the lack of an influent flow meter the plant is currently operating with a single point of failure that is nearing or beyond its useful life. WP recommends replacement of the flow meter with current generation equipment.
- The existing HACH AWRS 950 autosampler is in good condition. However, the sample tubing does not appear to be installed properly and a permanent routing solution should be implemented

Primary Effluent Wet Well

Existing pressure level instrument was functional on inspection and plant staff indicated that backup float control works when needed. No entry was made for further investigation of the instruments.

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MEMORANDUM

TO:	Dennis Dievert	**DATE:**	10/14/2021
FROM:	Steve LaPrise, PE	**PROJECT NO.:**	20705A
SUBJECT:	Facilities Plan – Electrical Evaluation Groton, CT , Groton Utilities Water Pollution Control Facility		

A meeting was held on site with Groton Utility Staff on October 5th, 2021, at the Water Pollution Control Facility (WPCF) in Groton CT. Wright-Pierce staff also walked through the WPCF with and took note of areas that would require improvements of should be upgraded in the near future.

Main Plant Distribution

The existing service into the facility consists of an overhead medium voltage riser pole that connects underground to a pad mounted NEMA 3R enclosed transformer. The utility service transformer is 480/277VAC secondary and connects to a main 800 amp rated disconnect located in the operations building electrical room. There is an automatic transfer switch, and main distribution panel labelled MDP. From this panel, the 480 Volt power is fed to the Blower Building, Digester Building and Operations Building Motor Control Centers (MCCs). Listed below are the respective MCC's that are powered by the switchgear and building locations:

1. MCC-1A Operational Building
2. MCC-3 Blower Building
3. MCC-4 Digester Building

All of the facilities are provided back-up power by a 600-kW diesel generator located in the Generator Building. As mentioned, there is an automatic transfer switch (ATS) that provides back up power to the entire plant. The generator is over 17 years old and oversized for the plant. A load bank unit was installed for the unit but it is no longer functioning.

Existing conditions and recommendations.

The main disconnect, step down transformers, automatic transfer switch, and main distribution panel were recently installed in 2015. MCC-1A is in fair condition and older vintage. If replaced it could be replaced with a smaller MCC as a lot of the starter buckets are marked spares.

The Blower Building MCC-3, assorted VFDs and Digester Building MCC-4 were also replaced in 2015 along with some of the distribution panels.

The existing 600-kW generator is 17 years old and is in fair condition and has a load bank assembly that is nonfunctional. The unit is oversized for the application and should be replaced with a smaller unit.

Notable Items during Walk Through:

Blower Building

- Most electrical infrastructure equipment was recently replaced as part of the 2015 upgrade.
- Lighting Panel No.1 in the garage is older and is showing signs of corrosion and should be replaced.
- Recommend replacing fluorescent fixtures with LED fixtures, or LED bulb replacement to save on energy usage.
- These is a loose mounted CAT 5 cable that connects to the SCADA panel in the electrical equipment area. Reinstallation is conduit is recommended.
- The Effluent Pump Circuit breaker is older and should be replaced.
- Some wiring is exposed in ceiling should be closed off in respective pull box.
- Pump room conduit and wire are showing some signs of corrosion.
- Some disconnects were abandoned in place and are no longer used. These items should be removed if not planned for future use.
- Most pumps have an emergency stop switch (E-stop). If pumps do not have an E-stop one should be installed near the respective pump.

Operations Building

- The headworks area is showing severe signs of corrosion on the support rods for unistrut and conduit. Replacement with a support rod that is stainless steel or PVC coated is recommended.
- The Heat detectors in the head works area do not appear to be rated for the Class 1, division 1 (C1D1) hazardous area. These detectors should be investigated and replaced with C1D1 rated equipment if they are not.
- Minor signs of corrosion in the Garage Bay.
- The electrical room should have a door installed, and a “warning high voltage” sign.
- The electrical room should have an air conditioning unit installed due to the heat generated by the VFDs.
- The Primary settling tank control panel should be labelled.
- Lower level: Some pumps have an emergency stop switch (E-stop). If pumps do not have an E-stop one should be installed near the respective pump.
- Abandoned conduits should be removed or capped.
- Electrical room lighting above should be relocated below the conduit racks to give the space better illumination.

- MCC-1A is of older vintage and is missing a label. It has just a few loads and could be replaced with a smaller footprint MCC.
- The Rotary Thickener VFD sometimes does not reset upon a power loss and must be reset. VFD Programmed should be investigated to trouble shoot reasons why it does not reset automatically.
- Recommend replacing fluorescent fixtures with LED fixtures, or LED bulb replacement to save on energy usage.
- There was a question on whether the screening area Gas detection was operational.
- The locker cabinet in the electrical room should be removed as the associated panels and electrical equipment do not have the required clearance requirements.

Digester Control Building

- Presently there are no fire alarm notification or annunciation devices within the building. Depending on the local Authority having jurisdiction (AHJ) these may be required and should connect to the existing fire alarm system installed at the operations building.
- The Heat Exchanger Pump VFD sometimes does not reset upon a power loss and must be reset manually. VFD Programming should be investigated to trouble shoot reasons why it does not reset automatically.
- Some VFDs are mounted loose in the electrical and boiler area of the building. It would be better to install them in an air conditioned enclosure to keep them cool and operational. The door to the space is kept open due to heat issues.

Sludge Srorage Building

- Presently there are no fire alarm notification or annunciation devices within the building. Depending on the local Authority having jurisdiction (AHJ) these may be required and should connect to the existing fire alarm system installed at the operations building.

Generator Building

- Presently there are no fire alarm notification or annunciation devices within the building. Depending on the local Authority having jurisdiction (AHJ) these may be required and should connect to the existing fire alarm system installed at the operations building.
- Recommend replacing fluorescent fixtures with LED fixtures, or LED bulb replacement to save on energy usage.

Outdoor Areas:

Primary Settling Tanks

- Recommend replacing fluorescent or metal halide site lighting fixtures with LED fixtures, or LED bulb replacement to save on energy usage.
- Some conduits are above grade and pose a tripping hazard.
- Minor signs of corrosion on some conduits.
- Some local control stations for the collectors do not have local E-stops, just "hand off auto" type switches. An E-stop is recommended if motor is exposed.

Final Settling Tanks

- Recommend replacing fluorescent or metal halide site lighting fixtures with LED fixtures, or LED bulb replacement to save on energy usage.
- Some corrosion at Final clarifiers at light post.
- Minor signs of corrosion on some conduits.
- Some local control stations for the collectors do not have local E-stops, just "hand off auto" type switches. An E-stop is recommended if motor is exposed.

Aeration Tanks

- Recommend replacing fluorescent or metal halide site lighting or under eave fixtures with LED fixtures, or LED bulb replacement to save on energy usage.
- Some corrosion on the aeration tank conduits.

Appendix E
October 4th, 2021 Odor Control Evaluation

WRIGHT-PIERCE
Engineering a Better Environment

MEMORANDUM

TO:	Groton Utilities	**DATE:**	10/4/2021
FROM:	Dennis Dievert Jr., PE Prashanth Emmanuel PE	**PROJECT NO.:**	20653A
SUBJECT:	Groton Utilities Water Pollution Control Facility Odor Control Evaluation - FINAL		

I. INTRODUCTION

Wright-Pierce entered in a contract with Groton Utilities (GU) on March 26th, 2021, to perform a comprehensive wastewater facility planning study of their water pollution control facility (WPCF). The project is anticipated to receive a 55% planning grant through the State of Connecticut Department of Energy and Environmental Protection Clean Water Fund (CWF). The overall draft facilities plan report is scheduled for completion in January of 2022. At the request of GU, Wright-Pierce has expedited the evaluation of the existing odor control system. This memorandum summarizes our evaluation including review of existing conditions, past odor studies and reports, public odor complaints and field survey data collected in the Summer of 2021.

II. DESCRIPTION OF EXISTING FACILITIES

Odor control at the GU WPCF is provided by a single-stage vertical packed bed chemical scrubber system. The scrubber system was originally installed in 1985 and manufactured by Ceilcote. The scrubber system has a rated capacity of 8,000 cfm. Air is drawn exhausted from various process areas for treatment using a single centrifugal fan located at the scrubber.

Initially, the scrubber system included a chemical feed pump that added sodium hypochlorite to the scrubbing liquid sprayed countercurrent to the odorous air as it passes through the scrubber/packing in the vessel. Oxidation-Reduction Potential (ORP) and pH probes located in the scrubber monitored the vessels internals to feed the appropriate amount of hypochlorite required for the effective treatment of odors. The use of the chemical feed pumps and ORP/pH probes were discontinued, and the plant staff currently adds chlorine tablets on a weekly basis to maintain the required chemistry to scrub the odors from the air stream. Additionally, plant staff installed a hydrogen sulfide probe in Fall 2020 at the odor scrubber stack discharge to monitor and record the hydrogen sulfide levels on the plants SCADA system.

The scrubber system was originally designed to exhaust odorous air from the preliminary treatment area (grit and screenings) and the control room (vacuum filter) in the Operations Building. Over time, the ductwork for the scrubber system was modified by capping areas from less odorous spaces in the Operations Building and new ductwork was added to exhaust odorous air from the rotary drum thickener, sludge hauling truck vent, primary sludge storage tank and primary settling tanks.

GU currently also has a contract with Evoqua Water technologies to monitor and add chemicals to the collection system to minimize the release of sulfides as wastewater is conveyed to the WPCF. The proprietary chemical Bioxide, is currently added at the Plant Street Pump Station and Eastern Point Pump Station for this purpose.

Odor Complaints

Plant staff have been and continue to maintain the facility to minimize odors from the daily operations of the treatment plant. Odor complaints are typically limited to one neighbor who resides across the street from the facility. GU maintains an active odor control log and records information including date, description of event, temperature, air quality index and H_2S readings at both the Eastern Point and Electric Boat Pump Stations. Numerous odor complaints have been recorded and logged by GU since July 2019. However, there does not appear to be any correlation of the complaints to the days when the H_2S readings were at their highest at either the Eastern Point or Electric Boat Pump Stations or both, nor is there an apparent correlation between the days of the odor complaints and the higher H_2S readings at the outlet stack of the scrubber.

Review of Past Odor Studies

Odor Control Studies from past evaluations were provided to Wright-Pierce for review. A site visit was conducted by Hazen and Sawyer on June 3rd, 2020, to evaluate the existing facility and operations towards understanding potential odor sources and mitigation measures at the facility. A site visit from CT DEEP was also conducted on September 14th, 2020 based on GU's request due to the number of odor complaints received from a single source adjacent to the facility. Additionally, as part of the facilities planning study, Tighe and Bond evaluated the existing scrubber system in 2013 and provided recommendations to upgrade/replace the system.

The findings from the Hazen and Sawyer report indicated that on the day of the site visit detectable odors were generally low. The engineers walked all the process areas at the facility to investigate odor emission levels from each process. The report indicated that the screenings dumpster had a strong, localized odor which dissipated at a short distance from the container. Operational practices at the facility which may have been exacerbating odor generation was not observed by Hazen and Sawyer per the site report. The report summarized a list of housekeeping recommendations to monitor odor complaints including evaluating the efficiency of the existing scrubber system based on the usage of the chlorine tablets.

The DEEP report summarized the site visit conducted by CT DEEP staff on September 14th, 2020. The odor survey was conducted at the request of GU. The report summarized that the odor control and plant process system appeared to be operating properly with no odors noted beyond the plant boundaries based on a walkthrough of each process area including the remote pump stations.

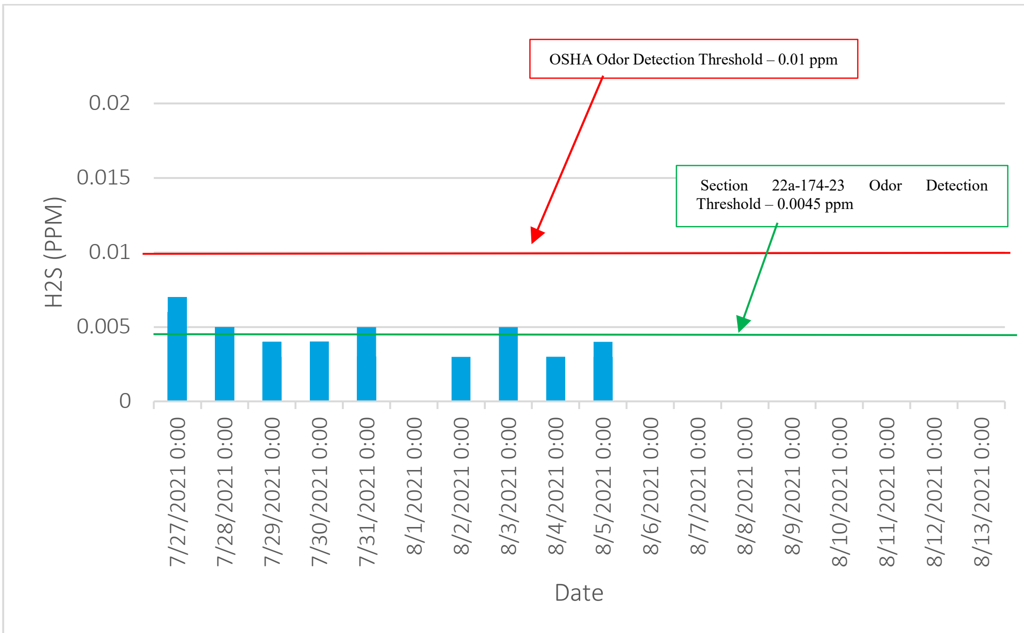
III. ODOR CONTROL MONOTORING

In order to further investigate the odor complaints, fence line monitoring was conducted to collect odor emission levels from July 27th, 2021 to August 13th, 2021. Wright-Pierce staff rented an Acrulog H_2S gas monitor to collect continuous data for this period. The Acrulog monitor can collect H_2S data in both parts per million (ppm) and parts per billion (ppb) which are typical units to measure odor levels. For the purpose of this evaluation, a model that collected data in ppb was utilized. The Acrulog H_2S monitor was installed at the entrance gate of the WPCF.

