WASTEWATER FACILITIES PLAN

for the

TOWN OF FAIRFIELD, CT

DRAFT

APRIL 2017

WRIGHT-PIERCE
Engineering a Better Environment
70 YEARS 1947 - 2017

April 18, 2017
W-P Project No. 13090A

Mr. Bill Norton, Superintendent
Fairfield Water Pollution Control Authority
330 Richard White Way
Fairfield, CT 06824

Subject: Fairfield Water Pollution Control Facility
Facility Plan Study
Draft Facilities Plan Report

Dear Bill:

Enclosed, please find two hard copies and one electronic copy of the Final Draft Wastewater Facilities Plan Report addressing all of your comments discussed at our March review meeting. One copy has also been provided to Joe Michelangelo and Ed Boman at the Department of Public Works and one to Ann Straut at the CT DEEP.

The report summarizes our evaluation of the wastewater treatment facilities, identifies and evaluates alternatives to meet the needs of the WPCF, and presents a recommended plan including preliminary capital cost estimates.

The wastewater facilities study evaluated alternatives for providing improvements to the existing water pollution control facility to meet the long-term needs of the Town. The evaluation considered current regulatory requirements, the age and condition of existing equipment, the capacity of existing unit processes to meet projected flows and loads, and process reliability. Major components of the recommended plan include the following:

- Improvements to preliminary and primary treatment facilities including the replacement of the mechanical bar screens, installation of screenings grinder/washer/compactors, construction of new aerated grit tanks and a grit washer, a new Raw Sewage Pump Station, process and structural improvements to the primary settling tank structures, and new concrete flow distribution structures to improve flow splitting to the primary settling tanks and to the Zone A aeration tanks.

- Improvements to the secondary treatment processes including modifications to the aeration system by converting the Zone A aerobic zone 1 tanks to swing zones and converting all Zone A tanks to three train operation, structural modification to facilitate the passing and removal of scum, installation of three new aeration blowers, optimization of aeration controls and methanol

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feed, replacement of mechanisms and drives in the final settling tanks, and improvements to process reliability and improved energy efficiency.

- Improvements to effluent disinfection and pumping including installation of new UV disinfection in a second redundant channel, new outfall pumps to handle peak hour flows and a new plant water system.

- Improvements to the solids handling system to account for increased flows and loadings including the installation of two screw presses, a mixing system in the secondary digester, new pumps, piping, boilers and heat exchanger in the primary digester, a new cover on the secondary digester and two new sludge storage tanks for use during periods of high loadings to maintain the required SRT in the digesters.

- Improvements to the compost facility to improve operator health and safety concerns including installation of negative aeration to reduce emissions within the building and new process and electrical equipment.

- Improvements to existing Building Systems including modifications to the existing Control Building to address HVAC control issues, upgrades to specific HVAC equipment to replace items that are approaching their service life or are currently inoperable, and addressing code-related ventilation, egress and electrical classification issues in specific spaces such as the Primary Settling Tanks, Dewatering Building, Return Sludge Pump Room and Control Building.

- Improvements to the Control Building including expansion to the men's locker room, laboratory and breakroom.

- Upgrading the instrumentation and controls and SCADA system.

- Replacing the older electrical distribution equipment that was constructed prior to the 2000 upgrade and modifying the remaining electrical distribution system as required based on process modifications to the facility.

- Install new odor control systems for all process areas and refurbish Biofilter B to be maintained for the compost building exhaust.

The draft report presents recommendations for a comprehensive upgrade to the Fairfield WPCF. The anticipated cost of the improvements is approximately $62.4 million based on escalated costs to an anticipated mid-point of construction in year 2021, including a contingency and the cost of engineering services during design and construction.

We have appreciated the opportunity to work with the WPCA on this project and look forward to continuing to work with the WPCA to implement the recommendations of this plan.

Once the DEEP hads had an opportunity to review the report, we will schedule a meeting with all parties to review the comments and a subsequent presentation at a public hearing (tentatively anticipated in August 2017) will be prepared once the WPCA has approved the report. Should you require additional information or have any questions, please call.

Sincerely,
WRIGHT-PIERCE

Dennis Dievert Jr., PE
Project Manager
dennis.dievert@wright-pierce.com

DAD/bls

Enclosures

cc: Joseph Michelangelo Public Works Director
Ed Boman, Assistant Director of Public Works
Ann Straut, CT DEEP

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EXECUTIVE SUMMARY

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70 YEARS 1947 - 2017

EXECUTIVE SUMMARY

The Town of Fairfield Water Pollution Control Authority (WPCA) owns and operates an extensive wastewater collection system and advanced water pollution control facility (WPCF) which handles wastewater from Fairfield's sewer service area. The WPCF has a design annual average flow rate of 9 million gallons per day (MGD) and peak flow rate of 24 MGD and currently processes an annual average flow rate of 8.64 MGD with peaks over 33 MGD. The WPCF was originally constructed in 1950 and was expanded in 1968 and 1972 to meet the needs of a growing Town and expansion of the sewer collection system. Additions were made in 1980 to improve biosolids dewatering, and a composting facility for beneficial reuse of the plant sludge was added in 1988. In 1996 and 2002, modifications to the plant's aeration system were completed to allow the plant to achieve nitrogen removal.

In 2014, the Town of Fairfield and their Water Pollution Control Authority proactively elected to commission this Facility Plan to evaluate and plan for needed improvements to the WPCF due to a variety of issues facing the Town at that time including:

- Seasonal I/I that impacts plant performance
- Maintaining stringent nitrogen removal and disinfection requirements with increasing operation and maintenance costs to achieve those limits
- Periodic nuisance odor problems
- Poor flow distribution to the Primary Settling Tanks and to the Aeration Tanks
- Reliability and health and safety concerns with their solids handling processes
- Undersized equipment including the raw sewage pumps, effluent pumps and return sludge pumps
- Capacity of anaerobic digestion process
- Aging, energy inefficient unit processes, equipment and building systems with increasing operating costs and increasing corrective maintenance requirements

In addition, this Facility Plan project has been coordinated with other projects on the WPCF site and adjacent Town facilities with the primary goal of ensuring continuous treatment of wastewater. The Town is currently installing a 2.0 MW photovoltaic (PV) system, implementing a microgrid, installing a 400 KW fuel cell, and constructing a berm around the WPCF and adjacent town facilities to EL 16.0, or 3-feet above the 100-year flood elevation of 13.0. Each of these projects are at various stages of completion.

The photovoltaic panels are currently being installed on top of the town's landfill by Greenskies. The microgrid project is currently in design by Schneider Electric and will include control panels and electrical infrastructure to allow the WPCF and surrounding town facilities to operate in 'island mode' being independent of the power grid during severe storm or power outage events. The project also includes the replacement of the existing 600 KW and 1,000 KW diesel powered emergency generators on the WPCF site to new natural gas powered units. The PV system and microgrid are scheduled to be commissioned in late 2017, early 2018.

An agreement is also in place with Doosan to install a 400KW fuel cell adjacent to the compost building, scheduled for installation in late 2017. The berm is in the early stage of design by Tighe & Bond. It will include a combination of earthen and sheet pile walls to EL 16.0 as well as two stormwater pump stations. A construction timeline is unknown, but it will be constructed prior to the comprehensive upgrade to the WPCF.

The purpose of this facilities plan was to identify the problems 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.

ES.1 BASIS OF DESIGN

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

TABLE ES-1
DESIGN FLOWS AND LOADS

Parameter	Current 2010 to 2016	Design Year (2040)
Average Daily Flow (mgd)	8.64	9.12
Peak Hourly Flow (mgd)	33.0[1]	34.77
Avg BOD_5 Load (lbs/day)	9,961	11,302
Avg TSS Load (lbs/day)	11,993	13,394
TKN Load (lbs/day)	2,017	2,285

Notes:

1 Current Peak Hour Flow based on 100% of data set.

ES.2 RECOMMENDED WPCF CAPITAL IMPROVEMENT PLAN

The evaluation of the WPCF generally focused on developing recommended improvements related to the capacity and process upgrades needed to accommodate growth, provide for additional nitrogen removal, comply with new disinfection requirements, and identify potential foreseeable changes in state regulations that may require additional unit processes in the future. The evaluation also included an overall evaluation of all other unit processes, structures and buildings, building systems, instrumentation and control, electrical service and distribution, and site conditions.

The recommended Capital Improvement Plan (CIP) for the overall evaluation generally includes: replacement of aging equipment with more modern and energy efficient equipment and systems; upgrades to meet projected flows and loadings; rehabilitation of aging structures; provision of an updated instrumentation and control system; building system improvements to improve the energy efficiency of the existing buildings; modifications to structure and buildings as required to meet current building codes, etc.

In addition to physical and operational changes at the WPCF, it is also important for the town to proactively continue to identify and remove inflow and infiltration (I/I) in the sewer collection system. Removal of I/I will contribute to a reduction in treatment costs and improved process and hydraulic control at the plant. Currently, the WPCF receives and treats an annual average I/I flow of 4.0 MGD, or almost half of their annual average total daily flow of 8.64 MGD. I/I was evaluated separately as part of this overall facilities plan a summarized in a January 2017 Report prepared by Wright-Pierce titled, *Inflow and Infiltration Evaluation for the Fairfield, CT Water Pollution Control Authority (WPCA).*

Specific improvements include:

- Replace the primary and secondary mechanical bar screens with new multi-rake mechanical bar screens to remove rags and other debris from the wastewater at the Influent Building and to prevent hydraulic back-ups and surges of influent flow.
- Install new screenings grinder/washer/compactors and a grit washer to allow for disposal screenings as a municipal waste and allow from dewatered grit to be re-used on site. Construct an addition on the Influent Building to store screenings prior to disposal.
- Construct a new Influent Pump Building in the location of the existing abandoned digester. The building will include two new aerated grit tanks, new raw sewage pumps, new primary sludge pumps, sludge storage tanks and primary influent flow distribution structure. The raw sewage pump station, auxiliary pump station and horizontal grit removal tank and equipment will be demolished and the spaced repurposed for other use.
- Replace mechanisms and drives in all five primary settling tanks and all three final settling tanks.
- Construct a new concrete flow spitting structure to improve flow splitting of primary effluent to the Zone A aeration tanks.
- Convert Zone A Aeration Tanks to three train operation and replace all 18 existing submersible mixers with a compressed air biomix system or hyperbolic mixers.
- Replace return sludge, waste sludge and effluent pumps with new larger pumps and relocate the waste sludge pumps to the Return Sludge Building.
- Replace all sludge pumps throughout the facility.
- Replace all polymer feed systems throughout the facility.
- Install a new plant water system and strainer.
- Install three new 150 to 200 hp aeration blowers.
- Construct second UV Disinfection channel and install two redundant, energy efficient disinfection trains.
- Replace all pumps, valves, heat exchangers and boilers associated with the primary digester and install new mixing equipment and a cover at the secondary digester.

- Replace the existing belt filter press with two screw presses for sludge dewatering to achieve higher cake solids to reduce materials handling and increase compost operation efficiency (pilot test recommended during preliminary design).
- Convert composting process to negative aeration and provide improved HVAC equipment for better working conditions. Include provisions to pre-treat or separately dispose of the condensate.
- Expand the existing laboratory, men's locker room and break room in the Control Building.
- Upgrade of specific HVAC equipment to replace items that are approaching their service life or are currently inoperable.
- Address NFPA 820 fire protection code-related ventilation and electrical classification issues in specific spaces such as the primary sludge pump room, primary settling tanks and Dewatering Room.
- Install a dedicated odor control system for the Dewatering Building and a second unit for the remaining process areas including the new Influent Pump Building. Replace all piping-in-stone system in the Compost Building biofilter. Provide odor control for the new Influent Pump Building, distribution boxes and sludge/elutriation tanks.
- Upgrade the automatic temperature control system, site instrumentation, controls and SCADA systems.
- Replace the older electrical distribution equipment that was constructed prior to the 2003 upgrade and modify the remaining electrical distribution system as required based on process modifications to the facility.
- Provide modern energy efficient electrical, HVAC and process equipment and controls to replace existing inefficient equipment and controls.
- Demolish abandoned primary digester to allow space for the new Influent Pump Building.
- Replace manual entry gates with automated gates and include man gates adjacent to each.

The recommended capital improvement project costs are summarized in Table ES-2. Total project capital costs include an allowance of almost 75% of the estimated base construction costs to account for unaccounted for items, construction contingency, design and construction engineering, permitting, as well as financing, administrative and legal expenses. The 75% allowance also includes an estimated inflation factor to the mid-point of construction (2021). The project cost information presented herein is based on ENR Construction Cost Index 10531 (February 2017) and was inflated at 2.5% per year for four years. The total project capital cost is estimated to be $62,369,000. Adjustments to this total project cost would be made depending on the actual project schedule.

TABLE ES-2

ESTIMATED PROJECT COSTS
(ENR CCI 10531, January 2017)

Item		Cost
Site Work/Site Piping/Process Demolition		$ 3,560,000
Influent Building - Screenings Upgrade		$ 1,312,000
Influent Pump Building - Grit, Raw Sewage Pumping Upgrade		$ 3,891,000
Primary Settling Tanks & Splitter Structure Upgrade		$ 1,829,000
Secondary Treatment Upgrade		$ 3,368,000
Solids Handling & Dewatering Upgrade		$ 1,602,000
Compost Building Upgrade		$ 1,083,000
Odor Control Upgrade		$ 958,000
Chemical Systems Upgrade		$ 355,000
UV Disinfection System Upgrade		$ 2,707,000
Effluent Pumping System Upgrade		$ 491,000
Administration Building Upgrade		$ 750,000
Miscellanous Building Rehabilitation		$ 1,249,000
Subtotal		$ 23,155,000
HVAC & Plumbing		$ 1,200,000
Instrumensation & SCADA		$ 1,200,000
Electrical		$ 4,000,000
Subtotal		$ 6,400,000
General Contractor OH&P and General Conditions	20.0%	$4,631,000
Subtotal of Subcontractors (M/P/I/E)		$6,400,000
General Contractor Mark-up on Subcontractors	7.5%	$480,000
Electrical/Telephone Allowance		$100,000
Bonds and Insurance	1.5%	$520,000
Unit Price Items	2.5%	$579,000
Project Multiplier, Design Contingency	1.25	
Project Multiplier, Inflation to Midpoint of Construction	1.09	
ENGINEERS ESTIMATE OF CONSTRUCTION COST		**$48,870,000**
Estimated Construction Cost		$48,870,000
Construction Contingency	5.0%	$2,440,000
Technical Services	18.0%	$8,797,000
Materials Testing	0.8%	$367,000
Hazardous Materials Abatement		$300,000
Legal/Adminstrative	2.0%	$977,000
Subtotal		$61,751,000
Financing	1.0%	$618,000
ENGINEER'S ESTIMATE OF TOTAL PROJECT COST		**$62,369,000**

SECTION 1

INTRODUCTION

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

The Town of Fairfield Water Pollution Control Authority (WPCA) owns and operates an extensive wastewater collection system and advanced water pollution control facility (WPCF) which handles wastewater from Fairfield's sewer service area. The WPCF has a design annual average flow rate of 9 million gallons per day (MGD) and peak flow rate of 24 MGD and currently processes an annual average flow rate of 8.64 MGD with peaks over 33 MGD, or the maximum flow capable of being recorded at the effluent flow meter.

The WPCF was originally constructed in 1950 to provide secondary treatment for collected sewage flows from the Town. Treated effluent from the plant is discharged to Long Island Sound. The plant was expanded in 1968 and 1972 to meet the needs of a growing Town and expansion of the sewer collection system. Additions were made in 1980 to improve sludge dewatering, and a composting facility for beneficial reuse of the plant sludge was added in 1988. In 1996, modifications to the plant's aeration system and Zone A aeration tankage were completed to allow the plant to achieve partial nitrogen removal. The most recent upgrade of the WPCF was completed in 2002 and included an upgrade of nearly all wastewater and sludge processing facilities including additional aeration tankage (Zone B), new final settling tanks, UV disinfection, effluent pumping and odor control biofilters to the current configuration. Figure 1-1 is an aerial photograph of the current treatment facility.

The Fairfield WPCF is an advanced secondary treatment facility which has stringent discharge limitations for total nitrogen. The existing treatment process consists of mechanical screening, grit removal, influent pumping, primary sedimentation, aeration tanks, nitrification/denitrification, final sedimentation, and ultraviolet (UV) disinfection. Biosolids are anaerobically digested, dewatered, and composted on site.

FIGURE 1-1

AERIAL PHOTOGRAPH OF FAIRFIELD WPCF

Wastewater is conveyed to the plant from the east and west trunk sewers. These two interceptors combine outside of the Influent Building into one 39-inch diameter influent pipe. Preliminary treatment at the plant includes mechanical screening, grit removal and fine mechanical screening. Screenings are compacted and grit is washed and hauled off-site as a special waste. Wastewater then flows to the raw sewage pump station wet well. Influent pumping consists of a total of five pumps - three raw sewage pumps in the basement of the Control Building and two auxiliary raw sewage pumps in the basement of the Influent Building. The raw sewage pumps in the Control Building pump to the primary settling tanks while the auxiliary raw sewage pumps bypass the primary settling tanks and pump to the Zone B aeration tanks. Flow is split between five primary settling tanks. After primary sedimentation, flow is sent to six Zone A aeration tanks and then to three Zone B aeration tanks. After biological treatment, the mixed liquor flows to three final settling tanks. Secondary effluent is then disinfected in the ultraviolet disinfection system where it is discharged by gravity or by effluent pumping to Long Island Sound.

Primary sludge generated in the primary settling tanks is pumped to the primary digester. Waste activated sludge is pumped to a gravity belt thickener, thickened, and then pumped to the primary digester. The combined sludge is then anaerobically digested. The digested sludge from the primary digester overflows to the secondary digester. Sludge is pumped from the secondary digester to a belt filter press, dewatered, and composted in an onsite sludge composting facility. The composted sludge is then managed by a private firm which handles the biosolids reuse.

The Fairfield WPCF is well operated and maintained and has an excellent regulatory compliance record. However, the WPCA is facing a variety of issues at the WPCF including increasingly stringent nitrogen removal requirements, disinfection requirements, periodic nuisance odor problems, flow splitting and hydraulic restrictions, reliability of solids handling facilities, and aging unit processes and equipment.

1.1.1 2002 General Permit for Nitrogen Discharges

In 2002, the Connecticut Department of Energy and Environmental Protection (DEEP) issued the General Permit for Nitrogen Discharges which assigned annual effluent total nitrogen mass discharge limits to each wastewater facility in Connecticut, with increasingly stringent limits until 2014. The General Permit was re-issued with revised discharge limits in 2005, 2010 and most recently on January 1, 2016 with an expiration of December 31, 2018.

The State has also established the Nitrogen Credit Exchange Program which allows facilities that do not meet their discharge limits to purchase nitrogen credits, or to sell credits if their nitrogen discharge is below their limits. The costs for the nitrogen credits increased each year as the discharge limits became more stringent. The Nitrogen Trading Program's success has produced a situation where significantly more credits are produced than are needed. This level of continued subsidization could not be sustained. To address this, DEEP and the Nitrogen Credit Advisory Board (NCAB) proposed continuing the trading program while moving it to a self-sufficiency model where the buyer's payments are shared proportionally by the sellers. Public Act 15-38 enacts this proposal.

The Fairfield WPCF underwent nitrogen removal projects funded by the Clean Water Fund in 1996 and 2003 effectively reducing the total nitrogen (TN) in their effluent. In 2010, Fairfield sold $197,943.00 in credits, averaging 325 pounds per day when their limit was 464 pounds per day, at a cost of $4.59 per pound. This trend continued and Fairfield has sold close to $1M in credits through 2015 prior to implementation of the self-sufficient trading program which reduced the cost per pound from $6.73 to $4.95 in 2015 and has projected a cost of $2.13 per pound in 2018. Even at $2.13 per pound, Fairfield is projected to sell back $72,302 in credits in 2018.

Although the Fairfield WPCF has met their discharge limits for nitrogen, that has not come without the associated operational costs. As part of the overall evaluation of the WPCF, long-term cost effective nitrogen reduction improvements will be identified to allow for the WPCF to cost effectively meet nitrogen reduction goals under future flow and loading conditions.

1.1.2 Disinfection Requirements

The Fairfield WPCF is required by permit to disinfect year round. As part of the most recent NPDES permit issued in 2015, there was change to Enterococci for effluent disinfection requirements. The geometric mean of the Enterococci bacteria shall not exceed 35 colonies per 100 milliliters in a period of a calendar month with an instantaneous limit of 500 colonies per 100 milliliters. There are concerns that the existing UV disinfection system is old, very inefficient, and lacks the proper redundancy and controls to maintain these limits and to meet TR-16 standards.

1.1.3 Odor Issues

The WPCF has also been subject to periodic odor problems. There are existing odor control systems at the Fairfield WPCF to continuously ventilate and treat the off-gases exhausted from the various treatment processes via two open-bed biofilter systems with piping-in-stone distribution systems. The air spaces from the Influent Building, Primary Settling Tank Effluent Distribution Channel, Return Activated Sludge Chamber, Septage Receiving Station, Gravity Thickener Tank, and Sludge Dewatering Building are conveyed to the Process Biofilter (Biofilter B). Two variable speed, centrifugal exhaust fans installed in the Biofilter Building are used to continuously ventilate air from the various process buildings. The airspace from the Compost Facility is conveyed to the Compost Biofilter (Biofilter A), by means of five exhaust blowers.

The biofilters are labor intensive to maintain, especially when the media is required to be replaced every 3 to 5 years. In addition, they take up a lot of real estate which may be needed for future tankage. As part of the facilities plan, an evaluation was conducted of alternative odor control systems for both the process areas and the compost building as well to maintain code compliant ventilation rates per NFPA 820 requirements.

1.1.4 Flow Splitting and Hydraulic Restrictions

Flow splitting and hydraulic restrictions can be problematic at times. There are concerns over the ability of the influent pumps, influent bar screen, outfall pumps and outfall piping to handle peak wet weather flows due to excessive inflow and infiltration (I/I). It was also reported that during Hurricane Sandy, some of the plant tankage came close to overtopping and there are periods when the influent pumps cannot keep up with the influent flows. The plant also experiences issues with unequal flow splitting to the primary clarifiers and to the Zone A aeration tanks due to limitations with the current configuration of piping and structures, ultimately affecting the ability for the plant to operate efficiently.

1.1.5 Solids Handling

Fairfield is the only municipality in the State of Connecticut that operates and maintains a composting facility for processing of municipal wastewater sludge. The existing compost facility has been in operation since 1989, receiving an upgrade in 2007 with new equipment and a stainless steel building shell. Digested primary and waste sludges are dewatered to 12-15% total solids and transported across the parking lot where it is mixed with amendment and loaded into six composting bays. The finished product is hauled across the street to Harvest Power where it is marketed by AgreSource. This process has worked well for the Fairfield but not without concern. Several studies have been completed over the years to evaluate the composting process and all have proven it to be the most feasible alternative. A similar evaluation was completed for the solids handling processes as part of this facilities plan and included:

- Evaluated elimination of composting and replace with sludge hauling or an alternate technology
- Evaluated clogging issues at belt filter presses caused by struvite precipitation
- Replacement of belt filter press with an enclosed technology to achieve higher cake solids

- Assessed available digester mixing technologies to eliminate clogging in the existing gas system
- Evaluated alternative sludge stabilization methods with the existing digesters
- Evaluated and address foaming issues in digesters and floating cover supports including ballast blocks and a new cover
- Provide improved ventilation in the compost building for an improved working environment for operators

1.1.6 Unit Process Issues

Portions of the existing equipment and structures are original, are at the practical end of their design life, and are inefficient compared to modern technologies. Fairfield intends for the facilities plan to include an evaluation of existing equipment, processes, controls, electrical and building systems in order to identify upgrade needs to ensure reliable and efficient operations over the 20-year planning period.

1.2 PURPOSE OF EVALUATION

This Facilities Plan builds upon the previously noted past efforts to develop a comprehensive evaluation of the wastewater treatment plant, 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 WPCF 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. Not only were these evaluation efforts utilized to develop a comprehensive facility upgrade plan, they were also necessary to meet the requirements of the Connecticut DEEP to be eligible for the Clean Water Fund prioritization list.

1.3 REPORT ORGANIZATION

This Facilities Plan is divided into several sections, as outlined below:

- Executive Summary
- Section 1: Introduction
- Section 2: Basis of Design
- Section 3: Liquid Processes
- Section 4: Nitrogen Technologies
- Section 5: Solids Handling
- Section 6: Odor Control
- Section 7: Energy Evaluation
- Section 8: Evaluation of Plant Wide Support Systems
- Section 9: Collection System Evaluations
- Section 10: Recommended Plan
- Section 11: Environmental Impact Assessment

A variety of efforts have been performed to develop the components of the plan listed above. An evaluation of the plant was conducted by all disciplines (i.e. structural, process, mechanical, electrical and instrumentation engineers and architects). 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.

In addition, and as stated above, the previous studies were re-evaluated and summarized in this plan. Separate engineering efforts were also being performed within the sanitary sewer collection system concurrent with the development of this plan. The results of these efforts have yielded separate engineering documents which have been summarized in Section 9 of this Facilities Plan.

SECTION 2

BASIS OF DESIGN

SECTION 2

BASIS OF DESIGN

2.1 INTRODUCTION

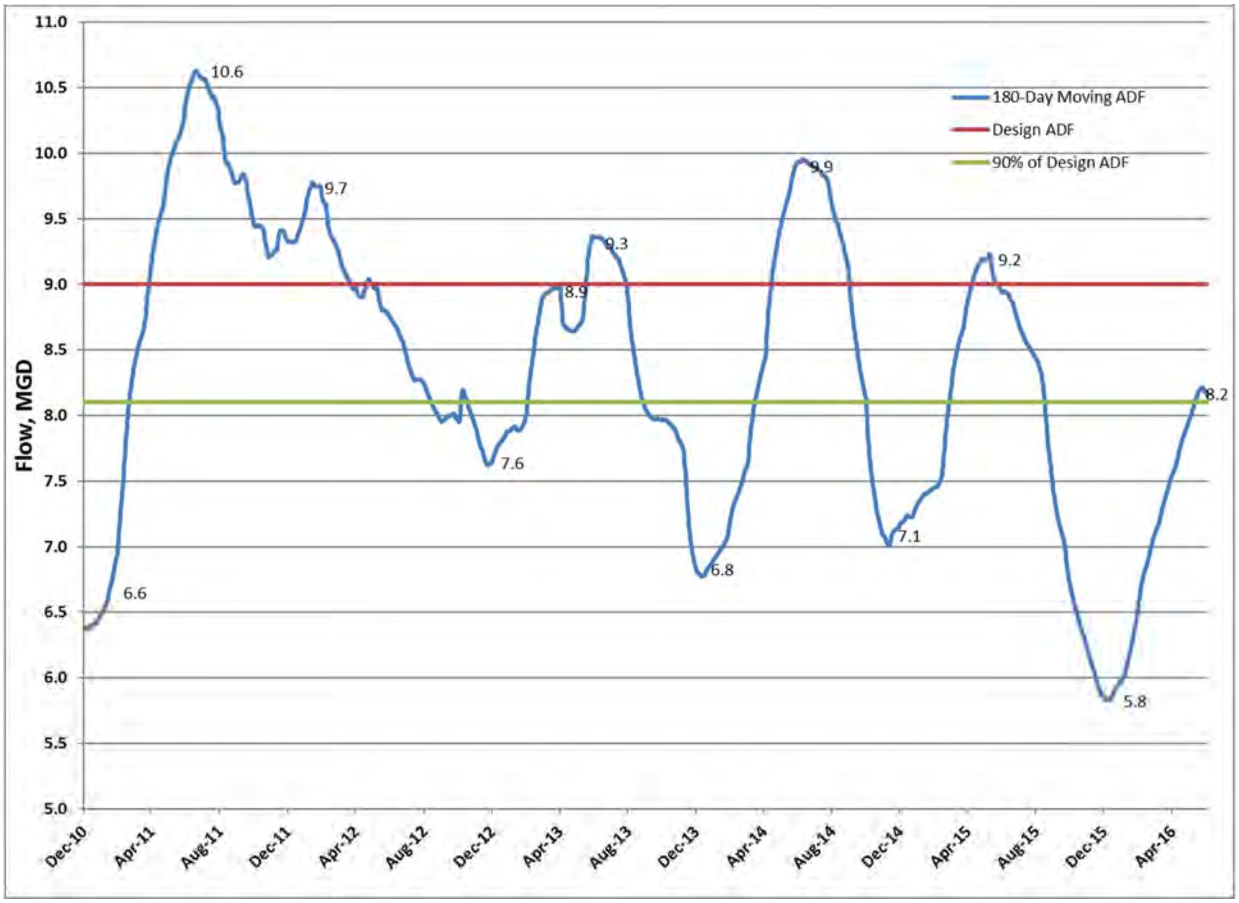
The Fairfield WPCF receives daily wastewater flows from the Town of Fairfield only. An assessment of the existing flows and loads from all waste streams was conducted to determine the historical wastewater flows and loadings received at the Fairfield WPCF. These values were then used as the basis for determining the future design flows and loadings. The WPCF currently receives and treats wastewater flows in excess of 90% of their design flow rate of 9.0 million gallons per day (MGD) triggering the need to perform a facilities plan. Per section 4. (L) of the current WPCF Municipal NPDES Permit issued on November 1, 2015, "*when the ADF from the WPCF for the previous 180 days exceed 90% of the design flow rate, the Permittee shall develop and submit within one year, for review and approval of the Commissioner, a plan to accommodate future increases in flow to the plant.* As shown in **Figure 2-1**, the 180-day moving average of the total daily flows exceed 90% of the design flow 57% of the time. In other words, 57% of the time, the 180-day moving average is greater than 8.1 MGD.

To establish the basis for evaluation of the Fairfield WPCF, projections of future wastewater flows and loadings were determined based on the anticipated total population for the 20-year planning period as well as planned residential, commercial, industrial and institutional growth within the sewer service area. Based on discussions with the Town, it is anticipated that any new facilities would likely be on line in 2022. Therefore, the design year was established to be 2045. 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 to the WPCF wastewater flows.

FIGURE 2-1

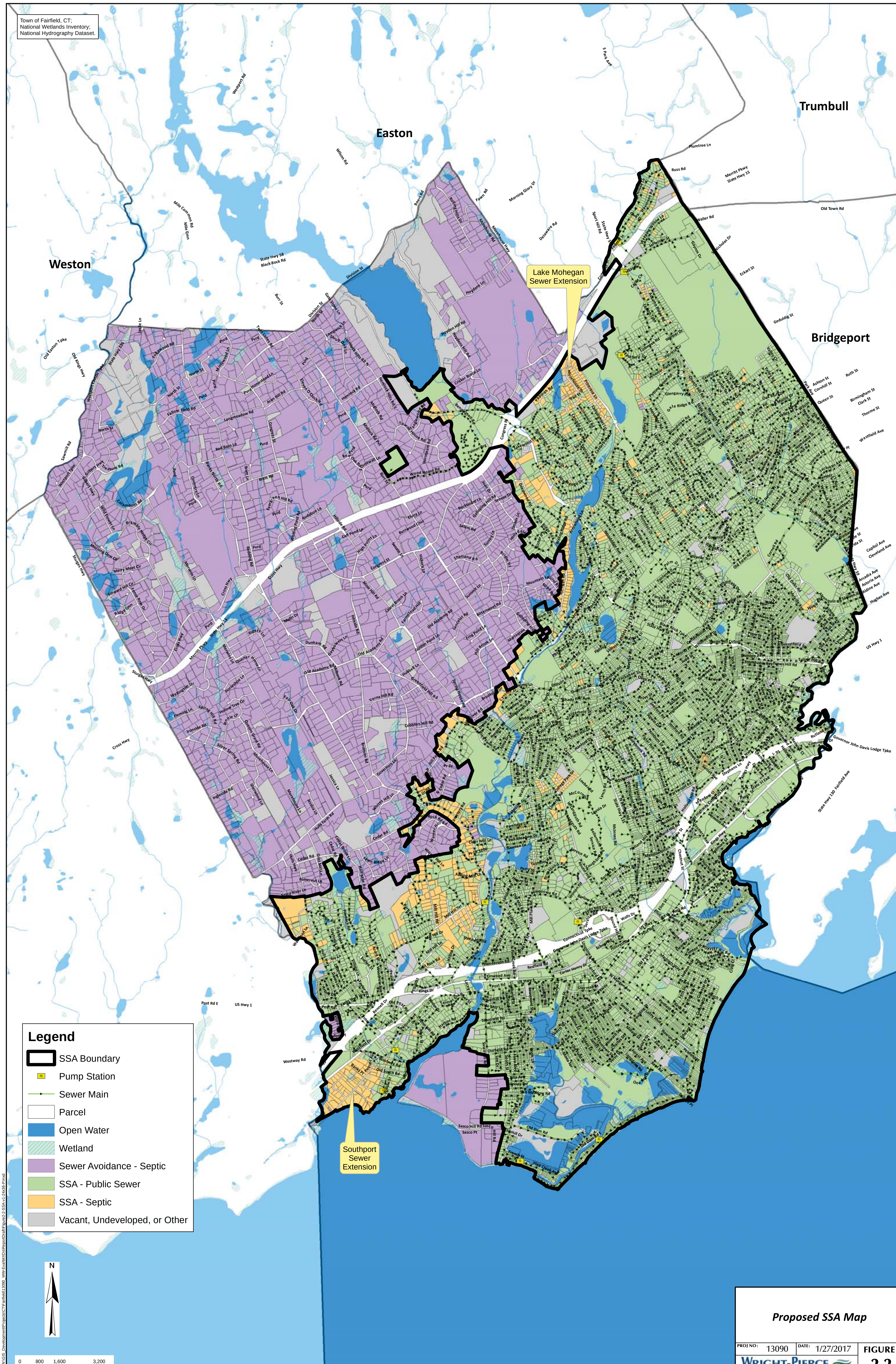
180 DAY MOVING AVERAGE OF TOTAL DAILY FLOW

JANUARY 2010 THROUGH JUNE 2016



Census Data was used to estimate population projections which were coordinated with the Town's Plan of Development Report and Sewer Service Area (SSA). The draft SSA for the Town of Fairfield is presented in **Figure 2-2**. This proposed SSA map represents the areas of Fairfield that are currently sewered or are planned to be sewered. Major changes from the last sewer service area map prepared by Stearns and Wheeler as part of the 1996 wastewater facilities plan include:

- Addition of Lake Mohegan, Springer Road and Southport sewer extension areas to the SSA;
- Decrease/truncation of the Galloping Hill, Cedar Road and Bronson Road sewer extension areas to the SSA.



Proposed SSA Map

PROJ NO: 13090 DATE: 1/27/2017

FIGURE: 2-2

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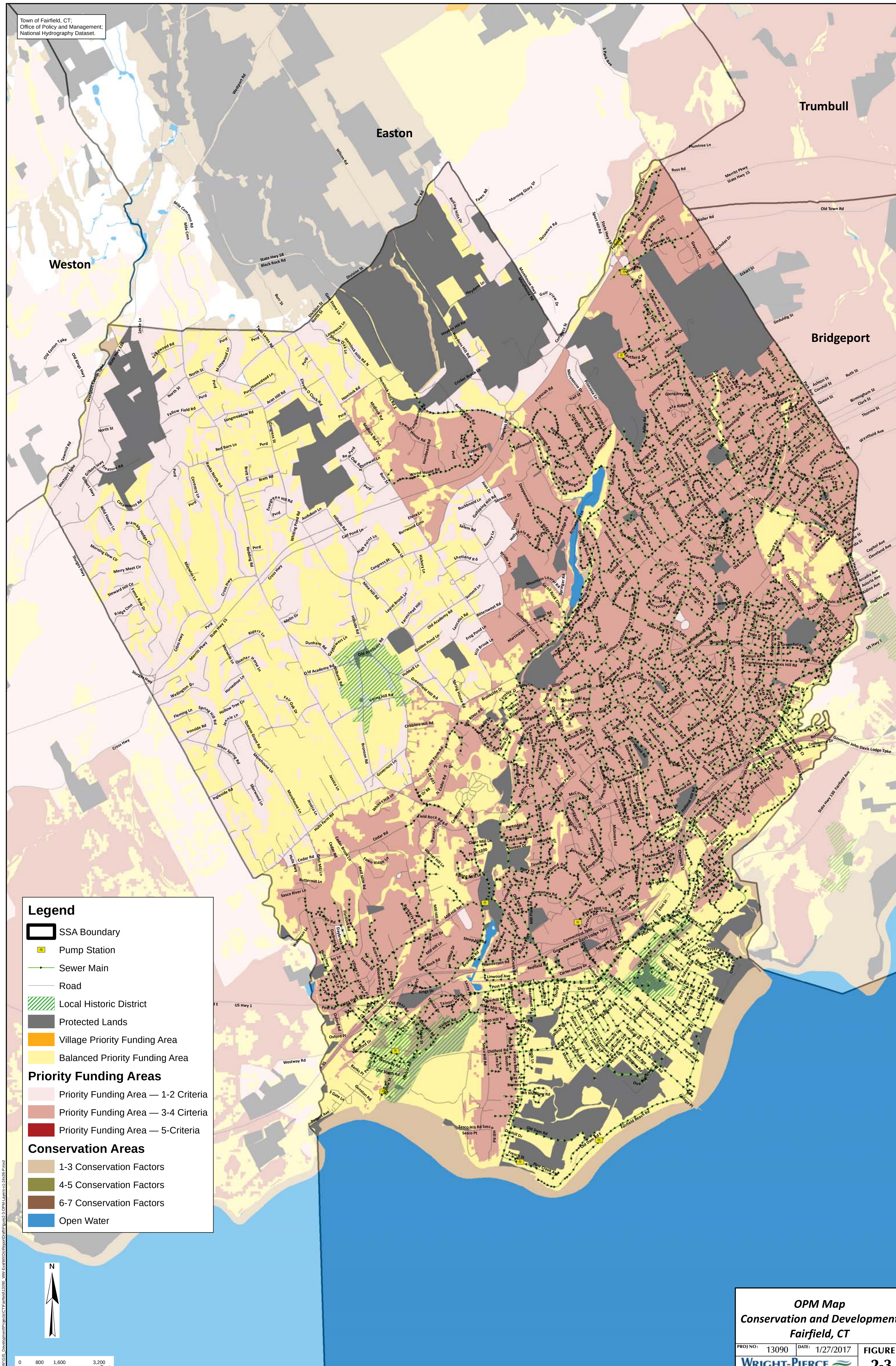
2.2 STATE PLAN OF CONSERVATION AND DEVELOPMENT

The State of Connecticut General Statutes 16a-24 through 16a-33 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.

The Town of Fairfield has developed a DRAFT Sanitary Sewer Service Area map as part of this facilities plan 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 Fairfield Open Space. The 2013-2018 C&D Plan Locational Guide Map (LGM) for the Fairfield area is presented in **Figure 2-3**. 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 35 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 conflicts	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*

* Note: 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. Furthermore, CGS Section 8-23(b) makes municipalities ineligible for discretionary state funding, effective July 1, 2014, if they have not updated their local plans within the required ten-year timeframe.



Town of Fairfield, CT;
Office of Policy and Management;
National Hydrography Dataset.
Weston
Easton
Trumbull
Bridgeport
Legend
SSA Boundary
Pump Station
Sewer Main
Road
Local Historic District
Protected Lands
Village Priority Funding Area
Balanced Priority Funding Area
Priority Funding Areas
Priority Funding Area — 1-2 Criteria
Priority Funding Area — 3-4 Cirteria
Priority Funding Area — 5-Criteria
Conservation Areas
1-3 Conservation Factors
4-5 Conservation Factors
6-7 Conservation Factors
Open Water
N
0 800 1,600 3,200 Feet
OPM Map
Conservation and Development
Fairfield, CT
PROJ NO: 13090
DATE: 1/27/2017
FIGURE: 2-3
WRIGHT-PIERCE
Engineering a Better Environment

Based on the revised 2013-2018 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).

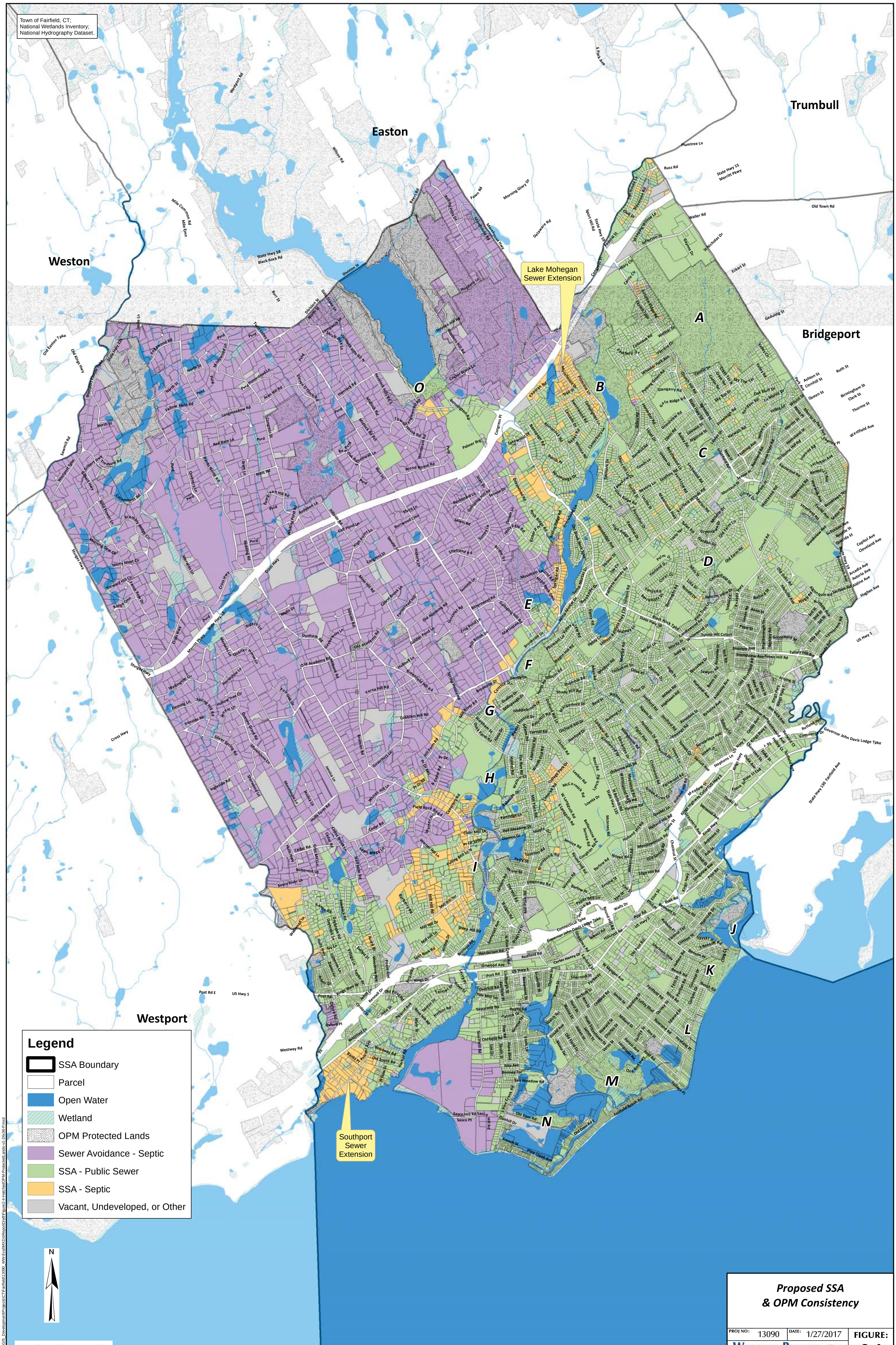
For Clean Water Funded Projects, these PFAs fall into two of six Growth Management Principles (GMP's):

- 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 Sewer Service Area, presented in **Figure 2-2**, is generally in conformance with the OPM C&D Plan Map for 2013 to 2018. **Figure 2-4** defines areas of non-conformance which are identified "A" through "O". These areas are designated by OPM as protected lands but are currently sewered and summarized below. There are no plans to expand or increase sewer service connections or availability on these parcels. The remainder of the currently sewered and proposed sewered parcels identified in **Figure 2-2** fall within a category 3-4 PFA or a Balanced PFA, which may proceed forward without exception.

- Area "A" – Fairchild Wheeler Golf Course on 320 acres with only the clubhouse facilities served by sewer.
- Area "B" – Lake Mohegan Park on 118 acres with only the public restroom facilities served by sewer.
- Area "C" – Lt. Own Fish Park on 11 acres with only the public restroom facilities served by sewer.
- Area "D" – Drew Park on 8 acres with only public restroom facilities served by sewer

- Area “E” – Trillium Road Open Space. It appears that the OPM Layer covers four single family sewered parcels and a portion of the Trillium Road Open Space. This should be modified to only cover the Trillium Road Open Space Parcel.
- Area “F” – Springer Glen Open Space. It appears that the OPM Layer covers six single family sewered parcels and the Springer Glen Open Space. The Springer Glen Open Space parcel is 35 acres with only a public restroom served by sewer.
- Area “G” – Mill River Open Space. It appears that the OPM Layer covers two single family sewered parcels and portions of the Mill River Open Space. This should be modified to only cover the Mill River Open Space Parcels.
- Areas “H” falls between Riverfield School and the Oak Lawn Cemetery. It is unclear what on this parcel is actually sewered.
- Areas “I” – Sturges Pond Open Space. It is unclear what on this parcel is actually sewered.
- Areas “J, K & L” are parcels owned by the Town of Fairfield which include the Fairfield Beach Club, Jennings Beach and the Fairfield Marina all of which are served by public sewer.
- Area “M” is a 124-acre parcel owned by the Town of Fairfield which includes the Public Works Department, Water Pollution Control Facility, Fire Training Center and Animal Control Office all of which are served by public sewer.
- Area “N” – Pine Creek Avenue Playground on 25 acres with only the public restroom facilities served by sewer.
- Area “O” is a 27-acre parcel owned by Aquarian Water Company and is part of the Hemlock Reservoir. An existing building/water treatment facility on the property is served by sewer.



Proposed SSA
& OPM Consistency

PROJ NO: 13090 DATE: 1/27/2017 FIGURE: 2-4

WRIGHT-PIERCE
Engineering a Better Environment

2.3 CURRENT FLOWS AND LOADS

Current influent wastewater flows and loads have been established based on facility operating data for the 68-month period from January 2010 through August 2015 (Analysis Period). The specific waste streams that make up the Fairfield WPCF influent include the following:

- Sanitary flows through the Fairfield wastewater collection.
- Trucked-in septage.
- Internal recycle streams at the facility including filtrate from the gravity belt thickener and belt filter press as well as supernatant from the primary and secondary digesters which discharge downstream of the influent sampler.

Both influent and effluent flows are measured at the facility. Effluent flow is measured via an ultrasonic level transducer and parshall flume downstream of the Ultraviolet (UV) Disinfection System. 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 33.00 MGD which was exceeded 8 times over the analysis period. Influent flows are measured by strap on type ultrasonic doppler flow meters on the discharge force mains from the main and auxiliary raw sewage pumps. These readings are used for process control only. The total influent load received at the Fairfield WPCF is determined by sampling the influent wastewater immediately downstream of the grit chamber. This sampling location is upstream of the influent wet well and includes influent wastewater flows from the collection system and septage. All solids handling recycle and filtrate flows discharge into the influent wet well downstream of the influent sampler. The frequency distribution of total daily flows, BOD_5 loading, and TSS loading have been determined for the period January 2010 through August 2015 and are presented in **Figure 2-5**. The influent BOD_5 and TSS concentration data for the period January 2010 through August 2015 are presented in **Figure 2-6**. The monthly average flows are presented in **Figure 2-7**.

FIGURE 2-5

INFLUENT FLOW & LOADING FREQUENCY DISTRIBUTION

JANUARY 2010 THROUGH AUGUST 2015

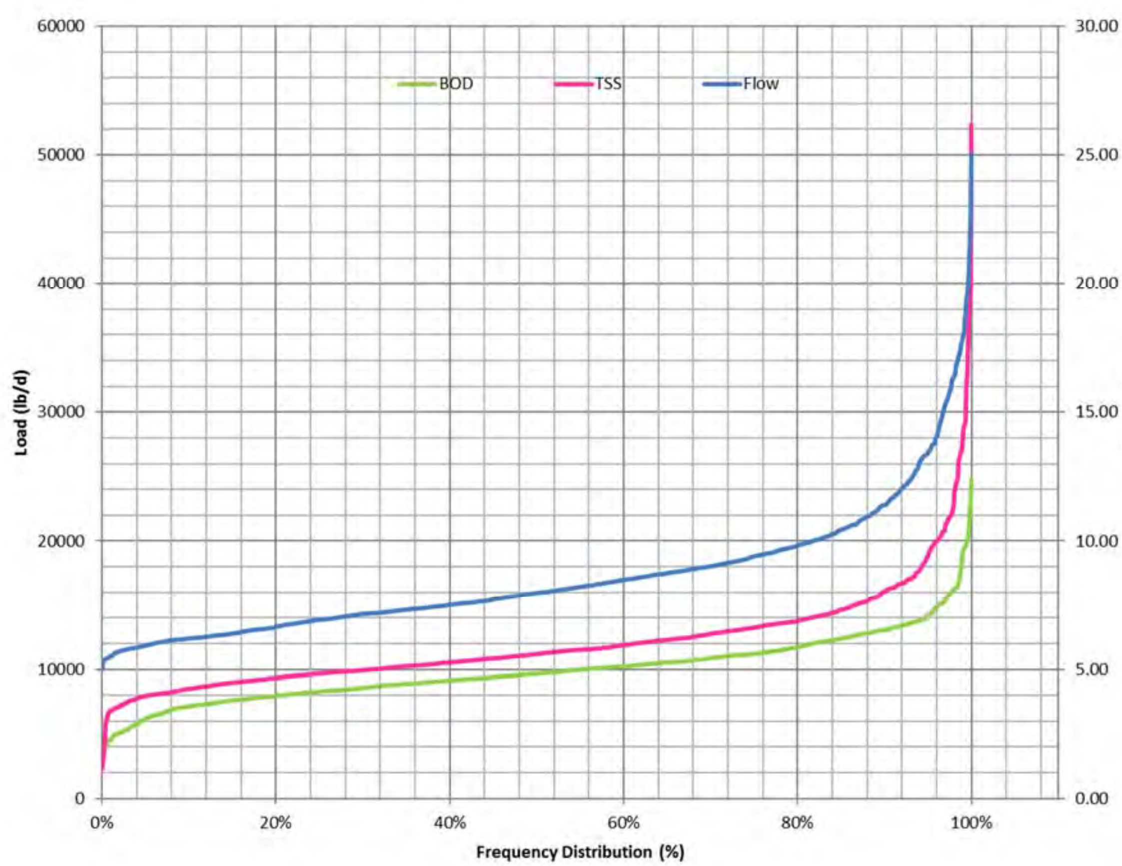
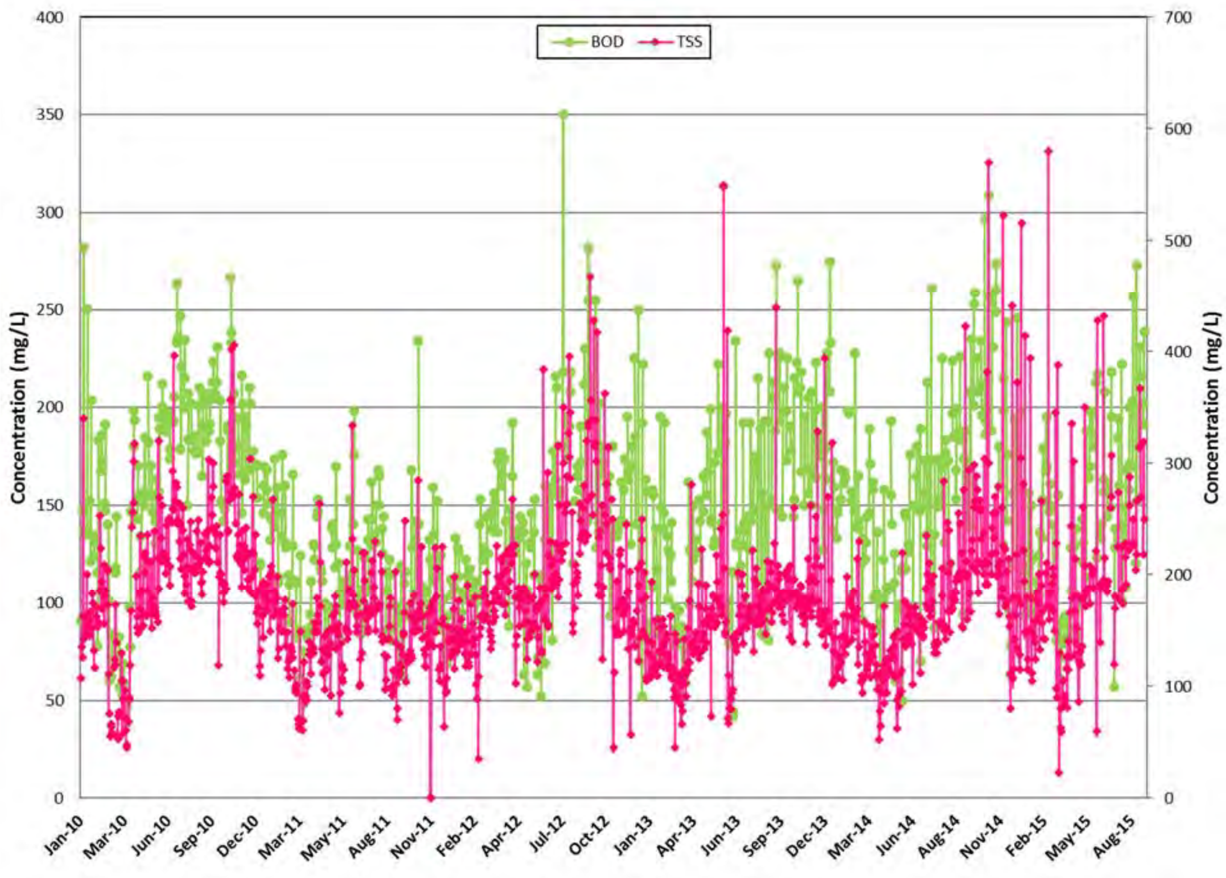


FIGURE 2-6

INFLUENT BOD5 AND TSS 7-DAY AVERAGE CONCENTRATIONS

JANUARY 2010 THROUGH AUGUST 2015



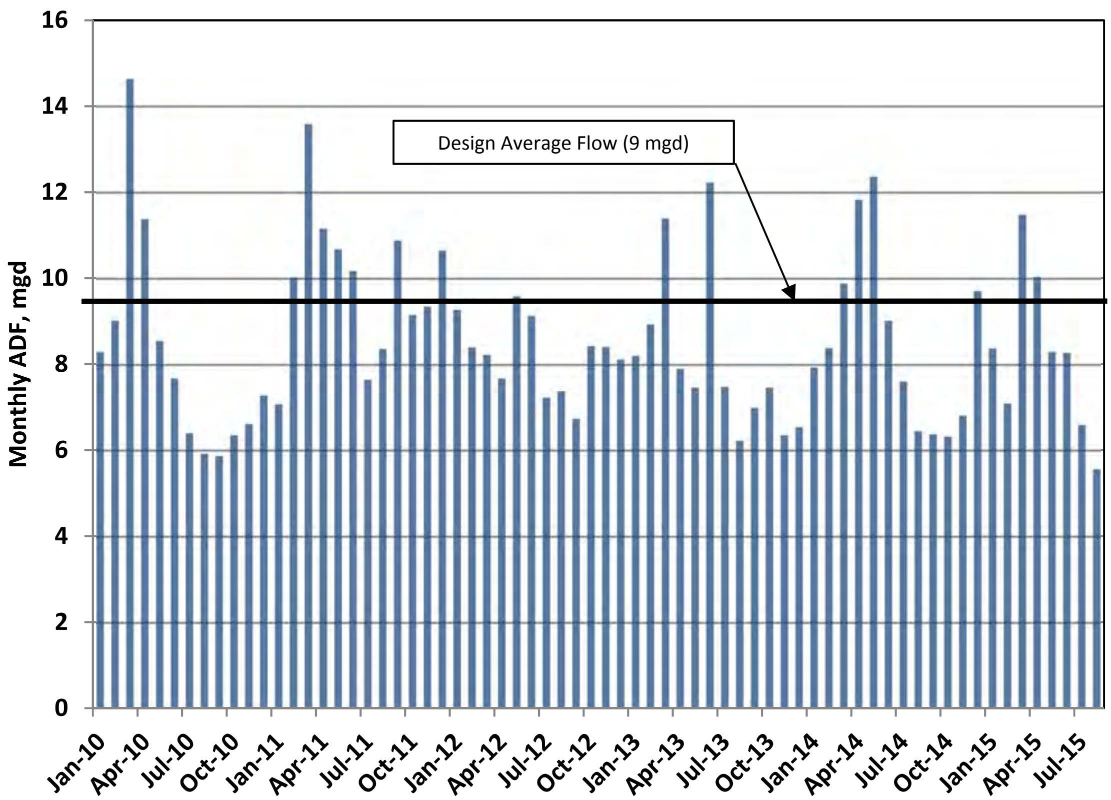
2.3.1 Influent Flow, BOD_5 and TSS Loadings

As seen in **Figure 2-6**, the influent BOD_5 loading and influent TSS loading had a value of approximately 10,000 lb/d and 12,000 lb/d respectively. The 98th percentile BOD_5 loading was around 16,230 lb/d and the 98th percentile TSS loading was around 23,182 lb/d. As seen in Figure 5, the influent BOD_5 and TSS loading have an average values of 150 mg/L and 180 mg/L respectively.

FIGURE 2-7

MONTHLY AVERAGE DAILY FLOWS

JANUARY 2010 THROUGH AUGUST 2015



2.3.2 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 (BOD_5, 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 BOD_5 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 only determined for flows, not loadings, and is an important hydraulic consideration for the design of unit processes at the WPCF. 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. Use of the 98th percentile value for the Fairfield WPCF is appropriate due to the operation of the raw sewage pumps. The raw sewage pumps are equipped with variable frequency drives. However, when the operating pump(s) reach 100% speed, should the wet well level continue to rise, the next pump comes on at 100% speed. Because flow is measured on the discharge side of the pump, the measured peak hourly flow rate may be greater than what is actually being received at the plant.

A summary of the existing influent characteristics is summarized in **Table 2-1**.

2.3.3 Nitrogen and Phosphorus Loading

The WPCF also monitors influent ammonia, TKN, nitrite and nitrate on a once per month basis. Data have been provided for the period January 2010 through September 2014. Influent orthophosphate and total phosphorus concentrations as well as effluent phosphorus are measured once per month. Typically, TKN concentration would be approximately 20% of the influent BOD5 loading. Ammonia is typically about 60% of the TKN loading and phosphorus is typically calculated by multiplying the existing BOD_5 loadings by 3.5%. From **Table 2-1**, the annual average influent TKN is around 20% of BOD5 and had an average concentration of 28 mg/l.

TABLE 2-1
CURRENT INFLUENT WASTEWATER FLOWS & LOADS
FAIRFIELD WPCF

	Flow		BOD_5			TSS			TKN[1]		
Parameter	**MGD**	**P.F.**	**mg/L**	**lb/day**	**P.F.**	**mg/L**	**lb/day**	**P.F.**	**mg/L**	**lb/day**	**P.F.**
Minimum Day	5.00	0.59	83	3,461	0.35	57	2,391	0.20	32	1,314	0.65
Annual Average	8.54	-	140	9,961	-	168	11,993	-	28	2,013	-
Maximum Month[2]	15.89	1.86	100	13,267	1.33	134	17,733	1.48	30	3,978	1.98
Maximum Day[3] (100th %)	25.01	2.93	119	24,740	2.48	251	52,347	4.36	24	4948	2.46
Maximum Day[4] (98th %)	16.40	1.92	119	16,230	1.63	169	23,182	1.93	24	3246	1.61
Peak Hour[5] (100th %)	33.00	3.87		-	-						
Peak Hour[6] (98th %)	20.52	2.40	-	-	-	-	-	-	-	-	-

	NH3-N[1]			TP[1,7]			Ortho-P[1,7]		
Parameter	**mg/L**	**lb/day**	**P.F.**	**mg/L**	**lb/day**	**P.F.**	**mg/L**	**lb/day**	**P.F.**
Minimum Day	20	835	0.70	3	121	0.35	1	36	0.35
Annual Average	17	1,186	-	5	349	-	1	105	-
Maximum Month[2]	13	1,717	1.45	4	464	1.33	1	139	1.33
Maximum Day[3] (100th %)	N/A	N/A	-	4	866	2.48	1	260	2.48
Maximum Day[4] (98th %)	N/A	N/A	-	4	568	-	1	170	-
Peak Hour[5] (100th %)									
Peak Hour[6] (98th %)	-	-	-	-	-	-	-	-	-

NOTES
1. TKN, Ammonia, are based on once per month influent sampling data (2010 through September 2014)
2. Maximum Month values are based on a maximum 30-day moving average.
3. Maximum Day is based on the actual maximum measured value during the data period.
4. Maximum Day is based on 98th percentile data.
5. Peak Hour is actual peak hour measured value during the data period.
6. Peak Hour is the 98th percentile data.
7. TP is assumed to be 3.5% of the influent BOD5; Ortho-P is assumed to be 30% of TP.

As shown in **Table 2-1**, the current arithmetic mean of the average daily flow (ADF) from the WPCF is 8.54 MGD, or 95% of the permitted flow of 9.0 MGD. The 180-day moving average of the ADF was 8.51 MGD.

2.4 FUTURE FLOWS AND LOADS

The Town of Fairfield published a Draft Plan of Conservation and Development in April, 2016 which was used as a reference in this evaluation. The Town of Fairfield is located in southwestern Connecticut and is one of the six towns that comprise the Connecticut Metropolitan Region. Fairfield borders Bridgeport and is within an hour's drive to both New York City and Hartford. Two highways serve the town, Route 15 and I-95, as well as the New Haven Line of the Metro-North Railroad. Fairfield's current population of more than 59,000 resides in over 20,000 households dispersed throughout the towns 30.2 square miles. The community is diverse with housing types ranging from multi-family dwellings on quarter acre lots or smaller lots in the Shore Area to large single-family homes of two-acre lots in Greenfield Hill.

Fairfield is a predominately residential community with significant commercial and industrial corridors. Commercial uses are concentrated along the I-95 and Route 1 corridors as well as Black Rock Turnpike. Industrial uses are concentrated between I-95 and Route 1 as well as the Commerce Drive area.

Future flow and load increases were developed based on the summary of current conditions presented in **Table 2-1** and adding flows and loads associated with projected growth within Fairfield. A discussion of the specific components that are anticipated to contribute future flows and loads to the Fairfield WPCF are presented below including:

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

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

A previous wastewater facilities plan was prepared in 1997 by Stearns and Wheeler in response to an Order from the State of CT DEEP, projecting flows and loads through the year 2020. In general, the WPCF flows are within a few percent of the projections in the previous plan for average daily flow but are much higher than the max month and peak hour projections of 10 and 24 MGD respectively. This is due to the fact that I/I has not been reduced to the level projected in the 1997 plan.

2.4.1 Population Projections

Two sources of data were utilized to obtain population projections for the Town of Fairfield. The first is the Connecticut State Data Center, University of Connecticut, November 1, 2012 updated Fairfield Population projections from 2015 to 2030. The second is the August 2016 Town of Fairfield Plan of Conservation and Development (POCD) Update. Both of these sources include projections through the year 2030. 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 2-2**.

Based on review of the projections by both sources, as well as follow-up discussion with the Fairfield Plan and Zoning Department, the population of Fairfield is expected to remain consistent between 58,000 and 59,000 people through 2030, of which approximately 75% is sewered. 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 (with the balance in growth occurring outside of the sewer service area), or an additional 35,000 gpd increase in average daily flow assuming 70gpd per capita.

TABLE 2-2

TOWN OF FAIRFIELD POPULATION PROJECTIONS

YEAR	CT STATE DATA CENTER	FAIRFIELD POCD PROJECTIONS
1990	53,418	--
2000	57,340	57,340
2010	59,404	58,570
2015	*59,254*	58,570
2020	*59,025*	*58,393*
2025	*58,912*	*58,662*
2030	*59,045*	*59,045*
2035	*59,295*	*59,295*
2045	*59,495*	*59,495*
2045	*59,545*	*59,545*

Italicized values are projected.

2.4.2 Residential Flows

The majority of future potential residential flows from the Town of Fairfield will occur in areas which are currently unsewered. These potential residential flows are all parcels with septic tanks installed that have been included in the proposed draft sewer service area (SSA) which may or may not connect during the 20-year planning period. A small portion of "fill-in" parcels with septic tanks are within the Town's existing sewer service area (SSA) with direct frontage to sewers. All of these parcels are shown in **Figure 2-2** and range in size from 0.1 to 2.0 acres, with an average parcel size 0.38 acres and are zoned residential AAA (min. lot size of 2.0 acres), AA (min lot size of 1.0 acres), A (min. lot size of 9,375 square ft.), R-2 (min. lot size of 14,000 square ft) and R-3 (min lot size of 20,000 square ft.). Parcels larger than 2.0 acres will be evaluated separately and categorized as large residential growth. Note there is no ordinance requiring a sewer connection.

2.4.2.1 Existing SSA – Vacant of Septic Tank Parcels

There are 478 residentially zoned parcels (AAA, AA, A, R-2 and R-3) in the Town of Fairfield that are currently either vacant or served by septic tanks but have direct frontage or are in close proximity to the existing sewer system. There is no ordinance on Fairfield requiring these parcels to connect to the sewer. By the year 2045, we have assumed that 30% of these parcels will have been connected to the sewer system at full parcel build out based on current zoning.

2.4.2.2 Proposed SSA Extension Areas - Septic Tank Parcels

The Town of Fairfield and Wright-Pierce met in January 2016 to discuss areas of Town that are adjacent to the existing SSA for inclusion in the revised SSA. The Town and Wright-Pierce were able to identify four areas to further delineate the SSA boundary.

Some of the reasons for these additional proposed SSA extensions are as follows:

- Septic tanks in these parcels have had documented repair work performed often indicating failure;
- Parcels have low potential soils to support subsurface sewage disposal systems;
- Parcels are too small to support septic tank replacements;
- Parcels are conveniently located near the existing sewer system;
- Parcels are adjacent to Lake Mohegan;

There are three major areas (“Lake Mohegan”, “Springer Road” and “Southport”) that were identified as potential sewer extension areas to the existing SSA and shown in **Figure 2-2**. In the future, these parcels will likely connect to the sewer system. Wright-Pierce has assumed that the likelihood that these sewer extensions are constructed by 2045 is high. There has already been some interest from DEEP about connecting the Southport area due to small lots and poor sandy soils as well as proximity to Long Island Sound. Similarly, the Lake Mohegan and Springer Road extension areas are comprised of parcels of around 0.5 acre making replacement or upgrading on-site disposal systems difficult. Review of septic system repair logs provided by the Town of Fairfield Health Department from 2010 through 2016 were reviewed as well as the *Soil Potential*

Ratings for Subsurface Disposal Systems GIS database layers from the CT DEEP website developed from historical soils surveys and last updated in April 2010. Refer to **Figure 2-8** for soil potential ratings in the Town of Fairfield.

Sewer extensions in the Galloping Hill and Cedar/Bronson areas of Town were initially evaluated as potential sewer extension areas. Based on discussion with the Town and review of available information, it was determined that these areas had parcels large enough to support on-site septic's and soils (1 acre or more on average) even though their soils provide for a medium to low probability to support septic systems. As a result, only those parcels within a hundred feet or so of an existing mainline sewer were included and categorized as an "infill" parcel.

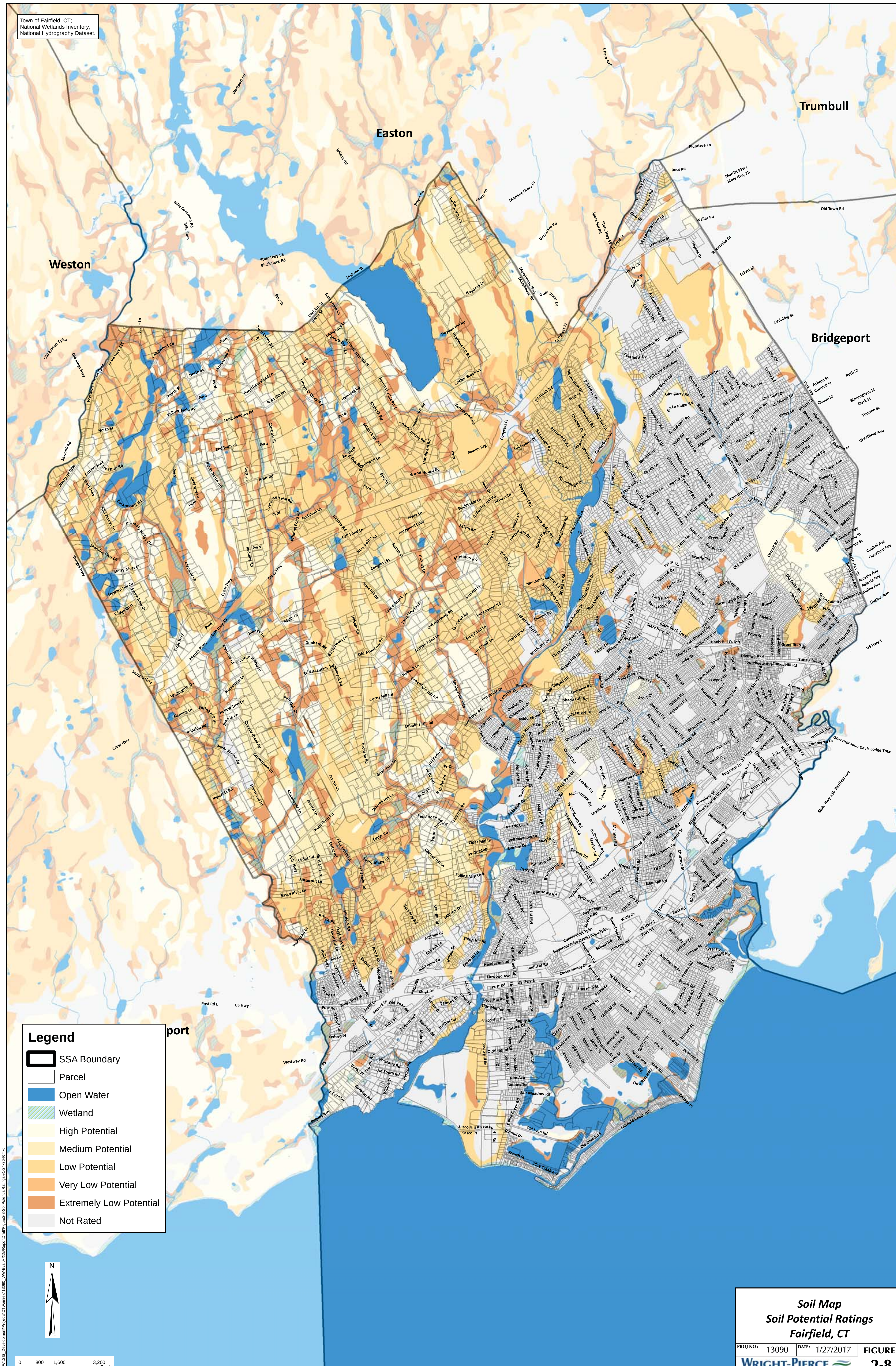
A potential flow increase of 62,513 gpd has been projected for residential flows as shown in **Table 2-3**. This is higher than the 35,000 gpd projected based on population alone due to the fact that it accounts for providing for sewer extensions into already populated areas. This increase assumes the following based on 2010 US Census data and town zoning:

- All single family parcel lots zoned A, R-2 and R-3 fully built out
- 2.77 people / household
- 70 gpd per capita

TABLE 2-3

TOWN OF FAIRFIELD RESIDENTIAL FLOW PROJECTIONS

LOCATION/ EXTENSION	TOTAL PARCELS	TOTAL PROJECTED FLOW	% PROBABILITY CONNECTED BY 2045	2045 PROJECTED FLOW
Fill-In Parcels	478	92,684	30%	27,805
Lake Mohegan	76	14,736	100%	14,736
Springer Road	32	6,205	100%	6,205
Southport	71	13,767	100%	13,767
TOTAL	**657**	**127,392**		**62,513**


Town of Fairfield, CT; National Wetlands Inventory; National Hydrography Dataset.
Easton
Weston
Trumbull
Bridgeport
Legend
SSA Boundary
Parcel
Open Water
Wetland
High Potential
Medium Potential
Low Potential
Very Low Potential
Extremely Low Potential
Not Rated
N
0 800 1,600 3,200 Feet
Soil Map
Soil Potential Ratings
Fairfield, CT
PROJ NO: 13090
DATE: 1/27/2017
FIGURE: 2-8
WRIGHT-PIERCE
Engineering a Better Environment

2.4.3 Inter-Municipal Flows

The Town of Fairfield WPCF currently does not have any formal inter-municipal agreements (IMAs) in place to treat wastewater conveyed from other adjacent Towns. Wright-Pierce contacted the local WPCAs in the Towns of Trumbull, Westport, and Easton to inquire about possible future flows. A brief discussion about each town is below. For the Town of Fairfield WPCF Facilities Plan Flows & Loads evaluation, no future IMAs will be assumed.

2.4.3.1 Town of Westport

The Town of Westport WPCA was contacted, and they said that there were no plans to convey wastewater in the future to the Town of Fairfield.

2.4.3.2 Town of Trumbull

The Town of Trumbull WPCA has an IMA with the City of Bridgeport to convey their wastewater flow to one of their WPCFs. Currently, on an emergency as needed basis, flow from the Park Avenue Pump Station in the Town of Trumbull can be conveyed to the Town of Fairfield sewer system at an average rate of 10,000 GPD.

The Town of Fairfield WPCA understands that the Town of Trumbull WPCA is currently evaluating conveying their wastewater flow to the Town of Fairfield. However, as of the writing of this Flows & Loads evaluation, there has been no formal written documentation proposing or requesting this possible IMA to the Town of Fairfield. Therefore, no future wastewater flows from the Town of Trumbull have been assumed for this Facilities Plan.

2.4.3.3 Town of Easton

The Town of Easton was contacted about future potential flows during the Flows & Loads evaluation. There is potential for a small senior housing development or other type of residential development to convey wastewater flow to the Town of Fairfield on the border of Easton and Fairfield. However, the town officials explained that this development was unlikely. Therefore, it is assumed that no future flow from the Town of Easton will be expected.

2.4.4 Institutional Flows

Sacred Heart University and Fairfield University are the two institutions that were considered as part of the Flows & Loads evaluation. Sacred Heart University has proposed to convey future wastewater flows to the Town of Fairfield collection system through purchase of the former Jewish Home for the Elderly property. Fairfield University has proposed an addition to their School of Nursing.

2.4.4.1 Sacred Heart University

Sacred Heart University is located in the Town of Fairfield. Their existing flows have historically been conveyed to the City of Bridgeport. Wright-Pierce made contact with Sacred Heart University and their consultants multiple times during this Flows & Loads evaluation. It is Wright-Pierce's understanding that Sacred Heart University has proposed to the Town of Fairfield to convey approximately 45,000 gallons per day from four buildings (2 apartment style dormitories, 1 dining hall with a diner and some additional apartment dormitories, and a fitness center) on the Sacred Heart University Campus and two existing buildings from the existing Jewish Home for the Elderly property.

Wright-Pierce understands that Sacred Heart University will be occupying two of the existing buildings on the Jewish Home for the Elderly property by April 2016. Both buildings will be renovated as dormitories for the University. The potential future flow from Sacred Heart University is expected to be equivalent to or less than the wastewater flow from the two existing buildings on the Jewish Home for the Elderly's campus when it was occupied previously. Therefore, no additional flow will be assumed for the future flows in the Town of Fairfield.

2.4.4.2 Fairfield University

Fairfield University has an approved plan for expanding the School of Nursing. No information was provided by the university. These flow projections are estimated to be an additional 22,485 gpd (calculated by Kohler Ronan, LLC, May 17, 2016) and are included in **Table 2-6**.

Additional allowances have also been included for both Sacred Heart and Fairfield University assuming a 10% increase in the current enrolled population by 2045. For Sacred Heart, that is an increase of a 2015 population of 6,500 to 7,150 by 2045. For Fairfield University, that is an increase of a 2015 population of 5,140 to 5,654 by 2045. This allowance of 58,000 gpd is included in **Table 2-6**.

2.4.5 Commercial / Industrial / Large Residential Growth Flow

The Town of Fairfield has expressed that additional new industrial flows are not expected to be conveyed in the future to the town's collection system. The Fairfield Community & Economic Development Department provided a development "hit list" to Wright-Pierce in January 2016 and some additional development information via email correspondence that tracks potential future commercial, industrial, and large residential growth in Town. The development list was reviewed and flow projections were developed for projects that could provide additional flows to the Town of Fairfield collection system in the future. If a project on the list involved a parcel that was not changing use or if the existing building footprint was not expanded, it was assumed that there would be no net flow increase from that project. For example, during the development of future flow projection, General Electric (GE) recently announced their plans to relocate to Boston, MA and sell their 69-acre campus and 600,000 SF of office space, recently purchased by Sacred Heart University for dormitories and offices. For purposes of this Facilities Plan, a net change of zero flow will be assumed. This list is summarized in **Table 2-4**. Other industries in town include Superior Plating and Wisconsin Incorporated.

TABLE 2-4

TOWN OF FAIRFIELD PLANNED COMMERCIAL/INDUSTRIAL/LARGE RESIDENTIAL FLOW PROJECTIONS

ADDRESS		DESCRIPTOR	Status	OWNER/PRIMARY TENANT	TOTAL FLOW PROJECTION (GPD)	% CONNECTED BY 2040	2045 PROJECTED FLOW
400	Mill Plain Road	Carolton Hospital	Approved	Benchmark/88-unit Assisted Living	9,020	100%	9,020
845, 917	Mill Hill Terrace	Garafolo	Proposed	Proposed 98-unit assisted living/memory care facility	10,250	50%	5,125
1571	Stratfield Road	Congregation Ahavath Achim	Proposed	assisted living / memory care facility. Assume 100 units.	15,400	50%	7,700
652	Commerce Drive	Syms/305 Black Rock Tnpke	Under Construction	Orthoepedic Specialty Group	1,150	100%	1,150
50,66	Unquowa Place	Blinn's	Under Construction	Medical Office	587	100%	587
4185	Black Rock Turnpike	Plant Factory	Approved	Medical Office	664	100%	664
345	Reef Road	Former Hanson's	Approved Delayed	Property for Sale; Approved for 15K Medical Office Bldg	399	100%	399
81	Black Rock Turnpike	Reiner	Potential	Possible mixed use residential site; in TOD overlay district	25,765	50%	12,883
665-711	Commerce Drive	Fitness Edge	Approved	5-story mixed use TOD with 100 studio/1-BR units over 15K retail	12,200	100%	12,200
355	Kings Highway	Miller VW	Approved Delayed	42 units/20K retail	8,156	100%	8,156
	Ash Creek Boulevard	Fairfield Metro	Approved Delayed	Approved for 1m. sf of office, retail and hotel; 180 room full service hotel or 500 units	119,433	100%	119,433
33-35	Beaumont Street		Proposed	Proposed 4-story mixed use; 3600sf office/3 units	648	50%	324
185	Thorpe Street	Fairfield Lumber	Proposed	Proposed 58-unit Residential	11,246	50%	5,623
333	Unquowa Road	Knights of Columbus	Planned	Proposed residential site; Assume 100 units	21,329	100%	21,329
92, 140	Bronson Road	Garden Homes	Denied/On Appeal	Proposed 91-unit set aside development	17,645	50%	8,822
1127-1305	Post Road	Citibank Building	Unknown	assummed 100 units	19,390	50%	9,695
1152	Kings Highway Cutoff	Daddario	Approved Delayed	Approved for Retail; Being proposed for medical office use	1,150	90%	1,035
1591-93	Post Road		Approved	Henry C. Reid & Son	88	100%	88
333	Grasmere Avenue	Handy & Harmon West	Potential	Possible retail site; needs remediation; wetlands	9,208	50%	4,604
3541	Post Road	Southport Walgreen's	Approved Delayed	Walgreen's	800	90%	720
1173	North Benson Road	Fairfield University	Proposed	Addition to School of Nursing	10,000	90%	9,000
2190	Post Road	Exide Battery	Potential	Retail/Mixed Use Site ready for Development 2017 (undergoing remediation)	7,153	100%	7,153
	TOTAL				**301,680**		**245,709**

Assumptions have been made of the probability of connection by the year 2045 for each project listed in **Table 2-4** based on discussions with Town staff as well as the current status of the project. If approved or under construction, a 90% to 100% probability was carried. If proposed or potential, a 50% probability was carried.

The following assumptions were utilized to generate the flow projections in **Table 2-5** from Metcalf and Eddy, Wastewater Engineering Treatment and Reuse, 4th Edition:

- 1150 gal / acres / day for commercial development
- 800 gal / acres / day for light commercial or retail development
- 2.77 people / apartment unit
- 70 gpd per capita for apartment units
- 80 to 100 gal / unit / day for assisted living units
- 10 gal / unit / day for employees in office, retail, assisted living, etc.

In addition to planned development, all sewered parcels within town greater than 2.0 acres were evaluated further for full build out conditions. In total, there are 392 parcels connected to sewer system ranging in size from 2.0 to 320.0 acres. Based on discussion with the town, this list was then purged to eliminate town owned parcels, state owned parcels, federal owned parcels, golf courses, cemeteries, open space, churches, large mansions and estates, shopping malls, and planned development already included in **Table 2-4** for further consideration. The remaining 189 parcels are comprised of 161 residentially zones parcels and 28 commercial/industrial zoned parcels.

For each of the 161 residential zoned parcels (R-2, R-3, A, AA, AAA, B), it was assumed that 85% of the available land was developable. Full build out conditions were then calculated based on allowable lot size per the town's zoning regulations resulting in the potential addition of 950 more single family homes. Assuming 2.77 people per home at 70 gpcd, that is an additional 184,205 gpd at full build out. The probability that these parcels will be sold and built out or rezoned by the year 2045 is low, therefore a 20% probability was carried.

For each of the remaining 28 commercial and industrial zoned parcels (CDBD, DCD, DID, DRD) not already accounted for in **Table 2-5**, 1,150 gpd per acre per day was carried for full build out of these parcels resulting in the potential addition of 127,660 gpd. Based on further discussion with the town, it was requested that future zoning changes be accounted for in terms of an allowance, particularly relating to parcels within or surrounding Fairfield major commercial and industrial corridors. In order to account for this allowance, 100% build out of all 111 acres of industrial and commercial zoned parcels over 2.0 acres was carried.

Commercial, industrial and large residential growth projection are summarized in **Table 2-6**.

TABLE 2-5

TOWN OF FAIRFIELD COMMERCIAL/INDUSTRIAL/LARGE RESIDENTIAL FLOW PROJECTIONS SUMMARY

PARCEL	TOTAL ADDITIONAL ADF (GPD)	% PROBABILITY OF FULL BUILD OUT BY 2045	2045 PROJECTED ADF (GPD)
Projected Residential	184,205	20%	36,841
Projected Commercial, Industrial and Research	127,660	100%	127,660
Planned Commercial, Industrial and Research	301,680	SEE TABLE 2-5	245,709
TOTAL	**613,545**		**410,210**

2.4.6 Summary of the Future Flows and Loads

Table 2-3, 2-4 and **Table 2-5** summarize future average daily flows from the projected future sewered residential population, institutional, commercial and industrial sources in the Town of Fairfield.

For the planned residential growth within the Town of Fairfield including potential sewer extension projects and the "fill-ins" from developed or vacant parcels that are currently not connected to the sewer, estimates of population served were developed and it was assumed that a BOD_5 loading of 0.17 lb/capita-day would be generated and a TSS loading of 0.2 lb/capita-day would be generated. In addition, it was assumed that the TKN loadings would be 20% of the BOD_5 loading and the TP loading would be 3.5% of the BOD_5 loading. For the remaining categories of future flows including commercial, industrial, institutional and large residential growth, TSS and BOD_5 wastewater loadings of 300 mg/l were used with TKN loadings being 20% of the BOD_5 loading.

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 Fairfield WPCF are presented in **Table 2-6**.

As shown in **Table 2-6**, the Town of Fairfield is projected to see a minor increase in wastewater flows and loadings by the year 2045 with a projected increase in permitted capacity from 9.0 to 9.12 MGD. However, the current design peak of 24.0 mgd has already been exceeded and will require an increase to ensure uninterrupted hydraulic conveyance through the facility. The relative increase in loadings is expected to be handled through process modifications. Regardless, all new processes will be designed to ensure 100% hydraulic conveyance of peak flows. In the event that an I/I program is unsuccessful, all new processes will be designed to ensure 100% hydraulic conveyance of peak flows and a permitted increase can always we requested from the DEEP in the future.

TABLE 2-6

FAIRFIELD WPCF BASIS OF DESIGN

FUTURE FLOW AND LOAD PROJECTIONS

Parameter	Minimum Day	Annual Average	Maximum Month	Peak Day	Peak Hr (98th %)	Peak Hr (100%)
EXISTING INFLUENT TOTALS (SANITARY)						
Flow, mgd	5.00	8.54	15.89	25.01	20.52	33.00
BOD_5, lb/d	3,461	9,961	13,267	16,230	--	--
TSS, lb/d	2,391	11,993	17,733	23,182	--	--
TKN, lb/d	1,314	2,017	3,978	3,246	--	--
PROJECTED INCREASE IN FUTURE RESIDENTIAL & INSTITUTIONAL FLOWS						
Flow, mgd	0.08	0.14	0.17	0.28	0.41	0.42
BOD_5, lb/d	118	340	453	554	--	--
TSS, lb/d	80	400	591	773	--	--
TKN, lb/d	44	68	110	109	--	--
PROJECTED INCREASE IN INDUSTRIAL/COMMERCIAL & LARGE RESIDENTIAL FLOWS						
Flow, mgd	0.234	0.40	0.480	0.800	1.18	1.20
BOD_5, lb/d	586	1,001	1,201	2,002	--	--
TSS, lb/d	586	1,001	1,201	2,002	--	--
TKN, lb/d	117	200	240	400	--	--
FUTURE I/I FLOWS FROM PLANNED SEWER EXTENSIONS [1]						
Flow, mgd	0.02	0.04	0.07	0.12	0.10	0.15
FUTURE I/I FLOWS FROM EXISTING COLLECTION SYSTEM						
Flow, mgd	0.00	0.00	0.00	0.00	0.00	0.00
DESIGN YEAR FLOWS						
Flow, mgd	**5.34**	**9.12**	**16.61**	**26.21**	**22.21**	**34.77**
BOD_5, lb/d	**4,165**	**11,302**	**14,921**	**18,785**	**-**	**-**
TSS, lb/d	**3,057**	**13,394**	**19,526**	**25,957**	**-**	**-**
TKN, lb/d	**1,475**	**2,285**	**4,328**	**3,756**	**-**	**-**

1. I/I OF 500 GPD/IDM BASED ON ESTIMATED EXTENSION AREAS.

2.5 CURRENT EFFLUENT DISCHARGE LIMITATIONS

The Town of Fairfield Water Pollution Control Facility (WPCF) discharges to the Long Island Sound 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 issued in November 2015 and expires on November 1, 2020. It allows the discharge of 9 million gallons per day (mgd) of flow on an average daily basis (Permit CT0101044). 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 Long Island Sound. The coastal waters portion of the Long Island Sound that receives the effluent from the Fairfield WPCF is classified as an “SC/SB” watercourse. Class SC/SB are designated as a habitat for marine fish and other aquatic life and wildlife, recreation, navigation, and industrial uses. The NPDES discharge permit requires that the WPCF meet specific discharge requirements for a number of parameters, which are summarized in **Table 2-7**.

TABLE 2-7

TOWN OF FAIRFIELD WPCF FACILITIES PLAN

NPDES EFFLUENT DISCHARGE LIMITATIONS

Parameter	Limitation	Sample Type/ Frequency of Collection
Flow[1]	9 mgd Average 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
UV[3]	≥ 24 mW-s/cm^2 (Dose) ≥ 6.10 mW/cm^2 (Intensity)	Work Day /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 BOD and TSS shall be 1.5 times the average monthly limit listed above.
3. The UV system shall be utilized year-round at the minimum limits.

2.5.1 Nitrogen Discharge Limitations

To reduce the occurrence of hypoxia (low dissolved oxygen conditions) in Long Island Sound, Connecticut and New York has 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 must 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.

As part of the Nitrogen General Permit development, a baseline for nitrogen loading of 811 lbs/day was established for the Fairfield WPCF. Based on a nitrogen reduction of 64% of the baseline, the fully implemented WLA or Nitrogen cap for Fairfield WPCF is 406 lbs/day. The WLA implementation schedule and limits for the Fairfield WPCF, as included in the Nitrogen General Permit are presented in **Table 2-8**. A copy of the *General Permit for Nitrogen Discharges* is included in **Appendix A**.