Figure 1 shows the H_2S levels in PPM vs time. According to OSHA, the odor detection threshold for H_2S when a rotten egg smell is first noticeable is between 0.01 to 1.5 ppm (OSHA). However, the detection threshold concentration for hydrogen sulfide is defined in Section 22a-174-23 of the Regulations of Connecticut Agencies at slightly lower at 0.0045 ppm, which is a commonly used value in the wastewater industry and the baseline value used in this evaluation. The minimum and maximum H_2S levels measured during the sampling period from July 27th, 2021 through August

13th, 2021 ranged from 0.000 ppm to 0.007 ppm which are well below the odor detection threshold limit published by OSHA but slightly above the odor threshold limit published in Section 22a-174-23 of the State of Connecticut Regulations.

FIGURE 1
GROTON CT, WPCF FENCELINE ODOR SAMPLING

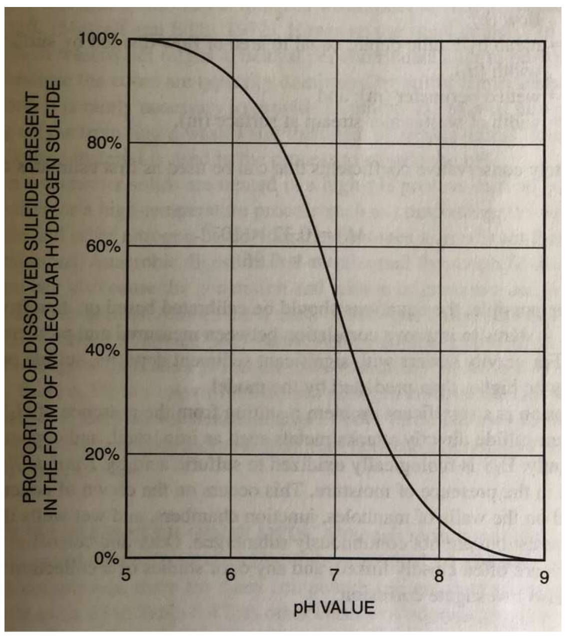


For comparison, H_2S readings at the Eastern Point Pump Station and Electric Boat Pump Station average 2.4 and 2.0 ppm respectively, with maximum readings of 127.0 and 255.7 ppm respectively. These concentrations are well above the odor threshold and any recorded readings at the WPCF fenceline during testing.

Plant staff also purchased a Drager bellows pump to measure organic sulfur compounds at the influent of the plant. The GU collection system includes several pump stations and additionally receives flow from the pump station at Electric Boat that tends to store wastewater at its facility for longer than normal periods prior to discharging its wastewater to the GU WPCF. Typically, wastewater subjected to anaerobic conditions in the waste stream often contain reduced sulfur compounds. Based on 4 measurements collected by plant staff between July 27th, 2021 and August 3rd, 2021 in the preliminary treatment area where influent wastewater first comes into the plant, organic sulfur compounds were not detected during any of the sampling events.

Additionally, W-P reviewed the plants influent data for the period of January 2018 to April 2021 to confirm the influent pH received at the facility. The data showed that the influent pH at the facility ranged from a minimum of 5.90 units to a maximum of 8.30 units with an average reading of 7.32 units. The *Water Environment Federation (WEF) Manual of Practice 25 - Control of Odors and Emissions from Wastewater Treatment Plant* indicates that the pH of wastewater has an important role in determining the amount of molecular H_2S gas available to be released to the sewer atmosphere. **Figure 2** shows a graphical representation of proportion of dissolved sulfide present in the form of molecular hydrogen sulfide vs pH.

FIGURE 2
RELATIVE CONCENTRATION OF DISSOLVED MOLECULAR H_2S



At pH 6.0 units, 90% of dissolved sulfide is present as dissolved gas and at a pH of 8.0 units less than 10% is available as gas for release from wastewater. A decrease of one pH unit in wastewater can significantly increase the release of H_2S gas in the collection system potentially causing odor and corrosion problems. Since GU injects chemicals (Bioxide) in the collection system, the release of sulfide gas into the atmosphere is significantly reduced which helps to minimize and better control odor emissions when wastewater enters the treatment facility.

IV. EVALUATION OF EXISTING SCRUBBER DATA

Plant staff installed a hydrogen sulfide probe in Fall 2020 at the odor scrubber discharge stack to monitor and record the hydrogen sulfide levels and take necessary corrective measures in case the H_2S levels are high. The hydrogen sulfide probe provides an alarm on the plant's SCADA system. The hydrogen sulfide levels are measured on an hourly basis and recorded by plant staff. **Table 3** shows a summary of minimum, average and maximum H_2S levels at the scrubber outlet from a period of January 1st 2021 to September 2nd 2021.

TABLE 3
SCRUBBER OUTLET H_2S DATA
JAN TO SEPT 2021

Month	Minimum (PPM)	Average (PPM)	Maximum (PPM)
January	0.02	0.03	0.03
February	0.02	0.03	0.03
March	0.02	0.03	0.03
April	0.02	0.03	0.04
May	0.02	0.03	0.22
June	0.02	0.03	0.24
July	0.02	0.03	0.38
August	0.01	0.05	0.69
September	0.02	0.12	0.45

Based on the data shown in the table the odor levels are present at the discharge stack and are slightly higher than the typical minimum H_2S odor detection threshold limit of 0.0045 ppm during the winter and early spring months but increase during the warmer, summer months which is to be expected. The exhaust stack for the scrubber is approximately 22.0 ft above the ground level and in line with adjacent homes on Thames Street. The scrubber stack is 24.0" in diameter and reduces down to 19.0" in diameter to improve dispersion of the scrubber exhaust. The total existing air flow in the stack ductwork was not evaluated as part of this evaluation. If the fan is operating at the original rated capacity of 8,000 cfm, a typical velocity of 4,065 ft/min can be expected at the exhaust outlet to disperse the odor exhaust. However, due to the age of the fan, which is 36 years old, if there is reduced capacity in the fan it may not produce sufficient velocity to disperse the exhaust from the stack. This issue can be exacerbated on a low windy day since the height of the stack tip is approximately at the same elevation of the adjacent homes on Thames Street.

Unfortunately, plant staff does not currently have any means to measure the influent H_2S loading to the scrubber. Having a probe to measure the influent concentrations to the scrubber would allow us to have a better understanding of the removal efficiency of the existing scrubber and take additional measures to reduce the outlet odor emissions.

V. SCREENING OF ODOR CONTROL ALTERNATIVES

As indicated, Groton Utilities (GU) is currently in the process of performing a comprehensive wastewater facility planning study of its WPCF. As part of the study, new process equipment and operational changes may be recommended which will require upgrading the odor control system to meet the design H_2S loading conditions as well as the need to draw from additional points in the plant.

Because influent H_2S loadings from each process area is not available, it would be beneficial to perform additional continuous odor monitoring at each of the process areas that are currently being exhausted to the scrubber system if replacement is deferred. If GU decides to replace the scrubber now, it will either need to be designed for expansion or a separate unit may need to be installed to accommodate any additional potential odor sources. Based on our past odor control experience of similar wastewater treatment plants the following odor control treatment alternatives are typically used to provide treatment:

- Wet Chemical Scrubber
- Activated Carbon System
- Biofilter
- Biotrickling Filter

A biofiltration unit was not considered any further as they typically require a large footprint, and the GU WPCF is limited in space. Additionally, a biotrickling filter was also not considered. Biotrickling filters are highly effective in removing hydrogen sulfide and can also be effective with mercaptan and other reduced sulfur compounds, but performance is highly dependent on temperature. Optimum performance is achieved when exhaust air temperature is greater than 70°F, and in general exhaust air temperature must be greater than 50°F for adequate removal rates.

The next section provides a summary of technologies that are feasible along with advantages and disadvantages of each. Please note that regardless of the chosen system, 100% odor removal is not possible.

Wet Chemical Scrubber System

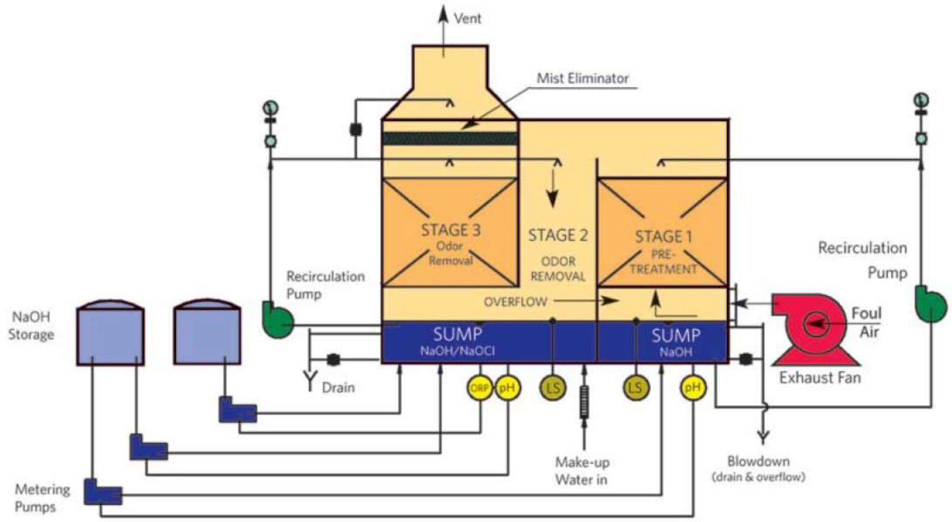
Wet scrubbing includes a range of potential configurations for applying water and chemical solution to remove contaminants from an air stream. Packed-bed scrubbers are by far the most common wet scrubber configuration for treating hydrogen sulfide and other reduced sulfur compounds typical of wastewater odor control applications.

Wet-chemical packed-bed scrubbers are a proven technology for treating hydrogen sulfide (H_2S), mercaptans, and other reduced-sulfur compounds using sodium hydroxide to enhance removal and sodium hypochlorite to oxidize removed contaminants. Packed-bed scrubber systems can be provided with a single, dual or multi-stage configuration with varying bed depths depending on the concentration of contaminants to be removed. **Figure 4** shows a schematic for a multi-stage packed-bed scrubber system in a single horizontally oriented vessel.

Some of the advantages and disadvantages of these systems include:

- Packed-bed scrubber systems can be highly effective and reliable but do have high operational complexity and significant safety considerations due to the chemical feed.
- Wet chemical scrubbers are most effective with relatively steady inlet conditions and can have difficulties treating short-term spikes in incoming contaminant concentrations.
- Wet chemical scrubbers can handle very high contaminant loadings – for example hydrogen sulfide levels up to 500 ppm, but with commensurate high chemical and water use/blowdown.

FIGURE 4
WET CHEMICAL SCRUBBER SCHEMATIC



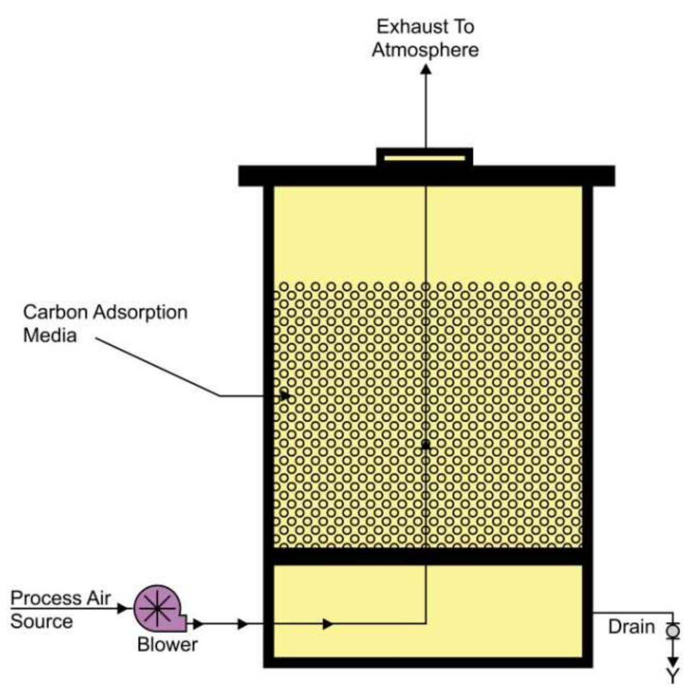
- While high chemical costs are a consideration, the chemical usage can be tailored within certain limits to the concentration of the incoming contaminants using pH and ORP control.
- Water use can also be high, especially for higher loadings. A portion of the recirculated scrubbing liquid must be "wasted" or "blown down" to sewer to prevent the buildup of contaminants, and fresh make-up is needed to replace the blow down.
- When the blow down rate is not high enough, precipitates can form that cause plugging and reduce scrubber performance. This necessitates removal of the packing for cleaning to remove the precipitate.
- Chemical storage needs to be taken into consideration. Sodium hypochlorite use will be significantly higher than sodium hydroxide and will require significantly more storage volume.
- Wet chemical scrubbers require a moderate footprint – moderately low if hypochlorite is already available from other uses. They can be located outside, but operation and maintenance is greatly facilitated if located indoors. If located outside, freeze protection is required including heat tracing the recirculation pumps and piping and the chemical feed lines and use of a sump heater for the scrubber liquid.

Activated Carbon System

Activated carbon systems utilize granular carbon media to remove odorous compounds through adsorption. There are a range of types of activated carbon and similar adsorptive media, with varying capabilities for the hydrogen sulfide and reduced sulfur compounds characteristic of the sludge holding tank exhaust. For hydrogen sulfide alone, the new "high capacity" carbons have significantly improved the cost effectiveness of activated carbon, and concentrations as high as 5 ppm can be treated cost effectively. Reduced sulfur compounds are more complicated and are best treated with a different activated carbon in a dual bed configuration.

Figure 5 shows a schematic of a single deep-bed system. Carbon systems also include radial bed configurations where flow is introduced to a plenum on the outside wall of the vessel and drawn out from the center. Both deep bed and radial designs can be provided with dual beds with different types of media. However, the radial design requires the installation of an additional plenum which increases the cost somewhat. For this capacity application, the radial flow would be more cost effective for a single bed design, but likely the same or more expensive for dual beds.

FIGURE 5
ACTIVATED CARBON SCHEMATIC



Some of the advantages and disadvantages of activated carbon include:

- Generally, the easiest system in terms of operation and maintenance requirements.
- The units require a grease and mist eliminator prior to the vessel with a mesh pad that needs to be removed about monthly for cleaning.
- Capital costs are relatively low. Overall cost effectiveness depends on the concentration of contaminants and the frequency that media replacement must be carried out.
- Often used as a second “finishing” step after other technologies.
- Moderately low space requirements.

VI. EVALUATION OF ALTERNATIVES

The following alternatives were considered as part of this evaluation:

- Alternative No.1: Reuse existing scrubber followed by a carbon system
- Alternative No. 2: New Packed Bed Wet Chemical Scrubber System
- Alternative No. 3: New Carbon System

Alternative No. 1: Renovate existing scrubber followed by a carbon system

The existing scrubber system has performed adequately in the past. Currently, the removal efficiency of the scrubber is unknown and based on H_2S levels recorded at the exhaust stack, it appears the H_2S concentrations are above the published threshold limit of 0.01 ppm (OSHA) and 0.0045 ppm (Section 22a-174-23 of the Connecticut State Regulations). The existing scrubber vessel is 36 years old and is manufactured of FRP which has a typical usable life of 40-50-years if well-constructed. If the intent is to reuse the existing scrubber vessel, this should be inspected by the FRP vessel manufacturer to estimate its remaining usable life.

The existing fan has exceeded its design life which will require replacement. The capacity of the existing fan is 8000 cfm with a static pressure of 7 inches of water column (W.C.). The new fan should be designed to meet the ventilation capacity and static pressure of the new processes recommended as part of the Facilities Plan Study. Likewise, the existing media, demister, recirculation piping and spray chambers piping will need to be replaced in kind.

The plant discontinued the use of sodium hypochlorite tanks and ORP/pH probes that monitor the addition of chemical to scrub the H_2S from the air to the liquid stream. Scrubber systems are relatively complex to operate and maintain due impart to the chemical safety considerations. However, a new sodium hydroxide and sodium hypochlorite chemical storage tank and chemical feed pumps with necessary probes will offer better removal efficiency of the scrubber system when compared to chlorine tablets that the facility currently uses.

The existing system can be retrofitted with a polishing step using a new activated carbon system to further reduce odor constituents that are not removed by the wet chemical scrubber.

Alternative No. 2: New Packed Bed Wet Chemical Scrubber System

Install a new three stage, low profile wet chemical scrubber system to treat process areas currently odor controlled at the facility and designed for expansion if required for new process areas requiring odor control that may be recommended as part of the Facilities Planning Study. Packed bed wet chemical scrubbers are effective in removing NH_3, H_2S and organic sulfides and can fit in smaller areas. Additionally, a multistage scrubber offers the ability to use less chemicals based on the configuration of the odor control system.

Alternative No. 3: New Activated Carbon System

The feasibility of an Activated Carbon System as a stand-alone technology can be established based on the additional testing conducted to establish the sulfur loading rates to the existing scrubber. Typically, high contaminant loadings would result in the need for frequent media replacement. Activated carbon systems has been successfully installed to treat odors from influent screening areas, primary tank launders, etc. at numerous treatment plants similar to GU's. However, if high odor emissions exist in the sludge storage tanks and the truck vent, this can significantly reduce carbon media life requiring frequent and expensive replacement.

VII. CONCLUSIONS AND RECOMMENDATIONS

The existing scrubber system, odor control fan, ductwork and dampers have served the facility well since installation in 1985. Based on our evaluation, the system has reached its anticipated useful life and is not currently operating as originally designed. Therefore, rehabilitation or replacement is recommended based on one of the three alternatives discussed above. In order to properly size and select a new system to serve the facility, the following additional work is recommended during the preliminary and final design phases:

- Conduct inlet H_2S monitoring of the existing odor control system and point sources to determine the actual odor loadings of the plant as well as removal efficiency of the existing equipment
- Determine all areas requiring odor control and size the new system based on that required exhaust air volume and anticipated odors
- Determine if any of the existing ductwork can be re-used
- Work with WPCF staff to locate the new unit on-site
- Conduct a present worth evaluation of the three alternatives
- Further investigate the potential source of odors outside the fence line of the WPCF and work to adjust or add Bioxide to other locations in the collection system
- Develop contract documents for bidding and construction

Should GU wish to implement the design and installation of a new odor control system to replace the existing scrubber prior to the completion and implementation of the recommendations of the Facilities Plan, the system should be designed to service the preliminary treatment area, rotary drum thickener and truck loading area only. Separate system(s) can be designed and installed as future treatment process changes occur, or the new system can be designed for future expansion. GU may also wish to defer installation until the Facilities Plan is completed if it is determined that a more comprehensive upgrade to the facility could receive sufficient priority points to be eligible for CWF grant/loan funding.

Proposed Project Schedule

A preliminary schedule to evaluate, design and install a new odor control system as a separate project has been prepared in **Table 4** to provide an understanding for the length of time a project of this magnitude would take in today's bidding and construction climate. The schedule assumes task order execution in October 2021 and should be extended accordingly based on that assumed start date. Please note equipment lead times are currently extended out in the 6 to 12 month range due to supply chain and raw material issues with wood, steel and resin materials to fabricate fiberglass components.

TABLE 3
ANTICIPATED PROJECT SCHEDULE

Milestone	Date
Submit Draft Odor Evaluation Memorandum	September 2021
Address GU Comments and Submit Final Odor Evaluation Memorandum	September 2021
Submit Scope and Fee for Design	October 2021
Execute Task Order	October 2021
Begin Preliminary Design Field Work	November 2021
Evaluate Data and Select Technology & Develop Construction Costs	December 2021
Begin Final Design Drawings and Specifications	January 2022
100% Contract Documents Completed	March 2022
Advertise for Bid	April 2022
Open Bids	May 2022
Award Contract	June 2022
Start Construction	September 2022
Construction Complete and Unit On-line	June 2023

Appendix F
CTDEEP Storm Resiliency Guidance Documents

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

79 Elm Street • Hartford, CT 06106-5127 www.ct.gov/deep Affirmative Action/Equal Opportunity Employer

Clean Water Fund Memorandum (2017-001)

Storm Resiliency of Municipal Wastewater Infrastructure

I. PURPOSE

To provide municipalities with requirements to prepare existing and proposed wastewater infrastructure to be resilient and better withstand the effects from severe weather events and expected climate change impacts including, but not limited to, increases in the frequency and severity of precipitation events, flooding, storm surge, wave action and sea level rise concerns.

II. GOVERNING AUTHORITIES

A. In 1998, Section 7 of Public Act 08-98 "An Act Concerning Global Warming Solutions" required the Governor's Steering Committee on Climate Change to establish an Adaptation Subcomittee to evaluate projected impacts of climate change on Connecticut agriculture, infrastructure, natural resources and public health, and develop mitigative and adaptive strategies to address those impacts. The 2011 Connecticut Climate Prepardness Plan created on the heels of this Public Act made a series of recommendations related to wastewater infrastructure including:

"Consider climate change as a part of DEEP facility planning checklist for public/community wastewater treatment plants financed through the Clean Water Fund" and "Consider climate change effects and adaptation in life cycle and asset planning for treatment plant reconstruction and operations and maintenance"

B. CGS Section 22a-92 establishes goals and policies under the Connecticut Coastal Management Act. In 2012, Public Act 12-101 added CGS Section 22a-92(5), which indicates that projects subject to the Connecticut Coastal Management Act shall:

"…consider in the planning process the potential impact of a rise in sea level, coastal flooding and erosion patterns on coastal development so as to minimize damage to and destruction of life and property and minimize the necessity of public expenditure and shoreline armoring to protect future new development from such hazards".

C. In 2013, Public Act 13-15 added Section 22a-478 (a) (8) to the Connecticut General Statutes (CGS), so that Clean Water Fund (CWF) projects must consider:

"the necessity and feasibility of implementing measures designed to mitigate the impact of a rise in sea level over the projected life span of such project."

D. Public Act 13-179 redefined "Rise in sea level" in CGS Section 22a-93 as:

"the arithmetic mean of the most recent equivalent per decade rise in the surface level of the tidal and coastal waters of the state, as documented in National Oceanic and Atmospheric Administration online or printed publications for said agency's Bridgeport and New London tide gauges."

E. Chapter 476a of the CGS (Section 25-68) defines Connecticut Flood Management Act (FMA) requirements in the State.

CGS Section 25-68d requires all state-funded projects to secure a certification or exemption if the projects is located within or affects floodplains or natural or man-made storm drainage facilities.

F. Sections 25-68h-1 through 25-68h-3 of the Regulations of the Connecticut State Agencies (RCSA) are the Connecticut floodplain management regulations. Section 25-68h-2(b) establishes restrictions which pertain to all new and substantially improved structures within the floodplain.

G. CGS Section 8-23 establishes a requirement for municipalities to amend or adopt a plan of conservation and development at least once every ten years. CGS Section 8-23(d)(11) indicates that the plan of conservation and development shall consider sea level rise.

III. FLOOD PROTECTION CRITERIA AND REQUIREMENTS

For all state-funded wastewater projects, the design criteria must adhere with the minimum flood protection levels included in the FMA requirements pursuant to CGS Section 25-68. The DEEP has also determined that state-funded wastewater projects must also adhere to the minimum flood protection levels in *TR-16 Guides for the Design of Wastewater Treatment Works* (TR-16), as may be amended. If there are any discrepancies between the applicable design standards regarding minimum levels of protection, the more conservative level shall prevail.

Not withstanding any of the requirements listed herein, new or rehabilitated wastewater infrastructure must be able to provide for uninterrupted operation and be protected from physical damage during a 100-year storm.

To meet these requirements, the DEEP strongly encourages municipalities to avoid the placement of new wastewater infrastructure within the 100-year flooplain, if possible. Should this avoidance be technically and/or economically unfeasible, all critical wastewater equipment and structures must be flood protected to the 100-year storm plus 3 feet, at a minimum. In addition, the DEEP may determine that certain critical activities may require flood protection to the 500-year (0.2%) flood elevation, as it is required with the storage of hazardous materials. All non-critical wastewater plants, facilities and pump stations must be be flood protected to the 100-year storm plus 2 feet, at a minimum.

A resiliency evaluation must be conducted during planning and/or early stages of design to determine for each existing or new structure and treatment system component whether it is considered critical per the FMA requirements pursuant to CGS Section 25-68b; and/or TR-16. The DEEP reserves the right to make a final determination on the criticality (i.e., critical versus non-critical status) of structures and equipment and the minimum levels of protection to be incorporated on a case-by-case basis.

Planning and/or design scopes of work previously approved without the resiliency evaluation will require amending to include this evaluation.

IV. GUIDANCE

Municipalities performing facility planning and/or design of upgrades to existing or planned wastewater infrastructure must evaluate and recommend, as applicable, all necessary measures to prepare critical infrastructure or equipment to better withstand the effects from severe weather events and climate change impacts, using best available actionable science and design criteria.

Greater vulnerability and complexity of wastewater infrastructure may require a more comprehensive resiliency evaluation. Facilities located in or near the coastal zone or in tidal areas must consider projected sea level rise over the life span of wastewater infrastructure or equipment. In addition, where appropriate, other factors such as storm surge, wave run-up, shoreline erosion, etc. should also be considered.

First, the resiliency evaluation should confirm the Base Flood Elevation (BFE), and Top Of Concrete (TOC) elevations associated with existing or proposed infrastructure within the entire footprint of the treatment or conveyance facility to determine what lies in the 100-year floodplain. It is also useful to determine what lies in the 500-year floodplain, such as hazardous materials. The resiliency evaluation should also include hydraulic profiles identifying areas of vulnerability.