TABLE 2-8

TOWN OF FAIRFIELD WPCF FACILITIES PLAN

DISCHARGE LIMITS FOR TOTAL NITROGEN

Year	2002	2003	2004	2005	2006	2014 - 2020
Total Nitrogen (lbs/day)	811	754	687	598	497	406

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

a) the facility's annual mass loading of total nitrogen is less than or equal to the discharge limit set forth in the permit; or

b) 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. The Fairfield WPCF has an equivalency factor of 0.85. Therefore, for every pound of nitrogen below or above the discharge limit, 0.85 pounds of equivalent nitrogen credits would be bought or sold.

With respect to nitrogen, the Fairfield WPCF is required to meet an end of pipe nitrogen discharge limit of 406 lbs/day for 2016-2020 permit period based on the *General Permit for Nitrogen Discharges*. Currently, they are achieving 318 lbs/day, and have sold credits every year since 2002. The WPCF has two alternatives for complying with the nitrogen requirements. The first consists of achieving a reduction of total nitrogen levels through treatment, while the second consists of the purchase of nitrogen credits based on the difference between the actual effluent total nitrogen discharged to the Long Island Sound and the annual permit limits. As stated previously, the WPCF, which as an equivalency factor of 0.85 due to its location proximity to the Long Island Sound, has been designed to achieve or exceed the effluent limits.

2.5.2 Saltwater-Water Quality Based Limits

The Fairfield WPCF currently has no water quality based limits in the permit, nor are any anticipated. The most significant inclusion in the 2015 permit is the revised bacteria monitoring requirements (fecal coliform and enterococci).

2.6 COMPLIANCE WITH EXISTING DISCHARGE LIMITATIONS

The Fairfield WPCF generally operates in compliance with the current discharge permit limits. There have been relatively few permit violations over the last five years, mainly due to excessive wet weather flows, and none have resulted in the need for any regulatory action. Permit violations that have occurred are presented in **Table 2-9** below.

TABLE 2-9

FAIRFIELD WPCF FACILITIES PLAN

PERMIT VIOLATIONS

Year	Days/Months of Violation	Violation
2010	February 26, 2010	UV Dose below minimum
	March 31, 2011	Over TSS maximum daily limit
2011	March 7, 2011	Over TSS maximum daily limit
2012	October 31, 2012	Over TSS maximum daily limit
	October 31, 2012	Over BOD_5 maximum daily limit
	October 31, 2012	Over fecal coliform maximum daily limit
2013	January 7, 2013	No fecal coliform analysis done
	February 27, 2013	Over TSS maximum daily limit
	February 28, 2013	Over BOD_5 maximum daily limit
	March 1, 2013	Solids settling issues
2014	May 1, 2014	Over BOD_5 maximum daily limit
2015	September 5, 2015	Over fecal coliform maximum daily limit

2.7 HYDRAULIC EVALUATION

The Fairfield WPCF passes a current design peak hour flow rate of over 33 MGD. As presented in this Section, the projected future design peak hour flow rate is 35.24 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 minimum of 5.34 MGD to the future peak hour flow of 35.24 MGD. These flows were evaluated against the current Long Island Sound 100-year high tide line, 20-year high tide line, mean high tide line, and mean sea level to determine the impacts from both “normal” and worst-case hydraulic constraints. The Fairfield WPCF hydraulic evaluation assessed all the existing unit processes from the influent building primary mechanical bar screens to the effluent wet well and to the outfall to Long Island Sound.

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, maintain velocities, etc. The hydraulic evaluation predicts the response of these unit processes to the anticipated range of flows.

In constructing the existing Town of Fairfield WPCF hydraulic model, the following key hydraulic controls were identified on as-built drawings and are summarized in **Table 2-10**. No field survey was conducted during the Facility Plan.

TABLE 2-10

HYDRAULIC CONTROLS

Location	Control Device	Elevation (Town Datum)
Effluent Pump Station	Pumps	--
Final Settling Tanks (FST)	V-Notch Weir	23.16
FST Distribution Box	Rectangular Weir	23.97
Aeration Tanks Zone B	Rectangular Weir	27.12
Aeration Tanks Zone A	Rectangular Weir	28.00
Primary Effluent Channel	Rectangular Weir	28.79
Primary Settling Tanks	Rectangular Weir	29.80
Auxiliary Pump Distribution Box	Rectangular Weir	30.16
Raw Sewage Pump Station	Pumps	--
Long Island Sound		
Mean Sea Level [1,2,3]	--	14.32
Mean High Tide [1,2,3]	--	17.69
20 -Year High Tide [1,2,3]	--	24.04
100 -Year High Tide [1,2,3,4]	--	27.54

Notes:

1. Sea level elevations converted to Town of Fairfield Datum (USGS Mean Sea Level Datum 1929 + 13.45 feet). Sea level elevations converted to USGS Mean Sea Level Datum 1929 from NAVD88 (NAVD88 + 1.093 feet).
2. Sea level elevations were taken from Table 1. Tidal Regime Bridgeport (Fairfield) from a drafted US Army Corps of Engineers Coastal Engineering Report entitled "Town of Fairfield, CT – Fairfield Beach Hurricane and Storm Damage Reduction Study: Coastal Engineering Report" issued 03-30-2016. This Engineering Report references FEMA's Flood Insurance Study for Fairfield County, Connecticut issued in October 2013 and another study issued by U.S. Army Corps of Engineers in January 2015.
3. No additional predicted sea level rise was assumed for this iteration of the hydraulic model for the WPCF. Additional predicted sea level rise for the design year may be added during preliminary design efforts.
4. 100 Year High Tide elevation was assumed to be 13.00 feet NAVD88. (Refer to FEMA FIRM panel 419 of 626 for Fairfield County, Map Number 09001C0419G, revised July 8, 2013).

2.7.1 Confirmation of 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 facility upgrade was recreated at the flow rates and assumed units in service identified on Drawing M-1 of the *Fairfield, CT the Water Pollution Control Facility Upgrade, Contract No. 2* (Stearns & Wheler, LLC, July 1998). No field measurements or surveys were conducted during this preliminary evaluation to compare calculated water surface elevations versus field conditions at known flow rates. For the purposes of this evaluation, the hydraulic profile was checked at the Mean Seal Level, Mean High Tide, 20-Year High Tide, and 100-Year High Tide line elevations under the existing plant configuration at 10.0 MGD (Design Flow) and 24.0 MGD (Peak Flow). Another iteration of the model also considers the existing plant configuration at 24.0 MGD (Peak Flow) with one train off-line.

The Headworks portion of the hydraulic profile accurately reflects conditions that the WPCF currently experiences; particularly, for example, flooding in the Influent Building at a peak flow of 24 MGD or greater because the primary mechanical bar screen cannot maintain a clean rack. In addition, the hydraulic profile accurately reflects the operation of the effluent pump station where the effluent pumps must operate during high flow conditions and high tide elevations in Long Island Sound. The effluent pump station does not need to operate during periods of normal, average flow at mean sea level conditions.

Overall, there is good correlation of the two models at the influent and effluent ends of the WPCF and the profile appears to behave similar to current plant operations. However, water surface elevations varied between the primary settling tanks and final settling tanks. Some of the potential reasons for discrepancies between the 1998 Hydraulic Profile and Wright-Pierce’s Hydraulic Model include differences in the modeled assumptions for the auxiliary (bypass) flow threshold (Wright-Pierce utilized 20 MGD for the bypass threshold), differences in modeling where the auxiliary (bypass) flow is discharged to (Primary Effluent Distribution Channel versus Zone B of the Aeration Tanks), increase in tidal elevations over the last 19 years, and assumptions made for head losses in screenings, grit removal, and UV disinfection modules.

Modeling of the plant under the Mean Sea Level, Mean High Tide, 20-Year High Tide, and 100-Year High Tide elevations resulted in no submerged weirs and no overtopping tanks downstream of the Influent Pump Station with the exception of the sharp crested weir located at the Final

Settling Tank Distribution Structure under the 1998 Peak Flow condition (24.0 MGD) when one final settling tank is off-line.

There may be some opportunities to optimize the hydraulic profile to minimize the FST distribution box weir flooding potential. For example, there is a fairly significant drop (3.15-feet) between the Aeration Tank Zone B weirs and FST Distribution Box weirs. This more than needed and the weir at the FST Distribution Box could be raised if this head is determined to be needed.

2.7.2 Hydraulic Profile Under Future Flows

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

- Minimum Day = 5.34 MGD
- Annual Average = 9.12 MGD
- Peak Day = 26.72 MGD
- Peak Hour (100th Percentile) = 35.24 MGD
- Peak Hour (100th Percentile) with 1 train off-line = 35.24 MGD

The hydraulic model was run using the above flows under Mean Sea Level, Mean High Tide, 20-Year High Tide, and 100-Year High Tide conditions. An overall evaluation of each iteration is provided below.

Mean Sea Level

- Effluent Pumps are not required to run under Minimum Day and Annual Average flow conditions under current tide line and sea level rise projections
- Effluent Chamber has adequate freeboard under all flow conditions
- The Final Settling Tank weirs are submerged at the Peak Hour flow condition with 1 Final Settling Tank off-line
- The Final Settling Tank Distribution Structure Sharp Crested Weirs are submerged at both Peak Hour flow conditions

- Flooding occurs at the lower level of the Influent Building during Peak Day and Peak Hour flow conditions due to flow bypassing around the primary screen because of blinding

Mean High Tide

- Effluent Pumps are required to run under all flow conditions
- Effluent Chamber has adequate freeboard under all flow conditions
- The Final Settling Tank weirs are submerged at the Peak Hour flow condition with 1 Final Settling Tank off-line
- The Final Settling Tank Distribution Structure Sharp Crested Weirs are submerged at both Peak Hour flow conditions
- Flooding occurs at the lower level of the Influent Building during Peak Day and Peak Hour flow conditions due to flow bypassing around the primary screen because of blinding

20-Year High Tide

- Effluent Pumps are required to run under all flow conditions
- Effluent Chamber has adequate freeboard under all flow conditions except both Peak Hour flow conditions
- The Final Settling Tank weirs are submerged at the Peak Hour flow condition with 1 Final Settling Tank off-line
- The Final Settling Tank Distribution Structure Sharp Crested Weirs are submerged at both Peak Hour flow conditions
- Flooding occurs at the lower level of the Influent Building during Peak Day and Peak Hour flow conditions due to flow bypassing around the primary screen because of blinding

100-Year High Tide

- Effluent Pumps are required to run under all flow conditions
- Effluent Chamber has adequate freeboard under all flow conditions except both Peak Hour flow conditions
- The Final Settling Tank weirs are submerged at the Peak Hour flow condition with 1 Final Settling Tank off-line

- The Final Settling Tank Distribution Structure Sharp Crested Weirs are submerged at both Peak Hour flow conditions
- Flooding occurs at the lower level of the Influent Building during Peak Day and Peak Hour flow conditions due to flow bypassing around the primary screen because of blinding

2.7.3 Summary of Findings and Recommendations

The existing Fairfield WPCF has or can be readily modified to have adequate hydraulic capacity to handle the future flow conditions; Some minor design modifications will eliminate potential flooding and tank overtopping at peak day and peak hour flow conditions such as modification to the Effluent Chamber (by raising the walls of the structure) and Influent Screenings Channel (by installing a mechanical bar screen with a reduced headloss).

In addition, the effluent pumps in the future will likely be running more frequently than they are running now. At Mean Sea Level in Long Island Sound, the effluent pumps will not have to operate at design minimum and design annual average flow conditions. However, at Mean High Tide, the effluent pumps will have to operate at all flow conditions.

During the preliminary and final design efforts for the upgrade of the facility, the weirs of the final settling tanks and final settling tank distribution structure will be further evaluated starting with a field elevations survey to determine if they can be reconstructed at a higher elevation to accommodate all flow conditions during Mean Sea Level, Mean High Tide, 20-Year High Tide, and 100-Year High Tide conditions. Although the weirs are submerged under these conditions, there is sufficient tank freeboard remaining to prevent overtopping of tanks and potential damage to equipment.

SECTION 3

EVALUATION OF LIQUID PROCESS UNITS AND OPERATIONS

SECTION 3

EVALUATION OF LIQUID PROCESS UNITS AND OPERATIONS

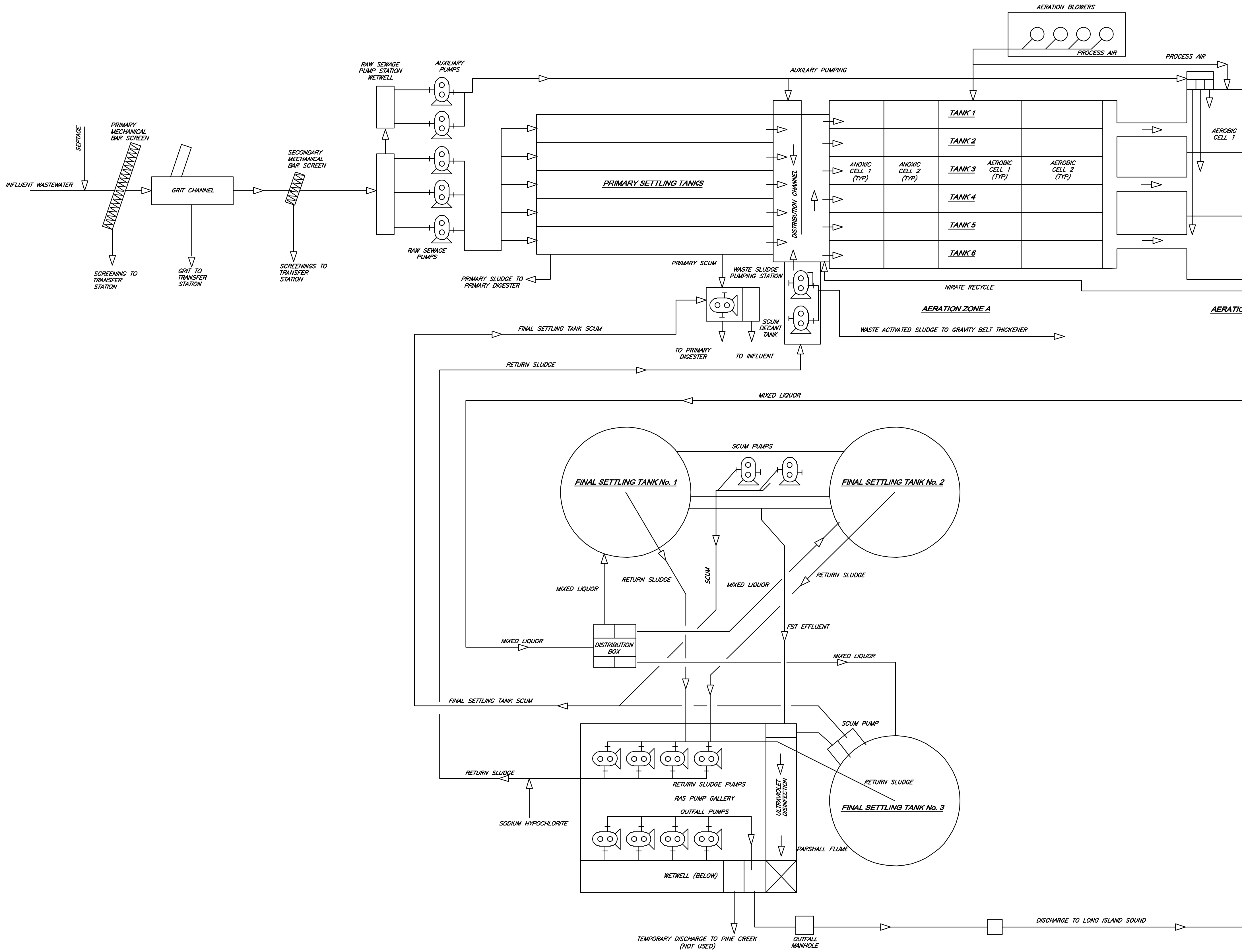
3.1 INTRODUCTION

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

The WPCF currently consists of the following liquid treatment processes:

- Septage Receiving
- Pretreatment Facilities including primary screening, grit removal, and secondary screening
- Raw sewage pumping/Auxiliary pumping
- Primary treatment
- Secondary treatment / activated sludge
- Disinfection using ultraviolet disinfection
- Support Systems (plant water, methanol)

Each liquid treatment process and associated components were evaluated with regard to the existing condition, capacity and performance to meet regulatory and operational requirements at the projected flows and loads for the planning period. A process flow schematic is shown in **Figure 3-1**. This section describes the alternatives evaluated and recommended improvements to meet the above stated requirements. Each of these processes are described herein.



WASTEWATER PROCESS FLOW DIAGRAM
SCALE: NTS

NO.	REVISIONS	DRAWN BY	APP'D
		SMC	DAD
1			
2			
3			

EXISTING WASTEWATER PROCESS FLOW

FIGURE: 3-1

CITY OF FAIRFIELD, CONNECTICUT
WATER POLLUTION CONTROL FACILITY
FACILITIES PLAN REPORT

PROJ NO: 13090A
DATE: JANUARY 2017

WRIGHT-PIERCE
Engineering a Better Environment

3.2 SEPTAGE RECEIVING

The existing septage receiving system is a fully automated packaged system furnished by Lakeside Equipment Corporation. Septage received at the plant is discharged from septage trucks to the Septage Receiving Station outside the Digester Building. The septage is screened and pumped to the Influent Building, upstream of the primary mechanical screen. The screenings from the Septage Receiving Station are washed, dewatered and discharged to a dumpster for storage and subsequent disposal off-site.

The septage transfer pump is equipped with a motor operated recirculation nozzle assembly on the downstream side of the discharge elbow to allow septage to be intermittently recirculated in the septic tank for a pre-set time period at regular intervals.

TABLE 3-1
SEPTAGE RECEIVING FACILITY
BASIS OF DESIGN

Parameter	Current Value	Typical Standard (TR-16)
Septage Receiving Station		
Design Flow, gpm	400	n/a
Manufacturer	Lakeside Equipment Corporation	n/a
Screen Size, inches	1/4	n/a
Screen Chamber Width, inch	36	n/a
Screening Conveyor Dia, inch	10	n/a
Drive motor size, HP	2	n/a
Wash System Flow, gpm	20	
Septage Mixing/Transfer Pump		
Number of pumps	1	
Capacity, gpm	330 @ 40' TDH	
Total Solids, %	4-6	
Motor HP	7.3	

3.2.1 Performance Evaluation

The existing septage receiving system is a packaged system installed in 2002 and is reportedly in good working condition. The offloading panel and tracking software is problematic and requires replacement.

3.2.2 Operations and Maintenance Evaluation

As reported by the plant operations staff, currently the septage system receives about 1-2 deliveries per month. Each load is about 2,500 gallons. The system does not require frequent operator attention for both operation and maintenance.

3.2.3 Process Alternatives Evaluation

Since the septage package system is functioning well and no operational issues have been reported, an alternative or replacement system will not be evaluated as part of this facility plan.

3.2.4 Recommendations

Since the amount of septage received is minimal, there is no significant flow or loading increase for the plant process. Also, the existing packaged system is fully automated and requires minimal operator attention. Therefore, it is recommended to maintain the existing system and install a new remote panel and new tracking software integrates into SCADA.

3.3 PRETREATMENT FACILITIES

The pretreatment facilities are located in the Influent Building. All upstream flow combines into a 39" reinforced concrete pipe, which enters the Influent Building on the south side of the building. These pretreatment facilities are divided into the following systems: Primary Screening System, Grit Removal System, and Secondary Screening System. Each of these systems are evaluated separately below.

3.3.1 Primary Screening System

Raw influent to the WPCF flows through a single mechanical climber type screen with 5/8” bar openings. The climber screen was installed during the last upgrade (2002) and rebuilt in 2013. The climber screen operates when the ultrasonic level sensors detect a preset level differential upstream compared to downstream of the screen, or when an interval timer is reached. The rake removes screenings from the influent wastewater and discharges into a washer compactor for dewatering, compaction and subsequent discharge via a screw conveyor into a container located in the Grit/Screenings Room.

Primary Screen

TABLE 3-2
PRIMARY SCREENING
BASIS OF DESIGN

Parameter	Current Value	Typical Standard (TR-16)
Mechanical Coarse Screen		
Number of Units	1	Multiple or manual bypass
Width, ft	4	
Screen spacing, inches	5/8"	0.25-1.5
Approach Velocity, fps		
10 MGD (2002 design flow), fps	1.9	>1.3
24 MGD (2002 peak flow), fps	4.5	>1.3
Manufacturer	IDI, Type II Climber	
Drive motor size, HP	2	
Compactor manufacturer	Waterlink	
Compactor motor size, HP	5	

3.3.2 Grit Removal System

Flow from the primary screen passes through the velocity controlled grit chamber, where grit is settled by slowing the flow velocity. The grit chamber is used to remove grit from sewage. This system was originally installed in 1950 and replaced during the 2002 upgrade. The single chamber is 8-ft wide channel and approximately 40-feet long. Settled grit is removed by a chain and bucket collector, which discharges the collected material into the grit washer located in the Grit/Screenings Room where organics are separated from the grit. The dewatered grit is discharged into a container also located in the Grit/Screenings Room.

Grit Removal

TABLE 3-3

GRIT REMOVAL

BASIS OF DESIGN

Parameter	Current Value	Typical Standard (TR-16)
Grit Channel		
Number of Channels	1	1 with bypass
Type	Horizontal Flow	
Length, ft	40	
Top Width, ft	8	
Bottom Width, ft	3	
Operating Depth, ft	4-6	
Velocity through tank, fps		
10 MGD (2002 design flow)	0.4	1.0
24 MGD (2002 peak flow)	0.9	1.0
Detention Time, seconds		
10 MGD (2002 monthly max flow)	100	60 @ 1ft/s
24 MGD (2002 peak flow)	40	60 @ 1ft/s
Grit Collector		
Collector Type	Chain and bucket	
Manufacturer, model	Amwell, VBE	
Capacity, cf per hour	15	
Collector Motor Size, HP	1.0	
Grit Washer		
Grit Washer manufacturer	Amwell	
Grit Conveyor		
Motor Size, HP	1.5	

3.3.3 Secondary Screening System

Secondary Screen

The flow from the grit chamber passes through a fine mechanical screen, which was installed prior to the 2002 upgrade as a replacement of the original comminutors and to prevent materials from passing through to the sponge media in the aeration tanks which has since been removed. This screen has 6 mm (¼") spacing and is continuously-cleaned with a collector belt fitted with rows of hook elements. This belt carries the screenings up and into a washer compactor hopper. The compacted screenings are discharged onto a C-conveyor which conveys the screenings to the container on the upper level. The screenings are stored in a roll-off container prior to disposal.

TABLE 3-4
SECONDARY SCREENING
BASIS OF DESIGN

Parameter	Current Value	Typical Standard (TR-16)
Mechanical Fine Screen		
Number of Units	1	Multiple or Manual Bypass
Width, ft	3'-10.5"	
Screen spacing	6 mm (1/4 inch)	
Approach Velocity, fps		
10 MGD (2002 design flow), fps	1.9	>1.3
24 MGD (2002 peak flow), fps	4.5	>1.3
Drive motor size, HP		
Screenings conveyor type	Double Belt C-Curve	
Conveyor motor size, HP	2	
Compactor manufacturer	Parkson	
Compactor motor size, HP	3	

3.3.4 Influent Flow Bypassing

The influent flow has a provision to bypass the coarse mechanical screen and grit channel via two side channels with respective manual slide gates. This allows the equipment to be taken out of service as needed for maintenance or when the equipment flow capacity is exceeded during peak flows. This flow can also bypass the fine screen and enter directly into the raw sewage and/or auxiliary sewage wet wells. Each bypass channel has a manually-cleaned bar rack with one-inch openings for removal of large debris to protect downstream equipment and processes. The bar rack is cleaned through manually raking the screenings off the rack and into a container for disposal. The secondary screen remains in service as a backup to the primary mechanical screen when it is bypassed.

TABLE 3-5
MANUAL BAR SCREENS
BASIS OF DESIGN

Parameter	Current Value	Typical Standard (TR-16)
Manual Bar Racks **<u>(Bypass Channels)</u>**		
Number of Bar Racks	2	1 unless multiple mechanical units
Channel Width, feet	4.0	
Bar Rack Width, feet	4.0	
Bar Spacing, inches	1	

3.3.5 Performance Evaluation

3.3.5.1 Primary Screening System

The 5/8" primary screen is often blinded by rags and debris, resulting in flow backing upstream and allowing grit to settle in the influent sewer. Backed up flow is released when the screen is raked, the flow surge is seen through the entire plant. Since the screen is a climber-type with a single rake, the cycle time for the cleaning of the screen is long and often times results in blinding of the screen especially during the high flow conditions.

3.3.5.2 Grit Removal System

The existing grit channel has an inlet flow diffuser designed to mitigate turbulence and distribute flow evenly across the channel. Since the downstream hydraulic control point (parshall flume) has been removed, the ability to maintain the recommended velocity of 1 foot per second is decreased. The water level in the grit chamber is maintained by an internal weir wall downstream.

The grit channel is undersized for the grit removal at the design peak flow of 24 MGD. There are short detention times and inconsistent velocities through the channel, allowing fine grit to pass through the grit collector and settle in the primary clarifiers. The inert material may then be transferred to the anaerobic digesters where it accumulates and reduces the active volume of the process.

Grit removal in a horizontal chamber is most effective when the flow is maintained at a constant velocity of 1 ft/s. Because of the difficulty in maintaining a constant velocity over a wide range of flows, and because the system has less detention time then desired at peak flows, this system is less effective then desired at removing grit, particularly when the primary screen is blinded and then flushed during high flows. However, the existing system does remove coarser grit and does help reduce the wear on downstream equipment.

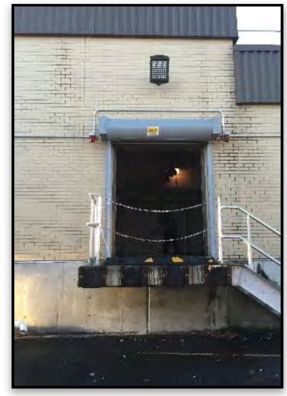
3.3.5.3 Secondary Screening System

The secondary mechanical screen, washer/compactor and C-conveyor belt are in poor operating condition according to WPCF staff.

3.3.6 Operations and Maintenance Evaluation

3.3.6.1 Primary Screening System

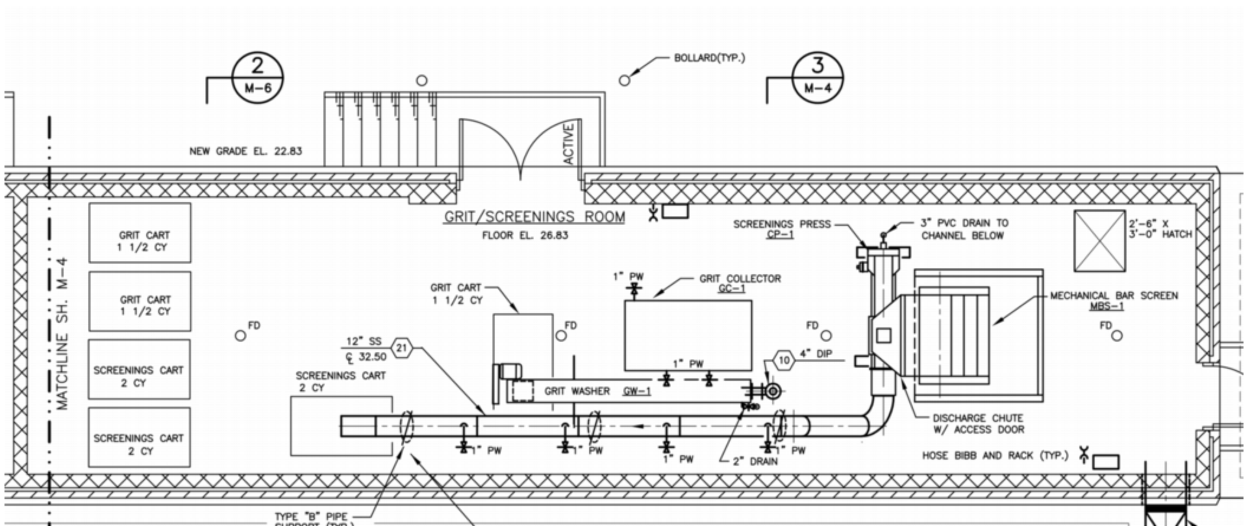
The primary screen is reported to be in good operating condition. However, the issue of screen blinding has resulted in additional operational issues for the process with flow and load fluctuations. When the screening collection containers are full, operators roll these to the outdoor platform, remove the railing and pick up the container and transport the screenings for off-site disposal. The operators find it difficult to move the containers from the compactor to the outdoor platform due to limited working and maneuvering space around the equipment as shown in **Figure 3-2**. It is also difficult to get them from the small elevated platform to grade.



Grit/Primary Screenings Removal

FIGURE 3-2

GRIT/PRIMARY SCREENINGS REMOVAL



3.3.6.2 Grit Removal System

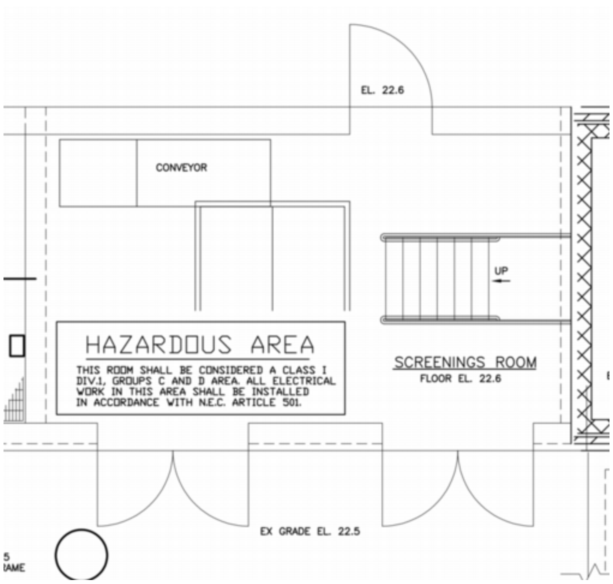
The significant operational or maintenance issues reported by plant staff include Fats, Oils and Grease (FOG) being trapped in the grit chamber at the downstream baffle wall which periodically needs to be cleaned. Operators report that handling of the grit is cumbersome, requiring the manual transport of roll-off containers into and out of the storage area shown**.**

3.3.6.3 Secondary Screening System

Although the secondary fine screen operates well, the C-conveyor is very maintenance intensive. The bearings, rollers, and belt often require higher than normal maintenance. Additionally, handling of the screenings is cumbersome, requiring the manual transport of roller containers into and out of the storage area. Also, the working space around the screen is limited and it affects the cleaning of the screen during maintenance as shown in **Figure 3-3.**

FIGURE 3-3

SECONDARY SCREENINGS REMOVAL



3.3.6.4 Influent Flow Bypassing

The manual slide gates and screens within the bypass channels in the Influent Building are reported to be in satisfactory condition. However, during high flow or during bypassing of the primary screen, these screens blind within minutes making manual raking impractical.

3.3.7 Process Alternatives Evaluation

As part of the evaluation, three main alternatives were considered. The first was to rehabilitate the existing 5/8-inch primary screen and ¼-inch secondary screen with new ¾-inch and/or 1/2 -inch bar spacing respectively. The second was to replace both the screens with new multi rake mechanical bar screens each with 3/4-inch or 3/8-inch bar spacing. The third was to construct an addition to the Influent Building to allow for installation of two screens side by side. The CTDEEP will permit the disposal of wastewater screenings as Municipal Solid Waste (MSW) if the screenings undergo grinding, washing and compacting. Therefore, grinder washer/compactors have been evaluated to work in tandem with screens.

3.3.7.1 Primary Screening System

3.3.7.1.1 Alternative 1 - Rehabilitation of Existing IDI Climber Screen

To address plant operations staff concerns of screen blinding due to reduced screen bar openings at high flows, the manufacturer of the existing primary screen was contacted to review the existing conditions and installation to determine the extent of rehabilitation required for the screen. Based on our discussions with the manufacturer, new bar screen kits which include bar racks, rake shelves and rake mechanisms can be purchased from the manufacturer to rehabilitate the screens with larger bar openings. The existing 5/8-inch spacing bars can be replaced with 3/4-inch spacing bars to reduce blinding of the screen and mitigate flow backup and potential solids deposition upstream. With this alternative, the existing operation and removal of screenings due to increased bar opening and its potential impact on the downstream processes need to be considered further. In addition, this modification would not solve the long time it takes for the screen to travel one revolution and blinding may still occur at high flows.

The existing screenings compactor would be replaced with a grinder/washer compactor, such as the JWC Environmental Screenings Washer Monster. The materials discharged from the screen will enter grinder/washer compactor units where plant effluent is used to wash additional organic material off the screenings and back into the influent. The screenings will then be compacted to remove additional water and reduce the volume. The washed and compacted screenings will then be discharged to containers utilizing a shaftless screw conveyor. This will re-classify the material as Municipal Solid Waste, which is currently being disposed of at a landfill.

3.3.7.1.2 Alternative 2 - Replace Existing IDI Climber Screen with new Multi Rake Bar Screen

To mitigate the issue of single rake climber screen blinding, a mechanically cleaned multi rake bar screen was evaluated. Multiple rake screen systems have several rakes installed at predetermined distances on a chain that travels along the length of the bar screen. Different manufacturers have differing configurations for how the chain is guided at the bottom of the channel. Some manufactures do not have a sprocket at the bottom of the screen which may reduce the need to drain the channel for screen maintenance.

Multi-Rake Screen

A multi-rake screen offers a lower profile than the existing screen and also offers the benefit of having the motor fixed at the top of the screen which eliminates any motor submergence concerns. One disadvantage of the multi-rake style screen is that the side channels extend all the way to the bottom of the channel reducing the multi-rake screen bar rack width by approximately 10 to 12 inches due to the side channels. To address this concern, we consulted with the screen manufacturer and determined that the concrete channel walls will be modified to accommodate the screen side channels and maintain the full 4’-0” width for the bar rack to accommodate 35.24 MGD peak flow with recommended velocities and headloss. The hydraulic calculations will be updated during preliminary design to verify the profile within the channel.

The operation of the rake mechanism can be done either based on the differential water level across the screen or based on a timed cycle. When differential water level is used, the screen will be operated continuously at higher flows and the screens can be equipped with either a two-speed or variable speed motor. This can result in more frequent cleaning of the bar racks than can be achieved with the existing single-rake screen.

Several manufacturers of multi-rake screens were considered as part of this evaluation that could provide equal type of screens including Headworks, JWC, Vulcan and Duperon. For facility planning, we contacted Headworks and JWC to obtain additional details including product data and budgetary quotes of the equipment as shown in **Table 3-6**.

TABLE 3-6

REPLACEMENT MECHANICAL SCREEN & COMPACTOR

Parameter	Mechanical Screen
Mechanical Screen	Bar Screen MS1 Headworks Intl.
Bar Spacing, inches	3/8 or 1/2
Channel size, feet	4.0
Installation Angle, deg	75
Headloss at 2 ft/s, inches	0.98
Max Flow at 3 ft/s. MGD	48.8
Overall Length, ft	31.57
Control Panel Grade	NEMA 4X
Rakes	Multiple
Screenings Grinder **Washer Compactor**	JWC Environmental SWM4018-90-XE

3.3.7.1.3 Alternative 3 – Install Two Screens Side by Side

The construction of an addition to the Influent Building would encompass provisions to the primary and secondary screening systems as well as the grit removal system. Doing so would allow for the installation of two influent mechanical bar screens installed side by side, each sized to handle peak flow, as well as a second grit tank. This alternative would also allow for the elimination of the secondary, or back-up screen operated in series. Preliminary review of the site constraints, proximity to the WPCFs property line and wetlands, as well as the fact that grit removal will still be problematic, this alternative was eliminated from further consideration. Hp0wever, the installation of two new screens as part of the new Influent Pump Building will be further evaluated during the preliminary design.

3.3.7.2 Grit Removal System

3.3.7.2.1 Alternative 1 - Rehabilitation of Existing Chain and Bucket

The manufacturer of existing grit removal system, Amwell, was contacted to review the existing conditions and installation to obtain pertinent details required for the in-kind replacement of the existing system. Based on our discussions with the manufacturer, new chain and bucket assembly kits which include a drive assembly with gear motor, head section, chain guard, shafts, sprockets, main chain, buckets, lower chain guards, dewatering screw and accessories can be purchased from the manufacturer to rehabilitate the grit collection system. From discussion with the manufacturer, we learned that durable cast stainless steel drive chain is available as an option for longevity. With this alternative, the plant operations staff can maintain the current O&M procedures for chain and bucket system. Enhancements to improve velocity control will also be investigated during the design phase by adding a proportional weir or flume.

Although the improvements under Alternative No. 1 will improve grit removal, it does not solve the fact that the single grit tank is too small. This alternative would not solve all the plants grit issues as the tanks is just too small. It also does not allow for dewatered grit to be reused on site.

3.3.7.2.2 Alternative 2 –Aerated Grit Chamber

During discussion with the operations staff, they indicated that they would prefer an aerated grit removal system. Accordingly, we evaluated this option which requires constructing air diffusers along one side of grit channel to introduce a roll pattern that allows grit to settle while keeping organic material in suspension. Removal of the grit that drops to the bottom of the channel could be removed manually using a "clam shell" type removal bucket to transfer the grit to a container where additional water can drain from the grit prior to disposal. Alternately, a mechanical removal system consisting of either a grit screw or chain and flight type collectors could be installed to move the grit to one end of the tank from where it can be pumped to a grit washing system. However, upon review of the design guidelines for an aerated grit chamber found in TR-16, it was determined that the existing grit tank is too shallow and minimum detention times could not be met even with significant channel modifications within the Influent Building.

For aerated grit to implemented, new tanks would need to be constructed. These new tanks can be constructed as part of the new Influent Pump Station discussed in Section 3.4. Two new tanks properly sized to handle the full range of WPCF influent flows would be designed. Chain and flight collectors will move grit to one end of the tank where it will be pumped to a grit washer. Grit pumping systems can be either submersible or air lift type.

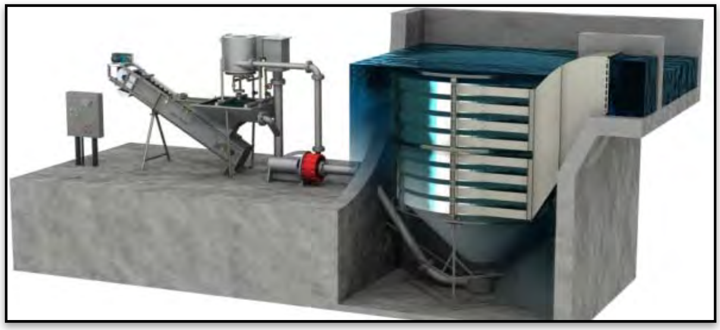
3.3.7.2.3 Alternative 3 – Grit Classifier / Washer

To provide a grit removal system that can be installed outside of the channel on a working level within the influent building, a new grit classifier/washer system has been evaluated. Conventional grit washers consist of a vortex unit to further separate grit from organics and then a washer with an inclined screw to wash and allow water to drain from the grit before being discharged to a container. The grit would then be disposed of off-site as a special waste. An alternate grit washing technology manufactured by Huber or Lakeside is available that classifies and washes grit in a single compact unit to provide a cleaner grit material. The CT DEEP is currently considering allowing for disposal as a municipal solid waste or reuse of grit from this newer technology on a case by case basis. If the disposal as MSW and/or reuse is allowed, the grit would not need to be disposed of as a special waste which in turn would reduce special waste disposal costs.

When influent is pumped to the stainless-steel unit, centrifugal forces create a spiraling, horizontal motion to separate organics. The water and lightweight organics discharge over an upper weir plate while grit and heavier materials settle in the conical-shaped hopper where they are agitated gently by mixer arms and washed. Organics released during agitation and washing are collected in a capture cone and removed through the blowdown valve. The inclined grit screw draws washed grit from the hopper and provides optimal dewatering. Discharge is typically 90% dry weight or greater, and organics are less than 5%. Based on the discussions with manufacturers, it is determined that this new system can be installed within the influent building with minimal modifications.

Grit washers, however, require a pumped feed and could not be installed if the existing grit removal system is maintained. This requirement further strengthens the alternative to construct new aerated grit tanks as part of a new Influent Pump Station. If the current grit removal system is maintained, a new grit classifier is recommended and grit would continue to be disposed of as a special waste.

3.3.7.2.4 Alternative 4 – Multiple Tray Tangential Feed System



Typical Euteck HeadCell Configuration

The Hydro International Eutek HeadCell Advanced Stacked Tray Grit Separation unit was also investigated for grit removal. The Eutek Multiple Tray unit would be placed inside the existing influent channel. Influent will flow into a distribution header and into the Multiple Tray unit. The tangential feed establishes a vortex flow pattern that causes the solids to separate into a boundary layer on each tray. Grit settles out by gravity along the sloped surface of each tray and then solids are swept to the center opening which allows the grit to fall to a collection sump. The degritted effluent flows out of the trays over a weir and on the downstream sides of influent channel. Settled grit is continuously pumped from the collection sump to a grit washing system and dewatered. The grit washing system would be similar to that described under Alternative No. 2. However, based on the information received from the manufacturer, the space required for the new equipment is significantly larger than available space within the influent building. Therefore, this alternative was not evaluated further without the need for substantial modifications to the Influent Building.

3.3.7.3 Secondary Screening System

TR-16 requires that '*installations using mechanically cleaned screens or comminution devices should include multiple units or a single unit with manually cleaned bypass screen.*' Since the upstream primary climber type screen was evaluated to either rehabilitate or replace it with a new multi-rake mechanically cleaned screen, the consideration was given to not install a downstream screen because the existing bypass channels currently include manually-cleaned bar racks. Therefore, a redundant mechanical screen would not be required. However, the use of manual bar rack during the maintenance and repair of the primary mechanical screen is not desired as the backup screening system by the plant staff due to the inability to keep up with the blinding of the manual bar racks occurring within minutes. As discussed during the primary screen evaluation, construction of an addition to the Influent Building is not feasible. Therefore, replacement of the existing secondary screen to act as the back-up to the primary screen and to meet TR-16 design standards was evaluated as follows:

3.3.7.3.1 Alternative 1 – Replacement with Multi-Rake Screen

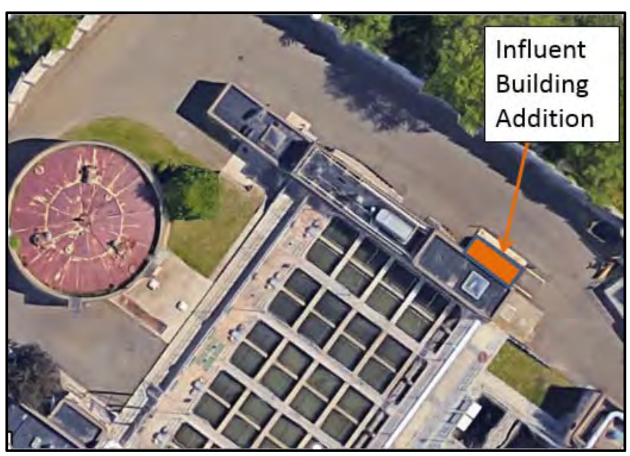
To streamline the screening equipment, the existing fine screen will be replaced with multi rake mechanical screen and grinder washer compactor for washing and compaction of the screenings for off-site disposal as Municipal Solid Waste as described above in Alternative 2 for primary screen. The screen will be extended vertically to the Screenings Room at grade. A new grinder washer compactor will be installed in the same room adjacent to the screen. The existing C-Belt conveyor will be demolished and ground and compacted screening will be discharged to a container located within the Screenings Room into a small container.

3.3.7.4 Screenings and Grit Handling

3.3.7.4.1 Alternative 1 – Maintain Existing Configuration

The existing configuration for grit and screenings handling and disposal is not ideal and very labor intensive. Operators must roll containers from an elevated room to s small loading dock and then to grade via a forklift. The containers are difficult to maneuver and space is limited. The loading dock also does not meet current codes.

3.3.7.4.2 Alternative 2 – Separate Screenings and Grit Containers Room



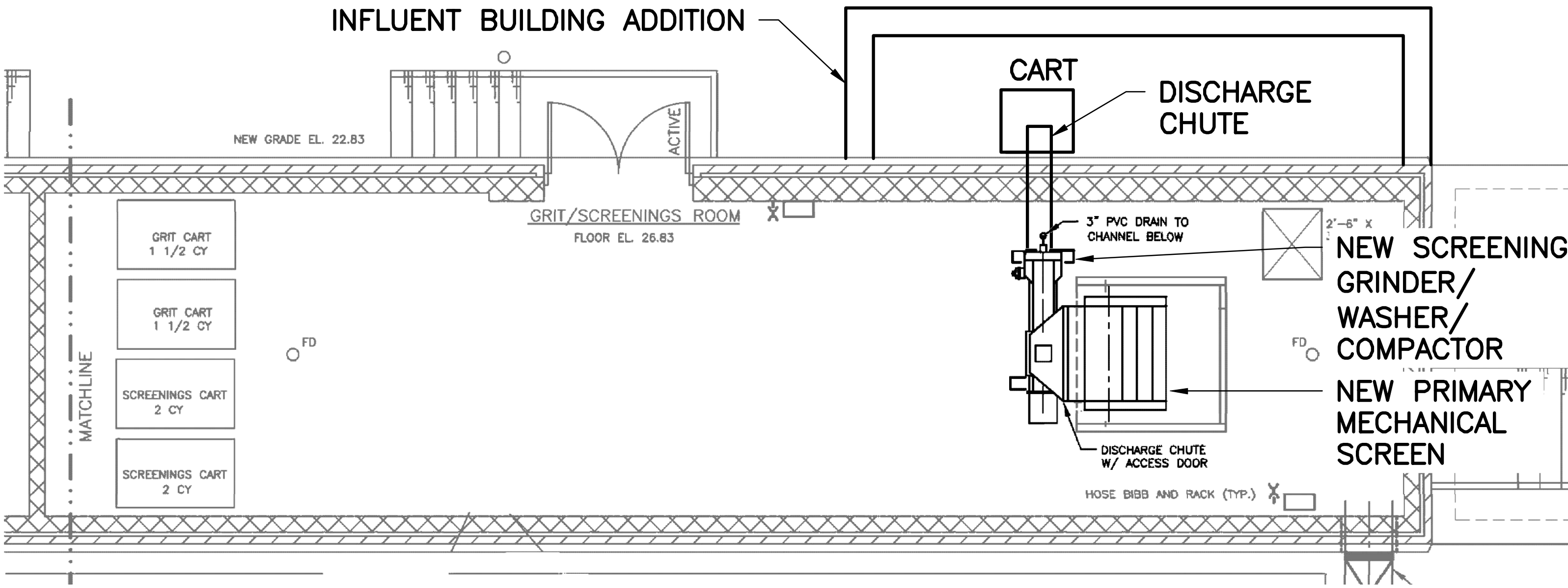
An alternative would be the construction of a canopy structure addition to the Influent Building to house containers for both screenings from the primary screen and grit, if the current grit removal process is maintained. The ground and compacted screenings as well as dewatered grit could be discharged through a chute extension or conveyor to the respective container located adjacent to the buildin**g**. The containers area would be a new canopy structure to allow for access to the roll-off truck for the hauling. Screenings from the secondary screen would need to be manually rolled to this location for disposal.

If new aerated grit tanks are constructed, dewatered grit from the grit washers installed on the upper level of the new Influent Pump Building will be minimal and can be transferred to this central location by WPCF staff.

3.3.8 Recommendations

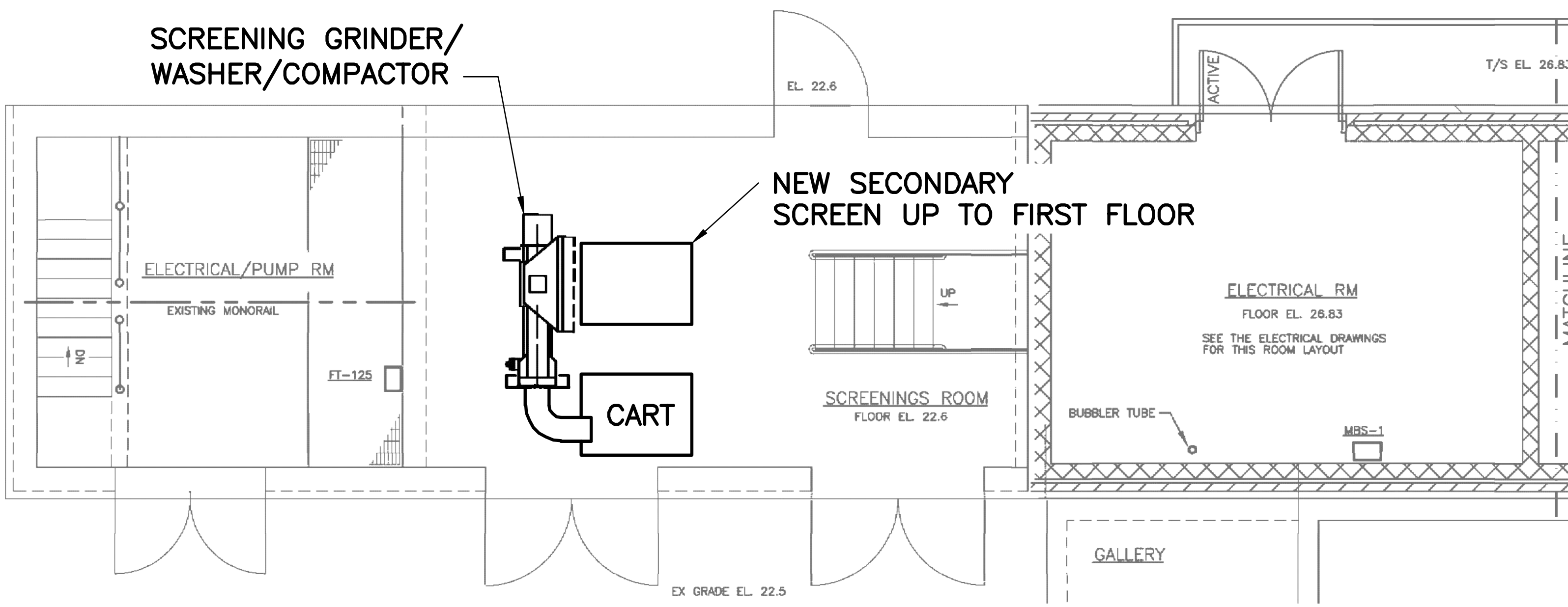
Based on the information presented above and workshops with WPCF staff, recommendations for the pretreatment facilities are summarized below and in **Figure 3-4** and **Figure 3-5**:

- Replace the existing primary screen with new multi-rake screen.
- Demolish C-conveyor and replace the existing secondary screen with a new multi-rake screen extended to grade. This screen will act as a back-up to the primary screen in the event of a failure.
- Install grinder/washer/compactors at the discharge of the primary and secondary screens to allow for disposal as a municipal solid waste.
- Construct an addition to the Influent Building to convey and store containers for screenings. Consideration to a rolling type dumpster with a scale will be evaluate during the design phase.
- Construct two new aerated grit tanks and a grit washer to remove grit.



PRIMARY SCREEN FLOOR PLAN

SCALE: 1/8"=1'–0"



SECONDARY SCREEN FLOOR PLAN

SCALE: 1/8"=1'–0"

NO.	REVISIONS	DRAWN BY	APP'D
1		SMC	DAD
2			
3			

FIGURE: 3-4

SCREENINGS STORAGE

CITY OF FAIRFIELD, CONNECTICUT
WATER POLLUTION CONTROL FACILITY
FACILITIES PLAN REPORT

DATE: MARCH 2017

PROJ NO: 13090A

WRIGHT-PIERCE
Engineering a Better Environment

3.4 INFLUENT PUMPING

Influent Pumps

Following preliminary treatment, influent wastewater flow is conveyed from the Influent Building to the raw sewage wet well, located below the Control Building, via 39-inch and 42-inch diameter pipes. Solids handling recycle flows, consisting predominantly of solids thickening and dewatering filtrate and digester overflows, are also conveyed to this wet well. The raw sewage pumping system consists of three 4,860 gpm, 100-HP pumps located in the dry well in the lower level of the Control Building. The suction piping is 20-inch and discharge piping is 18-inch which combines into a 24-inch header. This 24-inch header runs into the piping gallery at the head of the primary settling tanks, and progressively decreases to 8-inch diameter at Primary Settling Tank 1, with individual 8-inch branches off of it that feed each Primary Settling Tank. The raw sewage wet well, dry well and Control Building were originally constructed when the WPCF was first built in the 1950’s and has been in service since then. The combined capacity of the raw and auxiliary pumps are not sufficient to convey peak hour flow received at the facility.

3.4.1 Raw Sewage Pumping System

The raw sewage pumps and suction and discharge piping were replaced during the 2002 upgrade. Pump 3 was replaced with a new pump in 2013, Pump 2 was rebuilt in 2015, and Pump 1 is original and scheduled to be replaced in 2016. The pumps are vertical centrifugal non-submersible type driven by variable frequency drives (VFDs) located in the upper-level electrical room. During normal operation, the pumps are operated in a lead/lag/standby configuration, and have a capacity of 7 MGD each with two pumps running to accommodate daily average flow of 9 MGD and the third pump remains a standby. However, during high flow conditions, the third pump is operated to accommodate flows up to 20 MGD before the auxiliary pumps are activated. A seal water system provides water to the pump mechanical seals.

TABLE 3-7

RAW SEWAGE PUMPING SYSTEM

BASIS OF DESIGN

Parameter	Current Value	Typical Standard (TR-16)
Raw Sewage Pumps		
Number of Pumps	3 (RWP-1, 2 and 3)	
Operating Point, (each pump)	4,860 gpm @ 55' TDH	
Impeller Diameter	13.80"	
Suction/Discharge Size	8" x 8"	
Manufacturer	Ingersoll Dresser	
Type	Vertical, centrifugal non-clog	
Motor Size, HP	100 HP	
Motor Speed	1,185 RPM	
Drive Type	VFD	

3.4.2 Auxiliary Raw Sewage Pumping System

In addition to the raw sewage pumping system, an auxiliary raw sewage pumping system was added to the plant during the 1969 upgrade. This system was added to divert screened flow in excess of 20 MGD to the auxiliary raw sewage wet well located below the Influent Building and pump to the Aeration Tanks utilizing two pumps. The auxiliary pumps are located in a dry pit at the end of the Influent Building consist of two 4,170 gpm, 70-HP pumps. The suction piping is 20-inch and discharge piping is 18-inch header.

Auxiliary Pumps

When raw influent flow exceeds 20 MGD, levels in the influent channel rise until flow enters the auxiliary raw sewage wet well through a slide gate. The two auxiliary pumps are then operated to bypass either just the primary settling tanks to the Zone A of aeration tanks, or bypass the primary settling tanks and Zone A of aeration tanks to the Zone B of aeration tanks via 18-inch pipe through manual valve adjustments. Flow from the auxiliary pumps is measured by a flow meter located in a manhole outside of the influent building. The auxiliary pumps are dry-pit non-clog submersible type driven by VFDs. The pumps are 6 MGD each operated in a lead/lag configuration with a total design rating of 12 MGD (two-pump operation). The auxiliary wet well and pumping system can be taken out of service by closing a slide gate which is normally open.

TABLE 3-8
AUXILIARY PUMPING SYSTEM
BASIS OF DESIGN

Parameter	Current Value	Typical Standard (TR-16)
Auxiliary Pumps		
Number of Pumps	2 (AUX-RWP-1 and 2)	
Operating Point, (each pump)	4,170 gpm @ 45' TDH	
Impeller Diameter	13.80"	
Suction/Discharge Size	8" x 8"	
Manufacturer	ABS Pumps	
Type	Dry-pit non-clog submersible	
Motor Size, HP	70 HP	
Motor Speed	1,180 RPM	
Drive Type	VFD	

3.4.3 Performance Evaluation

3.4.3.1 Raw Sewage Pumps

The raw sewage pumps have performed as designed. Two of the three raw water pumps were replaced and rebuilt in 2015 after 13 years in operation as indicated above, which is the expected design life of heavy duty pumps. The wet well is monitored by a bubbler type control system with high and low level floats for pump protection. Both the suction and discharge piping for the pumps were observed to be in good working condition.

3.4.3.2 Auxiliary Raw Sewage Pumps

As reported by the plant operations staff, the auxiliary raw sewage pumps currently operate only once or twice a year during heavy storm events when total flow exceeds 20 MGD and are in good operating conditions. The wet well is monitored by a bubbler type control system with high and low level floats for pump protection. Both the suction and discharge piping for the pumps were observed to be in good condition.

3.4.4 Operation and Maintenance Issues

As reported in the 1997 Facilities Plan, the dry wells of both the raw and auxiliary pump rooms are very crowded, with little room to maneuver around piping and pumps for maintenance or to accommodate larger pumps. In addition, only one hatch is provided for pump removal from the lower to upper level of the Control Building.

Plant operations staff expressed concern about having non-submersible pumps and associated pump disconnects in the lower level pump rooms and are concerned that in the event of a flooded dry well, the pump motors and associated electrical gear may get damaged.

The combination of both systems working together is also under capacity for current and future peak flow conditions and determined to be inefficient during the energy audit presented in Section 7 and Appendix B.

3.4.4.1 Code-Related Issues

Access to the raw sewage wet well is gained through a hatch in the floor of the lower level inside the Control Building. This does not meet current Building Codes, which stipulate that access should be from outside of the building with an air lock between the hazardous and non-hazardous areas.

3.4.5 Process Alternatives Evaluation

It was determined during the workshop discussions that as part of the alternative evaluation for the pumps, various types of pumps should be evaluated, except pumps with shaft mounted motor on an upper level, to accommodate increased peak flow and ease of operation and maintenance.

3.4.5.1 Alternative No. 1 – Replace existing pumps with same configuration

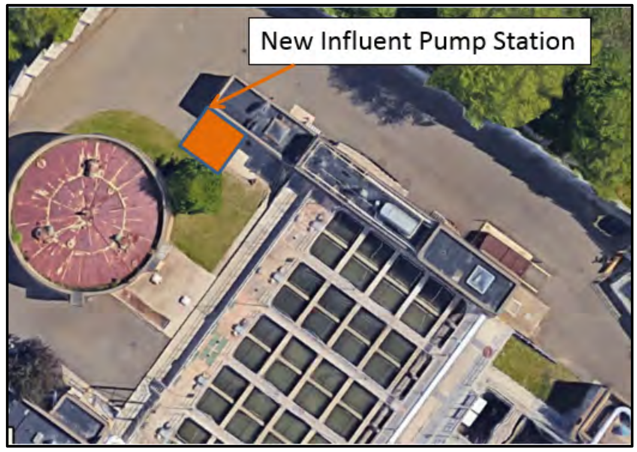
Based on discussions with plant operations staff, two types of centrifugal pumps have been evaluated; 1) vertical non-clog centrifugal and 2) submersible dry-pit. The type of pump selected would depend in large part on the operation and maintenance desired. Non-clog centrifugal pumps are easier to maintain by staff mechanics. Submersible dry-pit pumps with the pump disconnects installed on the upper level would have the advantage of being protected if the dry pit floods unexpectedly.

The existing raw sewage pumps are vertical non-clog pumps and are not rated for submersion. Due to this, the electrical equipment within the dry pit is prone to damage during flooding. To address this issue, we have evaluated dry pit submersible pumps. These new dry pit submersible pumps would have similar dimensional and operational characteristics to fit in the existing available space as well as current operational controls with minimal modifications. This will allow the plant operations staff to maintain their current operation and maintenance procedures. The existing auxiliary raw sewage pumps are dry-pit submersibles.

With this scenario, we propose two new 10 MGD pumps for raw sewage pumping system and two 15 MGD pumps for the new auxiliary pumping system with VFD controls to accommodate both minimum flow and 35.24 MGD peak flows with one largest capacity pump as a standby. With this configuration, both pumping systems will be streamlined and will simplify the operation and maintenance with controls and spare parts requirements and also the plant operations staff can maintain the current operating procedures during low and high flows. The new VFDs and electrical equipment including power cable junction boxes will be located in a separate electrical room on the upper level.

3.4.5.2 Alternative No. 2 – Common dry well and wet well with new pumps

Reviewing the existing overall layout of the auxiliary and raw sewage pumping systems, the combination of these systems into one system was evaluated as an alternative to streamline the influent pumping system. As part of this evaluation, the Auxiliary Pump Room of the Influent Building would be enlarged to include all influent pumps. Different manufacturers of dry pit submersible type pumps were contacted to obtain sizing and dimensional information to prepare a conceptual layout of the dry pit with influent pumping system. The existing auxiliary raw sewage wet well would also be enlarged to accommodate volume during peak flows and be divided into two sections for isolation and cleaning.



With this alternative, five 10 MGD pumps for the influent pumping system with VFD controls to accommodate both minimum and 35.24 MGD peak flows with one pump as a standby are required. With this configuration, all five pumps and a flow meter will be installed in the same room and will simplify the operation of the system.

The discharge piping would be configured such that during normal operation, the flow would be discharged to the head of the primary tanks until flow exceeds 20 MGD. At this point, flows above 20 MGD would bypass the primary tanks and be discharged to the aeration tanks. The plant will also have the ability to pump flows in excess of 20 MGD to the primary tanks if desired. This set-point will be adjustable.

The existing 39-inch and 42-inch pipes conveying flow to the raw sewage wet well will be abandoned in place and new piping will be installed to convey flow to the head of the primary tanks during normal operation. The existing 18-inch auxiliary pump discharge piping will be maintained to convey flow to Zone A or Zone B of the Aeration Tanks. However, as an alternate, the 18-inch pipe discharging to the aeration tank could be abandoned in place and a new 18-inch pipe could be installed on the north side of influent building.

The new VFDs and electrical equipment including power cable junction boxes will be located in a separate electrical room on the upper level. The enlargement of the auxiliary pump area would require another means of egress per the building code. Also, the monorail with hoist and provision of ceiling access hatches above each pump will be reviewed during the design phase. A conceptual architectural and structural discussion of these modifications is provided in the following respective sections.

Preliminary evaluation of this alternative resulted in construction sequencing issues related to the ability to maintain the raw and auxiliary pump station in operation during construction. There are also structural concerns with the proximity of the auxiliary pump station expansion to the primary settling tanks, which are already exhibiting signs of settlement. The concern is that disturbing the area immediately adjacent to the primary tanks may result is further settlement and the potential for the shearing of pipes below grade. If this alternative is selected, a detailed review of the architectural and structural aspect of this enlargement will be conducted during the design phase.

3.4.5.3 Alternative No. 3 – Construction new Influent Pump Building

Taking the concept presented in Alternative No. 2 a step further, construction of a new stand along influent pump station would allow for the installation and commissioning of new influent pumps and grit removal equipment with minimal disturbance to plant operations. The new structure will also be located far enough away from the Primary Settling Tanks to minimize tank settlement concerns. The proposed location in within the footprint of the abandoned primary digester tank. The new influent pump station will also include two new aerated grit tanks, a new primary sludge pump room, an electrical room, and a new primary settling tank influent distribution structure, discussed later in this section. A conceptual plan of the new influent pump station structure is presented in **Figure 3-5**.

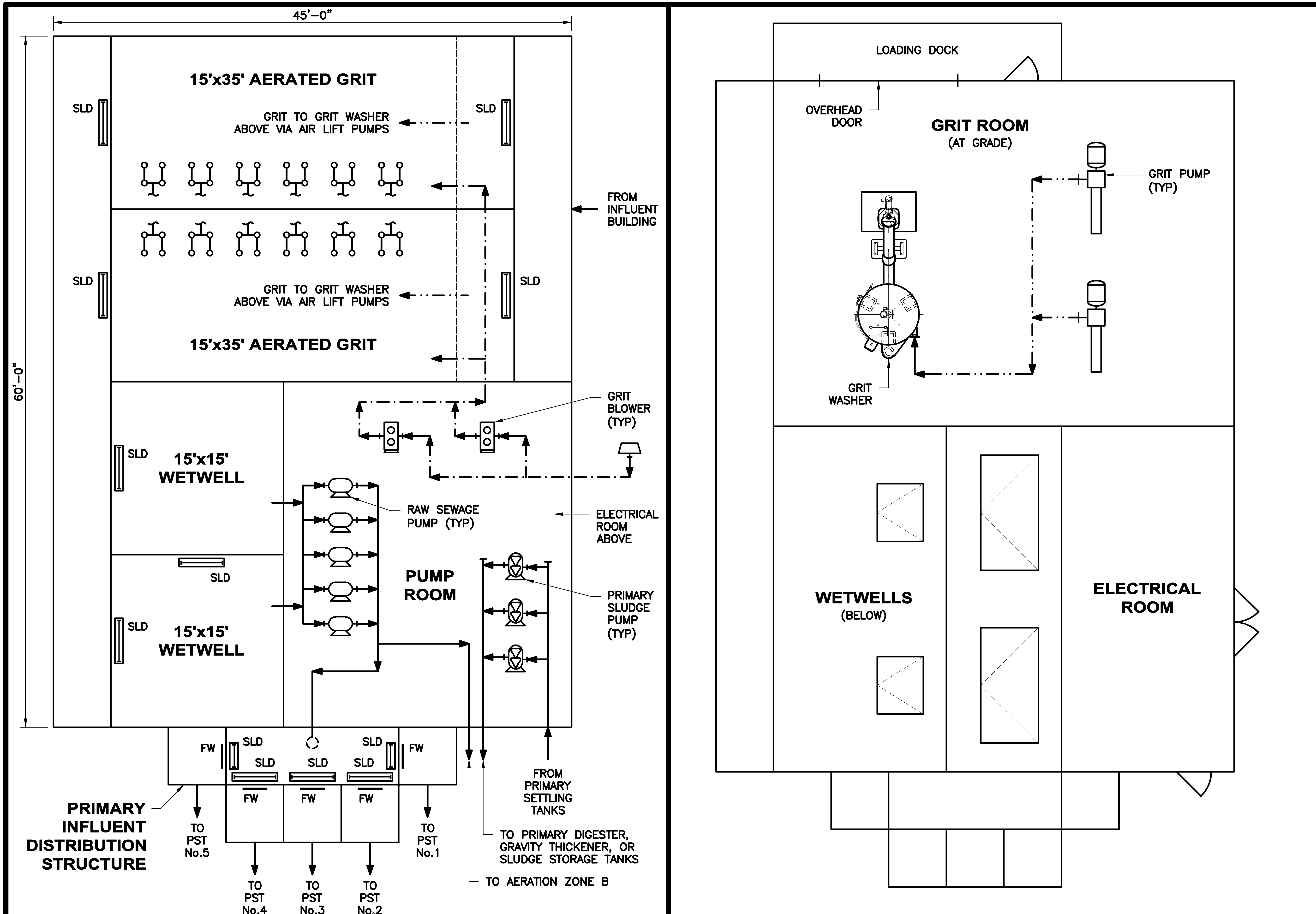


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FIGURE: 3-5

INFLUENT PUMP BUILDING

3.4.6 Recommendations

Based on the information presented above and workshops with WPCF staff, recommendations for influent pumping are summarized below:

- Construct new influent pump station in the footprint of the existing abandoned primary digester combining the existing raw and auxiliary pump stations. The building will also include two aerated grit tanks, three new primary sludge pumps and a primary settling tank influent distribution structure.

3.5 PRIMARY TREATMENT

Primary Settling Tanks

The Raw Sewage Pumps lift wastewater flow through a main distribution piping header to five primary settling tanks. Each tank is 85' long by 25' wide with a sidewater depth of 10-feet. Two tanks were constructed in 1950 followed by a third tank. The fourth and fifth tanks were added in 1972.

Flow to each primary tank is fed from a main distribution header through two 8-inch lines. Each 8-inch line is controlled through manual plug valves in order to balance the flow distribution. The flow exits the tank over a weir into an effluent channel before entering the Zone A Aeration Tanks. Scum floats to the surface while sludge and any leftover grit settle to the bottom of the tanks. A chain and flight system scrapes the sludge from the bottom of the tanks into a hopper located at the influent side of the tanks. Sludge and grit are collected using a chain and flight system. Many components of the original collectors were last replaced in 2002, including the drives, rails, shafts, and sprockets.

Scum is collected at the downstream end of the tanks in a manually rotated trough where it flows by gravity to the primary scum box. Scum is manually decanted from the scum box into a scum decant tank which is mixed using a recirculating chopper pump. Solids in the scum decant tank are pumped out periodically using a vacuum pump and sent offsite. Underflow from the scum box is returned to the raw sewage pump wet well.

Primary sludge pump

Primary sludge is withdrawn from each of the five Primary Settling Tanks sequentially via operation of a dedicated primary sludge valve (PSV) located at each tanks' sludge draw-off. These valves are automatically timed so that at any given time, the sludge is drawn from one hopper only. Sludge is conveyed from the primary tanks into the Primary Sludge Pump Room through an 8-inch ductile-iron pipe. Prior to passing through the sludge pumps, the flow passes through an inline sludge grinder. Sludge then is pumped through one of two piston pumps and is discharged through a 6" diameter ductile-iron pipe to the Primary Digester. The piston pumps, installed in 2008 and 2014, operate intermittently on a timer.

Primary sludge flow rate is measured by the primary sludge flow meter (FE-214) located in the Primary Sludge Pump Room.

TABLE 3-9

PRIMARY SETTLING TANKS

EXISTING DESIGN PARAMETERS

Parameter	Current Value	Typical Standard (TR-16)
Rectangular Primary Settling Tanks		
Number of Tanks	5	
Length, ft	85	50 – 300
Width, ft	25	
Side water Depth, ft	10	10-12 ft SWD minimum (1)
Surface Area, sf	2,125	
Volume, million gallons	0.143	
Surface Overflow Rate, gpd/sq.ft.		
Avg. Flow (9 MGD) (one tank out of service)	1,060	<1,200 gpd/sf(2)
Peak Hour (24 MGD) (one tank out of service)	2,825	<3,000 gpd/sf (2)

Notes:
1. TR-16 suggests that side water depth should not be less than 10 ft, although 12 ft is preferred.
2. TR-16 Guides for the Design of Wastewater Treatment Works; 2011 Edition.

3.5.1 Performance Evaluation

The primary clarifiers are performing adequately and the mechanisms are reported to be in good condition. Normally, one tank is out of service and 4 tanks are used. Based on a review of the TR-16 design guidelines, the existing tanks cannot adequately handle flow rates above 25 mgd with one tank out of service. To address this issue, the existing influent pump piping configuration only allows up to 20 MGD of flows to the primary tanks via the existing raw sewage pumps. During peak flow conditions, the auxiliary pumps convey the remaining flow, which bypasses the primary tanks and discharges to either the Zone A or Zone B Aeration Tanks.

Based on plant data, the primary clarifiers are removing an average of 62 percent of TSS, which is typical for primary clarification. Primary sludge is thickened in the clarifiers to 3-4% TS. The tank side water depth does not meet the recommended TR-16 design guidelines, which can limit solids settling and detention time.

3.5.2 Operational and Maintenance Issues

The control of flow distribution to each tank using two inlet pipes with manual valves is not ideal but the primary clarifiers have performed adequately. However, the operations staff would like to have an alternative configuration with automated valves and flow meters or a conventional flow splitting structure to provide equal flow distribution to each tank. Additionally, there are no torque alarms for the sludge collector. The drive is protected by using a shear pin that will break in order to stop the collector upon jamming. Concerning the chain and flight collection equipment replaced in 2002, it is reaching the end of its useful service life. However, no major operational issues have been noted.

Structurally, there is a tank joint between the two tanks constructed in 1972 that has expanded on its entire length, which appears to be a result of differential settlement between the two tanks. This issue has been described in detail in the structural evaluation section.

In the Primary Sludge Pumping Room, the inline sludge grinder is located approximately 7 ft above the finished floor, which makes maintenance on the unit difficult. Additionally, most of the piping and valves in the pumping room are original to the 1950 construction, are difficult to operate, and have reached the end of their useful life.

3.5.3 Process Alternatives Evaluation

3.5.3.1 Alternative No. 1 – Modify existing influent piping to optimize distribution to tanks

To address unequal flow distribution to the primary tanks, the existing piping configuration can be modified with a new configuration and automated valves and flow meters to improve influent flow distribution to each tank. Also, the existing longitudinal chain and flight sludge collection equipment and cross collectors with associated appurtenances will be replaced.

This alternative would require significant piping modifications and control requirements to maintain multiple automated valves and flow meters.

3.5.3.2 Alternative No. 2 – New Primary Influent Flow Distribution Structure

Pump raw sewage to a new flow distribution structure to evenly split the flow to each of the five Primary Settling Tanks. The structure will be part of the new influent pump station. Also, the existing longitudinal chain and flight sludge collection equipment and cross collectors with associated appurtenances will be replaced.

For both alternatives, the sludge suction piping will be modified with automated valves and controls to provide even sludge withdrawal from each of five tanks.

3.5.4 Recommendations

Based on the information presented above and workshops with WPCF staff, recommendations for the primary treatment are summarized below:

- Replace all chain and flight mechanisms in-kind.
- Construct a new flow splitting structure as part of the new influent pump station to improve influent flow distribution to each tank (refer to **Figure 3-5**).
- Reconfigure the draw off piping with automated valves to improve sludge draw from each primary tank.

3.6 SECONDARY TREATMENT SYSTEM –ACTIVATED SLUDGE PROCESS

The secondary biological treatment system utilized at the Fairfield WPCF is an activated sludge process configured for biological nitrogen removal using the Four-Stage Bardenpho process. The activated sludge process consists of the following unit processes and components:

- Aeration Tanks – including reactor tanks, aeration system (blowers, diffusers, and aeration piping), anoxic mixers, internal recycle pumping, and supplemental carbon feed

- Secondary clarifiers – clarifier tanks, recycle and waste sludge pumping, scum and solids removal internal mechanisms

These two unit processes work interactively to provide biological treatment and solids removal for secondary treatment at the WPCF.

Effluent from the primary settling tanks flows by gravity to the Primary Effluent Distribution Channel. In this channel, return activated sludge (RAS) from the final settling tanks and nitrate recycle from the Zone B aeration tanks combines with the primary effluent. The combined flows are distributed among six Zone A aeration tanks through the use of weirs. The effluent from the six Zone A aeration tanks flows to a common effluent channel to be distributed to the three Zone B tanks.

The basis of design for the activated sludge process is presented in **Table 3-10**.

TABLE 3-10
ACTIVATED SLUDGE SYSTEM
EXISTING DESIGN PARAMETERS

Treatment Process	**Current Value**	
Aeration Tanks	Zone A	Zone B
Number of Tanks	6	3
Tank dimensions, ft		
Length	95	160
Width	27	45
Side water depth	14	14
Total Volume (Mgal)	0.269	0.750
Total hydraulic detention time, hours		
Average flow (2)	11.1	
Peak Flow (3)	9.3	
Aerobic MCRT, days		
Winter Average	15	
Summer Average (one tank out of service)	9.5	
Total solids retention time days (3)	8	
MLSS concentration, mg/l	2500-3200	
F/M (4)	0.16-0.21	
Organic loading, lb BOD/day/1,000 cu ft	25-34	

Treatment Process	Current Value	
Submersible Mixers		
Number of Mixers	6 (Cell 1) 6 (Cell 2)	6
Capacity, gpm	6 (Cell 1) 4,400 (Cell 2)	11,100
Motor HP	4.6 (Cell 1) 6.5 (Cell 2)	13.0
<u>Aeration Equipment</u>		
Number of blowers (including standby)	4	
Type	2 Turbo and 2 multi-stage	
Capacity, scfm	2,000 – 9,500 (Turbo Combined) 4,414 (Centrifugal)	
Discharge pressure, psia	22.1	
Blower motor HP	150 & 300 Turbo 200 multi-stage	
Fine Bubble Diffusers		
Diffuser Type	<u>Fine</u>	<u>Fine</u>
Location	Zone A	Zone B
Minimum Air Flow, scfm	Cell 1, 2	Cell 1
Maximum Air Flow, scfm	1,768	9,144
Operation Pressure Range, psi	2,244	14,412
	7-7.5	
Coarse Bubble Diffusers		
Number of Header		
Location	4	
Air Flow Required, scfm	Primary Effluent Channel	
Location	106-300	
Air Flow Required, scfm	Aeration Zone A Effluent Channel	
	10-25	
<u>Nitrate Recycle Pumps</u>		
Internal Recycle, % of ADF	150	
Number of pumps (including standby)	3	
Design Capacity, gpm (each)	2,750 @ 14' TDH	
Solids/MLSS concentration, mg/l	4,500	
Solids Passing Capacity, inches	4	
Motor HP	14.1	

Notes:
1. Technical Resource 16 (TR-16) Guides for the Design of Wastewater Treatment Facilities. 2011.
2. Based upon Average Daily Flow (ADF) of 9 MGD.
3. Based upon Maximum Month Flow of 10 MGD.

3.7 AERATION TANKS

Zone B Aeration Tanks

There are two sets of aeration tanks (total of 9 tanks), which combine with the three final settling tanks to form the biological portion of the treatment process. Mixed liquor enters the Zone A Aeration Tanks through twelve Weir Gates (two per tank). The Zone A Aeration tanks are divided into four cells. The first cell is the anoxic cell no. 1. The Nitrate Recycle Pumps return nitrified mixed liquor to this cell to undergo the biological process of denitrification. Mixed liquor flows into the second cell, anoxic cell no. 2. Both anoxic cells have submersible mixers that keep solids in suspension.

The aeration tanks use 9-inch diameter membrane discs for fine-bubble diffusion. Two Slide Gates are used to isolate the aeration tanks into three separate trains before it enters Zone B Aeration Tanks, and a Coarse Bubble Diffuser system is used to keep solids in suspension.

The three Zone B Aeration tanks are divided into four cells. The first cell is the aerobic cell no. 1. In addition, wastewater from the Auxiliary Raw Sewage Pumps may be pumped to this cell. At the downstream end of the aerobic cell no. 1 are the Nitrate Recycle Pumps. After the aerobic cell no. 1, wastewater flows into two anoxic cells. Submersible mixers keep solids in suspension as in Zone A. Mixed liquor enters the Reaeration Cell and then flows by gravity to the Final Settling Tank Distribution Box. Baffle walls in the Zone B Aeration Tanks are submerged to allow scum to pass through the tank.

The twelve anoxic zones of the Zone A aeration tanks and 6 anoxic zones of the Zone B aeration tanks are mixed using submersible mixers.

Three submersible pumps installed in the three Zone B aeration tanks (one pump per tank) are used to continuously pump mixed liquor from the effluent end of the Zone B aeration tank aerobic cells to the primary effluent distribution channel for recycling into the Zone A aeration tank influent. Each pump is on a guide rail system that is mounted to the Aeration Tank wall. A hoist is located at each pump to allow the operator to remove the unit from the tank. Each pump has a check valve and isolation valve on the discharge piping.

3.7.1 Performance Evaluation

The aeration basins are small in terms of hydraulic residence time (HRT), with total HRT of approximately 9-10 hours during average conditions (8.5 MGD). As presented in **Table 3-11**, by comparison, TR-16 (NEIWPCC, 2011 Edition) recommends an HRT of 11 to 22 hours for a 4-Stage Bardenpho Process.

The activated sludge system suffers from a hydraulic imbalance (not equal flow to each aeration basin). The long primary effluent distribution channel and influent port configuration results in poor primary effluent flow distribution to the six zone A tanks. This hydraulic imbalance continues through the Zone A effluent channel and to the Zone B tanks, resulting in short-circuiting and reduced treatment performance, particularly during high wet-weather flows, which is why it is important to reduce collection system inflow and infiltration.

TABLE 3-11

AERATION TANKS HRT

Zone	Recommended HRT, hrs	HRT(all tanks online), hrs*
Pre-anoxic zones	3 to 6	1
Aerobic Zones	5 to 10	7
Post-anoxic zones	2 to 4	2
Reaeration	1 to 2	0.3
Total	11 to 22	10.3

* Assuming average daily flow of 8.5 MGD

Recently, due to low flows (5 MGD) the plant has been operating only 2 Zone A and 2 Zone B tanks to improve distribution and increase the F/M ratio in the pre-anoxic zones, which controls scum formation and foaming. Scum is problematic during low flow periods.

Under the State of Connecticut's General Permit for Nitrogen Discharges, effective since 2014, the Fairfield WPCF is allotted an annual average effluent loading of 406 lb/d of total nitrogen to the Long Island Sound. The plant is able to consistently meet this annual allotment over the last 3 years, although there have been occasional periods where effluent loadings have exceeded the allotment, particularly during cold and wet weather periods.

In order to meet the nitrogen criteria, the plant uses an average of 65,000 gallons of methanol per year, or roughly 180 gallons/day. The cost per gallon of methanol is highly variable from year to year. As of 2017, the current price is around $1.25/gal. Thus, the activated sludge system requires approximately $80,000/yr in supplemental carbon to achieve the current effluent nitrogen goals at the current average daily flow rate. Demand for methanol is possibly elevated by the following conditions inherent to the system:

- Pre-anoxic zones are relatively small, as shown in **Table 3-11**
- Internal nitrate recycle pumping is limited to 100% of max month flow, about 12 MGD
- Poor dissolved oxygen control

All of the conditions above result in “extra” methanol usage and thereby increase the operational costs of the activated sludge system. Strategies to minimize the reliance of supplemental carbon are discussed in Section 4.

3.7.2 Operational and Maintenance Issues

Under low flow conditions in the aeration tanks, growth of filamentous bacteria and intervals of excessive poly-saccharide/EPS slime on the probes in Zones A and B has been observed. Thick scum build up occurs in anoxic cells of Zone A and post anoxic cells of Zone B. There is no mechanism for removal of scum in the first anoxic zone, as all of the water is required to flow under the baffle walls. This is somewhat remedied by reducing the number of Zone A trains online, which increases the F:M ratio and selects against filamentous bacteria. However, scum and foam buildup in the aeration tanks remains a problem.

Anoxic cell mixers in Zone A and B are not efficient at keeping the mixed liquor in suspension and preventing scum build up, and require high maintenance. Replacement mixers are being evaluated to minimize operational maintenance concerns and improve denitrification process performance. Floating mixers were installed in the aerobic cells of Zone B to reduce energy expended by the aeration blowers during mixing-limited conditions.

The common drains for the aeration tanks are a foot above the tank floor, and at present the plug valves to operate the drains are damaged and not easy to access.

3.7.3 Process Alternatives Evaluation

Wright-Pierce identified the following areas where the operation and maintenance of the aeration tanks in the activated sludge process can be improved:

- Hydraulic distribution of primary effluent
- Anoxic mixing
- Foam and scum removal

Note that further improvements to improve the efficiency of the biological nitrogen removal process and provide capacity for future flows and loads are discussed in Section 4.

3.7.3.1 Hydraulic Distribution

Primary effluent distribution can be improved by:

- In-channel improvements
- Separate distribution structure

3.7.3.1.1 Alternative 1: In-Channel Improvements

Several in-channel modifications could be made at low-cost to improve primary effluent distribution. Preliminary modifications are shown in **Figure 3-6.** Though the goal of these modifications would be to split primary effluent, RAS, and internal recycle as symmetrically as possible, the original design and shape of the channel prevents ideal symmetry. Therefore, distribution would be improved over the current configuration, however effective distribution would not be achieved with this alternative. Modifications will be refined in preliminary design.

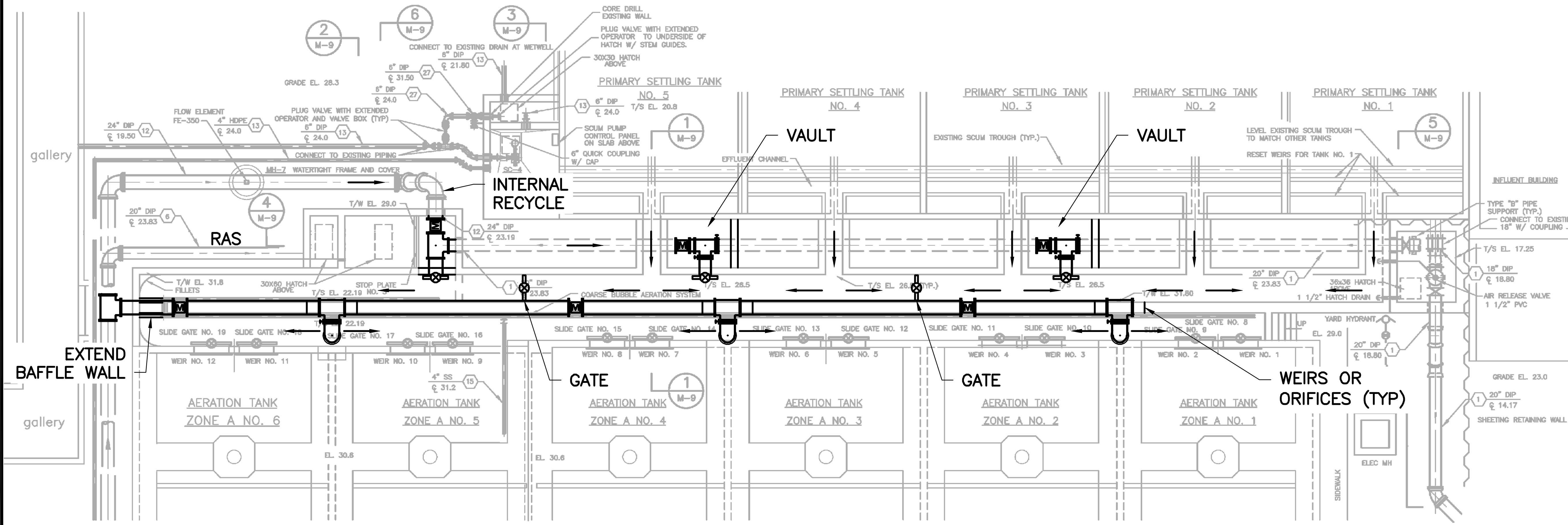

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FIGURE: 3-6

PRIMARY EFFLUENT CHANNEL IMPROVEMENTS

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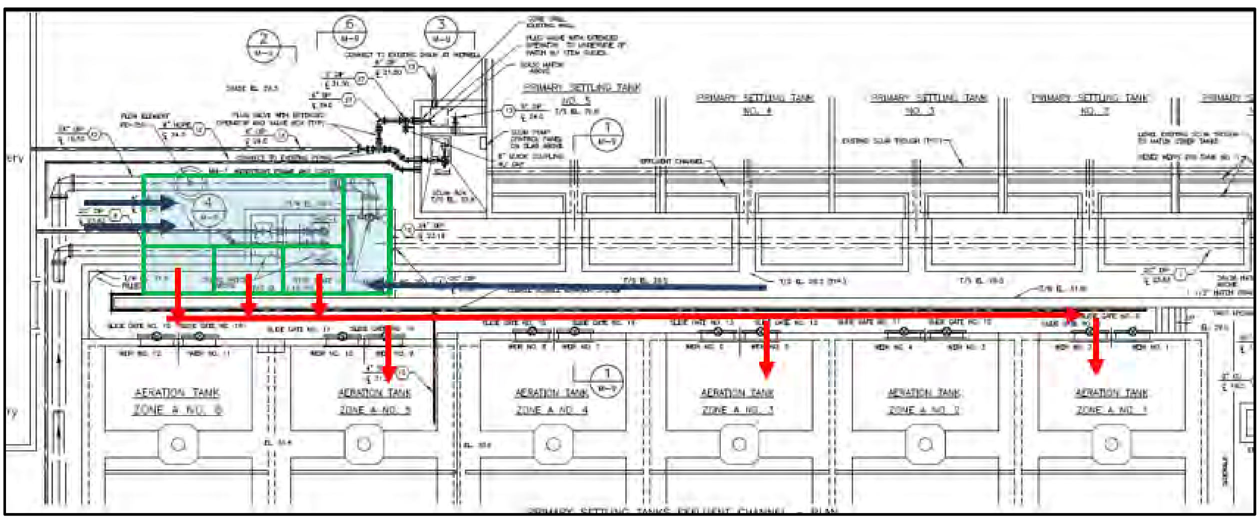
3.7.3.1.2 Alternative 2: Separate Distribution Structure

Ideally, distribution would be accomplished with a conventional flow splitter structure as shown in **Figure 3-7** with a 3-train aeration flow split. **Figure 3-7** show the flow splitting structure integral to the Zone A aeration tanks and primary effluent channel utilizing the existing waste sludge wet well, internal recycle chamber and return sludge chamber. The splitter structure can either be installed as shown or immediately outside the structure adjacent to the primary scum pump station. Considerations will be given to construction sequencing and site constraints during preliminary design to determine the most feasible location of this structure.

FIGURE 3-7

PRIMARY EFFLUENT DISTRIBUTION STRUCTURE



3.7.3.2 Anoxic Mixing

Anoxic mixing at Fairfield is currently provided by medium speed submersible mixers. A common design parameter for anoxic mixers with mechanical mixing is given in mixing energy input. **Table 3-12** shows the mixing energy input for the existing anoxic mixing system.