The BFE may be determined using the appropriate Federal Emergency Management Agency (FEMA) Flood Insurance Study and accompanying Flood Insurance Rate Map (FIRM). More recent FEMA flood mapping products, including Advisory Base Flood Elevation Maps, working maps, preliminary updated Flood Insurance Rate maps or FEMA non-regulatory RiskMAPs may be available in some locations. Check with the National Flood Insurance Program state coordinator at the DEEP; or the FEMA flood map service center at msc.fema.gov for the status of FEMA flood mapping products in your project area.

If more recent FEMA maps have higher BFEs, those elevations should be considered. If the FIRM depicts the project area within a floodplain that is suspected to be overly conservative, a revised floodplain must be supported with extensive field data, subject to DEEP approval. Such data should include a bathymetric study of the waterbody(ies) associated with the mapped floodplain, and a detailed topographic survey of the area prone to flooding. It is not sufficient for the municipality to say that its staff has never seen the project area flood, and therefore the project area does not require flood protection.

The resiliency evaluation should account for the hydrostatic and dynamic forces exerted by flood waters. The resiliency evaluation should also consider several worst-case scenarios that may occur during severe weather, which will be unique to each facility and each municipality.

The resiliency evaluation may select the appropropriate level of protection using one or more of the following approaches:

- Freeboard Value Approach (FVA): Freeboard (100-year base flood elevation + X, where X is 3 feet for critical actions and 2 feet for other actions);
- Climate-Informed Science Approach (CISA): Utilizing the best-available, actionable hydrologic and hydraulic data and methods that integrate current and future changes in flooding based on climate science;
- 0.2 percent annual chance Flood Approach: 0.2 percent annual chance flood (also known as the 500-year flood); or
- The elevation and flood hazard area that result from using any other method identified in an update to the Federal Flood Risk Management Standard (FFRMS).

Existing facilities planned for upgrade shall be improved to the maximum extent possible to meet the flood protection criteria described above. However, floodproofing measures may be allowed where elevation of equipment or structures may not be feasible, including but not limited to:

- The use of stop logs at entrances;
- Raising motor drives and pumps;
- Lab cabinets with positive latching systems to prevent lab chemicals from mingling with floodwaters;
- Storage at the highest practical elevation;
- The use of water tight enclosures;
- The use of equipment capable of withstanding flooding and;
- The use of quick-connect and/or disconnect mechanisms to enable equipment relocation and facilitate post-storm recovery tasks.

DEEP will verify adherence to the above-discussed requirements through the review of facilities planning reports, plans and specifications documents, and flood management certification process. Failure to comply with these requirements may render all or portions of a project ineligible for CWF funding assistance.

V. ADDITIONAL RESOURCES FOR MUNICIPALITIES

The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) at UCONN helps communities identify critical infrastructure that is at risk, measures the vulnerability, and identifies ways to reduce that vulnerability. CIRCA's mission is to help Connecticut's towns and cities be more resilient to the impacts of climate change and extreme weather. In order to do so, CIRCA researchers are making climate change predictions for Connecticut.

Importantly, a recent CIRCA report developed a predicted static sea level rise of 0.5 meters by 2050 along the Connecticut coastline. This static sea level rise prediction does not take into account tidal cycle, wave action or any other factors that may exacerbate storm surge. Information relating to calculating current and future flood risk from precipitation changes under climate change, modeling sea level rise and storm surge inundation, and others can be found on CIRCA web site at http://circa.uconn.edu/ .

VI. DEFINITIONS

Base Flood Elevation (BFE) is the topographic elevation having a one percent chance of being equaled or exceeded by flood waters in any given year. This is the regulatory standard also referred to as the "100-year flood" elevation.

CISA: Climate-Informed Science Approach

CIRCA: Connecticut Institute for Resilience and Climate Adaptation at UCONN

CGS: Connecticut General Statutes

Critical Activity: Any activity deemed to be vital to the core operation of wastewater facilities or that will prevent a facility to return to full function as safely and quickly as possible after a flood event. Per CGS Section 25-68b, this means any activity, including, but not limited to, the treatment, storage and disposal of hazardous waste and the siting of hospitals, housing for the elderly, schools or residences, in the 0.2 per cent floodplain in which the commissioner determines that a slight chance of flooding is too great.

Critical Equipment: According to TR-16, critical equipment includes conveyance and treatment system components identified for protection including, but not limited to, all electrical, mechanical, and control systems associated with pump stations and treatement facilities that are responsible for conveyance of wastewater to and through the treatment facility to maintain primary treatment and disinfection during the flood event. Other equipment that, if damaged by flood conditions, will prevent the facility from returning to pre-event operation after cessation of flood conditions is also critical equipment.

CWF: Connecticut Clean Water Fund

DEEP: Connecticut Department of Energy and Environmental Protection

EPA: Environmental Protection Agency

FEMA: Federal Emergency Management Agency

FFMRS: Federal Flood Management Risk Standard

FIRM: Flood Insurance Rate Map

Floodplain: That area located within the real or theoretical limits of the base flood or base flood for a critical activity.

FMA: Connecticut Flood Management Act

FVA: Freeboard Value Approach

PFA: Percent Annual Chance Flood Approach

RCSA: Regulations of the Connecticut State Agencies

TOC: Top of concrete elevation is defined as the lowest elevation that would provide infrastructure with structural protection from severe weather impacts such as from anticipated flood conditions.

TR-16: Technical Report #16, as may be amended, entitled *Guides for the Design of Wastewater Treatment Works*, prepared by the New England Interstate Water Pollution Control Commission.

November 14, 2017
Date

Denise Ruzicka, Director
Water Planning & Management Division
Bureau of Water Protection & Land Reuse

Connecticut Department of
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December 26, 2018

In accordance with Public Act 18-82, the University of Connecticut shall update and publish the sea level change scenarios published by the National Oceanic and Atmospheric Administration (NOAA) in Technical Report OAR CPO-1, and the Commissioner of the Department of Energy and Environmental Protection shall publish the sea level change scenario for the state. Such sea level change scenario shall guide municipal and state planning in the manner described in Public Act 18-82, including its use in the following planning documents:

1. Municipal evacuation or hazard mitigation plans;
2. The state's civil preparedness plan and program;
3. Municipal plans of conservation and development; and
4. Revisions to the state's plan of conservation and development.

The Connecticut Institute for Resilience and Climate Adaptation (CIRCA) at the University of Connecticut has updated the sea level change scenarios as required in Public Act 18-82. The analysis supporting this recommendation is available in the report entitled Sea Level Rise in Connecticut by James O'Donnell, available online at: https://circa.uconn.edu. The CTDEEP conducted a hearing on October 2, 2018 and published a Hearing's Officer's Report on December 21, 2018.

I hereby adopt CIRCA's recommended sea level change scenario as described in the Final Sea Level Change Scenario Report, and more specifically:

The sea level rise scenario shall be 0.5 m (1 foot 8 inches) higher than the national tidal datum in Long Island Sound by 2050.

The sea level change scenario report along with the hearing officer's report are published on the Department of Energy and Environmental Protection website.

Robert J. Klee
Commissioner

Connecticut Department of
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How to Calculate the 500 year Flood Elevation in a FEMA Designated Coastal Flood Hazard Area For the Purposes of Obtaining a Flood Management Certificate from DEEP

In the State of Connecticut activities, such as the construction of schools, hospitals, residential structures and the storage of hazardous or contaminated material in a floodplain are considered to be a critical activity. Critical activities are regulated to the 500 year Base Flood Event (BFE) when applying to the Department of Energy & Environmental Protection (DEEP) for a Flood Management Certification (FMC).

The Federal Emergency Management Agency (FEMA) has recently updated the Flood Insurance Studies (FIS) and Flood Insurance Rate Maps (FIRMS) for the state of Connecticut. The new FIS, that were published for Connecticut's coastal communities calculate only the still water elevation for the 500 year storm event in coastal flood hazard areas. The still water elevation does not include the wave crest elevation and therefore is not considered to be the 500 year BFE in a coastal flood hazard area.

DEEP, Inland Water Resources Division (IWRD) is recommending to applicants that they calculate the 500 year BFE in a coastal flood hazard area by following FEMA's Technical Fact Sheet 1.6 *Designing for Flood Levels Above BFE* dated December 2010. FEMA Technical Fact Sheet 1.6 suggests that the elevation for the 500 year flood event in a coastal flood hazard area can be approximated by multiplying the elevation of the 100 year BFE by 1.25. In the event an applicant may feel that using this method is inaccurate or too conservative, the applicant is at liberty to contact FEMA for a copy of the most recent coastal flood model and revise this model accordingly in order to obtain a more accurate 500 year BFE. Model revisions and analysis must be prepared by a Licensed Professional Engineer familiar with coastal storm surge and flood modeling, and using the most recent and best available data and science. The IWRD reserve the right to review and either approve or contest revised model results.

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FEMA Fact Sheet

Using the Limit of Moderate Wave Action to Build Resilient Coastal Communities

Coastal communities are special places and home to vital resources. What makes them so distinctive also creates a high risk of flooding. Floods are the nation's costliest natural disasters. Coastal areas are dynamic environments that are constantly reshaped by the forces of nature. Coastal communities face a range of flood hazards, including storm surge, waves and erosion. All of these can cause extensive damage to homes, businesses and infrastructure. Waves, in particular, can damage properties farther inland than one would expect.

Flood Maps in Coastal Areas

Flood maps, or Flood Insurance Rate Maps (FIRMs), show Special Flood Hazard Areas (SFHA) — the areas affected by a 1%-annual-chance flood. Properties in SFHAs have a high risk of flooding. These areas have at least a 26% chance of flooding over the course of a 30-year mortgage. In coastal areas, the SFHAs are designated primarily as Zone VE or AE.

- **Zone VE,** a Coastal High Hazard Area, is where waves and fast-moving water can cause extensive damage during the 1-percent-annual chance flood. Wave heights of 3 feet or higher are expected.
- **Zone AE** is used for areas that have at least a 1% chance of being flooded in any year, but wave heights are expected to be less than 3 feet.

The primary difference between these two flood zones is potential wave damage. Structures in Zone VE have a higher risk of significant damage by the moving water and waves. As a result, buildings in Zone VE must be built to higher standards and may have higher flood insurance premiums.

What is the Limit of Moderate Wave Action?

FEMA has documented storm damage for decades. Post-storm damage shows that even 1.5-foot waves can cause significant damage to buildings that were not built to withstand them. To highlight this risk on flood maps, FEMA developed the Limit of Moderate Wave Action (LiMWA).

The LiMWA is an informational line that can be found on flood maps for some coastal areas. On a flood map, it is shown as a black line with black arrows that point to areas where wave heights are between 1.5 and 3 feet. It also marks the inland limit of the Coastal A Zone.

Figure 1: A flood map panel showing the Limit of Moderate Wave Action (LiMWA), indicated by the black lines with arrows. The arrows point toward the inland limit of the Coastal A Zone.

Using the Limit of Moderate Wave Action in Floodplain Management

Due to the higher risk of wave damage to structures in the Coastal A Zone, FEMA encourages communities to apply VE Zone floodplain managements standards in this area. Communities are also encouraged to adopt the most recent International Building Codes. These require buildings in the Coastal A Zone to meet Zone VE standards. Adopting higher construction and floodplain management standards in the Coastal A Zone may also reduce flood insurance premiums.

Zone VE standards include:

- Buildings must be elevated on pile, post, pier, or column foundations, and must be adequately anchored to the foundation.
- Structural fill is prohibited.
- The bottom of the lowest horizontal structural member be at or above Base Flood Elevation (BFE).
- The area below the BFE must be built with flood-resistant materials and free of obstructions. If it is enclosed, the enclosure must be made of lightweight wood lattice, insect screening, or breakaway walls.
- The building design and method of construction must be certified by a design professional.

Find more information on Zone VE standards in Title 44 of the Code of the Federal Regulations, Section 60.3, and the Local Officials Guide for Coastal Construction.

What are the benefits of adopting higher codes and standards for Coastal A Zones?

- Building to higher standards makes structures and the people inside them safer from wave damage. Communities that adopt higher standards for the Coastal A Zone may have less damage and be able to recover more quickly.
- Communities that adopt higher building codes and standards in the Coastal A Zone may be eligible for discounted flood insurance premium rates through the Community Rating System. More information about the Community Rating system is available here.

Building Resilience in Coastal Communities

Adopting Zone VE standards in Coastal A Zones is one step communities can take to reduce their risk and build resilience. Communities across the country are exploring more ways to move toward resilience. This may include:

- **Adding freeboard.** Many communities adopt freeboard, a factor of safety usually expressed in feet above the Base Flood Elevation. Communities with freeboard will require structures to be built a few feet above the BFE. Freeboard accounts for the many unknown factors that could contribute to flooding that is higher than the BFE.
- **Planning for future conditions.** One way to keep families, businesses, and neighborhoods safe from natural disasters is long-term planning. Communities that invest in long-term planning and forward-looking projects will see fewer impacts and are more likely to recover quickly after severe events. Preparing for the future today supports growth and health. Learn more here.
- **Incorporating nature-based solutions.** Nature-based solutions weave protective natural features into a community's landscape through planning, design, and engineering. These practices can be applied to a community's built environment (for example, a stormwater park) or its natural areas (for example, land conservation). While nature-based solutions have many hazard mitigation benefits, they can also help a community meet its social, environmental, and economic goals. Learn more here.
- **Thinking beyond flood maps.** FEMA flood mapping data can be used for more than floodplain management ordinances or explaining flood insurance purchase requirements. This story map highlights four communities that are using these data to reduce risk and build resilience in innovative ways.

Additional Resources

- To access flood maps for your community, visit the Map Service Center, or contact the Flood Mapping and Insurance eXchange (FMIX) at 877-336-2627 or FEMA-FMIX@fema.dhs.gov.
- To learn more about flood insurance, visit www.FloodSmart.gov.

Appendix G
Asset Management Reports

TO:	Evaluation Team	**DATE:**	3/23/2021
FROM:	Eric Lemoi	**PROJECT NO.:**	20471A
SUBJECT:	Fulcrum Evaluation Form User Guide		

1.1 INTRODUCTION

This Fulcrum form was created to aid the evaluator in the inspection of assets. Everything is based on industry standards for asset management. This form was put together from EPA, AWWA, IIMM. The following is a user guide that will take you step by step through the form and how to properly fill it out.

1.2 METADATA

1.2.1 Status *(This will be the last thing you fill out at the end)*

- To Do
- All Complete
- Follow-Up in Field
- Follow-Up in Office
- Asset Not Evaluated
- New Asset

1.2.2 Project *(Pre-populated. If the asset belongs to a different discipline, then change it)*

- Architectural
- Electrical
- Instrumentation and Control
- Mechanical
- Process
- Structural

1.3 ASSET DETAILS

- Asset ID
- Description *(Be as detailed as possible when adding a new asset)*
- Location (*Will be a prepopulated list to choose from)*
- Room/Area
- Installed Date (Year) *(If not available estimate based on your professional judgement)*
- Install Date Estimated *(Did you estimate the install date or get it from Plans, O&M, Etc.)*
    - Yes
    - No
- Asset Class *(Choose the category the asset best fits into)*
- Current Equipment Cost $ *(Equipment cost not including installation or engineering. Strictly cost to purchase the asset, if you do not know it will be determined in the office)*
- Manufacturer
- Model Number *(get off nameplate if available)*
- Serial Number *(get off nameplate if available)*
- Vendor

The following fields only show up if it pertains to the asset you are evaluating, based on the asset class.

- Horse Power
- Speed (RPM)
- Voltage
- Phase
- Amperage
- Frequency (Hz)
- Efficiency (%)
- Instrument/Equipment Tag Number
- Motor Type
- Flow Meter Type
- Pipe/Valve/Flow Meter Size (inches)
- Pipe/Valve Material
- Valve Type
- Valve Open Direction
- Pump Type
- Pump Rotation (viewed from the drive)
- Capacity (GPM)
- TDH (Ft.)
- Seal Type
- Shaft Seal Type

- Pump Impeller Size (inches)
- Pump Suction Size (inches)
- Pump Discharge Size (inches)
- Allowable Solids (inches)
- Output Heating Capacity (BTU)
- Nominal Airflow (CFM)
- Tank Volume (Gal)
- Generator Size (kW)
- Generator Type
- Generator Fuel Type
- Harmonic Mitigation
- Appropriate NEMA Rated
- Class
- Division
- Well Type
- Well Size
- Well Depth (Feet)

Next choose what type of asset you are evaluating. Is it a piece of equipment, a structure, or grounds?

If you are evaluating a piece of equipment you will need to include closeup photos of all defects and components of the asset. Also include a location photo to determine where in the room or area the asset is located by pointing to it in the picture. Videos can be included for items that a picture cannot capture. For example, excessive noise or vibration cannot be captured with a photo so a video will help document the condition.

- Asset Photo(s) Closeup
- Location Photo
- Video(s) OPTIONAL

1.4 ASSET ASSESSMENT SECTION

1.4.1 Physical Assessment

Based on the asset type you chose above you will have to drill in to get to the equipment, structure, or grounds inspection based on your answer. Structures have two options an architectural inspection or a structural one. Some assets might have both architectural and structural components so both will have to be completed. Once you have finished either the equipment, structure, or grounds inspection you will need to go back to return to the main form.

1.4.1.1 Equipment Inspection

Questions for evaluator. For each question please choose the answer that best describes the current condition of the equipment asset. Not every question is applicable to each asset, only answer the questions that have to do with the asset you are evaluating and leave the rest blank.

1. Verify Operation, does the asset run?
   - Yes
   - No

   Note: If no and not repairable then the asset should receive a condition score of 10
2. Are there any installation problems?
   - Yes
     - If yes provide description
   - No
3. Is there any excessive vibration?
   - Yes
     - If yes what is the max rms (inches)
   - No
4. Is there any excessive noise?
   - Yes
     - If yes what is the average dB
   - No
5. Is the temperature abnormal?
   - Yes
     - If yes what is the temperature
   - No
6. What is the condition of the coatings?
   - Inoperable
   - Poor
   - Fair
   - Good
   - Excellent

   Note: If answered fair or less a description of the defects and photos are required.
7. Are there any signs of wear or corrosion?
   - Significant
   - Apparent
   - Minimal
   - None

   Note: If answered Apparent or Significant a description of the defects and photos are required.

8. Is there any leakage of fluids?
    - Significant
    - Apparent
    - Minimal
    - None
    - N/A

    Note: If answered Apparent or Significant a description and photos are required.
9. Visual Inspection Comments

1.4.1.2 Architectural Inspection

All architectural components are rated (Inoperable, Poor, Fair, Good, Excellent) and have a photo section with each component. Anything that is rated fair or less requires a description in the comments section and photos to be taken.

Interior Components

- Flooring
- Wall Finish
- Ceiling
- Partitions
- Doors
- Vision Lites
- Stairs
- Hatches
- Interior Comments

Exterior Components

- Exterior Walls
- Exterior Doors
- Exterior Windows
- Overhead Doors
- Louvers
- Roofing
- Soffits
- Edge Trim
- Venting
- Concrete Walls
- Concrete Slabs
- Hatches, Plates, and Grating
- Railings
- Exterior Comments

1.4.1.3 Structural Inspection

All structural components have a list of possible defects to choose from and have a photo section with each component. Any defects require a description in the comments section and photos to be taken.

- Steps and Landings
- General Concrete
- Beams
- Joists
- Handrail and Guards
- Floor/Ceiling
- Column
- Roof Structure
- Coatings
- Structural Comments

1.4.1.4 Grounds Inspection

The grounds are split up into two components, Fence/gate and landscaping. Both components are rated (Inoperable, Poor, Fair, Good, Excellent) and have a photo section. Anything that is rated fair or less requires a description in the comments section and photos to be taken.

- Fence and Gate
- Landscaping
- Grounds Comments

Once inspection is complete go back to the main page of the form.

1.4.1.5 Condition Rating

The condition rating is the evaluator's professional judgement based on how they answered the inspection questions.

- 1-New or Excellent Condition
- 2-Very Good Condition
- 3-Minor Defects Only
- 4-Some Defects and Deterioration
- 5-Moderate Deterioration
- 6-Moderate to Significant Deterioration
- 7-Significant Deterioration
- 8-Significant Deterioration w/ Major Repairs Performed on Equipment
- 9-Virtually Unserviceable
- 10-Unserviceable

1.4.1.6 Reliability Rating

The reliability is based on the history of the asset. If the asset is broken down at the time of the evaluation but repairable then the type of breakdown is chosen (Random, Occasional, Periodic, or Continuous) based on operator experience. If the asset is running at the time of the evaluation, then the operators experience is used to determine the assets reliability score 1-5. How often does the asset breakdown/need repairs?

- 1-Exceptional (No Problems)
- 2-Random Breakdown (Every 5 Years)
- 3-Occasional Breakdown (Every 2 Years)
- 4-Periodic Breakdown (Once per Year)
- 5-Continuous Breakdown (Multiple Times per Year)

1.4.2 Non-Physical Assessment

1.4.2.1 Current Performance

The performance is based on operator experience. What is the assets current performance?

- 1-Meets or Exceeds all Performance Targets
- 2-Minor Performance Deficiencies
- 3-Considerable Performance Deficiencies
- 4-Major Performance Deficiencies
- 5-Does not meet any Performance Targets

Note: The performance refers to both Capacity and Level of Service failure modes. For example, if a pump is operating at the anticipated capacity but still not meeting customer demands then it should receive a higher score.

1.4.2.2 Maintainability

The maintainability is based on operator experience. What level of maintenance is performed on the asset?

- 1-Easily Maintained
- 3-Largely Preventative Maintenance
- 5-Periodic Corrective Maintenance
- 7-More Frequent Corrective Maintenance
- 9-Work Orders Well Above Average
- 10-Corrective Maintenance has become Routine

Note: Maintainability is also accounting for the Efficiency failure mode. For example, if the asset is costing more money to keep running then an alternative, it should be rated higher.

1.4.3 Consequence of Failure

The CoF section consists of 10 questions about the asset's impact if it were to fail to determine the criticality of that asset.

1. What is the Replacement Time for this asset?
    - 1-<1 day
    - 2-Between 1 Day and 1 Month
    - 3-Between 1 and 3 Months
    - 4->3 Months
2. What is the acceptable Loss of Service?
    - 1-Can be out of service indefinitely
    - 3-Cannot be down a month
    - 5-Cannot be down a week
    - 7-Cannot be down a day
    - 9-Cannot be down 8 hours
    - 10-Cannot be down one hour
3. What is the Safety Impact of Failure?
    - 1-No Impact on Public Safety
    - 3-Minimal Impact on Public Safety
    - 5-Minor Injury
    - 7-Moderate Impact on Public Safety
    - 9-Significant Impact to Public Safety
    - 10-Significant and Immediate Impact to Public Safety
4. What is the effect on the Agency's Image?
    - 1-No Media or No Consequence
    - 3-Neutral Coverage
    - 5-Adverse Media
    - 7-Widely Adverse Media
    - 9-Continual; Political Opposition
    - 10-Nationally Adverse Media

5. What is the Financial Impact of Failure?
    - 1-Insignificant
    - 3-<$10k
    - 5-<$50k
    - 7-<$100k
    - 9-<$1 Million
    - 10->$1 Million
6. What is the Economic Impact of Failure?
    - 1-Low Cost
    - 3-Moderate Cost
    - 5-High Cost
    - 7-High Cost; Diverts $
    - 9-Painful Change in Priorities
    - 10-Likely to Trigger Rate Increase, Staff Changes
7. What will the Environmental Impact of a Spill, Flood be?
    - 1-No Impact
    - 3-Short Duration Small Quantity
    - 5-Moderate Flooding, Some Offsite Spillage
    - 7-Many Inconvenienced; Moderate Health and Habitat Issues
    - 9-Severe Health and Habitat Issues; Some Mandatory Vacation of Premises
    - 10-Large Areas Vacated and Closed to Public Access; Extensive Specialized Containment Cleanup Required
8. How will failure of this asset impact Permit Compliance?
    - 1-No Consequence
    - 3-Minor Violation - Reporting Only
    - 5-Regulatory Sanction Possible
    - 7-Regulatory Sanction Likely; Damage Reversible Less Than One Year
    - 9-Extensive Regulatory Sanction Virtually Assured; Damage Reversible in One to Five Years

- 10-Severe Sanctions; Damage Reversible in Five Years or More

9. What type of redundancy does this asset have?
   - 1-200% Backup
   - 2-100% Backup
   - 3-50% Backup
   - 4-No Backup

10. What CoF criterion is driving the risk up on this asset?
    - Replacement Time
    - Loss of Service
    - Safety Impact
    - Agency's Image
    - Economic Impact
    - Financial impact
    - Spill, Flood Impact
    - Permit Compliance
    - Redundancy

1.5 FINAL COMMENTS SECTION

- Repairs Required
  - If any defects or issues are noted above then a recommendation on how to correct or repair the problem should be included here.
- General Comments
  - Only for comments that are not included above
- Reason asset was not evaluated
  - Only shows up if status is set to Asset Not Evaluated, is required
- Reason for Follow-Up
  - Only shows up if status is set to follow up in field or office, required for follow-up in field

Once the form is completely filled out please return to the top and change the status from To Do to the current status whether it's All Complete or Follow-Up, and then save the evaluation for that asset by clicking the check mark.