TABLE 3-12

ANOXIC MIXING ENERGY INPUT

	Volume per train ft3	Current mixer horsepower (connected) HP	Mixing Energy Input HP/1000 ft3	Industry Standard Mixing Energy Input HP/1000 ft3
Zone A				
Preanoxic 1	7,653	4.6	0.60	0.25-0.75
Preanoxic 2	7,653	6.5	0.85	
Zone B				
Post Anoxic 1	17,640	13.0	0.74	
Post Anoxic 2	17,640	13.0	0.74	

The existing mixing energy input meets the industry-standard recommendations for the parameter. Scum and foam formation in the anoxic zones is more likely to be a product of underflow hydraulics rather than inadequate mixing. However, in the rectangular Zone A tanks, mixing of each tank with a single-point submersible propeller mixer is expected to leave dead zones. In addition, submersible mixers require high maintenance and frequent rebuilds.

Alternative anoxic mixing technologies that have been established include low speed submersible mixers, floating mixers, hyperboloid mixers, and large-bubble mixing.

3.7.3.2.1 Alternative 1. Large-Bubble Mixing

Large bubble mixing utilizes compressed air, solenoid valves, and a stainless-steel diffuser assembly to provide short bursts of air in sequence that can provide varying levels of mixing. This technology has been used for mixing a wide range of materials and a wide range of tank shapes. The rapidly rising large bubble of air creates an upward flow to the surface and downward flow along the edges inducing vertical circulation within the tank as shown in **Figure 3-8.** Pulsed air mixing has been successfully used in WWTFs for BNR anaerobic/anoxic mixing, sludge tanks, wet wells and chlorination tanks as well as in the water field for water storage tanks.

Currently, there are two companies, Enviromix Inc. and Pulsed Hydraulics Inc, competing in the municipal WWTF market. Both have had success in a variety of applications, and have passed performance testing during both pilot studies and full-scale installations in the United States. Enviromix has several installations that are currently operating in municipal BNR applications. Wright-Pierce contacted two of these in Warren, MI, and Abington, PA. Results of the phone survey is presented in **Table 3-13.**

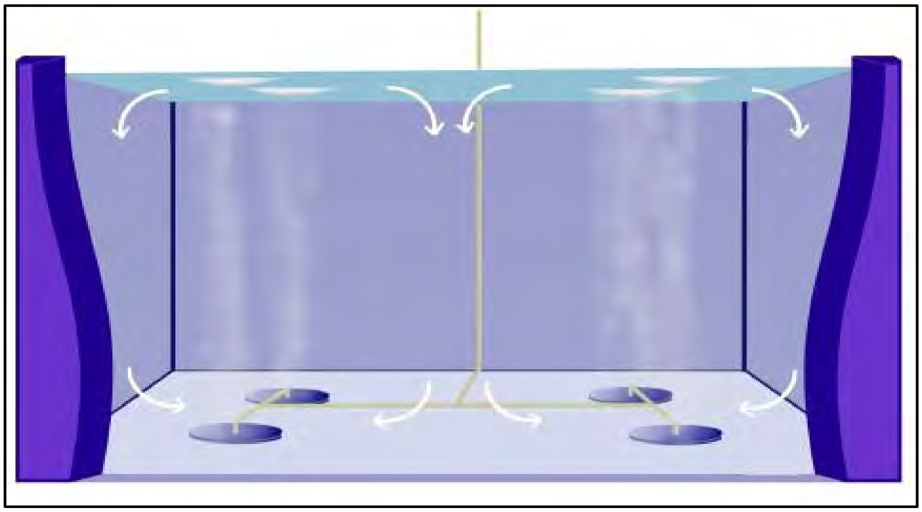
TABLE 3-13

RESULTS OF TELEPHONE SURVEY OF ENVIROMIX SYSTEMS

Item	Warren, MI WWTF	Abington, PA WWTF
Plant Information		
Capacity, MGD	36	2.5
Biological Process	AO Biological Phosphorus Removal	Nitrogen removal using MLE
Biomix system information		
Number of Nozzles	160	108
Year installed	2014	2014
Compressor Horsepower, HP	15	25
Performance		
BNR	Successful EBPR	Great nitrogen removal
Settling	None observed	Grit observed between nozzles before grit system was installed. Has gotten better since, but not completely.
Foaming	None observed	None observed
Operation and Maintenance Issues		
Operation	Air lines froze up due to condensation on startup. Dryer was installed, air lines insulated and now works great.	No problems. Only operating for a year.
Maintenance	No problems.	No problems.
Overall Satisfaction	Very positive. Enviromix provides great support.	Very positive. Enviromix provides great support.

The performance of large bubble mixing system provided by Enviromix has been evaluated in several pilot studies, including a study by Dr. Clifford Randall (commissioned by Enviromix), at the F. Wayne Hill Water Resources Center in Gwinnett County, Georgia, and an independent study at the Mauldin Road WWTP in Greenville, SC. These pilot studies compared side-by-side energy usage, mixing, and biological nutrient removal between the Biomix (i.e. large bubble) system and submersible mixers. Both studies concluded that mixing and biological nutrient removal were comparable between the two technologies with energy savings of about 60% to 75% (over submersible mixers) using the Biomix system.

FIGURE 3-8
CIRCULATION MODEL FOR LARGE-BUBBLE MIXING
(COURTESY OF PULSED HYDRAULICS, INC.)

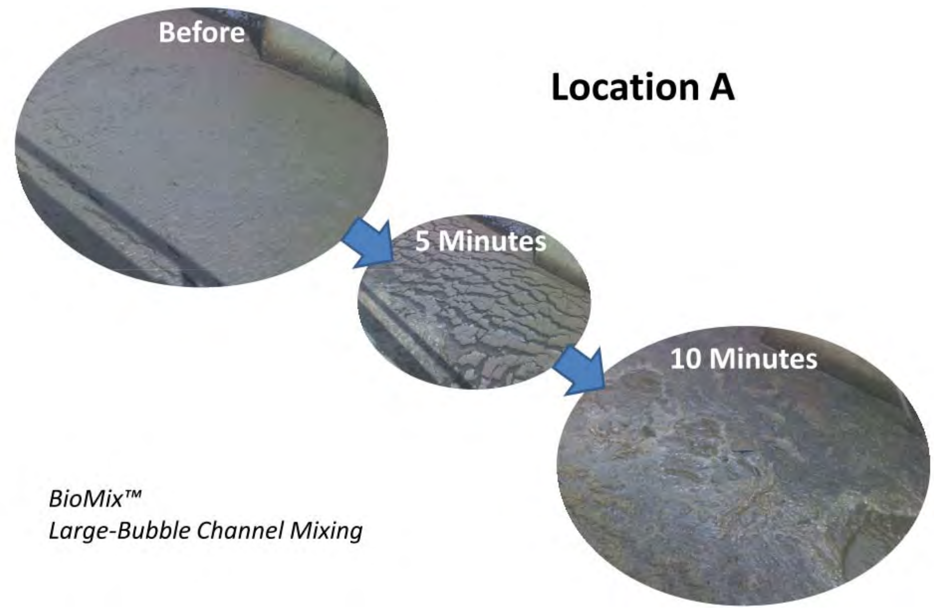


Advantages of this alternative include:

- *Low power required.* According to Enviromix, the Biomix system requires an energy input of around 0.09 to 0.15 HP per 1,000 ft3, which is comparable or lower than the Invent system. A proposal solicited from Enviromix for Fairfield features a unit mixing power for the anoxic/swing zones of the aeration tanks of 0.17 HP per 1,000 ft3, similar to the Invent proposal. This proposal is included as an appendix.
- *Fewer mechanical components.* An Enviromix Biomix system at Fairfield would include two 40-HP compressors in a duty/standby arrangement. The air is sent from the panels to stainless steel prefabricated headers and then to nozzles in the bottom of the aeration tanks. Pulsed Hydraulics uses larger bubbles with fewer nozzles and control valves.
- *Compatibility with fine-bubble diffusers.* The large bubble nozzles can be arranged around the optimal fine-bubble diffuser arrangement in the anoxic swing zone (or possibly in the future in the last tank when mixing limited).

- *Serviceability.* The compressors would require oil changes, occasional cleaning of dryer condenser coils, and belt tensioning. Receivers need to be periodically drained. The poppet valves would require routine checking of air filters and occasional replacement. The nozzles and internal piping are not expected to require service, but nozzles would be serviced when tanks taken off line for service of the aeration diffusers.
- *Foam.* Enviromix claims that the technology has the capability to break up stagnant foam buildup in the anaerobic/anoxic zones as shown in the photos in **Figure 3-9.** This capability has not been studied and verified by Wright-Pierce, although Pulsed Hydraulics, Inc. has installed the technology effectively for FOG removal on wet well surfaces at lift-stations across the country.

FIGURE 3-9
FOAM BREAKUP USING LARGE-BUBBLE MIXING
(COURTESY OF ENVIROMIX)



- *Easy Adjustment.* The firing rate for the large bubble systems can be easily adjusted, and thereby adjust the level of mixing provided to match the application.
- *Easy expansion.* Should the Town desire to create swing (anoxic/aerobic) zones in the aeration tanks, expansion of the system would be limited to additional piping, nozzles and poppet valves.

Disadvantages of large-bubble mixing include:

- *Grit Settlement.* It should be noted that one of the references contacted did observe grit settlement in locations away from the mixing nozzles. Settlement did improve after the installation of a grit removal system but was not completely eliminated. In addition, at Warren, MI, the airlines froze with condensate in the winter of 2014 when first installed. Dryers were installed along with insulation of the air piping, and the system has operated well since. Dryers and insulation would be required for the Fairfield application.

- *Maintenance and reliability of numerous solenoid valves.* The system will operate utilizing poppet valves. Facilities with these valves have not reported any undue burden operating and maintaining these types of valves.

At Fairfield, the large-bubble mixing system would consist of 2 x 40 HP (duty/standby) compressors, air piping, 5 valve panels, and a master control panel. The system would be sized with expansion capabilities should the Town desire to convert aerobic zones into swing zones. Operating horsepower at average annual loadings is expected to be 20 HP.

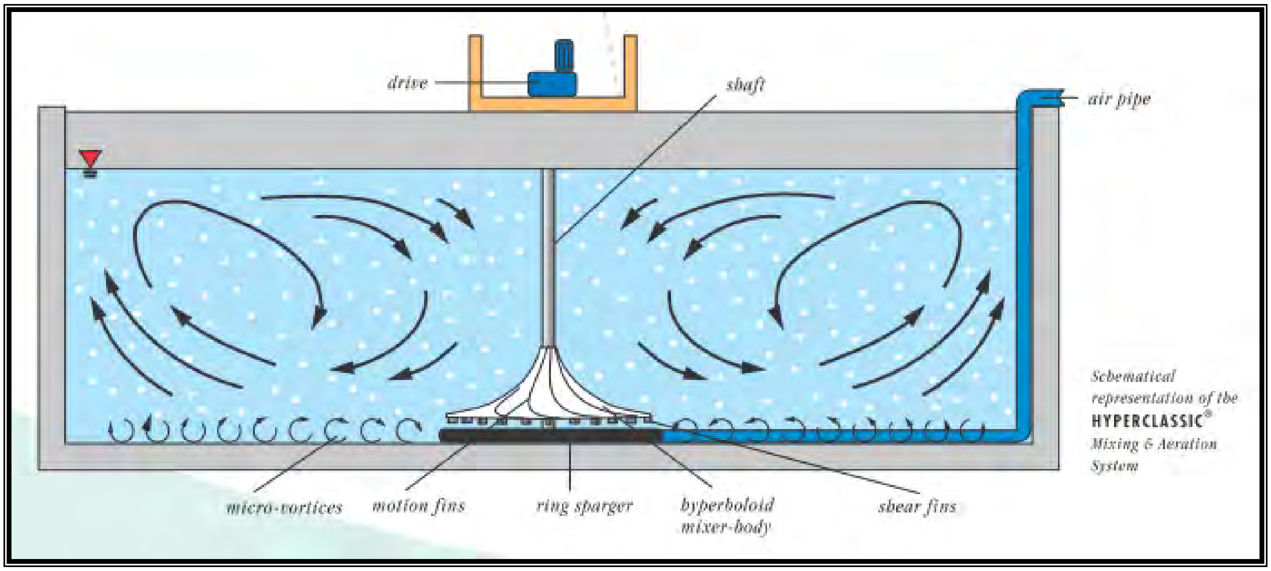
3.7.3.2.2 Alternative 2. Hyperbolic Top-Mounted Mixers

Hyperboloid mixers, as manufactured by Invent Environmental Technologies, are vertical mixers that utilize a hyperboloid-shaped mixer body to induce circulation currents and reduce required energy input compared to conventional mixing technologies as shown in **Figure 3-10**. Invent is the only established manufacturer of these mixers, although recently competitors have introduced similar products as the patent has run out on the technology. According to Invent, hyperboloid mixers require an energy input of around 0.1 HP per 1,000 ft3 of mixed liquor and have an allowable length to width (L/W) ratio on the order of 3:1, which is higher than conventional mixers.

Performance of the hyperboloid mixers has been evaluated during several pilot studies, including at the Bowery Bay WPCP in New York City and the DC WASA Blue Plains facility. These studies confirmed the homogenization of mixed liquor, low power energy input and low oxygen transfer of the technology. Since then, hyperboloid mixing has become well-established with numerous installations, including the above-mentioned facilities and locally at the Windham, CT, Manchester, CT, West Haven, CT and Mattabassett, CT WPCF's.

To improve surface entrainment of scum and foam in anoxic/anaerobic zone applications, Invent has added a small impeller blade a few feet below the surface to pull the surface down around the impeller shaft.

FIGURE 3-10
HYPERBOLOID MIXING
(COURTESY OF INVENT)



Advantages of this alternative include:

- *Low power required.* According to Invent, the hyperboloid mixers require an energy input of 0.1 HP per 1000 ft3 (versus typical 0.25 HP per 1000 ft3 for conventional mixing), and have an allowable length to width (L/W) ratio of 3-to-1, which is higher than conventional mixers.

- *Established, proven technology.* Invent mixers have been installed and operated successfully in numerous locations throughout North America and Europe for mixing in biological nutrient removal applications.

Disadvantages include:

- *Support System.* A support system above the tank top is required for each mixer. The support system can significantly increase the cost of an installation above the equipment costs. The structural supports can be supplied by the general contractor or can be supplied by Invent.
- *Additional mechanical maintenance.* Mechanical maintenance will be required for 10 mixers. However, maintenance is typically limited to changing lubrication oil in the gearboxes annually.
- *Difficulty in access and repair.* Although it is not foreseen that access will be required to the impellers or mixer shaft over the 20-year planning period, repair of this equipment will require lifting cranes. Repair of motors or gearboxes will require a lifting crane at a minimum.

3.7.3.2.3 Alternative 3. Floating mixers

Floating mixers are currently used for supplemental mixing in the aerated zones of the Zone B aeration tanks and have proven to operate well. Extending these mixers to the anoxic zones would serve to reduce maintenance of submersible mixers and possibly reduce surface foaming. The addition of on/off controls and timers would prove beneficial so that the mixers are not on all of the time.

3.7.3.2.4 Alternative 4. Low Speed Submersible Mixers

Low speed high efficiency mixers with speed control capabilities are currently being trialed at the Fairfield WPCF by Flygt/Xylem. As of January 2017, performance has been good with a reported noticeable reduction in power consumption. Review of the complete trial report will be conducted during the design phase.

3.7.4 Evaluation and Life Cycle Cost Analysis

A 20-year life cycle cost analysis was performed for the three mixing alternatives along with the baseline alternative of retaining submersible mixers. This analysis assumes the following:

- 2 Zone A Tanks and 3 Zone B Tanks operating during average annual conditions.
- Full replacement of existing submersible mixers required during the next 20 years
- $0.16/kwh midpoint electricity unit cost

Results of the analysis are shown in **Table 3-14.**

TABLE 3-14

SUMMARY OF 20-YR LIFE CYCLE ANALYSIS

ANOXIC MIXING

FAIRFIELD WPCF

	ALTERNATIVE	CAPITAL COST	PRESENT WORTH
	BASELINE (HIGH SPEED SUBMERSIBLE MIXERS)	$1,510,000	$3,800,000
1	HYPERBOLOID MIXERS	$875,000	$1,451,000
2	LARGE BUBBLE MIXING	$706,000	$1,087,000
3	FLOATING MIXERS	$792,000	$2,227,000
4	LOW SPEED SUBMERSIBLE MIXERS	$1,963,000	$2,880,000

The analysis indicates that retaining high speed submersible mixers or installing low speed submersible mixers would incur the most cost in both equipment replacement, maintenance, and energy expenditure required. The total life-cycle present worth is dominated by electricity costs, and therefore hyperboloid mixing and large bubble mixing, which provide the most efficient mixing, produce the greatest life-cycle advantage. Therefore, the Town should consider replacing the submersibles with these technologies moving forward.

3.7.4.1 Scum Removal

Wright-Pierce identified the following structural and mechanical modifications to help with foam and scum removal:

- Zone A anoxic tank baffle walls to be lowered, submerged orifices constricted to encourage overflow hydraulics and pass scum and foam
- Zone B anoxic tank baffle walls submerged orifices constricted to encourage overflow hydraulics and pass scum and foam
- Construct Surface baffle across aeration tank effluent and a scum wasting station

Zone A Walls

Zone B Walls

3.7.4.2 Internal Nitrate Pumping

Internal nitrate pumping is provided by 14 HP submersible propeller pumps. Seals on these pumps have been problematic with frequent replacement. Internal Nitrate pumping is further discussed in Section 4.

3.7.5 Recommendations

Recommendations to improve nitrogen removal performance of the overall activated sludge system are presented in Section 4. Improvements recommended here address specific operational and maintenance issues associated with the aeration tanks discussed in the previous section.

1. Construct in-channel modifications or a separate distribution structure to improve primary effluent distribution. The separate distribution box alternative is carried forward as a capital cost item to develop planning budget.
2. Replacement of submersible mixers with either hyperboloid or large-bubble mixers. The installation of large-bubble mixers is carried forward as a capital-cost item to develop the planning budget.
3. Structural modifications to facilitate the passing and removal of scum and foam from the aeration tanks.
4. Replace internal recycle pumps sized to handle 400% of flow. Evaluate installing outside of the tanks during the preliminary design.

3.8 AERATION SYSTEM

The aeration system consists of two recently installed turbo blowers (300 HP and 150 HP Neuros Blowers) and two older multi-stage blowers (Spencer Turbine Co.) installed in the Blower Building. The turbo blowers are currently in operation and are used to supply air to the Fine Bubble Diffuser system installed in the aerobic cells of the Zone A tanks and Zone B Aeration Tanks. The blowers also can deliver air to the coarse Bubble Diffuser system which lines the length of the Primary Effluent Distribution Channel and the lengths of each channel connection the Zone A Aeration Tanks to the Zone B Aeration Tanks. Currently this feature is not utilized.

Motor operated butterfly valves installed on the main feed aeration pipe that feeds each of the Zone A and B Aeration Tanks are used to adjust airflow to the fine bubble diffusers, which ultimately controls the dissolved oxygen (DO) concentration in the aerobic zones. Zone A Aeration Tanks use 8-inch butterfly valves and Zone B Aeration Tanks use a combination of 10-inch butterfly valves with 8-inch bypass butterfly valves. The air volume delivered to the coarse bubble diffusers is regulated by a manually operated throttling valve. The 46 diffusers in the Primary Effluent Distribution Channel tap off the main air header in the Zone A Aeration Tanks. The 3 diffusers lining each of the three channels connecting the aeration tank zones is taken from the air header feeding the Zone B Aeration Tanks.

3.8.1 Performance Evaluation

The high-speed turbo blowers have worked well and provide higher efficiency aeration than the older multistage centrifugal blowers. Blower curves indicate that the combination of large and small blowers provides a wide range of flows from approximately 2,000 to 9,500 scfm. However, it appears there is a gap in the coverage range in between the maximum output of the smaller blower and minimum turndown of the larger blower. The smaller of the two Neuros Blowers is more frequently in use, due to turndown limitations of the larger blower. **Figure 3-11** shows blower ranges versus expected current and future demands. Aeration demands are further discussed in Section 4. Also, shown in **Figure 3-11** is the range of a 200 HP Neuros Blower.

The installation of a 200 HP Neuros blower would be able to reduce load on the 150 HP and provide a level of redundancy if one of the blowers is out of service.

3.8.2 Operational and Maintenance Issues

Wright-Pierce has identified instrumentation calibration issues and control algorithm issues that are contributing to inefficient and uncoordinated aeration control. These include:

- It appears the aeration control system was modified from a pressure control system to some kind of time-based or manual based dissolved oxygen control system.
- The dissolved oxygen control directly modifies the valve position.
- There is no way to tie total aeration required by the dissolved oxygen control system with the aeration system automatically. The system is either drastically over-aerating in most cases or under-aerating in other cases.
- The dissolved oxygen control system limits the valve position to a “low end” position. This prevents the dissolved oxygen levels from meeting setpoint and causes over aerating.
- The aeration valves modulate to any position required to meet dissolved oxygen setpoint. This results in blower “over-pressurization” shutdowns and over-aeration.
- Dissolved oxygen control deadband appears excessively tight resulting in valve hunting and potential valve motor burnout.
- There are FCI AF-88 thermal mass dispersion flow meters that measure flow in SCFM to specific drops in the aeration basins. It was discovered that these flow meters were not in calibration. Typical Zone B flow meters 7, 8, and 9 error was 30% of reading to 100% of reading. Zone A flow meters 1, 2, 3, 4, 5, & 6 do not work.
- The motor-operated air valve actuators (installed in 1998/2000) are damaged (most valves are in open mode) causing uneven air distribution and need replacement.

Additionally, online ammonia probes could be installed that would allow operators to monitor nitrification performance and further optimize blower operation. These should be added.

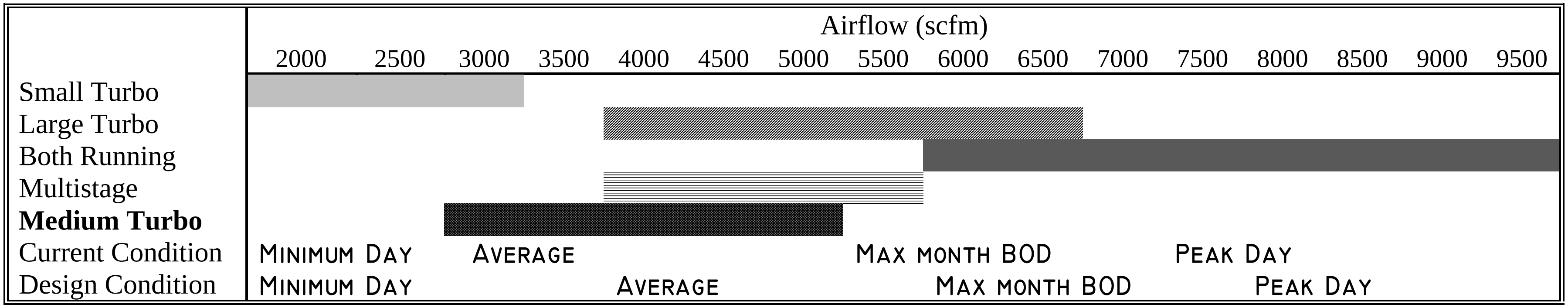
3.8.3 Recommendations

Wright-Pierce recommends the replacement of the two turbo blowers and installation of one new blower all sized between 150 and 200 HP to allow for easier DO control and to provide the redundancy the facility is currently lacking. In addition, aeration instrumentation and control shortcomings listed above should be remedied.

No additional changes in aeration piping configuration are anticipated, other than possible resizing of control valves at the aeration tank droplegs, and an additional control valve on the Aeration header to Zone A to compensate for the shallower depth of these tanks.

FIGURE 3-11

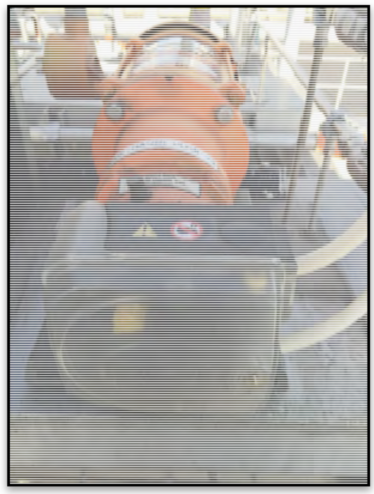
AERATION BLOWER FLOW RANGES



1. Ranges are approximate, interpreted from blower curves
2. Air demands for current and design conditions are presented in Table 4.

3.9 SUPPLEMENTAL CARBON FEED AND STORAGE

A methanol storage and feed system installed adjacent to the Zone B aeration tanks is used to store and meter liquid methanol into Anoxic Cell No. 1 in each Zone B aeration tank. The system is comprised of two 4,000-gallon aboveground storage tanks supplying three methanol feed pumps and associated piping, fittings and valves.



3.9.1 Performance Evaluation

The tanks and pumps have sufficient size and capacity for current operations.

3.9.2 Operational and Maintenance Issues

Control of the pumps is adjusted automatically via a nitratex analyzer. Nitrogen load varies greatly diurnally due to solids handling recycle loads. Efficiency of methanol feed may be optimized by installing online nitrate monitors and a flow signal to pace feed pumps.

The concrete walls of the tanks are spalling and have been repainted. Peristaltic pumps are worn and will need greater maintenance due to their age. There is no canopy protecting the pumps from the elements.

The level sensors in the tanks are not functional and there is a leak in the outer double walled tank into the interstitial space from the exterior.

3.9.3 Recommendations

Recommendations for the supplemental carbon feed system are listed as follows:

- Replace methanol storage tanks and protect to the 500-year flood elevation.
- Replace pumps.
- New level sensors are required.
- Safe Access to tank nozzles, consisting of extended platforms, should be provided.
- Add additional methanol feed points to the pre-anoxic zones.

3.10 FINAL SETTLING TANKS

The Fairfield WPCF initially consisted of two rectangular Final Settling tanks that were constructed as part of the original 1950 upgrade. In later treatment plant upgrades, these tanks were demolished to allow for construction of the Zone B aeration tanks nd three new circular Final Settling Tanks (Nos. 1, 2 and 3), were constructed as part of the 2000 treatment plant upgrade. Each tank is 105-feet in diameter with a side water depth of 14.0 feet. The design average and peak surface overflow rates for the existing tanks are shown in **Table 3-15** below. Aeration tank effluent from Aeration Tanks Zone B flows by gravity in a 60-inch diameter pipe to the secondary distribution structure and enters each settling tank. Sluice gates located on the distribution box are used to isolate flow to the final settling tanks.

TABLE 3-15

FINAL SETTLING TANKS

BASIS OF DESIGN

Parameter	Current Value	Typical Standard[1]
Number of Tanks		
Tank Dimensions	3	
Diameter, ft.	105	
Side Water Depth, ft.	14	16 feet
Surface Area, sq.ft.	25,980	
Volume, mgal.	Westech	
Mechanism Manufacturer	Rotating	
Sludge Collection	Rake	
Motor HP	0.75 HP	
Overflow Rate, gpd/sq.ft.		
@ Avg. Daily Flow (8.5 mgd)	327	
@ Future Avg. Day (9.12 mgd)	351	
@ 98% Future Peak Hour (22.21 mgd)	855	1,100 gpd/sq ft (2)

Notes:

1. Technical Resource 16 (TR-16) Guides for the Design of Wastewater Treatment Facilities. 2011.
2. Based upon an MLSS of 2,500 mg/l and RAS of 9,000 mg/l and employing use of selector as per TR-16.



Final Settling Tanks Nos. 1, 2 and 3 consists of a WesTech-Inc., spiral blade clarifier mechanism. The influent enters the settling tanks via a vertical pipe center feedwell and the energy dissipating baffles divert the flow to the bottom of the tank for uniform distribution. Current density baffles mounted on the effluent launders are used to redirect the flow away from the tank wall to ensure the entire tank volume is used for settling. Each settling tank has a spiral blade sludge collector mechanism and a scum skimmer assembly which is motor driven and runs continuously. The spiral blade mechanism continually scrapes the settled sludge on the bottom of the tank and conveys the sludge to a center sludge hopper. The sludge collected in the hopper is directed to return sludge pump suction pipe inlet for removal. The scum skimmer assembly has a full radius surface skimmer which diverts the scum collected into a scum trough. A scum baffle located at the periphery minimizes the amount of scum that escapes the final settling tank over the weir. The scum is flushed into the scum box to be pumped back to the primary tank by secondary scum pumps.

The clarified effluent overflows from the final settling tank weirs and is disinfected using an ultraviolet system prior to being discharged into the Long Island Sound. The settling tank launder cleaning mechanism, consists of a series of brushes attached to the end of the skimming mechanism, and is used to clean algae and debris from the scum baffle, weir and launder.

3.10.1 Performance Evaluation

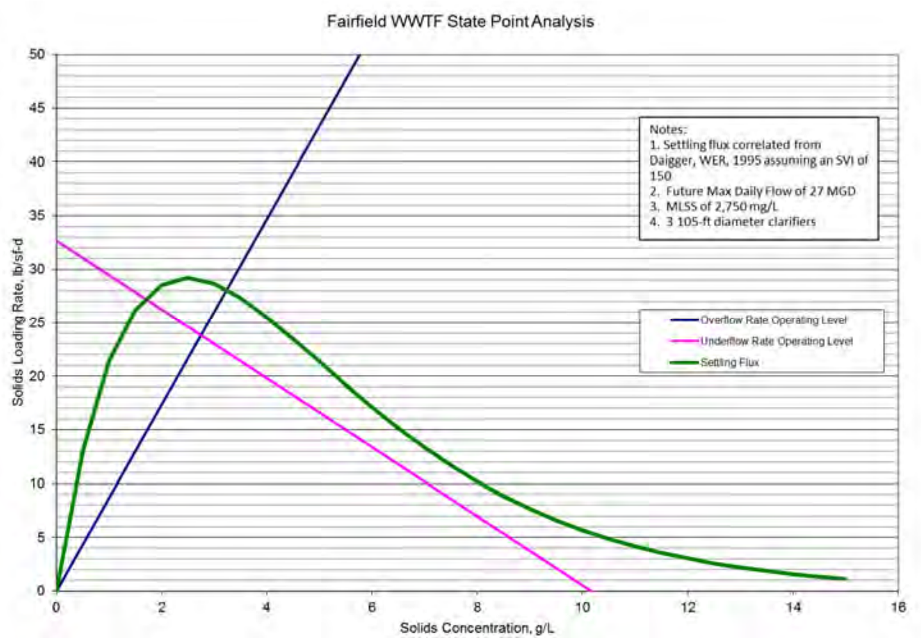
Typically, two final settling tanks are in operation to maintain a uniform sludge blanket of about 4 feet with all three on-line during excessive flow periods. A state point analysis was conducted for the final settling tanks to determine that the existing settling tank surface area can properly settle out the projected mixed liquor suspended (MLSS) concentration from the Aeration system. The result of the state point analysis is graphically illustrated and shows the intersection of the overflow rate and underflow rate operating level. The location of the settling flux curve is interpreted as follows:

- If a clarifier is operating within its settling parameters, the State Point (i.e., the intersection of the overflow rate and underflow rate) will be shown below the Settling Flux Curve calculated for the clarifier. In addition, the Underflow Rate Operating line will also be below the Settling Flux Curve.
- If the State Point is shown above the Settling Flux Curve in any condition, the material will not settle in the clarifier but will flow out of the clarifier via the effluent weir. Similarly, if the Underflow Rate Operating line is shown above the Settling Flux Curve in any condition, the sludge blanket is projected to rise and also exit the clarifier via the effluent weir.

Figure 3-12 shown below for the Fairfield WPCF final settling tanks graphically summarizes the results of the state point analysis for the Four-stage Bardenpho process using peak day design flow conditions (27 mgd) and a sludge volume index of 150.

FIGURE 3-12

STATE POINT ANALYSIS FUTURE (DESIGN) CONDITIONS



The results indicate that the three existing clarifiers are adequately sized to treat a maximum mixed liquor concentration of 2,750 mg/l at a future peak day flow rate of 27 mgd. Therefore, since it is unknown when a peak day flow event will occur, it is recommended that the operating mixed liquor always be kept at or below 2,750 mg/l. This is achieved by either modifying the desired sludge retention time or number of aeration basins online as a function of influent loading and wastewater temperature.

3.10.2 Operational and Maintenance Issues

The existing final settling tanks reportedly work well. A corrosion assessment was conducted by WesTech representative in 2013 on the three clarifier drives and clarifier equipment. The results of the assessment indicated that there was surface rusting on the lower gear housing on all three clarifier drives including deteriorated dust seals on the clarifier drives and excess grit were found under the lip of the dust seals. Additionally, extensive corrosion was noticed on the full radius skimmer mechanism and supports including delamination of the steel equipment. Minimal corrosion damage was also noticed on the lower parts of the clarifier rake and cage mechanism. The recommendations of the corrosion assessment indicated the following:

- Replace dust shields;
- Clean and repaint drives;
- Install sacrificial zinc anodes on the equipment;
- Check thickness of the existing clarifier mechanism and have additional material welded or replace the equipment in its entirety;
- Repair or replace the full radius skimmer supports with a hinged skimmer mechanism and a 6-foot scum box; and,
- Establish an annual maintenance program to inspect for corrosion and ensure that the gears are clean from rags and grit.

Additionally, plant staff has also indicated that due to excess algae formation in the clarifiers the brushes on the algae sweeps need to be replaced every six months which cause a significant expense to the WPCF. Also the drives and the scum pumps are aging and need to be replaced however no other major problems have been noted by the staff.

3.10.2.1 Process Alternative Evaluation

According to TR-16, secondary clarification area should be based on either a state point analysis (presented above) or the following criteria should be considered for optimum performance of a secondary clarifier:

- Surface Overflow Rate (SOR): The Surface Overflow Rate (SOR) is a measure of the amount of wastewater applied per unit surface area of the secondary clarifier. As the rate increases, it becomes harder for sludge to settle within the clarifiers, eventually leading to high effluent suspended solids concentrations. TR-16 recommends SOR values less than 1,100 gpd/ft^2 for optimum secondary clarifier performance.
- Solids Loading Rate (SLR): The Solids Loading Rate (SLR) is a measure of the amount of sludge applied per unit surface area of the secondary clarifier. As the loading rate increases,

sludge will build up in the clarifier increasing the sludge depth. Increasing sludge depth increases the likelihood of solids carryover into the effluent. SLR depends mainly on the design MLSS, flow rate, and RAS rate. TR-16 recommends SLR values less than 42 lb/(day-ft^2) for optimum secondary clarifier performance.

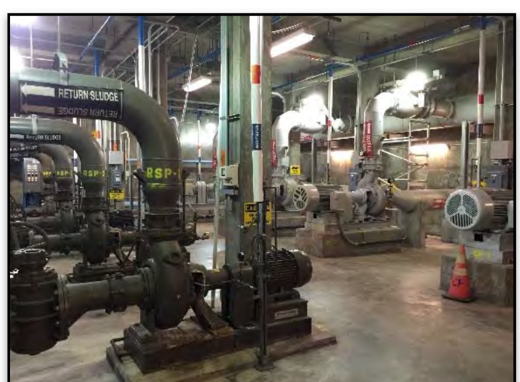
A review of the secondary clarification capacity, as a function of the future influent flows and loads, is presented in Section 4. In general, if the activated sludge MLSS concentration is maintained below 2,750 mg/l for all potential influent loading conditions, then the existing three clarifiers should have sufficient capacity to meet the current effluent permit limits.

3.10.3 Recommendations

Given the age of the existing three clarifier mechanisms and reviewing the evaluation provided by Westech, it is recommended that all secondary clarifier internals be replaced including the scum and algae control equipment. In-lieu of replacing the algae cleaning system with new brush equipment, WPCF staff have expressed a desire to install weir washing equipment that utilizes pressurized water to clean the launder walls, scum baffle and scum beach equipment and weirs. Different types of mechanisms will be evaluated during the preliminary design phase.

3.11 RETURN ACTIVATED SLUDGE PUMPING

Four Return sludge pumps located in the basement of the return sludge building convey sludge from Final Settling Tank Nos. 1, 2 and 3 to the primary effluent distribution channel that is located at the downstream end of the primary settling tanks. The pumps are non-clog centrifugal pumps with capacity ranging from 1,156 to 2,311 gpm and a total dynamic head between 13 to 32 feet respectively. Each pump is dedicated to one final settling tank and a standby pump is provided that acts as a back-up which allows the designated pumps to be taken out of service to provide maintenance. A magnetic flow meter is provided on the discharge piping of each pump and the



Return Sludge Pumps

pumps are also used to drain any of the three final settling tanks.

All the pumps are equipped with variable frequency drives that have a selector switch for automatic or manual operation. During automatic operation, the pump discharge is paced to the pump speed flow rate set points entered into the PLC for each pump. In manual mode, the pumps are operated manually.

3.11.1 Performance Evaluation

The return sludge pumps are typically designed to provide a return rate of 100% of the design year annual average flow rate which is capable to handle future design year flow conditions. The pumps are ideally designed to be turned down enough to handle low flow rate conditions and peak conditions with one pump offline. Plant staff has reported no performance issues with the existing return sludge pumps however on occasion, to maintain flows, all fourth rotational standby pump is place into operation.

3.11.2 Operational and Maintenance Issues

The plant staff has not reported any operation and control issues with the existing return sludge pumps. However, the return sludge pumps are approaching their useful service life and are in need of rehabilitation or replacement. They are also undersized for future projected flows and loadings. In addition, the existing pumps and drives are older and can be less energy efficient than currently available technology.

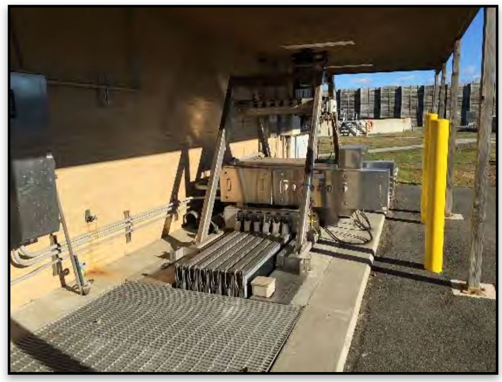
3.11.3 Recommendations

As indicated, the return sludge pumps are approaching the end of their anticipated useable lifespan and any comprehensive upgrade to the facility should include upgrading the return sludge pumps. The upgrade would include replacement of the existing VFDs and the use of high efficiency motors to improve the energy efficiency of the overall system. Each of the four new pumps will be rated to handle 2,800 gpm.

3.12 EFFLUENT DISINFECTION

Wastewater from the final settling tanks is disinfected by Ultraviolet (UV) disinfection and uses a UV-4000 system manufactured by Trojan Technologies. The system is located outdoors adjacent to the Return Sludge Building and flow from the secondary clarifiers enter the UV channel for disinfection. The UV system is used year round as required per the NPDES permit and consists of two banks located in a single channel.

Each bank is rated to handle peak flows with the second bank acting as a redundant bank. The lamps in the bank are medium pressure, high intensity and located in a horizontal configuration parallel to the path of the wastewater flow. Each bank consists of six sets of lamp modules with a total of 72 lamps. After the disinfection process, the flow enters a parshall flume located in the UV channel which measures the flow prior to being discharged into the Long Island Sound.



UV Disinfection System

3.12.1 Performance Evaluation

As mentioned above, the UV system is installed outdoors in a single channel. The system was installed as part of the last WPCF upgrade and will be nearing its 20-year design life. The system is performing well but plant staff has indicated several operational and control issues with the disinfection system. The two banks are operated with a common power, motor control center and cooling pumps. This set-up does not provide the true redundancy to meet TR-16 standards. Additionally, the UV system is not covered with an enclosure to protect it from the elements. The basis of design for the existing system is shown in **Table 3-16** below.

TABLE 3-16

UV DISINFECTION SYSTEM

BASIS OF DESIGN

Treatment Process	Current Value	Typical Standard
UV Disinfection System		
Number of Banks	2	
Process Flow (mgd)		
Design Peak Flow	28	
Peak Plant Flow	24	
Average Annual Flow	8.60	
Minimum Flow	4	
Number of Lamps	72	
Retention Time (seconds)	0.175	
Disinfection Dose (mW, s/cm^2)	≥24	
UV Intensity (mW/cm^2)	≥6.1	
Avg. Total Suspended Solids (mg/L)	30	
UV Transmission (%) at 253.7 nm		55
UV Dose (mJ/cm^2)		35,000-40,000
Effluent Disinfection Requirement		
(#fecal coliform/100 ml)	88 for 30-day geometric mean	200
(#enterococci/100ml)	35 for 30-day geometric meal	n/a

The TR-16 standard indicates that a UV system shall be capable of delivering the design dose and disinfecting effluent at peak instantaneous flows with one bank of modules out of service. For systems that require continuous, uninterrupted disinfection, more than one UV reactor (channel) is required. The standard also requires a backup electrical supply capable of powering the entire system. The electrical supply must be designed to prevent common- mode failure of an electrical component from disabling the entire disinfection system.

3.12.2 Operational and Maintenance Issues

The WPCF staff has reported some issues relative to the existing UV system as listed below:

- The system is operated inefficiently. The first bank operates in automatic mode with the second bank operating in manual mode at higher than permit dosage and intensity requirements (100%) to avoid discharge violations and protect the surrounding shell fish beds;

- The UV channels have the potential to build algae in the channels;
- The UV system is very inefficient and is run at much higher intensity than currently designed to maintain disinfection, thus consuming more power;
- The existing partial flume encounters Loss of Echo and does not transmit the accurate flow onto the SCADA system.

3.12.3 Control Issues

The control panel for the existing UV system can be operated in both manual and auto mode with the ability to run in auto mode at all times. However, plant staff encounter issues in operating it in auto mode. When operated in auto mode, the system is operated at a higher dosage rate and encounters glitches which shut the system down. Currently, one bank is being operated in auto mode with the second banks in manual mode.

3.12.4 Process Alternatives Evaluation

The existing UV system has been in service since the last upgrade and has served the facility well but has operation and control issues as mentioned above. In addition, Trojan Technologies is phasing out the UV4000 model and replacement parts will be hard to obtain when compared to currently available newer technologies.

The following alternatives were evaluated for upgrading the existing UV system:

1. Utilize the existing system as a backup and construct a new channel with new parshall flume, isolation gates and install a new UV system that is rated to treat flows up to 35.24 MGD. This scenario will not give the needed redundancy as required per TR-16 especially in a situation when peak hourly flows need to be treated with the new system taken down for maintenance.

2. The existing system is manufactured by Trojan Technologies and is set up in a horizontal lamp configuration. In order to be consistent with the controls of the UV system, it would be ideal that the newer system be supplied by Trojan Technologies

which now offer both horizontal and inclined lamp configurations. An inclined configuration offers the benefit of a smaller footprint especially in situations where the flow is greater than 20 MGD.

3. Another option is to construct a new channel to install a new UV system, with a new parshall flume and isolation gates; and modify the existing channel to retrofit it with a new UV system such that each channel will be designed to handle a peak hourly flow rate of 35 MGD with one channel offline as shown in **Figure 3-13.** The two channels will include a separate backup electrical supply and will offer the redundancy as required by the TR-16 guidelines.

4. The latest technology for municipal UV disinfection applications has "low pressure high output" systems. These new systems have a much higher intensity than the original "low pressure" systems, with the higher intensity lamps reducing the number of lamps required. Common configurations of UV lamps include lamps configured horizontal to the flow; lamps configured vertical to the flow or; lamps configured inclined to the flow. Typically, under this scenario, if there are two or more manufacturers that meet the design criteria for a project, the construction bid package will include a specification that either manufacturer can comply with. UV systems are "more proprietary" than many other equipment systems, therefore procurement methods for these must be carefully considered. In general, there are three approaches to specifying such a product as discussed in Section 3.12.6.

3.12.5 Recommendations

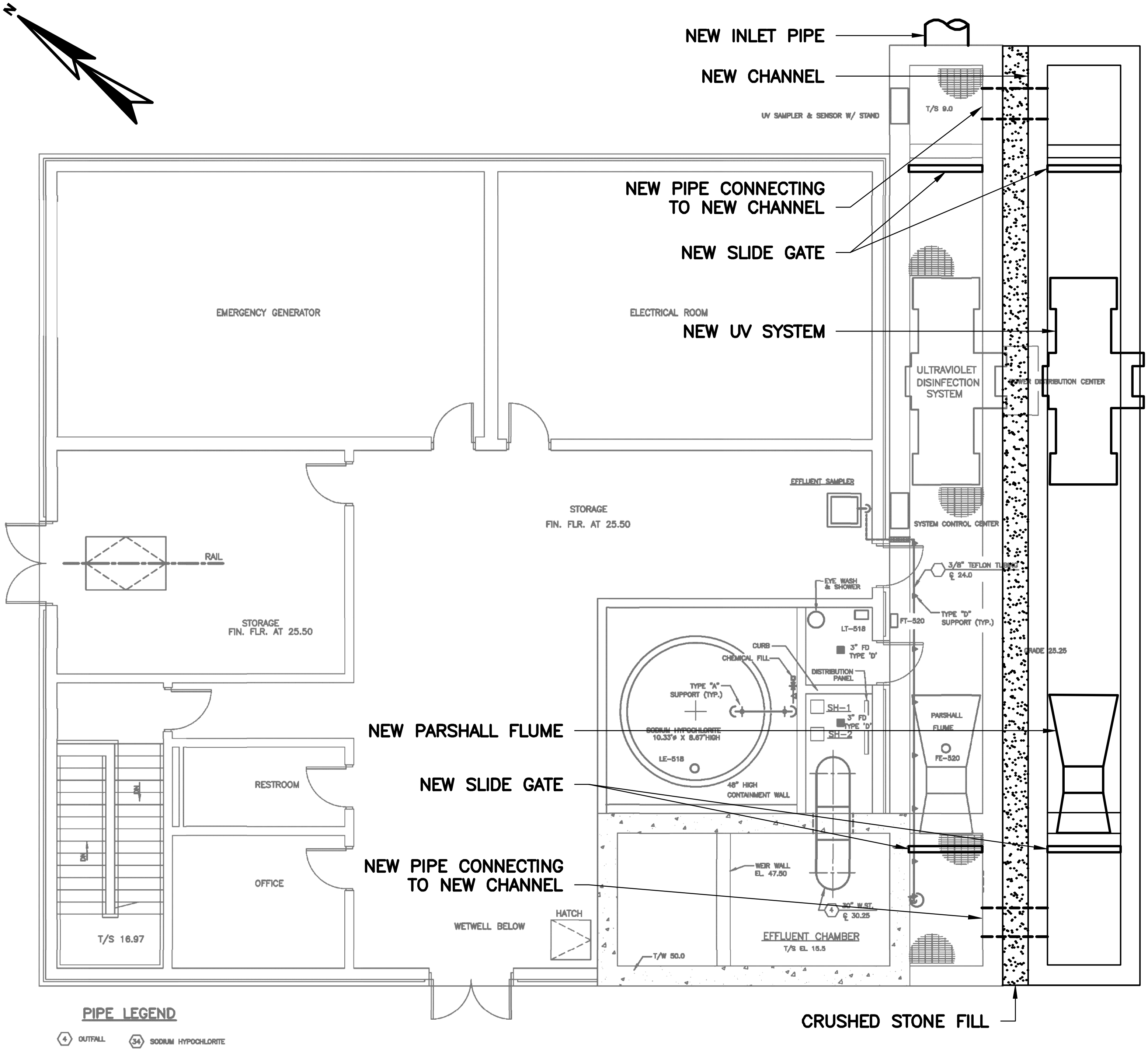
Based on the items noted above, it is recommended to construct a new second channel to install a new UV system, with a new parshall flume and isolation gates; and to modify the existing channel to retrofit it with a new UV system such that each channel will be designed to handle a peak hourly flow rate of 35 MGD with one channel offline. Replacement of the existing UV system is verified by the energy evaluation in Section 7. The two channels will include a separate backup electrical supply and will offer the redundancy as required by the TR-16 guidelines with only one channel being on-line at any given time. The WPCF should consider a pre-selection process of the UV system during the final design phase. Capital costs for the UV system have been obtained from both Trojan Technologies and Infilco Degremont Inc. and listed in **Table 3-17** below:

TABLE 3-17
UV DISINFECTION SYSTEM
CAPITAL COSTS

Manufacturer	Lamp Configuration	Cost
Trojan Technologies	Inclined	$1,417,600
Infilco Degremont Inc. (Ozonia Systems)	Vertical	$1,300,000

3.12.6 Procurement Options

- Designing two systems: Channel size requirements and the amount of headloss through each system are sufficiently different so that writing one specification to cover both types of lamp configurations could necessitate redesigning portions of the system after the project has been bid, unless two systems are designed. This approach would offer the most competitive bidding situation; however, this approach would result in additional engineering effort.
- Selecting a horizontal or vertical configuration and designing around that type of system: While this approach eliminates many of the design issues discussed above, it does make the WPCF vulnerable to a manufacturer knowing his equipment will be installed and therefore not providing his best price. Additionally, a bidder may be put in a situation where a manufacturer "packages" his equipment, possibly resulting in higher equipment costs for other pieces of equipment as well.
- Pre-Select (Evaluated Bid): This provides the WPCF with the opportunity to have greater control in the selection of the UV system which will be installed early in the design phase, reducing the chance for costly redesigns. Cost can be considered as part of the pre-selection process, eliminating the items noted above. Additionally, while a traditional bid review considers just capital costs, a pre-selection process allows for an analysis of operations and maintenance costs as well.



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FACILITIES PLAN REPORT

PROJ NO: 13090A

DATE: JANUARY 2017

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RETURN SLUDGE BUILDING - FIRST FLOOR PLAN
NEW UV CHANNEL

FIGURE: 3-13

3.13 EFFLUENT PUMPS

The final treated effluent from the Fairfield WPCF is usually discharged by gravity into the Long Island Sound during low flow conditions and when the water surface elevation in the Long Island Sound is lower than the water elevation in the WPCF effluent wet well. During periods of elevated water level conditions in the Long Island Sound, pumping of effluent is necessary to avoid hydraulic issues and backflow of ocean water into the WPCF.

Flow under gravity conditions occurs with treated final effluent from the ultraviolet disinfection system passing through the parshall flume into the effluent wet well through a 36” flap gate and into a 48” ductile-iron outfall pipe, 4,300 feet long to Long Island Sound. However, during elevated water level conditions in the Long Island Sound, the ocean water creates head to shut down the flap gate valve. Under this condition, treated effluent is pumped into the effluent chamber located at a higher elevation which provides the adequate head needed for the final effluent to flow through the outfall pipe to Long Island Sound.

Outfall Pumps

Four non-clog; horizontal centrifugal pumps (OP - 1, 2, 3 &4) located in the basement of the Return Sludge Building are used to pump the final treated effluent under elevated water conditions. The pumps used are non-clog centrifugal with OP-1 & 2 having a design capacity of 5,550 gpm and OP-3 & 4 having a design capacity of 8,330 gpm and all pumps having a total dynamic head ranging between 13 to 44 feet respectively. All the pumps are equipped with variable frequency drives that have a selector switch for automatic or manual operation.

3.13.1 Performance Evaluation

The four pumps are split into two pairs; the two smaller pumps OP-1 and OP-2 are the first pair and the two larger pumps OP-3 and OP-4 are the second pair. The pumps are ideally designed to be turned down enough to handle low flow rate conditions and peak conditions with one pump offline. Each pair of pumps operates on an exclusive lead/lag basis and operates in response to liquid level sensed in the effluent wet well through the use of a bubbler system. The effluent wet well is also equipped with a pressure transducer and transmitter that are used to control the pump in lieu of the bubbler system, if selected by the operator or if there is a bubbler system malfunction. Additionally, the effluent chamber is equipped with an ultrasonic level sensor that is used to limit the maximum pump speeds for all operating pumps based on the static head against which the pumps are pumping and a float switch located in the effluent wet well is used to monitor the effluent wet well and send an alarm in the event that a high water condition occurs.

3.13.2 Operational and Maintenance Issues

The plant staff has not reported any operation and control issues with the existing pumps. However, the pumps are approaching their useful service life and are in need of replacement. They are also undersized to handle the full range of future projected flows. In addition, the existing pumps and drives are older and can be less energy efficient than currently available technology.

3.13.3 Control Issues

The Fairfield facility due to its proximity to the Long Island Sound was isolated by flooding during Hurricane Sandy (October 2012), but no buildings were inundated. The outfall pumps were not running at full capacity to pump the high flows, and since then the settings were changed to have all four running in high flow and flooding conditions.

3.13.4 Recommendations

As indicated, the outfall pumps are approaching the end of their anticipated useable lifespan and are under sized to handle the future flows of 35.24 MGD. The upgrade would include replacement of the existing pumps with new, higher capacity pumps including VFDs and the use of high efficiency motors to improve the energy efficiency of the overall system. This is also verifed by the enegy evaluation in Section 7. Each of the four new pumps will be rated to handle 8,100 gpm. Under peak flow conditions, three of the four pumps will be capable to pump the 35.24 MGD flow with one pump as a back-up.

3.14 PLANT WATER SYSTEM

Plant effluent is recycled from the effluent wet well located in the south end of the basement of the Return Sludge Building for use in general clean up and treatment process area requirements. The plant water pumping system supplies effluent water to the following locations:

- Compactors and Grit equipment in the Influent Building;
- Final Settling Tank feed well spray water;
- Gravity Belt Thickener and Belt Filter Press in the Dewatering Building;
- Biofilter System;
- Gravity Thickener;
- Septage Screening Equipment; &
- Various hydrants and hose bibs

The system utilizes a factory assembled PACOFLO 9000 skid configuration system that includes three booster pumps with Pump-1 having a rated capacity of 40-90 GPM and Pumps 2-3 having a rated capacity of 180-287 GPM. All three pumps have a designed operating pressure range of 66 to 85 psi. A 790 gallon hydro-pneumatic tank is used to maintain the operating pressure between 65 – 85 psig in the piping system when flow demand varies. The skid system is also provided with flow sensors, control valves, pressure gauges and a manufacturer supplied control panel.

Plant Water System

The control panel is located in the basement of the Return Sludge Building. The panel has a HOA switch that allows the plant staff to operate in manual and auto mode. However, due the different pumping capacities of the pumps, plant staff has issues with operating the plant water system to meet the demands of the WPCF. Therefore, this system is operated in manual mode at all times. The skid system was originally set up to allow the three pumps to operate in parallel mode. When Pump-1 demand exceeds the system needs, Pumps 2 & 3 will start to operate. A pressure discharge system located at the pump discharge maintains a constant supply in the effluent water system at 60 to 80 psig through the variable demand range of 0 to 600 gpm. Under very low demand, the hydro pneumatic tank is used to supply water. The pump controls are connected to the WPCF's SCADA system and transmits signals for failure indications for each of the three pumps, or in the event that either a low suction pressure, low discharge pressure, or a plant water system alarm condition occurs.

3.14.1 Performance Evaluation

The plant staff has encountered several issues with this system and would like to replace it with a new system. It appears that the existing system is for drinking water use. TR-16 guidelines require that a water spray system be provided for froth and foam control. The skid systems provided will satisfy this requirement.

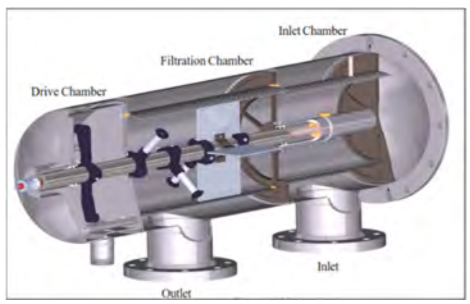
3.14.2 Operational and Maintenance & Control Issues

The plant water system was installed in the 2000 upgrade and plant staff had indicated concerns on the operational efficiency of the system. The existing system does not include a variable frequency drive which requires the plant staff to operate the system in manual mode at all times. Due to the varying pump capacities the plant staff has difficulties to adjust the plant water system in order to meet the demands of the WPCF. Additionally, a basket strainer installed on the suction-end pipe has a strainer that is sized too small and clogs frequently. This suction pipe does not include a bypass which requires the plant staff to shut down the entire plant water system when cleaning of the basket strainer is required.

3.14.3 Process Alternatives Evaluation

Due to the operational issues encountered by the plant staff, and the age of the system, it is recommended to replace the existing system with new centrifugal pumps on variable frequency drives. Use of VFD's on the pumps could allow for some power savings and should be evaluated during the detailed design phase based on future anticipated effluent flushing water demands. The suction piping to the pump system will be modified to include bypass piping and valves that will allow the operators to run the plant water system continuously during maintenance of the basket strainer.

3.14.4 Recommendations



The existing plant water skid system will be replaced with three new stand-alone pumps and custom controls having the same rated capacities and operated with variable frequency drives. The existing basket strainer will be replaced with a larger, mechanically cleaned sieve size strainer and a bypass this will allow the plant water system to operate continuously when maintenance is being performed on the strainer. The hydro-pneumatic tank can either be left in place or replaced with a small diaphragm tank.

SECTION 4

CAPACITY ANALYSIS AND EVALUATION OF ALTERNATIVES FOR NITROGEN REMOVAL

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SECTION 4

CAPACITY ANALYSIS AND EVALUATION OF ALTERNATIVES FOR NITROGEN REMOVAL

4.1 INTRODUCTION

This section summarizes the results of process modeling for: 1) establishing the capacity of the plant for projected flows and loads presented in Section 2, and 2) evaluating potential alternatives to optimize the nitrogen removal capabilities of the Fairfield WPCF. Specifically, the following issues should be addressed to improve the nitrogen removal capabilities:

- Reduce methanol consumption – As previously stated, ongoing methanol consumption allows the Fairfield WWTP to achieve low level nitrogen removal. However, methods should be considered to reduce the facility's chemical consumption while still maintaining current effluent nitrogen concentrations.
- Improved flow balancing – The Fairfield WWTP suffers from several flow balancing issues, both prior to and internal to the activated sludge process, this results in additional energy (aeration) and chemical (methanol) consumption.
- Improved process control – The activated sludge process could be enhanced to allow for plant staff to optimize control of the activated sludge process resulting in improved performance including dissolved oxygen control.

As discussed in Section 1, compliance with the *General Permit for Nitrogen Discharges* can currently be achieved either by meeting the annual total nitrogen limit by upgrading the WPCF or through the purchase of equivalent nitrogen credits through the Nitrogen Credit Exchange Program established by the State of Connecticut. The alternatives presented herein achieve compliance with the *General Permit* through removal of nitrogen (as currently being achieved).

4.2 PROCESS MODELING - EXISTING CONDITIONS

Modeling of plant processes was developed using BioWIN® Version 4.1. The model was calibrated using available WPCF operating data supplemented with additional wastewater characterization data. For the purpose of process alternatives analysis, a steady-state model is developed and calibrated to an extended period (typically for a duration of several solids residence times) to simulate sustained process performance. Once the model has been calibrated and validated using available data, it can be used to simulate the existing process under current and future design flows and loadings, as well as process alternatives under design conditions for nutrient removal.

4.2.1 Supplemental Sampling

Supplemental sampling was conducted during the winter of 2016 from the period of February 17, 2016 to March 7, 2016 to characterize the plant influent and performance as summarized in **Table 4-1**. The supplemental characteristics (COD fractions and nutrients) were sampled 3 times a week during this period from primary influent (which includes septage and solids handling recycle streams), primary effluent, and final effluent. Plant recycle flows including digester overflow, gravity belt thickener filtrate, and belt filter press filtrate, were sampled individually in order to estimate internal plant nitrogen recycle streams. In addition, methanol usage during the period was recorded and obtained for model calibration (recorded as methanol delivery logs). Raw influent data from the period that is part of routine plant data collection are also summarized in **Table 4-1** for comparison.

From the supplemental data the following was observed:

- TSS removal across the primary clarifiers exceeded 55-60 percent, indicating typical primary clarification performance.
- Volatile Fatty Acids (VFAs) concentrations, which are used by denitrifying bacteria in the anoxic zones of the aeration tanks, stayed constant across the primary clarifiers, suggesting little biological activity in the clarifiers.
- Addition of supplemental carbon averaging approximately 150 gallons of methanol addition per day) was required to reduce total nitrogen to <4 mg/L during the sampling period.
- Belt filter press filtrate was the primary nitrogen recycle stream, containing NH_3 concentrations from 400 to 700 mg/L, and TKN concentrations from 410 to 800 mg/L. Assuming filtrate and washwater flows of 90,000 gpd (8 hours a day) and average TKN concentrations of 600 mg/L,

this results in a daily filtrate recycle loading of roughly 150 lb/d TKN, which is less than 10% of the raw influent TKN loading (as a daily average).

- It should be noted that there is some uncertainty with respect to the volume of recycled wastewater. For WPCF's with anaerobic digestion the recycled nitrogen load would typically be greater than 10%, potentially up to 20%.
- High raw influent nitrate levels (2.1 mg/L), possibly indicating recycle loads from internal sources (i.e., biofilter) or industrial contributions.
- cBOD5 to BOD5 ratio was found to be 0.91 (typical for most wastewaters). This is used to convert measured BOD5 loadings to CBOD5 loadings in the model.
- Monovalent to divalent cation ratio in the mixed liquor suspended solids (MLSS) was found to be 2.0, which indicates little interference from saltwater to plant processes.

TABLE 4-1
SUPPLEMENTAL WASTEWATER CHARACTERISTICS

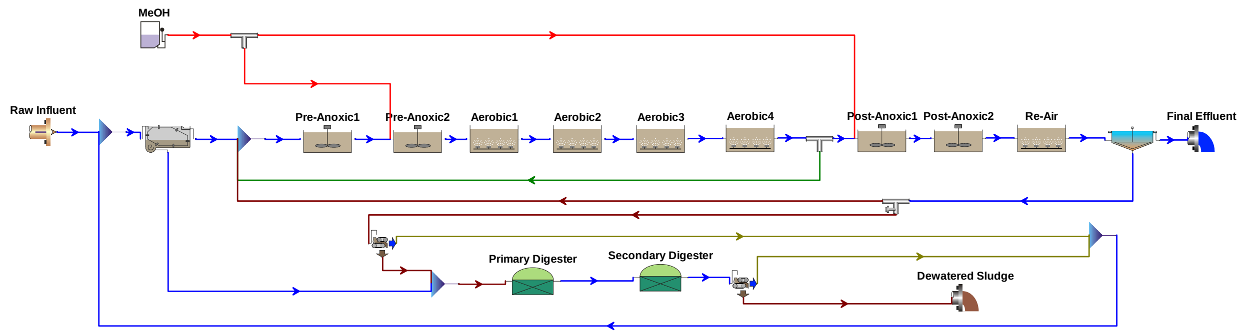
ANALYTE	Average Flow and Concentrations					
	Raw Influent	Primary Effluent	Final Effluent	GBT Filtrate	BFP Filtrate	Digester Supernatant
Min Flow (mgd)	6.2					
Max Flow (mgd)	12.9					
Avg Flow (mgd)	10.1			Non-measurable		
Temp (F)	49.6					
CBOD5 (mg/L)	104	74				
BOD5 (mg/L)	114	86	4	53	47	695
SC-BOD5 (mg/L)	30	25				
COD (mg/L)	234	182				
sCOD (mg/L)	85	78				
ffCOD (mg/L)	47	37				
Nitrite (mg/L)	0	0				
Nitrate (mg/L)	2.1	1.3	1.2			
Alkalinity (mg/L as CaCO3)		101				
Ammonia (mg/L)	13	16		0.6	540	630
TP (mg/L)	2.2	2.5		2.4	101	300
Ortho-P (mg/L)	1.5	2.0		1.9	102	163
TSS (mg/L)	130	61		40	233	14,000
TKN (mg/L)	20	21		4.8	607	1,003
VSS (mg/L)	41	34				

4.2.2 Model Calibration and Verification

The flow schematic of the model is shown in **Figure 4-1**. Note the number of primary clarifiers, aeration tanks, and secondary clarifiers were consolidated into one representative unit each for simplicity.

FIGURE 4-1

BIOWIN MODEL PROCESS FLOW DIAGRAM



The model was calibrated for the supplemental monitoring period of March 2016. The key calibration criterion was to verify that the model accurately simulated (within 10%) the MLSS concentration and the amount of waste activated sludge (WAS) produced by using a combination of BioWin default and adjusted stoichiometric coefficients. MLSS concentrations, waste activated sludge flow volumes, and WAS concentrations are measured and recorded daily. The results of model calibration are shown in **Table 4-2.**

TABLE 4-2

MODEL CALIBRATION AND VALIDATION RESULTS

	Plant Data	Calibration Results	Plant Data	Verification
	Feb-Mar 2016		Jun-15	
Raw Influent				
Flow rate, mgd	10.0	10.0	8.3	8.3
cBOD5, mg/L	101	101	149	149
TSS, mg/L	134	134	231	212
VSS, mg/L	115	115		190
TKN, mg/L	20	20		30
NH3, mg/L	13	13		22
NOx, mg/L	2.1	1.3		0.0
P, mg/L	2.1	2.1		3.0
Ortho P, mg/L	1.0	1.0		2.1
DO, mg/l	0	0		0
Alkalinity, mg/l	100.0	175.0	100.0	175.0
pH	6.8	6.8	6.9	6.8
Temp, C	11	11	17.8	17.8
Primary Clarifiers				
Primary effl. BOD, mg/l	**86**	66	**100**	95
Percent BOD Removal	15%	35%	33%	37%
Primary effl. TSS, mg/l	**61**	78	**83**	125
Percent TSS Removal	54%	43%	64%	42%
VSS, mg/L		66		111
TKN, mg/L	**20.0**	20.0		33.0
NH3, mg/L	**16.0**	14.9		24.0
NOx, mg/l	1.3	1.3		1.0
P, mg/L	2.5	2.2		2.0
Ortho P, mg/l	2.0	1.8		
P.C. Sludge, gpd	16,800	18,000		18,000
P.C. Sludge Conc, mg/l	31,000	30,837		39,116
P.C. Sludge, lb/day	**4,353**	**4,629**	**5,500**	**5,872**
Aeration Tanks				
No. of Zone A Tanks	2	2	2	2
No. of Zone B Tanks	3	3	3	3
SRT, Oxic Zone	11.83	12.44	10.12	9.66
MLVSS, Oxic Zone, mg/L		1,876		1,689
Internal Recycle, MG	12	12	12	12
MLSS, OxicZone, mg/L	**2,400**	2,541	**2,560**	**2,539**
Unaerated Tank Percentage, %	33%	33%	33%	33%
HRT(total), hr	9.0	8.9	10.8	10.8
SRT (total), day	18.2	19.2	15.6	14.9

	Plant Data	Calibration Results	Plant Data	Verification
	Feb-Mar 2016		Jun-15	
Chemical Addition				
Supplemental Carbon, gpd MeOH	150	200	200	200
Secondary Clarifier				
RAS, mgd	8.40	8.50	4.94	4.96
WAS, gpd	68,000	90,000	85,000	85,000
RAS TSS, mg/L	5,533	5,565	6,400	6,761
WAS TSS, mg/L	5,533	5,565	6,400	6,761
WAS TSS, lb/d	**3,400**	**3,423**	**4,237**	**4,407**
Final Effluent				
Effluent pH	6.60	7.00	6.80	6.90
Effluent CBOD5, mg/L	4	5	3	5
Effluent TKN, mg/L	2.0	2.3	2.2	2.3
Effluent NH3, mg/L	1.3	1.0	0.7	0.5
Effluent NOx, mg/L	1.2	2.8	2.0	6.9
Effluent TN, mg/L	3.2	5.1	4.2	9.2
Effluent TSS, mg/L	5	9	3	11
Effluent TN, lb/d	266	429	623	1366
Effluent TP, mg/l	1.5	1.4		1.8
Total Sludge Dewatered, lbs/day	**7,753**	**8,052**	**9,737**	**10,279**

The calibrated model was then validated by running the model with influent flows and loads recorded from June 2015. Results of the model validation runs are also shown in **Table 4-2.**

4.2.3 Model Development Conclusions

As shown in **Table 4-2**, the calibrated model simulated the observed biological yield by replicating both MLSS and WAS accurately (within 10%) for the calibration and validation periods.

Calibration of the model to simulate observed nitrogen removal met with limited success. The model correctly predicted complete nitrification, however under-predicted the degree of denitrification observed with the approximate supplemental carbon addition estimated from delivery logs. The under-prediction in nitrogen removal is attributed to uncertainty in the approximations of actual carbon usage, diurnal variations in nitrogen loading due to recycle streams, as well as the significant sensitivity of the process to dissolved oxygen levels provided by the aeration system (which is currently poorly controlled). Potentially, some level of denitrification is occurring in the end of the aerobic zones during periods of low DO levels.

MLSS concentrations of approximately 2,500 mg/L yielded an aerobic SRT during the modeling and calibration period ranging from 9 to 12 days.

The calibrated process model was developed from historical data and supplemental sampling. The model included solids handling unit processes in order to account for the impact of recycle loadings. The calibrated model simulated treatment of solids, organics, and the observed biological yield of the system during calibration and validation periods accurately.

4.3 NITROGEN REMOVAL ALTERNATIVES

The Fairfield WPCF consistently complies with nitrogen removal outlined in the General Permit of Nitrogen Discharges. Therefore, the process model was utilized to analyze alternatives to improve nitrogen removal efficiency (as well as capacity for future growth) by reducing supplemental carbon in the form of methanol required, including:

- Expanding the pre-anoxic zone and configure tanks for three train operation
- Equalization of solids processing flows and corresponding nitrogen loading

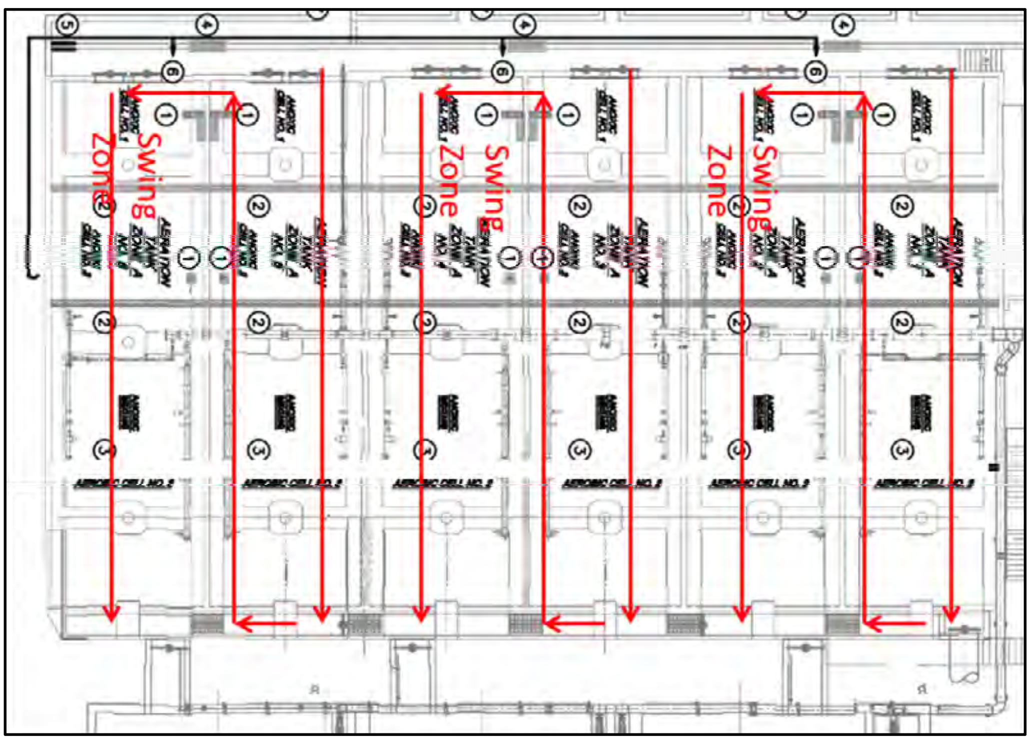
4.3.1 Three Train Operation

The existing activated sludge process consists of six individual aeration tanks followed by three larger and newer aeration tanks. Influent flow (from the primary clarifiers), internal recycle and return activated sludge are combined, flow down a channel and then divided (albeit not very equally) between the initial six aeration tanks. Effluent from the six aeration tanks is partially combined and then divided among three aeration tanks. The poor initial flow split is further exacerbated as wastewater is divided amongst the three final aeration tanks. Unequal flow split can result in poor aeration control (due to unbalanced oxygen demand), increase methanol consumption and a reduction in the facilities overall capacity.

To address this issue, it is recommended that the existing six initial aeration tanks be reconfigured to three aeration tanks (essentially three trains of two aeration tanks in series versus six aeration tanks in parallel). Once wastewater is equally split to the first three tanks, the downstream flow split issue is inherently addressed (due to the existing channel gates that allow for either a common channel or three separate influent channels). As shown in **Figure 4-2 and 4-3**, influent wastewater would be introduced to only three of the initial six tanks. An internal pipe would convey flow from the original effluent of one tank back to the front of the adjacent aeration tank. This configuration change also affords the plant the ability to increase the pre-anoxic zone volume which is one of the performance limiting factors at the Fairfield facility.

FIGURE 4-2

AERATION TANKS – THREE TRAIN OPERATION



1. REPLACE SUBMERSIBLE MIXERS WITH LARGE BUBBLE MIXERS
2. LOWER WEIR AND INFILL PORTS
3. ADD FLOW CONTROL DEVICE
4. NEW INTERNAL PIPE
5. EXTEND CHANNEL WALL
6. ADD TOP MOUNTED MIXER
7. STRUCTURAL MODIFICATIONS REQUIRED
8. REDUCE SUBMERGED PORT SIZE TO ENCOURAGE BAFFLE OVERFLOW HYDRAULICS
9. POTENTIALLY REPLACE FLOATING MIXERS
10. SURFACE BAFFLE SCUM PUMP STATION TO DIGESTER
11. REPLACE ANOXIC MIXERS WITH LARGE BUBBLE MIXERS

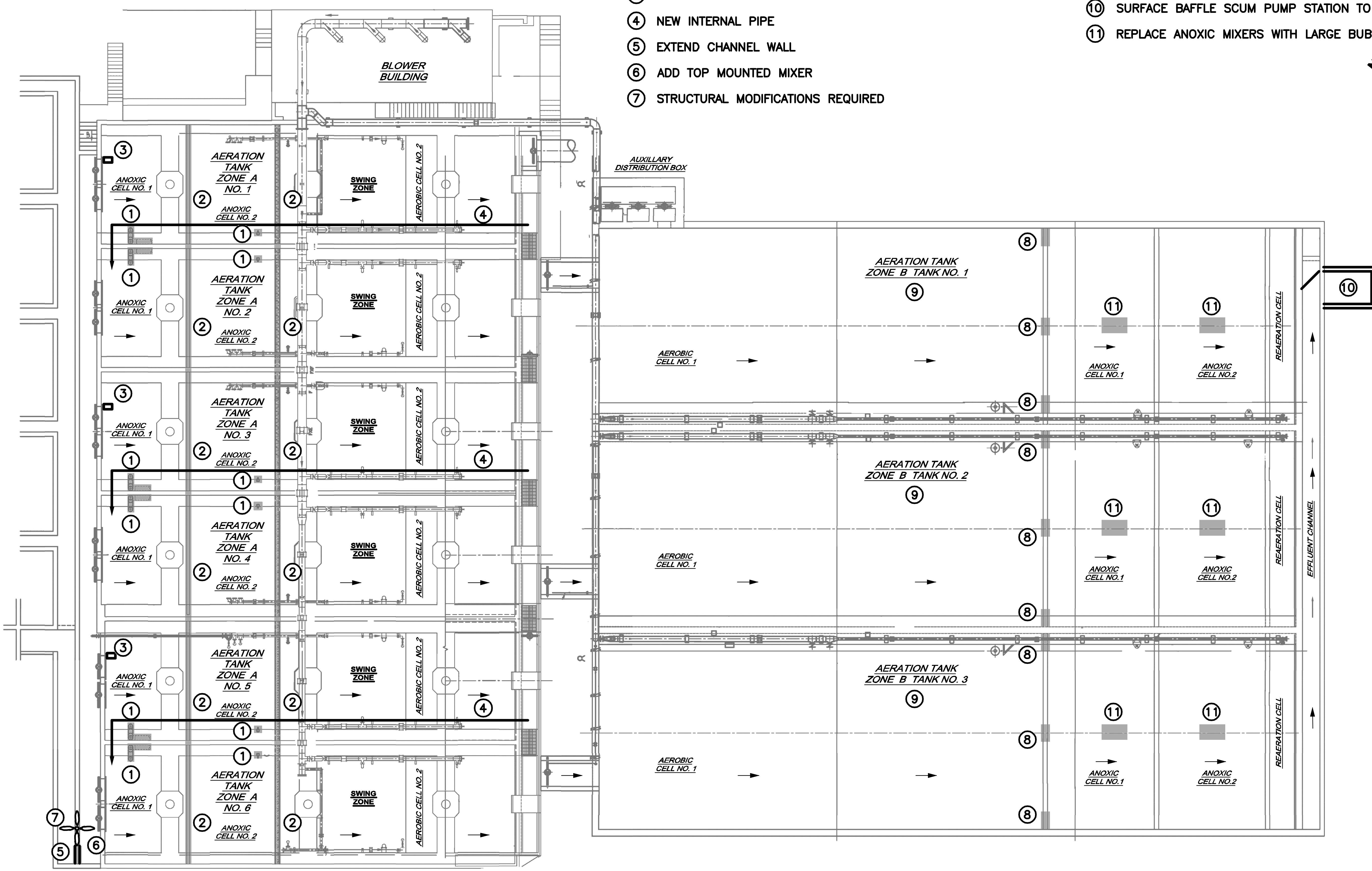


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FIGURE: 4-3

AERATION TANK IMPROVEMENTS

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4.3.2 Expanding Pre-Anoxic Zones

The process model was used to simulate the impact of the three train process configuration and effectiveness of increasing the volume of the pre-anoxic zones. This would be accomplished through installation of mixers within Zone A (i.e., future swing zones that could be operated either in anoxic conditions or aerobic conditions). During annual average conditions, the zone could be made anoxic to increase nitrogen removal. ***The results show that expanding the pre-anoxic zone volume could potentially reduce methanol usage by 45% to achieve the same degree of denitrification.***

Enhancing the denitrification performance of the activated sludge process will also provide the following benefits:

- **Reduced Aeration Requirements:** The results show that expanding the pre-anoxic zone volume and achieving improved exogenous denitrification could potentially reduce the downstream oxygen requirements by 5% to achieve the same degree of denitrification.

- **Reduced Sludge Production:** The results show that by improving the denitrification performance and subsequently reducing the methanol consumption the wastewater activated sludge production would be reduced by 10%.

4.3.3 Internal Recycle Streams

Solids generated in the liquid treatment processes are conveyed to the solids handling facilities for further processing. The processing of these solids (namely thickening and digestion) generates a concentrated liquid wastewater stream. These streams are then sent back to the activated sludge process increasing the organic and nutrient load that must be treated.

The anaerobic digestion process, compost facility and solids handling biofilter will contribute a significant amount of ammonia (approx. 10 to 20% of the total ammonia that is treated by the activated sludge process). The ammonia is a by-product of the biological processes occurring in each of these systems. The recycled ammonia will need to be subsequently treated in the activated sludge process. This will result in an increase in the amount of methanol and oxygen consumed by the activated sludge process.

Due to the current operation of the anaerobic digestion facility, a sizable portion of the recycled ammonia occurs during dewatering operations. The dewatering of anaerobically digested sludge results in a concentrated stream of nitrogen (i.e., ammonia) recycling back to the plant for approximately 7 to 8 hours a day, 6 days a week. The amount and timing of ammonia recycled from the biofilter facilities is dependent on the amount of rain that percolates through the biofilter, while the recycled ammonia from the compost facility is somewhat uniform. In summary, the amount of recycled ammonia varies throughout the day resulting in periods of sharp increases or decreases in ammonia loading to the activated sludge process.

To evaluate potential alternatives to address the impacts of the recycled nitrogen, the following scenarios were evaluated, assuming the recycled nitrogen was approximately equal to 10% of the influent total, nitrogen load:

- **Elimination of the nitrogen Recycle:** This hypothetical analysis assumes that the recycle load would not require treatment and thus would represent the maximum benefit achievable with respect to lower operational costs.

  Process modeling indicated that eliminating the solids handling recycle would eliminate approximately 130 gpd of methanol usage, 700 lbs/day of oxygen and reduce the total sludge production by 250 lbs/day. Ultimately, handling solids handling recycle flows result in an additional $80,000/year in operating costs (methanol and energy consumption).

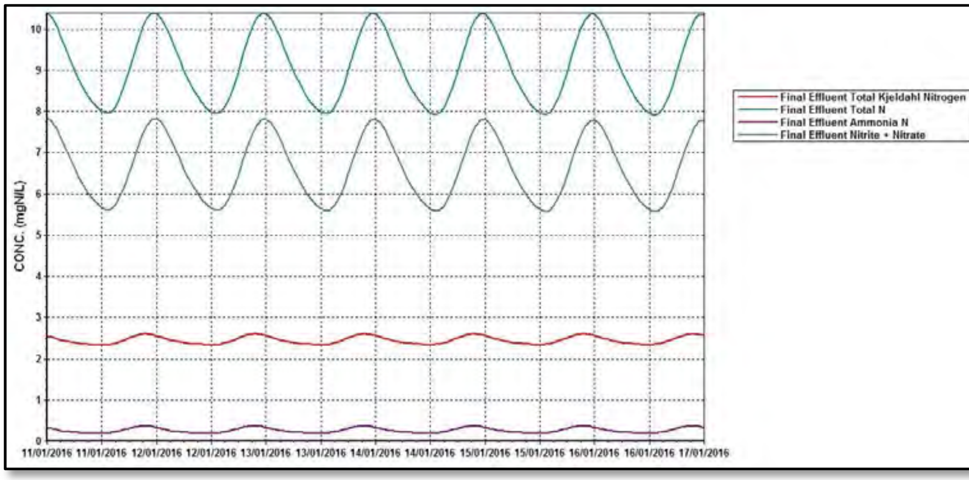
- **Equalization of the nitrogen Recycle:** The nitrogen load from the solids handling process is not recycled back equally throughout the day. The slug loading of nitrogen can have a negative impact on the facilities nitrogen removal performance.

  In order to evaluate the effects of this on plant performance, a simplified dynamic simulation of plant performance was developed under design annual average conditions.

A methanol addition of 200 gpd remained constant throughout the simulation. As presented in **Figure 4-4**, results indicate that un-equalized recycle loads produce swings in effluent total nitrogen, approximately 2 mg/l.

FIGURE 4-4

DYNAMIC PLANT SIMULATION



Equalization of this flow will reduce the propensity of increased effluent nitrogen concentrations. However, we believe that through modifications to the activated sludge configuration (3 trains, improved dissolved oxygen control, improved internal recycle control, methanol dosage control and online nutrient analyzers) the activated sludge system should be able to adjust to the changing influent condition during dewatering operations.

4.4 DESIGN CAPACITY ANALYSIS

The calibrated model was used to evaluate the activated sludge system in a three train configuration. 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 for the design flows and loads as presented in Section 2, assuming a total recycled nitrogen load of approximately 10% of the total influent nitrogen load. Results are shown in **Table 4-3.**

TABLE 4-3

MODEL RESULTS FOR DESIGN YEAR FLOWS AND LOADS

	2045 Design Annual Average	2044 Design Maximum Month
Raw Influent		
Flow rate, mgd	9.12	16.61
Peak Day Flow Rate, mgd	26.7	26.7
Ortho P, lbs/day	222	239
Primary Clarifiers, No CEPT		
Primary effl. BOD, mg/l	94	64
Primary effl. TSS, mg/l	99	79
Primary effl. TKN, mg/l	29	29
P.C. Sludge, lb/day	**5,662**	**8,600**
Aeration Tanks		
Aeration Tank Volume, mgal	3.86	3.86
Post - Anoxic Volume, mgal	1.15	0.8
Aerobic Volume, mgal	1.91	2.25
Post - Anoxic Volume, mgal	0.8	0.8
SRT, Oxic Zone	11	12
Internal Recycle, MG	20	12
MLSS, Oxic Zone, mg/L	**2,800**	**2,820**
Actual Oxygen Required, lbs/day	***14,208***	***20,880***
Chemical Addition		
Supplemental Carbon, gpd	160	75
Secondary Clarifier		
RAS, mgd	4.56	8.4
WAS, gpd	58,000	63,000
WAS TSS, lb/d	**4,074**	**4,432**
Final Effluent		
Effluent TKN, mg/L	2.5	3.0
Effluent NH3, mg/L	1.0	1.0
Effluent NOx, mg/L	3.0	9
Effluent TN, mg/L	5.5	12
Effluent TN, lb/d	418	1,698
Total Sludge to Digester, lbs/day	**9,736**	**12,580**

Major conclusions from the process modeling:

- The 5-stage Bardenpho process has sufficient capacity to treat the future flows and loads as defined in Table 2-7, without the need for additional aeration tank volume or secondary clarification capacity. It should be noted that the Fairfield wastewater is relatively dilute, presumably due to inflow and infiltration (I&I) impacts. Additional wastewater capacity could be acquired through a reduction in the collection system's I&I.
- The existing activated sludge process can achieve compliance with the Nitrogen General Permit via treatment. This will require the continued use of a supplemental carbon source.
- A sensitivity analysis was conducted to determine the resulting process impacts in the event the recycled nitrogen load was equal to 20% of the influent load. The additional recycled ammonia will not impact the maximum month MLSS value, and thus the treatment capacity of the activated sludge process. However, the increased nitrogen recycle will result in an elevated aeration demand (approx. 16%) and either an elevated supplemental carbon demand (average conditions) or an elevated effluent total nitrogen level (maximum month conditions).
- Total nitrogen removal will be compromised during the future maximum month condition.
- The three-train process configuration will enhance the efficiency of the nutrient removal process by reducing the amount of supplemental carbon required (to achieve the same level of nitrogen reduction). Alternatively, the WPCF could retain the initial six aeration tanks in parallel and increase the anoxic zone in each tank to achieve the desired nutrient removal improvements.
- The existing activated sludge process can successfully treat the recycled nitrogen from the anaerobic digestion process and composting facility (assuming an upgrade dissolved oxygen control system and automatic dosage control of the supplemental carbon). Treatment of the recycled stream, before it enters the activated sludge process, could be explored further during the preliminary design.
- Total WAS loadings to the gravity thickener are simulated at 4,432 lb/d during maximum month conditions. This corresponds to 76,000 gallons per day at 0.7% total solids.
- Total primary sludge loadings to the digester is simulated at 5,400 lb/d during maximum month conditions. This corresponds to 18,000 gallons per day at 3.7% total solids.

- Total solids loading to the dewatering belt filter press is simulated at 5,800 lb/d during maximum month conditions. This corresponds to 52,000 gallons per day at 2% total solids.
- The maximum month MLSS required for complete nitrification is 2,800 mg/L This value is slightly greater (less than 2% difference) than the value used in the State Point Analysis, which uses solids flux as a basis for evaluating the clarifiers and return sludge pumping.

4.4.1 Summary of Nitrogen Removal Alternatives and Plant Operational Improvements Recommendations

In summary, the following improvements are recommended for the optimization of the activated sludge process. Recommendations identified in both section 3 and 4 are presented here:

- *Modify the Activated Sludge Process to a three train configuration:* This is achieved by installing an internal pipe in the Zone A tanks and combining the operation of adjacent tanks as presented in **Figure 4-8**.
- *Increase the pre-anoxic volume:* The installation of a mixing system in the back-half of each of the Zone A tanks will increase the pre-anoxic zone volume. This will reduce the amount of supplemental carbon required to achieve compliance with the Nitrogen General Permit. An annual chemical cost savings of $60,000 is estimated from this process change.
- *Optimize Influent Flow Balancing:* It is recommended that a new flow balancing system be installed to positively control the influent to each activated sludge train. Options include a new splitter box, separate feed piping or flow control devices on each influent gate.
- *Optimize aeration control:* The ability to control the dissolved oxygen concentration is each zone of the activated sludge system is paramount for efficient nitrogen removal. The existing system needs to be reconfigured to include positive aeration flow control (valves and flow meters) to match the airflow rate applied to each zone with the corresponding oxygen demand. Furthermore, it is recommended that the Fairfield facility upgrade to an ammonia based DO control system. An additional 10% in air/energy savings can typically be achieved with an ammonia control system.
- *Increasing RAS pump capacity to allow for better wet weather flow performance.* See Section 3.

- *Modifications to anoxic baffle walls and installing scum removal at Zone B tanks.* See Section 3.
- *Replace submersible mixers with large-bubble anoxic mixing*. See Section 3.