Facility/Room Numbering Guide

Groton, CT					
Location		Facility		Room	
No.	Description	No.	Description	No.	Description
100	**Wastewater Treatment Facility**				
		110	Operations Building		
				01	Basement
				02	Blower Room
				03	Chief Operators Office
				04	Conference Room
				05	Control Room
				06	Electric Room
				07	Lab
				08	Passageway
				09	Preliminary Treatment Area
				10	Shop
				11	Storage Room #1
				12	Truckway
				EXT	Exterior
				R01	Roof
		120	Primary Settling Tanks		
		130	Aeration Tanks		
		140	Blower Building		
				01	Basement
				02	Blower Room
				03	Corridor
				04	Garage
				05	Men's Locker Room
				06	Stairwell
				07	Storage/Laundry Room
				08	Women's Locker Room
				EXT	Exterior
				R01	Roof
		150	Final Settling Tanks		
		160	Sludge Storage Building		
				01	Basement
				02	Office
				03	Upper Level
				EXT	Exterior
				R01	Roof
		170	Digester Building		
				01	Boiler Room
				02	Gas Gallery
				03	Pump Room
				EXT	Exterior
				R01	Roof
		180	Generator Building		
		190	Maintenance Garage		
		195	Grounds		

Appendix H
Cost Estimate Backup Documentation

GROTON UTILITIES
PAF WASTEWATER FACILITY PLAN
W-P PROJECT NO. 20653
AACE CLASS 3 ESTIMATE
ENR INDEX 12684, 02/2022
PROJECT COST SUMMARY

PROJECT COMPONENT		COST	COMMENTS
CONSTRUCTION		$7,080,000	Refer to Construction Summary
CONSTRUCTION CONTINGENCY	5.0%	$350,000	Allowance
TECHNICAL SERVICES	18.0%	$1,274,000	
MATERIALS TESTING	0.50%	$35,000	Allowance
ASBESTOS & LEAD PAINT ABATEMENT		$50,000	Allowance
DIRECT EQUIPMENT PURCHASE		$0	
LAND ACQUISITION/ EASEMENTS		$0	
LEGAL/ ADMINISTRATIVE	2.0%	$142,000	Allowance
SUBTOTAL		$8,931,000	
FINANCING	1.0%	$89,000	Estimated interim interest
ENGINEER'S ESTIMATE OF PROJECT COST		**$9,020,000**	

Notes:
1) Cost estimate is based on ENR INDEX .

GROTON UTILITIES
PAF WASTEWATER FACILITY PLAN
W-P PROJECT NO. 20653
AACE CLASS 3 ESTIMATE
ENR INDEX 12684, 02/2022
CONSTRUCTION COST SUMMARY

DESCRIPTION	BID ALTERNATE	ESTIMATED COST
CIVIL		
SITE WORK		$25,000
SITE PIPING (SECONDARY SCUM & TWSL TO PRIMARY DIG)		$75,000
ARCHITECTURAL		
EPDM ROOFING - DIGESTER AND SLUDGE STORAGE BLDGs		$80,000
MISCELLANEOUS MODIFICATIONS AND FINISHES		$50,000
PROCESS EQUIPMENT AND PIPING FINISHES		$49,000
STRUCTURAL		
MODIFY INFLUENT CHANNEL FOR FLOW METER		$25,000
REPAIR DIGESTER TANK INTERIOR WALLS & COVERS		$200,000
EQUIPMENT PADS		$30,000
AERATION TANK BAFFLE WALLS		$100,000
MISCELLANEOUS PIPE SUPPORTS		$75,000
PROCESS		
DEMOLITION		$105,000
OPERATIONS BUILDING		$1,147,000
BLOWER BUILDING/AERATION TANKS		$1,447,000
DIGESTER & SLUDGE STORAGE BUILDING		$137,000
SITE/MISCELLANOUS STRUCTURES		$130,000
HVAC/ PLUMBING		
FAN IN BLOWER BASEMENT, MISC UNIT HEATERS		$30,000
INSTRUMENTATION		
INSTRUMENTATION - GENERAL		$200,000
SCADA SYSTEM HARDWARE/ SOFTWARE UPGRADE		$100,000
ELECTRICAL		
POWER & LIGHTING - GENERAL		$500,000
SPECIALS		
PERMITTING FEES		$0
PROCESS BY-PASS PUMPING		$25,000
SHEETING		$0
PILES		$0
GROUNDWATER DEWATERING (OPEN)		$0
TEMPORARY SLUDGE THICKENING/ DEWATERING		$0
TEMPORARY FACILITIES (OWNER)		$0
SITE SECURITY		$0
WINTER CONSTRUCTION		$0
GENERAL CONTRACTOR, SUBTOTAL		$3,021,000
GENERAL CONTRACTOR OH&P	10.0%	$302,000
SUBCONTRACTORS, SUBTOTAL		$1,509,000
GENERAL CONTRACTOR MARKUP	7.5%	$113,000
UNIT PRICE ITEMS	1.0%	$30,000
GENERAL CONDITIONS	10.0%	$498,000
SUBTOTAL, CONSTRUCTION COSTS		$5,473,000
PROJECT MULTIPLIER, DESIGN CONTINGENCY	15%	
PROJECT MULTIPLIER, INFLATION TO MIDPT CONST.	13%	
ENGINEERS ESTIMATE OF CONSTRUCTION COST		**$7,081,000**

GROTON UTILITIES
PAF WASTEWATER FACILITY PLAN
W-P PROJECT NO. 20653
AACE CLASS 3 ESTIMATE
ENR INDEX 12684, 02/2022

NOTE
PROCESS ITEMS SHOWN BELOW ARE EXAMPLES. EDIT ALL ITEMS, INCLUDING UNIT COSTS TO SUIT PROJECT.

PROCESS - EQUIPMENT & INSTALLATION
NOTE: 1. THIS ESTIMATE EXCLUDES ALL STRUCTURAL, HVAC/PLUMBING, INSTRUM, ELECTRICAL COSTS, UNLESS SPECIFICALLY NOTED.

EQUIP. NAME	TAG	QUAN.	UNIT	DESIGN BASIS	Unit Cost	Equipment Cost Subtotal	Installation Multiplier	Installation Cost	Multiplier - Misc. Unaccounted For Items	Extended System Subtotal	System Extended Cost, Total
					Sales Tax	0.0%			5.0%		
DEMOLITION											
MISCELLANEOUS		1	LS	ESTIMATED	$100,000	$100,000		$0	$5,000	$105,000	
											$105,000
OPERATIONS BUILDING											
INFLUENT FLOWMETER		1	EA	FLO_DAR	$20,000	$20,000	30%	$6,000	$1,300	$27,300	
BAR SCREEN		1	EA	HUBER	$225,000	$225,000	30%	$67,500	$14,625	$307,125	
GRINDER/WASHER/COMPACTOR		1	EA	JWC	$150,000	$150,000	30%	$45,000	$9,750	$204,750	
SCREENINGS CONVEYOR		1	EA	SPIRAC	$50,000	$50,000	30%	$15,000	$3,250	$68,250	
GRIT BLOWERS		1	EA	ROOTS	$20,000	$20,000	30%	$6,000	$1,300	$27,300	
GRIT PUMP		1	EA	VAUGHN	$25,000	$25,000	30%	$7,500	$1,625	$34,125	
GRIT PIPING		1	LS		$10,000	$10,000	30%	$3,000	$650	$13,650	
PRIMARY SLUDGE PUMPS		2	EA	BOERGER	$35,000	$70,000	30%	$21,000	$4,550	$95,550	
PRIMARY SLUDGE PUMP PIPING AND FM		1	LS		$20,000	$20,000	30%	$6,000	$1,300	$27,300	
THICKENED WASTE SLUDGE PUMPS		2	EA	BOERGER	$40,000	$80,000	30%	$24,000	$5,200	$109,200	
THICKENED WASTE SLUDGE PIPING		1	LS		$20,000	$20,000	30%	$6,000	$1,300	$27,300	
DIGESTED SL TRANSFER PUMPS		2	EA	BOERGER	$40,000	$80,000	30%	$24,000	$5,200	$109,200	
DIGESTED SLUDGE PIPING		1	LS		$20,000	$20,000	30%	$6,000	$1,300	$27,300	
MISC PIPING/VALVING		1	LS		$50,000	$50,000	30%	$15,000	$3,250	$68,250	
											$1,146,600
BLOWER BUILDING/AERATION TANKS											
PE PUMPS		3	EA	FLYGT	$100,000	$300,000	30%	$90,000	$19,500	$409,500	
PE PIPING		1	LS		$10,000	$10,000	30%	$3,000	$650	$13,650	
AERATION BLOWERS		3	EA	AERZEN	$65,000	$195,000	30%	$58,500	$12,675	$266,175	
AERATION PIPING/CVs/FMs		1	LS		$200,000	$200,000	30%	$60,000	$13,000	$273,000	
MIXERS		2	LS	FLYGT	$50,000	$100,000	30%	$30,000	$6,500	$136,500	
IR PUMPS		2	EA	FLYGT	$40,000	$80,000	30%	$24,000	$5,200	$109,200	
IR PIPING		1	LS		$50,000	$50,000	30%	$15,000	$3,250	$68,250	
SECONDARY SCUM PUMP		1	EA		$10,000	$10,000	30%	$3,000	$650	$13,650	
FOAM SPRAY WATER PUMP		2	EA		$15,000	$30,000	30%	$9,000	$1,950	$40,950	
WASTE SLUDGE PUMPS		1	EA	BOERGER	$35,000	$35,000	30%	$10,500	$2,275	$47,775	
SCUM, WSL, FSW MISC PIPING/VALVES		1	LS		$50,000	$50,000	30%	$15,000	$3,250	$68,250	
											$1,446,900
DIGESTER & SLUDGE STORAGE BUILDING											
HEATED SL RECIRC PUMPS		2	EA	VAUGHN	$25,000	$50,000	30%	$15,000	$3,250	$68,250	
MISC PIPING & VALVING		1	LS		$50,000	$50,000	30%	$15,000	$3,250	$68,250	
											$136,500
SITE/MISCELLANOUS STRUCTURES											
REPAIR RETAINING WALL		1	LS		$30,000	$30,000	30%	$9,000	$1,950	$40,950	
REPLACE/REPAIR SITE FENCING		1	LS		$50,000	$50,000	30%	$15,000	$3,250	$68,250	
RESET STORM CB & GATE		1	LS		$15,000	$15,000	30%	$4,500	$975	$20,475	
											$129,675
PROCESS EQUIPMENT AND PIPING FINISHES				IN DIVISION 9	2.0%	$2,195,000			$141,175		
				RANGE: 2.0-3.0% OF EQUIP COST							$49,035
				TOTAL, EXCLUDING EQUIP. AND PIPING FINISH PAINT							
						$2,195,000	29%	$628,500	$141,175		$2,964,675

COST ESTIMATE - Groton Solids Stabilization and Disposal
JOB NAME: Groton Facility Plan
JOB NO.: 20653
BY: Dennis Dievert Jr.

Alternative:	Alt 1A Digestion of PSL	Alt 1B Digestion of PSL & WSL	Alt 2A Eliminate Digestion - Dispose Liquid	Alt 2B Eliminate Digestion - Dispose of Cake
TOTAL PROJECT COST	**$1,779,000**	**$2,068,000**	**$4,026,000**	**$6,577,000**
Construction Loan Rate	2.0%	2.0%	2.0%	2.0%
Loan Term, years	20	20	20	20
Capital Recover (A/P, i%, n)	0.061	0.061	0.061	0.061
Annual Debt Payment	$109,000	$126,000	$246,000	$402,000
OPERATION AND MAINTENANCE COSTS				
Operating and Maintenance Costs				
Annual O&M Cost ($/yr)	$76,900	$69,401	$37,500	$91,300
Annual Sludge Disposal Cost ($/yr)	$274,400	$222,479	$308,500	$140,000
Total Annual O&M Cost ($/yr)	$351,300	$291,879	$346,000	$231,300
Net Present Worth ($) - O&M	$5,744,259	$4,772,640	$5,657,596	$3,782,087
Total Net Present Worth	**$7,523,259**	**$6,840,640**	**$9,683,596**	**$10,359,087**

Notes:
1. Operation assumes mid-point energy at $0.15/kwh, $0.15/gallon for liquid sludge disposal and $350/dry ton of sludge cake disposal.

COST ESTIMATE - Maintain or Eliminate Sludge Digestion

JOB NAME: Groton Facility Plan

JOB NO.: 20653

BY: Dennis Dievert Jr.