SECTION 5

EVALUATION OF SOLIDS HANDLING SYSTEMS AND OPERATIONS

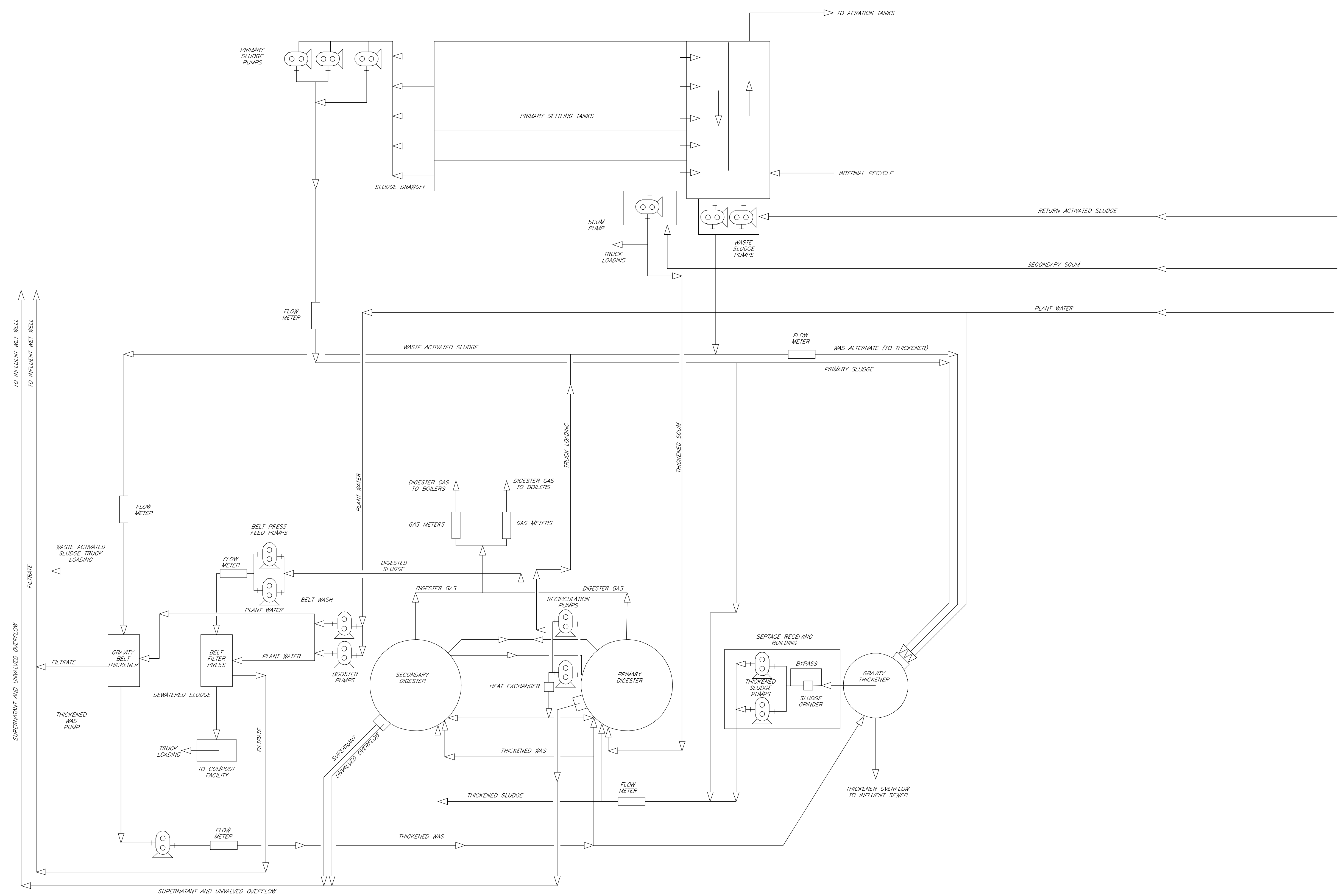
SECTION 5

EVALUATION OF SOLIDS HANDLING SYSTEMS AND OPERATIONS

5.1 INTRODUCTION

The solids handling facilities at the Fairfield WPCF process primary and secondary treatment sludges. A process flow schematic is shown in **Figure 5-1**. Primary sludge is thickened in the primary clarifiers and then pumped directly to the primary anaerobic digester. Waste activated sludge (WAS) is thickened using a gravity belt thickener and stored in a converted gravity thickener prior to being transferred to the primary digester. Anaerobically digested sludge is dewatered by a belt filter press and the cake is transported to the composting facility. The compost is hauled offsite and managed for beneficial use.

Table 5-1 presents current and design solids production rates. Current average and maximum month sludge production is taken from plant operating data from 2013 to 2015. Average design sludge production was simulated by modeling using projected design flows and loadings presented in Section 2. Maximum month design solids production is calculated using peaking factors from current maximum month sludge production. Digested solids assumed a 50% removal of total solids in the digester as a conservative assumption, although current values have seen greater removal (60% TS).



SLUDGE PROCESS FLOW DIAGRAM
SCALE: NTS

NO.	REVISIONS	DRAWN BY	APP'D
1		SMC	DAD
2			
3			

CITY OF FAIRFIELD, CONNECTICUT
WATER POLLUTION CONTROL FACILITY
FACILITIES PLAN REPORT

PROJ NO: 13090A
DATE: FEBRUARY 2017

WRIGHT-PIERCE
Engineering a Better Environment

EXISTING SLUDGE PROCESS FLOW

FIGURE: 5-1

TABLE 5-1

CURRENT AND FUTURE SLUDGE PRODUCTION

Loading Condition		Solids quantities (lb/d)			Hydraulic Loading (gpd)		
		Primary	Secondary	Digested	Primary	Secondary	Digested
Annual Average	Current	4,860	3,960	3,770	19,424	75,368	22,602
	Design	5,662	4,074	4,868	22,630	77,538	29,185
Maximum Month	Current	6,000	5,900	4,470	23,981	112,291	26,799
	Design	6,990	6,070	6,530	27,938	115,524	39,149

1. Primary solids at 3.5% TS
2. Secondary solids at 0.5% TS
3. Design Digested solids assuming 50% removal (TS) in digesters.

5.2 PRIMARY SLUDGE PUMPING SYSTEM

Primary Sludge Pumps

Primary sludge in the primary settling tanks is typically maintained in a blanket of 2-3 feet at a solids concentration of 3-4% TS. The sludge is drawn from the sludge hopper through a sludge grinder (SG-2) by two primary sludge pumps (PSP-1 and PSP-2) located in the Primary Sludge Pump Room. These pumps were originally installed as recessed impeller pumps to pump to the gravity thickener. However, the original pumps could not pump the high solids concentrations and were replaced by plunger pumps. These currently pump the primary solids directly to the primary anaerobic digester, as the gravity thickener is now utilized for thickened waste activated sludge (WAS) storage. The primary sludge pumping system basis of design is presented in **Table 5-2**.

TABLE 5-2

PRIMARY SLUDGE PUMPING SYSTEM

BASIS OF DESIGN

Parameter	Current Value
Primary Sludge Pumps (PSP-1, PSP-2)	
Number of pumps (including standby)	2
Type	Carter, Duplex Plunger
Capacity, gpm (each)	120 @ 30' TDH
Motor HP	3
Sludge Grinder (Primary Sludge) SG-2	
Number of grinders	1, JWC
Capacity, gpm	600
Motor HP	5

5.2.1 Performance Evaluation

Two plunger pumps were installed by WPCF staff in 2008 and 2014, replacing the original recessed impeller pumps. The WPCF staff has reported significant operational and maintenance issues with the primary sludge pumping system. The current system cannot pump more than three to four percent of primary sludge concentrations without clogging the sludge lines, which results in periodic deep sludge blankets in the primary setting tanks. This is likely due to the pumps total dynamic head (TDH) and motors being too small to pump thickened sludge. Typically, plunger pumps are sized to handle at least 100-feet of TDH to prevent sludge line plugging.

The sludge is pumped to the primary anaerobic digester after passing through a sludge grinder. The sludge grinder was installed as part of previous upgrade and will need to be replaced.

5.2.2 Operation and Maintenance Issues

Although problems are reported with the pumping system, the plunger pumps themselves are in good condition and operate well at lower sludge concentrations. The flow meter is clogged with grease from the sludge flow resulting in inaccurate flow monitoring primary sludge to the primary anaerobic digester. The flow meter may also not be constructed for the pulsating flow of a plunger style pump. The flow meter is hard to clean resulting in maintenance issues.

5.2.3 Process Alternatives Evaluation

Primary sludge (PS) pumping is currently limited by feed rate to the digesters. In order to keep a residence time in the primary digesters of twenty days, the maximum combined feed rate of primary and WAS sludge is 30,000 gallons/day. Plant operators have found that maintaining a mix of 60% PS to 40%WAS minimizes foaming and digester upset. Therefore, primary sludge pumping is limited to approximately 18,000 gallons/day, and the volumes are estimated because the flow meter is not reliable.

During periods of high loading to the plant, the limitation associated with digester feed causes deep and thick blankets in the primary settling tanks. In order to maintain low sludge blankets in the tanks during these periods, primary sludge pumping needs to be increased during periods of heavy sludge generation. This can be accommodated by either providing a primary sludge storage tank or increasing the capacity of anaerobic digestion.

The current capacity of the plunger pumps is 40,000 gallons/day, which is sufficient for current and future sludge generation, however, the motor and TDH available are too small and should be replaced.

5.2.4 Recommendations

Decreasing the retention time of the primary anaerobic digesters is recommended and offers many benefits (as discussed later in this section), including the ability to increase the primary sludge pumping rate when necessary. The following upgrades are recommended for the primary sludge pumping system:

- Replace primary sludge pumps with appropriately sized units to reduce plugging and relocate to the new Influent Pump Station Building.
- Replace Primary Sludge Grinder.
- Replace all piping and valves.
- Replace the primary sludge flowmeter.

5.3 WASTE ACTIVATED SLUDGE PUMPING SYSTEM

Return activated sludge (RAS) is pumped to the primary effluent channel by the return sludge pumps from the secondary clarifiers to the waste sludge pump station located adjacent to the primary effluent distribution channel. Waste activated sludge (WAS) is pumped from this pump station to the gravity belt thickener (GBT) located in the sludge dewatering building by two submersible waste sludge pumps (WSP-1 and WSP-2). These pumps are operated 7 days a week, 4 to 6 hours a day, limited to the hours of GBT operation.

Each WAS pump is sized for a maximum pumping capacity of 450 gpm. The operation of each WAS pump is controlled by a VFD. Separate flow meters are installed on the sludge lines for both pumping destination (GBT-1 or GT-1) to measure sludge flow rate. The waste activated sludge pumping system basis of design is presented in **Table 5-3**.

TABLE 5-3
WASTE ACTIVATED SLUDGE PUMPING SYSTEM
BASIS OF DESIGN

Parameter	Current Value	Typical Standard
Waste Sludge Pumps (WSP-1, WSP-2)		
Number of pumps (including standby)	2	n/a
Type	Submersible, Centrifugal	
Maximum Pump capacity, gpm (each)	450 @ 30' TDH	
Minimum Pump capacity, gpm (each)	100 @ 8' TDH	
Motor HP	7.4	

5.3.1 Performance Evaluation

The WAS pumping system appears to be functioning adequately with sufficient capacity for current and future WAS pumping requirements.

5.3.2 Operational and Maintenance Issues

Although the existing pumps operate well, they require frequent maintenance and have been problematic.

5.3.3 Process Alternatives Evaluation

As an alternative to the current system, WAS pumping can be located in the return sludge building and drawn for the return sludge piping from the clarifiers. This option would improve maintenance frequency.

5.3.4 Recommendations

Decommission the existing submersible waste sludge pump station and locate new WAS pumps in the Return Sludge Building. Removal of this structure will also make room for improved primary effluent flow distribution as discussed in Section 3.

5.4 SECONDARY SLUDGE THICKENING

WAS is thickened using a gravity belt thickener (GBT) and discharged to a hopper. The thickened waste activated sludge (TWAS) is pumped to the gravity thickener by the Thickened Waste Sludge Pump (TWSP-1). Alternately, thickened waste sludge may be pumped directly to the primary or secondary digesters. Filtrate from the gravity belt thickener is combined with filtrate from the belt filter press and returned to the influent wet well.

Gravity Belt Thickener

The GBT is equipped with a polymer feed system (SPF-1) which prepares liquid polymer emulsion for mixing with waste activated sludge to aid in agglomeration. A commercial polymer emulsion is fed into the feed line of the gravity belt thickener at the desired rate by a metering pump. The polymer feed system consists of two in-line static mixers located on the sludge feed line which blend the sludge with polymer emulsion. This occurs in the inlet retention tank just before being distributed across the gravity belt thickener to allow for sludge conditioning. Washwater booster pumps supply wash water to the gravity belt thickener. The gravity belt thickener basis of design is presented in **Table 5-4**.

TABLE 5-4

GRAVITY BELT THICKENER

BASIS OF DESIGN

Parameter	Current Value	Design Value
Gravity Belt Thickener (Secondary Sludge)		
Number of units	1	1
Weekly hours of operation	28 to 56	30 to 60
Hydraulic Loading, gpm	220	220
Solids loadings, lb dry solids/hour @ %solids feed	700 @ 0.5-1.0 %	700 @ 0.5-1.0 %
Thickened Sludge, %	4 to 5	4 to 5
Average hours/day	5.6	5.8
Belt Motor HP	7.5	7.5
Thickened Waste Sludge Pumps (TWSP-1)		
Number of pumps/Type	1/Progressive Cavity	
Capacity, gpm	20-125@ 14' TDH	
Motor HP	10	
Washwater Booster Pumps (WBP-2)		
Number of pumps/Type	1/Horizontal End Suction Centrifugal	
Capacity per pump, gpm	40 @ 117' TDH	
Working Pressure, psig	85	
Motor HP	5	
Gravity Belt Thickener Polymer Feed System (SPF-1)		
Number of Tanks/Type	1/Liquid Emulsion	
Pump Type	Volumetric Double Centric Auger	
Mixing Type	In-Line Static Mixer	
Maximum Wetting Rate (lbs/min)	4	
Filling Height (inches)	51	
Water Required (at Minimum 10 psig)	20	
Feeder Capacity (cu. ft)	2	
Motor HP	½	

5.4.1 Performance Evaluation

The GBT was installed during the last facilities upgrade. The GBT takes WAS at 0.5 to 0.7% TS and thickens consistently to 4 to 5% TS. The thickening capacity appears to be sufficient to handle design average sludge and design maximum month sludge production, with current operation of wasting 7 days/week (4 to 8 hours) during the daytime shift.

5.4.2 Operational and Maintenance Issues

The GBT has been well-maintained and in good condition. WPCF staff have reported no significant operational and maintenance issues with the GBT system. The existing thickened waste sludge pump is approaching 20 years in service and needs replacement. Operators report that spare parts are difficult to obtain from the pump manufacturers. In addition, there is no spare pump redundancy for TWAS pumping.

5.4.3 Process Alternatives Evaluation

WAS thickening is necessary to reduce the volume of waste sludge going to the digesters (as discussed later in this section). The WAS thickening system appears to be effective and in good condition. For future maximum month loadings, it is projected that the gravity belt thickener will have to be run an additional hour per day than current operation. Therefore, the existing system has sufficient capacity for the planning period.

The polymer system is antiquated and difficult to operate. It is recommended to be replaced with a packaged skid-mounted unit.

5.4.4 Recommendations

Use of the gravity belt thickener to thicken WAS is recommended to be continued. The TWAS pump and GBT polymer system should be replaced and provided with redundancy.

5.5 TWAS STORAGE

Gravity Thickener

Thickened WAS from the GBT is stored in the gravity thickener (GT-1), which is located next to the septage receiving station on the south side of the plant. It was originally designed for thickening of primary settling tank waste sludge prior to anaerobic digestion. The gravity thickener was designed to also accept waste activated sludge in the event that the gravity belt thickener was out of service or needed to be bypassed. The 30-foot diameter gravity thickening tank is equipped with a plow and rake style sludge and scum removal mechanism.

The gravity thickener is currently utilized as storage for thickened WAS from the GBT in order to avoid slug feeding to the primary anaerobic digester. Thickened WAS from the GBT is metered to the digester on a timer (approximately 4 minutes every two hours) throughout the day by thickened sludge pumps (TSP-1 and TSP-2) through the sludge grinder SG-1, located in the septage receiving building. Data indicate that the TWAS is not appreciably thickened in the GT. The rake appears to provide minimal mixing.

Thickened sludge flow pumped to either the primary or secondary digester is measured by a magnetic type flow meter mounted on the discharge side of the thickened sludge pumps. Design criteria for thickened sludge pumps and the existing sludge grinder are listed in **Table 5-5**.

TABLE 5-5
THICKENED SLUDGE PUMPS
BASIS OF DESIGN

Parameter	Current Value	Typical Standard
Thickened Sludge Pumps (TSP-1, TSP-2)		
Number of Pumps	2	
Basis of Design	100 gpm @ 50 ft. TDH	
Manufacturer	Komline-Sanderson	
Type	Duplex Plunger	
Motor Size, HP	2	
Motor Speed, RPM	1,800	
Sludge Grinder (SG-1)		
Number of Units	1	
Basis of Design	600 gpm	
Type	JWC Environmental	
Motor Size, HP	5	
Motor Speed, RPM	1,750	

5.5.1 Performance Evaluation

The gravity thickener (GT) was originally designed for the thickening of primary sludge, at a greater rate than pumped from the primaries currently. WPCF staff reported that the use of the GT for the thickening of primary sludge typically resulted in only approximately two percent thickened solids, most likely due to the high rate of feed. Plant operators also tried co-settling of the thickened waste activated sludge with the primary sludge in the GT in order to thicken the combined sludge further to 4% TS, but this resulted in excessive foaming and odor problems.

The gravity thickener provides approximately 63,000 gallons of TWAS storage, equivalent to five days of TWAS production. This represents sufficient equalization volume for TWAS storage, particularly if the digestion capacity is increased.

The TWAS pumps are operated on a repeat cycle timer, running 4 minutes of every 2 hours. They currently operate well and have sufficient capacity for the additional TWAS feed to the digesters.

5.5.2 Operational and Maintenance Issues

TWAS thicker than 5% will interfere with operation of sludge rake, as well as the feed pumps from the GT to the digesters.

5.5.3 Process Alternatives Evaluation

Since the GT is no longer used for thickening, the replacement of the sludge collector mechanism with a dedicated mixing system may lead to smoother operation and provide the ability increase the % TS of sludge stored. Options for sludge storage mixing include mechanical mixing, large-bubble mixing, and pumped jet-mixing. All three of these are viable and should be considered in preliminary design.

5.5.4 Recommendations

TWAS storage is necessary to avoid slug-feeding of the digesters. Utilizing the GT in this manner has worked well and is recommended to continue. It is recommended to replace the rake mechanism with mechanical mixing or a large-bubble mixing system and replace the thickened waste sludge pumps to allow for thickening of up to 5% to 7% solids depending upon the dewatering technology installed and its sludge feed requirements for optimal performance. The thickened sludge pumps should also be replaced, as they are old and undersized.

5.6 SOLIDS STABILIZATION

Primary and secondary solids are stabilized using mesophilic anaerobic digestion. At the Fairfield WPCF, this process consists of a primary digester and a secondary digester with an intermediate building that houses the digester mixing compressors, digester sludge recirculation pumps, sludge grinder, a heat exchanger, hot water circulation pumps, and a sump pump. Also, related to the process are the waste gas burner and boilers, located in the Septage Receiving Building.

5.6.1 Primary Digester

Thickened WAS from the gravity thickener and primary sludge from the primary settling tanks are fed to the primary digester. The sludge temperature in the digester is maintained between 90-95°F by a heating system consisting of recirculation pumps, dual-fuel boilers, a spiral sludge heat exchanger, and a closed circuit hot water heating system. Digested sludge in the primary digester is mixed by a confined gas mixing system using draft tube eductors. The tank has a fixed cover that is uninsulated. The design residence time in the digesters is 20 days. Excess gas that is not utilized by the heating system is flared off.

Primary Digester

5.6.2 Secondary Digester

Secondary Digester

The digested sludge from the primary digester overflows to the secondary digester to be stored prior to dewatering. This tank is neither heated nor mixed. The tank has a floating gasholder cover which provides 12,600 cubic feet of biogas storage, which represents approximately 5 hours of gas storage. Sludge is pumped from the secondary digester by the belt filter press feed pumps.

The anaerobic digestion system basis of design is presented in **Table 5-6**.

TABLE 5-6
ANAEROBIC DIGESTERS
BASIS OF DESIGN

Treatment Process	Criteria		Typical Standard
Digesters			
Type	Two-Stage High-Rate Digestion		
SRT, days[2]	20		15 to 30
Target Temperatures, ^{0}F	90-95 (mesophilic)		95-100
Volatile solids, lbs/cu.ft-day	0.10		0.12-0.16
Feed Solids, %	4%		4-6
Number of Digester Units	2		
	Primary	Secondary	
Diameter, ft	60	60	
Maximum Water Depth, ft	28	26	
Volume, gal	600,000	550,000	
Maximum Liquid Elevation, ft	40.50	38.50	
Maximum Gas Pressure, inches of water	10	10	
Volume per Inch of Depth, gal	1760	1760	
Digester Heating Recirculation Pumps (RP-1,2)			
Number of Pumps	2		
Capacity, gpm	170		
Motor HP	5		

Treatment Process	Criteria	Typical Standard
Digester Heating		
Heat Exchanger		
Type	Spiral	
Number	1	
Capacity	900 MBTU/hr	
Boiler		
Type	Dual-Fuel	
Number	2	
Capacity	400 MBTU/hr, each	
Sludge Grinders (Digester Sludge) SG-3	1	
Number of grinders	3,700	
Capacity, gpm	7.9	
Operating Pressure, psig	200	
Motor HP		
Digester Mixing Guns		
Compressors		
Number	2(duty/standby)	
Power	20	
Design setpoint	140 scfm at 13.1 psig	
Diameter, inches	30	
Hydraulic Length, ft	20.2	
Normal Operating Rate, cu. ft/min	140	
Maximum Digester Turnover Time, min	31.5	20 to 30[3]
Sewage Sludge Flow Rate, gpm	1,900	
Velocity Gradient G, 1/s	83 1/s	50 to 80 1/s[3]
Solids, %	5-6%	

Notes:

1. Technical Resource (TR-16) Guides for the Design of Wastewater Treatment Facilities. 2011.
2. Based upon Maximum Month Flow of 10 MGD, primary digester only.
3. Source: WEF (1987b), "Anaerobic Digesters Mixing Systems," Journal Water Pollution Control Federation, Vol. 59.

5.6.3 Performance Evaluation

The digesters have not been cleaned for over twenty years and are confirmed to have a decreased capacity. During the 2003 upgrade, sludge from the now abandoned primary digester was pumped to the existing primary digester. Sludge core sampling performed in 2010 indicated that the bottom of the primary digester is covered with up to 6 to 6.5 feet of heavy grit accumulation, with solids concentrations ranging from 16% to 43%. Despite the reduction of the active digester volume, the digester has performed as well as could be expected, with average digester volatile solids destruction (55%) and gas production (60,000 cf/day) typical of mesophilic digestion with 20-day residence time.

The digester mixing system operates by inducing currents from the bottom of the digester upward by generating large biogas bubbles within internal draft tubes. The performance of this system is most likely compromised and cannot be properly evaluated given the extent of heavy grit deposition in the bottom of the primary digester throughout its operating life. However, it appears to be somewhat effective given the observed performance of the digestion process. The system meets standard design criteria for both digester turnover time and mixing velocity gradient G, as presented in **Table 5-6**.

The heating system, including boilers, heat exchangers, and hot water loop, theoretically provide enough capacity to keep the primary digester at proper temperature. However, due to the mixing system being compromised, it is most likely that the heating is isolated to a portion of the reactor and unevenly distributed. In addition, boilers and heat exchanger have reached the end of their design life and require increased maintenance.

5.6.4 Operational and Maintenance Issues

The primary digester has experienced significant foaming, most notably shortly after installation, when foaming provided enough force to lift the fixed cover off by breaking its anchoring brackets. More recently foaming occurs seasonally and has been kept reasonably under control using an anti-foam chemical.

Biogas piping to the boilers does not have effective moisture removal, leading to corrosion of valves, which leaves them unable to operate. As a result, the biogas system needs to be shutdown with the boilers burning natural gas during periods of maintenance or replacement of biogas appurtenances. The waste gas flare works well and has no reported issues.

Testing of buildup on the belt filter press indicates the formation of struvite. Although struvite is controlled on the belt presses using an anti-struvite chemical, it is quite possible that it may be forming on sludge piping, valves, heat exchanger, and biogas mixing cannons, interfering with performance or operation. Struvite often forms where turbulence occurs, where the partial gas pressure drop allows CO_2 to escape solution and increases solution pH. Digester mixing, recirculation, and heating equipment should be inspected for the formation of struvite.

Magnetic meters on sludge feed to the digesters often get coated with grease which leads to erroneous flow measurement and difficulties in controlling digester feed.

5.6.5 Process Alternatives Evaluation

Anaerobic digestion is currently effective in conditioning and reducing the volume of biosolids prior to composting providing a more stable sludge.

The limited capacity of the digestion process at Fairfield represents a restriction in the solids handling process train. Anaerobic digestion at the WPCF is hydraulically limited rather than solids limited. With a recommended design loading criteria (TR-16, 2016 Edition) of 0.12 to 0.16 lb volatile solids per cubic foot (lb VS/ft^3), and assuming 90% volatile fraction, the maximum digester solids feed is 10,700 to 14,300 lb/day. To ensure sufficient stabilization of biosolids for composting, it is necessary to maintain a solids residence time in the primary digester of 15 to 20 days. The primary digester has a volume of 600,000 gallons, and the original design criteria for the residence time in the digesters was 20-days, which limits feed to the digester to 30,000 gallons per day. The gravity belt thickener and primary clarifiers have a combined feed thickened capacity to produce a solids concentration of 3.7 to 4.0 percent. At 30,000 gallons per day, this limits solids feeding to the digester to 9,500 to 10,000 lb.

Current combined average and maximum month solids production is on the order of 8,700 lb/day and 11,000 lb/day, respectively. As presented in **Table 4-3**, the projected average and maximum month design loadings to the digester are 9,736 lb/day and 12,580 lb/day, respectively. The digestion process needs to provide capacity for these projected maximum month loadings. Therefore, greater digestion capacity is needed. This can be accomplished through one or more of the following alternatives:

A. Decreasing the residence time to 15 days within the primary digester by increasing digester feed rate to 40,000 gallons/day when necessary to maintain MLSS and low sludge blankets in the clarifiers.
B. Increasing the solids concentration of the feed. This would be most easily accomplished by further thickening primary solids.
C. Converting the secondary digester into a primary digester. This is accomplished by adding heating and mixing to the secondary digester.
D. Restore the inactive primary digester into service.
E. Construct additional sludge storage tanks for thickened primary sludge and/or thickened waste sludge during periods of high loadings.

These alternatives are further evaluated below:

5.6.5.1 Alternative A: Increasing Feed rate to Digesters

This alternative would be the simplest solution to implement. By increasing the feed rate to 40,000 gallons per day (when necessary to maintain primary and secondary sludge blankets), the mean cell residence time would be decreased to 15 days, which is the minimum time required for the digested sludge (at 95 degrees) to meet the pathogen reduction requirement for Class B biosolids in the Federal biosolids regulation. Since digestion is followed by composting at the Fairfield WPCF to produce Class A biosolids, this criterion is not relevant, but serves as a good guide for minimum treatment required for the benefits of anaerobic digestion.

Advantages of Alternative A include:

- No capital cost
- A 15-day SRT is acceptable with composting as the final stabilization method.

Disadvantages of Alternative A include:

- Reduced performance of digestion process, resulting in increased volatile solids to dewatering and composting processes
- Potential for increased odors

5.6.5.2 Alternative B: Thickening Primary Sludge

Thickening primary sludge to 5% TS or greater would reduce the volume of feed sludge to the primary digester to provide sufficient digestion capacity to handle projected design maximum month solids loadings. This could be accomplished by restoring the gravity thickener (currently used for WAS storage) to handle primary sludge, and building a new TWAS storage tank to prevent slug loading to the digesters. While operators reported that prior experience with the gravity thickener on primary sludge yielded minimal thickening, this was most likely due to high throughput of primary solids.

The gravity thickener system basis of design for primary sludge thickening is presented in **Table 5-7.**

TABLE 5-7
GRAVITY THICKENING SYSTEM
BASIS OF DESIGN

Parameter	Current Value	Typical Standard
Gravity Thickener (GT-1)		
Number of Tanks	1	
Diameter, ft.	30	
Side Water Depth, ft.	12	
Surface Area, ft^2	707	
Volume, ft^3	8,482	
Mechanism Manufacturer	WesTech	
Motor Size, HP	1/2	
Unit Solids Loading ($lb/ft^2/d$)[2]	8	20 to 30
Typical underflow solids (primary sludge), %TS		5 to 10

Notes:
1. Technical Resource 16 (TR-16) Guides for the Design of Wastewater Treatment Facilities. 2011.
2. At design maximum month BOD5 loadings.

In order to implement this solution, an alternative for TWAS storage must also be constructed. This would require a new 30,000-gallon WAS storage tank with mixing capabilities. In addition, the GT plow-and-rake collection system, which currently has problems with high torque with thicker solids, should be replaced.

Advantages of Alternative B include:

- Relatively low capital cost, limited to the construction of a new TWAS storage tank, associated equipment, and new solids collection mechanism in the gravity thickener
- Maximize use of existing thickening and digestion processes
- Minimal changes in site piping

Disadvantages of Alternative B include:

- Provides no redundancy in digestion process for maintenance and cleaning
- Plant has experienced difficulty in pumping thicker solids due to poor piping configuration and undersized pumps
- Thicker feed solids may lead to reduced digester mixing and foam formation
- No flexibility in the handling of primary and waste sludges

5.6.5.3 Alternative C: Converting Secondary Digester to a Primary Digester

The Town could double the plant's digestion capacity by providing independent heating and mixing systems to the secondary digester. Although limited heating can currently be provided to both digesters using the existing recirculation pumping and heat exchanger, an independent pump and heat exchanger dedicated to the secondary digester is recommended to have better temperature control. Mixing of the secondary digester may be provided by various technologies, including pumped jet mixing, and biogas draft tube mixing, and linear motion mixing.

Advantages of Alternative C include:

- Provides redundancy for digestion during maintenance, cleaning
- Provides additional capacity for future consideration of co-digestion with food wastes or FOGs
- Maximizes use of existing digester infrastructure
- Relatively low capital cost for installing heat exchanger and recirculation pumps, mixing system
- Is expected to increase volatile solids destruction and methane generation by as much as 10%

Disadvantages of Alternative C include:

- Will require extra energy for heating and mixing, although hot water from the CHP system currently being proposed should be sufficient to heat both digesters simultaneously. Power required for mixing could be as much as 30 HP for a rotamix system.
- Extra mean cell residence time will result in greater volatile solids reduction, methane generation, and stabilization of the biosolids
- Town will have to operate and maintain two digesters
- If secondary digester is continuously operated at full capacity, there will be no storage provided for digested sludge prior to dewatering. However, if one or both digesters are operated at less than full capacity (75%), storage would be available for dewatering operational flexibility while providing sufficient digester residence time.

5.6.5.4 Alternative D: Restoring Currently Inactive Primary Digester

This alternative would offer the same benefits as Alternative C while retaining the secondary digester for digestate storage. However, it would require extensive installation of site piping (sludge and gas piping) and digester modifications (including structural repair, heating and mixing systems), as well as modification of existing solids piping and infrastructure. Structural rehabilitation of the tank may also be cost prohibitive.

Advantages of Alternative D include:

- Provides redundancy for digestion during maintenance, cleaning
- Provides additional capacity for future consideration of co-digestion with food wastes or FOGs
- Is expected to increase volatile solids destruction and methane generation

Disadvantages of Alternative D include:

- Will require extra energy for heating and mixing. Hot water from the CHP system should be sufficient to heat both digesters simultaneously. Power required for mixing could be as much as 30 HP for a rotamix system.

- Significant capital cost for structural rehabilitation, installing heat exchanger and recirculation pumps, mixing system, structural modifications to the inactive digester, as well as extensive site piping, pumping installation and modifications.
- City will have to operate and maintain two digesters and will need to alternate feeding and withdrawal between the two digesters.
- Add level monitoring to both digesters to prevent overflow to the head of the plant.

Due to the significant effort that is expected to restore the inactive primary digester to service based on a process and structural site inspection, this Alternative is expected to cost significantly higher while providing the same benefits as Alternative C. Therefore, Alternative D was not considered any further.

5.6.5.5 Alternative E: Construct Additional Sludge Storage Tanks

This alternative would allow for additional storage of thickened primary sludge during periods of high loadings if reducing the SRT in the primary digester is not desirable. Two 30,000 gallon tanks would be constructed as part of the primary clarifier effluent splitter structure. Each tank would be piped to store thickened primary sludge if the gravity thickener is maintained as a TWAS storage tank or thickened waste sludge if the gravity thickener is repurposed to thickened primary sludge prior to pumping to the primary digester. The tank(s) can also be used to batch thickened blended sludge feeding it directly to the new dewatering equipment, and the primary digester bypassed, during periods of high loading, or as elutriation tanks to further condition anaerobically digested sludge improving its dewaterability. Additional engineering evaluations will be conducted during the preliminary design phase regarding the benefits of elutriation.

Advantages of Alternative E include:

- Limited to the construction of two new sludge storage tanks, associated equipment, and minimal site piping
- Maximize use of existing digestion processes
- Provides additional flexibility in the storage and handling of thickened primary and waste sludge and improve sludge dewaterability

Disadvantages of Alternative E include:

- Provides no redundancy in digestion process for maintenance and cleaning
- Will require additional energy for added equipment
- Will increase solids production for any sludge that is not anaerobically digested during periods of high loadings

5.6.6 Evaluation and Life Cycle Cost Analysis

A 20-year life-cycle cost evaluation was completed for Alternatives A, B, C & E. Results of the analysis are presented in **Table 5-8**.

TABLE 5-8

SOLIDS STABILIZATION ALTERNATIVES

LIFE CYCLE COST EVALUATION

	Alt A	Alt B	Alt C	Alt E
Alternative:	**Reduce SRT**	**Thicken Feed**	**Secondary Digester Upgrade**	**Additional Sludge Storage/ Elutriation Tanks**
TOTAL PROJECT COST	**$0**	**$1,022,000**	**$1,039,000**	**$1,205,000**
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	$0	$63,000	$64,000	$74,000
OPERATION AND MAINTENANCE COSTS				
Operating Costs				
Annual Operating Cost ($/yr)	$14,400	$4,700	$29,816	$5,200
Equipment Maintenance				
Labor and Equipment	$40	$2,500	$3,200	$1,600
Annual O&M Cost ($/yr)	$14,440	$7,200	$33,016	$6,800
Net Present Worth ($) - O&M	$236,115	$117,730	$539,859	$111,190
Total Net Present Worth	**$236,115**	**$1,139,730**	**$1,578,859**	**$1,316,190**

Notes:
1. Operation assumes mid-point energy at $0.16/kwh
2. Operating costs for Alt C include energy for pumped mix system.

As indicated in **Table 5-8**, Alternative A represents the least-costly alternative because there is no capital cost. As stated above, Alternative E provides the plant with the most flexibility store excess thickened primary sludge during periods of high loadings or to store thicken waste sludge if the gravity thickener is repurposed to further thicken primary sludge (Alternative B). For this facilities plan, Alternatives A and E are recommended for implementation and will be carried in the project cost estimate. The actual use of the tanks will be further evaluated during the preliminary design phase.

5.6.7 Combined Heat and Power System for Cogeneration

The WPCF has also considered installing Combined Heat & Power (CHP) systems for cogeneration on the existing digesters to utilize the methane in the biogas and produce energy for several years. A 2013 feasibility study by Fuss & O'Neill concluded that the installation of a 180kW reciprocating engine at the Fairfield WPCF had a payback period of 10 years. These conclusions were based on the following key assumptions:

- Current digestion operation is continued
- Reciprocating engine feed will be conditioned biogas supplemented by natural gas
- Digester gas production is 60,000 /day with a BTU value of 560 BTU/CF
- System will be installed within the footprint of the existing 200kW fuel cell or the existing microturbines outside the Septage Building

We have reviewed the 2013 evaluation and agree that the installation reciprocating engines utilizing conditioned digester biogas will provide power to help offset the amount of power purchased from United Illuminating, and heat to be used for digester biogas and/or building heating.

The timing of the CHP is unknown and depending on the funding source, may be implemented separately from the WPCF Upgrade funded by the CT DEEP. If not implemented prior to the upgrade, the combined heat and power (CHP) system will be included in the WPCF upgrade project scope. Due to this unknown, the installation of CHP system has been included as part of this project for budgeting purposes of this facilities plan. Potential funding for these projects could be obtained through the Connecticut Department of Energy & Environmental Protection (DEEP) Public Utilities Regulatory Authority (PURA) for Renewable Energy Credits (RECs). Under the current legislation, anaerobic digestion biogas is considered a Class 1 renewable energy source, which is then eligible to participate in the states REC generation program known as the Low and Zero Emission Renewable Energy Credit program (LREC/ZREC). The program requires

Eversource and United Illuminating to procure Class 1 RECs over a six-year period with a 15-year agreement. A REC represents 1,000 kWh of electricity. Based on recent bidding and sale of LRECs and ZRECs, biogas is considered an LREC, meaning there are low emissions associated with the fuel source. Historical values of LREC purchased by UI average about $50 to $55 since 2014.

5.6.8 Recommendations

Recommendations for solids stabilization are summarized below:

- Construct two new sludge storage/elutriation tanks for use during periods of high loadings
- Increase feed to primary digesters if/when necessary to maintain an SRT of at least 15-days
- Replacement of boiler(s)
- Addition of condensate traps and inspection of biogas piping
- Replacement of spiral heat exchanger for the primary digester
- Installation of mixing system in the secondary digester to improve VS reduction and grit accumulation
- Installation of a CHP system
- Inspection of solids piping for struvite formation. If extensive struvite is formed in the piping, the Town may consider additional struvite control including ferric chloride or anti-struvite chemical feed.
- Installation of magnetic meters with self-cleaning or bullet-nosed electrodes to improve control of feed volumes

5.7 DEWATERING

Digested sludge from the primary and secondary digesters is pumped by the belt filter press feed pumps (BPFP-1 and BPFP-2) to the belt filter press. Digested sludge that is pumped from the secondary digester (and sometimes the primary digester) to the belt filter press for dewatering first passing through sludge grinder SG-3, located in the digester room. Alternatively, the sludge grinder can be bypassed, allowing sludge to be pumped directly from the digesters to the belt filter press.

Belt Filter Press

The belt filter press is used to dewater sludge to 15% TS before discharging it to the dewatered sludge conveyor (SC-1), where it is eventually loaded onto trucks that transport it to the compost facility. Filtrate from the gravity belt thickener is combined with filtrate from the belt filter press and returned by gravity to the influent wet well.

The belt filter press is equipped with a polymer feed system (SPF-2) which prepares liquid polymer emulsion for mixing with the digested sludge, coming from the primary and secondary digesters, prior to entering the belt filter press to aid in agglomeration. A commercial polymer emulsion is fed into the feed line of the belt filter press at the desired rate by a metering pump. Washwater booster pumps (WBP-1, WBP-2 and WBP-3) supply wash water to the belt filter press. The belt filter press system basis of design is presented in **Table 5-9**.

TABLE 5-9

BELT FILTER PRESS SYSTEM

BASIS OF DESIGN

Parameter	Current Value	Typical Standard
Belt Filter Press (Anaerobic Digested Sludge)		
Number of units	1	
Solids loadings, lb dry solids/hour @ %solids feed	1,815 @ 2.5-5%	1,600
Dewatered Sludge, %	15	15-25
Belt Motor HP		3-5
Belt Filter Press Feed Pumps (BPFP-1, BPFP-2)		
Number of pumps	2	
Type	Progressive Cavity	
Capacity, gpm	NA	
Motor HP	10	
Washwater Booster Pumps (WBP-1,3)		
Number of pumps/Type	2/Horizontal End Suction Centrifugal	
Capacity per pump, gpm	40	
Working Pressure, psig	85	
Motor HP	5	5-10
Belt Filter Press Polymer Feed System (SPF-2)		
Number of Tanks/Type	1/Liquid Emulsion	
Pump Type	Volumetric Double Centric Auger	
Mixing Type	In-Line Static Mixer	
Minimum Solids Capture, %	95	
Max. Chemical Usage (lbs of Polymer/Ton of Dry Sludge)	11.5	
Motor HP	3/4	
Dewatered Sludge Conveyor (SC-1)		
Type	Shaftless Spiral	
Trough		
Length, ft	15	
Width, mm	350	
Loading Rate, dry lbs/hr	2000	
Solids Content of Conveyed Material, %	15-30	
Motor HP	5	

5.7.1 Performance Evaluation

The belt filter press was installed as part of the previous upgrade and has performed well but has seen deterioration recently. The facility has averaged approximately 15% to 19% cake solids since installed, but is currently producing cake at 15% TS on average. The BFP was installed in the 2003 upgrade and is ready for an overhaul or replacement.

The compost facility downstream of the belt filter press operates optimally at biosolids 20%TS or greater. Wetter biosolids increases compost amendment, weight of biosolids to handle and dispose, as well as increased ammonia released from solution into the air of the compost building.

5.7.2 Operational and Maintenance Issues

The WPCF staff have reported some operational and maintenance issues with the BFP system. The belt press conveyor is a shaftless screw system that moves solids, but the liner wears out quickly and needs to be replaced frequently. Struvite deposition on the press is wearing the belt, which is periodically cleaned by the operators. The WPCF staff has been using anti-struvite to minimize the struvite formation and precipitation which has worked well. There is no redundancy for dewatering using the belt filter press.

5.7.3 Process Alternatives Evaluation

Dewatering technology alternatives to be considered at the Fairfield WPCF consist of the following:

- Refurbished Belt Filter Presses (baseline alternative)
- Centrifuges
- Rotary screw presses

5.7.4 Alternative A: Belt Filter Press

A request for proposal was solicited from Ashbrook for refurbishing the existing belt filter press. Refurbishment includes an overhaul and replacement of all components including rollers, bearings, pans, hosing, fittings, cylinders, belts, seals, scraper blades, gravity drum screen, and wedge section support.

The advantages of this alternative include:

- Lowest capital cost alternative
- This technology has dominated the municipal sludge dewatering market for many years and is still a cost - effective means of dewatering

Some of the disadvantages of a Belt Filter Press include:

- Environment can be corrosive due to the high moisture content of air resulting from the spray wash water mist and the wash water and filtrate drains
- Requires a continuous spray of wash water on both belts because fines and polymer are continually pushed through the belts; the wash water system requires a booster pump and high flow
- Has seen deteriorating performance in dewatered solids content
- Large footprint
- Increase odor control requirements due to its open design
- Typically lower cake solids and more handling of materials resulting in higher amendment usage at the compost facility

For purposes of this dewatering assessment, information from Ashbrook was used for developing capital and O&M costs.

5.7.5 Alternative B: Screw Press

Screw Presses have been used extensively in industrial applications and especially at pulp and paper wastewater treatment facilities for many years. Historically, screw presses have not been used in municipal sludge dewatering due to higher cost and lower throughputs, however, screw presses have proven cost effective on a life-cycle (LCA) costs basis due to the potential for higher cake solids with many recent New England installations in the municipal market.

There are two technologies that have proven successful; the horizontal rotary screw press (FKC) and the Inclined Rotary Screw Press (Huber). For this preliminary assessment the horizontal screw press is used for developing capital and O&M costs, but both types of presses should be considered for final design and installation.

The screw press consists of a screw with a conical shaft and flights that can vary in pitch and taper. The solids are fed into the space between the screw and a screw basket. Clarified liquid (filtrate) is discharged through the screen. The conditioned sludge can be fed either by gravity or under pressure. With a gravity feed, the conditioned sludge flows from the floc tank to the open feed box on top of the screw. Sludge dewaters first by gravity drainage out through the bottom. With a pressured feed, the conditioned sludge is pumped to the inlet to maintain the desired inlet feed pressure. The screw moves the solids, and gradually increases the pressure. The discharge pressure can be controlled to help produce the desired cake solids.

Some of the advantages of the Screw Press include:

- Typically outperforms belt filter presses with sludge of the same characteristics and performs very well with high concentrations of waste sludge
- Reduced amendment usage at the compost facility
- Fully automated, designed to run unattended
- Slow rotation, small motor; lower energy cost
- Odor control system size is minimized because the process is totally enclosed
- Smaller footprint (than BFP)

Some of the disadvantages of the Inclined Screw Press include:

- The feed pressure requires a significant pressure drop at the polymer and sludge mixer; pressure loss requirements increase as the feed solids increase.
- Screw Press overloading can cause pressure build up in the inlet chamber shutting down the screw press; feed pumps need to be controlled automatically by the screw press system.

Additional Ancillary Items for the Screw Press include:

- Flocculation mixers

- Spray wash water system (continuous plant water flushing not required)

FKC estimates final cake solids of 22-25% with 30 to 50 gallons of polymer/dry ton. A pilot test prior to final design is recommended.

For purposes of this dewatering assessment, the FKC Screw Press was used for developing capital and O&M costs. Due to the small footprint required for the screw press, a second redundant system could also be installed in the footprint required for the existing belt filter press as shown in **Figure 5-2**. For the purpose of the alternative life-cycle cost evaluation, the installation of one screw presses was evaluated.

5.7.6 Alternative C: Centrifuges

Centrifuges also have a strong presence in the municipal sludge dewatering market. Centrifugal sludge dewatering uses the centrifugal force developed by the rotation of a cylindrical drum or bowl to separate the sludge solids from the liquid. Centrifuges have been favored whenever sludge disposal costs are significantly reduced by having a high solids content. The centrifuge market is very competitive, with several manufacturers offering units with significant ranges in price, size, capacity, and features.

The solid bowl centrifuge is horizontally mounted and tapered at one end. Thickened sludge is fed into the cylindrical bowl assembly, which rotates between 2,500 and 4,000 revolutions per minute. The high centrifugal force drives the solids against the bowl's interior walls. Difference in densities between the sludge solids and the liquid causes the formation of two distinct layers; sludge cake and liquid centrate. The dewatered sludge cake is discharged at the tapered end, while the centrate is discharged at the opposite end of the unit.

Some of the advantages of the Centrifuge include:

- Typically provides the highest dewatering cake thickness and capacity per unit

- Based on typical performance for primary/secondary mixtures, a high solids centrifuge can be expected to achieve a final dewatered cake of 24% to 30% solids. Dewatering performance would be expected to meet or exceed current requirements for regional contract disposal of dewatered sludge.
- Reduced amendment usage at the compost facility
- Smallest footprint of all alternatives
- Ability to provide redundancy in available footprint
- Odor control system size is minimized because the process is totally enclosed

Some of the disadvantages of the Centrifuge include:

- High energy consumption
- High maintenance costs

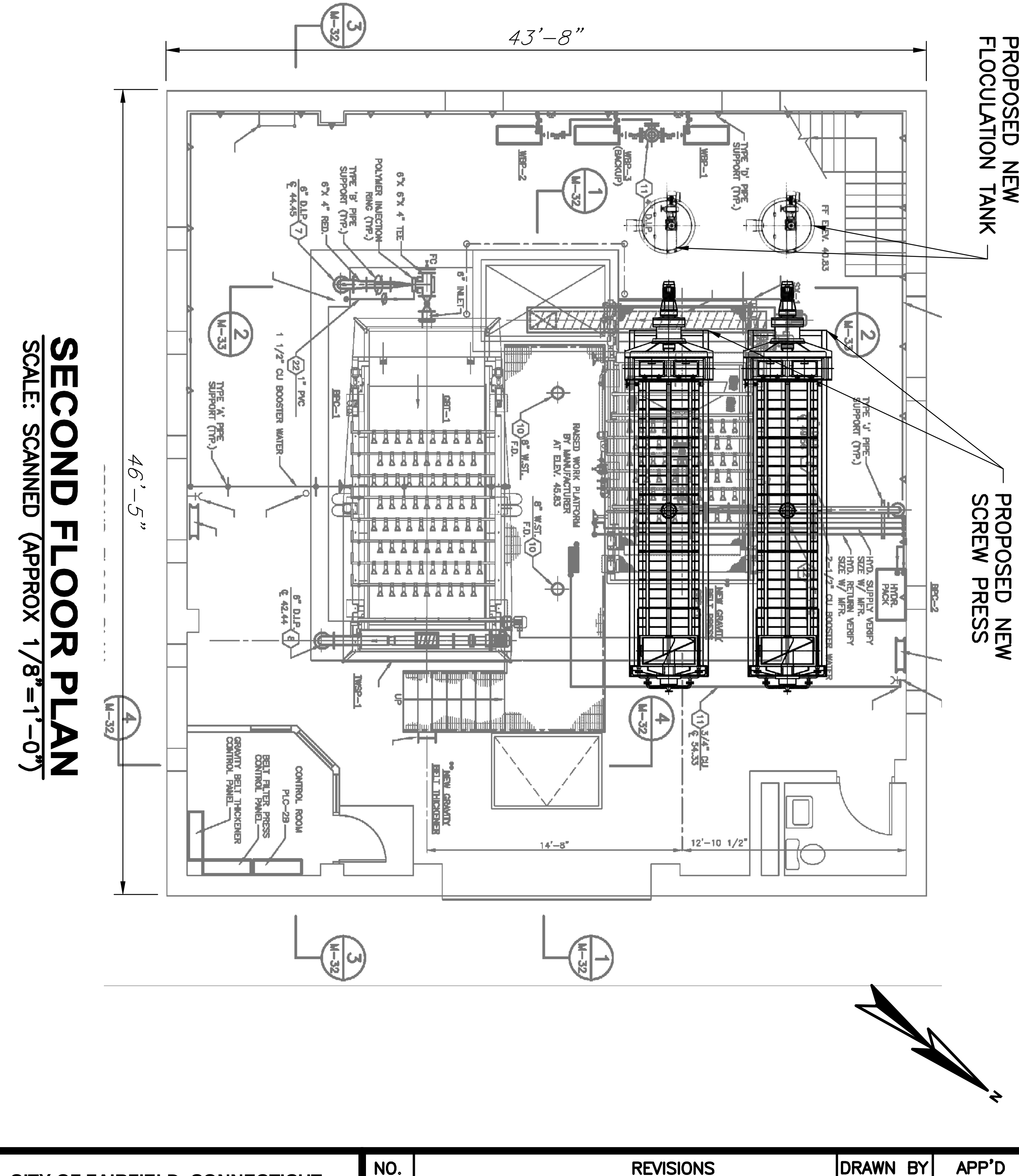
For purposes of this dewatering assessment, a proposal was solicited from Centrysis. This proposal was used for developing capital and O&M costs. Although the Centrysis unit has automation to run unattended, due to the larger complexity of the equipment and as it operates at a high rpm rate, it is not recommended to run when the WPCF is not staffed. It is recommended that if a centrifuge is selected, it should be designed to operate 6 hours/day, 5 days/week, during normal working hours.

Due to the small footprint required for the centrifuge, a redundant system could also be supplied. For the purpose of the alternative life-cycle cost evaluation, the installation of one centrifuge was evaluated.

5.7.7 Evaluation and Life Cycle Cost Analysis

Alternative A, which consists of refurbishing or replacing the belt filter press, is considered the baseline alternative. This alternative will not require any capital costs (aside from equipment replacement) but will also maintain decreased performance of the digestion process. This decreased performance results in higher O&M costs realized during disposal and discussed later in this section.

A 20-year life-cycle cost evaluation was completed for Alternatives B and C including capital and operation and maintenance costs. Results of the analysis are presented in **Table 5-10.**



CITY OF FAIRFIELD, CONNECTICUT
WATER POLLUTION CONTROL FACILITY
FACILITIES PLAN REPORT

PROJ NO: 13090A | DATE: JANUARY 2017

WRIGHT-PIERCE
Engineering a Better Environment

NO.	REVISIONS	DRAWN BY	APP'D
1		DHF	DLS
2			
3			

SLUDGE DEWATERING BUILDING
NEW SCREW PRESS LOCATION

FIGURE: **5-2**

TABLE 5-10

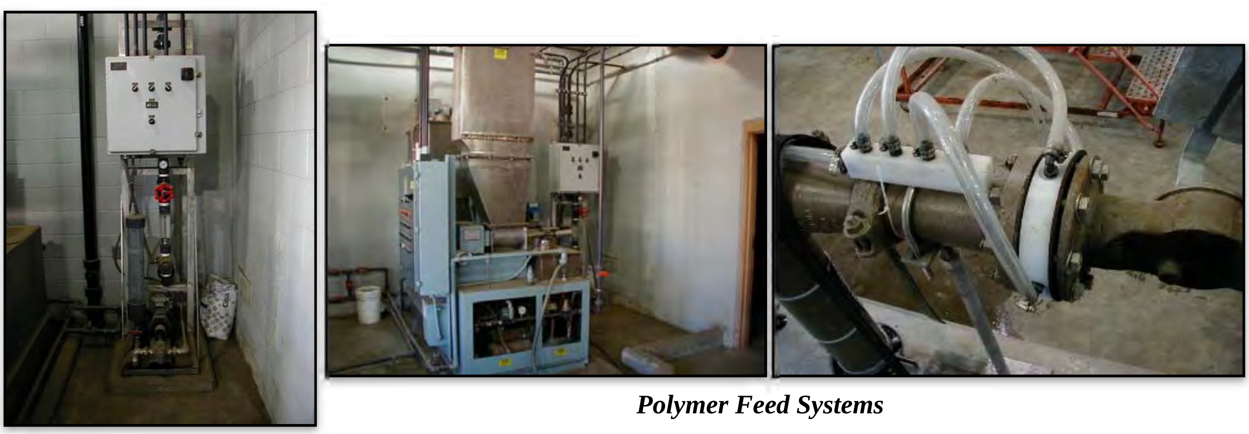
SLUDGE DEWATERING ALTERNATIVES

LIFE CYCLE COST EVALUATION

ALTERNATIVE	CAPITAL COST	PRESENT WORTH
1 BELT FILTER PRESS ALTERNATIVE	$257,000	$345,000
2 SCREW PRESS ALTERNATIVE	$372,000	$462,000
3 CENTRIFUGE ALTERNATIVE	$569,000	$922,000

As presented in **Table 5-10**, if dewatered cake solids were not a consideration, the replacement of the belt filter press would be the most cost-effective solution. However, the merits of the various dewatering technologies will largely depend on the choice of final solids conditioning (composting versus thermal lime conditioning). If the Town continues to use composting for final conditioning, a technology that produces higher solids cake (centrifuges or screw presses) is recommended. If thermal-lime conditioning is pursued, the refurbishment of the existing BFP will be sufficient for dewatering. Therefore, an evaluation of the preferred and recommended dewatering alternative is presented along with the discussion of 'Final Conditioning' later in this section.

5.8 POLYMER FEED SYSTEM (WAS THICKENING AND DEWATERING)



Polymer Feed Systems

A polymer feed system (SPF-1 and SPF-2) is used to inject polymer emulsion it into the pipes carrying waste activated sludge conveyed by the waste sludge pumps prior to the sludge entering the gravity belt thickener and digested sludge coming from the primary and secondary digesters prior to entering the belt filter press. The polymer feed system for the gravity belt thickener also serves as a backup to the belt filter press polymer feed system.

Commercial polymer emulsion is diluted in the wetting chamber where it is mixed with turbulently flowing water. The emulsion then drops directly into the transfer pump and is immediately and continuously transferred into a mixing tank without damaging the polymer chain. Prepared polymer solution is then fed into the feed lines of the gravity belt thickener and belt filter press at the desired rates by the metering pumps.

The polymer feed system basis of design is presented in **Table 5-11**.

TABLE 5-11
POLYMER FEED SYSTEM
BASIS OF DESIGN

Parameter	Current Value	Typical Standard
Sludge Type	**Polymer Dosage (lbs/Ton Dry Sludge)**	
Raw Primary	4-8	
Primary + Waste Activated	6-10	
Waste Activated	8-16	
Anaerobically Digested Waste Activated	12-18	
Anaerobically Digested (50% Primary+ 50% Waste Activated)	10-16	
Aerobically Digested	10-16	
Gravity Belt Thickener Polymer Feed System (SPF-1)		
Number of Tanks/Type	1/Liquid Emulsion	
Pump Type	Volumetric Double Centric Auger	
Mixing Type	In-Line Static Mixer	
Maximum Wetting Rate (lbs/min)	4	
Filling Height (inches)	51	
Water Required (at Minimum 10 psig)	20	
Feeder Capacity (cu. ft)	2	
Motor HP	½	

Parameter	Current Value	Typical Standard
Belt Filter Press Polymer Feed System (SPF-2)		
Number of Tanks/Type	1/Liquid Emulsion	
Pump Type	Volumetric Double Centric Auger	
Mixing Type	In-Line Static Mixer	
Minimum Solids Capture, %	95	
Max. Chemical Usage (lbs of Polymer/Ton of Dry Sludge)	11.5	
Motor HP	3/4	

5.8.1 Performance Evaluation

The WPCF staff has performed extensive modifications to the original design and installed polymer systems as they never worked properly. An emulsion polymer system is currently in use for both GBT and BFP systems. The systems are antiquated and should be replaced with a self-contained system.

5.8.2 Operational and Maintenance Issues

The WPCF have reported that the current polymer system is difficult to operate and maintain. The system needs to be upgraded and simplified with better placement in the process train and redundancy.

5.8.3 Recommendations

A new self-contained packaged polymer feed system with redundancy should be installed for both the GBT and BFP processes. The BFP system will be replaced with an appropriately sized system for the dewatering technology designed around.

5.9 FINAL CONDITIONING

The Town of Fairfield owns and operates an agitated bin composting facility at its Water Pollution Control Facility (WPCF). Dewatered sludge is further stabilized and converted to a useable end product by composting with yard waste in what was formerly known as International Composting System (IPS) agitated bin composting process, now acquired and managed by BDP Industries. The facility began operations in 1989 processing wastewater sludge from the treatment plant with yard waste amendment to produce a high-quality compost product.

Compost Facility

The compost operations are housed in a pre-engineered stainless steel building and the process consists of six composting bins, one compost turners, and an aeration system. Each compost bin has five aeration zones, which provide air to the compost mixture to maintain optimum temperatures, remove excess moisture, and ensure adequate oxygen supply to the microbes in the system. The compost facility uses a positive-mode aeration system. The positive-mode aeration system utilizes small 3-hp centrifugal blowers and an air distribution grid. The blowers, located on shelving at the far end bays, pull air from the building atmosphere and discharge it to the bottom of each agitated bin through a perforated PVC pipe manifold system bedded in a layer of stone. The blowers supply air to the compost mixture in response to a timer and temperature feedback from temperature sensors mounted in the wall of the bins. The building shell, blowers, PVC air distribution piping, thermocouples, lighting and agitator were replaced in 2008.

Collected yard waste (leaves or wood chips) is ground and used as an amendment with the dewatered sludge. The feed to the compost building are about 40 percent solids (sludge and amendment). The amendment material is provided by Harvest Power (Yard Waste Facility) across the street from the WPCF. Under the terms of their current agreement with the Town of Fairfield, they provide about 10,000 cubic yards of amendment material per year. Dewatered wastewater sludge and amendment are combined in a truck-mounted mixing unit to produce a homogenous compost feed mix, which is then loaded in the front end of each processing bay.

The compost turner rides on rails mounted on concrete bin walls, and is used to mix and move the compost feed through the aeration zones. The agitator moves the compost through the length of the bin, providing and average residence time of 28 days. The finished product is transported across the street to cure for additional time. AgreSource markets the finished biosolids from the WPCF Compost Facility through the operation of the yard waste facility. Under the terms of their agreement, the Town receives $4/cubic yard from AgreSource for the biosolids produced. Based on the present mode of operation, the composting system currently processes on average 350 tons of sludge per year. The compost facility basis of design is presented in **Table 5-12**.

TABLE 5-12

COMPOST FACILITY

BASIS OF DESIGN

Parameter	Current Value
Composting Facility	Agitated Bin
Number of Compost Turners	1
Number of Compost Bins/Bays	6
Compost Bin Dimensions (L*W*H), feet	220*6*6
Compost Bay Operation	Positive Aeration
Aeration System	Pipe-In-Stone
Aeration Blowers	
Number of Units	30
Motor Size, HP	5
Exhaust Blowers	
Number of Units	5
Capacity, CFM (each)	7,525
Motor Size, HP	25
Make-Up-Air Units	
Number of Units	2
Capacity, CFM (each)	20,000
Motor Size, HP	15

5.9.1 Performance Evaluation

Although composting has been operationally challenging for Fairfield operators (as noted in the next section), it has successfully produced Class A biosolids for the past 28-years that is marketable for land application at a minimal cost to the Town, which is exceptional given the biosolids regulations in Connecticut. The facility is also underloaded and adequate to handle future loadings.

5.9.2 Operational and Maintenance Issues

The WPCF staff has reported moderate operational and maintenance issues with the composting facility, as noted below:

- The enclosed space of the compost facility is prone to a humid environment that contains a high concentration of ammonia. The compost building with stainless steel interiors is resistant to corrosion. However, other equipment housed inside the building are still exposed to the poor environmental conditions. The WPCF staff has expressed concerns for worker safety and operation in the facility, due to poor ventilation and lighting.

- The two make-up air units are not in operation, as they do not have efficient supply of hot water supply to maintain consistent temperatures inside the facility during the colder months. This results in very damp and moldy conditions which greatly reduce visibility. To compensate for the reduced lighting and ventilation, the loading/mixing doors side doors to the facility are kept open all year round.
- The one existing agitator is in need of repairs to prevent failure. The machine comes off the track at times, which requires removal and leveling the tracks to ensure minimal interruption to composting operations.
- The indoor light fixtures that were replaced in the 2008 upgrade were replaced with more energy efficient lighting, but soon failed due to high humidity conditions. They were replaced again, and failed again. They need to be upgraded with appropriate lighting for the atmosphere within the space.
- The electrical distribution equipment which is housed in an external building attached to the compost building need upgrades. The rooftop solar panels appear to function.
- The exhaust blowers located outside the building ventilate the building airspace into the compost process biofilter. They operate on high (occupied) and low (un-occupied) speeds. Due to the high moisture content of the compost building exhaust, the condensate escapes through the blower turbine motor shaft and leaks to the ground.
- The biofilter associated with odor control for composting requires a moderate degree of maintenance and periodic media replacement.

5.9.3 Process Alternatives Evaluation

5.9.3.1 Alternative A: Maintain Composting Operations with Positive-Mode Aeration (Baseline Alternative)

Continuing to compost at the WPCF will require the following system modifications:

- Increase cake solids from dewatering from 15% TS to 20% to reduce quantities and volatile NH3

- Rehabilitate the existing agitator unit, and purchase a spare unit for redundancy
- Upgrade heating and ventilation, consisting of make-up air supply units and aeration blowers
- Upgrade electrical distribution equipment
- Replace lighting

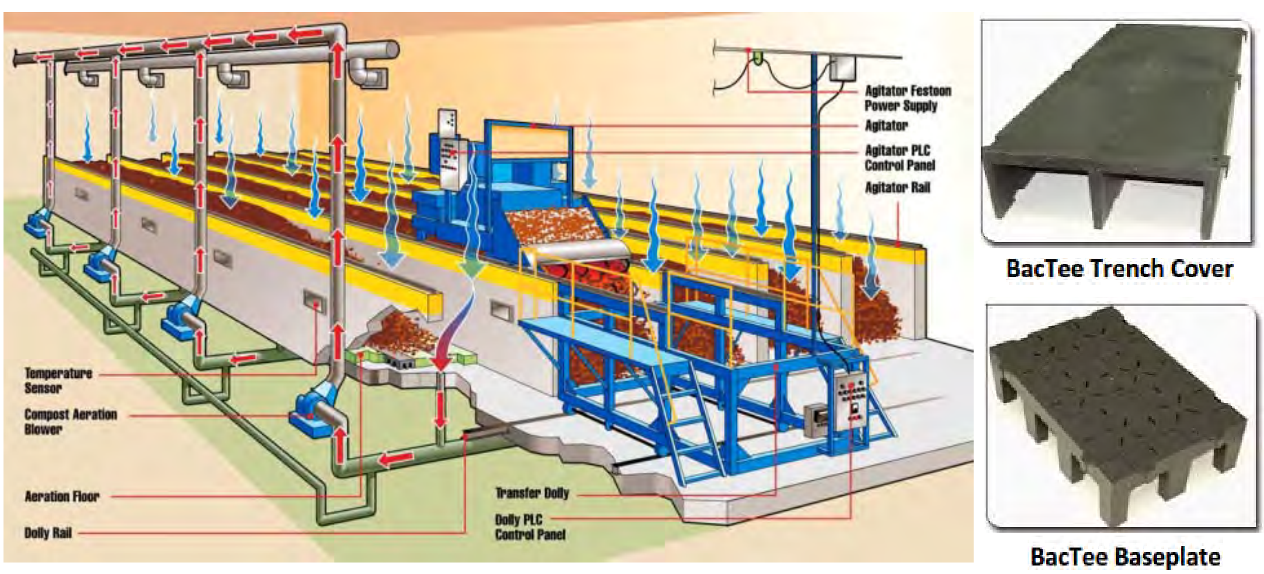
5.9.3.2 Alternative B: Maintain Composting Operations with Negative-Mode Aeration

Under this alternative, the compost facility at the WPCF will require all the modification under Alternative A. In addition, the existing pipe-in-stone aeration floor system in the process bays which operates under 'positive aeration' will be converted to plenum aeration floor system which operates under 'negative aeration'. A schematic of the proposed system is shown in **Figure 5-3**.

The negative-mode aeration is being considered as a means to improve the compost building environment and provide better working conditions, by minimizing the discharge of process-generated heat and moisture into the building ventilation space. The plenum floor system unlike pipe-in-stone system does not rely on small diameter orifices to balance air flow under the composting material. Instead, they use static pressure drop created by the air flowing through the bulk structure to create the backpressure necessary to provide a more uniform air distribution all plenum.

FIGURE 5-3

BACTEE NEGATIVE-MODE AERATION SYSTEM AND COMPONENTS



Advantages of Alternative B include:

- Easy installation of plenum floors, with minimal operation and maintenance.
- More uniform air distribution with little pressure drop issues.

Disadvantages of Alternative B include:

- Significant capital costs for conversion to negative-mode aeration, not including the costs for demolition of existing system, concrete work and piping.
- Collection, transport and handling of condensate.

5.9.3.3 Alternative C: Thermal Hydrolysis

Any feasible alternative to composting as final stabilization of biosolids at Fairfield WPCF will require the following:

- low capital expenditures
- operational simplicity
- ability to produce Class A biosolids suitable and desirable for land application

One potential alternative to composting was identified, consisting of a new technology utilizing low-temperature thermal hydrolysis, as patented by Lystek.

The Lystek process uses a combination of high-speed shearing, alkali and low pressure steam in an enclosed vessel to hydrolyze the cell walls of microbial cells. In combination with anaerobic digestion, the final product is a stable slurry that is certified Class A Exceptional Quality (EQ), that exceeds standards for Class A biosolids.

The batch stabilization process requires a short residence time (1 hour per batch), which allows for a small reactor size and process footprint. A picture of an installed reactor is shown in **Figure 5-4.** The reactor is an enclosed stainless steel vessel with mixing, alkali (lime or caustic) and steam injection. The product is a pumpable liquid slurry at 15% TS (also shown in **Figure 5-4**).

Ancillary equipment includes a dewatered biosolids storage tank, progressive cavity transfer pumps, low-pressure natural gas steam boiler, alkali storage and feed, progressive cavity transfer pumps to product storage, and control panel. The system can be fully automated and run un-attended, with only an estimated one hour of operator attention per day.

The process has been installed and is operating in various facilities in Canada, and is currently being constructed at the Fairfield, CA WWTP. The product has typically proven a salable commodity, which Lystek may also be hired to market and distribute.

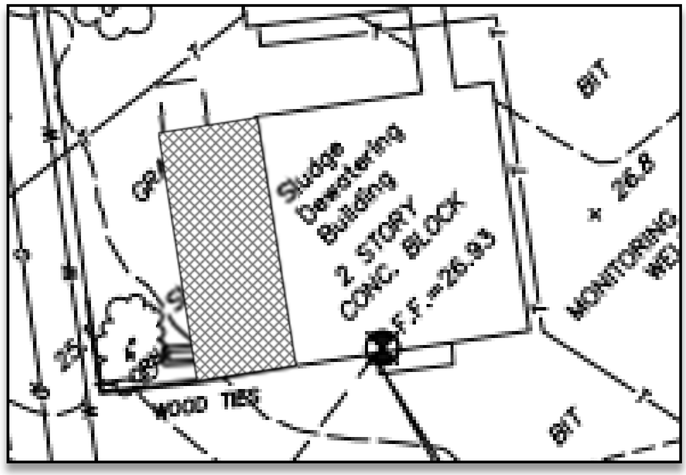
FIGURE 5-4
LYSTEMIZE REACTOR AND FINAL PRODUCT

Studies have shown that the product can also be used as a recycle stream to feed back to the anaerobic digesters to enhance methane generation, or as an effective source of supplemental carbon to the aeration tanks for total nitrogen removal.

At Fairfield, implementation of the Lystek process will require the following plant modifications:

- *Refurbishment of the belt filter press*. For the Lystek process, dewatering to 15% TS cake solids is acceptable, which can be accomplished by refurbishing the existing belt filter press.

- *Expansion of Sludge Dewatering Building*. Installation of Lystek equipment will require 800 square feet of building space with 24 feet of floor height. Expansion of the sludge dewatering building is proposed to install process equipment, including dewatered sludge storage, process reactor, chemical feed, and pumping. Installing the process equipment in the vicinity of the dewatering units minimizes conveyance of dewatered sludge.



Proposed Sludge Dewatering Building Expansion

- *Modification of the inactive digester to stabilized biosolids storage during the non-growing season.* This will require a small recycle pumping system for mixing and a packaged odor control system, sludge piping to and from the sludge dewatering building.

Operational costs will include electricity for mixing and pumping, chemicals, and natural gas for heating. For this preliminary analysis, the use of caustic is assumed, but lime as an alkalinity source is also available if preferred.

5.9.3.4 Alternative D: Haul Dewatered Sludge to Incinerator

Hauling liquid or cake solids will require moderate upgrades to the plant to allow for both sludge storage and truck loading. The town of Fairfield has not hauled sludge for some time and has no plans to revert back to relying on sludge hauling fees, fuel costs and incineration fees. The town has also made a significant investment in their composting facility in 2008 where the building was replaced with a stainless steel shell to extend its life and continues to do so with several green project including the installation of a new fuel cell and a microgrid.

In order to haul dewatered cake off-site, the dewatering building would need to be expanded to house two roll-off containers and a new dewatering technology would need to be installed to achieve cake solids of at least 20% as well as conveyors to transfer cake to each respective container. Additional operational costs will include hauling and disposing of the cake at an incinerator. For this preliminary analysis, a cost of $400/dry ton was used to cover hauling and disposal costs based on discussion with Synagro and the MDC.

5.9.4 Life Cycle Cost Evaluation

A 20-year life-cycle cost evaluation was completed for the three final stabilization alternatives. Results of the analysis are presented in **Table 5-13.**

TABLE 5-13

FINAL CONDITIONING ALTERNATIVES

LIFE CYCLE COST EVALUATION

	Alt B	Alt C	Alt D
Alternative:	**Compost**	**Thermal Hydrolysis**	**Haul Cake**
TOTAL PROJECT COST	**$3,151,000**	**$7,672,000**	**$1,829,000**
Construction Loan Rate	2.0%	2.0%	2.0%
Loan Term, years	20	20	20
Capital Recover (A/P, i%, n)	0.061	0.061	0.061
Annual Debt Payment	$193,000	$469,000	$112,000
OPERATION AND MAINTENANCE COSTS			
Operating Costs			
Annual Operating Cost ($/yr)	$295,727	$37,448	$497,815
Equipment Maintenance			
Labor and Equipment	$28,000	$53,500	$13,900
Annual O&M Cost ($/yr)	$323,727	$90,948	$511,715
Net Present Worth ($) - O&M	$5,293,397	$1,487,130	$8,367,277
Total Net Present Worth	**$8,444,397**	**$9,159,130**	**$10,196,277**

As indicated in **Table 5-12**, Alternative B represents the least-costly alternative and the initial capital investment is significant for Alternative C when compared to Alternatives B and D. Thermal hydrolysis is also a new technology and the future stability of the market is unknown.

5.9.5 Recommendations

The town has benefitted from composting for the past 28 years and the operators at the WPCF are comfortable with the process. In addition, a significant investment was made by the town to replace the Compost Building in 2008 and is in the process of installing a fuel cell outside of the building in the Spring of 2017. Waste heat from the fuel cell will be used to heat the air in the Compost Building. Therefore, it is recommended that maximize this investment by implementing Alternative B, which continues to compost biosolids at the plant while providing safer working environment and new dewatering equipment for improved composting performance. Upgrades will include:

- Installation two screw presses to achieve higher cake solids
- Replace polymer feed systems
- Upgrade electrical distribution equipment in Compost Building and install process on emergency power
- Install HVAC equipment and gas monitoring in Compost Building
- Replace all lighting in Compost Building
- Install Bac-Tee negative mode aeration with provision to pretreat or separately dispose of the condensate
- Replace bin and floor rails
- Replace agitator

SECTION 6

ODOR CONTROL SYSTEM EVALUATION

SECTION 6

ODOR CONTROL SYSTEM EVALUATION

6.1 INTRODUCTION

The Fairfield WPCF includes raw wastewater treatment, septage and sludge handling and a compost facility, all of which result in odor emissions that can have an off-site impact. There are existing odor control systems at the Fairfield WPCF to continuously ventilate and treat the off-gases exhaust from the various treatment processes via two open-bed biofilter systems with piping-in-stone distribution systems as shown in **Figure 6-1**. The air spaces from the Influent Building, Primary Settling Tank Effluent Distribution Channel, Return Activated Sludge Chamber, Septage Receiving Station, Gravity Thickener Tank, and Sludge Dewatering Building are conveyed to the Process Biofilter (Biofilter B). Two variable speed, centrifugal exhaust fans installed in the Biofilter Building are used to continuously ventilate air from the various process buildings. The airspace from the Compost Facility is conveyed to the Compost Biofilter (Biofilter A), by means of five exhaust blowers. The basis of design for the process and compost odor control ventilation system is presented in **Table 6-1**.

FIGURE 6-1
EXISTING OPEN-BED BIOFILTERS

TABLE 6-1

EXISTING ODOR CONTROL VENTILATION SYSTEM

BASIS OF DESIGN

Parameter	Process Odor Control	Compost Odor Control
Design Ventilation Rate (CFM)	20,160	37,625
No. of Fans	2	5
Type of Fan	Centrifugal	Centrifugal
Capacity, each (CFM)	20,160	7,525
Static Pressure (in. WC)	14	12
Motor (HP)	75	25
Speed Control	Variable	Two Speed
Manufacturer	Greenheck	McQuay Intl.
Year Installed	2003	1989

6.2 VENTILATION RATES & NFPA 820

The ventilation rates and electrical classifications in accordance with NFPA 820-2012 edition are shown in **Table 6-2** (Process Odor Control) and **Table 6-3** (Compost Odor Control) for each space at the Fairfield WPCF that is tied into the associated odor control system. These existing classifications shall be utilized where work is performed as a part of this project, unless changed by proposed ventilation rate modifications.

TABLE 6-2
PROCESS ODOR CONTROL
EXISTING AND PROPOSED MINIMUM VENTILATION RATES

Building/Structure	Ventilation Rate (CFM)	Ventilation Rate (Air Changes/ Hour)	Ventilation Rate Code[a]	NEC-Area Electrical Classification (All Class 1, Group D)[b]	Comments
Influent Building	**6,120**	**13**	**B**	**Division 2**	
Lower Floor Influent Channel	900	9	A	Division 1, 2 (See comment)	The exhaust flow from the channels needs to be rebalanced to provide 1,350 CFM, resulting in Division 2 rating
Lower Floor Screen Room	1,000	12	B	Division 2	
Upper Floor Fine Screenings Room	700	15	B	Division 2	
Upper Floor Grit/Screening Room	3,520	15	B	Division 2	
Septage Receiving Station	**1,650**	**12**	**B**	**Division 2**	
Septage Pump Room	850	13	B	Division 2	
Septage Receiving Room	800	12	B	Division 2	
Primary Settling Tanks					
Effluent Channels	400	12	B	Division 2	Two 6 inch-Drop lines to the Process Odor Control tied to the PST effluent channels
Return Activated Sludge					
Chamber	100	12	C	Unclassified, except connected to Division 2 spaces	One 6 inch-Drop line to Process Odor Control tied to the activated sludge box at AT A

Building/Structure	Ventilation Rate (CFM)	Ventilation Rate (Air Changes/ Hour)	Ventilation Rate Code[a]	NEC-Area Electrical Classification (All Class 1, Group D)[b]	Comments
Gravity Thickener					
Tank	1700	12	B	Division 2	One 6 inch- Drop lines are tied to the tank
Sludge Dewatering Building	**12,000**	**15**	**B**	**Unclassified, except connected to Division 2 spaces**	Must be ventilated at 6 ac/hour or rated Division 2
Upper Section	9,000	19	B	Unclassified, except connected to Division 2 spaces	
Lower Section	3,000	10	B	Unclassified, except connected to Division 2 spaces	
Influent Building- Auxiliary Wet Well	200	12	B	Division 2	**Building/Structures not tied into the Main Process Odor Control System**
Control Building- Main Wet Well	350	12	B	Division 2	
Totals					
Existing Process Odor Control System	21,970	Varies		Division ½ (See comment)	Reduces to Division 2 once exhaust in Influent Building is rebalanced to provide 12 AC/hr from Influent Channel
Proposed Process Odor Control System	10,870	12		Division 2	
Proposed Sludge Dewatering Building	4,805	6		Unclassified	

TABLE 6-3
COMPOST ODOR CONTROL
EXISTING AND PROPOSED MINIMUM VENTILATION RATES

Building/Structure	Ventilation Rate (CFM)	Ventilation Rate (Air Changes/ Hour)	Ventilation Rate Code[a]	NEC-Area Electrical Classification (All Class 1, Group D)[b]	Notes
Minimum Required Ventilation Rates					
Receiving Mixing and Loading Area	7,560	6	C	Unclassified	
Composting Area	17,388	6	C	Unclassified	
Finishing Pits	1,200	6	C	Unclassified	
Totals					
Existing Compost Odor Control System	37,625	8.5	>C	Unclassified	Can be turned down by 50% (13,074 CFM) when ambient temperature is < 50^0 F
Proposed Compost Odor Control System with Existing Positive Aeration	52,296	12	>C	Unclassified	
Proposed Compost Odor Control System with Negative Aeration	26,148	6	C	Unclassified	

Notes:

The following ventilation codes are used in the Tables 6-2 and 6-3:

[a]**A**: No ventilation or ventilated at less than 12 air changes per hour.
B: Continuously ventilated at 12 changes per hour
C: Continuously ventilated at six air changes per hour
D: No ventilation or ventilated at less than six air changes per hour
NR: No requirement

The following electrical classification codes are used in Tables 6-2 and 6-3:

[b]**Class 1, Division 1**: <12 air changes per hour
Class 1, Division 2: 12 air changes per hour
Unclassified: No requirement (NR)

6.3 PROCESS ODOR CONTROL VENTILATION SYSTEM

The ventilation rates for the existing process odor control system at the Fairfield WPCF were compared with NFPA 820 requirements for liquid and solids treatment processes, as shown in **Table 6-2**. The Influent Building, Septage, Receiving Station, Primary Settling Tanks Channels and Gravity Thickener are spaces that would be rated Division 1 if ventilated at less than 12 air changes per hour (AC/hour). These spaces meet the NFPA 820 required minimum ventilation rates of 12 continuous air changes per hour, and hence are designated as Class 1, Division 2 spaces. It should be noted that the air intakes to the influent channel needs to be revised to increase the exhaust rate to 1,350 CFM to provide 12 AC/hour. This should be possible without increasing the overall exhaust rate from the Influent Building.

The Sludge Dewatering Building containing the gravity belt thickener (GBT) and belt filter press (BFP) systems requires no more than 6 AC/hour to be considered unclassified under NFPA 820. However, the existing building is cross-connected with Division 2 air spaces and therefore must be classified as a Division 2 space, even though the actual ventilation rate of 12,000 CFM provides 15 AC/hour.

6.4 COMPOST ODOR CONTROL VENTILATION SYSTEM

Table 6-3 shows the ventilation rates for the compost odor control system that are required to be considered unclassified under NFPA 820. The compost facility is an enclosed area where compost system feed mix is prepared by blending the dewatered sludge with amendments (leaves and wood chips) in the receiving/mixing area. The feed mix is then loaded into the composting bins which operate under 'positive aeration' with process air moving through the compost material and released into the enclosed building. The compost is discharged into the finishing pits and hauled across the street to the yard waste facility for further processing and distribution by others. The actual compost facility ventilation capacity of 37,625 CFM exceeds the NFPA 820 required minimum of 6 AC/hour which corresponds to around 26,500 CFM.

6.5 VENTILATION ALTERNATIVES

The Sludge Dewatering Building is a major portion of the overall Process Odor Control exhaust. The Sludge Dewatering Building currently is ventilated at 12,000 CFM which corresponds to 15 AC/hour and is significantly higher than that required under NFPA 820 to be unclassified. Since the Sludge Dewatering Building is cross-connected with Division 2 rated spaces it must be considered a Division 2 rated space under the National Electrical Code/NFPA 820, even with the high ventilation rate. The high ventilation rate was presumably selected due to the use of a belt filter press for dewatering. Odor levels were observed to be quite low in the Dewatering Room, and it might be possible to reduce the ventilation rate event if the plant continues with BFP dewatering. However, new enclosed Screw Presses have been proposed for dewatering, and would allow the ventilation rate to be reduced to 6 AC/hour or 4,805 CFM.

Currently, the equipment in the Sludge Dewatering Building is unclassified and does not meet Division 2 requirements. The recommended approach for the proposed dewatering upgrade is to separate the dewatering exhaust from the other process exhausts, so that the Dewatering Building can be considered unclassified, rather than having to upgrade to Division 2 as part of any dewatering upgrade. The ventilation for the Sludge Dewatering Building would be reduced to 4,805 CFM (6 AC/hour), in conjunction with a new enclosed dewatering technology. This will also minimize electrical and heating costs. Options for odor control of the dewatering exhaust are presented in the Odor Control Alternatives Section.

The auxiliary wet well in the Influent Building and the main wet well in the Control Building are currently not tied into the Process Odor Control System. Wet wells are typically completely enclosed structures and are Class 1, Division 1 rated spaces, unless ventilated at 12 AC/hour or greater. The auxiliary wet well is currently not a ventilated space and would require approximately 200 CFM at 12 AC/hour. This could easily be ducted to the Process Odor Control System, especially if the Dewatering Building exhaust is removed as proposed.

The main wet well in the Control Building has its own ventilation system (300 CFM), which discharges directly to atmosphere. The system is currently not operated due to odor control issues. The odorous exhaust is often recycled back into the building through rooftop intake units. The exhaust from the ventilation system could be extended and tied into the Process Odor Control duct and routed to the biofilter.

After removal of the Dewatering exhaust and addition of the auxiliary wet well from the Influent Building and Main Wet Well from the Control Building, the resulting ventilation rate for the Process Odor Control System would be 10,870 CFM. All spaces connected to this system would be rated Division 2. Options to upgrade the existing Process Biofilter for the revised flow are addressed in the Odor Control Alternatives section.

The existing ventilation system for the Composting Facility provides 37,625 CFM capacity which corresponds to 8.5 AC/hour. This exceeds the minimum ventilation rate of 6 AC/hour or 26,148 CFM for an unclassified rating. Nevertheless, the ventilation rate has been considered unsatisfactory in terms of providing adequate working conditions. Several alternatives have been identified for improving working conditions including:

- Increasing the ventilation rate to 12 AC/hour or 52,926 CFM, while continuing to rely on positive aeration for the composting process. In addition, the existing hydronic make-up air units would be renovated to be either indirect or direct natural gas-fired furnace systems, and one of the units would be relocated to discharge through the feed mix end wall.
- Converting the Compost Process to utilize negative aeration, which would allow the ventilation rate to be reduced to 6 AC/hour or 26,148 CFM. The make-up air system would be upgraded.

Options to upgrade the existing Compost Biofilter for the revised flows are addressed in the Odor Control Alternatives Section.

A final consideration is that it would be possible to combine the Dewatering exhaust and the compost Facility exhaust in the context that they would not affect the electrical classification under NFPA 820. For the negative aeration option, the existing Compost biofilter might be considered to have adequate capacity for the additional Dewatering exhaust (26,148 CFM + 4,805 CFM = 30,953 CFM). However, this option was ruled out, because the ventilation system controls would be fairly complex, and there would be the potential for back flow from the Compost Area to the Dewatering Area at times when the Dewatering Area is not in operation.

6.6 PROCESS & COMPOST BIOFILTERS

The Process Biofilter (A) and Compost Biofilter (B) are located on the western side of the Compost Facility. A combination of above-ground and buried ductwork is used to convey odorous air to the biofilters. The biofilters are comprised of a network of perforated piping installed in a crushed stone base (pipe-in-stone) under the biofilter media. The media is comprised of 95%-hardwood chips and 5%-yard waste compost which supports the growth of naturally-occurring microorganisms that can oxidize odorous compounds including hydrogen sulfide, sulfur dioxide and ammonia. The biofilters are lined with an impermeable synthetic membrane and an underdrain system to collect leachate, which is returned to the headworks. Periodic watering of the biofilter media may be necessary, particularly during warm dry weather conditions to provide the moisture needed for odor removal and for biological growth in the filter media. The basis of design for the biofilter systems is presented in **Table 6-4**.

The existing pipe-in-stone biofilters are currently effective in treating the process and compost odors generated at the plant. The biofilter media is provided by Harvest Power (Yard Waste Facility) across the street from the WPCF, as part of their agreement with the Town of Fairfield. Harvest Power also markets the spent biofilter media, when the media is replaced. The biofilters were designed to provide odor removal efficiency of about 80-95% for hydrogen sulfide and ammonia.

TABLE 6-4

EXISTING BIOFILTER SYSTEMS

BASIS OF DESIGN

Parameter	Process Biofilter (B)	Compost Biofilter (A)
Media Depth, ft.	4	4
Surface Area, sq. ft.	6,240	13,920
Design Air Flow Rate (CFM)	20,160	37,625
Design Air Loading Rate (CFM/sq. ft.)	3.2	2.7
Detention Time at Max Air Flow (min)	68	89

6.6.1 Biofilter A Exhaust Blowers

The two Biofilter A exhaust blowers are located in the biofilter building. They are both old and inefficient and will no longer be required if a new activated carbon unit is installed. If the process biofilter is maintained, these will be replaced with new smaller blowers or rebuilt.

6.6.2 Biofilter B Exhaust Blowers

The five Biofilter B exhaust blower are located at the exterior of the Compost Building. They are both old, inefficient, leak condensate and are recommended for replacement.

6.7 SCREENING OF ODOR CONTROL ALTERNATIVES

As discussed in the Ventilation Alternatives section, a number of changes to the existing Process and Compost Odor Control Systems are either necessary to comply with electrical classification issues in the most cost effective manner or are desired to improve odor control and working conditions at the facility. The net result is that there will be three odor control systems after the upgrades, and the following options were identified for more detailed evaluation of odor control alternatives.

I. Dewatering Building Exhaust: 4,805 CFM

II. Process Odor Control System Exhaust: 10,520 CFM

III. Compost Odor Control System Exhaust:

- 52,296 CFM with Positive Aeration, or
- 26,148 CFM with Negative Aeration

Although the existing biofilters have been effective at odor removal, there have been issues with low ventilation rates due to high headloss. As the organic media ages, it degrades resulting in higher head loss. Often organic media is replaced every 1 to 2 years in order to maintain the headloss in the range for centrifugal exhaust fans to achieve their design ventilation rates. This is an issue for both the Process and Compost Biofilters, and is a key concern of the WPCF staff with continued reliance on biofilters.

In addition, the existing pipe-in-stone air distribution systems for the existing biofilters have reached the point where they need to be rebuilt due to migration of fines from the media into the stone layer. The existing pipe-in-stone distribution systems have also been problematic because they were not designed to allow traffic by construction vehicles like front-end loaders that are used for media replacement. As a result, special protective measures have been required that increase the cost of media replacement and make it more difficult to schedule.

The facility has not conducted monitoring of exhaust air concentrations of hydrogen sulfide, ammonia or other odorous compounds in any of the exhaust streams. Consequently, engineering judgement has been used to assess the feasibility of alternatives based on staff preferences for technologies as well as the positive experience with adequate odor removal for the existing open bed biofilters. As discussed further below, some monitoring of hydrogen sulfide levels is recommended prior to proceeding with design of improvements. The odor control alternatives for Dewatering, Process, and Compost exhausts identified for further evaluation at the Fairfield WPCF are presented in **Table 6-5** and summarized below:

TABLE 6-5

ODOR CONTROL ALTERNATIVES AND REVISED VENTILATION RATES

Odor Sources	Revised Ventilation Rates (CFM)	Odor Control Alternatives			
DEWATERING EXHAUST	4,805			Packaged Proprietary Biofilter	Activated Carbon System
PROCESS EXHAUST	10,870	Refurbished Pipe-in-Stone Biofilter	BacTee Biofilter with Organic Media	Open Bed Proprietary Biofilter	Activated Carbon System
COMPOST EXHAUST	52,296 CFM (Positive Aeration) 26,148 CFM (Negative Aeration)	Refurbished Pipe-in-Stone Biofilter	BacTee Biofilter with Organic Media		

6.7.1 Refurbished Pipe-in-Stone Biofilters

The pipe-in-stone distribution system for both biofilters is in need of replacement. There has been significant fines migration into the stone layer, and this needs to be removed and replaced to reduce pressure drop. This option is viable for the remaining Process Exhaust and the Compost Exhaust. However, there was no viable location for an open-bed biofilter for the dewatering exhaust.

6.7.2 BacTee Biofilter with Organic Media

The existing pipe-in-stone distribution plenum was not designed to allow construction equipment traffic over it. The BacTee floor is representative of plenums that would allow construction equipment traffic. This would make it easier to replace the media, and would allow for more frequent replacement more feasible. This option is viable for the remaining Process Exhaust and the Compost Exhaust. However, there was no viable location for an open-bed biofilter for the dewatering exhaust.

6.7.3 Packaged Proprietary Biofilter – With BacTee or Packaged Configuration

Proprietary media are available in a wide range of materials including both organic and inorganic matrices. The advantage of inorganic matrices is extremely long media life with consistent headloss characteristics. Effective treatment can usually be provided at a lower detention time compared to organic media. The primary disadvantage is higher cost. The options include product offerings from BioRem, ECS, and Anua resulting in a competitive marketplace. Given the size of the Process exhaust, an open bed configuration using the BacTee air distribution system was considered the preferred configuration. The compost exhaust was not considered a good option for proprietary inorganic media due to the high ammonia and particulate in the exhaust. For the smaller air flow rate of the Dewatering Building exhaust, an enclosed packaged configuration was considered preferred.

6.7.4 Activated Carbon System

Activated carbon can be a highly cost effective option for applications with moderate hydrogen sulfide levels. The annual average loading of hydrogen sulfide is the key consideration in determining media life. This option was considered applicable for the process exhaust and the dewatering exhaust. For the compost exhaust, the high levels of particulate and the wider range of odorous compounds are not a good fit for activated carbon.

6.8 DETAILED ODOR CONTROL ALTERNATIVES

Table 6-6 summarizes the design criteria for the odor control alternatives for the Dewatering, Process and Compost exhaust. The alternatives for each exhaust stream, including the advantages and disadvantages, are further evaluated below.

6.8.1 Dewatering Exhaust

As noted above, there is no monitoring data for the concentration of odorous contaminant in the dewatering exhaust. The odor sources including dewatering of the anaerobically-digested sludge, cake storage in the compost feed mix truck, and gravity belt thickening of the waste activated sludge (prior to digestion). The observed odors in the dewatering area with both dewatering and thickening in operation were moderately low. The odor emissions from the dewatering operation and cake storage are anticipated to be relatively constant throughout the year, since the anaerobic digester operates under controlled temperature conditions. Based on site observations with the existing exhaust rate of approximately 12,000 CFM, it is estimated that the projected annual average hydrogen sulfide level will likely be in the range of 1 ppm to 5 ppm at the revised exhaust air flow rate of 4,805 CFM. The two alternatives of proprietary biofilter and activated carbon were evaluated based on this anticipated level of hydrogen sulfide and other reduced sulfur compounds. It should also be noted that anaerobically-digested sludge often releases significant quantities of ammonia. This is not typically an off-site odor concern, but the impact of ammonia needs to be considered in assessing odor control alternatives. Both odor control options are considered to be compatible with the ammonia emissions.

6.8.1.1 Alternative 1 – Proprietary Biofilter

For the proprietary packaged biofilter alternative, the vessel would be pre-fabricated of either stainless steel or FRP. The exhaust would be preconditioned in a humidification stage prior to passing through the inorganic media (ECS-BioPure / Biorem-Biosorbens / Anua) for removal. The bacteria present within the moisture film surrounding the media surface oxidize the odorous compounds prior to atmospheric discharge. A picture of an engineered media system similar to that proposed to treat Dewatering exhaust is shown in **Figure 6-2**. The proprietary media would provide considerable performance flexibility to handle both the anticipated range of hydrogen sulfide emissions and ammonia emissions. In fact, the proprietary biofilter would be expected to provide adequate hydrogen sulfide removal for levels up to 10 ppm on average.

TABLE 6-6

DESIGN SUMMARY OF ODOR CONTROL ALTERNATIVES

<table>
<tr><th>I</th><th colspan="4">DEWATERING EXHAUST</th></tr>
<tr><th>Design Parameters</th><th colspan="2">Packaged Proprietary Biofilter</th><th colspan="2">Activated Carbon System</th></tr>
<tr><td>Revised Ventilation Rates (CFM)</td><td colspan="4">4,805</td></tr>
<tr><td>Dimensions (sq. ft.)</td><td colspan="2">440</td><td colspan="2">240</td></tr>
<tr><td>Media Depth (ft.)</td><td colspan="2">5</td><td colspan="2">6</td></tr>
<tr><td>Detention Time (seconds)</td><td colspan="2">25</td><td colspan="2">3.60</td></tr>
<tr><th>II</th><th colspan="4">PROCESS EXHAUST</th></tr>
<tr><th>Design Parameters</th><th>Refurbished Pipe-in-Stone Biofilter</th><th>BacTee Biofilter with Organic Media</th><th>Open Bed Proprietary Biofilter</th><th>Activated Carbon System</th></tr>
<tr><td>Revised Ventilation Rates (CFM)</td><td colspan="4">10,870</td></tr>
<tr><td>Dimensions (sq. ft.)</td><td>3,120</td><td>3,090</td><td>1,000</td><td>320</td></tr>
<tr><td>Media Depth (ft.)</td><td>4</td><td>4</td><td>6</td><td>2.5</td></tr>
<tr><td>Detention Time (seconds)</td><td>68</td><td>68</td><td>30</td><td>3.10</td></tr>
<tr><th>III</th><th colspan="4">COMPOST EXHAUST</th></tr>
<tr><th>Design Parameters</th><th colspan="2">Refurbished Pipe-in-Stone Biofilter</th><th colspan="2">BacTee Biofilter with Organic Media</th></tr>
<tr><td>Media Depth (ft.)</td><td colspan="2">4</td><td colspan="2">4</td></tr>
<tr><td>Revised Ventilation Rates (CFM)</td><td colspan="4">52,296
(Positive Aeration w/ 12 AC/hour)</td></tr>
<tr><td>Dimensions (sq. ft.)</td><td colspan="2">13,920</td><td colspan="2">13,920</td></tr>
<tr><td>Detention Time (seconds)</td><td colspan="2">64</td><td colspan="2">64</td></tr>
<tr><td>Dimensions (sq. ft.)</td><td colspan="2">19,350</td><td colspan="2">19,350</td></tr>
<tr><td>Detention Time (seconds)</td><td colspan="2">89</td><td colspan="2">89</td></tr>
<tr><td>Revised Ventilation Rates (CFM)</td><td colspan="4">26,148
(Negative Aeration w/ 6 AC/hour)</td></tr>
<tr><td>Dimensions (sq. ft.)</td><td colspan="2">9,680</td><td colspan="2">9,680</td></tr>
<tr><td>Detention Time (seconds)</td><td colspan="2">89</td><td colspan="2">89</td></tr>
</table>

Advantages of Proprietary Engineered Media Biofilter Units:

- The engineered media provides an optimal surface for microbial growth without media degradation. This allows use of lower detention times while providing predictable and consistent removal efficiency
- Smaller footprint allows use of biofiltration in tighter areas.
- Lower headloss characteristics minimize power costs.
- The engineered media typically has a guaranteed media life of 10 years, and actual life can be 20-years or more.
- Operations and maintenance costs of the engineered media units is minimal.

Disadvantages of Proprietary Engineered Media Biofilter Units:

- High capital costs. The engineered media biofilter systems require additional equipment for humidity and temperature control to ensure optimum performance.
- Winter performance requires maintenance of adequate exhaust air temperature, and can result in additional heating costs for optimum performance.

FIGURE 6-2

TYPICAL PACKAGED BIOFILTER

6.8.1.2 Alternative 2 - Activated Carbon System

An activated carbon system for a dewatering system will sometimes utilize two carbons in series. The first carbon will be for hydrogen sulfide and other reduced sulfur compounds, and the second carbon will have additional reduced sulfur capacity as well as for other VOCs. Based on discussions with ECS, a dual-bed, radial flow vessel has been proposed for activated carbon for this application for budgetary purposes. The vessel would be constructed of FRP. The system would include an FRP grease and mist eliminator prior to the carbon. The exhaust fan would also have an FRP sound enclosure. A picture of a similar activated carbon system is shown **in Figure 6-3**. The proposed carbon is the new high capacity catalytic carbon with a 0.3 g H2S/cc carbon capacity. While the manufacturer has suggested the dual bed media for this application, the ammonia in the exhaust would interfere with VOC removal. Consequently, the possibility of going with a single bed design using the catalytic carbon would likely be favored. The carbon life was estimated based on an annual average concentration for hydrogen sulfide of 3 ppm and 5 ppm, and assuming that the entire bed was the catalytic carbon. The corresponding bed life was estimated to be 8.4 years for the 3 ppm annual average and 5 years for the 5 ppm annual average.

FIGURE 6-3

TYPICAL ACTIVATED CARBON SYSTEM

Advantages of Activated Carbon System:

- The standalone system is compact with high performance and relatively low capital costs.
- Based on the estimated moderate levels of hydrogen sulfide, the projected bed life is reasonably long (5 to 8.4 years) between media change out.
- The system is straightforward to operate, and the only monitoring is to check the level of sulfur building on the media.

- Operations and maintenance costs are minimal, except for the carbon change out cost.

Disadvantages of Activated Carbon System:

- The life cycle costs increase substantially when the need for media change out is more frequent.

6.8.2 Process Exhaust

As noted above, there is no monitoring data for the concentration of odorous contaminants in the process exhaust. The odor sources include Influent Building, Primary Settling Tank effluent channels, Return Activated Sludge chamber, Gravity Thickener, and Control Building main wetwell. The wastewater sources typically release predominantly hydrogen sulfide, which the sludge source (Gravity Thickeners) would be expected to include other reduced sulfur compounds. The overall exhaust is predominantly from wastewater sources, so the emissions should be predominantly hydrogen sulfide with a small amount of other reduced sulfur compounds. Based on site observations, it is estimated that the projected annual average hydrogen sulfide level will likely be in the range of 5 ppm to 10 ppm at the revised exhaust air flow rate of 10,870 CFM. The four odor control alternatives were evaluated based on this anticipated level of hydrogen sulfide.

6.8.2.1 Alternative 1: Refurbishing Pipe-in-Stone Biofilter

Under this alternative, the existing pipe-in-stone media would be refurbished to continue to treat the Process exhaust. Because the exhaust flow rate has been reduced due to separation of Dewatering exhaust, the area of the piping in stone air distribution system would be reduced proportionally, and the overall biofilter would decrease to 3,120 sq.ft. to maintain the same detention time of 68 seconds. Since the existing biofilter has been successful in treating the odorous emissions at this detention time, the upgraded system would be designed for the same. The system is proposed to utilize the existing organic media blend of 95% hardwood chips and 5% yard-waste compost. Ideally, the frequency of organic media replacement would be increased from the current 4 to 5-year period to 2 to 3 years to reduce problems with high pressure drop. The maintenance requirements for the biofilters include watering of the bed to maintain moisture levels and control of weeds.

Advantages of Piping-in-Stone Biofilter:

- Relatively low capital cost, limited to the construction of a new pipe-in-stone system.
- Minimal changes to existing site features and operation.
- The material costs associated with recurrent organic media replacement are marginal, as it is provided by Harvest Power under their agreement with Town of Fairfield.

Disadvantages of Piping-in-Stone Biofilter:

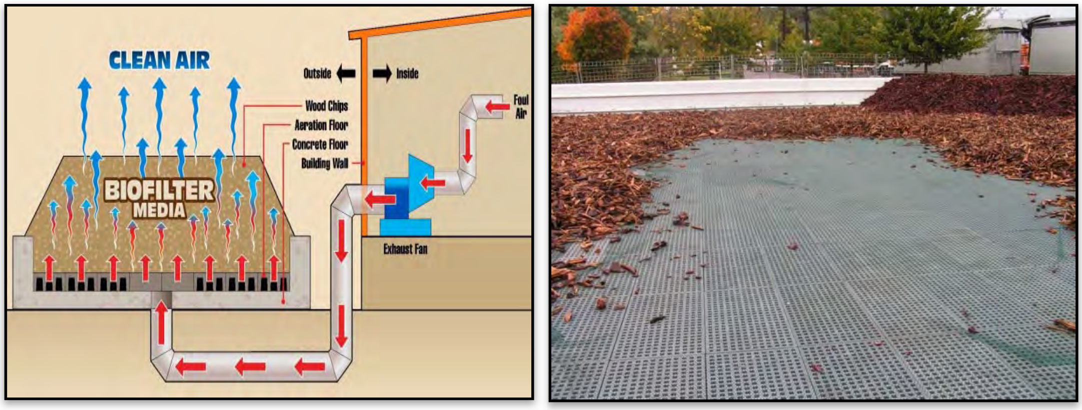
- Significant amount of time and labor for removal and installation of the media.
  Highly variable headloss over time due to media compaction.
- Buildup of hardpan on the plenum surface.

6.8.2.2 Alternative 2: BacTee Biofilter with Organic Media

Under this alternative, the existing pipe-in-stone biofilter would be converted to a BacTee (BDP-BacTee) plenum floor type system with the existing organic media. The BacTee system is designed to create more uniform distribution of air through the media with a lower pressure drop while allowing construction vehicle traffic. It should be noted that BDP-BacTee recommends use of higher media depths of 6-7 feet to reduce the area of the biofilter, while providing the same detention time. This requires a courser style of media that might not have the same removal characteristics as the existing media. For this reason, the BacTee floor was evaluated for the area required using the existing media at 4-foot depth. The BacTee system is illustrated in **Figure 6-4**. In order to implement this solution, the existing biofilter would be completely removed to install contiguous cells with the necessary concrete base for the recessed areas to house the BacTee Baseplates and Trench Covers. These components are very easy to install and have a very high strength-to-weight ratio, which gives them the ability to support both static and live loads typically associated with the periodic placement and removal of biofilter media using conventional construction equipment such as large front end loaders.

FIGURE 6-4

BACTEE SYSTEM



Advantages of BacTee Biofilter with Organic Media:

- Easy installation of plenum floors with minimal operation and maintenance,
- Easy media replacement.
- The material costs associated with recurrent organic media replacement are marginal, as it is provided by Harvest Power under their agreement with Town of Fairfield.

Disadvantages of BacTee Biofilter with Organic Media:

- Significant capital costs for BacTee flooring system not including the costs for demolition of existing system, concrete work and piping.
- Significant amount of time and labor for removal and installation of the media.
- Highly variable headloss over time due to media compaction.

6.8.2.3 Alternative 3: BacTee Biofilter with Proprietary Media

Under this alternative, the existing pipe-in-stone biofilter would be converted to a BacTee (BDP-BacTee) plenum floor type system using a proprietary media from either BioRem and ECS. The BacTee system is designed to create more uniform distribution of air through the media with a lower pressure drop while allowing construction vehicle traffic. With the proprietary media, the detention time would be reduced to 30 seconds and the media depth increased to 6 feet to reduce the area of the biofilter. The BacTee system is illustrated in **Figure 6-4**.

In order to implement this solution, the existing biofilter would be completely removed to allow installation of the new concrete base cells to house the BacTee Baseplates and Trench Covers. These components are very easy to install and have a very high strength-to-weight ratio, which gives them the ability to support both static and live loads typically associated with the periodic placement and removal of biofilter media using conventional construction equipment such as large front end loaders.

Advantages of BacTee Biofilter with Engineered Media:

- The engineered media provides an optimal surface for microbial growth without media degradation. This allows use of lower detention times while providing predictable and consistent removal efficiency
- Smaller footprint allows use of biofiltration in tighter areas.
- Lower headloss characteristics minimize power costs.
- The engineered media typically has a guaranteed media life of 10 years, and actual life can be 20-years or more.
- Operations and maintenance costs of the engineered media units is minimal.

Disadvantages of BacTee Biofilter with Engineered Media:

- High capital costs both for the installation of BacTee system and the engineered media for the system.
- The engineered media biofilter also requires additional equipment for humidity and temperature control.
- Winter performance requires maintenance of adequate exhaust air temperature, and can result in additional heating costs for optimum performance.

6.8.2.4 Alternative 4 - Activated Carbon System

An activated carbon system for the Process exhaust would have a single bed focused on hydrogen sulfide removal, and should have adequate capacity for other reduced sulfur compounds as well. Based on discussions with ECS, a radial flow vessel has been proposed for activated carbon for this application for budgetary purposes. The vessel would be constructed of FRP. The system would include an FRP grease and mist eliminator prior to the carbon. The exhaust fan would also have an FRP sound enclosure. A picture of a similar activated carbon system is shown in **Figure 6-3**. The proposed carbon is the new high capacity catalytic carbons with a 0.3 g H2S/cc carbon capacity. The carbon life was estimated based on an annual average concentration for hydrogen sulfide of 5 ppm and 10 ppm. The corresponding bed life was estimated to be 4.6 years for the 5 ppm annual average and 2.4 years for the 10 ppm annual average.

Advantages of Activated Carbon System:

- The standalone system is compact with high performance and relatively low capital costs.
- Based on the estimated moderate levels of hydrogen sulfide, the projected bed life is reasonable (2.4 to 4.6 years) between media change out.
- The system is straightforward to operate, and the only monitoring is to check the level of sulfur building on the media.
- Operations and maintenance costs are minimal, except for the carbon change out cost.

Disadvantages of Activated Carbon System:

- The life cycle costs increase substantially when the need for media change out is more frequent.

6.8.3 Compost Exhaust

As noted above, there is no monitoring data for the concentration of odorous contaminants in the Compost exhaust. The odor sources include the feed mix area, the composting area, and the finishing pit. The odor emissions are typically a mixture of reduced sulfur compounds where hydrogen sulfide is present, but not predominant, as well as large quantities of ammonia. There are also typically high levels of particulate in the exhaust air from the various material handling steps of the agitated bin composting process. As previously noted, the high particulate was considered incompatible with the proprietary engineered media, because clogging with particulate could dramatically reduce effective media life. The existing organic media has been highly effective at odor removal, but as previously noted degrades over time resulting in high headloss and reduced air flow rates. Nevertheless, the organic media was considered the best option for treating the composting exhaust for both the positive and negative ventilation alternatives. The goal for each alternative was to maintain the same detention time as the existing system.

6.8.3.1 Alternative 1: Refurbishing Pipe-in-Stone Biofilter

Under this alternative, the existing pipe-in-stone media would be refurbished to continue and treat the Compost exhaust for either the positive or negative aeration alternatives. As shown in **Table 6-6**, the area required increases to 19,350 sq.ft. to maintain the desired 89 second detention time. This might be possible depending on the alternative selected for the Process exhaust. However, if it is necessary to limit the Compost biofilter to the size of the existing biofilter of 13,920 sq.ft., then the detention time would be reduced to 64 seconds for the positive mode alternative. Conversely, under the negative mode alternative, the size of the biofilter decreases to 9,680 sq.ft. The system is proposed to utilize the existing organic media blend of 95% hardwood chips and 5% yard-waste compost. Ideally, the frequency of organic media replacement would be increased from the current 4- to 5-year period to 2 to 3 years to reduce problems with high pressure drop. The maintenance requirements for the biofilters as they decompose over time include the control of moisture and weeds.

Advantages of Piping-in-Stone Biofilter:

- Relatively low capital cost, limited to the construction of a new pipe-in-stone system.
- Minimal or no changes to existing site features and operation.
- The material costs associated with recurrent organic media replacement are marginal, as it is provided by Harvest Power under their agreement with the Town of Fairfield.

Disadvantages of Piping-in-Stone Biofilter:

- Significant amount of time and labor for removal and installation of the media.
- Highly variable headloss over time due to media compaction.
- Buildup of hardpan on the plenum surface.

6.8.3.2 Alternative 2: BacTee Biofilter with Organic Media

Because the media is proposed to be the same as for the piping-in-stone alternative, the BacTee system sizing would be the same as with Alternative 1. The BacTee system is designed to create more uniform distribution of air through the media with a lower pressure drop while allowing construction vehicle traffic. In order to implement this solution, the existing biofilter would be completely removed to allow installation of concrete cells to house the BacTee Baseplates and

Trench Covers. These components are very easy to install and have a very high strength-to-weight ratio, which gives them the ability to support both static and live loads typically associated with the periodic placement and removal of biofilter media using conventional construction equipment such as large front end loaders.

Advantages of BacTee Biofilter with Organic Media:

- Easy installation of plenum floors with minimal operation and maintenance,
- Easy media replacement.
- The material costs associated with recurrent organic media replacement are marginal, as it is provided by Harvest Power under their agreement with Town of Fairfield.

Disadvantages of BacTee Biofilter with Organic Media:

- Significant capital costs for BacTee flooring system not including the costs for demolition of existing system, concrete work and piping.
- Significant amount of time and labor for removal and installation of the media.
- Highly variable headloss over time due to media compaction.

6.9 LIFE CYCLE COST ANALYSIS OF ODOR CONTROL ALTERNATIVES

Each of the alternatives was evaluated on a life-cycle cost basis by developing both a capital cost estimate and an annual operating and maintenance cost estimate. The results are summarized in **Table 6-7** presenting the 20-year life cycle costs for the Dewatering exhaust; **Table 6-8** for the Process Exhaust; and **Table 6-9** for the Compost exhaust. **Table 6-10** presents a simplified 40-year life cycle analysis for the Compost exhaust.

6.9.1 Dewatering Exhaust

The 20-year life cycle costs for the Dewatering exhaust strongly favors the activated carbon option due to both lower capital costs and lower operating and maintenance costs as shown in **Table 6-7**. The lower operating and maintenance requirements reflect the ease of operation and maintenance. This option also has a smaller footprint, and would be easier to site adjacent to the Dewatering

Building. Conversely, the proprietary biofilter would offer the ability to readily handle a greater range of contaminants and higher concentrations.

TABLE 6-7

DEWATERING EXHAUST

SUMMARY OF 20-YEAR PRESENT WORTH COSTS

ALTERNATIVES	CAPITAL COSTS	PRESENT WORTH ANNUAL COSTS	TOTAL NET PRESENT WORTH
Proprietary Packaged Biofilter	$522,000	$173,000	**$695,000**
Activated Carbon System	$186,000	$147,000	**$333,000**

It is recommended that emissions testing be conducted prior to proceeding with preliminary design of an activated carbon system to ensure that the estimates for hydrogen sulfide concentrations can be confirmed. However, the life cycle analysis is based on an assumed average hydrogen sulfide concentration of 5 ppm, and activated carbon appears to be strongly favored. Thus, it not anticipated that the monitoring results would affect the recommendation to proceed with a new activated carbon system.

6.9.2 Process Exhaust

For the Process exhaust, the demolition costs for the existing biofilter were broken out separately, because they were adversely affecting alternatives with smaller footprints. It was felt that budgeting for complete demolition is appropriate rather than abandoning in place, and the recovered/reusable space is a meaningful benefit for those options with a smaller footprint. However, for comparison of alternatives, the capital cost without demolition has been used.

As shown in **Table 6-8 and Table 6-9**, the life cycle cost comparison is essentially a tie between replacing the existing piping-in-stone biofilter with a new unit sized for the smaller air flow rate, and a new activated carbon system. The replacement piping-in-stone biofilter is estimated to have a meaningfully lower capital cost, but higher annual operating and maintenance expenses. The activated carbon system has the second lowest capital cost, and the lowest annual operation and maintenance costs. It should be noted that the activated carbon system was evaluated assuming the upper end of the estimated annual average hydrogen sulfide concentration of 10 ppm. If actual concentrations are lower, the evaluation would shift to more clearly favor activated carbon, while if the actual annual average concentrations are higher the life cycle analysis would shift to favor the biofilter option.

The recommended plan is to proceed with a new activated carbon system, but to conduct emission testing prior to proceeding with preliminary design to confirm the magnitude of hydrogen sulfide levels is consistent with the recommendation for activated carbon.

TABLE 6-8

PROCESS EXHAUST

SUMMARY OF 20-YEAR PRESENT WORTH COSTS

ALTERNATIVES	CAPITAL COSTS	PRESENT WORTH ANNUAL COSTS	TOTAL NET PRESENT WORTH
Demolition & Excavation Costs	$77,000	$0	**$77,000**
Pipe-in-Stone Biofilter with Organic Media	$206,000	$590,000	**$796,000**
BacTee Biofilter with Organic Media	$379,000	$530,000	**$909,000**
Open-Bed Proprietary Biofilter	$679,000	$491,000	**$1,170,000**
Activated Carbon System	$332,000	$459,000	**$791,000**

6.9.3 Compost Exhaust

For the Compost exhaust, there were three size options evaluated for each of the two biofilter alternatives (piping-in-stone versus BacTee). As previously noted, the negative mode exhaust rate is proposed to be 26,148 cfm with a biofilter area of 9,680 sq.ft. For the 20-year life cycle cost analysis shown in **Table 6-9**, the piping-in-stone system is favored due to lower capital costs and only slightly higher operating and maintenance costs. An important consideration is that the piping-in-stone system would be expected to have a short useful life than the BacTee system. In **Table 6-10,** a 40-year life cycle cost analysis is presented assuming that the piping-in-stone system has a useful life of 20 years and the BacTee system has a useful life of 40 years. The 40-year life cycle analysis favors the BacTee system slightly if the piping-in-stone system must be replaced again at 20 years. Since it is difficult to ascertain that the town will continue to utilize the Compost Facility for more than 20-years, it appears that the piping-in-stone biofilter is favored overall. However, town staff should be consulted for the final decision based on the labor intensive task of media replacement.

For the positive mode exhaust rate of 52,296 cfm, there were two size options. The first was the desired sizing of 19,350 sq.ft. in order to maintain the same detention time as the existing, and the second was to use the existing biofilter size of 13,920 sq.ft. and allow a lower detention time. Similar to the negative mode evaluation, the piping-in-stone is favored over BacTee for the both of the 20-year life cycle analyses. However, for the 40-year life cycle analysis, the piping-in-stone system is still slightly favored for the two positive mode alternatives. For the desired sizing of 19,350 sq.ft., the positive mode aeration alternative would have a higher capital cost by $411,000 compared to negative mode, and a higher 20-year life cycle cost by $1,490,000. This is a strong compensating cost savings compared to the cost to implement negative aeration.

TABLE 6-9

COMPOST EXHAUST

SUMMARY OF 20-YEAR PRESENT WORTH COSTS

ALTERNATIVES	CAPITAL COSTS	PRESENT WORTH ANNUAL COSTS	TOTAL NET PRESENT WORTH
VENTILATION RATE (12 AC/hour)	**52,296 CFM**		
AERATION MODE	**POSITIVE**		
DIMENTIONS	**13,920 SQ. FT.**		
Pipe-in-Stone Biofilter with Organic Media	$864,000	$2,324,000	**$3,188,000**
BacTee Biofilter with Organic Media	$1,579,000	$2,188,000	**$3,767,000**
DIMENTIONS	**19,350 SQ. FT.**		
Pipe-in-Stone Biofilter with Organic Media	$1,115,000	$2,418,000	**$3,533,000**
BacTee Biofilter with Organic Media	$2,048,000	$2,270,000	**$4,318,000**
VENTILATION RATE (6 AC/hour)	**26,148 CFM**		
AERATION MODE	**NEGATIVE**		
DIMENTIONS	**9,680 SQ. FT.**		
Pipe-in-Stone Biofilter with Organic Media	$704,000	$1,339,000	**$2,043,000**
BacTee Biofilter with Organic Media	$1,182,000	$1,265,000	**$2,447,000**

TABLE 6-10

COMPOST EXHAUST

SUMMARY OF 40-YEAR PRESENT WORTH COSTS

ALTERNATIVES	CAPITAL COSTS	PRESENT WORTH ANNUAL COSTS	TOTAL NET PRESENT WORTH
VENTILATION RATE (12 AC/hour)	**52,296 CFM**		
AERATION MODE	**POSITIVE**		
DIMENTIONS	**13,920 SQ. FT.**		
Pipe-in-Stone Biofilter with Organic Media	$1,391,040	$2,324,000	**$3,715,040**
BacTee Biofilter with Organic Media	$1,579,000	$2,188,000	**$3,767,000**
DIMENTIONS	**19,350 SQ. FT.**		
Pipe-in-Stone Biofilter with Organic Media	$1,795,150	$2,418,000	**$4,213,150**
BacTee Biofilter with Organic Media	$2,048,000	$2,270,000	**$4,318,000**
VENTILATION RATE (6 AC/hour)	**26,148 CFM**		
AERATION MODE	**NEGATIVE**		
DIMENTIONS	**9,680 SQ. FT.**		
Pipe-in-Stone Biofilter with Organic Media	$1,133,440	$1,339,000	**$2,472,440**
BacTee Biofilter with Organic Media	$1,182,000	$1,265,000	**$2,447,000**

6.10 RECOMMENDED ODOR CONTROL ALTERNATIVES

Odor control improvements were evaluated for implementation as part of the overall WPCF upgrades, and significant revisions to the existing odor control systems are recommended.

The evaluation of existing odor control systems determined the need to separate the dewatering exhaust from the Process odor control system to avoid problems with NFPA 820. In conjunction with new dewatering equipment (evaluated separately), the exhaust rate in the Dewatering Building would be reduced from 12,000 cfm to 4,805 cfm. This will result in significant heating and ventilation system cost savings. The recommended odor control technology for the Dewatering exhaust is activated carbon, which had the lowest capital and life cycle costs. It also has the smallest footprint requirements, and consequently will be the easiest to locate near the Dewatering Building.

The Process odor control system will be modified significantly by the elimination of the Dewatering exhaust as well as the addition of small air flows from the new raw sewage wet well, Influent Pump Building and sludge storage tanks. The overall Process exhaust rate will change from 21,970 cfm to 10,870 cfm (to be confirmed during preliminary design). The recommended odor control technology is a new activated carbon system. However, the life cycle cost comparison with a new piping-in-stone biofilter is very close, and it is recommended that emissions testing for hydrogen sulfide be conducted to confirm that levels are consistent with the assumptions of the life cycle cost analysis. The life cycle analysis indicated that activated carbon had slightly lower costs for an annual average hydrogen sulfide concentration of 10 ppm. It should be noted that the activated carbon system has significantly smaller footprint requirements which would free up space on-site for other uses.

For the Compost Building, there is a strong desire to improve working conditions. The existing exhaust rate of 37,625 cfm does not provide adequate working condition with the existing positive mode aeration for the composting process. As a result, two ventilation alternatives were considered:

- Use negative aeration for the composting process to improve containment of composting off-gases, and allow the use of a slightly lower ventilation rate of 26,148 cfm.
- Continue with use of positive aeration for the composting process, and increase the ventilation rate to 52,296 cfm (12 air changes per hour).

For the odor control technology, replacement of the existing biofilter was considered necessary because of the building up of fines in the piping-in-stone distribution system. For both size options, a new piping-in-stone biofilter was the favored approach, but a BacTee biofilter was found to have a comparable or slightly lower life cycle cost over a 40-year evaluation period. The negative mode of operation would result in lower capital costs by $411,000 and lower 20-year life cycle costs by $1,490,000, which is a strong compensating savings for the cost of converting the composting process to negative aeration.

SECTION 7
ENERGY EVALUATION

WRIGHT-PIERCE
Engineering a Better Environment
70 YEARS 1947 - 2017

SECTION 7

ENERGY EVALUATION

7.1 INTRODUCTION

An energy evaluation of the Fairfield WPCF 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 WPCF which was performed through the following tasks:

- A review of the energy usage of the facility through electrical, fuel oil and natural gas bills.
- Site visits and on-site testing of flow, head and energy use of various equipment and systems to determine the breakdown of the quantity of energy being utilized in various parts of the facility.
- 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.
- Calculate Energy Benchmarking based on other similar sized facilities.

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)

7.2 CURRENT FACILITY ENERGY USE

To determine the current energy use and the cost of the existing WPCF a review of the 2015 electrical billing history was performed. A summary of the overall annual energy use at the facility is shown in **Table 7-1**. The monthly breakdown of energy usage and peak demand is presented in **Figure 7-1** below.

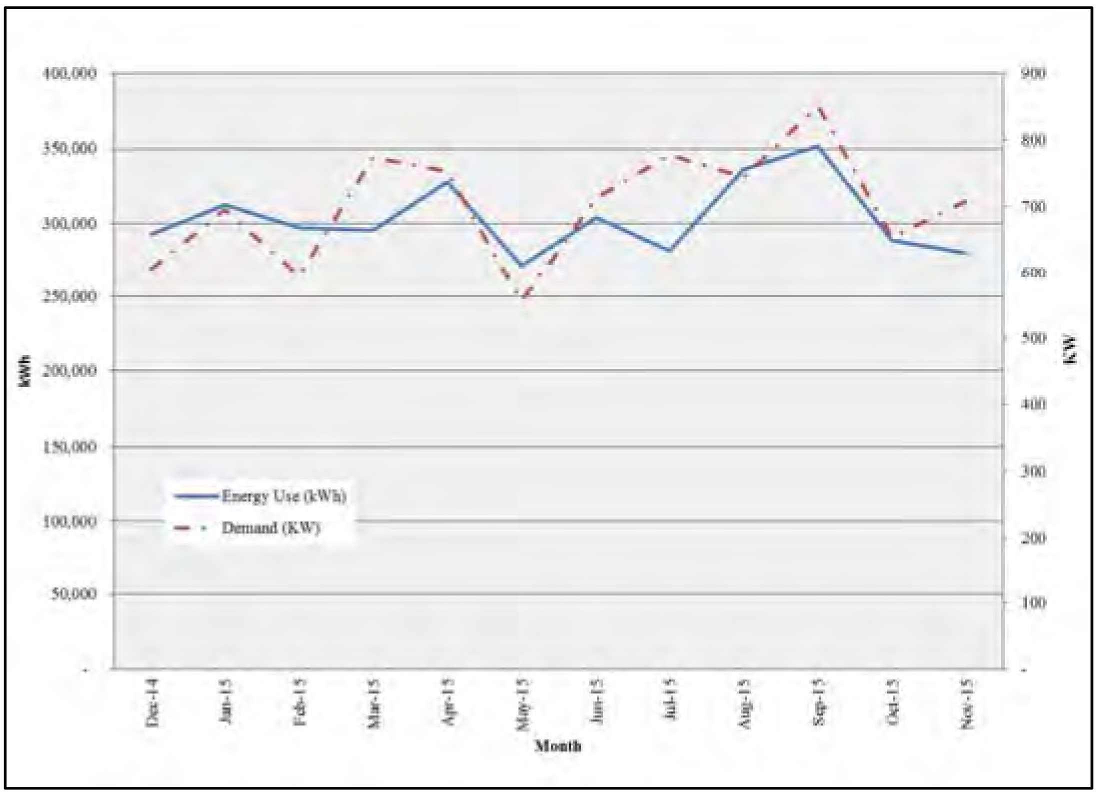
TABLE 7-1

2015 WPCF ELECTRICAL ENERGY USAGE

Facility	Annual Use (kWhs)	Average Monthly Cost	Annual Cost	Unit Cost
Fairfield WPCF	3,637,200	$37,256	$447,071	$0.123

FIGURE 7-1

2015 WPCF ELECTRICAL ENERGY USE



7.2.1 Rate Structure

The Fairfield WPCF is billed under United Illuminating's General Service Time-of-day (GST). This rate structure includes charges associated with generation rates on-peak and off-peak hours, combined public benefits charge, and Distribution charges including a basic service charge. The GST has a monthly service charge of $83.53 where demand (kW) is billed. The distribution demand charge remains constant throughout the year for on and off peak hours at $3.64 per kW. During the summer months (June through September) transmission demand charge is $8.71 per kW and $6.97 per kW for the remainder of the year for on-peak hours. The demand charge is $0.00 per kW for off-peak hours throughout the year. The distribution cost of electricity remains constant on and off peak hours and during summer and winter months at a rate of $0.0198 per kWh.

7.2.2 Generation Rate

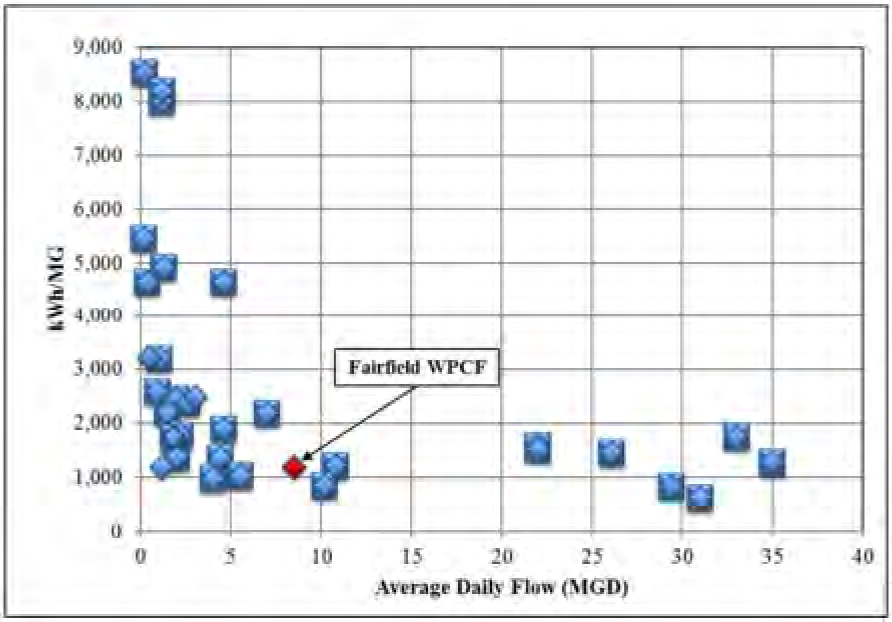
The Town of Fairfield has a third party generation supplier agreement with Nextera. Currently, the generation rates for GST are $0.12 for on-peak and $0.09 for off peak hours. The town-wide agreement through Nextera is currently lower than these rates. In December 2015 and January 2016, Fairfield paid a rate of $0.0864 per kWh through Nextera. This rate is a negotiated townwide contractual agreement for generation rates.

7.3 WASTEWATER ENERGY USE BENCHMARK

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 2,920 million gallons of wastewater treated in 2015, and the energy usage above, the plant consumes approximately 1,246 kWh per million gallons of wastewater treated, this energy usage is average when compared to other similarly sized plants as shown in **Figure 7-2**.

FIGURE 7-2

WPCF ENERGY USE PER MILLION GALLONS TREATED



7.4 ADDITIONAL RENEWABLE ENERGY PROJECTS

The Town of Fairfield has sought multiple renewable energy projects and improvements at the WPCF. Currently, the additional projects to be implemented in the short term include solar panel installation, establishing a microgrid, and installing a 400 kW fuel cell. Both the solar power and microgrid have both been funded through state programs and are in the construction and design phase, respectively.

The WPCF has also considered installing Combined Heat & Power (CHP) systems on the existing digesters to utilize the methane in the biogas and produce energy. Potential funding for these projects could be obtained through the Connecticut Department of Energy & Environmental Protection (DEEP) Public Utilities Regulatory Authority (PURA) for Renewable Energy Credits (RECs). Under the current legislation, anaerobic digestion biogas is considered a Class 1 renewable energy source, which is then eligible to participate in the states REC generation program known as the Low and Zero Emission Renewable Energy Credit program (LREC/ZREC). The program requires Eversource and United Illuminating to procure Class 1 RECs over a six-year period with a 15-year agreement. A REC represents 1,000 kWh of electricity. Based on recent bidding and sale of LRECs and ZRECs, biogas is considered an LREC, meaning there are low emissions associated with the fuel source.

7.5 SHORT-TERM EFFICIENCY IMPROVEMENTS

A detailed description of the results of the facility energy audit and potential energy efficiency improvements is provided in the Energy Evaluation Report, included in **Appendix C**. The potential improvements were divided into short-term and long-term upgrades based on their payback period and the integration of the improvements with other plant upgrades. The short-term recommended improvements are summarized in **Table 7-2** below and are consistent with the recommendations made in other sections of this report. It should be noted that the costs (reported in 2015 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 Town 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 WPCF upgrade.

TABLE 7-2
SHORT-TERM ENERGY EFFICIENCY IMPROVEMENTS

Cost Saving Measures	Annual Energy Savings (kWh)	First Year Annual Savings ($)	Initial Cost ($)	Simple Payback (yrs)
Add Timers to Zone B Surface Aerators	165,564	$20,384	N/A	Immediate
Solids Handling Off-peak Operation	N/A	$113,248	N/A	Immediate
Potential Energy Program Cost and Savings	**165,564**	**$133,632**	**N/A**	**Immediate**

7.6 LONG TERM EFFICIENCY IMPROVEMENTS

The long term recommended improvements are summarized in **Table 7-3** and are consistent with the other recommendations in this report. It should be noted that the costs (reported in 2015 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 Town may wish to incorporate. It should also be noted these long term efficiency improvements would be implemented during the WPCF upgrade.

TABLE 7-3
LONG-TERM ENERGY EFFICIENCY IMPROVEMENTS

Cost Saving Measures	Annual Energy Savings (kWh)	First Year Annual Savings ($)	Initial Cost ($)	Simple Payback (yrs)
Aeration Blower Optimization/Replacement	21,900	$2,694	$125,000	NA
Raw Sewage Pump Replacement	128,707	$15,831	$545,875	34.5
Return Sludge Pump Replacement	38,487	$4,734	$234,000	49.4
Replace Zone A Aeration Mixers	182,383	$22,433	$706,200	31.5
Coarse to Fine Bubble Diffusers in Zone B	304,130	$37,408	TBD	NA
Ammonia Based Process Control Programming	96,360	$11,852	$201,850	17.0
Re-aeration System Optimization	22,408	$2,756	$44,000	16.0
UV System Replacement	1,292,976	$159,036	$1,305,934	8.5
Sludge Recirculation Pump Replacement	9,831	$1,209	$29,000	24.0
Install Dewatering Screw Press	14,372	$1,768	$367,500	NA
Replace Plant Water System	Additional Investigation Recommended			
Replace Waste Sludge Pumps	2,576	$317	$36,000	NA
Demand Reduction Program	Additional Investigation Recommended			
HVAC System Upgrades	Additional Investigation Recommended			
Lighting System Upgrades	Additional Investigation Recommended			
Potential Energy Program Cost and Savings	**2,111,130**	**$260,038**	**$3,595,359**	**NA**

7.7 GREEN DESIGN STANDARDS

In addition to the energy efficiency improvements and possible renewable energy technologies that can be incorporated into the treatment plant upgrade, the 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 into this project 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.
- Stormwater management strategies that minimize run-off and water pollution can be implemented. More extensive methods such as a green roof and potential options for paved surfaces could also be assessed if Fairfield desired to determine their applicability for this site.
- Minimize impervious areas where possible and feasible. This includes limiting pavement as well as minimizing building footprint and using building space in an efficient manner.
- Water efficient landscaping utilizing native plant species.
- Minimizing the use of potable water for any processes that do not require it, or replacing potable water with plant water supply when possible.
- 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.
- 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.

SECTION 8
PLANTWIDE SUPPORT SYSTEMS

SECTION 8

PLANTWIDE SUPPORT SYSTEMS

8.1 INTRODUCTION

An evaluation was performed of on-site buildings, structures and process tankage by architectural, structural, process, mechanical and instrumentation and electrical engineers in March of 2016 and January of 2017. This section of the report will serve to summarize the results of the evaluations done of the WPCF site only; evaluations performed on the off-site pumping station are documented separately.

A summary of findings and recommendations, organized by engineering discipline, is included below.

8.2 SITE/ CIVIL EVALUATION

The following is a description of the general site/civil observations made during a January 10, 2017 site visit. It should be noted that a separate project aimed at providing flood protection at the facility is currently underway which could have an impact on proposed future improvements at the plant.

8.2.1 Site Fencing and Security

The perimeter of the existing facility is secured with an 8-foot high chain link fence, as well as an existing sound barrier wall on the northeast and southeast sides of the site. There are four access points into the facility with manual double swing gates. They include the headworks access, septage receiving area, final settling tank area, and main entrance to the west of the composting building. Overall, the fencing and gates are in good condition.

Automatic sliding gates are desired at 3 of the 4 gate locations. The gate for access to the headworks area will remain as a manual double swing gate and would likely be included in the

Flood Protection work discussed further below. New sliding gate locations will be equipped with card readers and induction loops for opening and closing. FOBs can be provided for the facility personnel. Gate controllers would be programmed to open at a set time of day and close when the facility is not staffed. Additional personnel gates will also be added adjacent to each automated gate.

8.2.2 Flood Protection Project

The Town of Fairfield is undertaking a Wastewater Treatment Plant Hardening Project. This is aimed at providing flood protection around the perimeter of the facility including One Rod Highway. Hurricane Sandy created major flooding problems for the plant due to the storm surge. Under the hardening project, the proposed berm height is elevation 16. There are several components of this hardening project that will need to be coordinated with future wastewater facility improvements. One of the areas where the storm surge flooded the facility was along One Rod Highway. The current concept is to raise the grade of One Rod Highway to elevation 17 at the entrance to the plant. Work in this area will require removing and resetting of the existing chain link fence and swing gate. The entrance drive to the headworks area will be reconstructed and grading against the aeration tanks will need to be coordinated.

Storm drains within the facility will be reconfigured and redirected to a new stormwater pumping station located to the southwest of the new Fire Training Facility. All of the remaining stormwater outfalls will be equipped with flap gates and valves to prevent stormwater from backing up into the facility. New drainage associated with the treatment facility improvements will need to tie into existing outfall locations to avoid any rework to the hardening berm.

Near the Final Settling Tanks (FSTs), paved access will need to be maintained to the northeast side of the tanks. This area is currently used for access by vacuum trucks for cleaning, and for crane setup associated with maintenance of the FSTs. The side slopes from the berm will require raising of the top of the concrete for FST 1 and 2 to maintain a level working platform on the east side

Final Settling Tank Access

of the tanks. Soil materials were stockpiled to the west of the tanks as part of previous construction efforts. The soil stockpile area will be the likely location for a future FST. It is envisioned that soil from the stockpile can be utilized for grading and constructing the berm. Soil testing should be conducted prior to any re-use of the stored on-site materials.

Other areas where the hardening project will impact the existing facility includes the west side of the facility where the existing garage spaces and parking areas are located. The grade at the main entrance to the facility may also be raised as part of the berm construction. This will also affect current fencing and security gate arrangements.

8.2.3 Yard Pump Station

A pump station is located between the south end of the Compost Building and the Biofilter Blower Building. This pump station collects leachate from the biofilter, a catch basin located between the biofilter building and the compost building, the trench drain located between the Methanol and Septage Receiving, and sheet flow from surrounding paved drive areas. It is a simplex pump with float switches that are currently not functioning. The pump often plugs with solids from the composting operation. The existing pump discharges through a 2-inch force main to a sewer manhole located in One Rod Highway where it is directed back to the headworks of the plant. This pump station should be replaced or upgraded as part of any improvements project with a duplex style pump station designed to pass or grind larger solid materials collected.

8.2.4 Final Settling Tanks

A location for a future fourth Final Settling Tank is identified on the current facility drawings. The location of the future fourth tank is within the soil stockpile area from previous construction projects. Some of this material may be utilized for construction of the Hardening project as noted previously. Although not recommended for construction in this facility plan, the footprint of the future 4^{th} tank shall be maintained and left clear of obstructions.

An additional UV disinfection channel is recommended adjacent to the current UV channel. Construction of this channel will block access to the Final Settling Tank scum pump station and vactor truck access points. As part of the upgrade, the new access drive will be extended to provide access to all settling tanks from the interior area beyond the Secondary Distribution Box.

8.2.5 Sludge Building/Compost Building Yard Drains

The paved yard area between the Compost and Sludge Dewatering Buildings slopes strongly to the west to a catch basin in front of the garage area. Material from the composting and sludge dewatering operations often gets tracked onto the paved area and eventually washed into the catch basin. The catch basin is connected to the storm drain system in One Rod Highway. This catch basin will get redirected to either the improved yard pump station or to the headworks of the plant. Due to its location, a separate pump station may be needed to direct this flow to the headworks.

8.2.6 Spill Containment Area – East of Influent Area

Spill Containment Area

When the WPCF accepts sludge from other communities, the standard operating procedure is to dump the material into the influent manhole at the north side of the Influent Building. This manhole is located in the proposed GPR area for the berm hardening project and thus require coordination with the final grading of that area and the small proposed stormwater pump station. If the Town wishes to maintain this access point for accepting off-site wastes, a spill containment area will need to be constructed to catch any spills from this unloading area and direct it by gravity to the raw sewage wet well. A sludge truck unloading station is also recommended at the gravity thickener and/or primary digester.

8.2.7 Parking Areas & Pavement Condition

Parking for employee vehicles and visitors is limited at the facility and handicapped parking is available on the east side of the control building. 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. In areas where new construction will not affect the existing pavement, the surface pavement should be milled and a new 1-1/2" minimum layer of surface pavement placed. Thickened pavement areas will be provided for high truck traffic and turning areas.

8.2.8 Methanol Area Improvements

The Methanol Storage area will be protected to the 500-year flood elevation of 16.25 as part of future upgrades to the facility. New concrete containment walls will be constructed around the new tanks. Minor site grading and access walkways will be provided in the design of the improvements.

8.2.9 Fire and Yard Hydrants

Two fire hydrants are located along One Rod Highway adjacent to the facility. One is located just outside the gate of the Final Settling Tank area and the other is just outside of the main entrance to the facility. No fire hydrants are located within the fenced in area of the facility. The yard hydrants within the facility are in poor condition and many are not functioning properly. All of the yard hydrants will be replaced and new hydrants added as part of any future upgrades to the facility.

8.3 ARCHITECTURAL EVALUATION


Abandoned Digester

The majority of buildings were upgraded in early 2000's and are in good condition. Several upgrades have been made in which newer structures were attached to or constructed over the top of the original 1950's structures. There are many areas throughout the site that pose potential code concerns regarding egress and fire protection. In recent years, code requirements have become increasingly more stringent particularly regarding below grade spaces. All work anticipated in these areas will require a detailed code evaluation during the final design phase to ensure that current requirements are met. The brick veneer on all of the structures is in relatively good condition with the exception of the abandoned digester. This structure shows significant signs of moistures within the cavity. The veneer does not appear to have adequate venting and the bottom courses of bricks have failed and are splitting and falling off. Major repairs will be required to facilitate the rehabilitation of this structure for future use if it is slated to be repurposed.

Reportedly, the majority of the building roofs were replaced during the upgrade in 2000's. The roof section located between the two digesters has been leaking for quite a while. This roof has been evaluated by a roofing consultant and recommendations have been made for the replacement. It is recommended that this failure be addressed as soon as possible to prevent subsequent damage. There are no reported leaks on the remaining buildings. All roofs likely have exceeded a good portion of their expected life and should be considered for replacement in the next 10-15 years.

If not already available a Hazardous Material Survey should be conducted to identify materials that contain asbestos, lead and PCB's during the preliminary design phase.

The following is a description of general architectural observations made during a March 9, 2016 site visit.

8.3.1 Influent Building

Influent Building

The Influent Structure consists of the original 1950's Screenings and Pump Room. The Building was added onto with a 100' long by 16' masonry addition as part of the upgrade in 2000. The spaces within this structure consists of a combination of below grade areas, at grade rooms and other rooms approximately 4'-0" above grade. Reportedly this structure was below the flood water elevations experienced in hurricane Sandy. The upper most level is in good condition. The CMU and brick veneer is in fair condition with staining and mortar degradation closer to grade. The Metal Wall panels at the roof line have been damaged in several locations. It appears these locations are subjected to equipment or vehicle damage. The following are the observations made during the March 9, 2016 site visit as well as the resulting recommendations:

- The exterior brick veneer and mortar joints closer to grade exhibit sings of moisture and growth with several chipped and cracked brick units. Damaged units should be removed and replaced. Mortar should be cleaned and resealed.
- Painted hollow metal doors and frames are in fair condition considering the environment. The door bottoms, hollow metal frames and door hardware exhibit signs of corrosion and should be replaced.
- Below grade concrete walls are painted. The coating is failed in many locations. Below grade painted concrete requires a great deal of maintenance. Removal of loose and chipped coatings is recommended with no recoating of surface. Painted CMU walls are in need of cleaning, patching and repainting.
- The door on the east side of the Screenings Room has been removed and replaced with a large double leaf door in doing so there is an area of unfinished CMU block that should be prepped and painted. There are no thresholds at the exterior doors which allow for a lot of infiltration. The stair to the lower level likely met code at the time it was constructed however the guardrails and handrails to not meet current standards.
- The double doors at the Grit/Screenings Room loading dock have been removed and replaced with a roll-up door. The roll-up door cannot be considered a means of egress from the space. Therefore, egress from this space is limited to a single man door and will need to be evaluated for compliance with code. The exterior fall protection at the loading dock is a chain. This should be replaced with a rigid removable guardrail. The current container loading configuration does not meet the staff's needs. Design improvements are desirable to streamline the operation process.

- The Electrical Room at this building appears to be at capatown and may require an expansion.

8.3.2 Control Building

Control Building

The existing Control Building is a 72’ long by 96' wide, flat roofed building. The original control building was majorly renovated and added onto in the 2000 upgrade. Though modifications were done relatively recently, the staff has expressed a variety of space needs as well as building material updates that would be desirable for their operations. The basement of this building poses a fair amount of code concerns pertaining to egress, exit access, and fire protection. The building houses administrative functions and the lab, as well as an attached Maintenance Garage. It has a small vestibule and reception area. There are several enclosed offices, a Conference Room, Men’s and Women’s Bathroom’s/Locker Rooms, a Lab and a Lunch Room. Accessory spaces include a Janitor’s closet, a small Mechanical Room and an Electrical Room.

The following are the observations made during the March 9, 2016 site visit as well as the resulting recommendations:

- The brick veneer and mortar joints closer to grade exhibit sings of moisture and growth. These should be cleaned and resealed.
- The interior walls and doors require repainting.
- Replace tile and carpet floors finishes with a durable low maintenance floor system. A preference for an epoxy resin floor cover was expressed at the time of the meeting.

- The main basement area connects to below grade pipe galleries. The area exceeds the allowable area for a windowless story defined by current code. In addition, the egress travel distances exceed those allowed by code. Any modification to this space will likely require improvements to be made to improve code compliance. A fire suppression system would be recommended for this space.
- The connection to the Raw Water pump station is an area of concern, as this space does not meet egress requirements. This should also be physically separated from the remaining building. Ideally this function would be relocated elsewhere on the site and the existing pump room would be infilled.

Raw Water Pump Station Access

- In the basement Storage room there is signs of moisture from above the ceiling. The source should be identified and the leaks repaired as necessary. Once the leak is addressed ceiling materials should then be replaced.
- The current Lab design does not meet the staff need. The center island provides no toe kick or knee space. The counter surface contains many raised electrical outlets and various gas and water nozzles that are not utilized. The Fume hood is grossly oversized for their needs taking up approximately 30+ square feet of space. The counters often become cluttered with larger items. Open shelving or closets for storage of larger items is desirable.
- The current Lab office has adequate space however the finishes should be removed and replaced with finishes suitable for an industrial facility. The indoor air quality should be addressed.
- The finishes in all of the office and secretary areas should be removed and replaced with finishes suitable for an industrial facility, in particular the carpeted areas. No notable space needs were mentioned.
- Part of the Women's locker room has been taken over for general storage. Use of the shower is impractical due to the items stored in the vicinity. The space should be returned to its original function.
- The Men's locker area is too small for current and anticipated staff needs. Additional lockers and showers are priority.

- The Breakroom is undersized for current staff needs. Updated casework, counters and eating space for a staff of 18 is desirable.
- The addition of a welding hood for ventilation is needed in the garage.

8.3.3 Primary Digester Complex

The Primary Digester Complex consists of two digester tanks with a multi-level masonry building located between the two tanks. The building spaces consist of a Gas Room, Electrical Room, and Stair. This was constructed in the 2000 upgrade.

Digester Complex Roof

The following are the observations made during the March 9, 2016 site visit as well as the resulting recommendations:

- There is noticeable staining in the exterior mortar joints. The exterior masonry should be cleaned and resealed.

8.3.4 Septage Receiving Building

The Septage Receiving Building was constructed in the 2000 upgrade. The Building contains a Pump Room, Electrical Room, Boiler Room, Gas Room, and Septage Receiving Room. This building is located adjacent to the exterior Methanol Storage tanks and an Electrical Transformer. Proposed modifications to this area should be evaluated in accordance with the codes for fire and life safety.

Septage Receiving Building

The following are the observations made during the March 9, 2016 site visit as well as the resulting recommendations:

- There is noticeable staining in the exterior mortar joints. The exterior masonry should be cleaned and resealed.
- The finish on the aluminum door leafs is peeling and failing in areas.
- The floors are concrete and appear to be in good condition, there is some surface staining that could be cleaned and the floors sealed. This is a cosmetic concern only.

8.3.5 Return Sludge Building

The Return Sludge Building is a 62'- 8" by 64'-0" masonry building constructed in the 2000 upgrade. The Building is remotely located from the other buildings on site. It contains a basement Pump Room, with an Office and support spaces on the ground floor level.

Return Sludge Building

The following are the observations made during the March 9, 2016 site visit as well as the resulting recommendations:

- There is noticeable staining in the exterior mortar joints. The exterior masonry should be cleaned and resealed.
- The floors are concrete and appear to be in good condition, there is some surface staining that could be cleaned. This is a cosmetic concern only.
- The basement area exceeds the allowable area for a windowless story defined by current code. In addition, the egress travel distances exceed those allowed by code. Any modification to this space will likely require improvements to be made to improve code compliance. A fire suppression system could be required. As well as a second stair or modifications to the existing stair to provide access direct to the exterior.
- At the interior double door that separates the two storage rooms there is no physical barrier at the door threshold to contain spills. A permanent threshold set in sealant is recommended as a solution in-lieu of the temporary measures currently in place.
- The Electrical Room is in good condition. There is currently only one access to the room by an interior door. This door should be replaced with a door swinging in the direction of travel and panic hardware. It would also be recommended though not required by code to add a second door direct to the exterior.
- The Chemical storage room is in good condition however there is no fire suppression in this area. The volume stored likely exceeds to the exempted amount. Changes to this area could prompt additional modifications for fire suppression.

8.3.6 Biofilter Building

The Biofilter Building is a 32'-8" by 24' single story masonry building. It was constructed in the 2000 upgrade. The Building contains a small Electrical Room and a Blower Room.

Biofilter Building

The following are the observations made during the March 9, 2016 site visit as well as the resulting recommendations:

- There is noticeable staining in the mortar joints. The exterior masonry should be cleaned and resealed.
- The floors are concrete and appear to be in good condition, there is some surface staining that could be cleaned. This is a cosmetic concern only.

8.3.7 Sludge Dewatering Building

The existing Sludge Dewatering Building is a 55'-6" long by 46'-6" wide 2-story, flat roofed building constructed in the 1970's upgrade. This building is physically connected to the Control Building by a 6-foot-wide enclosed walkway. The Sludge Dewatering Building is about 14' tall from lower level slab to the upper level slab and about 14' to roof steel from upper level slab. The structure is a CMU with brick veneer exterior walls. The roof is a bar joist with metal deck and EPDM roofing system.

Sludge Dewatering Building

At some point after the original construction a large Roll-up door was added to the second floor. Presumably to facilitate removal of the old equipment and installation of new. An open concrete stair provides access to the second floor. This stair is the only means of egress from the upper level. A fully enclosed exit stair that discharges directly to the exterior should be provided with any significant upgrades to this area.

The following are the observations made during the March 9, 2016 site visit as well as the resulting recommendations:

- The windows appear to have exceeded their life expectancy and should be replaced.
- Most of the interior walls are painted CMU. As part of the renovations, the interior will be completely prepped and repainted.
- The concrete columns show signs of minor vehicular damage. The addition of bollards or other means of protection will prevent possible structural damage.
- The ceilings at the lower level are painted concrete and at the upper level are painted metal deck. Both are in fair condition the upper level shows signs of corrosion in places. The affected areas should be surface prepped and repainted to prohibit further damage.
- The concrete stairs require some rehabilitation. There is cracking and chipping particularly at the embedded plates.
- The garage area is in fair condition considering its use. The concrete floor is heavily stained in areas and shows signs of wear. Particularly at the container area where the concrete has become porous and the aggregate is now visible, the floor should be cleaned, sealed and repaired as required. The addition of steel skid plates would help prevent further damage. The exterior pad at the door is heavily damaged and should be removed and replaced. The Man door to the exterior has a lever style lockset with a cylindrical lock. Mortise style locks are consistent throughout the remainder of the facility and provide a greater level of security.
- The existing stair is concrete and open at both levels. To meet current codes, the stair would be enclosed at both floors and provide direct egress to the exterior. This is an existing condition that appears to have meet code however the proposed level or work may require improvements to the means of egress from the upper level.
- A single user restroom containing a toilet and lavatory. The door is missing hardware and should be replaced.
- The dewatering room is in fair condition. There is currently a plastic curtain separating the stair from the dewatering area. A wall would improve egress from this space and provide a better separation than the curtain.

8.3.8 Compost Building

The Compost Building was recently renovated and was not evaluated at the time of the site visit.

8.3.9 Garage Building

A cursory review was done of the existing Garage Buildings. Work at these buildings is not anticipated. Currently they serve the facilities cold storage needs.

8.4 STRUCTURAL EVALUATION

The following is a description of structural observations and recommendations made during a site visit on March 9, 2016. Most process tanks were in service at the time of the site visit. All tanks should be drained for inspection during the final design phase. An important consideration is longer term planning for the plant. Four of six Zone A Aeration Tanks and two of five Primary Tanks were constructed in 1950, and have been in service for 66 years. These tanks would be considered to be approaching, if not surpassing, their anticipated design life. Even the newest Zone A Aeration and Primary Tanks were constructed in 1972 and have been in service approaching 50 years. Readily observable condition issues are described below. The following observation and recommendation sections assume that unless otherwise indicated, the structures are in good working condition.

8.4.1 Primary Digester Pump Room

8.4.1.1 Observations:

- The operator indicated that water is leaking in through joints in the roof slab at both the digester wall and the pipe gallery wall.
- The exterior wall along stair well has cracking, and the paint is aged and stained.
- The concrete at a portion of the horizontal construction joint between the top of the wall and the roof slab appears to be deteriorating.

8.4.1.2 Recommendations:

- Pressure-inject joints and/or cracks at roof slab with polyurethane to stop leakage.
- Remove vegetation and unsound concrete at joint between top of slab and digester wall and provide new sealant.
- Abrasive blast exterior face of wall to remove existing coating. Inject larger cracks in wall with epoxy. Stain wall with breathable concrete stain.

- Route out unsound concrete along construction joint at top of wall and provide joint sealant.

8.4.2 Abandoned Primary Digester

8.4.2.1 Observations:

Abandoned Digester

- The exterior brick veneer around the entire tank shows cracking, efflorescence staining, and bulging. Above the first course the brick has been pushed outward significantly and the faces of some bricks have spalled off. The mortar fillet along the top of the concrete wall supporting the brick has failed in some locations and the concrete wall below the brick has areas of spalling.

  It is likely that water leaked through the concrete tank wall into the insulated cavity behind the brick, and/or water leaked into the cavity through the roof. No weeps were observed in the mortar joints at the bottom of the brick veneer, so moisture within the cavity would be trapped. Expansion of any trapped moisture could lead to the deterioration observed.

- The roof area between the steel dome and parapet is heavily vegetated.
- The exterior surface of the steel roof dome is almost completely rust stained with some paint remnants. Some welds between dome panels had loose laminated rust that readily flaked away. Notwithstanding, the dome appeared to be generally sound.

8.4.2.2 Recommendations (Unless demolished):

- The condition of the interior of the tank requires inspection. The contents should be removed and surfaces thoroughly cleaned. For such an inspection, confined space procedures are required, and excellent lighting will be necessary.
- The exterior of the dome requires recoating.
- All interior surfaces of the steel dome are expected to require repainting. This is expected to be very costly due to the need for scaffolding within the entire tank to perform this work.

With scaffolding erected, the interior of the dome will require inspection for any obvious deficiencies that warrant repair.

- If the tank is to be repurposed, the brick veneer and insulation should be completely removed. The roof parapet should be removed, and a better means for drainage at the dome perimeter provided. Any cracks with signs of leakage found in the concrete wall behind the brick should be injected with polyurethane. The digester should be re-sided with a different material for aesthetics.
- The existing spiral stair to the roof should be evaluated with respect to current building code requirements.

8.4.3 Grit Chamber & Influent Building

The Auxiliary Pump Building was constructed in 1972 as an addition to the north end of the Grit Chamber. The Influent Building superstructure was constructed on top of the original Grit Chamber in 2000.

Subgrade Wall Leaks

8.4.3.1 Observations:

- The subgrade walls of the grit chamber have vertical cracks with brown staining and moderate active groundwater leakage, which puddles on the floor.
- Two concrete beams toward the north end of the grit chamber show severe horizontal cracking and large hollow areas. One beam supports an aluminum grating stair that extends to the bottom floor level. These beams appear to have been previously patched, however the repair is failing.
- Exposed rusted rebar was observed at opening in floor slab with aluminum grating.
- The concrete slab outside north end of building (Auxiliary Pump Building area) is very poorly graded and appears to have settled, resulting in a puddle inches deep after rain. There is no drain or catch basin in this area.
- The segmental precast retaining wall shows some signs of distress and movement, including some open vertical joints.

8.4.3.2 Recommendations:

- Pressure-inject cracks in foundation walls with polyurethane to stop leakage.
- Remove hollow, distressed, and cracked concrete from beams and provide concrete repair. Alternatively, consider removing existing concrete beams and replacing with galvanized steel or aluminum beams.
- Provide concrete repair at exposed rebar at grating opening.
- Remove exterior concrete slab, re-grade area for proper drainage, and replace slab. Consider providing a catch basin in this area. Alternatively, consider pressure grouting beneath the slab in order to raise it.
- Consider replacing the precast segmental retaining wall.

8.4.4 Blower Building

8.4.4.1 Observations:

- Pipe hangers are failing where the hangers attach to unistruts embedded in the precast roof planks. The plant operator indicated that the sprayed-on soundproofing on the ceiling has been wet from roof leaks. Roof leakage has likely led to corrosion of the hanger fasteners.

8.4.4.2 Recommendations:

- Provide new roofing.
- Consider removing soundproofing from ceiling if not needed.
- Provide new pipe hangers to support conduits. It is expected that existing embedded unistruts can be used, which requires verification.

8.4.5 Aeration Tanks Zone B

8.4.5.1 Observations:

Zone B Aeration

- The concrete slab-on-ground between Aeration Tanks Zones A and B has settled up to a few inches. This poses a tripping hazard.
- A portion of the top of the north wall of the eastern tank shows severe cracking in the area of an expansion joint and a construction joint. The expansion joint sealant has separated widely, and the distortion of the sealant indicates that the tank wall has moved inward. The top of the north wall of the western tank also shows severe longitudinal cracking and joint distress. The cracking could be an indication of alkali-silica reaction (ASR), a chemical reaction between the alkalis and the aggregate in the concrete that causes concrete expansion.
- Some areas of the exterior face of the west wall of the west tank show map cracking with efflorescence. An expansion joint on the face of this wall has been compressed significantly, causing the joint sealant to squeeze out of the joint. Map cracking and such joint movement can be signs of ASR.
- The top of the south end of the west wall was repaired by removing cracked concrete and providing a concrete repair material. The repair is recent, and appears to be holding up. However, cracking in the top of the wall to the south of the repaired area was observed. It is speculated that this cracking was not evident at the time of the repair work, or it would have been included in the repairs. If true, this would mean that this deterioration is spreading.
- A portion of the top of the east wall of the east tank had been similarly repaired as described above.
- Two expansion joints in the south channel wall do not appear to have been provided with properly functioning waterstops, as leakage had occurred at these locations until the joints were sealed. Joint sealant alone should not be relied upon as a permanent fix. The plant operator indicated that before it was buried, a person could look straight through these wall joints - and indication that no waterstop was provided.

8.4.5.2 Recommendations:

- Consider removing the concrete slab-on-ground between the Zone A and Zone B Aeration Tanks, and replacing it with a structural slab spanning between tank walls. Besides providing a level walking surface, this would allow any further ground settlement to occur without settlement of the walkway areas. Pressure grouting beneath the slab to level it could be considered an economic alternative. However, it is possible that settlement would continue over time.

- ASR is a very serious problem that may not be possible to arrest. This is especially true for tank structures because water is the catalyst for the chemical reaction. The repairs already performed should provide some benefit as they prevent moisture ingress through cracks in the top of the wall at these locations. However, it is not expected that these repairs will fully solve the problem. It is also possible that additional areas of the tank will show evidence of this deterioration in time.

  Core samples should be taken for petrographic examinations - both in an area where the deterioration is evident, and in an area where it is not. This will confirm the deterioration mechanism and provide an indication as to whether similar deterioration can be expected in other areas of the tanks.

  The exterior above grade surfaces of the walls should be coated with a silane water repellent. This will help prevent further water ingress in these areas. If submerged concrete is found to be susceptible to ASR, application of cementitious crystalline waterproofing to interior tank surfaces could be considered. However, because the tanks are expected to be exposed to groundwater, options are very limited.

- Repair the two expansion joints in the south tank channel with a retrofit waterstop appropriate for expansion joints.

8.4.6 Aeration Tanks Zone A

Zone A Aeration

The four easterly tanks were constructed in 1950, and the two westerly tanks were constructed in 1972.

8.4.6.1 Observations:

- The plans for the 1950 work show a detail for expansion joints in concrete slabs and walls comprising a tapered void of apparent 3" depth that is of maximum ¾" width at the concrete surface. The void is filled with oakum and "rope and rubber compound". That may have been a customary jointing method for liquid tightness in 1950, however integral waterstops have been used in construction and expansion joints for at least 50 years. (Such waterstops are shown on the 1969 plans for the work constructed in 1972.) Reinforcement does not extend through the expansion joints. It would not be unexpected for leakage to be occurring at these joints.
- The concrete slab-on-ground between Aeration Tanks Zone A and the Primary Settling Tanks has settled up to a few inches. This poses a tripping hazard.
- The embedded aluminum support for the aluminum tread plate has caused a crack and hollow concrete along much of this area. It is possible that the aluminum was not isolated from the concrete with a protective coating. Aluminum in contact with concrete causes a chemical reaction and expansive corrosion products, which may have led to this defect.
- Some interior tank walls are constructed of masonry block. Although they appear to be in fair to good condition, such construction would not be recommended due to the porous nature of masonry block, and the severe environmental exposure in an exterior wastewater tank. Such walls would not be considered to be liquid tight. If they are intended to function as structural walls, for example retaining liquid at different levels on each side of the wall, they would have minimal capatown.
- Some interior concrete walls were added to the original tanks, and these walls show exposed aggregate below what appears to be the high water level. At the time it was observed, the water level in the tank was a few feet below this apparent high water mark. So, it isn't known if the wall beneath the water is in similar condition. Such exposed aggregate is the result of erosion of the concrete surface paste, and can have many causes.

8.4.6.2 Recommendations:

- There are three primary options pertaining to the existing 1950 expansion joints. The first option is to accept that an unknown amount of leakage is expected to be occurring. The amount of actual leakage at the joints depends on the effectiveness of this type of joint after 66 years of service, and the driving hydrostatic pressure, which is the difference between the water level in the tanks and the groundwater level outside the tanks.

  The second option is to assume the 1950 tank expansion joints are leaking, and to include repairs in the plant upgrade to make them watertight. However, the groundwater level will need to be considered - it may not be possible to make the joint repairs while groundwater is leaking in through the joints. The groundwater may require temporary lowering to do the work.

  The third option would be to leak test the tanks. When new tanks are constructed, they are normally leak tested prior to backfilling. This permits visible observation of any leaks that may occur through the walls. However, for tanks in service that are backfilled, this would not be practical – so, testing would be performed with the backfill in place. ACI 350.1-10, *Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures* provides requirements for performing tightness tests. Unless a different criterion is specified, the permissible leakage amount is 0.050% loss of volume per day. Each tank would be tested individually – filled, and isolated from process flow. Abutting tanks would require draining during the test to prevent the replenishing any volume loss from the tank being tested. In order to accurately record leakage, any leakage through shared walls would require repair prior to commencement of test measurements.

  However, the practicality of performing such tests should be given careful consideration. If measured leakage is considered excessive, it can be difficult to determine the location where such leaks are occurring in order to repair them. This is especially true since the walls are backfilled. In order to make repairs, the tank would have to be drained. Re-testing after repairs are made may be desired. However, it is presumed that most leakage would be occurring at expansion joints, given the observations discussed above.

- Consider removing the concrete slab-on-ground between the Zone A Aeration Tanks and the Primary Tanks, and replacing it with a structural slab spanning between tank walls. Besides providing a level walking surface, this will allow any further ground settlement to occur without settlement of the walkway areas. Alternatively, pressure grouting beneath the slab in order to level it could be considered, in which case it is possible that settlement would continue.
- Sawcut the concrete and remove cracked and hollow concrete along the embedded aluminum support for the tread plate. Remove and reset the aluminum support using polymer modified concrete repair material. Coat aluminum in contact with concrete to prevent chemical reaction.
- Interior tank walls constructed of masonry block warrant further investigation. It may be prudent to replace these walls with cast-in-place concrete walls.
- Further investigation is required to determine the extent of deterioration of concrete walls with exposed aggregate, including draining and cleaning the tank for inspection. Resurfacing with a cementitious repair material followed by the application of a durable coating is likely to be warranted to protect the concrete from further deterioration.

8.4.7 Primary Settling Tanks

Two tanks were constructed in 1950, and a third tank was added to the east in 1968. Two more tanks were added 1972: one to the east that was “shoe-horned” between the 1968 tank and the grit chamber, and one to the west of the 1950 tanks.

8.4.7.1 Observations:

Primary Settling Tanks

- The plans for the 1950 work show one transverse expansion joint through the two primary tanks. Refer to observations of the 1950’s expansion joints above under “AERATION TANKS ZONE A”. It would not be unexpected for leakage to be occurring at this joint. The plans for the 1968 tank show joints in the two long walls, but not in the slab. It is also unclear if these are expansion joints or construction joints with continuous reinforcement, or what type of waterstop may have been used.

- The joint between the two easterly tanks was measured at approximately 1¼ inches where it is widest - at south end of the tanks. The east-most tank was constructed on fill, with a foundation approximately 20 feet higher than the foundation of the abutting grit chamber. The wide joint is an indication that the tank has settled, rotating toward the Grit Chamber, which is effectively supporting the tank. Such settlement would have been predictable. The operator said he believed the joint movement had stabilized.

Separated Joint

- Evidence of movement at the joint between the other Primary Settling Tanks was observed, but to a much lesser degree and with some sealant separation.
- The sealant between the metal flashing at the base of the brick wall of the Influent Building and the abutting concrete surface of the Primary Tank has separated.
- The operator indicated that the scum trough incorrectly slopes toward the grit chamber, whereas it is supposed to slope in the opposite direction. This is consistent with the rotational settlement described above.
- The concrete grid at the top of the tank shows varying degrees of cracking with some spalling.

8.4.7.2 Recommendations:

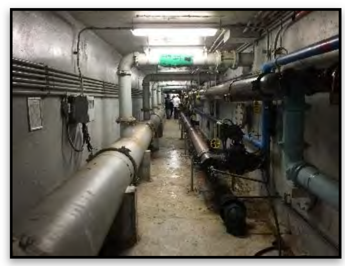
- As discussed above under "AERATION TANKS ZONE A", there are three primary options pertaining to the existing 1950 expansion joint. The first option is to accept that an unknown amount of leakage is expected to be occurring. The second option is to assume the expansion joint through the two 1950 tanks is leaking, and to include repairs to make it watertight in the Work. It is also recommended to assume the 1968 wall joints are leaking and to include repairs there as well. The third option is to leak test the tanks, followed by necessary repairs.
- At the joint between the two tanks that are furthest east, provide backer rod and joint sealant to keep debris and water out of the joint, and to make it more aesthetic. It is possible that

water getting into the joint could lead to further settlement if any subgrade soil migration is in play. Hard debris getting into the joint could also affect any desirable movement at the joint, e.g., thermal movement due to temperature fluctuations.

- Reseal joints where the other tanks abut.
- Replace sealant at joint between flashing at bottom of brick wall of Influent Building and abutting Primary Tank concrete.
- The scum trough has already been adjusted as much as possible via slotted connections. It should be re-supported so that it is properly sloped. Some allowance should be provided for future adjustment if more settlement should occur.
- Some cracks may require injection. Areas of concrete deterioration should be repaired.

8.4.8 Pipe Galleries

The Primary Gallery was constructed in 1950 - integrally with the first two Primary Settling Tanks, extending north from the Control Building. It was extended further to the north in 1968 when the third Primary Tank was constructed. The gallery was extended to the north again in 1972, when the two additional Primary Tanks were constructed.



Pipe Gallery

The Digester/Aeration Tank Gallery was constructed in 1950 with the construction of the first four aeration tanks and the two original Digesters. It extends from the Control Building east, with a jog to the north toward the aeration tanks, followed by a jog south to the two Digester Tanks.

8.4.8.1 Observations:

- Several cracks with water staining in the concrete walls and roof slab were observed inside the galleries. Some areas of spalling were also observed. The operator indicated that the galleries leak significantly in some areas.

8.4.8.2 Recommendations:

- Concrete surfaces in the areas of leaking cracks should be abrasive blasted to remove stains. Cracks should be pressure injected with polyurethane to arrest leakage. Any leakage at expansion joints should be repaired, and joint sealants replaced. Concrete spalling should be repaired. Painting of interior concrete surfaces that are below grade is not recommended due to their likely failure due to vapor transmission through the concrete walls.

8.5 HEATING, VENTILATING AND AIR CONDITIONING SYSTEMS

The following is a description of observations made during the March 9, 2016 site visit to review the existing heating, ventilating and air conditioning (HVAC) and plumbing equipment and to develop a priority rating for equipment replacement. Unless otherwise indicated, the components are in good working condition and do not require any upgrades.

8.5.1 General Observations

- Most buildings have simple controls. Thermostats are often not located in the areas they serve, but are located in MCC rooms and electrical rooms. This arrangement does not provide accurate temperature control.
- The Fairfield WPCF HVAC systems are controlled by a variety of automatic temperature control systems, including electrical/electronic controls and an Earthcore DDC system in the Control Building.
- Eight micro turbines are on the site. Six operate, but the waste heat is not used. Two units at the septage building are inoperable. In general, electrical rooms are very hot, and will require cooling. Temperatures reach as high as 110°F, although most electrical rooms and MCC panel rooms are ventilated with louvered outside air openings and roof-mounted exhaust fans.
- In process-related buildings, heating and ventilation systems and the odor control systems are interconnected.
- In general, heating is inadequate in all of the buildings.

- Air conditioning is provided in the control building and in the office at the return sludge building.

8.5.2 Influent Building Observations

- Heating and ventilating units in the building are old; however, ventilation in the influent building generally works well.
- Heat to the lower (influent) level comes from a roof-mounted makeup air unit (MAU) unit.
- An explosion proof unit heater manufactured by Chromalox heats the middle level.
- A 10” x 10” exhaust vent rises up through the roof upper level. Aluminum supply air ductwork is in good condition.
- In the MCC Room, the intake air louver/damper assembly operates. However, the ½” mesh bird screen is very clogged with dust. According to operating staff, the MCC room overheats in the summer. The thermostat serving the MAU is located in the MCC room, and not located in any of the areas it serves. This arrangement does not provide accurate temperature control.
- A roof-mounted indirect gas-fired makeup air unit (MAU) is operational. Operation of this unit has been problematic; burner fittings and unit controls have been replaced at various times, probably due to corrosion.

8.5.3 Auxiliary Pump Station Observations

- Lower level is rated Class 1/Division 2 per NFPA 820, since it is not continuously ventilated. However, a sump pump (not explosion proof) without a float switch is in a sump in the southwest corner. It operates, but is not plugged in. A duplex receptacle nearby is not explosion proof. A wall-mounted float switch assembly near the duplex does not operate.
- Upper level area is rated Class 1/Division 2 per NFPA 820, since it is open to the Lower Level below. An 18” x 18” sidewall intake air louver/damper assembly is closed. Airflow to the lower level travels into the building through a sidewall register on the upper level and through a grating in the floor when the damper is open, and is exhausted via a sidewall

exhaust fan EF-1-1. A 10-pound portable fire extinguisher is on the wall and is in good condition.

8.5.4 Control Building Observations

8.5.4.1 Primary Sludge Pump Room

- Primary Sludge Pump Room is rated Class 1/Division 2 per NFPA 820, since it is not continuously ventilated. A 10kW electric unit heater is in good operating condition and operating. It is not explosion proof.
- A freestanding service sink is in good condition, but is dirty. This sink uses non-potable water.
- A sidewall exhaust fan exhausts the space. It is not explosion proof.

8.5.4.2 Wet Well (North End)

- An explosion proof, fiberglass reinforced plastic (FRP) exhaust fan is outside. It is no longer used, since it discharges directly outdoors.

8.5.4.3 Raw Sewage Pump Station

- SP-5 and SP-6 in the northeast corner are both operable. They are both rusty.
- A small sump pump is located in the northwest corner. It appears to be in average to good condition.
- All ventilation takes place through the stairwell.

8.5.4.4 Laboratory

- The four countertop lab sinks are in good condition.
- A lab hood with 10’-0” wide x 3’-0” high opening is in very good condition, but is underutilized. Operating staff indicated that this hood is significantly oversized.
- A recessed emergency shower is in good condition. There is no flow switch.
- A 10 lb. portable fire extinguisher is in good condition.

8.5.4.5 Lab Office

- Office ventilation is poor.
- Perimeter fin tube radiation in the office is in poor condition.

8.5.4.6 Training Room

- Perimeter fin tube radiation is in very poor condition.
- Supply and return air registers in the training room appear to be in fair condition. They are somewhat dirty and often get clogged by airborne particulates from Harvest.
- A wall-mounted control panel is connected to an Earthcore DDC system, which provides automatic temperature control in the Control Building (this system is equipped with system heating/cooling switchover when three zones call for heating or cooling, wall-mounted control panel, and electronic control systems).

8.5.4.7 Office #1

- Perimeter fin tube radiation in the office is in poor condition.
- Supply and return air registers in the training room appear to be in fair condition. They are somewhat dirty and often get clogged by airborne particulates from Harvest.

8.5.4.8 Office #2

- Perimeter fin tube radiation in the office is in poor condition.
- Supply and return air registers in the training room appear to be in fair condition. They are somewhat dirty and often get clogged by airborne particulates from Harvest.

8.5.4.9 Vestibule

- A wall mounted convector is in fair condition; some rust is evident at the enclosure.

8.5.4.10 Dispatch

- Supply and return air registers are somewhat smudged.
- This room is over-ventilated.

- According to operating staff, a composting mulch plant located upwind of the plant creates sawdust, which passes airborne into the control building ventilating systems. Poor filtration is the possible cause for this condition.

8.5.4.11 Women's Shower/Toilet

- A flush valve water closet, wall hung lavatory and shower stall are all in good condition.

8.5.4.12 MCC Room

- This room is ventilated by a roof exhaust fan and intake air duct. Both are dirty; the room is hot.

8.5.4.13 Roof

- Two York gas-fired rooftop units appear to be in good condition. These units replaced original units which failed.
    - A 4-ton unit serves the laboratory and lab office. This unit is in very good condition.
    - A 12.5-ton unit serves general offices, training and break rooms, locker and shower rooms. This unit is also in very good condition.
- Roof-mounted exhaust fans appear to be in good condition and operating.
- A Reznor indirect gas-fired makeup air unit is not operating.
- A condensing unit serving a ductless A/C system appears to be in poor condition.

8.5.4.14 Men's Room

- Two flush valve water closets (floor outlet) are in good condition.
- Two lavatories are in good condition.
- Two urinals are in good condition. These are equipped with battery-powered automatic flush valves; both work only on manual flush.
- Two shower stalls appear to be in good condition. These appear to be seldom used.
- Fin tube radiation with a Danfoss thermostatic control valve appears to be in good condition.

8.5.4.15 Break Room

- Fin-tube radiation appears to be in good condition.
- The break room sink appears to be in poor condition.
- Ceiling registers are smudged.

8.5.4.16 Basement

- A 4” non-potable RPZ appears to be in good condition.
- A 3” potable water RPZ appears to be in good condition.
- Most of the ductwork is galvanized and is in good condition.
- The boiler is an HB Smith, 19 series, 5 section boiler which fires on natural gas. It is in good to very good condition.
- A 1” diameter RPZ which provides boiler makeup water and water to a washing machine. It is in good condition.
- A Lochinvar 120-gallon gas water heater is in good condition. It is equipped with an electric control damper.
- Two hydronic unit heaters are in good condition.

8.5.4.17 Maintenance Manager’s Office

- Perimeter fin tube radiation is in very good condition.
- Supply and return air registers are in good condition. They are somewhat dirty.

8.5.4.18 Custodial Room

- A cast iron service sink is in good condition.

8.5.4.19 IT Room

- A Sanyo ductless split A/C unit appears to be in good condition.
- A 36” length of electric baseboard appears to be in poor condition.

8.5.4.20 Pipe Gallery

- A pair of 18” x 8” transfer grilles (one at each end) provide ventilation through the pipe gallery.

8.5.4.21 Digester Pump Room

- Two unit heaters are in very good condition.
- A heat exchanger for digested sludge heating is in excellent condition.
- A sump pump is in operable condition, in a 24” x 24” sump.
- A stainless steel service sink discharges to the sump. The seven PVC valves are leaky.

8.5.4.22 Roof Above Digester Pump Room

- Roof exhaust fans EF-4-2, 4-3 and 4-4 are in good condition and are operating.
- Upper stairwell roof: A 3” diameter storm drain piping appears to be in good condition.

8.5.4.23 Digester Blower Room

- Two hydronic unit heaters are in good condition.

8.5.4.24 MCC Room

- A 3 kW electric unit heater is in excellent condition. Exhaust Fan EF-4-1 ventilates the space.

8.5.5 Septage Receiving Building Observations

8.5.5.1 Thickened Sludge Pump Room

- Two hydronic unit heaters are in good condition
- A duplex sump pump system is operable, but old.

8.5.5.2 Electrical Room

- A 10kW unit heater is in very good condition.

- Ventilation is from a roof exhaust fan with a 10” x 10” inlet and a 12” x 12” outside air intake.

8.5.5.3 Septage Receiving Room

- Two explosion proof unit heaters are in good condition.

8.5.5.4 Boiler Room

- Two H.B. Smith 19 series, 6-section boilers with power flame burners are 16 years old. They operate well, but are approaching the end of their operating lives. These boilers operate on both natural gas and digester gas.
- Two large circulating pumps supply heat to digester processes.
- Two smaller circulating pumps serve the building.
- The system operates on propylene glycol; a makeup water line is valved off.
- An Aquastar Model 240 FX gas-fired instantaneous water heater is in good condition.
- Combustion air louver/damper assemblies are in good condition.

8.5.5.5 Supplemental Carbon

- An emergency shower/eyewash unit (ES/EWU) located outside has two freeze-proof safety valves, which actuate below grade. It operates on cold water.

8.5.5.6 Chemical Room

- An electric unit heater (not NEMA 4X) is in good condition.
- An emergency shower/eyewash unit is in good condition. It operates on cold water.

8.5.6 Biofilter Building Observations

- Two Greenheck FRP blowers operate. They appear to be in average to good condition.
- A Marley explosion proof electric unit heater is in good condition.
- A 4” diameter RPZ is in good condition.

8.5.7 Composting Building Observations

8.5.7.1 Building Exterior

- Two pad-mounted York makeup air units (York Mod. XTO-069X11-HACA146A) located outside the building are in very good condition, but do not operate. These units were oversized for the fuel cells which operated them prior to the fuel cells failing altogether. The intent of the WWTP administration is to restore the operation of these units.

8.5.7.2 Electrical Room

- A sidewall exhaust fan and intake air louver ventilate the room. This room overheats.
- An electric unit heater is in good condition.

8.5.8 Dewatering Building Observations

8.5.8.1 MCC Room

- A small exhaust fan removes air from this room. The need for cooling is not extreme.

8.5.8.2 Press Room

- A bathroom off of the press room has a flush valve-type water closet and wall hung lavatory. Both are in good condition.
- Exhaust air from the press room goes to the odor control system. A stainless steel exhaust hood over one press was added.
- Aluminum supply air ductwork in the press room is in good condition.

8.5.8.3 Garage Bay

- Drain piping from the press room extends across the garage; makeup air is supplied by an indirect gas-fired makeup air unit. This equipment is in average condition; a Reznor unit was replaced in 2005 with a Carrier gas-fired makeup air unit.
- A 1-1/4” RPZ extends overhead. It appears corroded, but operable.

- All floor drains are plugged and are problematic.