Groton, CT
Alt 1A - CONTINUE DIGESTION OF PRIMARY SLUDGE ONLY
COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Total Project Cost				**$1,779,000**
Annualized Capital Cost	20yrs @ 2% inter.		$0.0612	**$109,000**

Operating and Maintenance Cost Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
Operations Labor	416.0	Hrs/yr	$50	$20,800
Maintenance Labor	416.0	Hrs/yr	$50	$20,800
Power Usage	200,000	kw-hrs/yr	$0.150	$30,000
Sludge Disposal	1,829,090	gallons/yr	$0.15	$274,400
Insurance	0.3	%		$5,300
Total				$351,300
Total Annual Cost				
Annual Capital Cost	0.061	A/P(2%, 20 yr.)		$109,000
Annual O&M cost				$351,300
Total Annual Cost				$460,300
Life Cycle Cost	20yrs @ 2% interest		16.35	**$ 7,522,755**

Groton, CT
Alt 1B - DIGESTION OF PRIMARY AND WASTE SLUDGE
COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Total Project Cost				**$1,779,000**
Annualized Capital Cost	20yrs @ 2% inter.		$0.0612	**$109,000**

Operating and Maintenance Cost Estimate

Item	Quantity	Unit	Unit Cost	Total Cost
Operations Labor	416.0	Hrs/yr	$50	$20,800
Maintenance Labor	416.0	Hrs/yr	$50	$20,800
Power Usage	150,000	kw-hrs/yr	$0.150	$22,500
Insurance	0.3	%		$5,300
Sludge Disposal	1,483,190.0	gallons/yr	$0.15	$222,479
Total				$291,879
Total Annual Cost				
Annual Capital Cost	0.061	A/P(2%, 20 yr.)		$109,000
Annual O&M cost				$291,879
Total Annual Cost				$400,879
Life Cycle Cost	20yrs @ 2% interest		16.35	**$ 6,551,222**

Groton, CT
Alt 2A - ELIMINATE DIGESTION - DISPOSE OF LIQUID SLUDGE
COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Total Project Cost				**$4,026,000**
Annualized Capital Cost	20yrs @ 2% inter.		$0.0612	**$246,000**

Operating and Maintenance Cost Estimate

Operations Labor	104.0	Hrs/yr	$50	$5,200
Maintenance Labor	104.0	Hrs/yr	$50	$5,200
Power Usage	100,000	kw-hrs/yr	$0.150	$15,000
Sludge Disposal	2,056,668.0	gallons/yr	$0.15	$308,500
Insurance	0.3	%		$12,100
Total				$346,000
Total Annual Cost				
Annual Capital Cost	0.061	A/P(2%, 20 yr.)		$246,000
Annual O&M cost				$346,000
Total Annual Cost				$592,000
Life Cycle Cost	20yrs @ 2% interest		16.35	**$ 9,683,100**

Groton, CT
Alt 2B - ELIMINATE DIGESTION - DISPOSE OF CAKE
COST ESTIMATE

Item	Quantity	Unit	Unit Cost	Total Cost
Total Project Cost				**$6,577,000**
Annualized Capital Cost	20yrs @ 2% inter.		$0.0612	**$402,000**
Operating and Maintenance Cost Estimate				
Operations Labor	416.0	Hrs/yr	$50	$20,800
Maintenance Labor	416.0	Hrs/yr	$50	$20,800
Power Usage	200,000	kw-hrs/yr	$0.150	$30,000
Insurance	0.3	%		$19,700
Sludge Disposal	400.0	DT/yr	$350.00	$140,000
Total				$231,300
Total Annual Cost				
Annual Capital Cost	0.061	A/P(2%, 20 yr.)		$402,000
Annual O&M cost				$231,300
Total Annual Cost				$633,300
Life Cycle Cost	20yrs @ 2% interest		16.35	**$ 10,358,755**

CITY OF GROTON
FACILITY PLAN (SOLIDS HANDLING ALTERNATIVES)
20653
FEASIBILITY
[February 2022] [(ENR INDEX 12684)]
PROJECT COST ESTIMATE

PROJECT COMPONENT		Alt 1A COST	Alt 1B COST	Alt 2A COST	Alt 2B COST
CONSTRUCTION		$1,261,000	$1,466,000	$2,857,000	$4,670,000
CONSTRUCTION CONTINGENCY	10.0%	$130,000	$150,000	$290,000	$470,000
TECHNICAL SERVICES	25.0%	$315,000	$367,000	$714,000	$1,168,000
MATERIALS TESTING	1.0%	$13,000	$15,000	$29,000	$47,000
ASBESTOS & LEAD PAINT ABATEMENT		$0	$0	$0	$0
DIRECT EQUIPMENT PURCHASE		$0	$0	$0	$0
LAND ACQUISITION/ EASEMENTS		$0	$0	$0	$0
LEGAL/ ADMINISTRATIVE	2.0%	$25,000	$29,000	$57,000	$93,000
SUBTOTAL		$1,744,000	$2,027,000	$3,947,000	$6,448,000
FINANCING	2.0%	$35,000	$41,000	$79,000	$129,000
ENGINEER'S ESTIMATE OF PROJECT COST		$1,779,000	$2,068,000	$4,026,000	$6,577,000

CITY OF GROTON
FACILITY PLAN (SOLIDS HANDLING ALTERNATIVES)
20653
FEASIBILITY
[February 2022] [(ENR INDEX 12684)]
CONSTRUCTION COST ESTIMATE

DESCRIPTION		Alt 1A ESTIMATED COST	Alt 1B ESTIMATED COST	Alt 2A ESTIMATED COST	Alt 2B ESTIMATED COST
CIVIL					
Thickened WSL site piping from Ops Bldg. to Primary Digester			$100,000		
ARCHITECTURAL					
Misc. Modification and Finishes				$50,000	$50,000
Dewatering Building Windows, Doors, Masonry, etc.					$250,000
STRUCTURAL					
Convert SST No. 1 to Blended Sludge Storage Tank				$50,000	
Convert SST No. 2 to Primary Sludge Storage Tank					$50,000
Rehab & Convert Primary Digester to Gravity Thickener				$150,000	$150,000
Rehab & Convert Secondary Digester to TPSL storage tank				$150,000	
Repair Digester Concrete - Allowance		$ 100,000	$100,000		
Dewatering Building mid level floor, roof, supports, etc.					$500,000
PROCESS					
Demolition				$100,000	$200,000
Gravity Thickener Mechanism				$175,000	
Additional Odor Control System				$300,000	$300,000
Replace digested sludge transfer pumps		$ 75,000	$75,000		
Replace heated sludge recirc. Pumps		$ 50,000	$50,000		
Primary Digester Fixed Cover Repairs		$ 150,000	$150,000		
Secondary Digester Floating Cover Repairs		$ 150,000	$150,000		
Maintain Heat Exchanger, Bolier and Controls		$ 50,000	$50,000		
New sludge transfer pumps				$60,000	
Miscellaneous pump/piping/valve modifications				$100,000	
Sludge Mixing System Modifications				$125,000	
Sludge Mixing System - 3 tanks					$300,000
Dewatering Equipment (2 screw presses, feed pumps, polymer, etc.)					$500,000
HVAC/ PLUMBING					
Miscellaneous Replacements/Upgrades				$20,000	$200,000
INSTRUMENTATION					
Instrumentration and Controls		$ 20,000	$20,000	$75,000	$200,000
ELECTRICAL					
Power and control conduit/wire/disconnects/etc		$ 20,000	$20,000	$200,000	$500,000
SPECIALS					
MOBILIZATION		$ -	$0	$0	$0
DEMOBILITZATION		$ -	$0	$0	$0
PROCESS BY-PASS PUMPING		$ -	$0	$0	$0
SHEETING		$ -	$0	$0	$0
PILES		$ -	$0	$0	$0
GROUNDWATER DEWATERING (OPEN)		$ -	$0	$0	$0
TEMPORARY SLUDGE THICKENING/ DEWATERING		$ -	$0	$0	$0
TEMPORARY FACILITIES (OWNER)		$ -	$0	$0	$0
SITE SECURITY		$ -	$0	$0	$0
WINTER CONSTRUCTION		$ -	$0	$0	$0
SUBTOTAL, CONSTRUCTION		$ 575,000	$675,000	$1,135,000	$1,500,000
GENERAL CONTRACTOR OH&P AND GENERAL CONDITIONS	25.0%	$ 144,000	$169,000	$284,000	$375,000
SUBTOTAL, SUBCONTRACTORS		$ 40,000	$40,000	$295,000	$900,000
GENERAL CONTRACTOR MARKUP	10.0%	$ 4,000	$4,000	$30,000	$90,000
ELECTRICAL/ TELEPHONE ALLOWANCE		$ 9,999	$10,000	$10,000	$10,000
BONDS & INSURANCES	2.0%	$ 15,000	$18,000	$35,000	$57,000
UNIT PRICE ITEMS	2.0%	$ 12,000	$14,000	$23,000	$30,000
SUBTOTAL, CONSTRUCTION COSTS		$ 799,999	$930,000	$1,812,000	$2,962,000
PROJECT MULTIPLIER, DESIGN CONTINGENCY	1.46				
PROJECT MULTIPLIER, INFLATION TO MIDPT CONST.	1.08				
ENGINEERS ESTIMATE OF CONSTRUCTION COST		**$ 1,261,000**	**$1,466,000**	**$2,857,000**	**$4,670,000**

COST ESTIMATE - LCCA - Regional Alternative
JOB NAME: Groton Facility Plan
JOB NO.: 20653
BY: Dennis Dievert Jr

Alternative:	Maintain PAF	Pump To Groton
TOTAL PROJECT COST	**$9,030,000**	**$25,000,000**
Construction Loan Rate	2.0%	2.0%
Loan Term, years	20	20
Capital Recover (A/P, i%, n)	0.061	0.061
Annual Debt Payment	$552,000	$1,529,000
OPERATION AND MAINTENANCE COSTS		
Operating and Maintenance Costs		
Annual O&M Cost ($/yr)	$0	$0
Annual Sludge Disposal Cost ($/yr)	$0	$0
Total Annual O&M Cost ($/yr)	$2,230,000	$1,834,000
Net Present Worth ($) - O&M	$36,463,696	$29,988,529
Total Net Present Worth	**$45,493,696**	**$54,988,529**

Appendix I
May 2022 Cost of Service Study

Wastewater Report

GROTON UTILITIES WASTEWATER DEPARTMENT

Wastewater Cost of Service Study and Financial Projection

May 2022

UFS UTILITY FINANCIAL SOLUTIONS, LLC

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UTILITY FINANCIAL SOLUTIONS, LLC

May 2022

Dennis Dievert Jr., PE
Wright-Pierce
Senior Project Manager

Dear Mr. Dievert:

We are pleased to present the Wastewater Report identifying the rate adjustments and bonding requirements to fund the capital improvement plan for the wastewater treatment plant and the collection system.

The specific purposes of this rate study are:

- Using the cost of service and financial model completed in January 2022 update with revised capital plan
- Review cash balances and debt coverage ratio
- Establish a long term rate track to help ensure the capital plan is funded with limited rate impacts on customers

This report is intended for information and use by the utility and management for the purposes stated above and is not intended to be used by anyone except the specified parties.

Sincerely,

Utility Financial Solutions, LLC
Mark Beauchamp
CPA, MBA, CMA
185 Sun Meadow Ct
Holland, MI 49424

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LIST OF TABLES

1. Introduction

This report was prepared to provide the Groton Utilities Wastewater Department (GU) with a wastewater cost of service study and financial projection. The specific purposes of the study are identified below:

1) ***Determine wastewater utility's revenue requirements for fiscal years 2023 - 2042.*** GU's revenue requirements were projected for the period from 2023 – 2042 and included adjustments for the following:

   a. Projected costs
   b. Projected changes in staffing levels
   c. Capital improvement plan projected over next twenty years

2) ***Recommend rate adjustments needed to meet targeted revenue requirements.*** The primary purpose of this study is to identify appropriate revenue requirements and the rate adjustments needed to meet targeted revenue requirements. The report includes a long-term rate track for GU to help ensure the financial stability of the utility in future years.

2. Summary of Study Results

Utility Rate Process

Utility Financial Solutions, LLC was retained to review utility rates and potential rate impacts of proposed capital plans. A cost of service and financial projection was completed in 2021 with a long-term capital plan of $35,000,000 projected over the next 20 years; however, the specific timing of the expenditures was not identified. Upon completion of the study GU retained Wright-Pierce to review and update the long term capital plan for the wastewater treatment facility and develop a time frame on improvements. The capital plan was reviewed by GU's utility staff and improvements to the collection system was added to the twenty year projection. This report includes a projection for rate adjustments to customers and the amount and timing of debt issuances.

Capital Improvement Plan

The amount and timing of the capital plan was provided by Wright-Pierce for the wastewater treatment plant and combined with the capital plan for the collection system provided by GU. The results were reviewed, and the timing of improvements modified to smooth out and limit customer rate adjustments in any year. The projections excluded any grant funding or loan forgiveness that may be available to GU. The capital plans are listed in the table below:

Table 2 is a long term financial summary that identifies that annual rate adjustments varying between 3% and 3.5% each year will be needed to fund the capital improvement program. The summary table on the next page identifies projected cash reserves and required debt issuances to fund the capital plan. ***The projected financial statements are for planning purposes only. Actual results will vary from projections as assumptions may not materialize and events may occur that were not anticipated.***

Table 1 – Capital Improvement Plan

Fiscal Year	Projected Rate Adjustments	Capital Improvements Plan	Debt Coverage Ratio	Adjusted Operating Income	Target Operating Income	Projected Cash Balances	Recommended Minimum Cash	Bond Issues Including Fees
2023	3.0%	$ 1,250,000	1.82	$ 696,318	$ 603,316	$ 5,152,993	$ 1,787,505	1,000,000
2024	3.0%	$ 1,050,000	1.49	647,574	685,135	5,460,871	1,927,118	1,000,000
2025	3.0%	$ 500,000	1.41	649,251	661,828	6,288,823	2,003,938	1,000,000
2026	3.5%	$ 1,000,000	1.39	675,076	685,769	6,617,599	2,091,625	1,000,000
2027	3.5%	$ 1,530,000	1.35	682,753	757,718	6,411,959	2,202,212	1,000,000
2028	3.5%	$ 4,000,000	1.32	632,983	1,020,862	3,730,086	3,107,457	1,000,000
2029	3.5%	$ 4,500,000	1.29	526,470	1,014,883	3,530,760	2,704,823	4,000,000
2030	3.5%	$ 500,000	1.04	492,723	1,194,070	3,586,010	2,875,534	500,000
2031	3.5%	$ 1,000,000	1.07	531,856	1,185,822	3,679,166	2,921,063	1,000,000
2032	3.5%	$ 1,388,000	1.07	556,225	1,230,113	3,386,421	3,012,955	1,000,000
2033	3.5%	$ 1,400,000	1.08	596,083	1,228,111	3,605,318	3,056,780	1,500,000
2034	3.5%	$ 1,400,000	1.08	640,068	1,248,943	3,834,688	3,206,037	1,500,000
2035	3.5%	$ 1,400,000	1.07	688,598	1,269,475	4,058,480	3,372,560	1,500,000
2036	3.5%	$ 1,400,000	1.07	741,858	1,289,206	4,281,401	3,539,213	1,500,000
2037	3.5%	$ 3,545,000	1.06	757,141	1,288,749	4,363,371	3,775,638	3,500,000
2038	3.5%	$ 1,600,000	0.99	773,547	1,413,595	4,338,513	4,067,389	1,600,000
2039	3.5%	$ 1,600,000	1.13	834,182	1,415,821	4,614,588	3,982,676	1,600,000
2040	3.5%	$ 1,600,000	1.13	900,363	1,421,671	4,893,961	4,150,998	1,600,000
2041	3.5%	$ 1,600,000	1.12	972,314	1,426,882	5,182,420	4,319,466	1,600,000
2042	3.5%	$ 3,911,000	1.23	1,004,045	1,340,265	5,383,245	4,390,282	3,600,000