8.5.9 Return Sludge Building Observations

8.5.9.1 Bathroom

- A water closet, wall-hung lavatory, and service sink are in like-new condition. An electric water heater is mounted 8’-0” above finished floor.

8.5.9.2 Office

- A Sanyo packaged ducted split A/C unit is wall-mounted. A 4” diameter duct passes through to the roof.

8.5.9.3 MCC Room

- This room is ventilated using a roof exhaust fan and 12” x 12” inlet air duct. This room overheats.

8.5.9.4 Generator Room

- A Tramont fuel oil day tank is in excellent condition.
- The combustion air/ventilation air louvers and dampers are in very good condition.
- A 2,000 gallon main fuel oil tank is located outdoors. It is in good condition.
- A Reznor indirect gas-fired makeup air unit provides heat to the building.
- Aluminum ductwork in the building is in excellent condition.

8.5.9.5 Basement Return Sludge Pump Room

- Supply air and exhaust air ductwork in this room is in very good condition.
- The indirect fired makeup air unit operates satisfactorily.
- The duplex sump pump assembly works well; at 16 years old, it is approaching the end of its operating life.

8.5.10 HVAC Recommendations

8.5.10.1 General Recommendations

- Relocate thermostats from MCC rooms and electrical rooms and locate them in the areas they serve.
- Consolidate the existing DDC control systems to be operated by a single server.
- Convert the electrical/electronic controls systems in numerous buildings to direct digital controls.
- Replace all HVAC equipment and systems in the Control Building.
- Provide ductless split air conditioning units in all electrical rooms. Remove the existing exhaust fans and outside air louver/damper assemblies. In process-related buildings, heating and ventilation systems and the odor control systems are interconnected.
- Address heating in buildings where heating deficiencies exist.
- Clean all ductwork and registers.

8.5.10.2 Influent Building Recommendations

- In the MCC Room, provide a ductless split heat pump-type air conditioning unit. Install the air-cooled condensing unit on the roof. Remove the roof exhaust fan and outside air louver/damper assembly.
- Repair and refurbish roof-mounted indirect gas-fired makeup air unit. Replace the furnace section with a stainless steel furnace. Replace burner fittings and fan belts. Lubricate bearings. Clean interior of cabinet and interior of control panel. Inspect flue gas vent. Test and adjust unit controls.

8.5.10.3 Auxiliary Pump Station (northwest end) Recommendations

- Provide an explosion-proof sump pump with float switch assembly. Coordinate the installation of a Class 1/Division 2-compliant electrical service to serve the sump pump.
- Restore the intake air louver/damper assembly to operation. Replace the damper actuator, and refurbish the damper assembly. Vacuum-clean the louver/damper assembly.

- Rebalance the existing exhaust air duct down from EF-1-1 to the Lower Level Pump Room and the exhaust register serving the upper level.
- Renovate controls to operate the ventilation system when the Auxiliary Pump Station is occupied.

8.5.10.4 Control Building Recommendations

8.5.10.4.1 Primary Sludge Pump Room

- Ventilate Primary Sludge Pump Room to provide 6 air changes per hour (ACH) with 75 percent recirculation when unoccupied, to satisfy Unclassified rating requirements per NFPA 820. A 10kW electric unit heater in good operating condition may be retained if 6 ACH are provided to this area.
- The sidewall exhaust fan airflow capability should be evaluated as to whether it can exhaust 6 ACH from the space.

8.5.10.4.2 Wet Well (north end)

- Odor control should be considered for this area; the existing fiberglass reinforced plastic (FRP) exhaust fan should be refurbished and restored to service.

8.5.10.4.3 Raw Sewage Pump Station

- Replace SP-5 and SP-6 in the northeast corner.
- Provide direct mechanical supply and exhaust ventilation to serve the Raw Sewage Pump Station in accordance with NFPA 820.

8.5.10.4.4 Laboratory

- Reconfigure heating, ventilation and air conditioning systems to accommodate renovations to take place in the laboratory.
- Reconfigure plumbing systems to accommodate renovations to take place in the laboratory.

- Provide a tepid (lukewarm) water supply and a flow switch to serve the existing recessed emergency shower.

8.5.10.4.5 Training Room

- Upgrade the existing Earthcore DDC system to make it more user-friendly; provide a desk with an operator's workstation. If DDC systems are provided in other buildings, integrate the systems to make all of them accessible from this workstation.

8.5.10.4.6 Dispatch

- Rebalance the airflow serving this room to establish comfortable occupant conditions.
- Provide MERV-13 filtration at the roof-mounted air handling units and air intakes (RTMAU-2-1, RTHVAC-2-2, RV-2-1), to capture wood dust and particles prior to entering the building airstream.

8.5.10.4.7 MCC Room

- Provide a ductless split heat pump-type air conditioning unit. Install the air-cooled condensing unit on the roof. Remove the roof exhaust fan and outside air louver/damper assembly.

8.5.10.4.8 Roof

- Upgrade the filters, lubricate shaft bearings and replace fan belts serving the two York gas-fired rooftop units.
- Lubricate shaft bearings and replace fan belts serving the roof-mounted exhaust fans.
- Refurbish the existing Reznor indirect gas-fired makeup air unit. Engage the services of technicians experienced in the operation and maintenance of Reznor equipment to evaluate the unit and determine remedial action. Upgrade the filters, lubricate shaft bearings and replace fan belts.

8.5.10.4.9 Men's Room

- Replace the batteries on the two urinals equipped with battery-powered automatic flush valves.

8.5.10.4.10 Pipe Gallery

- Provide mechanical ventilation in the pipe gallery comprised of either 6 ACH or air moving at a minimum velotown of 37 feet per minute passing through the pipe gallery.

8.5.10.4.11 Digester Pump Room

- Replace the seven leaky PVC valves.

8.5.10.4.12 MCC Room

- Provide a ductless split heat pump-type air conditioning unit. Install the air-cooled condensing unit on the roof. Remove the roof exhaust fan and outside air louver/damper assembly.

8.5.10.5 Septage Receiving Building Recommendations

8.5.10.5.1 Thickened Sludge Pump Room

- Replace the duplex sump pump assembly.

8.5.10.5.2 Electrical Room

- Provide a ductless split heat pump-type air conditioning unit. Install the air-cooled condensing unit on the roof. Remove the roof exhaust fan and outside air louver/damper assembly.

8.5.10.5.3 Boiler Room

- Replace the two H.B. Smith 19 series, 6-section boilers with new high-efficiency boilers which can provide approximately 600,000 BTUh of heat and can operate on both natural gas and digester gas. The new boilers will circulate propylene glycol/water heat transfer fluid (30 percent concentration). Replace flue gas venting; replace the actuators controlling the combustion air louver/damper assemblies.

8.5.10.5.4 Supplemental Carbon

- Provide a tepid (lukewarm) water supply, a flow switch and buried water circulation piping (insulated and heat traced) to serve the existing emergency shower/eyewash unit (ES/EWU) located outside.

8.5.10.5.5 Chemical Room

- Provide a tepid (lukewarm) water supply and a flow switch to serve the existing recessed emergency shower.

8.5.10.6 Biofilter Building Recommendations

- Replace the two existing Greenheck FRP blowers.

8.5.10.7 Composting Building Recommendations

8.5.10.7.1 Building Exterior

- Establish a heating source for the two York makeup air units located outside the building to replace the failed fuel cells.
- Refurbish the existing pad-mounted York makeup air units. Engage the services of technicians experienced in the operation and maintenance of York equipment to evaluate the unit, replace filters, lubricate shaft bearings and replace fan belts.

8.5.10.7.2 Electrical Room

- Provide a ductless split heat pump-type air conditioning unit. Install the air-cooled condensing unit on the roof. Remove the roof exhaust fan and outside air louver/damper assembly.

8.5.10.8 Dewatering Building Recommendations

8.5.10.8.1 MCC Room

- Provide a ductless split heat pump-type air conditioning unit. Install the air-cooled condensing unit on the roof. Remove the roof exhaust fan and outside air louver/damper assembly.

8.5.10.8.2 Garage Bay

- Drain piping from the press room extends across the garage; makeup air is supplied by an indirect gas-fired makeup air unit. This equipment is in average condition; a Reznor unit was replaced in 2005 with a Carrier gas-fired makeup air unit.
- Refurbish the existing Carrier gas-fired makeup air unit. Replace filters, lubricate shaft bearings and replace fan belts.
- Clean the 1-1/4" RPZ located overhead, and test for proper operation in accordance with the plumbing code.

8.5.10.9 Return Sludge Building Recommendations

8.5.10.9.1 MCC Room

- Provide a ductless split heat pump-type air conditioning unit. Install the air-cooled condensing unit on the roof. Remove the roof exhaust fan and outside air louver/damper assembly.

8.5.10.9.2 Basement Return Sludge Pump Room

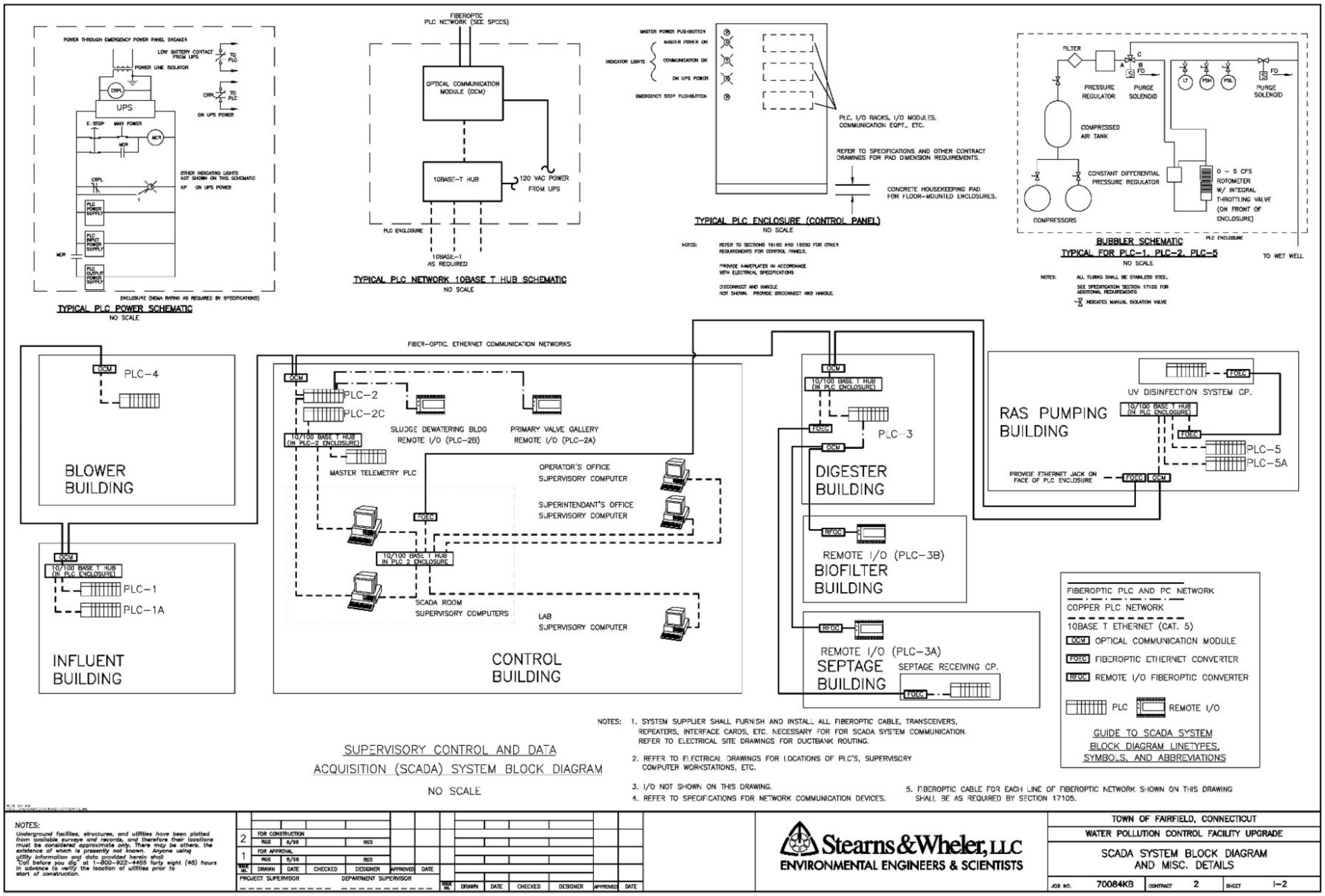
- Supply air and exhaust air ductwork in this room is in very good condition.
- The indirect fired makeup air unit operates satisfactorily.
- Replace the duplex sump pump assembly (pumps, float controls) with an explosion-proof assembly. Coordinate the installation of explosion-proof electrical service with the electrical contractor

8.6 INSTRUMENTATION AND CONTROLS

This section describes plant-wide control and communication systems and is organized by physical location of the equipment. Instrumentation equipment that is local to process equipment is described in the respective liquid or solids handling systems discussed in Sections 3, 4 and 5. An existing network architecture diagram is shown in **Figure 8-1**.

FIGURE 8-1

EXISTING SCADA NETWORK ARCHITECTURE DIAGRAM



8.6.1 Control Building

The SCADA system is located on the first floor of the Control Building in the SCADA Room. There are two GE Proficy SCADA Servers that were installed in 1998. Each Server has a 21" monitor with a 16:9 aspect ratio. There was a single open and accessible 19" network communication rack that contains:

- Two fiber optic patch panels
- A Cisco Catalyst 3560 Managed Ethernet switch with two fiber uplink connections and twenty-four 10/100 Base-T for Ethernet copper connections
- Four Procurve Managed Ethernet switches with twenty-four 10/100/1000 Base-T connections with a total of 96 RJ-45 ports for Ethernet CAT5 copper connections.

There is a large UPS (uninterruptable power supply) located at the base of the network communication rack. It appeared to provide power for the network equipment and the two SCADA Servers.

There are GE Proficy SCADA Client Workstation computers located in the operator's office, superintendent's office, and lab supervisor's office. Staff can logon to the SCADA System and with proper logon credentials, can monitor systems, change operational modes, setpoints, alarm setpoints, acknowledge alarms, generate reports, and view trends from either the Servers, or the client workstations.

Typical Control Panel

There is a large NEMA 12 control panel that contains PLC-2 in the Electrical Room. It is a Modicon Quantum CPU with modular chassis mounted I/O (inputs/outputs). A Magelis OIT (operator interface terminal) is mounted on the front of the enclosure which provides the operator a means for local monitoring, configuration, and control of the local equipment. There is a RACO Verbatim Autodialer that uses a phone line to dial out alarms to the operator. There is a compressor and air storage tank for a bubbler system that utilizes pressure switches and a transmitter in order to perform level (pressure) based control. There is a large SmartPro NET UPS (by TrippLite) installed within the control panel. It was very warm in the control panel due to the combined heat output of the UPS, compressor, transformer and +24vdc power supplies, Operations staff keeps the enclosure doors open to prevent potential overheating of the critical control and communications equipment inside the control panel.

Four Hirschman Ethernet Switches (10/100Base-T) are used to connect the local PLC and OIT as well as the SCADA Servers, Client Workstations, and the Remote I/O (RIO) in the sludge dewatering building and the primary valve gallery to the fiber optic network via the Phoenix Digital OCM module. There is a fiber optic patch panel that connects the OCM to the Plant fiber ring network.

There is a master telemetry panel adjacent to the PLC-2 panel. It consists of a Modicon Compact PLC that communicates with a data-linc leased line modem via Modbus (MB1 port 1) communications. The modem communicates via dedicated pair of wires to other modems / PLCs at remote sites. Operators have indicated that this communication has never worked correctly. As such, power has been removed from this panel.

The plant laboratory is located in the Control Building across from the SCADA Room. Chemical testing is performed and any manual data entry required for reporting is done on a laboratory PC. This lab PC is connected to the Plant SCADA System as a SCADA Client Workstation. Laboratory staff does not currently have any reporting software. However, they are interested in obtaining lab reporting software such as HachWIMs and Op10 software.

In the basement, there is a main sewage pipe that has an ultrasonic strap-on Flowmeter by PEEK. In addition, there is a sump pump control panel integral with alarm and control floats for two sump pumps. A pull-box is located in the tunnel. Fiber is for SCADA, communication cables, and cables for the fire alarm system.

8.6.2 Influent Building

A mechanical screening system (course screening) is controlled by PLC-1A [Infilco Degremont Inc. (IDI)] located in the adjacent Electrical Room. PLC-1A is located in a NEMA 4X stainless steel control panel. It is presumed that PLC-1A also controls the screening equipment.

There is a local NEMA 7 control station with a Local-Off-Remote and FOR-OFF-REV selector switches as well as an Emergency Stop for operator control local to the equipment. In Remote Mode, PLC-1A issues forward-off-reverse commands as necessary. In Local Mode, the operator selects forward, reverse, or off operation.

There are H2S and LEL gas detectors interfaced directly with local alarm horns and beacons both in the room, and near the outdoor entrance to the room. It was noted that the sensors were located approximately 10 feet above finished floor (AFF).

There is a large NEMA 12 control panel that contains PLC-1 in the Electrical Room. It is a Modicon Quantum CPU with modular chassis mounted I/O (inputs/outputs). A Magelis OIT (operator interface terminal) is mounted on the front of the enclosure which provides the operator a means for local monitoring, configuration, and control of the local equipment. There is a compressor and air storage tank for a bubbler system that utilizes pressure switches and a transmitter in order to perform level (pressure) based control. There is a large SmartPro NET UPS (by TrippLite) installed within the control panel. It was very warm in the control panel due to the combined heat output of the UPS, compressor, transformer and +24vdc power supplies, Operations staff keeps the enclosure doors open to prevent potential overheating of the critical control and communications equipment inside the control panel.

A single Hirschman Ethernet Switch (10/100Base-T) is used to connect the local PLC and OIT to the fiber optic network via the Phoenix Digital OCM module. There is a fiber optic patch panel that connects the OCM to the Plant fiber ring network.

In the basement, there are H2S and LEL gas detectors interfaced directly with local alarm horns and beacons in the room. It was noted that the sensors were located approximately 1-1/2 feet above finished floor (AFF). There are two ultrasonic level transmitters located in the influent channel, one upstream of the mechanical screenings equipment, the other sensor, downstream of the mechanical screening equipment. The mechanical screening equipment is controlled via differential level.

An ISCO 5800 influent sampler has a start/stop local control station that provides a continuous influent sample flow from the channel downstream of the mechanical screens. The influent sampler is paced from the influent flow meter signal.

8.6.3 Generator Building

There is a 500KW diesel generator with an ASCO ATS (automatic transfer switch) that provides generator power automatically to a portion the plant in the event of a utility power loss. There are a couple of signals (running and generator) that interface with SCADA.

8.6.4 Blower Building

There is a large NEMA 12 control panel that contains PLC-4. It is a Modicon Quantum CPU with modular chassis mounted I/O (inputs/outputs) and an expansion rack with I/O. A Magelis OIT (operator interface terminal) is mounted on the front of the enclosure which provides the operator a means for local monitoring, configuration, and control of the local equipment. There is a large UPS (by TrippLite) installed within the control panel. The UPS appears to be connected via RS-232 Modbus communications to the PLC. There are dual +24vdc power supplies installed. A single Ethernet Switch (10/100Base-T) is used to connect the local PLC and OIT to the fiber optic network via the Phoenix Digital OCM module. There is a fiber optic patch panel that connects the OCM to the Plant fiber ring network.

A common discharge thermal mass dispersion flow meter by FCI (fluid components international) measures blower flow to the aerations basins in SCFM. The overall scale and calibration cannot be confirmed at this time. Operational staff may have last known calibration data in O&M manuals.

There were four original multi-stage cast centrifugal blowers by The Spencer Turbine Company. They were replaced with two Neuros high speed turbo blowers; an NX150 and an NX300. A pressure transmitter is installed in the common discharge header. It is currently scaled 0-10psi. It was noted that the Neuros blower operational curves and speed determined that the actual pressure was about 12psi. It appears the pressure transmitter was never recalibrated to accommodate the pressure ranges of the newly installed Neuros blowers.

There is a differential pressure gauge across the blower inlet filters. Operation staff needs to visually confirm differential pressure (via a gauge) across the inlet filter every day. They are requesting a high differential pressure alarm and shutdown switch with alarming to SCADA to provide operational efficiency.

8.6.5 Aeration Basins

8.6.5.1 Aeration Zone A (Tanks 1 through 6)

In Zone A, there are six tanks with one aeration zone per tank. In each aeration zone, there is one modulating valve, one thermal mass flow meter, and one D.O. probe.

8.6.5.2 Aeration Zone B (Tanks 7, 8, and 9)

In Zone B, there are three tanks with one aeration zone per tank. In each Aeration zone, there are two modulating valves, one thermal mass flow meter, and one D.O. probe. Only one of the two modulating valves in each zone are online at a given time.

There are currently nine FCI AF-88 thermal mass dispersion flow meters installed in 9 aeration zones. The flow meters measure air flow in SCFM to specific drops in the aeration basins. The Plant Electrician found that these flow meters were not in calibration. Typical Zone “B” error was 30% of reading to 100% of reading. Zone “A” flow meters 1, 2, 3, 4, 5, & 6 do not work.

There are twelve modulating aeration valves (EIM) to vary aeration flow for each of the nine aeration zones (remember two valves for each of the Zone B tanks). There is a 4-20mA position command and a 4-20mA position feedback signal for each valve to/from PLC-4. The current dissolved oxygen (D.O.) control methodology compares the D.O. setpoint to the actual D.O. process variable via nine HACH LDO dissolved oxygen probes. A PID (proportional- integral - derivative) control block calculates the valve position required to increase/decrease the D.O. in the aeration zone.

The following issues were observed related to the blower aeration controls and the dissolved oxygen control at the aeration basins:

1. It appears the aeration control system was modified from a pressure control system to some kind of time-based or manual based dissolved oxygen control system.
2. The dissolved oxygen control directly varies the valve position. This type of control does not lend itself to calculating an aeration requirement (air-flow setpoint) for each aeration zone and summating the total flow for the blower air-flow setpoint.
3. There was no way to tie total aeration required by the dissolved oxygen control system with the aeration system automatically. The system was either drastically over-aerating in most cases or under-aerating in other cases
4. The dissolved oxygen control system limited the valve position to a “low end” position. This prevented the dissolved oxygen levels from meeting setpoint and caused over aerating.
5. The aeration valves modulated to any position required to meet dissolved oxygen setpoint. This resulted in blower “over-pressurization” shutdowns and over-aeration.
6. Dissolved oxygen control deadband appears to be unnecessarily tight resulting in valve hunting and potential valve motor burnout.

8.6.6 Primary Settling Tanks

There are five primary settling tanks with longitudinal chain & flight skimmers and cross collectors to collect the sludge. A local power disconnect and start/stop control station control the equipment. There is no specific instrumentation associated with this system.

8.6.7 Digester Building

There is one digested sludge tank with an internal mixer and a radar level transmitter to monitor and alarm sludge level. Digested sludge is pumped via two recycle pumps through a three-way valve that controls the amount of sludge recycled through a heat exchanger. A local PLC modulates the valve to control sludge temperature. Maintaining the sludge at a specific temperature will produce more digester gas which is conditioned and stored in a gas tank with a floating dome. Also in the Digester Building pump room is:

- Sludge pump control panel that controls a sludge feed pump in order to maintain sludge level in the tank.
- Sludge grinder control panel that controls a sludge grinder pump in order to grind solids prior to sludge pumping.
- Sump pumps in the sludge room with integral float control and alarming.

There is a large NEMA 12 control panel that contains PLC-3. It is a Modicon Quantum CPU with modular chassis mounted I/O (inputs/outputs) and an expansion rack with I/O. A Magelis OIT (operator interface terminal) is mounted on the front of the enclosure which provides the operator a means for local monitoring, configuration, and control of the local equipment. There is a large (1500VA) Ferrups UPS (by Best Power) installed within the control panel and there are dual +24vdc power supplies. There are two Ethernet Switches (10/100Base-T) which are used to connect the local PLC and OIT to the fiber optic network via the Phoenix Digital OCM module. There are two fiber optic patch panels that connect the OCM to the Plant fiber ring network. There are other patch panels that connect fiber to the RAS Building, to Septage Building, and the Biofilter Building. There is also a copper to fiber media converter by Black Box. There are two ABB VFDs that control the Waste Sludge Pumps No. 1 & No. 2.

8.6.8 Composting Building

There is one control panel that provides lighting control. It includes a Siemens S7-300 PLC, a Siemens Color “OneTouch” graphical operator interface for setup and control, and an APC Back-UPS Pro 1000 UPS.

There is another control panel that controls the composting system. It also includes a Siemens S7-300 PLC, a Siemens Color “OneTouch” graphical operator interface for setup and control, and an APC Back-UPS Pro 1000 UPS. Additionally, a Profibus DP/PA converter is included as well as a Scalance X108 eight port unmanaged Ethernet switch.

There is aldo a Siemens-based SCADA System in the Composting Electrical Room. It appears that the SCADA Software is WinCC and runs on Windows 7. The composting operator indicated that Siemens is difficult to get onsite for edits and the application is locked from making any SCADA based modifications. The operator indicated that the SCADA application is copy protected and they don’t have a backup copy. The Composting Electrical Room gets very hot in the summer and operations staff is worried the SCADA PC will overheat and fail leaving the plant with no application backup.

8.6.9 Photovoltaic System

There are five photovoltaic control panels located on the side of the composting building. These control the conversion solar radiation to electritown and distribution to the plant. It is unclear at this time if they are functional and delivering power to the plant.

8.6.10 Fuel Cell System

There is a 200kw UTC Fuel Cell powered from natural gas. The system is not operational at this time. The fuel cell is not connected to the SCADA System.

8.6.11 Micro-Turbine System

There are six (6) 60kw micro-turbines powered by natural gas supplied from the local gas utility. The system is has been taken out of service.

8.6.12 Standby Generator System

There is a 600kw stand-by diesel fueled generator system across from the Administration Building. There is an Onan automatic transfer switch (ATS). There is a diesel fuel tank located outside the generator enclosure.

8.6.13 Septage Receiving Building

There is a Septage Receiving Plant Control Panel by Lakeside (S-1). The control panel has a main disconnect with a number of pilot lights for status and alarming indication including: Power On, Screen Running, Screen Standby, Pos. Sensor Malfunction, Drive Malfunction, and Overload Shutdown. There is an Overload Reset Pushbutton. There is an AC Tech MC series VFD for the screen drive.

There is an Allen-Bradley SLC 5/05 PLC with a Fiber/Copper media converter from Black Box that communicates with the SCADA System. There is also a fiber optic patch panel that likely runs to the Digester Building.

There is a Septage Transfer Control Panel by Vaughn (STP-1). The control panel has a main disconnect with a number of pilot lights for status and alarming indication as well as "HAND-OFF-AUTO" and "Recirc. - Disc." Selector switches. There are a series of pilot lights that include: Discharge, Recirculate, Overload, Running, Low Oil, and Seal Fail.

There are three (3) ABB ACS 60 VFDs for Nitrified Recycle Pumps, 1, 2, & 3. Controls include Local-Remote and Hand-Off-Auto selector switches, a speed pot, and a reset button. There are a series of pilot lights that include: Motor Run, VFD Fault, MoL. Fault, Seal Water Fail, and Moisture Det. Fault.

There is a large NEMA 12 control panel that contains PLC-3A. It consists of a series of Modicon Momentum Units configured as Modbus based RIO with modular din rail-mounted I/O (inputs/outputs). A Modicon Line Drop Repeater (490 NRP 254 00) has a fiber optic connection and converts to Modbus copper connection for the RIO. There is also a fiber to copper media converter for Ethernet. There is a large (1000VA) UPS installed within the control panel and there are dual +24vdc power supplies. There is a fiber patch panel that connects fiber to the Digester Building.

There are three (3) Reliance Electric VFDs for Methanol Pumps, 1, 2, & 3. Controls are all on the VFD keypad.

8.6.14 Methanol Tank System

There are two (2) outdoor Methanol Delivery Storage Tanks. There is a loading station for Methanol delivery for each tank. There is a Methanol delivery control panel with an OMNTEC unit that monitors level and provides a printed receipt for chemical delivery volume. An LCD display provides level information, status, and alarms.

There are three (3) NEMA 7 (explosion proof) control panels with a 3-phase disconnect and what appears to be a Hand-Off-Auto selector switch and running pilot light. There is mechanical reset for pump motor overload where you can view the overload status through an explosion proof view window. There is a local chemical eye-wash and shower station in the event of operation staff coming into contact with the Methanol. There is no flow or pressure switch at the eye-wash / shower station for SCADA alarming.

8.6.15 Dewatering Building

On the first floor, there are two solids polymer feed control panels (SPF-1, SPF-2). SPF-1 Control Panel has a “On-Off-Reset-Polymer”, “Auto-Manual” (for speed control), and a speed control loading station (manual control and indication). SPF-2 Control Panel has a “Hand-Off-Auto”, “Flush-Off-Polymer”, “Auto-Manual” (for speed control), a speed pot and a speed indicator.

There is also a polymer mixing control panel with “Hand-Off-Auto” controls and “running” indicator lights for dry polymer feeder, water solenoid, mixer, pump, transfer valve and transfer pump. Alarm lights include: dry, low water pressure, general alarm, age tank low level, solution pump, and liquid (level) alarms. Liquid or dry mode selectors with start/stop pushbuttons are also included.

On the second floor, there are two large ABB Magmeters; one for Thickened Sludge, the other for Waste Sludge.

There is a large NEMA 12 control panel (Sludge Dewatering Remote I/O). It consists of a series of Modicon Momentum Units configured as Modbus based RIO with modular din rail-mounted I/O (inputs/outputs). A Modicon Line Drop Repeater (490 NRP 254 00) has a fiber optic connection and converts to Modbus copper connection for the RIO. There is a medium capatown UPS installed within the control panel and there are dual +24vdc power supplies. There is a fiber patch panel that connects fiber to the Digester Building. There are two large NEMA 4X stainless steel control panels. Each controls a dewatering train.

8.6.16 Biofilter Building

There is a large NEMA 12 control panel (BioFilter Building Remote). It consists of a series of Modicon Momentum Units configured as Modbus based RIO with modular din rail-mounted I/O (inputs/outputs). A Modicon Line Drop Repeater (490 NRP 254 00) has a fiber optic connection and converts to Modbus copper connection for the RIO. There is a medium capatown UPS installed within the control panel and there are dual +24vdc power supplies. There is a fiber patch panel that connects fiber to the Digester Building.

There are two (2) ABB VFDs for the Biofilter Exhaust Fans 1 & 2. Controls include Local-Remote, Hand-Off-Auto selector switches, a speed pot, and a reset button. There are a series of pilot lights that include: Motor Run, VFD Fault, and MoL. Fault.

There is a differential pressure transmitter with square root extraction to measure, display, and transmit exhaust fan flow for the Biofilter. The Flowmeter is outside located in a NEMA 4X enclosure with a window kit.

8.6.17 Final Settling Tanks

There are three final settling tanks. Each settling tank has a "start/stop" local control station and (very likely) running and high torque shutdown status to SCADA.

8.6.18 UV Disinfection

There is an ultrasonic level transmitter upstream of the UV channel to determine submergence depth. There is a UV sensor and a transmittance sensor to determine biological kill. A NEMA 4X stainless steel control panel with a PanelView 550 OIT along with an Allen-Bradley PLC (model undetermined as panel was operational).

8.6.19 Effluent Flow

There is an ultrasonic open channel flow meter to measure effluent flow from a Parshall flume in the outfall channel.

8.6.20 RAS Pumping Building

There is a large NEMA 12 control panel that contains PLC-5 for the RAS Pumping Building. It is a Modicon Quantum CPU with modular chassis mounted I/O (inputs/outputs). A Magelis OIT (operator interface terminal) is mounted on the front of the enclosure which provides the operator a means for local monitoring, configuration, and control of the local equipment. There is a compressor and air storage tank for a bubbler system that utilizes pressure switches and a transmitter in order to perform level (pressure) based control. There is a large SmartPro NET UPS (by TrippLite) installed within the control panel. It was very warm in the control panel due to the combined heat output of the UPS, compressor, transformer and +24vdc power supplies. Operations staff keeps the enclosure doors open to prevent potential overheating of the critical control and communications equipment inside the control panel.

A single Hirschman Ethernet Switch (10/100Base-T) is used to connect the local PLC and OIT to the fiber optic network via the Phoenix Digital OCM module. There are three fiber optic patch panels: one connects to Digester Building, the other to Control Building, the third to UV system.

There are four (4) ABB VFDs for the Return Sludge Pumps RSP-1 through 4. Controls include Local-Remote, Hand-Off-Auto selector switches, a speed pot, and a reset button. There are a series of pilot lights that include: Motor Run, VFD Fault, MoL. Fault, Seal Water Fail, and Leak Det Fault.

There are four (4) ABB VFDs for OP-1 through 4. Controls include Local-Remote, Hand-Off-Auto, Norm-Off-Bypass selector switches, a speed pot, and a reset button. There are a series of pilot lights that include: Motor Run, VFD Fault, MoL. Fault, Seal Water Fail, Motor Thermal Fault, and Check Valve Limit Fault.

There is a CISCO Catalyst 3560 Managed Ethernet Switch with fiber uplinks and 24 RJ-45 connections for copper Ethernet. A small APC UPS provides backup power.

There is a 1000kw stand-by diesel fueled generator system in the RAS Building. It is interlocked with the louver control system to open the louvers when the generator is running. A Tramont Diesel fuel transfer system transfers fuel from the diesel storage tank to the generator day tank. A Kohler charging system provides automatic charging of the generator's batteries for starting.

An ISCO 5800 effluent water sampler has a start/stop local control station that provides a continuous effluent sample flow from the channel downstream of the UV Disinfection System. The effluent sampler is paced from the effluent flow meter signal.

A magnetic flow meter with remote flow tube measures the combined RAS. The transmitter is a 4-wire, 120vac powered ABB Transmitter.

There are also sump pumps (SP-7, SP-8) in the basement room with integral float control and alarming.

There is a PACFLO 9000 plant water control skid that provides non-potable water for plant process. It consists of three pumps that operate at constant speed. Operations staff indicate that there is quite a high duty cycling and of the pumps in order to maintain plant water pressure to an acceptable level.

A manual plant water strainer has no alarming on it to indicate clogging or reduced performance. Operations staff indicates the strainer must be cleaned every few days.

8.6.21 Recommendations

All the control panels at the plant are currently working. However, most of the PLCs operating in the plant are obsolete and no longer produced.. Below is a list of the PLCs used in the plant that are in need of replacement:

8.6.21.1 Modicon (Concept) Quantum (CPU programmed via Concept Software)

These CPUs are obsolete and are no longer manufactured. There are a number of replacement options for these obsolete processors per the following:

- The first option includes replacing the obsolete processor to a (Unity) Quantum Processor (available CPU programmed via Unity Software) combined with utilizing the existing I/O structure. This option allows for upload and recompilation of the existing code and download into a (Unity) Quantum PLC. This option is the least expensive alternative. There may be some reconfiguration and minimal programming required for the code conversion relative to communication options and functional block use and availability.
- The second option would be to replace the (Concept) Quantum to the new M580 Processor and utilize the existing I/O structure. This will more expensive than the first option, but far less expensive than a complete PLC and I/O replacement.
- The third option would be a complete PLC and I/O replacement. This option is the most expensive.

8.6.21.2 Allen-Bradley SLC 5/05

The Allen-Bradley SLC 500 Series PLCs are no longer manufactured by Allen-Bradley (AB), but are still available as new from AB in limited quantities. Additionally, refurbished and used processors are also available on Industrial Controls Websites. There are a number of replacement options available with this processor per the following:

- The first option is the purchase of spare CPUs. Upon a CPU failure, the spare PLC can be downloaded with the PLC code and placed into operation. The new Processors are in excess of twice their original price and come with a guarantee. Refurbished or used processors are more moderately priced, however, there is risk associated with this choice. Processors are used and reliability may be questionable. Some refurbished or used processors can be purchased with a guarantee. This is the least expensive option that mitigates the risk of a failed processor and associated process controls.
- The second option would be to replace the existing processor with a new PLC processor by the same manufacturer, but different model/series in a separate rack. The obsolete processor would be removed from the existing I/O rack and replaced with an Ethernet communication module. The new PLC processor in the separate rack would communicate with the existing I/O via Ethernet communications as an "Ethernet remote I/O" rack. This is the second least expensive way to mitigate risk of a failed SLC 500 processor by upgrading to the latest Processor (different model/series) by the same manufacturer. The older SLC 500 I/O has a far less likelihood of failure as compared to the SLC 500 processor and is far less costly in terms of replacement. This option is a viable alternative but requires recompilation and reprogramming and reconfiguration. Typical percentage of code conversion is 50% to 60%.
- The third option would be a complete PLC and I/O replacement. This option is the most expensive. It would be accomplished via an entirely new control panel. All processes would need to be reprogrammed.

8.6.21.3 Siemens S7-300

It is recommended to replace the S7-300 PLC with an entirely new PLC Manufacturer consistent with the new Processors installed within the plant.

Based on the PLC replacement method selected above, if a Processor is replaced, it may be feasible to utilize the existing control panel enclosure provided that additional I/O quantities do not exceed available panel space. If a PLC and I/O are to be entirely replaced, it makes more sense to manufacture and commission a whole new control panel. For planning purposes, Wright-Pierce is suggesting all new control panels. This subject can further be discussed with the town during the design phase.

The majority of PLCs in the plant are Modicon. As such, there may be sufficient justification to support sole sourcing of a Modicon PLC replacement. Wright-Pierce is prepared to specify around two or three PLC manufacturers such as Modicon, GE, and Allen-Bradley. Manufacturers are proposed based on prevalence in the Wastewater Industry, reliability, sales, support and maintenance. This subject can further be discussed with the town during the design phase.

The town currently has an SCADA Software installation base of GE Proficy (formerly known as IFIX). It makes sense to upgrade the existing SCADA Software for the new hardware configuration. This will allow the system integrator to modify existing screens and develop new screens utilizing the clients upgraded software. The IFIX tag database can be edited and added to rather than be completely rebuilt. Wright-Pierce is prepared to specify around two or three SCADA Software manufacturers such as IFIX, Wonderware, Rockwell and CiTech. Manufacturers are proposed based on prevalence in the Wastewater Industry, reliability, sales, support and maintenance. Wright-Pierce will also recommend VTSCADA not based on prevalence in the Wastewater Industry, but base on licensing cost effectiveness, ease of use and deployment, as well as packaging of SCADA, alarming, reporting, and trending software by one manufacturer. This subject can further be discussed with the town during the design phase.

The new control panels will communicate over a redundant fiber optic, self-healing loop network. A new multimode 6-pair fiber optic cable will be run in a loop around the WPCF with a Network

Control Panel located in each building. Two pair will be used for the plant PLC network (1-utilized, 1-spare); the other 4 pair will be terminated and available for future plant network requirements (i.e. future IP video system). Fiber and CAT 6 patch panels will be provided. All fiber pair will be terminated in the Network Control Panels. CAT6 connections will be provided between the Network Panels and the Control Panels internal to the building. If a control panel is external to a building, a fiber connection will be provided.

Additional fiber cable for HVAC, Security, and Fire Systems will be provided. These systems will in no way utilize the same communication equipment as the SCADA System.

Each new network panel will include a Managed Ethernet Switch with SNP modules to accommodate both CAT6 and multimode fiber based Ethernet ports. The switch will be automatically programmed to reverse the communication direction when it senses a break in the main fiber communication ring. The switch will also include embedded software that allows a user to monitor network traffic and switch diagnostics from a central location. In addition, switch status contacts can be wired to the local PLC and for monitoring and alarming on SCADA. These switches will be isolated to the SCADA Network and will not be connected to the HVAC, Security, and Fire System Networks.

A main plant SCADA Rack (Network Panel-1) will be located in the electrical room of the Control Building. The rack will be the enclosed type and lockable. It will contain a redundant SCADA Server, UPS, CAT6 and fiber patch panels, stackable managed Ethernet switches, KVM (keyboard, video, mouse) switch, NAS (network addressed storage), etc. It will also connect to the existing MTU located in the electrical room. The SCADA Servers will have redundant Server and network software as provided by GE Proficy (formerly Intellution iFIX). A redundant software alarm dialer will be provided in order to dial out alarms via text, cell, and/or e-mail. The SCADA Network will be provided with a firewall should the town want to remotely access it.

There will be eight Desktop SCADA Client Operator Workstations (OWS). Five will be located in the Control Building (Superintendent’s office, Assistant Superintendents office. 2-SCADA Room, Lab); one in the Dewatering Building, one in the RAS Building, and the last one in the

Composting Building. They will be provided with 24" widescreen (16:9) monitors. The Client Workstations will be provided with GE Proficy SCADA (formerly IFIX) Client Runtime software. It is recommended that the town enter or renew its Global Care Service and Update Client/Server Licenses to an unlimited tag count for both runtime and development.

It is recommended that the following process related items will also be implemented:

- High Differential Pressure Alarm across blower filter to SCADA.
- Gas detection instrumentation located at the correct elevations with calibration gas tubing for instruments out of reach.
- Reporting software for Lab Technicians and Superintendent to submit to reporting agencies.
- Setup of MTU for radio telemetry for remote site communication.

8.7 ELECTRICAL EVALUATION

A site visit took place on Tuesday March 29th, 2016 to evaluate the existing electrical conditions at the Fairfield CT, WPCF. The following observations were made during the site visit.

8.7.1 Existing Conditions - Incoming Electrical Power and Micro-turbines

The incoming Electrical Service from the (Power Company) consists of 13.8 kVAC into an Outdoor Rated S&C Medium Voltage Switchgear. The front area of the MV Switchgear has some overgrown bushes within the national electrical code working clearance envelope. The Switchgear has seven bays, with one bay used for controls. Each Bay feeds power to various transformers throughout the facility that provide secondary 480/277, 3 phase service to four selected areas. These areas include the Control/Administration Area, Septage Receiving Building, the Influent Area, and the RAS Building area. With the exception of the Septage Receiving Building, the three other areas have a local standby generator. In addition the MV gear connects to another 750 kVA transformer and local distribution panels for the purposes of back-feeding power from six 60kw Capstone micro-turbines and a 200kW fuel cell. The micro-turbines run on natural gas and provide 360 kW of electrical power. Currently the micro-turbines are not using any exhaust heat recovery and are slated for decommissioning in early 2017. The fuel cell also uses natural gas to generate electritown however the fuel cell has not been in operation since 2010. Presently the micro-turbines require a voltage source in order to synchronize and run and are not equipped with back-up power capabilities.

8.7.2 Existing Conditions – Influent Building

The Influent Building is powered from a local 1500 kVA transformer that feeds 480/277 VAC 3 phase power to a 2000 amp rated MCC-1 located in the electrical room. MCC-1 has main breaker with an 1800 amp trip setting. All devices are manufactured by Square D, QED and Model 6 series MCC. MCC-1 also has an Asco transfer switch with attached buckets for feeders and starters. MCC-1 also powers the Blower Building MCC. There is a step down 45 kVA transformer and 208/120 volt distribution panel. There are two ABB 75HP VFDs within the electrical room that power pumps AP-1 and AP-2. These VFDs are generating a lot of heat in the space. There are also assorted control panels, within the electrical room. The MCC, VFDs and associated equipment were installed in 2000 and are in fairly good condition. No electrical concerns were raised by the electrician while on site. I did not see any code working clearance issues with the electrical room though the space was limited.

The lower areas of the influent building were fairly clean with minor corrosion on devices near the bar rack assembly. The area has flooded in the past and it affected the pager system. No one is able call out from the lower floor areas. The exterior lighting was replaced with LED Wall pack lighting recently. The interior lighting is T8 type fluorescent fixtures in the various areas, with Class 1 Division 1 T8 lighting in the Hazardous areas that are very hard to replace.

There are gas detection systems installed on the lower floors; however the WP Instrumentation Engineer pointed out that the LEL sensor was mounted near the floor and should be mounted near ceiling.

There is an on-site diesel driven 500 kW, 480/277VAC 60 Hz Standby Generator EG-INF located within a walk in enclosure outside of the Influent Building. The generator has a belly fuel tank and is tested weekly under no load, and quarterly under load. The operational hours were not readily available on the generator control panel. There is also a step down transformer and lighting panel for lighting and louver controls in the walk in enclosure. The 1500 kVA transformer is also located outdoors near the enclosure. The generator is manufactured by Kohler. The generator acts as a back-up source and connects to an automatic transfer switch (ATS) in the influent building electrical room. The generator provides back up power to the Influent Building MCC-1 and the Blower Building MCC-5.

8.7.3 Existing Conditions – Blower Building

MCC A

The Blower Building is powered from MCC-1 in the Influent Building. MCC-1 feeds 480/277 VAC 3 phase power to a 1000 amp rated MCC-5, located in the Blower Building. MCC-5 has an older section labelled MCC-A, manufactured by Westinghouse and several new sections added in 2000, manufactured by Square D. The older sections of MCC-5 were dated, and parts may be hard to come by for this old equipment. MCC-5 powers two Spencer type 200 hp centrifugal blowers, and two Turbo Blowers, as well as mixers in the Aeration Tank Zone A. MCC-5 has main breaker with a 1000 amp trip setting. There is a 480 volt panel PDA, a small step down kVA transformer and 208/120 volt distribution panel. There are also assorted control panels, and a power correction controller within the building. The MCC expansion, and new turbo blowers and associated equipment were installed in 2000 and are in fairly good condition. There is an awful lot of surface rust on the older MCC sections and distribution panels, and the intake louvers that lead to the outside. These panels may be part of the original construction when the older MCC sections were installed. It is suspected that the moisture from the aeration tanks enters the space when the louvers are opened, causing surface rust.

No electrical concerns were raised by the electrician while on site. The electrical conduits and devices are in good to fair condition. Heat dissipation was not a factor within the building. I did not see any working clearance code issues within the space. The exterior lighting was replaced with LED Wall pack lighting recently. The interior lighting is T8 type fluorescent fixtures in the various areas and some low bay metal halide fixtures.

8.7.4 Existing Conditions – Primary Settling and Aeration Tanks

The Aeration tank, Primary Settling tank electrical systems and controls appear to be in good condition. In the PST tank areas, the 18” above wall envelope is considered a Class 1, Division 2 area. Any electrical equipment and conduit fittings within this envelope should be reviewed to ensure area classification compliance. Aluminum conduits are in good shape however some conduit fittings are showing minor signs of corrosion. Per the electrician some conduits were frozen and cracked due to moisture collection in the past and were since replaced. New LED tank exterior sight lights were installed recently in all of the tanks. Depending on the proposed operational systems recommended for these tanks, some equipment and conduit could be reutilized as part of the project.

8.7.5 Existing Conditions – Control Building

The Control Building is powered from a local 1500 kVA transformer that feeds 480/277 VAC 3 phase power to a 1600 amp rated Breaker and Automatic Transfer Switch located in a room adjacent to the walk in enclosure for the area Standby Generator. These assemblies power MCC-2 located in the control building electrical room. MCC-2 has main breaker with a 1600 amp trip setting. All devices are manufactured by Square D, QED and Model 6 series MCC. MCC-2 also powers the Dewatering Building MCC-4, Primary Digester Building MCC-6, and the Biofilter Building MCC-7. There is a step down 112.5 kVA transformer and 208/120 volt distribution panels. There are three 100 HP VFDs within the electrical room that power raw water pumps RWP-1,2,3, These VFDs are generating a lot of heat in the space. The temp in the room registered 80 degrees, on a day when outdoor temperatures were in the high 50’s. There are also assorted control panels, and an outdated fire alarm panel within the electrical room. The MCC, VFDs and associated equipment were installed in 2000 and are in fairly good condition. No electrical concerns were raised by the electrician while on site. There were no working clearance code issues with the electrical room.

The other areas of the control building were fairly clean. These include office spaces, conference room, rest rooms, maintenance, break, mechanical, reception, storage, and lab. Emergency lighting and fire alarm devices are located throughout. The Raw Water Pump Area was confined to a small area on the lowest floor, though the electrician did not have any electrical or operational concerns for this area. The exterior lighting was replaced with LED Wall pack lighting recently. The interior lighting is T8 type fluorescent fixtures in the various areas. Lighting and general overview of these areas was fair to good condition.

There is an on-site diesel driven 600 kW, 480/277VAC 60 Hz Standby Generator EG-ADMIN located within a walk in enclosure across from the Control Building. The enclosure has a small room attached that houses a 1600 amp main breaker manufactured by Siemens/ITE, and an automatic transfer switch manufactured by Onan. There is also a step down transformer and a lighting panel for lighting and louver control in the walk in enclosure. The main breaker is labelled as a delta connection with ground fault monitor; however record drawings indicate a solidly grounded wye connection. The generator has a belly fuel tank outside and is tested weekly under no load, and quarterly under load. The operational hours were approximately 438 hours. A nameplate on the Onan generator was not readily available. A 1500 kVA transformer is also outdoors located near the enclosure. The generator is manufactured by Onan. This equipment was installed in 1977 and is scheduled for replacement later this year using FEMA funding.

The generator acts as a back-up source and connects to the automatic transfer switch (ATS) in the attached room. The generator provides back up power to the Control Building MCC-2, and these other respective MCCs powered by MCC-2:

- Dewatering Building MCC-4
- Primary Digester Building MCC-6
- Biofilter Building MCC-7

8.7.6 Existing Conditions – Primary Digester Building

The Primary Digester Building is powered from MCC-2 in the Control Building and feeds 480/277 VAC 3 phase power to a 600 amp rated MCC-6, located in the electrical room. MCC-6 has main breaker with a 150 amp trip setting. MCC-6 contains starters and feeder breakers for the Digester Process. There is a 480 volt panel, a step down 15 kVA transformer, and 208/120 volt distribution panel. There are two 7.5 hp ABB VFD’s within the electrical room for the pumps WSP-1, and 2.

Heat dissipation was not a concern in this electrical room. The MCC and associated equipment were installed in 2000 and are in fairly good condition. There are also assorted control panels within the electrical room.

The roof was in need of repair, and the both digester covers have lighting protection. EMT conduit was observed on the roof. The wasted methane is used to fuel some boiler equipment; excess methane is burned off.

No electrical concerns were raised by the electrician while on site. The electrical conduits and devices are in good to fair condition. Heat dissipation was not a factor within the electrical room. I did not see any clearance code issues within the space. The exterior lighting was replaced with LED Wall pack lighting recently. The interior lighting is T8 type fluorescent fixtures in the various areas and fairly low bay metal halide fixtures in the hazardous areas. Conduit in hazardous areas was rigid pvc coated and all devices in the hazardous space appeared to meet the area classification requirements.

8.7.7 Existing Conditions – Compost Building

The compost building has a solar PV system on the roof. The PV system is manufactured by Sun Power and ties into local disconnects and Inverter systems on the outside wall of the compost building. It was not clear how the Inverter systems connect to the electrical switchboard.

Compost Area lighting has had moisture issues in the past and corrosion in this area is a big concern. Conduits and local disconnects should be replaced during any upgrades. LED lighting was recently installed in the area, and failures have occurred recently with these upgrades.

The Electrical Room has an old Square D Main QED 800 amp rated switchboard and connected MCC's for the compost area blowers and other equipment. This Compost Building is connected to the secondary side of the 1500 kVA transformer located in front of the Control Building. Besides solar PV, the Compost Building does not have any generator back-up power. The equipment was installed in the late 1980's. Per the site electrician the electrical equipment is old and in need of replacement. The Main Breaker was recently replaced due to operational issues. As the Switchboard and MCC's are over 26 years old parts for repair have been difficult to come by. There is a new distribution panel, and three small VFD's within the electrical room for various pumps and MAU equipment. A small desk and HMI computer and also in the space.

Compost Building MCCs

8.7.8 Existing Conditions – Septage Receiving Building

The Septage Building is powered from a local 500 kVA transformer that feeds 480/277 VAC 3 phase power to a 600 amp rated MCC-3 located in the electrical room. MCC-3 has main breaker with a 600 amp trip setting. MCC-3 powers related aeration tank devices for Area B, and related septage receiving equipment. All devices are manufactured by Square D Model 6 series MCC. There is a step down 30 kVA transformer and 208/120 volt distribution panel. There are three ABB 20HP VFDs within the electrical room that power pumps NR-1, NR-2 and NR-3, and one small VFD labeled "Tarby". There are also assorted control panels, within the electrical room. The MCC, VFDs and associated equipment were installed in 2000 and are in fairly good condition. No electrical concerns were raised by the electrician while on site. The room was fairly warm as other electrical room and ventilation and or air conditioning should be considered. I did not see any working clearance code issues with the electrical room though the space was limited. There are also three small VFD controllers associated with the Methanol Feed Pumps. There is a methanol tank skid located outdoors with three explosion proof disconnects, one for each respective methanol pump.

The exterior lighting was replaced with LED Wall pack lighting recently. The interior lighting is T8 type fluorescent fixtures. Building has fire alarm devices. The rigid conduit and equipment appears in good condition within this area.

There is a 500 kVA transformer located just outside of the Building. There is also a fenced in area that houses two 30kw Capstone Micro-turbine units that ran on the waste gas generated from the septage tanks. There is also an outdoor rated distribution panel that connects the micro-turbines to the Septage MCC-3. These micro-turbines have not been in operation for several years. Currently the MCC-3 does not have a back-up source.

8.7.9 Existing Conditions – Biofilter Building

The Biofilter Building is powered from MCC-2 in the control building that feeds 480/277 VAC 3 phase power to a 600 amp rated MCC-7 located in the electrical room. MCC-7 has main breaker with a 200 amp trip setting. MCC-7 powers the Biofilter Blowers. All devices are manufactured by Square D Model 6 series MCC. There is a step down 15 kVA transformer and 208/120 volt distribution panel. There are two ABB 75HP VFDs within the electrical room that power fans EF-9-1 and EF-9-2. These VFDs are generating a significant amount of heat in the space. There are also assorted control panels, within the electrical room and fire alarm indicating devices. The MCC, VFDs and associated equipment were installed in 2000 and are in fairly good condition. No electrical concerns were raised by the electrician while on site. The Exterior light control panel is a working clearance code violation of the National Electrical Code and should be relocated on the same wall but to the other side of the transformer.

The adjacent fan/blower room, was in fair condition, and had explosion proof fittings and PVC coated rigid conduit throughout the room.

8.7.10 Existing Conditions – Sludge Dewatering Building

The Sludge Dewatering Building is powered from MCC-2 in the control building that feeds 480/277 VAC 3 phase power to a 600 amp rated MCC-4 located in the electrical room. MCC-4 has main breaker with a 400 amp trip setting. MCC-4 powers the associated control panels for the dewatering process. All devices are manufactured by Square D Model 6 series MCC. There is a step down 15 kVA transformer and 208/120 volt distribution panel. There are two VFD’s within the electrical room, that power PFP-1 and PFP-2 No heat dissipation concerns were raised in this space. There are also assorted control panels, within the electrical room and fire alarm indicating devices. The MCC and associated equipment were installed in 2000 and are in fairly good condition. No electrical concerns were raised by the electrician while on site. I did not see any working clearance code issues with the electrical room though the space was limited.

Other lower floor areas were examined, no concerns were raised. The back-up polymer system is non-operational.

In the open area on the upper floor are the Gravity Belt Thickener and the Belt Filter Press. Per the electrician no operation problems exist. The Belt Filter Press and Gravity Belt Thickener panels are located within an enclosed control room on the upper floor. The upper floor areas of the dewatering building were fairly clean with minor corrosion on pumps and devices near the equipment. The exterior lighting was replaced with LED Wall pack lighting recently. The interior lighting is T8 type fluorescent fixtures in the various electrical and control room areas, with Metal Halide fixtures in the open areas on lower and upper floors.

8.7.11 Existing Conditions – RAS Building and Final Clarifiers

The RAS Building is powered from a local 1500 kVA transformer that feeds 480/277 VAC 3 phase power to a 1600 amp rated main switch. The switch has a 1600 amp main circuit breaker and powers a 1200amp PP-1 switchboard. PP-1 has a main 1200 amp breaker and powers MCC-8 and several large VFDs within the electrical room for the RSP and OP pumps. MCC-8 has main breaker with a 200 amp trip setting and 600 amp rated bus and primarily powers the final settling tanks. All of the main electrical devices are manufactured by Square D, QED and Model 6 series MCC. The switchboard also has a local ASCO automatic transfer switch. There is a step down 45 kVA transformer and 208/120 volt distribution panel. There are four ABB 100HP VFDs that power the outfall pumps OP-1, 2, 3, and 4. There are also four 30 hp ABB VFDs that power the Return Sludge Pumps RSP-1, 2, 3, and 4. These VFDs are generating a lot of heat in the space, and operators need to keep door open to the electrical room with an operating fan to dissipate the excessive heat. There are also assorted control panels within the electrical room. The Switchboard, MCC, VFDs, and associated equipment were installed in 2000 and are in fairly good condition. No electrical concerns were raised by the electrician while on site. There were no working clearance code issues with the electrical room.

The other areas of the RAS building ground floor were fairly clean with minimal corrosion. These include the Generator room, Office, Restroom, Chemical room and Storage room areas. Egress doors have manual pull stations and fire alarm strobe indicators. The ground floor has T8 fluorescent lighting throughout.

The lower floor that houses the Pumps OP-1,2,3 and 4 as well as the RSP-1,2,3, and 4 was in very good condition. It may be an area that has continuous ventilation but it was not confirmed. No corrosion problems were identified. A few return sludge pump disconnects have a working clearance code issue as conduit racks are located within the required working clearance. Space was lit with Metal Halide and T8 fluorescent lighting. The Plant Water Pump System has a few operational issues and replacement is planned in the future. There is also a sump pump control panel.

Outside the building is a canopy covered UV train(s) and UV control panel. The canopy was added to the building by plant staff. The canopy lighting is LED type. Per electrician no issues exist and the conduits and devices we in good condition.

There is an on-site diesel driven 1000 kW, 480/277VAC 60 Hz Standby Generator EG-RAS located within the generator room of the RAS Building. The generator has a fuel day tank within the space, and a larger fuel tank located outdoors near the 1500KVA transformer. The generator is tested weekly under no load, and quarterly under load. The operational hours were not readily available on the generator control panel. The generator is manufactured by Kohler. The generator acts as a back-up source and connects to an automatic transfer switch (ATS) in the RAS building electrical room. The generator provides back up power to the switchboard PP-1, the RSP and OSP pumps, as well as devices powered by MCC-8. The generator appears to be oversized, based on the plant operational loads at the RAS building.

8.7.12 Recommendations

8.7.12.1 NFPA 820 Implications

During the site visit, it was observed that the Primary Settling Tank devices are located in a Class 1 division 2 area. Per NFPA 820, the Fire Protection Standard in Wastewater and Treatment and Collection Facilities, a pretreatment tank is considered a Class 1 Division 2 over water surface to 18" above tank wall. The 18" envelope extends outward ten feet. A Class 1 Division 2 area is an area, where hazardous processes are handled or stored, that are normally confined, but flammable gases could exist if there were an accidental rupture of the confined systems.

All devices within the area should be rated Class 1 Division 2 and installed per the article 501 of the National Electrical Code. Any equipment in the area envelope should be reviewed for compliance. Modifications (if necessary) would bring the existing devices and respective new devices up to code requirements per NFPA 820, and NFPA 70.

8.7.12.2 Electrical Power and Incoming Service

Electrical loads at the Fairfield WPCF were reviewed based on the available 2000 upgrade record drawings, and each MCC, Switchboard, Main Gear, and respective transformers are adequate to serve the facility electrical needs. Current plant daily average demands are 10,500 kW. Recommendations include:

- Remove bushes in front of the medium voltage switchgear for proper working clearance requirements.
- Use infrared technology to scan the Medium voltage gear and main switchboards, and MCC's throughout the plant to ensure there are no hot spots.
- Conduct a Short Circuit and Arc Flash coordination study for the entire electrical infrastructure. Attach PPE equipment requirement stickers to all electrical distribution equipment and control panels based on the study.
- If new process equipment is installed in a respective building consider installation of a new 480 volt Switchboards and MCC's.

- The new generator installation planned for later this year to replace ENG-ADMIN should be sized to back up maximum operational loads for MCC-2 and other loads as needed. Consider adding compost facility or septage loads to Generator. Generator will be natural gas. Main breakers and ATS ratings should be similar. Short circuit ratings should be verified by conducting a Short Circuit and Arc Flash Coordination Study.

8.7.12.3 Influent Building

- Install low bay LED Hazardous lighting in the hazardous areas.
- Relocate the gas detection equipment as suggested by the instrumentation engineer.
- Install new conduit and wire for any new equipment planned for the upgrade. Conduit wire and devices should meet compliance with any hazardous areas as defined by NFPA 820. PVC coated rigid conduit is recommended in these spaces.
- New equipment could be powered by the existing MCC-1 located in the electrical room.
- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.
- As the electrical room was rather warm install adequate ventilation or air conditioning within the electrical room.

8.7.12.4 Blower Building

- Install new MCC-5 sections to replace the older Westinghouse sections.
- Install new distribution panels to replace existing rusted panels
- Install some sort of Dehumidification to alleviate humid air entering building when louvers are opened.
- Install new conduit and wire for any new process equipment planned for any upgrades.

- New Equipment could be powered by modified MCC-5.
- If required by the authority having jurisdiction, new fire alarm systems should be installed within the existing building for any upgrades
- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.

8.7.12.5 Primary Settling and Aeration Tanks

- Install new conduit and wire for any new process equipment planned for any upgrade. Conduit wire and devices should meet compliance with any hazardous or areas as defined by NFPA 820.
- Replace Primary Settling tank devices within the 18" Class 1 Division 2 envelope as defined by NFPA 820.
- New tank equipment should be powered by modified MCC-5 located in the Blower Building or MCC-3 located in the Septage Receiving building.
- New Aeration mixers, valve actuators, and or pumps shall require local disconnects and local control stations.

8.7.12.6 Control Building

- Install new conduit and wire for any new process equipment planned for the upgrade. Conduit wire and devices should meet compliance with any hazardous areas as defined by NFPA 820.
- New Equipment and process pumps should be powered by MCC-2 located in the electrical room.
- If required by the authority having jurisdiction, new fire alarm systems should be installed within the existing building.
- A new fire alarm panel is recommended based on the age of existing panel.

- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.
- As the electrical room was very warm (80 plus degrees) install adequate ventilation or air conditioning within the electrical room.

8.7.12.7 Primary Digester Building

- Install new conduit and wire for any new process equipment planned for the upgrade. Conduit wire and devices should meet compliance with any hazardous areas as defined by NFPA 820.
- New Equipment and process pumps should be powered by MCC-6 located in the electrical room.
- If required by the authority having jurisdiction, new fire alarm systems should be installed within the existing building.
- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.
- If conduit replacements on roof are planned consider Aluminum conduit to replace the EMT conduit.

8.7.12.8 Compost Building

- As the MCC and switchboards in the existing electrical room are outdated, this equipment should be replaced within the near term.
- Consider whether the new electrical equipment should be on a back-up power source. The EG ADMIN generator if replaced may be able to power some of the compost building equipment. A further analysis should be conducted if back-up power needs are anticipated.
- New conduit should be installed if any electrical or instrumentation upgrades are to take place in compost area or electrical room based on area classifications as defined by NFPA 820

- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.
- Compost area lighting should be replaced with corrosion resistant LED type high bay fixtures, with an installation method to avoid condensation build up and corrosion. Check with utility company to see which light fixtures may qualify for installation rebates.
- If required by the authority having jurisdiction, new fire alarm systems should be installed within the existing building for any upgrades
- New installations of Electrical Equipment should be reviewed for heat dissipation and new ventilation or air conditioning should be installed accordingly.

8.7.12.9 Septage Receiving Building

- Install new conduit and wire for any new equipment planned for any upgrades. Conduit wire and devices should meet compliance with any hazardous areas as defined by NFPA 820. PVC coated rigid conduit is recommended in these spaces.
- New equipment should be powered by the existing MCC-3 located in the electrical room.
- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.
- As the electrical room was rather warm install adequate ventilation or air conditioning within the electrical room.
- Repair or remove the 30 kW Micro turbines and respective distribution equipment.

8.7.12.10 Biofilter Building

- Install new conduit and wire for any new equipment planned for the upgrade. Conduit wire and devices should meet compliance with any hazardous areas as defined by NFPA 820. PVC coated rigid conduit is recommended in these spaces.

- New equipment should be powered by the existing MCC-7 located in the electrical room.
- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.
- As the electrical and fan/blower room were rather warm install adequate ventilation or air conditioning within these areas.

8.7.12.11 Sludge Dewatering Building

- Install new conduit and wire for any new process equipment planned for the upgrade. Conduit wire and devices should meet compliance with any hazardous areas as defined by NFPA 820.
- Replace the back-up polymer system.
- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.
- New Equipment could be powered form the existing MCC-4
- If required by the authority having jurisdiction, new fire alarm systems should be installed within the existing building.

8.7.12.12 RAS Building Final Settling Tanks

- Install new conduit and wire for any new process equipment planned for the upgrade. Conduit wire and devices should meet compliance with any hazardous areas as defined by NFPA 820 and depending on if the lower levels are isolated from the upper levels.
- If required by the authority having jurisdiction, new fire alarm systems should be installed within the existing building.
- Install new emergency, general, and hazardous area LED lighting throughout the building based on area classifications as defined by NFPA 820. Check with utility company to see which light fixtures may qualify for installation rebates.

- Relocate conduit rack structures in front of the Return Sludge Pump Disconnects.
- Replace the Plant Water Pump system.

  As the electrical room was very warm install adequate ventilation or air conditioning within this area.

SECTION 9
COLLECTION SYSTEM EVALUATION

Wright-Pierce
Engineering a Better Environment
70 YEARS 1947 - 2017

SECTION 9

COLLECTION SYSTEM EVALUATION

9.1 BACKGROUND

The Town of Fairfield Connecticut wastewater collection system consists of approximately 210 miles of gravity sewers, eight pump stations, over 2 miles of force mains and an advanced wastewater treatment facility (WPCF) with a design average flow of 9.0 MGD. The WPCF treats wastewater from the Town of Fairfield only. Wastewater is generated from residential, commercial, industrial and institutional sources and flows to the WPCF where it receives secondary treatment prior to being discharged to Long Island Sound.

An evaluation of the Fairfield Collection System was conducted in several phases in order to asses the overall condition, efficiency and hydraulic capacities of the collection system sewer pipes and sewer pump stations in an effort to identify deficiencies in the system and to develop a long-term plan to meet the needs of the community. The following evaluations were conducted and summarized in this section of the report:

- Inflow and Infiltration Evaluation
- Interceptor Sewer Hydraulic Modeling
- Pump Station Evaluation

Separate reports were developed and provided to the Town for each of the evaluations listed above. As of the writing of this report, the Inflow and Infiltration Evaluation Report has been finalized, the Pump Station Evaluation Report has been submitted as a draft, and the Interceptor Sewer Hydraulic Modeling Evaluation Report will be submitted concurrently with this Draft Facilities Plan Report.

9.2 INFLOW/INFILTRATION STUDY

Identifying sources of Inflow and Infiltration (I/I) that could be cost-effectively removed was an important goal of this study, as the presence of I/I in the wastewater collection system utilizes sewer capacity that would otherwise be available to convey sanitary flows. In addition, I/I increases the cost of treatment through increased pumping and reduces the treatment capacity at the Water Pollution Control Facility (WPCF). Therefore, the cost effective removal of I/I flows can provide for additional capacity within the existing collection system and treatment facility.

9.2.1 Continuous Flow Metering

Due to the size of the Fairfield collection system, an initial I/I Study was performed in the Spring of 2016 to determine the overall magnitude of I/I entering the system. The results of the initial study are summarized in the Wright-Pierce report entitled *Infiltration and Inflow Evaluation, January 2017*. As part of the initial I/I analysis, influent flow records for the Fairfield WPCF were evaluated to assess seasonal variations in flow. These flows were then compared to water consumption data to determine the overall magnitude of I/I entering the system. Continuous flow monitoring and an evaluation of pump station run-time data was then conducted to further evaluate the system and to identify the specific drainage areas and drainage sub-areas contributing the most significant I/I.

An evaluation of the WPCF influent flow data, compared with the calculated baseline sanitary flows for the period January 1, 2010 through December 31, 2015, estimated an annual average I/I contribution to the WPCF of approximately 4 to 5 mgd. Similarly, the peak flows recorded at the facility during the spring, wet weather months can increase between 25 and 33 mgd or more following a significant storm event indicating the likelihood of direct inflow and/or rain-induced infiltration into the collection system.

To identify which sub-basins within the collection system may contribute greater I/I rates than others, continuous flow monitoring within each sub-basin was performed. Wright-Pierce retained the services of ADS Environmental to install a total of 40 flow meters within the Fairfield Collection System between March 10, 2016 and May 18, 2016. A summary of the continuous flow metering is included in the ADS report entitled *Fairfield, CT Temporary Flow Monitoring Report, March 2016 – May 2016*. Pump station run-time data and WPCF influent flows were also evaluated during the flow monitoring period to further isolate areas of I/I within each sub-basin and/or pump station drainage area.

Based on the results of the Flow Monitoring Evaluation, specific areas were identified for additional SSES evaluations to locate non-sanitary flow sources, and to prioritize these sources according to the feasibility and cost effectiveness of their removal. The additional recommended investigations consisted of a combination of flow isolations, smoke testing, manhole inspections, television inspections, and house-to-house inspections performed on portions of the collection system to determine the specific locations of possible I/I sources and recommend rehabilitation methods. SSES work was broken down into three phases, with Phase 1 and 2 recommended to be conducted immediately.

The anticipated cost to carry out the Phase 1 and Phase 2 SSES efforts is approximately $550,000 in current year costs. Based on the towns current budget, this work is scheduled to begin in the Spring of 2018 and is anticipated to be 55% Clean Water Fund Planning Grant eligible. Refer to the January 2017 report for a prioritized listing of the target areas.

9.3 INTERCEPTOR SEWER HYDRAULIC MODELING

As part of the facilities planning process, the Town of Fairfield identified potential capacity issues with their two main sewer interceptors leading to the Water Pollution Control Facility (WPCF) including the East and West Trunk Sewers. In particular, overflows have been reported along the East interceptor Between Interstate 95 and Kings Highway East, from the area of Exit 24 off I-95 to the intersections of Routes 1 and 58 and in the vicinity of Exit 23 off I-95, along Grassmere and Woodside Avenues, as well as Crestwood Road and Home Street. To identify potential bottlenecks in these interceptors, a hydraulic model of each of these two interceptor sewers was developed including the three siphons. Details of the modeling can be found in the Wright-Pierce report entitled *Hydraulic Modeling and Investigations - DRAFT, February 2017*.

During this study, the Fairfield system was evaluated at present and projected future flow conditions to determine available capacities at each condition. The developed model can also be used to identify potential capacity problems in smaller portions of the collection system directly impacted by development, proving beneficial to the Fairfield Public Works and Planning Departments.

9.3.1 Modeled Flow Scenarios and Results

The SewerCAD model was used to run a hydraulic analysis to develop a flow profile within the existing east and west main interceptors for the following three scenarios:

- Scenario 1: Present population, average daily flow;
- Scenario 2: Future population, average daily flow; and
- Scenario 3: Future population, peak instantaneous flow.

9.3.2 Hydraulic Modeling Conclusions and Recommendations

The interceptor hydraulic modeling study has developed tools that can be used to assess the effects of any future flow on the existing sewer collection system main interceptors. In addition, the modeling effort has indicated potential issues within the existing interceptors that will need to be addressed. The draft report is currently in review with the Town. The Current conclusion and recommendations include:

- There are existing documented SSOs occurring within the system
- Based on the modelling effort, it appears to be due to excessive flow causing pipe surcharges in areas of limited cover
- These SSO's tend to occur when the East Interceptor conveys 5 MGD or more through the SSO, which seems to occur during plant flows of 20 MGD or greater
- Performing the "Upper East" relocation would divert flows away from the SSO area.
- Rehabilitating the pipe upstream of the SSO area may also provide needed relief from increased wet-weather flows
- Performing "Lower East" Relocation could be performed if the WPCA determines that a new route is beneficial to them for access or other concerns, but is not considered a high-priority project.
- Relocation of the West Interceptor is not recommended.
- The "central interceptor" area where the other SSO cluster is located should also be further investigated and modeled to confirm the case of the reported issues in that area.
- The Riverside siphon should be further evaluated to determine the cause of the increased flow measurements, and potentially upgraded during the tidal gate replacement, if warranted.

9.4 PUMP STATION EVALUATION

The Town of Fairfield's wastewater collection system includes 8 pump stations that convey sewage to the Fairfield Water Pollution Control Facility (WPCF). The existing pump stations include four wet well/dry well “cast-in-place” stations, one wet well/dry well "can-style" station, two submersible stations and one suction-lift station. The oldest station was built in 1959, while others as recently as 1994.

As part of collection system evaluation, a comprehensive evaluation of each pump station was performed to inventory/assess their process equipment, building structures, electrical equipment, and heating/ventilation equipment to establish recommended improvements and an overall implementation plan for the Town of Fairfield's pump stations. It was observed that many of the pump stations have aged equipment that has surpassed their useful design lives. It was recommended that these stations undergo a complete upgrade in order to maintain reliable operation for the next 30 to 40 years. The following pump stations were observed to be in need of a full comprehensive upgrade in the following order:

1. Easton Turnpike Pump Station & Force Main
2. Fairfield Beach Pump Station & Force Main
3. Center Street Pump Station & Force Main
4. Pine Creek Pump Station
5. Mill Hill Pump Station

In addition to the recommended comprehensive pump station upgrades, interim improvements were recommended for the remaining three stations, the Willow Street, Eastfield Drive and Toll House Pump Stations.

9.5 COLLECTION SYSTEM ASSET MANAGEMENT PLAN

A summary of the costs associated with the recommended improvements and prioritized target completion dates was developed and presented as part of a 15-year Pump Station Capital

Improvements Plan (CIP) included in the Wright-Pierce report entitled *Pump Station Evaluation Report-DRAFT, November 2016.* This capital improvement plan has been expanded to include the other collection system improvements that have been identified as part of the I/I study and the interceptor hydraulic modeling evaluation.

As shown in **Table 9-1**, pump station estimated costs range in magnitude from complete and comprehensive upgrades including but not limited to new pumps, controls, heating and ventilation, electrical gear and generators, etc., to minor improvements including but not limited to painting, heating and ventilation replacements, bypass pumping connections and/or improvements to address safety concerns. In general, many of the stations evaluated are in need of immediate repairs and it is recommended that the Town budget for at least one full comprehensive upgrade every two years. In addition, costs for SSES work and gravity sewer and manhole rehabilitation work throughout the collection system have been budgeted.

It is important to note that the costs presented in **Table 9-1** are in 2017 dollars. They have been projected forward over a 15-year budget period with an anticipated five per cent per year inflation factor. The costs presented are intended to be used as a budgeting tool for the Town and the fiscal year in which specific projects are completed, inflation rates assumed and priority of projects can all be adjusted as work moves forward and additional projects are identified. We have not included the cost for the potential rerouting of the East Interceptor within this Capital Improvements Plan at this time.

TABLE 9-1

COLLECTION SYSTEM CAPITAL IMPROVEMENTS PLAN

Item/Equipment	2017 Budget Cost	Target Replacement/Upgrade Year [1] 2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Inflation factor @ 5%	**1.00**	**1.05**	**1.10**	**1.16**	**1.22**	**1.28**	**1.34**	**1.41**	**1.48**	**1.55**	**1.63**	**1.71**	**1.80**	**1.89**	**1.98**	**2.08**
Pump Stations (Tier 1)																
Toll House	$504,000										$821,000					
Easton Turnpike (Includes Force Main)	$1,656,000	$1,739,000														
Eastfield Drive	$331,000												$594,000			
Mill Hill	$1,094,000							$1,539,000								
Center Street (Includes Force Main)	$1,922,000			$2,225,000												
Willow Street	$540,000														$1,069,000	
Pine Creek	$504,000					$643,000										
Fairfield Beach (Includes Force Main)	$1,584,000		$1,746,000													
Re-Evaluate All Pump Stations (2048)	$30,000															
Force Mains (Tier 2)																
Force Main Inspections [2]	$50,000				$61,000											
SSES Field Investigations [3]	$550,000	$577,500														
Sewer Rehabilitation [4]	$3,000,000	$210,000	$220,500	$231,525	$243,101	$255,256	$268,019	$281,420	$295,491	$310,266	$325,779	$342,068	$359,171	$377,130	$395,986	$415,786
Upper East Trunk Replacement [5]	$7,000,000	$7,000,000														
Lower East Trunk Replacement [5]	$8,000,000			$8,000,000												
Riverside Siphon	TBD															
Subtotal	$26,765,000															
Total	**$30,546,000**	$9,526,500	$1,966,500	$10,456,525	$304,101	$898,256	$268,019	$1,820,420	$295,491	$310,266	$1,146,779	$342,068	$953,171	$377,130	$1,464,986	$415,786

Notes

(1) Costs assume a 5% inflation factor for each year. Budget is a working plan which should be updated periodically. Targeted dates identified to develop budget projections over 15 years. Cost shown for anticipated actual year of expenditure.

(2) Costs for future inspection of the force mains to be determined based on the results of the evaluations, see Section 5.2.3.2 for more details.

(3) Costs are elibible for 55% Cleasn Water Fund Grant.

(4) Costs assume $200,000 per year.

(5) Cost not included in overall Capital Improvement Plan. East Trunk may be Clean Water Fund Loan only eligible.

SECTION 10
RECOMMENDED PLAN

SECTION 10

RECOMMENDED PLAN

10.1 INTRODUCTION

The Town of Fairfield is facing several challenges at their water pollution control facility (WPCF) including:

- Seasonal I/I that impacts plant performance
- Maintaining stringent nitrogen removal and disinfection requirements with increasing operation and maintenance costs to achieve those limits
- Periodic nuisance odor problems
- Poor flow distribution to the Primary Settling Tanks and to the Aeration Tanks
- Reliability and health and safety concerns with their solids handling processes
- Undersized equipment including the raw sewage pumps, effluent pumps and return sludge pumps
- Capacity of sludge storage tanks and anaerobic digesters
- Aging, energy inefficient unit processes, equipment and building systems with increasing operating costs and increasing corrective maintenance requirements

The purpose of this facilities plan is to identify the problems 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.

10.2 DESCRIPTION OF THE RECOMMENDED PLAN

The recommendations are outlined below and generally organized by process area or building space. The proposed work associated with each phase of the upgrade is presented separately below. All general non-process related recommendations (i.e. building system improvements) are outlined in the last section. The specific key recommendations are presented below.

10.2.1 Removal of Inflow and Infiltration

- Implement a system wide program to identify and remove inflow and infiltration (I/I) to reduce its impacts on plant performance.

10.2.2 Mechanical Screenings

- Install new multi-rake mechanically cleaned bar screens in the area of the existing primary and secondary mechanically cleaned bar screens. Each screen will be sized to handle design peak hour flow to prevent surging during raking and should discharge above grade to a new grinder wash press. The primary screen will have ¾-inch bar spacing and the secondary screen will have 3/8-inch bar spacing. Each screen will serve as a redundant back-up to the other.
- Construct a new screenings disposal area at grade with roll-up doors, dedicated containers, and a scale to eliminate the need to transfer containers from an elevated platform.

10.2.3 Grit Removal

Construct two new aerated grit tanks as part of a new Influent Pump Building. Each tank will be sized to handle the design peak hour flow with a detention time of 3 minutes. This will minimize grit passing through the plant at higher flows and collecting in the primary settling tanks and anaerobic digester tanks. The associated components are generally described below:

- Construct two 35-foot long by 15-foot wide by 10-foot deep concrete tanks with a sump and air diffusers.
- Install air lift pumps to transfer grit from the aerated grit tank to a new grit washer located on the level above the aerated grit tanks.
- Install two new aerated grit blowers in Influent Building Pump Room or in the existing Auxiliary Sludge Pump Room.

10.2.4 Raw Sewage Pumping Station

Construct a new raw sewage pump station as part of a new Influent Pump Building. The existing dry pit in the Control Building will be abandoned. This will eliminate the code issues associated with the current below grade pump room. The station will centrally locate all raw and auxiliary pumping systems to one location. The associated components are generally described below:

- Provide five (5) equally sized dry-pit submersible variable speed pumps, 4 duty / 1 stand-by, to handle a peak hour flow of 35 MGD.
- Construct new divided wet well.
- Provide building space above the structure for electrical equipment and controls.
- Provide a new influent magnetic flow meters on the discharge of the pumps with controls to pump to both the primary settling tanks and aeration tank bypass.

10.2.5 Primary Settling Tanks

- Replace all primary settling tank chain and flight mechanisms and drives.
- Construct new flow splitter structure to provide a positive flow split to each of the primary settling tanks. The structure will be part of the new Influent Pump Building.
- Reconfigure the draw off piping with automated valves to improve sludge draw from each primary tank.
- Drain and inspect the primary settling tanks, repair all cracks, replace sealant in joints on Primary Settling Tank Nos. 1 through 5, resurface all concrete surfaces with exposed aggregate.
- Infill the separated joints between Primary Settling Tank No. 1, 2 and 3 with backer rod and joint sealant.
- Re-support scum trough so that it is properly sloped.

10.2.6 Aeration Tanks

- Construct separate distribution structure to mix and split primary effluent, RAS, and internal recycle as symmetrically as possible to the Zone A Aeration Tanks. The original design and shape of the channel prevents ideal symmetry.
- Replacement of submersible mixers with either hyperboloid or large-bubble mixers to minimize dead zones and to increase process and reduce energy requirements.
- Convert Zone A Aerobic Zone 1 to swing zones by installing an anoxic mixing system into these zones and converting the Zone A tanks to three trains by constructing baffle walls thus reducing methanol usage.
- Structural modifications to facilitate the passing and removal of scum and foam from the aeration tanks. Zone A anoxic tank baffle walls to be lowered and the submerged orifices constricted to encourage overflow hydraulics and passing of scum and foam. Zone B anoxic tank baffle walls submerged orifices will be constricted to encourage overflow hydraulics and passing of scum and foam. The surface baffle installed across aeration tank effluent and surface wasting station will be constricted.
- Install three new 150 to 200-hp aeration blowers.
- Install online ammonia probes to allow operators to monitor nitrification performance and further optimize blower operation through aeration trim control.
- Correct instrumentation calibration issues and control algorithm issues that are contributing to inefficient and uncoordinated aeration control. Include optimization of the control systems for the aeration control and methanol feed systems to handle fluctuations in sludge recycle flows and loadings.
- Install extended platforms to access methanol feed nozzles.
- Provide additional methanol feed points to the pre-anoxic zones.
- Further investigate the condition of Aeration Tank Zone A and Zone B during the design phase which were flagged as concrete structures of concern. Rehabilitate the existing tanks as necessary via grout injection, surface repairs, etc.

10.2.7 Supplemental Carbon Feed and Storage

- Replace methanol storage tanks and protect to the 500-year flood elevation.
- Install a canopy for protection against the elements.
- Replace all pumps and level sensors.

10.2.8 Final Settling Tanks

- Replace existing sludge collection mechanisms. The full radius skimmers will be eliminated and replaced with a hinged skimmer mechanism and a 6-foot scum box.
- Install a weir washing system to replace the algae sweep brush system.
- Rehabilitate the existing tanks as necessary via grout injection, surface repairs, etc.
- Relocate scum pump station to allow for installation of new UV disinfection channel.
- Replace scum pumps.
- Provide paved access to interior courtyard area.

10.2.9 Return Sludge Building

- Replace four existing return activated sludge (RAS) pumps with four new larger pumps rated for 2,800 gpm.
- Replace the effluent pumps with four new equally sized variable speed pumps, 3 duty / 1 stand-by, to handle a peak hour flow of 35 MGD.
- Replace the plant water skid system with three new stand-alone horizontal end suction centrifugal pumps and controls to maintain plant water needs throughout the facility.
- Replace the existing basket strainer with a larger, mechanically cleaned sieve size strainer and install a piped bypass around the unit to allow the plant water system to operate continuously when maintenance is being performed on the strainer.

10.2.10 UV Disinfection

- Construct a new channel to install a new UV system, with new parshall flume and isolation gates; and modify the existing channel to retrofit it with a new UV system such that each channel will be designed to operate independently to handle a peak hourly flow rate of 35 MGD with one channel offline.

- Drain and inspect tanks, rehabilitate tanks as necessary via grout injection, surface repairs, etc.

10.2.11 Solids Handling Systems

- Construct two new 30,000-gallon sludge storage tanks for use during periods of high influent loadings. The tanks will be constructed as part of the new Influent Pump Building or adjacent to the new primary effluent splitter structure and may also be used for elutriation of anaerobic digested sludge prior to dewatering.
- Demolish the existing primary sludge pump room and install new primary sludge pumps located in the new Influent Building Pump Room.
- Demolish the existing submersible waste sludge pumps at the head of the primary settling tanks and install two new waste activated sludge pumps (positive displacement or centrifugal non-clog) in the basement of the Return Sludge Building to allow for better pumping control and to eliminate maintenance issues. Install new discharge waste sludge lines to the Gravity Belt Thickener.
- Maintain the gravity belt thickener to thicken waste sludge but replace the thickened waste sludge transfer pump.
- Convert the existing gravity thickener to a true storage tank. Demolish the existing mechanism and install a mixing system to keep the waste sludge homogenous prior to transferring to the primary digester.
- Install two new thickened waste sludge pumps and a grinder with the ability to pump thickened waste sludge at concentration of 5% to 7% to the primary digester.
- Install two new screw presses to replace the belt filter press to achieve cake solids of 20% or greater, reducing the amount of material to be transferred to the compost facility and to increase the efficiency of the compost process will also be increased at the higher cake solids. Screw presses can also be automated to operate during off-peak hours to further reduce power consumption.

- Install two new screw press feed pumps to pump sludge from the digesters to the screw presses.
- Replace all thickening and dewatering polymer feed and storage systems with appropriately sized packaged skid units.

10.2.12 Sludge Digesters

- Clean the primary and secondary digester tanks.
- Reduce the SRT in the primary digesters to 15-days.
- Installation of mixing system in the Secondary Digester and replace cover.
- Replacement of all boilers.
- Addition of condensate traps and inspection of biogas piping.
- Replacement of spiral heat exchanger for the existing primary digester.
- Inspection of solids piping for struvite formation. If extensive struvite is formed in the piping, the Town may consider additional struvite control including ferric chloride or anti-struvite chemical feed.
- Installation of magnetic meters with self-cleaning or bullet-nosed electrodes to improve control of feed volumes.
- Install a 200-kW reciprocating engine combined heat and power (CHP) system to utilize digester biogas id proven cost effective. Additional research will need to be conducted during the preliminary design phase based on available funding and following sampling of the biogas to determine the requirements of the gas pretreatment system.

10.2.13 Composting

The town has benefitted from composting for the past 28 years and the operators at the WPCF are comfortable with the process. In addition, a significant investment was made by the town to replace the Compost Building in 2008 and is in the process of installing a fuel cell outside of the building in the Spring of 2017. Waste heat from the fuel cell will be used to heat the air in the Compost Building. Therefore, it is recommended that maximize this investment by continuing to compost while providing safer working environment and new dewatering equipment for improved composting performance. Recommendation include:

- Installation screw presses to achieve higher cake solids
- Replace polymer feed systems
- Upgrade electrical distribution equipment in Compost Building and install process on emergency power
- Install HVAC equipment and gas monitoring in Compost Building
- Replace all lighting in Compost Building
- Install Bac-Tee negative mode aeration with provisions to pre-treat or separately dispose of the condensate
- Replace bin and floor rails
- Replace agitator

10.2.14 Odor Control

- Separate the dewatering exhaust from the process odor control system (Biofilter B) to maintain compliance with NFPA 820 and treat it through a dedicated activated carbon unit located near the Dewatering Building.
- Maintain and upgrade pipe-in-stone Biofilter B and install new smaller, higher efficient blowers in the Biofilter Building or install an activated carbon unit with new exhaust blowers to treat exhaust from air spaces at the Influent Building, Primary Settling Tank Effluent Distribution Channel, Return Activated Sludge Chamber, Septage Receiving Station, Gravity Thickener Tank and the new raw sewage wet well. It is recommended that emissions testing for hydrogen sulfide be conducted to confirm that levels are consistent with the assumptions of the life cycle cost analysis during the design phase. Existing ductwork will be reused.
- Maintain and upgrade pipe-in-stone Biofilter A and replace existing blowers at the Compost Building with new smaller, higher efficiency units to treat exhaust from the Compost Building. Combined with the recommendation to move to negative aeration for composting to improve containment of composting off-gases, the ventilation rate to

Biofilter A will be reduced, possibly extending the life of the media. Existing ductwork will be reused.

- Provide odor control to new Influent Pump Building, Primary Influent and effluent distribution boxes and new sludge/elutriation tanks.

10.2.15 Miscellaneous

- Provide additional plant water hydrants and replace all existing.
- Replace or refurbish all sluice and slide gates that do not currently operate properly.
- Replace all check and plug valves that are old and do not properly operate.

10.2.16 Site Improvements

- Install automatic sliding access gate with card readers or key FOBs at three of the four plant access points with man gate access adjacent to each.
- Upgrade the yard pump station with a duplex style grinder pump station.
- Provide/Maintain paved access to all final settling tanks.
- Re-pipe catch basin in front of garage bay to the new yard pump station or to the influent upstream of the wet well.
- Construct a spill containment area to the north of the Influent Building to catch any spills from truck unloading from off-site wastes area and direct it by gravity to the raw sewage wet well.
- Install a sludge truck unloading station is at the gravity thickener and/or primary digester.
- Repave all access drives with heavy duty pavement.

10.2.17 Building System Improvements

A variety of building system improvements were identified in Section 8. In general, they include rehabilitation of existing tanks and structures to allow for reuse as part of the upgraded facilities. Many of these recommendations are associated with:

- Removal of peeling paint from existing concrete surfaces and not recoating these surfaces to minimize future maintenance;
- Replacement of doors, windows and general repair of existing building facades and roofing components (repointing, flashing, crack and joint repairs, etc.);
- Pressure injection repair of structural cracking in structures and tanks;
- Repair or replacement of corroded metals; and
- Resealing of pipe penetrations as required.
- Test and abate any lead, asbestos and PCB's not removed during the last upgrade.

In addition, specific recommendations of note include:

- Upgrade of specific HVAC equipment and sump pumps to replace items that are approaching their service life or are currently inoperable.
- Replace the two H.B. Smith 19 series, 6-section boilers with new high-efficiency boilers which can provide approximately 600,000 BTUh of heat and can operate on both natural gas and digester gas.
- Provide tepid (lukewarm) water feeds for all emergency showers.
- Consolidate the existing HVAC DDC control systems to be operated by a single server.
- Convert the HVAC electrical/electronic controls systems in numerous buildings to direct digital controls.
- Provide ductless split air conditioning units in all electrical rooms.
- Address NFPA 820 code-related ventilation and electrical classification issues in specific spaces and upgrade to provide appropriate ventilation rates and electrical infrastructure.
- Upgrade of the instrumentation and controls and SCADA system plant wide.
- Replacement of the older electrical distribution equipment that was constructed as part of the pre-2000 upgrade (MCC-5 in Blower Building and MCCs in Compost Building) and modifications to the remaining electrical distribution system as required based on process modifications to the facility.
- Conduct a Short Circuit and Arc Flash coordination study for the entire electrical infrastructure. Attach PPE equipment requirement stickers to all electrical distribution equipment and control panels based on the study.

- Investigate fire alarm and lighting systems upgrades during the design phase.
- Upgrade and reconfigure the laboratory.
- Expand the men's locker area and provide additional showers.
- Expand or reconfigure the breakroom.
- Provide a second means of access/egress from the Return Sludge Pump Room to meet current codes if modifications in this space require a code review.
- Enclosure stairs in Dewatering Building to meet current codes if modifications in this space require a code review.
- Demolish abandoned primary digester.

10.3 PRELIMINARY LAYOUT OF PROPOSED IMPROVEMENTS

The following figures are provided at the end of this section to generally illustrate the proposed recommendations. Refer to individual sections within this report for proposed building and structure layouts.

- Figure 10-1: Proposed Site Plan (Aerial)
- Figure 10-2: Proposed Wastewater Process Flow Diagram
- Figure 10-3: Proposed Solids Process Flow Diagram

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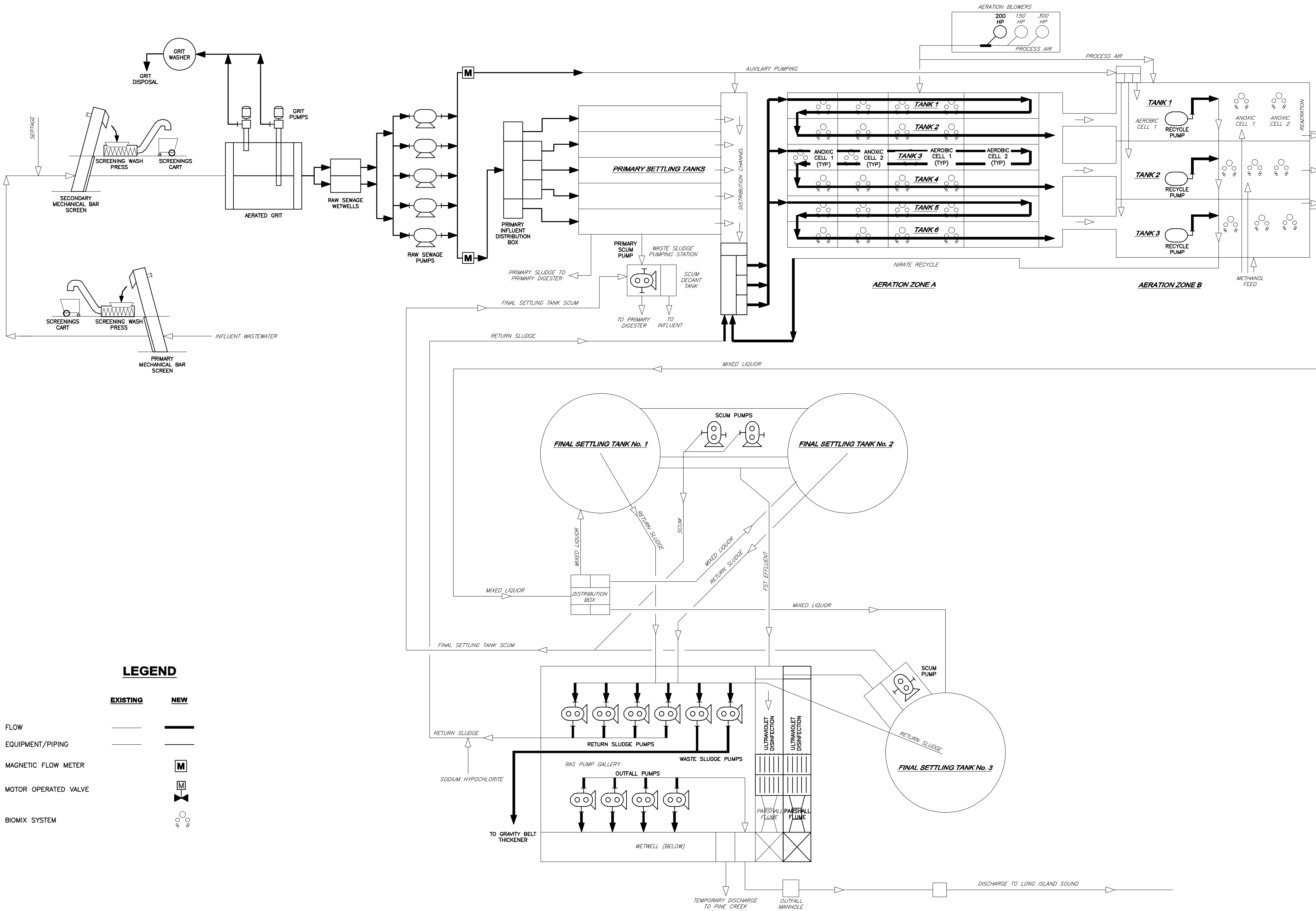
CITY OF FAIRFIELD, CONNECTICUT
WATER POLLUTION CONTROL FACILITY
FACILITIES PLAN REPORT

PROPOSED SITE PLAN

DRAWING
10-1

LAST SAVED BY: ELLIOTT.LAGNER 4/13/2017 11:44 AM

G:\DWGS\CT\FAIRFIELD\13090-FACILITIESPLAN\13090-CD\PRO\13090-PRS-GIS-AERIAL.DWG | ProposedSitePlan | 1:10.1236 | ---- | 4/13/2017 11:46:32 AM | ELLIOTT.LAGNER



WASTEWATER PROCESS FLOW DIAGRAM

SCALE: NTS

NO.	REVISIONS	DRAWN BY	APP'D
1		SMC	DAD
2			
3			

CITY OF FAIRFIELD, CONNECTICUT
WATER POLLUTION CONTROL FACILITY
FACILITIES PLAN REPORT

PROJ NO: 13090A

DATE: FEBRUARY 2017

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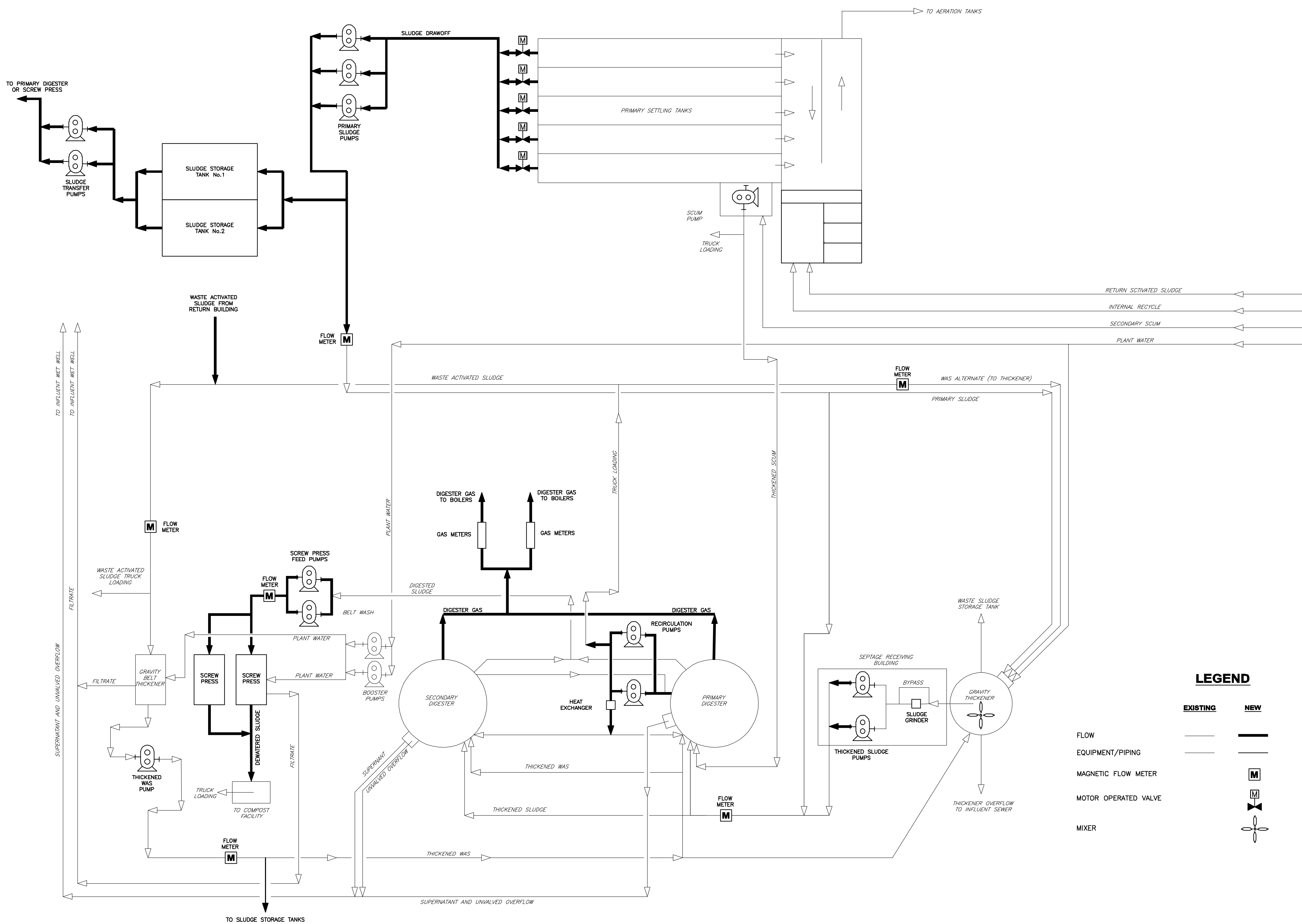
PROPOSED WASTEWATER PROCESS FLOW

FIGURE: 10-2



SLUDGE PROCESS FLOW DIAGRAM
SCALE: NTS

NO.	REVISIONS	DRAWN BY	APP'D
1		SMC	DAD
2			
3			

CITY OF FAIRFIELD, CONNECTICUT
WATER POLLUTION CONTROL FACILITY
FACILITIES PLAN REPORT

PROJ NO: 13090A
DATE: MARCH 2017

WRIGHT-PIERCE
Engineering a Better Environment

PROPOSED SLUDGE PROCESS FLOW

FIGURE: **10-3**

10.4 ESTIMATED CAPITAL COSTS

Planning-level project costs have been prepared for the recommended facilities and are presented in **Table 10-1**. These 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 capital costs include an allowance of almost 75% of the estimated base construction costs to account for unaccounted for items, construction contingency, design and construction engineering, permitting, as well as financing, administrative and legal expenses. The 75% allowance also includes an estimated inflation factor to the mid-point of construction (2021). The project cost information presented herein is based on ENR Construction Cost Index 10531 (January 2017) and was inflated at 4% per year for four years. The total project capital cost is estimated to be $62,369,000. Adjustments to this total project cost would be made depending on the actual project schedule.

These estimates have been developed primarily for evaluating alternative solutions and are generally reliable for determining the relative costs of various options. Many factors arise during final design (e.g. foundation conditions, hazardous material abatement, permitting programs and associated requirements, owner selected features and amenities, code issues, delays in bidding the project, etc.) that cannot be definitively identified and estimated at this time. These factors are typically covered by the 75% allowance described above; however, this allowance may not be adequate for all circumstances.

TABLE 10-1
ESTIMATED PROJECT COSTS
(ENR CCI 10531, January 2017)

Item		Cost
Site Work/Site Piping/Process Demolition		$ 3,560,000
Influent Building - Screenings Upgrade		$ 1,312,000
Influent Pump Building - Grit, Raw Sewage Pumping Upgrade		$ 3,891,000
Primary Settling Tanks & Splitter Structure Upgrade		$ 1,829,000
Secondary Treatment Upgrade		$ 3,368,000
Solids Handling & Dewatering Upgrade		$ 1,602,000
Compost Building Upgrade		$ 1,083,000
Odor Control Upgrade		$ 958,000
Chemical Systems Upgrade		$ 355,000
UV Disinfection System Upgrade		$ 2,707,000
Effluent Pumping System Upgrade		$ 491,000
Administration Building Upgrade		$ 750,000
Miscellanous Building Rehabilitation		$ 1,249,000
Subtotal		$ 23,155,000
HVAC & Plumbing		$ 1,200,000
Instrumensation & SCADA		$ 1,200,000
Electrical		$ 4,000,000
Subtotal		$ 6,400,000
General Contractor OH&P and General Conditions	20.0%	$4,631,000
Subtotal of Subcontractors (M/P/I/E)		$6,400,000
General Contractor Mark-up on Subcontractors	7.5%	$480,000
Electrical/Telephone Allowance		$100,000
Bonds and Insurance	1.5%	$520,000
Unit Price Items	2.5%	$579,000
Project Multiplier, Design Contingency	1.25	
Project Multiplier, Inflation to Midpoint of Construction	1.09	
ENGINEERS ESTIMATE OF CONSTRUCTION COST		**$48,870,000**
Estimated Construction Cost		$48,870,000
Construction Contingency	5.0%	$2,440,000
Technical Services	18.0%	$8,797,000
Materials Testing	0.8%	$367,000
Hazardous Materials Abatement		$300,000
Legal/Adminstrative	2.0%	$977,000
Subtotal		$61,751,000
Financing	1.0%	$618,000
ENGINEER'S ESTIMATE OF TOTAL PROJECT COST		**$62,369,000**

Cost estimates for capital improvements vary depending on the degree of project definition that exists at the time of the estimate. The Association for the Advancement of Cost Engineering (AACE) identifies three major project phases as exploration (planning and conceptual design), evaluation (basic/preliminary design), and execution (detailed engineering design). The level of accuracy in a cost estimate will become greater as the project stage proceeds from exploration through evaluation to execution. The levels of accuracy for each project phase are presented in **Table 10-2**. The Fairfield WPCF Facilities Study is considered to be in the *Exploration* phase.

Capital costs used in the development of project costs estimates include material and installation costs for structures, site work, process equipment, and auxiliary equipment associated with the project.

TABLE 10-2
FAIRFIELD WPCF FACILITY PLAN
CAPITAL COST IMPROVEMENTS ACCURACY LEVEL

Phase	Type of Estimate	Expected Accuracy
Exploration	Order of Magnitude	+50% to -30%
Evaluation	Budget	+30% to -15%
Execution	Detailed	+15% to - 5%

10.5 ESTIMATED OPERATIONS AND MAINTENANCE COSTS

The WPCA has projected expenditures for the 2018 fiscal year of just over $5.5 million; this include costs associated with pump station and collection system maintenance as well as debt service and capital outlay. The budget to operate and maintain the Fairfield WPCF for the 2016 fiscal year was approximately $5.2 million.

As part of the facilities plan, an estimate of the annual operation and maintenance (O&M) costs for the facility following implementation of the recommended plan was developed. The O&M costs for the Fairfield WPCF during the first year of operation following the recommended initial improvements was developed using the FY 2018 requested budget as a baseline and then adjusting specific line items based on the proposed modifications to the WPCF. The modified budget was then projected forward to fiscal year 2023 which was assumed to be the first full year of operation of the completed new facilities. The modified budget includes office related costs but does not include debt service or capital outlay costs.

The following major assumptions were made in developing the projected operation and maintenance costs for the new facilities:

- Salary/ benefits and overtime costs were assumed to increase at 4% per year.
- The adjustment in electrical cost was determined based the proposed installation of a more energy efficient aeration and UV disinfection system including a low energy aeration mixing system and more efficient UV modules.
- Heating costs were assumed to increase at 4% per year.
- Chemical costs were increased by 4% per year. Modifications in chemical usage were assumed to balance out based on the anticipated reduction in methanol usage.
- Other line items were increased by 4% per year to account for inflation.

Based on these assumptions, annual O&M costs at the Fairfield WPCF for FY 2023 are projected to be $5.7 million. which is the first year that the upgraded facilities are likely to be on line.

10.6 IMPLEMENTATION PLAN AND SCHEDULE

The recommended improvements could be constructed as a single comprehensive upgrade at the WPCF. This approach would offer several benefits to the Town including the economy of scale of having a single construction contract with a general contractor and maximizing the grant funding of the project from the Clean Water Fund. Under this scenario and a total project cost of $62,369,000, it is estimated that the Town could potentially receive a Clean Water Fund grant of approximately 22% or $13,722,000, depending on funding availability and the Town's status on the Priority List. If this grant funding is available, the Town's commitment, which would be funded with a 2% loan over 20 years through the Clean Water Fund would be approximately $48,648,000. The debt retirement on this loan would be approximately $2,953,000 per year.

Should the Town desires to move forward with the implementation of the recommended upgrade, the anticipated schedule is outlined in **Table 10-3**.

TABLE 10-3
PROJECTED MILESTONE SCHEDULE

Task	Completion date
Publish Draft Report - Submit to DEEP	April 2017
Public Hearing	August 2017
Finalize Report	September 2017
DEEP CWF review and approval	December 2017
Draft Preliminary Design Report	April 2018
Preliminary Design Report - Submit to DEEP	May 2018
30% VE Review	June 2018
60% Design Submittal	November 2018
60% VE Review	December 2018
90% Design Submittal	March 2019
Client/DEEP Review	April 2019
100% Design Submittal	June 2019
Bidding/ Award	October -November 2019
Construction	February 2020 – February 2023

10.7 FINANCING OPTIONS

10.7.1 DEEP Clean Water Fund

As discussed above, this project would qualify for funding through the State of Connecticut's Clean Water Fund. The majority of improvements would qualify for a 20% grant while those related to nutrient removal may qualify for a 30% grant, but considerations should be given to the fact that the facility underwent a nitrogen removal improvement upgrade in 2003. The remaining portion of the project would be funded through a 2% loan over 20 years.

10.7.2 United Illuminating

Many of the recommended improvements could potentially qualify for energy efficiency rebate grant funding through United Illuminating (UI). Energy efficiency improvements can qualify for up to a 40% grant. The most significant opportunity for this grant funding would be for the aeration and UV systems. There are also other opportunities for prescriptive rebate regarding HVAC and lighting upgrades.

10.8 STAFFING ASSESSMENT

10.8.1 Current Staffing and WPCF Classification Requirements

As in any sewered community, the WPCF represents a significant investment by ratepayers and proper operation 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 Fairfield WPCF is currently staffed by a total of 16 full-time employees with various levels of responsibility and expertise. The specific positions include:

- 1 - Superintendent
- 1 - Assistant Superintendent
- 1 - Administrative Assistant
- 2 - Lab Analyst
- 4 - Class III Operators
- 2 - Class II Operators
- 2 - Class I Operators
- 3 - Plant Maintainers

There are also two additional operators that are dedicated to maintaining the wastewater collection system, for a total of 18 staff.

10.8.2 Future Staffing and WPCF Classification Requirements

Future staffing requirements for the Fairfield WPCF were developed using the methodology found in the New England Interstate Water Pollution Control Commissions' (NEIWPCC) *The 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 (9.12 MGD) and its number of personnel shifts per day (one shift a day, seven days a week) are used to make this determination.

The Fairfield WPCF will use the chart for one plus shift plant with design flows between 5.0 MGD to 10.0 MGD. The plant has 320 working days based on the operators working seven days a week. The WPCF staff member is staffed on the weekend. Currently, plant staff receives 13 holidays per year and 6 sick days. In addition, due to the longevity of the WPCF staff, there is an average of 20 vacation days per year per employee. Based on these numbers, it was assumed that the average staff person will have 39 days of off time based on sick, vacation and holiday time. This results in the average employee having 1,435 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 WPCF has five 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 1300 staffing hours annually to operate the primary settling tanks (5 primary clarifiers x 1 hr/day/clarifier x 320 days/yr = 1,600 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 WPCF. The second item corresponds to the time operators spend maintaining the processes and systems at the WPCF. The third item takes into account 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 WPCF. 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 10-4** below. Based on this evaluation, the Fairfield WPCF is currently staffed in accordance with the NEIWPCC guidelines.

TABLE 10-4

FAIRFIELD WPCF

FUTURE STAFFING ESTIMATES

Chart Number and Description	Annual Hours (Upgraded WPCF)
Chart 1 – Basic and Advanced Operations and Processes	6,928
Chart 2 – Maintenance	4,820
Chart 3 – Laboratory Operations	2,284
Chart 4 – Biosolids/Sludge Handling	8,480
Chart 5 – Yard Work	800
Estimated Operation and Maintenance Hours	23,312
Estimated Operation and Maintenance Staff	16.25
Estimated Additional Staff from Chart 7	2
Total Staffing Estimate (rounded)	19

The estimated hours for the upgraded facility, as shown in **Table 10-4** above and as determined from Charts 1 through 5, are 23,312 hours. This corresponds to a staffing need of 17 (rounded to the nearest ½) for the future facility. In answering the questions for Chart No's 6 and 7, there appears the need for a minimum of two additional employees. Hence, the total number of employees planned for the upgraded facility should be at 19.

Based on this evaluation, the Fairfield WPCF would have to employ one additional staff member to operate the facility in accordance with the NEIWPCC guidelines.

SECTION 11
ENVIRONMENTAL IMPACT ASSESSMENT

SECTION 11

ENVIRONMENTAL IMPACT ASSESSMENT

11.1 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 WPCF with minimal anticipated growth within the sewer service area. Therefore, the direct environmental impacts would be limited to activities during construction of the upgrades to the Fairfield Water Pollution Control Facility (WPCF). 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.

11.2 BACKGROUND

As project background, a separately funded project involving building a berm around the WPCF and other associated Town facilities is currently being permitted separately and is anticipated to begin construction prior to these WPCF upgrades. This separate project is called the "Fairfield Wastewater Treatment Plant (WWTP) Hardening and Microgrid Project". The berm to be constructed around the plant is planned to be built to elevation 16 feet NAVD 88 which is three (3) feet above the 100-year floodplain elevation or base flood elevation (BFE) of 13 ft. NAVD 88 for the area. This elevation was selected to satisfy the NEIWPCC TR-16: "Guides for the Design of Wastewater Treatment Works" and Executive Order 13690. Both the NEIWPCC TR-16 and the Executive Order require designing components of wastewater treatment plants to address storm resiliency. Specifically, critical equipment is to be protected to 3 ft. above the BFE, and non-critical equipment is to be protected to 2 ft. above the BFE. Therefore, construction of the berm to 3 ft. above the BFE surrounding the WPCF will meet these standards.

The major site components of the WPCF upgrade include:

- A new influent pump station;
- Addition for screening and grit disposal at the Influent Building;
- Demolition of abandoned primary digester to be replaced with parking;
- Construction of a second UV Disinfection Channel; and
- Installation of replacement methanol storage tanks; and

The WPCF itself is wholly located within Zone AE (the 100-year floodplain), as shown on FEMA FIRM panel 419 of 626 for Fairfield County, Map Number 09001C0419G, revised July 8, 2013, **Figure 10-1**.

11.3 EXCEPTIONS

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

- The site is not 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 5.2' NAVD 88 for Fairfield.
- The site does not appear to contain any prime farmland soils.
- No Wild or Scenic Rivers will be affected by this project.
- It appears no tidal wetlands will be affected by the project.
- There are no Aquifer Protection Areas (APAs) in the Town of Fairfield.
- Currently, it appears the project will have no impacts on historical or archaeological resources.

11.4 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.

11.5 WATER QUALITY IMPACTS

The upgrade of the treatment facilities will have an overall positive impact on water quality as a result of improved and upgraded treatment facilities. Continued operation of the existing facilities during construction is anticipated and the upgraded 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.

11.6 WETLANDS IMPACTS

Based on a preliminary review of available wetlands mapping, it appears that the northwest corner of the site may fall within mapped 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 50-foot setback review area for the Pine Creek watershed. Applicable permits would be obtained and any requirements followed.

11.7 FLOOD PLAIN IMPACTS

The WPCF itself falls entirely within the 100-year floodplain Zone AE with a BFE of 13 feet NAVD 88. Construction, under a separate project, of a flood-protection berm surrounding the entire WPCF will protect the plant from the 100-year flood, including three (3) feet of freeboard to elevation 16 feet NAVD 88.

A CTDEEP Flood Management Certification (FMC) Approval will be required if this project is State funded separately from the berm construction project which is anticipated. Based on preliminary discussions with the CTDEEP, the berm itself will be considered to provide protection of the site to the 100-year flood elevation. Any hazardous or flammable chemical storage (e.g., methanol) will either need to be protected to the 500-year flood elevation or a variance obtained via the FMC permit process. Of note, the 500-year flood elevation for the site has been calculated using the CTDEEP Guidance document to be elevation 16.25 ft. NAVD 88.

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

11.8 STORM RESILIENCY REQUIREMENTS

The plant upgrades will need to 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. Construction of the flood protection berm under a separate project will address these design requirements as the entire plant will be protected to three (3) feet above the BFE, or to elevation 16 feet NAVD 88. This berm will, therefore, satisfy the NEIWPCC TR-16 design criteria along with the requirements outlined in Executive Order 13690.

11.9 OTHER DIRECT IMPACTS

The recommended plan will take place within the existing boundaries of the WPCF. 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.

Fairfield is located within the Coastal Area and the WPCF site is located within the Coastal Boundary. 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.

11.10 INDIRECT IMPACTS

Indirect impacts from wastewater facilities projects can include items such as induced growth. Construction of new sewer lines to serve an existing area with failing septic systems 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.

11.11 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 Town of Fairfield Planning & Zoning Commission Approvals, including Coastal Site Plan Review.
- Any necessary CTDEEP OLISP or Coastal Zone approvals.
- Local Town of Fairfield Floodplain Permit, including any potential variances necessary.
- Local Town of Fairfield 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.

11.12 CONSERVATION AND DEVELOPMENT

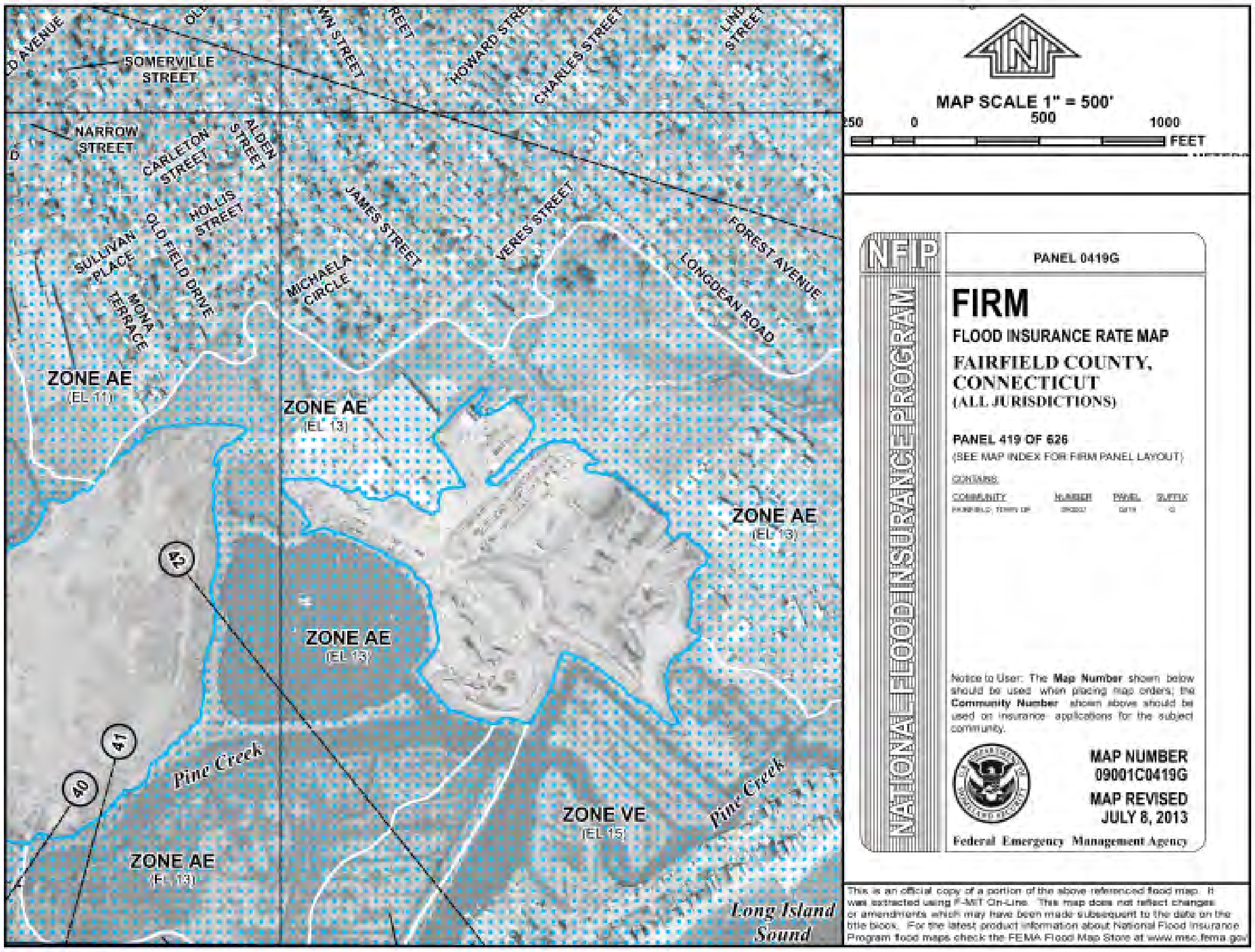
The Fairfield WPCF has a current design rated permit capacity of 9.00 MGD. It is expected that the next permit renewal or permit modification will reflect no increase, or a very small increase in its design rated permit capacity.

The Sewer Service Area is described in greater detail in Section 2 - Basis of Design 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 2. Development of the sewer service area boundaries was performed in consultation with other town departments including Public Works and Planning, and was developed to be consistent with the Town's development plans and with the State's Plan of Conservation and Development map.

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

FIGURE 11-1

FEMA FIRMETTE



APPENDIX A

2015 NPPDES PERMIT

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Engineering a Better Environment
70 YEARS 1947 - 2017

Connecticut Department of
ENERGY &
ENVIRONMENTAL
PROTECTION

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

MUNICIPAL NPDES PERMIT

issued to

Permittee:
Town of Fairfield
DPW Admin,
725 Old Post Road
Fairfield, Connecticut 06824

Location Address:
Town of Fairfield
Water Pollution Control Facility
One Rod Highway
Fairfield, Connecticut 06824

Facility ID: 051-001 **Permit ID:** CT0101044 **Permit Expires:** November 1, 2020

Receiving Stream: Long Island Sound **Design Flow Rate:** 9.0 MGD

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 Town of Fairfield, ("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 $2,682.50

(I) The Permittee shall discharge so as not to violate the Interstate Environmental Commission (IEC) Water Quality Regulations promulgated pursuant to the authority conferred upon the IEC by the Tri-State Compact (CGS 22a-294 et seq.) as defined in Attachment 1 Table A.

(J) This permitted discharge is consistent with the applicable goals and policies of the Connecticut Coastal Management Act (Section 22a-92 of the CGS).

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 month of June.

"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-Monthly" in the context of any sampling frequency, shall mean once every two months including the months of January, March, May, July, September, and November

"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 March, June, September and December.

"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 #201004890 for permit reissuance received on July 16, 2010 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 Municipal Facilities Section of said new discharge.

(C) The Permittee shall maintain a system of user charges based on actual use 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.

(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 June 30, 2018 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 H 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.

(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
Beryllium, Total	0.001 mg/l
Cyanide, Total	0.010 mg/l
Mercury, Total	0.0002 mg/l
Thallium, Total	0.005 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 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%).

SECTION 7: RECORDING AND REPORTING REQUIREMENTS

(A) The results of chemical analyses and any aquatic toxicity test required above in Section 5 and the referenced Attachment 1 shall be entered on the Discharge Monitoring Report (DMR) and reported to the Bureau of Water Protection and Land Reuse. The report shall also include a detailed explanation of any violations of the limitations specified. The DMR must be received at the following address 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, Planning and Standards Division
79 Elm Street
Hartford, Connecticut 06106-5127

(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 above in Section 7 (A) of this permit by the 15th day of the month following the month in which samples are collected.

(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, must be received at the address specified above in Section 7 (A) of this permit by the 15th day of the month following the month in which the data and samples are collected.

(D) NetDMR Reporting Requirements

(1) Unless otherwise approved in writing by the Commissioner, no later than one-hundred and twenty (120) days after the issuance of this permit, the Permittee shall begin reporting to the Department electronically using NetDMR, a web-based tool that allows Permittee to electronically submit discharge monitoring reports (DMRs) and other required reports through a secure internet connection. Specific requirements regarding subscription to NetDMR and submittal of data and reports in hard copy form and for submittal using NetDMR are described below:

(a) NetDMR Subscriber Agreement

On or before fifteen (15) days after the issuance of this permit, the Permittee and/or the person authorized to sign the Permittee discharge monitoring reports ("Signatory Authority") as described in RCSA Section 22a-430-3(b)(2) shall contact the Department and initiate the subscription process for electronic submission of Discharge Monitoring Report (DMR) information. On or before ninety (90) days after issuance of this permit the Permittee shall submit a signed and notarized copy of the *Connecticut DEP NetDMR Subscriber Agreement* to the Department.

(b) Submittal of Reports Using NetDMR

Unless otherwise approved by the Commissioner, on or before one-hundred and twenty (120) days after issuance of this permit, the Permittee and/or the Signatory Authority shall electronically submit DMRs and reports required under this permit to the Department using NetDMR in satisfaction of the DMR submission requirement of this permit. DMRs shall be submitted electronically to the Department no later than the 15th day of the month following the completed reporting period.

(c) Submittal of NetDMR Opt-Out Requests

If the Permittee is able to demonstrate a reasonable basis, such as technical or administrative infeasibility, that precludes the use of NetDMR for electronically submitting DMRs and reports, the Commissioner may approve the submission of DMRs and other required reports in hard copy form ("opt-out request"). Opt-out requests must be submitted in writing to the Department for written approval on or before fifteen (15) days prior to the date a Permittee would be required under this permit to begin filing DMRs and other reports using NetDMR. This demonstration shall be valid for twelve (12) months from the date of the Department's approval and shall thereupon expire. At such time, DMRs and reports shall be submitted electronically to the Department using NetDMR unless the Permittee submits a renewed opt-out request and such request is approved by the Department.

All opt-out requests and requests for the NetDMR subscriber form should be sent to the following address:

Attn: NetDMR Coordinator
Connecticut Department of Energy and Environmental Protection
Water Permitting and Enforcement Division – 2nd Floor
79 Elm Street
Hartford, CT 06106-5127

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) 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, Planning and Standards Division, Municipal Facilities Section (860) 424-3704, the Department of Public Health, Water Supply Section (860) 509-7333 and Recreation Section (860) 509-7297, and the local Director of Health shall be notified within 2 hours of the Permittee learning of the event by telephone during normal business hours. If the discharge or bypass occurs outside normal working hours (8:30 a.m. to 4:30 p.m. Monday through Friday), notification shall be made within 2 hours of the Permittee learning of the event to the Emergency Response Unit at (860) 424-3338 and the Department of Public Health at (860) 509-8000. A written report shall be submitted to the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Planning and Standards Division, Municipal Facilities Section within five days of the Permittee learning of each occurrence, or potential occurrence, of a discharge or bypass of untreated or partially treated sewage.

The written report shall contain:

(i) The nature and cause of the bypass, permit violation, treatment component failure, and/or equipment failure,

(ii) the time the incident occurred and the anticipated time which it is expected to continue or, if the condition has been corrected, the duration,

(iii) the estimated volume of the bypass or discharge of partially treated or raw sewage,

(iv) the steps being taken to reduce or minimize the effect on the receiving waters, and

(v) the steps that will be taken to prevent reoccurrence of the condition in the future.

For treatment plants south of Interstate 95 and any other plants which may impact shellfishing areas the Department of Agriculture/Aquaculture Division must also be notified within 2 hours of the Permittee learning of the event by telephone at (203) 874-0696 and in writing within 72 hours of each occurrence of an emergency diversion or by-pass of untreated or partially treated sewage and a copy of the written report should be sent to:

State of Connecticut
Department of Agriculture/Aquaculture Division
P.O. Box 97
Milford, Connecticut 06460]

(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 of this Section, the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse Planning and Standards Division, Municipal Facilities Section except, if 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 of this Section, the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Planning and Standards Division, Municipal Facilities Section except, if 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 of this Section, the Department of Energy and Environmental Protection, Bureau of Water Protection and Land Reuse, Planning and Standards Division, Municipal Facilities Section 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 11/2/15

Betsey Wingfield
Bureau Chief
Bureau of Water Protection and Land Reuse

I CERTIFY THAT THIS DOCUMENT IS A TRUE COPY OF THE ORIGINAL.
NAME Theresa Iacone
TITLE Processing Tech
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER MANAGEMENT

ATTACHMENT 1

Tables A through H

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): **1375cfs**				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 D	mg/l	30mg/l	50mg/l	3/week	Daily Composite	NA	NR	NA	DMR/MOR	
Fecal coliform	Colonies per100 ml	NA	NA	NR	NA	see remark (B) below	3/week	Grab	DMR/MOR	
Fecal coliform	Percent of samples exceeding 260 colonies per100 ml	NA	NA	NR	NA	≤10	3/week	Grab	DMR/MOR	
Enterococci see remark (C) below	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	DMR/MOR	

Solids, Settleable	ml/l	NA	NA	NR	NA	------	Work Day	Grab	MOR	
Solids, Total Suspended[1] See remark D	mg/l	30mg/l	50mg/l	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	
UV Dose See remark A	$mW,s/cm^2$	NA	NA	NR	NA	≥24.0	4/Work Day	Grab	DMR/MOR	
UV Intensity See remark A	mW/cm^2	NA	NA	NR	NA	≥6.10	4/Work Day	Grab	DMR/MOR	

TABLE A – CONDITIONS

Footnotes:

[1] The discharge shall not exceed an average monthly 30 mg/l or a maximum daily 50 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 limits except for UV Dose and UV Intensity which are minimum limits.

Remarks:

(A) Ultraviolet disinfection shall be utilized year-round.

(B) 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.

(C) 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.

(D) 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): **1375 cfs**		In-stream Waste Concentration (IWC): **1%** (allocated)			
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/MOR
Solids, Total Suspended Percent Removal[1]	% of Influent	85	3/week	Calculated[2]	DMR/MOR

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**						
Allocated Zone of Influence (ZOI): 1375 cfs			In-stream Waste Concentration (IWC): 1% (allocated)			
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 promelas[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	
Phosphorus, Total	mg/l	-----	Quarterly	Daily Composite	ATMR/DMR	
Phenols, 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 <u>% survival</u> 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	4/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	Bi-monthly	DMR
Beryllium, Total	mg/kg	Bi-monthly	DMR
Cadmium, Total	mg/kg	Bi-monthly	DMR
Chromium, Total	mg/kg	Bi-monthly	DMR
Copper, Total	mg/kg	Bi-monthly	DMR
Lead, Total	mg/kg	Bi-monthly	DMR
Mercury, Total	mg/kg	Bi-monthly	DMR
Nickel, Total	mg/kg	Bi-monthly	DMR
Nitrogen, Ammonia *	mg/kg	Bi-monthly	DMR*
Nitrogen, Nitrate (total as N) *	mg/kg	Bi-monthly	DMR*
Nitrogen, Organic *	mg/kg	Bi-monthly	DMR*
Nitrogen, Nitrite (total as N) *	mg/kg	Bi-monthly	DMR*
Nitrogen, Total *	mg/kg	Bi-monthly	DMR*
pH *	S.U.	Bi-monthly	DMR*
Polychlorinated Biphenyls	mg/kg	Bi-monthly	DMR
Solids, Fixed	%	Bi-monthly	DMR
Solids, Total	%	Bi-monthly	DMR
Solids, Volatile	%	Bi-monthly	DMR
Zinc, Total	mg/kg	Bi-monthly	DMR

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

TABLE H

Discharge Serial Number: **001-1**	Monitoring Location: L		
Wastewater Description: **Digested sludge**			
Monitoring Location Description: **Each Anaerobic Digestion Unit**			
PARAMETER	**INSTANTANEOUS MONITORING**		**REPORTING FORM**
	Sample Frequency	Sample Type	
Temperature	Weekly	Grab	MOR
Alkalinity	Weekly	Grab	MOR
Volatile Acids	Weekly	Grab	MOR
pH	Weekly	Grab	MOR

ATTACHMENT 2

MONTHLY OPERATING REPORT FORM

DATA TRACKING AND TECHNICAL FACT SHEET

Permittee: Town of Fairfield

PERMIT, ADDRESS, AND FACILITY DATA

PERMIT #: CT0101044 **APPLICATION #:** 201004890 **FACILITY ID.** 051-001

Mailing Address:	Location Address:
Street: 725 Old Post Road	Street: 330 One Rod Highway
City: Fairfield ST: CT Zip: 06824	City: Fairfield ST: CT Zip: 06824
Contact Name: William Norton	Contact Name: William Norton
Phone No.: (203) 256-3140	Phone No.: (203) 256-3140
	DMR Contact email address: wnorton@fairfieldct.org

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__

DEP STAFF ENGINEER Ann Straut **DATE DRAFTED:** 08/25/2015

PERMIT FEES

Discharge Code	DSN Number	Annual Fee
111000e	001-1	$2,682.50

FOR NPDES DISCHARGES
Drainage Basin Code: 005 Water Quality Classification Goal: SA Segment: Long Island Sound 120

NATURE OF BUSINESS GENERATING DISCHARGE
Municipal Sanitary Sewage Treatment

PROCESS AND TREATMENT DESCRIPTION (by DSN)
Secondary Biological Treatment and UV 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*

_X_ *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)*

_X_ *In order to meet in-stream water quality (See General Comments)*

_ *Anti-degradation policy*

GENERAL COMMENTS

The Town of Fairfield ("Fairfield") operates a municipal water pollution control facility ("the facility") located at 330 One Rod Highway, Fairfield. The facility is designed to treat and discharge up to 9.0 million gallons a day of effluent into the Long Island Sound. The facility currently uses secondary treatment with denitrification and UV disinfection to treat effluent before being discharged. Pursuant to Conn. Gen. Stat. § 22a-430, the Department of Energy and Environmental Protection has issued Fairfield a permit for the discharge from this facility. Fairfield has submitted an application to renew its permit. The Department has made a tentative determination to approve Fairfield's application and has prepared a draft permit consistent with that determination.

The most significant changes from the current permit are the inclusion of revised bacteria monitoring requirements (fecal coliform and enterococci), Aluminum monitoring to be consistent with the most recent CT Water Quality Standards and Iron monitoring to be consistent with EPA's National Recommended Water Quality Criteria.

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 limits were included in the permit at this time.

WATER QUALITY LIMIT CALCULATIONS

See attached

Fairfield WPCF

Discharger:	Fairfield WPCF			by: StrautA, 8/18/2015, 09:58	
Receiving Water:	Long Island Sound	CURRENT CONDITIONS			
Design Flow:	9.000 MGD	Avg. Flow:	8.590 MGD	2014 Data	
Allocated ZOI:	1375.00 CFS	Max. Flow:	12.400 MGD	2014 Data	
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	0.6	7.11E+03	1.43E+04	2.42E+02	4.86E+02	
Ammonia	0.5	6.33E+04	1.17E+05	2.16E+03	3.98E+03	
Antimony	1.7	2.79E+04	8.31E+04	9.52E+02	2.83E+03	
Arsenic	1.4	2.10E-02	5.95E-02	7.16E-04	2.03E-03	ML
Beryllium	0.5	1.30E+01	2.39E+01	4.42E-01	8.16E-01	
Cadmium	1.3	5.86E+02	1.62E+03	2.00E+01	5.53E+01	
Chlorine	0.6	6.13E+02	1.23E+03	2.09E+01	4.19E+01	
Chromium (hex)	0.1	4.82E+03	5.58E+03	1.64E+02	1.90E+02	
Chromium (tri)	2.3	1.01E+08	3.17E+08	3.43E+06	1.08E+07	
Copper	1.1	3.37E+02	8.82E+02	1.15E+01	3.01E+01	
Cyanide (amen)	0.8	4.35E+01	9.97E+01	1.48E+00	3.40E+00	ML
Lead	0.9	6.03E+02	1.46E+03	2.06E+01	4.96E+01	
Mercury	0.2	5.09E+00	6.74E+00	1.73E-01	2.30E-01	
Nickel	1.6	5.07E+02	1.49E+03	1.73E+01	5.07E+01	
Phenol	0.4	8.58E+07	1.44E+08	2.92E+06	4.90E+06	
Selenium	0.2	6.62E+03	8.77E+03	2.26E+02	2.99E+02	
Silver	0.9	7.85E+01	1.90E+02	2.68E+00	6.46E+00	
Thallium	1.4	4.69E+01	1.33E+02	1.60E+00	4.53E+00	ML
Zinc	0.4	7.84E+03	1.31E+04	2.67E+02	4.48E+02	

Current Conditions

Compound	# DETECTS	AMC ug/l	MMC ug/l	AMM kg/d	MMM kg/d
Aluminum				0.00E+00	0.00E+00
Ammonia	19	2.43E+03	5.70E+03	7.91E+01	2.68E+02
Antimony	3	6.30E+00	5.00E+01	2.05E-01	2.35E+00
Arsenic	0	7.30E+00	5.00E+01	2.38E-01	2.35E+00
Beryllium	0	8.10E+00	1.00E+01	2.64E-01	4.70E-01
Cadmium	0	3.10E+00	2.00E+01	1.01E-01	9.39E-01
Chlorine					
Chromium (hex)	0	4.84E+01	5.00E+01	1.57E+00	2.35E+00
Chromium (tri)	1	5.00E+00	5.00E+01	1.63E-01	2.35E+00
Copper	18	1.73E+01	9.00E+01	5.63E-01	4.23E+00
Cyanide (amen)	0	1.21E+01	5.00E+01	3.94E-01	2.35E+00
Lead	4	2.80E+00	1.30E+01	9.11E-02	6.11E-01
Mercury	1	2.00E-01	4.00E-01	6.51E-03	1.88E-02
Nickel	15	1.02E+01	5.10E+01	3.32E-01	2.40E+00
Phenol	7	3.07E+01	5.40E+01	9.99E-01	2.54E+00
Selenium	0	5.30E+00	1.00E+01	1.72E-01	4.70E-01
Silver	1	2.70E+00	1.20E+01	8.79E-02	5.64E-01
Thallium	0	7.40E+00	5.00E+01	2.41E-01	2.35E+00
Zinc	19	6.06E+01	8.90E+01	1.97E+00	4.18E+00

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
Cyanide (amen)	0.010 mg/L
Thallium	0.005 mg/L

APPENDIX B

ENERGY EVALUATION
FAIRFIELD WPCF 2017

WRIGHT-PIERCE
Engineering a Better Environment
70 YEARS 1947 - 2017

Town of Fairfield Water Pollution Control Facility Energy Evaluation

February 2017

Conducted by:

JK Muir, LLC in coordination with **Wright Pierce**

JK MUIR

Contents

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Executive Summary

This report details energy saving recommendations identified by JKMuir for the Town of Fairfield WPCF, located in Fairfield, Connecticut.

The objective of the report included identifying specific operation and maintenance and capital improvements that would result in energy savings. The projects have been categorized as energy conservation measures (ECMs), for those that require a capital investment, and operational measures (OMs) for projects that can be done at a minimal cost.

Economic Evaluation of Proposed Measures

The Projected Annual Cost and Savings Summary shown below provides an overview of our estimates for total project costs and annual energy savings associated with each of the proposed measures evaluated in this study. The economic summary includes savings estimates only for those measures where adequate information and data were available. On a number of the measures evaluated, however, further analysis and data collection would be required to provide a more thorough assessment of the potential savings.

Table 1. Summary of Energy Reduction & Proposed Measures

Cost Saving Measures		Annual Energy Savings (kWh)	First Year Annual Dollars ($)	Initial Project Cost ($)	Simple Payback (yrs)[2]
OPERATIONAL MEASURES					
OM 1	Solids Handling Off-peak Operation[1]	N/A	$113,248	N/A	Immediate
OM 2	Surface Mixers - Zone B (30 min)	110,376	$13,576	N/A	Immediate
OM 2	Surface Mixers - Zone B (15 min)[1]	165,564	$20,364	N/A	Immediate
ENERGY CONSERVATION MEASURES					
ECM 1	Aeration Blower Optimization	21,900	$2,694	$125,000	NA[3]
ECM 2	Raw Sewage & AuxiliaryPump Replacement	128,707	$15,831	$545,875	34.5
ECM 3	RAS Pump Replacement	38,487	$4,734	$234,000	49.4
ECM 4	Submersible Mixers - Zone A	182,383	$22,433	$706,200	31.5
ECM 5	Coarse to Fine Bubble Diffusion - Zone B	304,130	$37,408	TBD	NA[3]
ECM 6	Ammonia Based Process Control	96,360	$11,852	$201,850	17.0
ECM 7	Re-aeration System Optimization	22,408	$2,756	$44,000	16.0
ECM 8	UV System Replacement	1,292,976	$159,036	$1,350,934	8.5
ECM 9	Sludge Recirculation Pump Replacement	9,831	$1,209	$29,000	24.0
ECM 10	Digested Sludge Dewatering - Screw Press[1]	14,372	$1,768	$367,500	NA[3]
ECM 11	Plant Water System Replacement	Additional investigation recommended.			
ECM 12	WAS Pump Replacement	2,576	$317	$36,000	NA[3]
ECM 13	Demand Reduction	Additional investigation recommended.			
ECM 14	HVAC	Additional investigation recommended.			
ECM 15	Lighting	Additional investigation recommended.			
Potential Energy Program Cost and Savings		**1,881,529**	**$231,428**	**$3,111,859**	**13.4**

Notes:

1) Not included in the potential energy program cost and savings.

2) Payback period does not include potential incentives.

3) Payback period is not incuded in this table and is not factored into the overal potential cost and savings.

Energy Usage Data

Historical energy usage for 2015 was evaluated using billing history data. The table below summarizes the overall annual energy use of the facility, as well as the average billed demand, and associated costs. The following figure provides a monthly breakdown of energy usage and peak demand at the facility.

Table 2. 2015 Energy Usage Fairfield, CT WPCF

Facility	Annual Use (kWhs)	Average Monthly Cost	Annual Cost	Unit Cost
Fairfield WPCF	3,637,200	$37,256	$447,071	$0.123

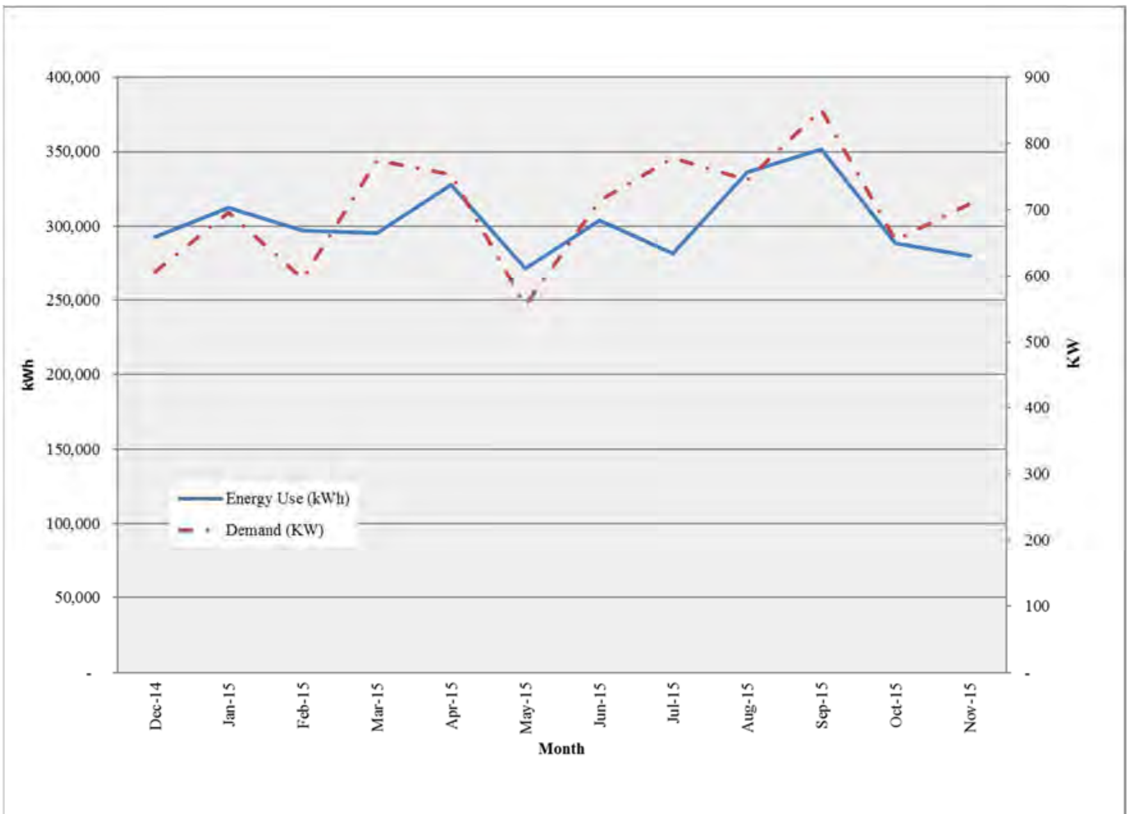


Figure 1. Monthly Electrical Energy Use and Billed Demand Breakdown

Rate Structure

General Service Time-of-day (GST)

The WPCF is billed under UI's General Service Time-of-day (GST) rate., which may be single or three phase service at a standard voltage. This rate structure includes charges associated with generation rates on-peak and off-peak hours, combined public benefits charge, and Distribution charges including a basic service charge. There are differences in the rates based on whether the facility is billed for demand, in this case, the evaluated facility is billed for demand, therefore, this demand structure is addressed. The GST has a monthly service charge of $83.53 where demand (kW) is billed. The distribution demand charge remains constant throughout the year for on and off peak hours at $3.64 per kW. During the summer months (June through September) transmission demand charge is $8.71 per kW and $6.97 per kW for the remainder of the year for on-peak hours. The demand charge is $0.00 per kW for off-peak hours throughout the year. The distribution cost of electricity remains constant on and off peak hours and during summer and winter months at a rate of $0.0198 per kWh.

Generation Rate

The Town of Fairfield has a third party generation supplier agreement with Nextera. Currently, the generation rates for GST are $0.12 for on-peak and $0.09 for off peak hours. The town-wide agreement through Nextera is currently lower than these rates. In December 2015 and January 2016, Fairfield paid a rate of $0.0864 per kWh through Nextera. This rate is a negotiated town-wide contractual agreement for generation rates.

Wastewater Energy Use Benchmark

Based on historical data from January 2010 through September 2015 facility data, the plant treats an average of 8.5 million gallons per day (MGD), and a calculated total of approximately 3,103 million gallons a year. Based on the electrical energy usage presented above, the plant consumes approximately 1,172 kWh per million gallons treated. This facility is similar to other facilities of similar size and flow.

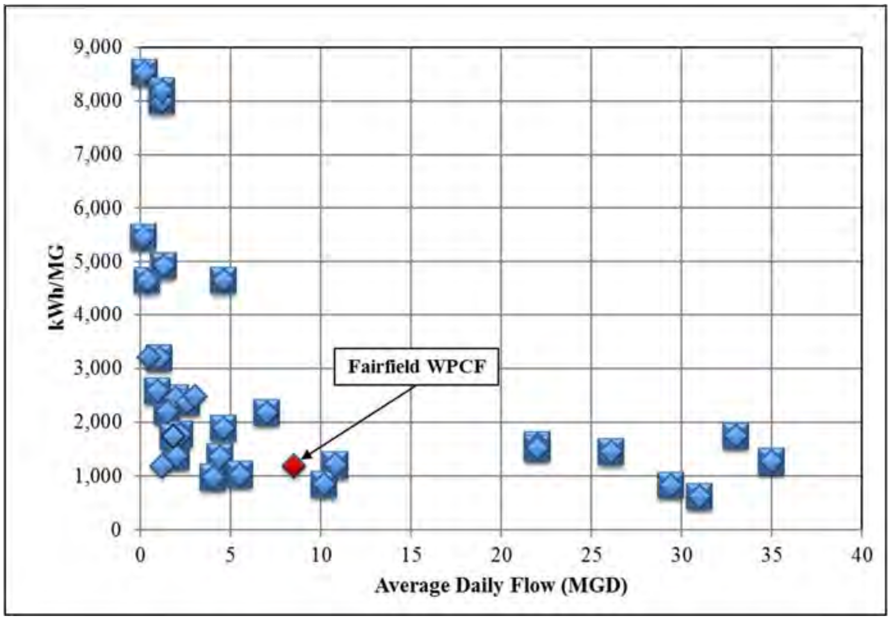


Figure 2. Energy Use per Million Gallons Pumped

Treatment Process & Building Systems

The facility was originally constructed in 1953, and the most recent major upgrade of the facility was completed in 2003. The plant treats an average daily of flow of approximately 8.5 MGD including septage with a minimum day flow of 3.86 MGD and a max day of 25.02 MGD. The plant is typically staffed for one shift a day, approximately 7:00 a.m. to 3:30 p.m., seven days a week, with limited staff on weekends.

Influent Headworks

Influent flow to the facility is handled by three, 100 hp Raw Sewage Pumps that are located in the lower level of the administration building. The pumps operate on level set points in the wet well. Typically, one pump continuously operates. The wastewater then flows through a course bar rack, followed by the grit system, which includes a bucket/conveyor system for removal of settled material. Following the grit removal system, the flow travels through a fine screen, installed as part of the 1995 upgrade. The facility also receives septage, which is combined with the influent flow for treatment.

Primary Treatment

There are five primary clarifiers with typically three in operation. Primary sludge is pumped by two piston pumps, which operate on timers, such that one pump operates at a time (sludge is removed from one clarifier at a time). The two primary sludge pumps transfer sludge directly to the digester.

Aeration and Internal Recycle Systems

There are nine aeration tanks, and typically eight are in operation. Each tank is equipped with a dissolved oxygen (DO) meter, an air flow meter and air flow control valve, which allow for individual air flow control to each basin through the SCADA system. The DO set point is varied based on plant conditions and treatment performance, however, it is typically maintained at approximately 2.0 mg/L. The air is provided to the tanks through fine bubble diffusers, most of which were replaced as part of the 2003 upgrade. There are two anoxic zones at the head of the aeration tanks for denitrification. Each anoxic tank has two submersible mixers. Supplemental carbon is used in the secondary treatment process, as necessary, and several products have been utilized at the facility, depending on the unit price and treatment effectiveness. Each Zone B train has ammonia analyzers for carbon addition.

Air was originally provided by two 200 hp centrifugal blowers, installed as part of the 1996 aeration upgrade, and in 2011, a high efficiency, 300 hp turbo blower was also installed (manufactured by Neuros). In 2013, one 150 hp turbo blower was installed to meet low air flow conditions (manufactured by Neuros). Typically, the two turbo blowers run, and the older two units are not utilized. Discharge air pressure is typically 6-6.25 psi, which is lower than the design condition of 7.14 psi.

Flow is returned to the head of the aeration tanks by the submersible nitrate recycle pumps, which are located in the three zone B tanks. The pumps are sized to return up to 120% of the influent flow. Typically, the recycle flow is paced to return 60% of influent flow, with flow split between the recycle pumps.

There is a post aeration zone, equipped with course bubble diffusers to maintain material in suspension and provide mixing. There are also mixers installed in several of the aeration tanks (zone B tanks), which are operated at a single speed. There are two, 5 hp floating surface mounted mixers located in each of the zone B aeration tanks, which operate continuously. These mixers were installed in order to prevent solids settling in these zones. The DO control system reduced air flow in these tanks below adequate mixing levels, in order to conserve blower energy usage.

Final Treatment and Activated Sludge Systems

There are three final clarifiers, and typically two are on-line. The 30 hp return activated sludge (RAS) is flow paced at 70% of influent flow. There is a total of four VFD driven pumps, and two pumps are typically on-line, with one pump dedicated to each operating clarifier. The two submersible, 7.5 HP waste activated sludge (WAS) pumps transfer waste sludge from the waste sludge wet well to the gravity belt thickener (BGT). The WAS pumps operate on a timer cycle while the GBT is in operation.

WAS is thickened by the GBT for approximately six hours per day, five days per week, while the facility is staffed. The thickened WAS flows to the gravity thickener and is then pumped to the digesters.

Disinfection and Discharge

Effluent flow is disinfected through a UV system manufactured by Trojan, which operates throughout the year. There are two banks of lamps, with 36 lamps per bank, which operate based on a flow pacing system, and have a capacity of up to 28 MGD.

The facility is also equipped with four outfall pumps. Two pumps are 100 hp and two pumps are 150 hp. The pumps operate as required based on the daily tidal levels. The pumps operate on variable frequency drives (VFDs) and the speed and number of pumps is controlled by the level in the UV channel.

Solids Handling

Digested sludge is dewatered and composted on site. Dewatering takes place five days per week, for approximately six hours per day, using a 7.5 hp belt filter press (BFP). The plant also dewaters during the weekend shift for roughly 4 hours. The indoor composting operation includes five compost exhaust fans, which operate continuously to transfer air from the compost building to the biofilter. The two speed fans operate at low speed (5 hp) from 4 PM to 6 AM, and high speed (20 hp) from 6 AM to 4 PM. Compost aeration is provided by thirty (30) 1 hp floor blowers, which operate chronologically as compost moves through the facility. The 50 hp composting machine operates six times per day, for approximately 1 hour per compost bay, for a total time of approximately 6 hours per day. There are a number of smaller fans, which provide ventilation inside the building, and two of the fans transfer air from the garage bays to the compost area in order to minimize fugitive odors out of the garage area. All of these fans operate continuously at single speed.

A second smaller biofilter system is used for the process areas and buildings, including septage receiving, gravity thickener, and dewatering. It has a 75 hp and 60 hp fan that are operated on VFDs, and the speeds are manually adjusted through SCADA. Typically, one fan operates continuously.

Service and Plant Water

There are three plant water pumps, two 20 hp, and one 7.5 hp. These pumps are single speed and flow is controlled by a pressure reducing valve, which maintains the discharge pressure between approximately 60 and 80 pounds per square inch (psi).

HVAC and Building Systems

Most of the buildings at the facility are heated by natural gas. The Administration Building includes a natural gas fired hot water boiler. The building also has two roof mounted heating, ventilation, and air conditioning (HVAC) units, and a small split system to provide air conditioning for the SCADA room. The Influent Building includes rooftop HVAC units, which include natural gas fueled heating. The screenings and grit areas are continuously ventilated and are heated during the winter months.

The Digester Building is heated by the hot water, digester gas fired boilers. There are two garages, the maintenance garage and the flusher garage, which are heated by oil fired units. The composting building is not heated.

The RAS building is heated by a roof mounted natural gas fired unit. There is also a small air conditioning unit for the office.

Exterior and interior lighting retrofits were completed in 2013. New lighting consists of low power ballasts and light emitting diode (LED) fixtures.

The facility is participating in the demand response program and utilizes the two emergency generators to reduce load during response events. The generators are rated for 600 kW and 1 MW.

The facility was also producing power utilizing a 200 kW natural gas fed fuel cell for several years. The system was originally intended to operate as a cogeneration system, which would provide heat to the facility. However, the low temperature of the exhaust heat limited the usefulness of the heat, although some heating was provided to the compost building while the system was on-line. The fuel cell was removed from service in 2010 due to equipment failure. Placing the fuel cell back on-line would require substantial equipment replacement/maintenance.

The facility is currently operating six, 60 kW Capstone microturbines, which are fueled with natural gas. This system provides electrical generation for the plant, however, there is currently no heat recovery.

The electrical and natural gas supply contracts are negotiated on a town wide basis through an aggregate contract. The facility receives electric delivery service through United Illuminating.

Building Monitoring System

A Unity Energy Dashboard system was installed in the 2010's. This system is currently used to monitor and display energy usage and power demand of HVAC equipment in the administration building. The system could potentially be expanded to include lighting systems, as well as power draw from pumping, aeration, and other treatment systems. It could also be incorporated into the plant's existing SCADA system to control equipment based on energy usage.

Digester Equipment

The digester is currently mixed with an IDI cannon bubble mixer, which was installed at the facility in 2003. There have been on-going operational issues associated with this mixing system, which has caused excessive foaming in the digesters. The foaming requires emergency overflow out of the digesters and this residuals stream must then be stored (using one of the existing aeration tanks), pumped and treated.

The digester gas produced at the facility is currently utilized by two boilers, which provide for digester heating. There are 30 kW microturbines, which were originally intended to operate on digester gas, but are currently not in operation primary due too operational and maintenance problems caused by inadequate digester gas conditioning (i.e., compression, moisture removal, siloxanes removal). These units have been out of service for over 10 years.

Due to the build-up of material in the digester, the unit should be cleaned to ensure both optimal solids reduction performance as well as gas production. The excess material in the digesters also limits the usable capacity. In addition, due to the age and condition of the existing mixing system, a new, upgraded system is required to improve the digester performance and gas production capacity.

The two digesters operate in a primary/secondary configuration. The primary digester includes a fixed cover and is mixed continuously the secondary digester has a floating cover. The excess gas is burned through the flare system.

The 2003 upgrade included new controls, piping, corbels, covers, gas flare, and gas safety equipment, and replacement of roof insulation.

The primary digester is heated through a spiral sludge heat exchanger (installed in 2003), which obtains heat from hot water loop fed by the boilers (manufactured by Smith and rated for 800 MBH), located in the septage building. The boilers can operate using either digester gas or natural gas and typically operate using digester gas. Under normal operating conditions only one of the boilers is operated at a time. Sludge is transferred through the heat exchanger by the circulation pumps.

The secondary digester is not heated or mixed and is currently utilized to some extent for sludge storage/gas storage. The digester building is heated through a hot water loop also fed from the boiler.

The digester gas is either sent to the boiler for digester heating or is flared. There are two meters, which record the flow to each location. The existing gas cleaning system includes a desiccant dryer, a refrigerated dryer, and a packed carbon tower.

Most of the digester equipment and digester gas systems were replaced or rehabilitated as part of the 2003 upgrade. A number of additional items would need to be addressed in order to optimize the operation of the digesters and gas production, including the gas cleaning system, digester cleaning, mixing systems, and potential consideration of a natural gas blending system.

Additional Renewable Energy Projects

The Town of Fairfield has sought multiple renewable energy projects and improvements at the WPCF. Currently, the additional projects to be implemented in the short term include solar panel installation and establishing a microgrid. Both the solar power and microgrid have both been funded through state programs and are in the construction and design phase, respectively.

The WPCF has also considered installing Combined Heat & Power (CHP) systems on the existing digesters to utilize the methane in the biogas and produce energy. Potential funding for these projects could be obtained through the Connecticut Department of Energy & Environmental Protection (DEEP) Public Utilities Regulatory Authority (PURA) for Renewable Energy Credits (RECs). Under the current legislation, anaerobic digestion biogas is considered a Class 1 renewable energy source, which is then eligible to participate in the states REC generation program known as the Low and Zero Emission Renewable Energy Credit program (LREC/ZREC). The program requires Eversource and United Illuminating to procure Class 1 RECs over a six-year period with a 15-year agreement. A REC represents 1,000 kWh of electricity. Based on recent bidding and sale of LRECs and ZRECs, biogas is considered an LREC, meaning there are low emissions associated with the fuel source. The following table presents the historic values of LRECs through bidding purchased by UI.

Table 3. Historical LREC values

Year	UI LREC Value
2012	$51.08
2013	$49.43
2014	$56.12
2015	--

NOTE: Year 4 has not been released at the time of this report.

Pump Efficiency Analysis

During the site visit, electrical field measurements were taken in an effort to determine the hydraulic efficiency of selected process pumps. Spot readings of operating power, flow rate, and suction and discharge pressure were recorded, where available, for the operating pump(s) at a number of the unit processes. Where pumps were operated by variable speed devices, readings were obtained at multiple operating speeds, when possible.

In order to determine existing pump hydraulic efficiency, the spot readings were applied to the pump equation, as defined below.

$$\text{Pump eff.}\,(\%) = \frac{\text{Flow (GPM)} \times \text{Head (Feet)} \times 0.746}{3{,}960 \times \text{kW} \times \text{Motor eff.} \times \text{Drive eff.}}$$

As part of the evaluation, the flow rate of the Influent Pumps was measured with the plant's flow meter and compared to JKMuir's portable flow meter. JKMuir's portable flow meter is an ultrasonic with clam on transducers Fluxus ADM 6725 manufactured by Flexim. The following table presents the flow measurements between each meter.

Table 4. Influent Flow Meter

WPCF Flow Meter (gpm)	JKMuir Flow Meter (gpm)	Percent Difference
3,199	3,798	15.8%
4,261	4,250	0.3%
4,681	4,800	2.5%

Based on this information, the plant and portable flow meter appear to have similar readings. The JKMuir flow meter was higher for two of the three tests, however, both readings are similar. Based on this, it may be concluded that the flow meter on the influent pumps is relatively accurate.

Calculated pump efficiencies are provided in the following table. Energy readings for additional process equipment is presented in the tables following.

Table 5. Pump Efficiency Table

Pump Name	Operation	Phase	Voltage	Current (Amps)	Power (kW)	Power Factor	Flow (gpm)	Motor Eff.	VFD Eff.	Suction Pressure (psi)	Discharge Pressure (psi)	TDH (ft)	Pump Eff.
Influent Pump #2[1]	90%	A	275	62	15.7	0.92	4,285	93%	97%	2.9	10.5	18	**35%**
		B	276	58	14.5	0.92							
		C	275	58.6	14.7	0.9							
		AVG/TOT	**476**	**59**	**44.9**	**0.91**							
Influent Pump #3[1]	80%	A	275	48	11.8	0.9	4,264	93%	97%	2.9	12.2	21	**56%**
		B	277	45	11.2	0.9							
		C	275	45	10.8	0.87							
		AVG/TOT	**477**	**46**	**33.8**	**0.89**							
Influent Pump #3[1]	100%	A	275	76	19.5	0.93	6,944	93%	97%	2.6	13	24	**61%**
		B	276	73	18.5	0.94							
		C	274	70	18.7	0.92							
		AVG/TOT	**476**	**73**	**56.7**	**0.93**							
Outfall Pump #1	72%	A	277	39	8.4	0.67	1,500	95%	97%	1.0	7	14	**NA**
		B	277	38	7.3	0.76							
		C	278	45	5.6	0.66							
		AVG/TOT	**480**	**41**	**21.3**	**0.70**							
Return Sludge Pump #2	79%	A	277	14	3.5	0.89	1,597	94%	97%	2.3	9.5	17	**55%**
		B	277	11.5	2.68	0.9							
		C	278	14.8	3.84	0.92							
		AVG/TOT	**480**	**13**	**10.02**	**0.90**							
Return Sludge Pump #3	76%	A	276	12.0	2.7	0.84	1,788	94%	97%	2.8	8.6	13	**60%**
		B	--	--	2.4	0.89							
		C	--	--	3.16	0.9							
		AVG/TOT	**477**	**12.0**	**8.26**	**0.88**							
PWS Pump 1 & 3	Constant - PRV Regulated	A	276	17.0	3.3	0.8	--	91%	NA	--	--	NA	NA
		B	--	--	3.7	0.84							
		C	--	--	3.7	0.8							
		AVG/TOT	**477**	**17.0**	**10.7**	**0.81**							
PWS Pump 3 Only	Constant - PRV Regulated	A	276	13.0	2.5	0.81	--	91%	NA	--	--	NA	NA
		B	276	12.0	2.6	0.86							
		C	278	12.0	2.8	0.84							
		AVG/TOT	**479**	**12.3**	**7.9**	**0.84**							
Nitrate Recycle #2	63%	A	279	5.5	1.32	0.87	--	--	--	--	--	NA	NA
		B	278	5.2	1.36	0.92							
		C	280	5.8	1.45	0.92							
		AVG/TOT	**482**	**5.5**	**4.13**	**0.90**							
WAS Pump #2	95%	A	--	--	1.6	0.91	--	--	--	0.8	15	33	NA
		B	--	--	1.74	0.93							
		C	--	--	1.69	0.93							
		AVG/TOT	**--**	**--**	**5.03**	**0.92**							
Recirculation Pump #2	Constant	A	275	6	1.15	0.66	--	--	--	2	15	30.4	NA
		B	276	7	1.3	0.72							
		C	274	6	1.23	0.73							
		AVG/TOT	**476**	**6**	**3.68**	**0.70**							

NOTES:

1) Motor efficiency based on similar size motor.

Additional electrical field readings on other, non-pumping systems are included in the following tables.

Table 6. Process Equipment Efficiency Table

Equipment Name	Operation	Phase	Voltage	Current (Amps)	Power (kW)	Power Factor
Submersible Mixer Zone A Tank 5 - 5A	Constant	A	279	9	1.13	0.46
		B	280	9	1.12	0.47
		C	278	9	1.17	0.49
		AVG/TOT	**483**	**9**	**3.42**	**0.47**
Submersible Mixer Zone B Tank 8 - 8B (MB2-1)	Constant	A	278	8	1.18	0.5
		B	278	8	1.18	0.50
		C	280	8	1.16	0.5
		AVG/TOT	**482**	**8**	**3.52**	**0.50**
Submersible Mixer Zone A (MA3-2)	Constant	A	279	6	0.79	0.47
		B	280	6	0.8	0.46
		C	278	6	0.81	0.48
		AVG/TOT	**483**	**6**	**2.4**	**0.47**
Submersible Mixer Zone B Tank 8 (MB2-2)	Constant	A	278	8	1.6	0.73
		B	278	8	1.64	0.7
		C	280	8	1.7	0.73
		AVG/TOT	**482**	**8**	**4.94**	**0.72**
Floating Mixer Tank 8	Constant	A	279	6	1.37	0.8
		B	280	6	1.45	0.82
		C	278	6	1.4	0.83
		AVG/TOT	**483**	**6**	**4.2**	**0.82**
Turbo Blower 3 (150 hp)	88%	A	--	--	--	--
		B	--	--	--	--
		C	--	--	--	--
		AVG/TOT	**--**	**--**	**82.2**	**--**
UVA Bank 1A	95% in Auto	A	276	116.0	31.9	0.99
		B	276	117.0	32	1
		C	--	--	--	--
		AVG/TOT	**477**	**116.5**	--	**1.00**
UVA Bank 1A	81% in Hand	A	278	96.0	26.4	0.99
		B	276	99.7	27.4	0.99
		C	277	99.0	27.3	0.99
		AVG/TOT	**479**	**98.2**	**81.1**	**0.99**
UVA Bank 1B	100% in Hand	A	276	123.0	34	1.00
		B	275	124.0	34.00	1
		C	278	121.0	33.5	1
		AVG/TOT	**478**	**122.7**	**101.5**	**1.00**

Table 7. Sludge Equipment Efficiency Table

Equipment Name	Operation	Phase	Voltage	Current (Amps)	Power (kW)	Power Factor
Belt Filter Press 1 Train	Constant	A	276	8	1.72	0.82
		B	277	8	1.88	0.85
		C	275	8	1.8	0.87
		AVG/TOT	**477**	**8**	**5.4**	**0.85**
Gravity Belt Thickener Train 1	Constant	A	276	6	1.26	0.65
		B	278	6	1.42	0.83
		C	278	6	1.35	0.87
		AVG/TOT	**480**	**6**	**4.03**	**0.78**
Biofilter OC #2	89%	A	276	--	7.7	0.94
		B	278	28	7.4	0.95
		C	276	28	7	0.92
		AVG/TOT	**479**	**28**	**22.1**	**0.94**
Compost Fan CB-1	high speed	A	277	19	3.6	0.67
		B	278	20	3.8	0.7
		C	276	19	3.74	0.70
		AVG/TOT	**479**	**19**	**11.14**	**0.69**
Compost Fan CB-4	high speed	A	277	18	3	0.6
		B	279	19	3.3	0.6
		C	276	18	3.2	0.63
		AVG/TOT	**480**	**18**	**9.5**	**0.61**
Compost Floor Fans Bay 3 - Zone D	Constant	A	277	1	0.3	0.8
		B	278	1	0.32	0.8
		C	276	1	0.3	0.82
		AVG/TOT	**479**	**1**	**0.92**	**0.81**
Gas Comp GC-1	Constant	A	275	21	4.5	0.78
		B	275	21	4.6	0.8
		C	277	21	4.65	0.80
		AVG/TOT	**477**	**21**	**13.75**	**0.79**

Operational & Energy Conservation Measures

OM #1 – Solids Handling and Off-Peak Hours of Operation

Description

Currently, a number of the solids handling system operations occur during the day time hours and for a number of hours on the weekend. It may be feasible to transition some of the operations to the off-peak hours, a change that would result in electrical demand and transmission/distribution savings.

Sludge Thickening and Dewatering

Sludge thickening and dewatering occurs for a number of hours between 6 AM and 4 PM at the Fairfield WPCF on a daily basis. Typically, the operation is for six hours a day on weekdays and four hours a day on weekend days. Below is a summary of the sludge processing operation:

- One of two 10 hp waste sludge pumps feed the Gravity Belt Thickener (GBT);
- Operation of the GBT for the thickening of waste sludge occurs for 6 hours a day on weekdays and 4 hours a day on weekend days;
- Operation of the polymer system for the GBT occurs for the duration of the thickening time;
- One of two 10 hp thickened waste sludge pumps transfer the sludge to the digesters following thickening;
- One of two 10 hp belt filter press pumps feed the Belt Filter Press (BFP);
- Operation of the BFP for the dewatering of digested sludge occurs for 7.5 hours a day (1.5 hours include warm up and shutdown) on weekdays and for 5.5 hours on weekdays;
- Operation of the polymer system for the BFP for the duration of the dewatering time;
- The plant water system (PWS) provides water to the GBT and BFP during their operation;
- One of two odor control fans feeding the biofilter are operated at high speed (89% speed) during the solids handling operation. One fan is 75 hp and the other is 60 hp.

An energy balance of the thickening and dewatering processes was completed to assess the energy load (kW and kWh) of the solids handling operations.

Table 8. Solids Handling Process Equipment – Energy Balance

Process Equipment	Motor (HP)	Percent Loading	Power (kW)	Weekday (Hrs)	Energy Use kWh/Day	Notes
Waste Sludge Pumping						
WSP-1	7.5	-	5.0	6	30.2	WAS Pump
WSP-2	7.5	-	5.0	-	-	WAS Pump
WAS Thickening						
Gravity Belt Thickener GBT-1						
Belt Motor and Reducer	2	-	-	-	-	
Hydraulic Motor	1	-	-	-	-	
BPC-1	1.5	-	-	-	-	
Total GBT (field measured)	4.5	-	4.0	6	24.2	
WBP-2	7.5	0.75	4.2	6	25.2	Washwater booster pump
GBT Polymer SFP-1	0.5	0.75	0.3	6	1.7	Polymer booster pump
TWAS Pumping						
TWSP-1	10	0.75	5.6	6	33.6	Thickened Waste Sludge Pump
Dewatering						
Belt Filter Press Feed Pump BPFP-1	10	0.75	5.6	6	33.6	
Belt Filter Press Feed Pump BPFP-2	10	0.75	5.6	6		
BFP Polymer SFP-2	0.75	0.75	0.4	6	2.5	Static mixer system
Belt Filter Press BFP-1						Warm up, process, shutdown
Hydraulic Motor	1	-	-	-	-	
Belt Press Motor	3	-	-	-	-	
BF-1	1.5	-	-	-	-	
BPC-2	1.5	-	-	-	-	
BFP Total (field measured)	-	-	5.4	6	32.4	
SX-1	5	0.75	2.8	6	16.8	Dewatered sludge screw conveyor
WBP-1 or 3	7.5	0.75	4.2	6	25.2	Washwater booster pump
Plant Water System						Feeds BFP, GBT, GT
PW-1 (Lead)	7.5	-	2.8	6	16.8	Small unit typically runs.
PW-2 (Main)	20	-	7.9	6	47.4	Large unit typically runs.
PW-3 (Main)	20	-	-	-	-	
Odor Control						
Biofilter Fan EF-9-1 (solids handling)	75	-	22.1	7.5	165.8	89% speed ON during solids handling
Biofilter Fan EF-9-2 (process)	60	-	-	-	-	69% speed other hours
Total			**81.0**		**455.2**	

Note: Majority of equipment loading assumed, field readings used for applicable items.

The table included above indicates that the solids handling components create a demand of 81.0 kW and consumes 455.2 kWh/day based on 6 hours of operation.

Calculations

Under United Illuminating's GST tariff (C.P.U.C.A. 824), on-peak hours occur between 10 AM and 6 PM on weekdays. During these on-peak times, higher rates are incurred based on the summer and winter season. The demand charges are summarized in the following tables.

Table 9. Demand Charges per On-Peak kW

Demand	On-peak $/kW		Total
	Transmission	Distribution	
Summer	$6.97	$3.64	$10.61
Winter	$8.71	$3.64	$12.35

Notes:
1) Fees based on UI's 2016 GST (C.P.U.C.A 824) rate structure.
2) Summer months include June through September.
3) Off peak hours begin at 6:00 PM and end at 10:00 AM on weekdays and include all weekend hours.

As can be seen in the table above, the demand during summer is higher than winter by approximately 14%. The following table presents the demand charge during off-peak hours.

Table 10. Demand Charge per Off-Peak kW

Demand	Off-peak (in excess) $/kW		Total
	Transmission	Distribution	
Summer	$0.00	$3.64	$3.64
Winter	$0.00	$3.64	$3.64

Notes:
1) Fees based on UI's 2016 GST (C.P.U.C.A 824) rate structure.
2) Off-peak demand charges are incurred when the off-peak demand exceeds the on-peak demand.
3) Summer months include June through September.
4) Off peak hours begin at 6:00 PM and end at 10:00 AM on weekdays and include all weekend hours.

By shifting the operation of the solids handling operation to the off-peak hours, the facility would see a demand charge savings based on 81.0 kW demand. The following table presents the demand costs for on and off peak hours in the summer and winter months.

Table 11. Monthly Demand Costs and Savings

Demand	ON-PEAK $	OFF-PEAK $	Savings
Summer	$4,615	$1,179	$3,436
Winter	$8,359	$2,358	$6,001
		Total	$9,437

Notes:
1) On-peak costs are based on a solids handling demand of 81.00 kW.

Based on the above evaluation, if the solids handling process was switched from on-peak hours to off-peak hours there would be monthly savings of $9,437 for annual savings of over $100,000. These numbers are based on the UI rate structure for 2016, the structure may be periodically modified. Modifications could also include distribution charges for the cost per kWh of electricity. Currently, these values are the same seasonally and for on and off peak hours.

Other sludge thickening equipment including centrifuge and screw press are currently being evaluated. Based on the potential for these technologies to be fully automated, they could operate during off-peak hours resulting in energy savings.

OM #2 – Surface Mixers – Zone B

Description

There are currently six, 5 hp, single speed surface mounted mixers in the aerobic zones of the zone B aeration tanks. Two units are installed in each of three trains. During low aeration demand periods, the amount of air supplied to the tanks by the diffused air system is not adequate to sufficiently mix the tanks and keep the material in suspension. To prevent settling and to maintain thoroughly mixed conditions, the mixers operate continuously. There may be opportunities to reduce the operation of these mixers or to modify how mixing energy is applied to these tanks in order to reduce energy usage and costs.

Calculations

The six, 5 hp, single speed surface mounted mixers in the aerobic zones of the aeration tanks operate continuously. The estimated base case electrical consumption is presented in the following table.

Table 12. Existing Energy Use

Equipment	kW[1]	No. in Operation	Hrs/yr[2]	kWh/yr	Cost/yr[3]
5 HP Surface Mixer	4.2	6	8,760	220,752	$27,152

Notes:
1) Field measured energy draw, assumed to represent average energy use.
2) Six units in operation continuously.
3) Based on an estimated blended rate of $0.123/kWh

Minimum mixing energy can be estimated using a theoretical value of 0.11 kW per 1,000ft^3. Based on the volume of each zone B in the aerobic tanks (~60,500 ft^3), the required mixing energy per tank is approximately 6.5 kW. Based on two 5 hp mixers operating in each of these tanks, the applied mixing energy is currently approximately 7.5 kW. This value represents excess mixing energy (1.0 kW). In addition, these tanks also include coarse bubble diffusers, with air provided by the aeration blowers. The air to these tanks is controlled by valves located at the drop legs to each tank. The valve to the Zone B tanks is automated based on dissolved oxygen (DO) levels. The two valves on the drop legs in the center of the tanks are not automated, and are adjusted manually. In order to reduce the load on the aeration blowers and control DO levels, the valves are both automatically and manually adjusted to reduce the air flow. This has resulted in airflow to the Zone B tanks that is below the minimum mixing requirements for aerated mixing, and resulted in the need for the mechanical mixers to maintain suspension.

Because the continuous airflow to the Zone B tanks through the coarse bubble diffusers is providing some of the required mixing, it may be feasible to operate one mixer in each Zone B tank on an alternating or timed basis (one mixer on, another off). Which would reduce the energy usage of the mixers on an annual basis by 50% for operation every 30 minutes or 75% for operation every 15 minutes (off for 45 minutes) depending on which alternative was selected. It may also be feasible to only operate the mechanical mixers when the airflow to the Zone B tanks is below the minimum mixing requirements. The theoretical minimum airflow to allow for adequate mixing is 0.12 cfm/ sq. ft. of tank area. Each zone B tank is approximately 4,500 sq. ft. and would require approximately 540 cfm for mixing per tank, or 1,620 sq. ft. for all three tanks. The air flow to the Zone B tanks could potentially be monitored through SCADA using existing airflow meters at the Zone B valves, or through new air flow meter(s) as may be required.

The savings associated with reducing the mixer operation through alternative operation by placing on timers is summarized below.

Table 13. Proposed Energy Use – 50% Mixer Operation

Equipment	kW[1]	No. in Operation	Hrs/yr[2]	kWh/yr	Cost/yr[3]
5 HP Surface Mixer	4.2	3	8,760	110,376	$13,576

Notes:
1) Field measured energy draw, assumed to represent average energy use.
2) Three units in operation 24/7, alternating between units and/or operating based on airflow.
3) Based on an estimated blended rate of $0.123/kWh.

Alternatively, if the operation of the floating mixers is reduced by putting them on timers, there could also be energy savings. The following table presents the energy consumption if the mixers if they were operated on timers; on for 15 minutes and off for 45 minutes.

Table 14. Proposed Energy Use – Timers

Equipment	kW[1]	No. in Operation	Hrs/yr[2]	kWh/yr	Cost/yr[3]
5 HP Surface Mixer	4.2	6	2,190	55,188	$6,788

Notes:
1) Field measured energy draw, assumed to represent average energy use.
2) Hours of operation based on 15 minutes on and 45 minutes off every hour.
3) Based on an estimated blended rate of $0.123/kWh.

The estimated electrical and cost savings by reducing the operation of the surface mixers by 50% and periodically operating for 15 minutes every hour are presented below.

Table 15. Energy & Savings Summary

Condition	kWh/yr	Cost/yr
Existing	220,752	$27,152
Proposed (50%)	110,376	$13,576
Savings	**110,376**	**$13,576**
Proposed (15 min)	55,188	$6,788
Savings	**165,564**	**$20,364**

Budgetary Cost Estimate

For the purpose of this evaluation it is assumed that to implement this measure, timers would need to be installed. It is assumed that this could be done at a minimal cost and is presented as an Operational Measure (OM). The payback period is assumed to be immediate for this measure.