Capital Improvement Plan

The amount and timing of the capital plan was provided by Wright-Pierce for the wastewater treatment plant and combined with the capital plan for the collection system provided by GU. The results were reviewed, and the timing of improvements modified to smooth out and limit customer rate adjustments in any year. The projections excluded any grant funding or loan forgiveness that may be available to GU. The capital plans are listed in the table below:

Table 2 – Capital Improvement Plan

Fiscal Year	Major Plant Capital	Normal Capital	Grant Funding	Total Capital Improvements Plan
2023		1,250,000		$ 1,250,000
2024		1,050,000		$ 1,050,000
2025		500,000		$ 500,000
2026	500,000	500,000		$ 1,000,000
2027	1,030,000	500,000		$ 1,530,000
2028	3,500,000	500,000		$ 4,000,000
2029	4,000,000	500,000		$ 4,500,000
2030	-	500,000		$ 500,000
2031	-	1,000,000		$ 1,000,000
2032	888,000	500,000		$ 1,388,000
2033	-	1,400,000		$ 1,400,000
2034	-	1,400,000		$ 1,400,000
2035	-	1,400,000		$ 1,400,000
2036	-	1,400,000		$ 1,400,000
2037	3,295,000	250,000		$ 3,545,000
2038	-	1,600,000		$ 1,600,000
2039	-	1,600,000		$ 1,600,000
2040	-	1,600,000		$ 1,600,000
2041	-	1,600,000		$ 1,600,000
2042	2,411,000	1,500,000		$ 3,911,000

It is anticipated that $15.6 million of improvements will be needed for the wastewater treatment plant and $20.6 million in collection system improvements over the next twenty years.

Projected Cash Flow – With Rate Adjustments

Table 3 details the minimum level of cash reserves required to help ensure timely replacement of assets and to provide financial stability of the wastewater utility. The methodology used to establish this target is based on certain assumptions related to a percentage of operating expense, historical investment, capital improvements, and debt service to be kept in cash reserves. Based on these assumptions, the cash balance for 2023 is projected at $5.2M and $3.7M in 2028. The recommended minimum cash reserve levels for 2023 is $1.8M and $3.1M for 2028.

Table 3 – Projected Cash Flows

Description	Projected 2023	Projected 2024	Projected 2025	Projected 2026	Projected 2027	Projected 2028
Minimum Cash Reserve Allocation						
Operation & Maintenance Less Depreciation Ex	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%
Historical Rate Base	3%	3%	3%	3%	3%	3%
Current Portion of Debt Service Payment	83%	83%	83%	83%	83%	83%
Five Year Capital Improvements - Net of bond p	20%	20%	20%	20%	20%	20%
% Plant Depreciated	68%	67%	67%	67%	65%	61%
Calculated Minimum Cash Level						
Operation & Maintenance Less Depreciation Ex	$ 196,371	$ 206,383	$ 214,882	$ 223,398	$ 234,598	$ 253,344
Historical Rate Base	1,018,765	1,050,265	1,065,265	1,095,265	1,141,165	1,261,165
Current Portion of Debt Service Reserve	506,370	604,470	657,791	706,962	760,450	815,348
Five Year Capital Improvements - Net of bond p	66,000	66,000	66,000	66,000	66,000	777,600
Minimum Cash Reserve Levels	**$ 1,787,505**	**$ 1,927,118**	**$ 2,003,938**	**$ 2,091,625**	**$ 2,202,212**	**$ 3,107,457**
Projected Cash Reserves	**$ 5,152,993**	**$ 5,460,871**	**$ 6,288,823**	**$ 6,617,599**	**$ 6,411,959**	**$ 3,730,086**

Cash balances increase over the five years shown above but are above the recommended minimum cash throughout the projection period.

Debt Coverage Ratios – With Rate Adjustments

Table 4 is the projected debt coverage ratios with capital additions as provided. Debt coverage ratio is a measurement of debt affordability and measures the cash flow from operations in that fiscal year. A ratio of 1, indicates there was enough cash flow from operations to pay the debt payment one time. The minimum recommended debt coverage ratio for prudent financial planning purposes is 1.40. Maintaining a 1.40 debt coverage ratio is good business practice and helps to achieve the following:

- Helps to ensure debt coverage ratios are met in years when sales are low due to cold or wet summers or loss of a major customer(s).
- When debt coverage ratios are consistently met, it may help obtain a higher bond rating if revenue bonds are sold in the future, to lower interest cost.
- GU is planning on issuing General Obligation Bonds and does not typically carry Bond Covenants that require specific Debt Coverage Ratios.

Table 4 – Projected Debt Coverage Ratios

Description	Projected 2023	Projected 2024	Projected 2025	Projected 2026	Projected 2027	Projected 2028
Fixed Cost Coverage Ratio						
Cash Available for Debt Service	$ 1,112,480	$ 1,086,155	$ 1,120,471	$ 1,180,538	$ 1,240,564	$ 1,300,474
Total Available	$ 1,112,480	$ 1,086,155	$ 1,120,471	$ 1,180,538	$ 1,240,564	$ 1,300,474
Debt Service Including Off System Debt	$ 610,084	$ 728,277	$ 792,519	$ 851,762	$ 916,204	$ 982,347
Fixed Costs Coverage Ratio	**1.82**	**1.49**	**1.41**	**1.39**	**1.35**	**1.32**
Minimum Fixed Costs Coverage Ratio	**1.40**	**1.40**	**1.40**	**1.40**	**1.40**	**1.4**

Debt coverage falls below the minimum debt coverage ratio for years 2026 – 2028, but exceeds requirements typically requested for General Obligation financing.

Rate of Return

The optimal target for setting rates is the establishment of a target operating income to help ensure the following:

A. Funding of interest expense on the outstanding principal on debt. Interest expense is below the operating income line and needs to be recouped through the operating income balance.
B. Funding of the inflationary increase on the assets invested in the system. The inflation on the replacement of assets invested in the utility should be recouped through the Operating Income.
C. Funding of depreciation expense.
D. Adequate rate of return on investment to help ensure current customers are paying their fair share of the use of the infrastructure and not deferring the charge to future generations.
E. The rate of return identifies the target operating income and is used to identify the appropriate funding for replacement of existing infrastructure to recover in rates charged to customers.

As improvements are made to the system, the optimal operating income target will increase unless annual depreciation expense is greater than yearly capital improvements. The revenue requirements for the study are set on the utility basis. Table5 identifies the utility basis target established for 2023 is $603k and increases to $1.0M in 2028.

Table 5 – Rate of Return Calculation

Description	Projected 2023	Projected 2024	Projected 2025	Projected 2026	Projected 2027	Projected 2028
Target Operating Income Determinants						
Net Book Value/Working Capital	$ 10,911,436	$ 11,551,928	$ 11,611,419	$ 12,140,911	$ 13,149,802	$ 16,518,093
Outstanding Principal on Debt	7,673,253	8,253,080	8,797,906	9,310,980	9,785,465	10,219,433
System Equity	$ 3,238,183	$ 3,298,848	$ 2,813,514	$ 2,829,931	$ 3,364,337	$ 6,298,661
Debt:Equity Ratio	70%	71%	76%	77%	74%	62%
Target Operating Income Allocation						
Interest on Debt	3.73%	3.73%	3.83%	3.92%	3.99%	4.07%
System Equity	11.74%	11.43%	11.53%	11.34%	10.91%	9.60%
Target Operating Income						
Interest on Debt	$ 223,246	$ 308,104	$ 337,345	$ 364,836	$ 390,690	$ 416,314
System Equity	$ 380,070	$ 377,031	$ 324,483	$ 320,933	$ 367,028	$ 604,548
Target Operating Income	**$ 603,316**	**$ 685,135**	**$ 661,828**	**$ 685,769**	**$ 757,718**	**$ 1,020,862**
Projected Operating Income	**$ 696,318**	**$ 647,574**	**$ 649,251**	**$ 675,076**	**$ 682,753**	**$ 632,983**
Rate of Return in %	**5.5%**	**5.9%**	**5.7%**	**5.6%**	**5.8%**	**6.2%**

The current rate track is projected to fall below the target operating income in all years of the projection period.

3. Significant Assumptions

This section outlines the procedures used to develop the cost of service for GU and the related significant assumptions.

Forecasted Operating Expenses

Forecasted expenses were based on 2021 and 2022, and 2023 budget and adjusted for inflation. Table 6 is a summary of the expenses used in the analysis.

Table 6 – Projected Operating Expenses

Description	Projected 2023	Projected 2024	Projected 2025	Projected 2026	Projected 2027	Projected 2028
Operating Expenses:						
Sewer Operations						
Cost of Operations	$ 1,851,134	$ 1,943,710	$ 2,002,041	$ 2,062,123	$ 2,124,008	$ 2,187,750
Digester Cleaning	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000	$ 35,000
City Services	$ 7,230	7,591	7,819	8,053	8,295	8,544
Miscellaneous A&G	$ 670,452	$ 703,975	$ 725,094	$ 746,847	$ 769,253	$ 792,330
IT Admin	$ 170,959	$ 179,507	$ 184,892	$ 190,439	$ 196,152	$ 202,037
Administration Labor	$ 95,111	$ 99,866	$ 102,862	$ 105,948	$ 109,127	$ 112,401
Total Meter O&M	$ 27,307	$ 28,673	$ 29,533	$ 30,419	$ 31,332	$ 32,272
Customer Care Administration	$ 35,623	$ 37,404	$ 38,527	$ 39,682	$ 40,873	$ 42,099
Customer Service	$ 130,953	137,501	141,626	145,875	150,251	154,758
Billing Services	$ 2,403	2,523	2,599	2,677	2,757	2,840
Springbrook	$ 4,974	$ 5,223	$ 5,380	$ 5,541	$ 5,707	$ 5,879
Taxes	$ 66,493	69,818	71,913	74,070	76,292	78,581
Depreciation Expense	$ 388,509	409,509	440,509	470,509	521,109	631,709
Total Operating Expenses	$ 3,486,149	$ 3,660,300	$ 3,787,794	$ 3,917,183	$ 4,070,155	$ 4,286,198

Unit Sales

Growth projection of 0.001% was used for 2023 - 2028 and was discussed with management.

Inflation

Inflation was assumed at 5.0% for years 2023 and 2024, and 3.0% for years 2025 – 2032 and 2.5% after 2033.

Depreciation Expense

Depreciation expense was projected based on historical capital additions and discussions with management on future capital additions.

Interest Income

Interest income was forecasted based on projected cash balances and an interest rate of 0.5%.

Capital Improvements
The capital improvement projections were provided by Wright-Pierce and GU. Projections for 2023 - 2042 are outlined below.

Fiscal Year	Major Plant Capital	Normal Capital	Grant Funding	Total Capital Improvements Plan
2023		1,250,000		$ 1,250,000
2024		1,050,000		$ 1,050,000
2025		500,000		$ 500,000
2026	500,000	500,000		$ 1,000,000
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2039	-	1,600,000		$ 1,600,000
2040	-	1,600,000		$ 1,600,000
2041	-	1,600,000		$ 1,600,000
2042	2,411,000	1,500,000		$ 3,911,000

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Accountant's Compilation Report

Governing Body
Groton Utilities Wastewater Department

The accompanying forecasted statements of revenues and expenses of the Groton Utilities Wastewater Department (GU) were compiled for the year ending June 30, 2023 in accordance with guidelines established by the American Institute of Certified Public Accountants.

The purpose of this report is to assist management in forecasting revenue requirements and determining the cost to service each customer class. This report should not be used for any other purpose.

A compilation is limited to presenting, in the form of a forecast; information represented by management and does not include evaluation of support for any assumptions used in projecting revenue requirements. We have not audited the forecast and, accordingly, do not express an opinion or any other form of assurance on the statements or assumptions accompanying this report.

Differences between forecasted and actual results will occur since some assumptions may not materialize and events and circumstances may occur that were not anticipated. Some of these variations may be material. Utility Financial Solutions has no responsibility to update this report after the date of this report.

This report is intended for information and use by the governing body and management for the purposes stated above. This report is not intended to be used by anyone except the specified parties.

UTILITY FINANCIAL SOLUTIONS, LLC

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Holland, MI
May 2022

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