ECM #1 – Aeration Blower Optimization & Installation

Description

Four aeration blowers supply compressed air to the aeration tanks. Two 200 hp centrifugal, multi-stage blowers (provided by Spencer Turbine Co.), one 300 hp high speed turbine blower (APG Neuros), and one 150 hp high speed turbine (APG Neuros) provide the air to the fine bubble diffuser system installed in the aerobic sections of the Zone A and Zone B tanks.

Typically, the 300 hp high speed turbine blower is in service, with the 150 hp unit operating during low air flow requirements (i.e. cold weather or overnight). The speed of the turbine blower is controlled by VFDs. The older 200 hp and 300 hp centrifugal blowers are operated as backups and are controlled by inlet throttling. Based on discussion with plant staff, the Spencer blowers are not currently used.

The air supplied to the aeration tanks is monitored and controlled by the dissolved oxygen (DO) control system. The system consists of valves located on the air piping at each of the aeration tanks, air flow meters, pressure sensors, and dissolved oxygen meters in the aeration tanks. The valves on the air piping are regulated to maintain the DO set point. The speed of the high speed turbine blowers is adjusted to maintain the air pressure set point in the air piping header and to supply the adequate amount of air to the aeration trains.

The operation of the high speed turbine blowers could be further optimized through the implementation of a process energy management system that would select the blower with the lowest power requirements to meet the aeration DO set points without over aerating and consuming more energy.

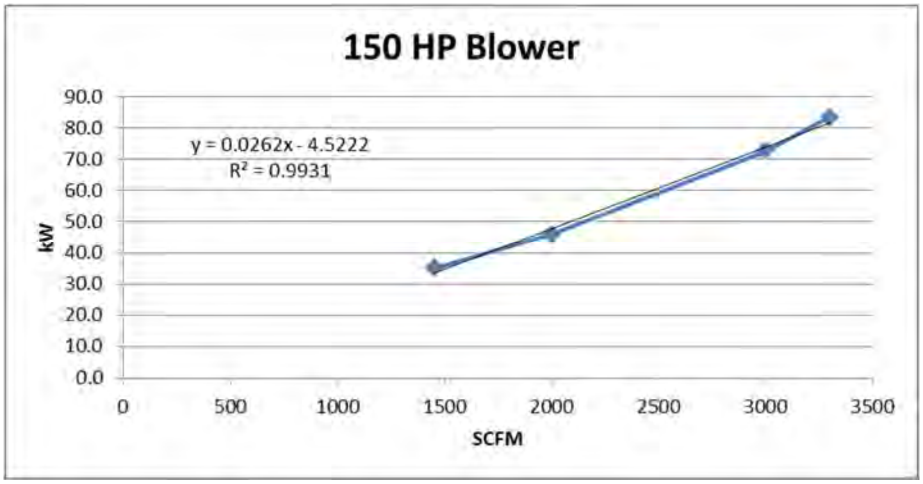
Calculations

The high speed turbine blowers have the following specifications.

Table 16. 150 HP Blower Specifications

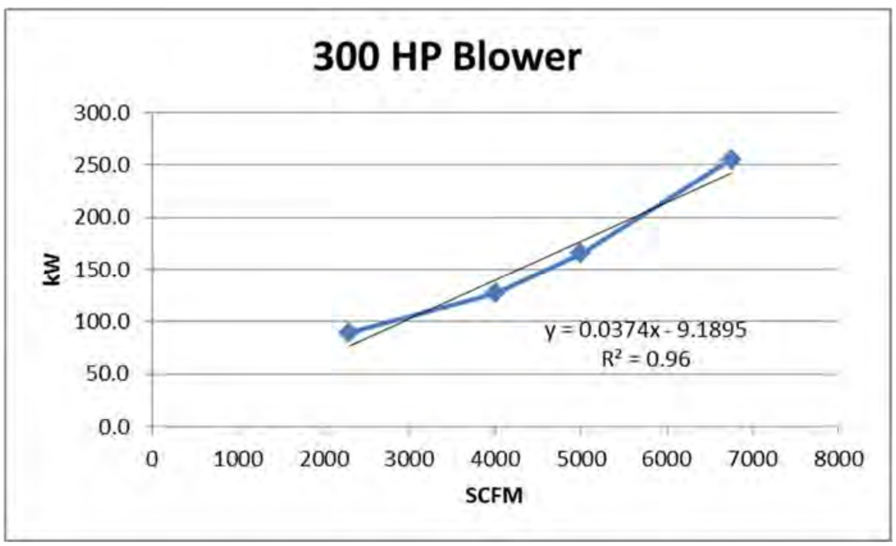
Parameter	150 HP	300 HP
Discharge Pressure (psig)	7.41	7.41
Minimum Air Flow (SCFM)	1,454	2,300
Maximum Air Flow (SCFM)	3,300	6,750

Using the manufacturer's curve and data, a power relationship between the air flows and power draw were developed for each of the blowers (these relationships represent a snapshot of power versus airflow for specific temperature and humidity conditions and are based on manufacturer provided data and curves).



Note: Values based on blower curve and manufacturer provided data (7.4 psi; 100°F and 90% humidity).

Figure 3. 150 HP Turbo Blower



Note: Values based on blower curve and manufacturer provided data (7.4 psi; 100°F and 90% humidity).

Figure 4. 300 HP Turbo Blower

Using the power relationship presented above, a comparison of electrical consumption for the air flow requirements was developed for each of the blowers and for the operation of two of the 150 hp units.

Table 17. Power Consumption Comparison Between Blowers

Air Flow	1-150 HP	2-150 HP	1-300 HP	Savings	Comments
SCFM	kW	kW	kW	kW	
1454	33.6				MIN Flow of 1-150 HP Blower
1500	34.8				
2000	47.9				
2300	55.7		76.8	21.1	MIN Flow of 1-300 HP
2400	58.4		80.6	22.2	
2500	61.0		84.3	23.3	
2600	63.6		88.1	24.5	
2700	66.2		91.8	25.6	
2800	68.8		95.5	26.7	
2900	71.5	143	99.3	27.8	MIN of 2-150 HP Blowers (2908 SCFM)
3000	74.1	148	103.0	28.9	
3100	76.7	153	106.8	30.1	
3200	79.3	159	110.5	31.2	
3300	81.9	164	114.2	32.3	MAX Flow of 1-150 HP Blower
3400		169	118.0		
3500		174	121.7		
4000		201	140.4		
4500		227	159.1		
5000		253	177.8		
5500		279	196.5		
6000		305	215.2		
6500		332	233.9		
6600		337	237.7		MAX of 2-150 HP Blowers
6700			241.4		
6800			245.1		MAX Flow of 1-300 HP Blower

Note:

1) Savings reflect kW difference between the operation of one (1) 150 hp blower and one (1) 300 hp blower.
2) Values based on blower curve and manufacturer provided data (7.4 psi; 100°F and 90% humidity).

Blower Optimized Operation

The findings indicate that there is an efficiency gain depending on the air flow regime requirements. Based on the manufacturer performance data, there appears to be a savings associated with the operation of the smaller blower (150 hp) during certain air flow regimes, as can be observed from the improved cfm/kW shown on the table above.

Based on this high level analysis, it appears that prolonging the switch over to the 300 hp unit provides savings. The savings may be reflective of a loss of efficiency when the larger, 300 hp blower is turned down and operates within the lower flow regime. The typical air flow demand at the facility may fall in the "cross-over" range between the two blower sizes, making optimization important. The efficiency of the units and minimum and maximum air flow capacities will change under varying/seasonal temperature and humidity conditions. However, this analysis does suggest that keeping the smaller, 150 hp unit in operation to the greatest extent of its capacity would provide savings.

Based on table above, the use of the 150 hp blower would provide approximately 25 kW in savings compared to the use of the 300 hp unit. Assuming that the smaller unit could be operated for 10% of the time more often than the 300 hp blower, the savings would total 21,900 kWh a year ($2,694 a year).

Recommendations

- Perform long term monitoring of blower performance to better optimize the blower "switch over" point/control loop. This could be done through field readings, which would be more accurate than utilizing the manufacturer curves. In addition, the cfm and kW for each of the blowers could be incorporated into SCADA control, allowing for the continuous monitoring of the cfm per kW readouts. The trending for each blower would provide a clear indication of the performance and efficiency of the two blowers along their operating ranges.

- Allow for reduced DO in the aeration tanks (as can be tolerated without disrupting the process) to prolong the operation of the 150 hp unit for longer periods during the day. Also, at the lower pressure conditions typically seen, the 150 hp unit will provide more airflow than indicated by the manufacturer data for the specific temperature and humidity conditions.

Table 18. Recommended Optimized Blower Operation

Condition	Blower Operation
< 3,300 SCFM	1-150 hp Blower
> 3,300 SCFM	1-300 hp Blower

Note: Values based on blower curve and manufacturer provided data (7.4 psi; 100°F, and 90% humidity).

As previously mentioned, operating the smaller 150 hp blower more frequently could result in additional energy savings. Further savings may also be achievable through implementing control strategies at additional cost.

As part of the Wright-Pierce evaluation, they are recommending the installation of an additional 200 hp high speed turbo blower to cover the air flow ranges between the 150 and 300 hp blowers. The blower curve for the 200 hp blower was not available for analysis, however, based on the calculated savings for the operation of the 150 hp blower and the cost of the new blower, the following savings and payback are presented. The savings are based on 21,900 kWhs per year.

Table 19. Savings & Payback

Parameter	Value
Annual Energy Savings (kWh)	21,900
Annual Energy Savings	$2,694
Proposed Cost	$125,000
Simple Payback	46

Additional evaluation may be conducted to determine the specific savings with operating the 150 and 200 hp blowers continuously.

ECM #2 – Raw Sewage & Auxiliary Pump Replacement

Description

Influent flow to the facility is handled by three 100 hp Raw Sewage Pumps which operate on VFDs and maintain the water level at the required set points in the wet well. The pumps are designed to discharge 4,860 gallons per minute (gpm) at a total dynamic head (TDH) of 55 feet and at a hydraulic efficiency of 82%. Typical operation is for two of the pumps to accommodate the average 9.0 MGD flow. One influent pump is able to handle approximately 7.0 MGD. During high flows up to 20 MGD, all three pumps are in operation. When the flows are over 20 MGD, the two Auxiliary Pumps are used to bypass primary clarification. There are two 70 hp Auxiliary pumps rated for 4,170 gpm at 45 feet TDH. The excess flow enters a wet well and calls the Auxiliary pumps on when it reaches a certain level. These pumps are able to bypass primary clarification or both primary clarification and Zone A of aeration. Each Auxiliary pump is controlled through a VFD and is able to pump approximately 6.0 MGD and operate in lead-lag orientation.

Wright-Pierce is proposing replacing the existing influent/raw sewage pumps and the auxiliary pumps with a single influent pump station where the Auxiliary Pumps are currently located at the Influent Building. This would replace the existing two pumps with five equally sized pumps capable of handling 9,700 gpm each at 45 feet TDH.

Field readings of electrical power, flow, and pressure were recorded to determine the hydraulic efficiency of the pumps. The influent pumps were found to be operating below their original design efficiencies. Rebuilding the pumps would allow the units to run at like-new conditions, closer to their original design efficiencies.

Calculations

The average flow to the Fairfield WPCF is approximately 8.5 MGD. To meet the average flow conditions, two Raw Sewage pumps would operate. Based on historic flow data from 2014 and 2015, the flow ranges are presented in the following table. The average flow for each flow range is also used for further calculations in the existing and proposed energy use tables.

Table 20. Historic Flow Range & Hours

Flow Range	Percentage	Annual Hours	Average Flow (MGD)
<7 MGD	34.33%	3,007	6.16
<10 MGD	82.76%	7,250	7.44
7 - 14 MGD	62.54%	5,478	9.03
14 - 20 MGD	2.82%	247	16.00
10 - 20 MGD	16.93%	1,483	12.17
>20 MGD	0.31%	27	22.02

The historic flow ranges in the table above were used to calculate the existing and proposed operating hours in the following tables. The average flow rate was determined based on a bin analysis where the average flow rate in each bin of flow ranges was averaged based on the historical data. Because the existing Influent pumps have a maximum capacity of 7.0 MGD, a single pump operates 3,007 hours per year, which is approximately 34% of the time over a year. This means that out of the 8,760 hours per year, one pumps runs for approximately 34% of it. If the pump capacity was increased to 10 MGD, then a single pump could operate for 7,250 hours per year, which is 82.8% of the year, based on historical data.

A system curve was developed based on static head, field testing data points and the design point for multiple pumps in operation. The system curve was used to determine the approximate TDH for each operating condition at varying flow rates. The following figure presents the estimated system curve.

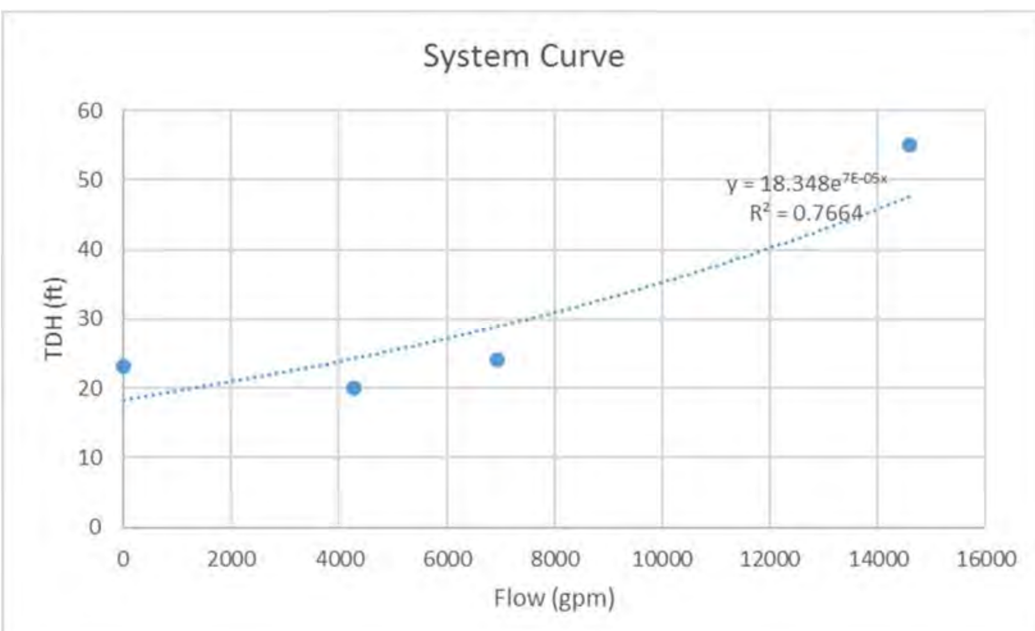


Figure 5. Raw Sewage Pump System Curve

Based on the field readings and pump testing conducted in the field, the pumps seem to be operating at hydraulic efficiencies significantly below the design conditions. Using an average pump efficiency based on the multiple field readings, flow rates based on historical data, and TDH based on the estimated system curve, the energy usage of the pumps was determined. The BEP efficiency was used for the auxiliary pumps. Shown below is the existing energy usage of the raw sewage and auxiliary pumps.

Table 21. Existing Energy Use – Raw Sewage & Auxiliary Pumping

Condition	Flow Per Pump (gpm)[2]	Total Plant Flow (gpm)	TDH (ft)[3]	Pump Eff. [4]	Motor Eff.[5]	VFD Eff.[6]	Power per Pump (kW)	Total Power (kW)	Annual Hours	Annual Energy Use	Annual Cost
0 - 7 MGD	4,276	4,276	24	52%	95%	97%	40.3	40.3	3,007	121,315	$14,922
7 - 14 MGD	1,997	6,273	28	52%	95%	97%	21.6	61.9	5,478	339,299	$41,734
14 - 20 MGD	4,839	11,111	38	52%	95%	97%	72.3	134.2	247	33,172	$4,080
20+ MGD	4,180	15,292	50	75%	94%	97%	57.6	191.8	27	5,267	$648
Total									**8,760**	**499,054**	**$61,384**

Notes:
1) Pumps run time is based on flow data from 2014 & 2015 and assumed to be typical flow conditions.
2) Flow based on average flow rate in the range of flows that pump is able to handle.
3) Head based on estimated system curve.
4) Pump Efficiency based on field readings and pump curve.
5) Motor Efficiency based on typical values for similar size motor.
6) VFD efficiency based on typical performance.
7) Cost based on $0.123/kWh.

As flow fluctuates seasonally and diurnally, the number of influent pumps online, as well as their speeds, will vary. Since the pumps are operating on VFDs, an analysis was performed to determine the iso-efficiency curves, which represent the operation of the pump at various speeds. As shown below, under the average conditions, the two influent pumps operate at 67% of their rated speed. At these operating conditions, the hydraulic efficiency should be 84%.

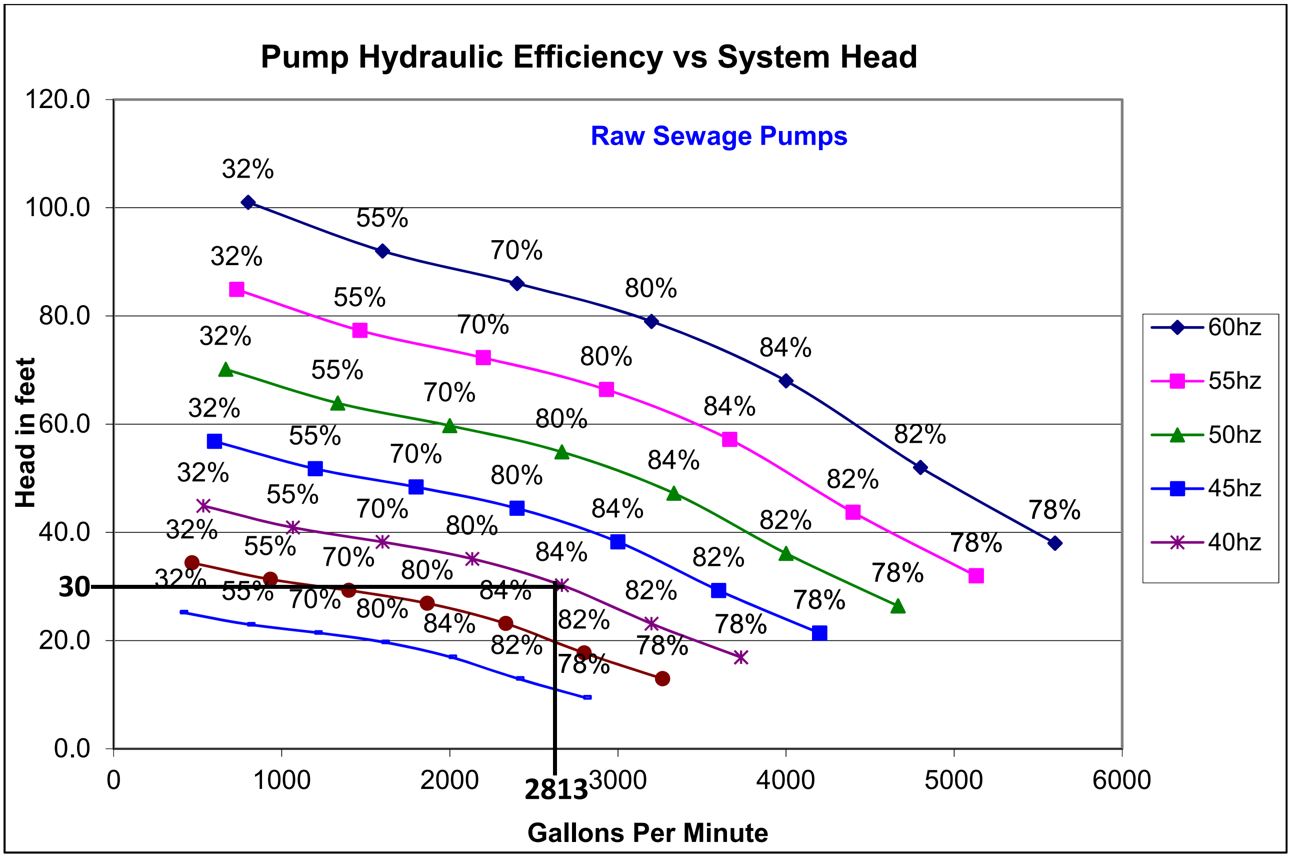


Figure 6. Variable Speed Analysis

By replacing these pumps, the efficiencies would be higher than the current measured efficiency of 52%. A conservative value of 75% is used for the average efficiency of the new 10.0 MGD pumps. As presented in the table above, the historic flow data indicates that the flow rate is less than 10.0 MGD over 80% of the time. Shown below is the estimated energy usage of the new pumps. Based on historical flow rate data presented above, it is assumed that up to three pumps operate, while the other pumps are for emergency or standby operation. The TDH was also estimated based on the system curve.

Table 22. Proposed Enegy Use

Condition	Flow (gpm)[2]	Total Plant Flow (gpm)	TDH (ft)[3]	Pump Eff. [4]	Motor Eff.[5]	VFD Eff.[6]	Power per Pump (kW)	Total Power (kW)	Annual Hours	Annual Energy Use	Annual Cost
0 - 10 MGD	5,164	5,164	26	75%	94%	97%	37.0	37.0	7,250	268,155	$32,983
10 - 20 MGD	3,285	8,449	32	75%	94%	97%	29.0	65.9	1,483	97,792	$12,028
20+ MGD	6,842	15,292	50	75%	94%	97%	94.2	160.2	27	4,399	$541
Total									**8,760**	**370,346**	**$45,553**

Notes:
1) Pumps run time is based on flow data from 2014 & 2015 and assumed to be typical flow conditions.
2) Flow based on average plant data.
3) Head based on estimated system curve.
4) Pump Efficiency estimated for new pump.
5) Motor Efficiency based on typical values for similar size motor.
6) VFD efficiency based on typical performance.
7) Cost based on $0.123/kWh.

Shown below is the estimated energy and cost savings associated with this measure:

Table 23. Energy & Cost Savings

Condition	Energy Usage	Energy Cost
Existing	499,054	$61,384
Proposed	370,346	$45,553
Total Savings	**128,707**	**$15,831**

Notes:
1) Energy cost based on $0.123 per kWh.

Budgetary Cost Estimate

The following budgetary cost estimate is for the replacement of the existing three influent and two auxiliary pumps with five new influent pumps. The following cost estimate does not include demolition and removal of the existing pumps of the additional building extension structure for the new pumps to be housed.

Table 24. Budgetary Cost Estimate

Item	Cost
5 New Pumps	$465,000
5 New VFDs	$31,250
Subtotal	$496,250
Contingency 10%	$49,625
Total Capital Cost	$545,875

Summary of Cost and Savings

The savings associated with this measure and the simple payback are presented in the following table.

Table 25. Savings & Payback

Annual Reduction (kWh)	128,707
Billing Rate	$0.123
Annual Savings	$15,831
Project Cost	$545,875
Simple Payback	**34.5**

It should be noted that the energy savings and payback is based on a current efficiency of 52% for the influent pumps, the efficiency of each pump may vary due to when or if it was rebuilt and the hydraulic conditions of that individual pump. Previous measurements were conducted on these pumps, which resulted in a lower pump efficiency. The recent efficiencies were calculated based on field readings from JKMuir's portable flow meter and digital pressure gauges. These values may represent more accurate numbers than the previous values from installed instruments.

Incentive

It is anticipated that this project may be eligible for incentive through UI's Custom Measure program. The incentive would be based on the current program cap of $0.35 per annual kWh saved or up to 40% of the project cost (the lesser of). Further testing of each individual pump may provide more precise efficiency and saving values for these pumps.

Based on the relatively long payback period, if may also be feasible for the existing influent pumps to be rebuilt in the interim. The measured efficiency of the existing raw sewage pumps is approximately 52%, where the pump curve demonstrates is should be approximately 83%. Rebuilding the existing pumps may bring them back to "like-new" conditions, with a higher efficiency resulting in energy and cost savings. Based on the study conducted by JKMuir through United Illuminating in 2014, rebuilding these pumps may demonstrate annual savings of 216,994 kWh (over $30,000 based on $0.14/kWh cost). The estimated project cost was $60,000 to rebuild all the pumps, resulting in a 2-year payback period.

ECM #3 – RAS Pump Rebuild or Replacement

Description

Return activated sludge (RAS) is pumped back to the aeration basins by four 30 hp units controlled through VFDs. The RAS pumps are designed to discharge 2,311 gpm at a TDH of 32 feet with a hydraulic efficiency of 78%. The pumps are flow paced based on the influent flow to the facility. Typically, two pumps are in service, each dedicated to an operating clarifier.

Field readings of electrical power, flow, and pressure were recorded to determine the hydraulic efficiency of the pumps. The RAS pumps were found to be operating below their original design efficiencies. Due to the age and reduced efficiency of the RAS pumps, replacement would result in energy conservation and cost savings with increased pump efficiency.

Calculations

The average flow to the Fairfield WPCF is approximately 8.5 MGD. Typically, two pumps are in service.

The estimated base case electrical consumption is presented in the following table.

Table 26. Existing Electrical Use

Condition	No. of Pumps[1]	Flow per Pump (gpm)[2]	TDH (ft)[3]	Pump Eff.[4]	Motor Eff.[5]	VFD Eff.[6]	Power (kW)	Annual Operating Hours	Annual Energy Use (kWh/yr)
Existing RAS Pumps	2	1,693	15	57%	93.6%	97%	18.4	8,760	161,554

Notes:

1) Number of pumps running assumed based on typical flow conditions.
2) Flow based on flow produced at approximately 77% speed and assumed to be typical average flow.
3) TDH based on field readings and system pressure.
4) Pump Efficiency based on field readings.
5) Motor Efficiency based on typical values for premium efficiency motors.
6) VFD efficiency based on typical performance.

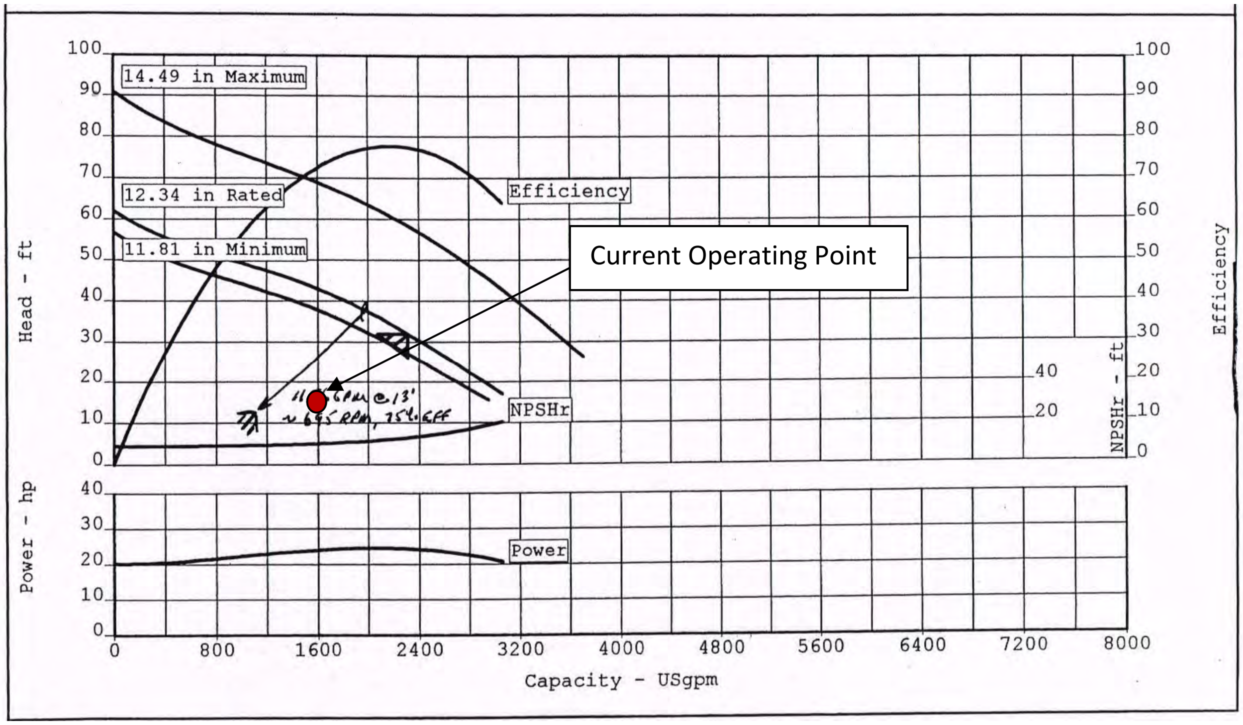


Figure 7. Existing Return Sludge Pump Curve

Based on the field readings and pump tests conducted in the field, the pumps seem to be operating at hydraulic efficiencies below the design conditions. As presented in the figure above, the pump is operating at a lower flow and TDH than designed, to the left of its curve. This may suggest that the pump is oversized for the current hydraulic conditions. The proposed design is to replace the RAS pumps with pumps designed for the current hydraulic conditions and would have a higher efficiency at these points. The following calculations are based on an assumed best efficiency point (BEP) of 75% to remain conservative.

The estimated proposed case electrical consumption is presented in the following table. Again, the flow rate and TDH are based on field readings. It is assumed that the replacement pumps would be sized to fit these conditions.

Table 27. Proposed Energy Use

Condition	No. of Pumps[1]	Flow per Pump (gpm)[2]	TDH (ft)[3]	Pump Eff.[4]	Motor Eff.[5]	VFD Eff.[6]	Power (kW)	Hrs/ yr	Total kWh/ yr
Rebuilt RAS Pumps	2	1,693	15	75%	93.6%	97%	14.0	8,760	123,067

Notes:
1) Number of pumps running assumed based on typical flow conditions.
2) Flow based on flow produced at approximately 77% speed and assumed to be typical average flow.
3) Head based on field readings and system pressure.
4) Pump Efficiency based assumed efficiency of new pumps.
5) Motor Efficiency based on typical values for premium efficiency motors.
6) VFD efficiency based on typical performance

The estimated electrical and cost savings are presented in the following table.

Table 28. Energy Savings & Cost

Condition	Energy Usage	Energy Cost
Existing	161,554	$19,871
Proposed	123,067	$15,137
Savings	**38,487**	**$4,734**

Note:
1) Energy cost based on $0.123/kWh

Budgetary Cost Estimate

The replacement pumps were assumed to cost approximately $45,000 each for a total equipment cost of $180,000. Based on this and a 30% contingency, the estimated project cost is approximately $234,000 to replace four pumps. Alternatively, or in the interim, the pumps could be rebuilt at a lower cost of $15,000 per pump for a total project cost of $78,000.

Summary of Cost and Savings

The savings associated with this measure and the simple payback are presented in the following table.

Table 29. Savings & Payback

Parameter	Replaced	Rebuilt
Annual Reduction (kWh)	38,487	38,487
Billing Rate	$0.123	$0.123
Annual Savings	$4,734	$4,734
Project Cost	$234,000	$78,000
Simple Payback	**49.4**	**16.5**

It should be noted that the energy savings and payback is based on a current efficiency of 57%, the efficiency of each pump may vary due to when it was rebuilt and the hydraulic conditions of that individual pump. Previous measurements were conducted on these pumps, which resulted in a lower pump efficiency. The recent efficiencies were calculated based on field readings from JKMuir's portable flow meter and digital pressure gauges. These values may represent more accurate numbers than the previous values.

The Facility Plan being conducted by Wright-Pierce recommends replacement of these pumps. Due to the relatively long payback period, the plant may benefit from rebuilding these pumps. The previous energy evaluation conducted at the facility by JKMuir through United Illuminating in 2014 recommended rebuilding these pumps. Based on those calculations, rebuilding these pumps resulted in over 240,000 kWh at $0.14/kWh for over $34,000 annual savings. This resulted in a payback period of 1 year. Based on the short payback period, these pumps could be rebuilt to consume less energy following rebuilding prior to the facility's major upgrades.

Incentive

It is anticipated that this project would be eligible for incentive through UI's Custom Measure program. The incentive would be based on the current program cap of $0.35 per annual kWh saved or up to 40% of the project cost (the lesser of). Further testing of each individual pump may provide more precise efficiency and saving values for these pumps.

ECM #4 – Submersible Mixers – Zone A

Description

The Anoxic Zone in Zone A has 12 submersible mixers, which suspend the solids and mix the return sludge into the influent stream. The Facilities Plan includes replacement of the submersible mixers with the EnviroMix, BioMix proprietary technology, which produces mixing through periodic and staggered large bubble injection from the base of the tank.

Calculations

The following calculations are based on twelve submersible mixers operating continuously in the anoxic area of Zone A aeration.

Table 30. Existing Energy Use

Equipment	kW[1]	No. in Operation	Hrs/yr[2]	kWh/yr	Cost/yr[3]
12 Submersible Mixers	2.9	12	8,760	305,899	$37,626

Notes:
1) Field measured energy draw, assumed to represent average energy use.
2) Twelve units in operation continuously.
3) Based on an estimated blended rate of $0.123/kWh.

The facility plan proposes to replace the submersible mixers with a proprietary system, which consumes less energy on a continuous basis than the exiting submersible mixers. The following energy use is based on manufacturer provided data designed for the Fairfield WPCF. Please note that the system would operate in both Zones A and B, based on this energy consumption.

Table 31. Proposed Energy Use – BioMix

Equipment	kW[1]	No. in Operation	Hrs/yr[2]	kWh/yr	Cost/yr[3]
BioMix	14.1	1	8,760	123,516	$15,192

Notes:
1) Manufacturer data, assumed to represent average energy use.
2) Based on continuous operation.
3) Based on an estimated blended rate of $0.123/kWh.

The following table presents the existing and proposed energy use of the mixers that are already installed at the plant if they were to be replaced in kind. It should be noted that the electricity presented is based on the field readings.

Table 32. Proposed Energy Use – Mixers

Condition	kWh/yr	Cost/yr
Existing	305,899	$37,626
Proposed	305,899	$37,626
Savings	0	$0

Notes:
1) Based on an estimated blended rate of $0.123/kWh

The following table presents the energy savings and cost based on the existing and proposed conditions for the BioMix and replacing the mixers in kind.

Table 33. Savings & Cost – BioMix

Item	Total
Biomix System	$550,000
Installation	$38,500
Subtotal	$588,500
Contingency (20%)	$117,700
Total Capital Cost	$706,200

Table 34. Savings & Cost – Mixers

Budgetary Cost Estimate

The following tables present the proposed project cost based on manufacturer provided budgetary cost of equipment and installation for the proposed Biomix system and the cost to replace the mixers in kind for comparison purposes.

Table 35. Proposed Project Cost – BioMix System

Item	Total
Biomix System	$550,000
Installation	$38,500
Subtotal	$588,500
Contingency (20%)	$117,700
Total Capital Cost	$706,200

Table 36. Proposed Project Cost – Mixer Replacement In Kind

Item	Total
Sub Mixers	$312,000
Installation	$20,000
Subtotal	$332,000
Contingency (20%)	$66,400
Total Capital Cost	$398,400

Summary of Cost & Savings

The following table presents the energy savings and payback period based on the proposed budgetary cost estimate. The energy used for the proposed Biomix system is

Table 37. Savings & Payback

Parameter	BioMix	Mixers
Annual Reduction (kWh)	182,383	0
Billing Rate	$0.123	$0.123
Annual Savings	$22,433	$0
Project Cost	$706,200	$398,400
Simple Payback (yrs)	**31.5**	**NA**

It should also be noted that the existing surface mixers have reached the end of their useful life and would need to be replaced with similar mixers or with another technology. The cost to replace the existing mixers with similar submersible mixers would cost approximately $26,000 per mixer. The estimated project cost to replace the twelve submersible mixers with installation and contingency is approximately $400,000, however, there are limited potential energy savings available with this alternative and there would not be available incentives from the electric utility for replacing these mixers in kind. The additional cost associated with utilizing the Biomix system verses traditional mixing technology can be eligible for incentives through the utility.

ECM #5 – Coarse Bubble to Fine Bubble Diffusion – Zone B

Description

The existing Zone B aeration is added through coarse bubble diffusers. Fine bubble diffusion can provide a better transfer of oxygen due to the larger surface area provided with each individual bubble as compared to coarse bubble diffusion. Based on oxygen transfer testing conducted by Sanitaire, a database was developed to provide information on oxygen transfer with different kinds of aeration equipment, geometric designs, and depths. Based on this data base, general oxygen transfer rates were developed for fine and coarse bubble diffusion equipment. In addition, the Actual Oxygen Requirements (AOR) are converted to Standard Oxygen Requirements (SOR) to calculate the AOR/SOR ratio for sizing aeration equipment. The AOR is a measure of the oxygen demand of the wastewater under the specific site conditions. SOR conditions are considered to be at sea level, 20°C and a zero value for dissolved oxygen. The ratio is a comparison of the field conditions over the ideal conditions. Because of this, the SOR is always larger than the AOR, therefore, the lower this ratio value is, the better the actual requirements meet the standard requirements. Based on the testing and database, the following values were estimated for fine and coarse bubble diffusion.

Table 38. Coarse & Fine Bubble Design Values

	Coarse Bubble	Fine Bubble
AOR/SOR Ratio	0.50	0.33
Oxygen Transfer Efficiency (OTE)	0.75% per ft	2.0% per foot

NOTE: Data provided by “Diffused Aeration Design Guide” produced by Sanitaire

The values presented above were used to determine the difference in air required between coarse bubble and fine bubble aeration. Based on the site visit, two of the three Zone B aeration trains were in operation. The scfm going to each tank was 760.6 at 122.9°F and 751.6 scfm at 116.7°F. Based on these numbers, the total flow going to both tanks were 1,512.2 scfm. Based on the blower operation, the total amount of air for Zone A and B was 2,870 scfm, which means that Zone B was receiving 52.7% of the air provided by the blower at the time of field testing. The remaining air is sent to Zone A.

Based on these values, the following horsepower was calculated for coarse and fine bubble aeration based on the following equations.

$$SOR\left(\frac{lbs}{day}\right) = \frac{SCFM}{(0.075\ x\ 0.232\ x\ (24x\ 60)x\ SOTE\%}$$

$$AOR = SOR\ x\ \frac{AOR}{SOR}$$

$$Blower\ HP = SCFM\ x\ psig\ x\ 0.006$$

Based on these equations and the known values presetned, the following values were calculated.

Table 39. Coarse & Fine Bubble Power Use Values

Parameter	Coarse Bubble	Fine Bubble
Flow (scfm)	1,512	161.9
SOR (lbs/day)	656	994
AOR (lbs/day)	328	328
AOR/SOR	0.50	0.33
OTE (%/ft)	0.75%	2%
SOTE (%)	9.2%	24.5%
Discharge Pressure (psi)	6.55	6.55
Blower Horsepower (hp)	59.4	12.9
Blower Kilowatt (kW)	44.3	9.6

Notes:
1) Coarse bubble flow is total flow in Zone B during site visit.
2) AOR/SOR is based on Sanitaire provided values.
3) OTE%/ft is based on Sanitaire provided values.
4) SOTE% is based on depth of diffusers and OTE.
5) Discharge pressure values were observed during field visit.
6) Blower HP calculated based on scfm*psi*0.006.
7) kW based on HP * 0.746.

Calculations

Based on field measured values, the kW reading for the 300 hp blower operating at 88.4% speed and providing air for both Zone A and B was operating at 82.2 kW. Based on this measurement and the calculated values presented in the table above of 44.3 kW, the Zone B coarse bubble aeration consumes approximately 54% of the total energy used by the blower. This corresponds with approximately 53% of the air flow being sent to Zone B. The existing energy use of the blowers is presented in the following table. For the purposes of these calculations, it is assumed that a single blower operates at the above calculate hp continuously to meet the demand.

Table 40. Existing Energy Use – Aeration Zone B

Condition	kW[1]	Hrs/yr[2]	kWh/yr	Cost/yr[3]
Zone B Aeration Energy	44.3	8,760	388,369	$47,769

Notes:
1) Calculated kW draw, assumed to represent average use.
2) Continuous operation.
3) Based on an estimated blended rate of $0.123/kWh

Based on the calculations above, the estimated kW draw with fine bubble aeration would consume 9.6 kW, which is a reduction from 44.3 kW for coarse bubble to meet the same demand. The energy use for these conditions are presented in the following table.

Table 41. Proposed Energy Use – Aeration Zone B

Condition	kW[1]	Hrs/yr[2]	kWh/yr	Cost/yr[3]
Zone B Aeration Energy	9.6	8,760	84,239	$10,361

Notes:
1) Calculated kW draw, assumed to represent average use.
2) Continuous operation.
3) Based on an estimated blended rate of $0.123/kWh

The energy savings available for switching from coarse bubble aeration to fine bubble aeration are presented in the following table.

Table 42. Energy Savings

Condition	kWh/yr	Cost/yr
Existing	388,369	$47,769
Proposed	84,239	$10,361
Savings	304,130	$37,408

The cost of upgrading the coarse bubble diffusion with fine bubble diffusion may prohibit moving forward with this installation. There is a potential to retrofit the existing piping system with different diffusers based on the existing installation, however, further investigation is recommended to determine the potential savings throughout the day and year. When this is determined, detailed cost estimates may be obtained from manufacturer(s) to determine potential costs and evaluation of the existing infrastructure for re-use, if possible.

Incentive

It is anticipated that this project would be eligible for incentive through UI's Custom Measure program. The incentive would be based on the current program cap of $0.35 per annual kWh saved or up to 40% of the project cost (the lesser of). Further investigation is recommended to determine the installation and project costs for this measure.

ECM #6 – Ammonia Based Process Control

Description

The Fairfield WPCF has an effluent discharge permit with a total nitrogen limit, which requires the plant to both nitrify and denitrify as part of the biological treatment process. The aeration blowers (150 hp and 300 hp Neuros high speed turbo blowers) provide the airflow required for nitrification in the aerated zones of the first and second stage aeration tanks. The blower airflow output and speed are currently controlled based on the dissolved oxygen (DO) set points in the aeration tanks. This type of control focuses on maintaining adequate DO levels in the aerobic section of the aeration tank.

The secondary process at the Fairfield WPCF consists of nine aeration tanks, eight of which are typically in service. Aeration Zone A consists of six tanks, while aeration Zone B consists of three. Each of the aeration tanks is equipped with an air flow meter, air flow control valve, and DO meter. Air to each of the tanks is provided by fine or coarse bubble diffusers and is controlled through the SCADA system. The air flow is varied to maintain a DO set point of approximately 2.0 mg/L. There two anoxic zones at the head of the aeration tanks provide denitrification. Supplemental carbon is used in the secondary treatment process, which is currently monitored with nitrogen analyzers.

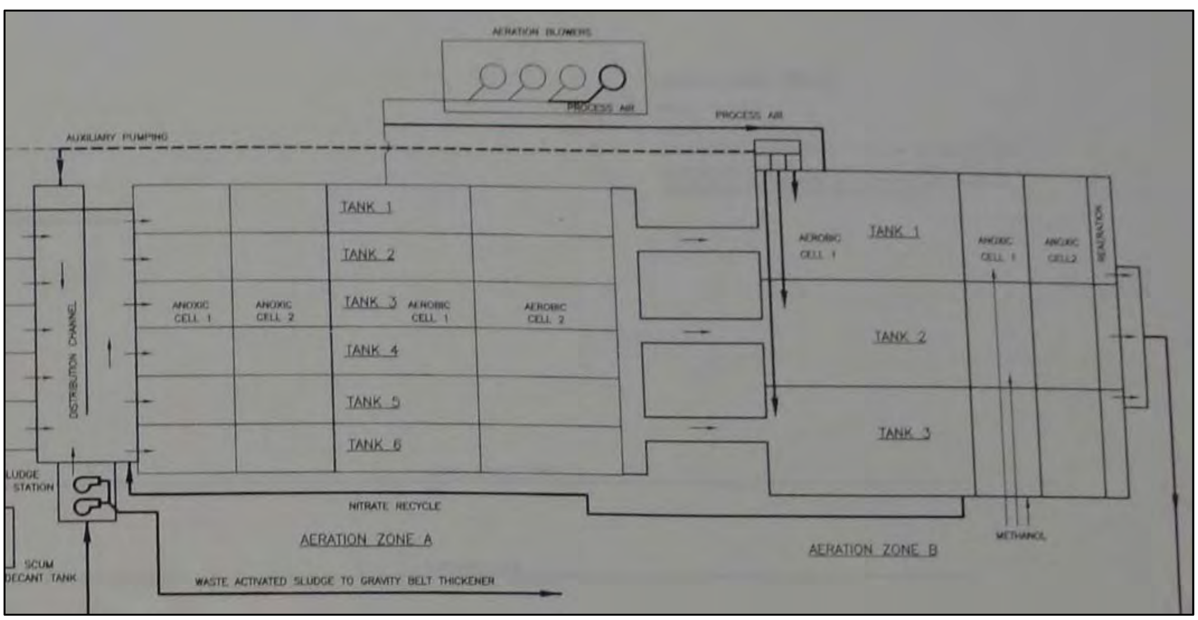
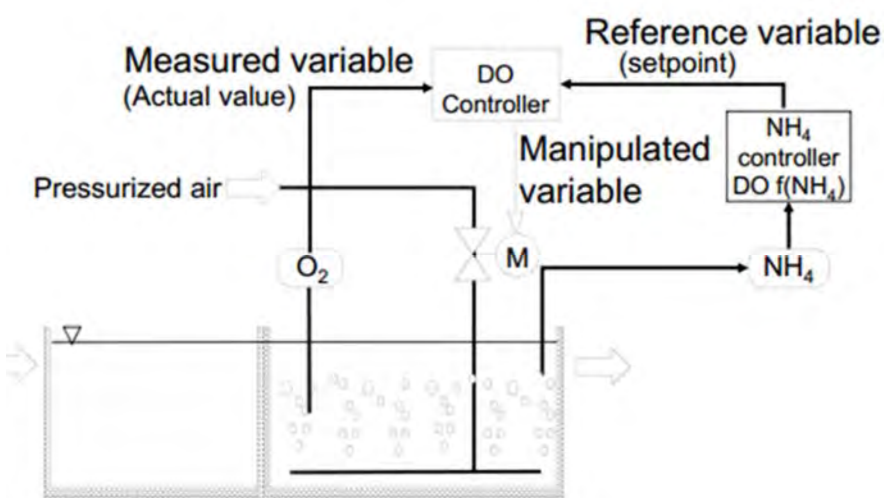


Figure 8. Fairfield WPCF Aeration Tanks Process Flow Diagram

There may be further opportunity to reduce excess aeration by incorporating the use of nutrient analyzers (ammonium and nitrate analyzers) as part of the aeration system control. Ammonia based control process strategies focus on optimizing the nitrification process, thus limiting aeration. In a DO controlled system, for example, aeration can continue to occur even after the ammonia in the wastewater is gone, thus resulting in over aeration of the process flow. By measuring ammonia, however, the amount of aeration would be varied according to the nitrification needs preventing over aeration. This strategy limits nitrification and optimizes the control of the aeration blowers, which results in reduced energy consumption. Case studies have shown a reduction in energy use of 10 to 20%.

There are several approaches to the integration of ammonium/nitrate analyzers into the existing DO control strategy. These strategies can be in the form of either feedback or feedforward control, or a combination.

In a feedback strategy with DO control, measurement of the ammonia levels would be made in the Zone B tanks and would be used to indicate whether full nitrification has occurred. The control strategy would be based on a comparison of the ammonium level measured in the tanks to the ammonium set point, which would be the basis for calculating and setting a DO set point. The DO levels measured in the tanks would trigger the control of the air flow to maintain the DO at the required set point. This strategy would allow for reduced DO set points, and air flow in the Zone B tanks. (If nitrification is complete or near complete, the biological process will not require oxic conditions, and denitrification can provide the final required conversion). This would also reduce any limitation of the denitrification process by increasing or ensuring anoxic conditions.



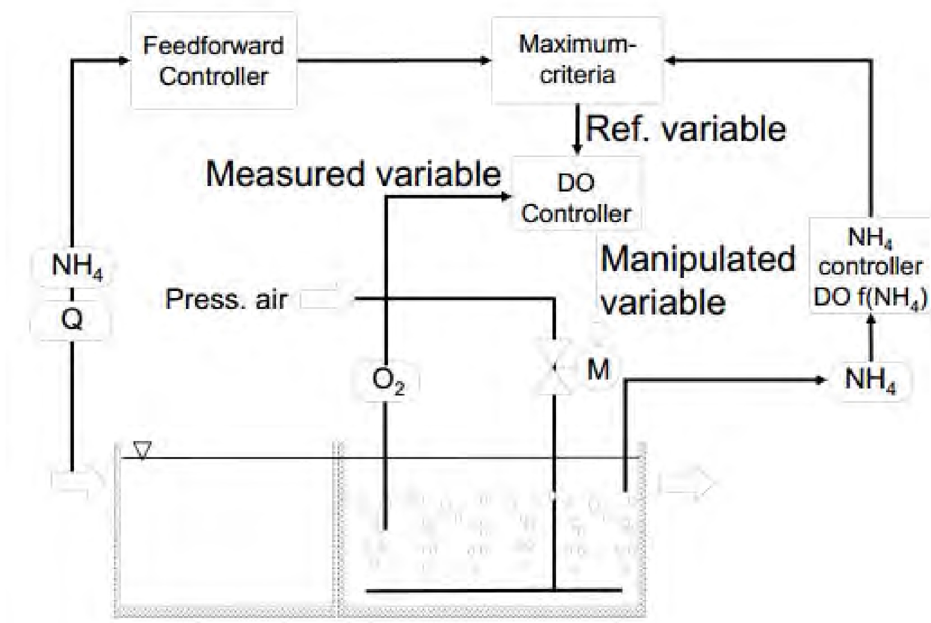
Source: Leiv Rieger, in CTRL Solutions Inc., Canada, “Low Energy Process Control.” January 23, 2013.

Figure 9. Feedback Control Diagram

Unlike the feedforward control strategy, this approach does not require the development of a process model as the system responds to the ammonium measurements toward the end of the tanks, thus incorporating the aeration system’s performance. This strategy is, therefore, simpler and requires fewer instruments. However, in highly dynamic systems, these types of control loops have a delayed reaction as peak loadings are not detected until the end of the process. Corrective measurements can be difficult to address without the use of swing zones to address ammonia peaks.

In a feedforward strategy that incorporates ammonium and DO, the aeration blower output would be controlled on the direct measurement of the ammonium in the influent/upstream to the aeration basins (Zone A). Blower output/airflow would be controlled to maintain an ammonium concentration set point in the aeration trains, thus controlling the nitrification process. If the ammonium concentration drops below the set point, the airflow would reflect the minimum requirements for mixing and/or could be based on a reduced DO concentration. This type of programming would vary the airflow according to the nitrification needs as based by a process model and the influent ammonium levels of the wastewater flow, while also responding rapidly to peaks in oxygen demand, which can be impacted by loading from recycle streams associated with solids handling processes. It should also be noted that this control system could address over aeration during high flow and low loading evens experienced during wet weather events.

The success of the feedforward strategy depends on the type of the aeration system and the sophistication of the process model that is incorporated in the control strategy. Case studies have shown that this control approach is more complex and requires additional inputs to account for safety factors associated with the use of a process model. To compensate for the limitations of the process model, the use of an ammonium sensor to measure levels in the effluent is often recommended (see figure below). With the additional sensor, the control strategy would receive feedback, enabling for corrections in the process model. The feedforward approach, however, works well in systems that are very dynamic, as process controls would have the ability to respond quickly to any disturbance measured by the upstream meter. This is particularly important if the process does not allow for the use of swing zones to address ammonia peaks.



Source: Leiv Rieger, in CTRL Solutions Inc., Canada, "Low Energy Process Control." January 23, 2013.

Figure 10. Feedback & Feedforward Control Diagram

The specific savings associated with this measure would require a more detailed study, which would include the following.

1. Determination of the base case or existing airflow requirements and blower energy usage through the collection of SCADA data and potentially the installation of data loggers on the blowers to monitor energy use (for a period of several weeks);
2. Temporary (or permanent) installation of several combination ammonium/nitrate analyzers at the selected locations in the aeration tanks;
3. Development of the control loop for integrating the ammonium and nitrate levels into the process control strategy. The development of the programming/control strategy can be done by working with the facility's systems integrator and the existing SCADA system, or by utilizing a vendor's specific/proprietary software/control strategy;
4. Optimization of the set points and control loops to determine adequate operating points;
5. Monitoring of airflow, blower kW, and effluent wastewater characteristics to determine the effectiveness of the technology, and to quantify savings; and
6. Benchmark and quantify performance, energy usage, and effluent quality.

Reduction of airflow requirements would reduce the energy usage of the blowers, and may allow for the smaller, 150 hp unit to operate more frequently.

Calculations

Although quantifying the savings associated with this measure would require detailed modeling and/or pilot testing, simplified calculations are included below in order to provide a conservative estimate of the of the potential savings.

The current energy usage of the blowers is estimated based on field readings and a conservative assumption that the hours of operation are split evenly between the 150 hp and 300 hp blowers. (The 300 hp blower curve was also used in developing this estimate, and these curves are highly dependent on specific temperature and humidity conditions, which provide blower performance at very specific conditions).

The estimated base case electrical consumption is presented in the following table.

Table 43. Existing Energy Use

Blower	kW[1]	No. in Operation	Hrs/yr[2]	kWh/yr
150 HP	80	1	4,380	350,400
300 HP	140	1	4,380	613,200
			Total	963,600

Notes:
1) 150Hp Based on field readings at airflow of ~3,000 scfm; 300Hp based on blower curve and air flow of ~4,500 scfm
2) Hours based on at least one blower operating continuously.

A conservative and achievable savings associated with this time of optimization or fine tuning of the aeration/DO control can be estimated to be 10%. The facility staff has previously implemented considerable energy savings associated with the aeration and secondary treatment system. This additional instrumentation and control can be expected to further reduce the blower energy usage (as well as optimize process control).

Table 44. Energy Use & Savings

Condition	kWh/yr	Cost/yr
Existing Conditions	963,600	$118,523
Savings - 10%	96,360	$11,852

Note: Costs based on a blended rate of $0.123/kWh.

Budgetary Cost Estimate

Budgetary costs for ammonia/nitrate instrumentation, installation, and potential pilot study/data collection effort are estimated below. Please note that this cost estimate was developed based on the cost for implementing and quantifying the results of a pilot study. However, the installation of the pilot study would reduce the capital investment for a full-scale installation. In addition, the plant currently has some ammonia analyzers in place for monitoring carbon addition.

Table 45. Project Cost Estimate

Item	Quantity	Cost	Total
Analyzers	9	$9,500	$85,500
Controllers	9	$2,000	$18,000
Installation and wiring	1	$50,000	$50,000
Systems integration & SCADA	1	$15,000	$15,000
Pilot Study & Evaluation	1	$15,000	$15,000
Subtotal	--	--	$183,500
Contingency (10%)	--	--	$18,350
Total Capital Cost			$201,850

Summary of Cost and Savings

The following table presents the calculated savings and payback based on the savings and budgetary cost information presented above.

Table 46. Savings & Payback

Annual Reduction (kWh)	96,360
Billing Rate	$0.123
Annual Savings	$11,852
Project Cost	$201,850
Simple Payback	**17.0**

Incentive

It is anticipated that this project would be eligible for incentive through UI's Custom Measure program. The payback period presented above is calculated prior to any available incentives through UI, and these incentives would be expected to reduce the payback period. The incentive would be based on the current program cap of $0.35 per annual kWh saved or up to 40% of the project cost (the lesser of). As discussed above, the pilot study would allow for real time quantification of the achievable savings.

ECM #7 – Re-aeration System Optimization

Description

The facility's aeration system includes three post aeration zones that are equipped with course bubble diffusers. Air is delivered to these zones to increase the dissolved oxygen levels, to maintain the material in suspension, and to provide mixing. Air flow to these basins, however, is not monitored. It is suspected that the basins are receiving excess air, a condition that is resulting in excess energy use. It may be feasible to optimize the delivery of air to these basins, which would result in energy savings.

Calculations

Air to the re-aeration zones is supplied by the aeration blowers. The air to these zones increases the dissolved oxygen level in the flow and provides adequate mixing. Therefore, the air flow requirements are dependent on the water quality and characteristics in these zones (which will vary with diurnal, seasonal, and monthly influent conditions) and on the flow.

These re-aeration zones have an area of approximately 200 sq. ft. each. At a typical aerated mixing requirement of 0.12 cfm/sq. ft., the amount of air required for mixing in each zone is approximately 25 cfm, for a total of 75 cfm for all three zones. This value reflects the minimum air flow requirement for mixing, therefore, the actual mixing and aeration requirements are higher.

Assuming a conservative estimate of the excess air quantity currently being supplied to these three zones, and utilizing the typical airflow per kW of the 300 hp blowers, the potential energy savings associated with optimizing the air flow control to the reaeration zones was calculated and presented in the following table.

Table 47. Energy Use & Savings

	300 hp Blower	150 hp blower
Typical blower energy usage (cfm/kW)[1]	41.6	36.9
Excess air currently applied (cfm)[2]	100	100
Energy Required to provide excess air (kW)	2.4	2.7
Operating hours per year[3]	4,380	4,380
Annual Energy Savings (kWh/yr)	10,539	11,870
Annual Cost Savings	$1,296	$1,460
Total Annual Cost Savings	**$2,756**	

Notes:
1) Based on field data.
2) Assumed value.
3) Assumed the 150 hp and 300 hp blower each run half the time.
4) Cost based on $0.123/kWh.

Options for improving the air flow control to the reaeration basins includes potentially installing an actuator on the butterfly valve at each zone drop leg and a DO meter in each zone to allow for automated DO control. The valves at each drop leg could also be manually adjusted to and/or air flow meters could be installed at each tank for monitoring of the actual airflow into these zones.

Budgetary Cost Estimate

For the purpose of this evaluation the budgetary cost of a potential upgrade to the air flow control in the reaeration/post aeration zones estimated below. This cost would need to be further developed during a more detailed study, and quotes for both the instrumentation and systems/SCADA integration would be obtained.

Table 48. Project Cost Estimate

Item	Total
Instrumentation	$35,000
Programming & SCADA	$5,000
Subtotal	$40,000
Contingency (10%)	$4,000
Total Capital Cost	$44,000

Summary of Cost and Savings

The following table presents the estimated savings and payback based on the savings and cost estimate presented above.

Table 49. Savings & Payback

Annual Reduction (kWh)	22,408
Billing Rate	$0.123
Annual Savings	$2,756
Project Cost	$44,000
Simple Payback	**16.0**

Incentive

It is anticipated that this project would be eligible for incentive through UI's Custom Measure program. The payback period presented above represent is calculated prior to any available incentives through UI, and these incentives would be expected to reduce the payback period. The incentive would be based on the current program cap of $0.35 per annual kWh saved or up to 40% of the project cost (the lesser of). An additional study on this measure could include temporary

DO metering in the reaeration zones to determine if adequate air is currently provided, as well as obtaining cost quotes for the required instrumentation.

ECM #8 – UV System Replacement

Description

The Fairfield WPCF is required to disinfect final effluent year-round prior to discharge based on its NPDES permit. The disinfection process consists of a Trojan 4000 UV system that was installed as part of the 2003 upgrades and operates continuously. The system consists of two banks of UV bulbs (36 lamps each), which are controlled via flow pacing of the effluent flow. Since the installation of the system in 2003, the control technology of these types of disinfection systems and the UV bulbs themselves have significantly improved, particularly relating to the UV transmittance monitoring and controls hardware and software. As part of the facility plan, the proposed design is to replace the existing system with a new system that consumes less energy.

Calculations

Field testing of both of the UV banks was conducted during the site visit in order to obtain spot readings of the electrical power usage. The system has one bank that is automatically controlled to maintain adequate dosing under varying flow and effluent quality conditions, while the other bank is consistently operating in hand at 100%. This method of operation was established to maintain the target dose of 55%, which represents adequate disinfection for this facility based on experience. The electrical energy usage varies under diurnal, seasonal, and monthly conditions, however, it is assumed that the readings collected at the time of the site visit represent typical operation.

The estimated base case electrical consumption is presented in the following table.

Table 50. Existing Energy Use

UV Bank	kW[1]	Hrs/yr[2]	kWh/yr	Cost/yr[3]
1A	101.5	8,760	889,140	$109,364
1B	81.1	8,760	710,436	$87,384
Total	182.6	--	1,599,576	$196,748

Notes:
1) Based on field readings, 100% operation for 1A and 81% operation for 1B, assumed to represent typical operation.
2) Both units in operation continuously.
3) Based on an estimated blended rate of $0.123/kWh

During the site visit the following information was recorded, which represents a snapshot of the typical operation (as noted above some parameters are changed either manually or with the variable flow rate).

- Bank 1A (lead bank): 100% power
- Bank 1B: 81% power
- Intensity = 100.6 mW/cm^2 (1A)
- Intensity = 100.6 mW/cm^2 (1B)
- UV dose = 41.06 mw sec/cm^2
- UV transmittance = 55%
- Detention time = 0.56 sec
- UV dose = 62.15 mW*sec/cm^2
- UV dose at full output = 124.0 mW/cm^2

The proposed replacement UV system recommended for installation by Wright-Pierce in the Facility Plan is a Trojan Signa UV disinfection system. The proposed design is for a maximum flow of 33 MGD and an average flow of 8.5 MGD. The design represents a minimum UV transmittance of 65% and a disinfection limit of 88 fecal coliforms per 100 milliliter (mL) and 35 enterococci per 100 mL. The proposed system would be installed in the existing UV channel with five banks of 22 lamps per bank for a total of 110 UV lamps. Installation will require an additional channel for the new UV banks.

Based on manufacturer data, this system is designed for large wastewater applications (over 22 MGD), the UV lamps are installed at an angle and are staggered to reduce the number of lamps in the installation and provide maximum disinfection contact time. The lamps are also designed to consume a minimal amount of energy with the Trojan solo lamp based on the ability to turn down, and off, based on the wastewater characteristics and flows. Based on the manufacturer data, the system designed for the Fairfield WPCF will consume an average of 28.4 kW (max output of 115.8 kW) at 8.5 MGD. Please find the attached manufacturer data in Appendix B for the calculated energy use data. The following table presents the operating conditions at the time of the site visit in addition to the manufacturer provided operating data for comparison.

Table 51. UV Operation Data

Parameter	Existing Trojan	Proposed TrojanSigna
Flow Rate (MGD)	8.4 MGD	8.5 MGD
UV Transmittance (%)	55%	65%
Energy Use (kW)	183	28.4

The UV Transmittance (UVT) is the measure of the ability for ultraviolet frequency light to pass through the water. A higher UVT indicates that it is easier for the UV light to pass through the water, therefore, disinfection is easier. Based on the data presented above, the proposed system energy calculations are based on a lower level of disinfection than the existing system (65% UVT verses 55% UVT). This would suggest that the proposed system may use more energy than presented by the manufacturer. To remain conservative, the energy use for the proposed system has been increased to 35 kW based on the UVT.

The following table presents the proposed energy use for the Trojan Signa system.

Table 52. Proposed Energy Use

UV Bank	kW[1]	Hrs/yr[2]	kWh/yr	Cost/yr[3]
Proposed UV System	35.0	8,760	306,600	$37,712

Notes:
1) Based on manufacturer data.
2) Based on an estimated blended rate of $0.123/kWh

The following table presents the energy savings from the existing and proposed UV systems.

Table 53. Energy Use & Savings

Condition	kW	kWh/yr	Cost/yr
Existing	182.6	1,599,576	$196,748
Proposed	35.0	306,600	$37,712
Savings	--	1,292,976	$159,036

Notes:
1) Cost is based on $0.123 per kWh.

Budgetary Cost Estimate

The budgetary cost estimate to install the new UV system is presented in the following table. Installation will require an additional channel for the five UV banks. A 50% contingency was used to address this installation. The UV system cost estimate was provided by the manufacturer.

Table 54. Project Cost Estimate

Item	Total
Trojan Signa UV System	$783,150
Electrical & Wiring (10%)	$78,315
Systems integration/SCADA (5%)	$39,158
Subtotal	$900,623
Installation & Contingency (50%)	$450,311
Total Capital Cost	$1,350,934

Summary of Cost and Savings

The following table presents the energy savings and payback based on the calculations presented above.

Table 55. Energy Savings & Payback

Annual Reduction (kWh)	1,292,976
Billing Rate	$0.123
Annual Savings	$159,036
Project Cost	$1,350,934
Simple Payback	**8.5**

Incentive

It is anticipated that this project would be eligible for incentive through UI's Custom Measure program. The payback period presented above is calculated prior to any available incentives through UI, these incentives would be expected to reduce the payback period. The incentive would be based on the current program cap of up to $0.35 per annual kWh saved or up to 40% of the project cost (the lesser of).

ECM #9 – Sludge Recirculation Pump Replacement

Description

The sludge in the primary digester is heated and recirculated with centrifugal recirculation pumps. These units circulate the sludge through the heat exchanger. Due to the high solids material being pumped and their continuous operation, these pumps most likely experience significant wear and may not be operating at their best efficiency point.

Under current conditions, one of the 10 hp sludge recirculation pumps (Hayward Gordon, belt drive centrifugal) operates continuously at constant speed to circulate sludge from the bottom of the digester through the heat exchanger and back into the top of the digester.

Based on field readings, the following annual energy use calculations were determined.

Table 56. Existing Energy Use

Pump	kW[1]	Hrs/yr	kWh/ Yr	Cost/yr[3]
Recirculation Pump	3.7	8,760	32,500	$3,997

Notes:
1) Based on field measurements.
2) Cost based on $0.123/kWh.

If the pump were to be replaced with a more efficient pump, the cost of annual operation would be lower. The following table presents a more efficient pump for installation based on field readings and a higher pump efficiency. It should be noted that the design conditions should be checked prior to selection and installation of the new pump. They are based on estimated of flow and head.

Table 57. Proposed Energy Use

Flow (gpm) [1]	Total Dynamic Head (ft)[1]	Estimated Pump Eff.[2]	Estimated Motor Eff. [3]	Calculated Energy Draw (kW)	Annual Operating Hours	Annual Energy Use (kWh)	Annual Cost
350	25.0	0.70	0.91	2.6	8,760	22,668	$2,788

Notes:
1) Estimated existing operating point.
2) Estimated new pump efficiency.
3) Estimated new motor efficiency.

The following table presents the potential energy and cost savings associated with replacing the pumps.

Table 58. Proposed Energy Use & Savings

Condition	kWh/yr	Cost/yr
Existing	32,500	$3,997
Proposed	22,668	$2,788
Savings	9,831	$1,209

The following table presents the capital cost of installing two new sludge recirculation pumps.

Table 59. Proposed Capital Cost

Item	Total
New Pump	$24,000
Installation	$5,000
Total Capital Cost	$29,000

The following table presents the proposed savings and payback period for installing two new sludge recirculation pumps.

Table 60. Savings & Payback

Annual Reduction (kWh)	9,831
Billing Rate	$0.123
Annual Savings	$1,209
Project Cost	$29,000
Simple Payback	**24.0**

Incentive

Replacing the existing pump with more efficient pumps may be eligible for incentives through the UI custom measure program.

ECM #10 – Digested Sludge Dewatering Replacement

Description

The current solids treatment process takes WAS from secondary clarification and thickens it using the existing Gravity Belt Thickener (GBT). Following thickening, the sludge is sent to the anaerobic digesters. After digestion, the sludge is sent to the Belt Filter Press (BFP) to remove more liquid and increase the percent solids of the cake produced. The cake produced from the BFP is then composted on-site.

The two digesters operate in a primary/secondary configuration. The primary digester has a fixed cover, is continuously mixed with an IDI cannon bubble mixer, and is heated using digester gas with a spiral sludge heat exchange. The secondary digester has a floating cover and currently does not contain heating or mixing. The primary digester is mixed continuously. Excess gas is burned through the flare system.

The current mixing system in the primary digester has had significant and on-going operational issues, which has caused excessive foaming in the digesters. In addition, the foam and general operation prevent the digesters from producing the optimal amount of biogas.

Wright-Pierce is currently exploring alternatives for treating the solids stream including replacing the BFP with a Centrifuge or Screw Press, which would increase the cake solids. Higher solids cake would increase the efficiency of the existing composting process. Alternatives to modify the existing digesters are also being evaluated to increase efficiency of the digesters and increase biogas production. More biogas could result in opportunities for cogeneration and energy production. A better digested product could also reduce the amount of energy used to further thicken the cake prior to composting.

The existing BFP has the following mechanical components:

- Belt Motor – 3 HP
- Washwater Booster Pump – 5 HP
- Polymer Feed System – 0.75 HP
- Conveyor – 5 HP

Calculations

The total for the existing BFP is 13.75 hp. The current operation of the BFP is approximately 6 hours per day during week days and 4 hours per day on weekend days. The current energy consumption based on the motor sizes and approximate hours of operation is presented in the following table.

Table 61. Existing BFP Energy Use

Equipment	kW[1]	Hrs/yr[2]	kWh/yr	Cost/yr[3]
Existing BFP	10.3	1,976	20,269	$2,493

Notes:
1) Energy use is based on motor sizes.
2) Operate 6 hrs/day on weekdays and 4 hours per day on weekends.
3) Based on an estimated blended rate of $0.123/kWh

The alternatives being evaluated to replace the BFP are a centrifuge and a screw press. Wright Pierce has obtained design information and proposals for these alternatives, which are presented below. For the purposes of these calculations, it is assumed that the operating hours would be the same for either process. There may be some differences in operating hours based on the solids produced by either process, however, these are considered minimal.

Screw Press

- Screw Motor – 3 HP
- Polymer Feed System – 1 HP
- Total = 4 HP

Table 62. Screw Press Energy Use

Equipment	kW[1]	Hrs/yr[2]	kWh/yr	Cost/yr[3]
Screw Press	3.0	1,976	5,896	$725

Notes:
1) Energy use is based on motor sizes.
2) Operate 6 hrs/day on weekdays and 4 hours per day on weekends.
3) Based on an estimated blended rate of $0.123/kWh

Centrifuge

- Centrifuge Motor – 50 HP
- Total = 50 HP

Table 63. Centrifuge Energy Use

Equipment	kW[1]	Hrs/yr[2]	kWh/yr	Cost/yr[3]
Centrifuge	37.3	1,976	73,705	$9,066

Notes:
1) Energy use is based on motor sizes.
2) Operate 6 hrs/day on weekdays and 4 hours per day on weekends.
3) Based on an estimated blended rate of $0.123/kWh

The following table presents the energy use calculated above for each process.

Table 64. Sludge Processing Alternative Energy Use Analysis

Equipment	Annual Energy Use (kWh/yr)	Annual Energy Cost ($/year)
BFP	27,170	$3,342
Screw Press	5,896	$725
Centrifuge	73,705	$9,066

Notes:
1) Based on an estimated blended rate of $0.123/kWh

Based on energy consumption, the Screw Press alternative would consume the least amount of energy based on motor size. The following table presents the energy use and savings for both alternatives.

Table 65. Energy Use & Savings

Condition	kWh/yr	Cost/yr
Existing BFP	20,269	$2,493
Proposed Screw Press	5,896	$725
Savings	**14,372**	**$1,768**
Proposed Centrifuge	73,705	$9,066
Savings	**(53,436)**	**-$6,573**

Notes:
1) Based on an estimated blended rate of $0.123/kWh.

Based on the table above, the energy consumption of the centrifuge system consumes more energy than the existing BFP.

Budgetary Cost Estimate

The following table presents the estimated project costs for both dewatering technologies. This cost estimate assumes that the current method used to transport the digester sludge to the BFP then to the composting facility would also be utilized for the other process alternatives.

Table 66. Budgetary Cost Estimate

Item	Screw Press	Centrifuge
Proposed Equipment	$225,000	$349,750
Installation	$20,000	$20,000
Subtotal	$245,000	$369,750
Contingency (50%)	$122,500	$184,875
Total Capital Cost	**$367,500**	**$554,625**

Note:
1) Equipment Costs are provided by manufacturer proposals.

As presented in the tables above, there are limited energy savings with the Screw Press alternative. Based on the cost of this equipment, it may not be economically feasible to replace this system based on energy savings alone.

ECM #11 – Plant Water System Replacement

Description

The plant water system consists of three pumps that supply water to the influent building, the solids handling processes, the spray water systems of various unit processes, hydrants, and hose bibs located throughout the Fairfield WPCF. The smaller, 7.5 hp pump is designed to discharge 90 gpm at a TDH of 152 feet. The two, 20 hp, larger units are designed to discharge a high capacity flow of 287 gpm and a TDH of 152 feet. Based on discussion with the operators, typical operation during the summer months is for all three pumps to be in operation; during the winter months the two larger pumps are typically in operation. During low flow demand, the hydro-pneumatic tank is used to meet the process water needs. As the demand increases, the pumps are used to meet the demand based on pressure reducing valve (PRV) control.

Typically, the two large pumps are in service and the flow is regulated by throttling the pressure reducing valves. Flow readings and suction pressures were not available for the system. It was assumed that the electrical readings collected during the site visit represent typical operation.

Calculations

The electrical consumption presented below is based on field collection data. During the visit, one large and one small pump were in operation because the additional larger pump was not currently functional.

Table 67. Energy Use – 1 Large Pump

Condition	kW
1 Large Pump	7.90

Notes:
1) kW based on pump size.

Table 68. Energy Use – 1 Large Pump & 1 Small Pump

Condition	kW
1 Large & 1 Small Pump	10.70

Notes:
1) kW based on field testing.

Based on design data from the plant operation and maintenance manual, the pumps operate at the following conditions.

Table 69. PWS Operation & Maintenance Data

	Flow (gpm)		TDH (ft)	
	Average	Range	Average	Range
Small Pump (7.5 HP)	75	40 - 90	173	152 - 196
Large Pumps (20 HP)	225	180 - 287	173	152 - 182

Assuming that the PWS operates during the summer months with all three pumps and during the winter with one small and one large pump, the following table presents the existing energy use. Note that it is assumed that the pumps operate in this scenario for 16 hours per day and do not operate overnight.

Table 70. Existing Energy Use

Condition	kW	Hrs/ yr	kWh/ yr	Cost/yr
Summer Operation - 3 Pumps	18.60	1,920	35,712	$ 4,393
Winter Operation - 2 Large Pumps	15.80	3,840	60,672	$ 7,463
Overnight & Low Flow Operation - 1 Large Pump	7.90	3,000	23,700	$ 2,915
Total	34.40	8,760	120,084	$ 14,770

Notes:
1) kW based on field readings.
2) Cost based on $0.123/kWh.

By replacing the existing system with a system designed for the existing hydraulic conditions and flow demand along with the installation of VFDs to control the flow, the pumps would discharge less flow and the excess headloss from the pressure reducing valves would be eliminated resulting in more efficient operation. These improvements would result in energy savings.

The flow demand was calculated based on the existing operation to determine the required flow of the proposed PWS. Based on the current flow scenarios, there are two large pumps operating during the winter months (450 gpm) and all three pumps operating during the summer months (525 gpm). The proposed operating hours for the new system is based on these flow rates and operating hours. The proposed system is assumed to operate two pumps at full speed during the winter months and two at full and one at reduced speed for the summer months.

The following table presents the energy calculations for a PWS with the previously presented flows at 70 psi controlled with VFDs.

Table 71. Proposed Energy Use

Condition	Flow per Pump (gpm)	TDH (ft)	Pump Eff.	Total kW	Hrs/ Yr	Total kWh/ yr	Cost/yr
Summer Operation	525	161.7	75%	24.2	1,920	46,381	$5,705
Winter Operation	450	161.7	75%	20.7	3,840	79,510	$9,780
Overnight & Low Flow Operation	225	161.7	75%	10.4	3,000	31,059	$3,820
Total					8,760	156,950	$19,305

Notes:
1) Flow, head and efficiency based on proposed pumps.
2) kW includes a 91% motor efficiency.
3) Hours of operation adjusted based on the required demand.
4) Cost based on $0.123/kWh.

As can be seen in the tables above, the proposed PWS consumes more energy than the existing system based on flow rates. The field measurements for the PWS are lower than expected. It is also possible that this system is producing less flow than anticipated. Accurate flow measurements or calculated demand for the PWS should be calculated to determine the required system use.

Budgetary Cost Estimate

The following table presents the budgetary cost estimate including controls, installation and electrical connection.

Table 72. Budgetary Cost Estimate

Item	Total
Pump Skid System	$38,900
Installation	$10,000
Subtotal	$48,900
Contingency (50%)	$24,450
Total Capital Cost	$73,350

Based on the proposed system, there may not be significant energy savings. There is a potential that the method of control is able to reduce energy consumption of the exiting system. Further investigation is recommended to determine the existing energy use and energy use of the proposed system.

ECM #12. WAS Pump Replacement

Description

There are currently two 7.5 hp submersible WAS pumps that operate on timers to waste sludge from the primary settling tanks. The proposed design through the facility plan is to replace these pumps with centrifugal pumps at a different location in the process. Currently, these pumps are located in a tank adjacent to the primary clarifiers and the facility plan proposes to relocated these pumps across the street to the Return Sludge Building with the RAS and Outfall Pumps. The relocation of these pumps will change the hydraulic conditions for these pumps.

The pumps currently operate on VFDs to maintain flow to the Gravity Belt Thickeners (GBTs) for approximately 6 hours per day for 5 days per week. The WAS pumps send flow directly to the GBTs, therefore, they only operate when the GBT operates.

Calculations

The current electrical consumption of the WAS pumps is presented in the following table.

Table 73. Existing Energy Use

Pump	kW[1]	Hrs/yr	kWh/ Yr	Cost/yr[3]
WAS Pump	5.0	1,976	9,939	$1,223

Notes:
1) Based on field testing at 95% speed, assumed to represent typical operation.
2) Hours of operation are based on 6 hours per day for 5 days per week.
3) Cost based on $0.123/kWh.

The current WAS pumps are submersible pumps, which do not require premium efficiency motors under current regulations in the United States. Submersible pumps can have premium efficient motors, however, since this is typically at an increased cost, these pumps most often do not have them installed. Premium efficiency is a certification provided through National Electrical Manufacturers Association (NEMA) indicating the motor meets the minimum efficiency requirements for that size motor. There are other similar certifications, such as the International Electrotechnical Commission (IEC) for premium efficiency motors (IE3). Current regulations for water and wastewater submersible pump motors do not require high efficiency motors, therefore, it is possible to purchase a motor that is less efficient with the potential to increase electrical costs.

The proposed design of the WAS pumps is a capacity of 450 gpm at 30 feet of TDH. Based on this and the estimated motor efficiency and pump efficiency, the energy use is presented in the following table.

Table 74. Proposed Energy Use

Flow (gpm) [1]	Pressure (ft)[1]	Pump Eff.[2]	Motor Eff. [3]	kW	Hrs/yr	kWh/ Yr	Cost/yr
450	30.0	75%	91%	3.7	1,976	7,363	$906

Notes:
1) Estimated existing operating points.
2) Estimated new pump efficiency.
3) Estimated new motor efficiency.
4) Cost is based on $0.123 per kWh.

The following table presents the existing and proposed energy use from the WAS pumps.

Table 75. Energy Savings & Cost

Condition	kWh/yr	Cost/yr
Existing	9,939	$1,223
Proposed	7,363	$906
Savings	2,576	$317

Notes:
1) Savings based on $0.123/kWh.

Budgetary Cost Estimate

The proposed replacement pumps cost is presented in the following table.

Table 76. Project Cost

Item	Total
New Pumps	$30,000
Contingency (20%)	$6,000
Subtotal	$30,000
Total Capital Cost	$36,000

The estimated payback period for replacing these pumps may not be economically feasible based on the limited annual savings. However, if the pumps are replaced, the incremental cost increase for a more efficient motor can be considered eligible under the UI incentives program.

ECM #13. Demand Reduction

Description

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.

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.

Calculations

Based on the current rate structure at the plant, demand charge is billed for on and off peak hour operation and the time of year (seasonal). Currently, the Transmission demand charge during on-peak hours in the summer (June through September) is $8.71 per kW and $6.97 during the remaining months. The off-peak Transmission demand charge during these times is currently $0.00 per kW. The Distribution demand during the summer and winter months is $3.64 per kW consistently. The following table presents the averages and ranges of demand for 2015 to demonstrate the potential savings that could be achievable if demand was altered to off-peak hours and the difference in summer and winter operation.

Table 77. Historical Demand Charge

Demand Period	Average Billed Demand (kW) per Month	Demand Cost ($/kW)	Cost per Month
Winter 2015	667.6	$10.61	$7,083.24
Summer 2015	772.1	$12.35	$9,535.44

Notes:
1) Demand costs are based on the current demand rate for 2016.

Based on this data, it may be feasible to reduce demand during the on-peak hours to reduce overall energy costs. The Transmission demand is $0.00 during off-peak hours in the summer and winter. Based on the 2015 numbers, the WPCF is paying $7,083 during the eight (8) winter months and $9,535 during the remaining four summer months. On an annual basis, this is a total of over $29,000. It should be noted that the summer verses winter demand may not consistently be higher during the summer months. There may be an opportunity to reduce the demand during on-peak hours to lessen the annual cost of 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.

As previously discussed under OM #2, solids processing could be changed from on-peak hours during the staffed weekday hours to after hours or weekends to reduce over $12,000 on an annual basis through demand reduction.

ECM #14. Heating Ventilation and Air Conditioning (HVAC)

Description

The current HVAC systems throughout the plant are mostly natural gas powered. With the facility plan, there may be the addition of air conditioning units in some of the electrical rooms, which house MCCs. During the full-scale design, consideration should be given to the Seasonal Energy Efficiency Ratio (SEER). As of 2017, there is an HVAC system rebate through United Illuminating referred to as the Cool Choice Rebate for Commercial and Industrial Customers. This rebate is prescriptive, meaning it has a set monetary rebate value depending on the size and type of system installed. The rebate is given to systems with a minimum qualifying SEER or EER, therefore, it may be beneficial to require the minimum SEER and EER in the plans and specifications. The requirements and prescriptive incentives available may be found on the Energize CT CoolChoice Application.

Based on the design currently proposed by Wright-Pierce, the following HVAC systems are being considered for upgrade through the plant.

- Automatic Temperature Control System is being recommended for replacement. There are currently two control systems that are going to be integrated into a single integrated system that effectively reduces energy use through temperature controls.
- New energy efficient split ductless air conditioning systems are proposed for each electrical room at the plant.
- The two boilers at the plant are being replaced with new energy efficient models that can be fueled with natural gas or biogas.
- New Make-up Air Units (MAU) will also be installed in the compost building.

At the time of construction, the current requirements for incentives should be consulted for potential rebates. The temperature controls, split ductless air conditioning system, and the energy efficient boilers may be eligible for prescriptive rebates through the Cool Choice program.

ECM #15. Lighting

Description

United Illuminating (UI) currently provides a Prescriptive rebate program for all types of high-efficiency retrofit fixtures, on a per-unit basis. Additionally, any retrofit and new construction lighting programs may be incentivized by UI's Custom incentive program based on kilowatt hours (kWh) saved. These programs also include funding for the installation of occupancy sensors or astronomical timers.

Typical conversions of lighting at wastewater treatment facilities includes replacing existing florescent lamps, ballasts and fixtures with higher efficiency models. The existing florescent lamps, ballasts and fixtures could be replaced with T5 and T8 models, which are considered High Performance and Reduced Wattage (HP/RW). The Consortium for Energy Efficiency (CEE) provides a list of lamps, ballasts and fixtures that are considered HP/RW along with corresponding manufacturer makes and models. The CEE website list may be found with the following link, www.cee1.org.

Significant energy efficiency and increased lifespan may also be achieved through installing Light-Emitting Diodes (LEDs) to replace existing fixtures and lamps. The Design Lights Consortium (DLC) provides a list of energy efficiency alternatives for linear retrofit tube kits available at their website www.designlights.org. In addition, Energy Star rated LEDs are most likely incentivized through the UI programs. The intended lighting upgrades at the plant include replacing existing lighting fixtures with LEDs.

Exterior lights also have the potential to be replaced with more energy efficient options. These are also listed on the Design Light Consortium website, mentioned above.

Additional energy reduction measures may include occupancy sensors (remote or wall mounted), daylight sensors, and dimming controls. There are fixtures installed on the exterior corners of each building which operate at night, and would be good candidates for LED replacement.

ATTACHMENT A

Rate Structure

The United Illuminating Company

General Service Time-of- Day Rate GST

Applies throughout the Company's Service Area.

Availability:

Service under this rate is optional for all requirements on a Customer's Premises, subject to the availability and installation of metering equipment.

Character of Service:

Service is alternating current, nominally 60 cycles, single or three phase at one standard secondary voltage as determined in accordance with the Company's Requirements for Electric Service.

Service will be delivered at one point through a single meter. When the Company elects to meter the service at primary voltage the kilowatt-hours metered will be reduced by 3% for billing purposes.

Rate Per Month:

Generation Charges

January - June	**On-Peak**	**Off-Peak**
Standard Service Generation	12.1890¢/kWhr	9.1890¢/kWhr
Bypassable FMCC	(0.0615)¢/kWhr	(0.0615)¢/kWhr

Delivery Charges

Systems Benefits Charge (SBC)**	0.4762¢/kWhr
Conservation Charge**	0.6000¢/kWhr
Renewable Energy Charge**	0.1000¢/kWhr

Non-Bypassable FMCC* (Non Demand)

		On-Peak	**Off-Peak**
Winter:	Jan. – May	0.0000¢/kWhr	0.0000¢/kWhr
	Oct. – Dec.	0.0000¢/kWhr	0.0000¢/kWhr
Summer	June – Sept.	0.0000¢/kWhr	0.0000¢/kWhr

Non-Bypassable FMCC*(Demand)

		On- Peak	Off-Peak
Winter:	Jan. – May	$ 0.00/kW	0.0000¢/kW
	Oct. – Dec.	$ 0.00/kW	0.0000¢/kW
Summer:	June – Sept.	$ 0.00/kW	0.0000¢/kW

* Federally Mandated Congestion Costs
** On bills these items are combined and labeled "Combined Public Benefits Charge".

Transmission Charge (Non Demand)

		On- Peak	Off-Peak
Winter:	Jan. – May	6.0172¢/kWhr	0.0000¢/kWhr
	Oct. – Dec.	6.0172¢/kWhr	0.0000¢/kWhr
Summer:	June – Sept.	7.5215¢/kWhr	0.0000¢/kWhr

Transmission Charge (Demand)

		On-Peak	Off-Peak
Winter:	Jan. – May	$ 6.97/kW	$0.00/kW
	Oct. – Dec.	$ 6.97/kW	$0.00/kW
Summer:	June – Sept.	$ 8.71/kW	$0.00/kW

Distribution Charges:

Where Demand is not billed:

Basic Service Charge: $ 30.95

Charge per Kilowatt-hour:

Summer: June - Sept.

On-Peak Hours 1.8001¢

Off-Peak Hours 1.8001¢

Winter: Oct. - May

On-Peak Hours	1.8001¢
Off-Peak Hours	1.8001¢

Where Demand is billed:

Basic Service Charge:	$ 83.53

Summer: June – Sept.

Demand Charge:	
On-peak hours	$ 3.64 per kilowatt
Off-peak hours	$ 3.64 per kilowatt of Excess kW
Charge per Kilowatt-hour:	
On-peak hours	1.9796¢
Off-peak hours	1.9796¢

Winter: Oct. – May

Demand Charge:	
On-peak hours	$ 3.64 per kilowatt
Off-peak hours	$ 3.64 per kilowatt of Excess kW
Charge per Kilowatt-hour:	
On-peak hours	1.9796¢
Off-peak hours	1.9796¢

Demand:

Where consumption exceeds 1560 kilowatt hours per month for a single monthly billing cycle, a demand meter will be installed and the customer must remain on the time-of-day rate.

The On-peak Demand will be the greatest demand registered during the on-peak hours of the month. The Off-peak Demand will be the greatest demand registered during the off-peak hours of the month.

Determination of Excess Demand:

The Excess kW is the amount of kW by which the Off-peak Demand exceeds the On-peak Demand.

Off-Peak Hours:

The hours after 6 P.M. and before 10 A.M. on weekdays Eastern Prevailing Time, and all weekend hours.

Minimum Bill:

The applicable Basic Service Charge but not less than:
$8.71 per kilowatt of On-Peak Demand in the summer months.
$7.41 per kilowatt of On –Peak Demand in the winter months.

Purchased Power Adjustment Clause:

The above ***Rate Per Month*** will be increased or decreased, as appropriate, by an amount determined in accordance with the Company's Purchased Power Adjustment Clause.

Transmission Adjustment Clause:

The above transmission charge will be increased or decreased every six months by an amount determined by state and federal regulations.

Decoupling Rider:

This rate is subject to a decoupling adjustment which will be assessed in accordance with the Company's DR Rider C.P.U.C.A. No. 634.

Minimum Term of Service:

One year for non-generation service only.

Terms and Conditions:

The Company's Terms and Conditions in effect from time to time where not inconsistent with any specific provisions hereof are a part of this rate.

Effective: January 1, 2016

Effective January 1, 2016
Decision dated November 23, 2015
Docket No. 16-01-02

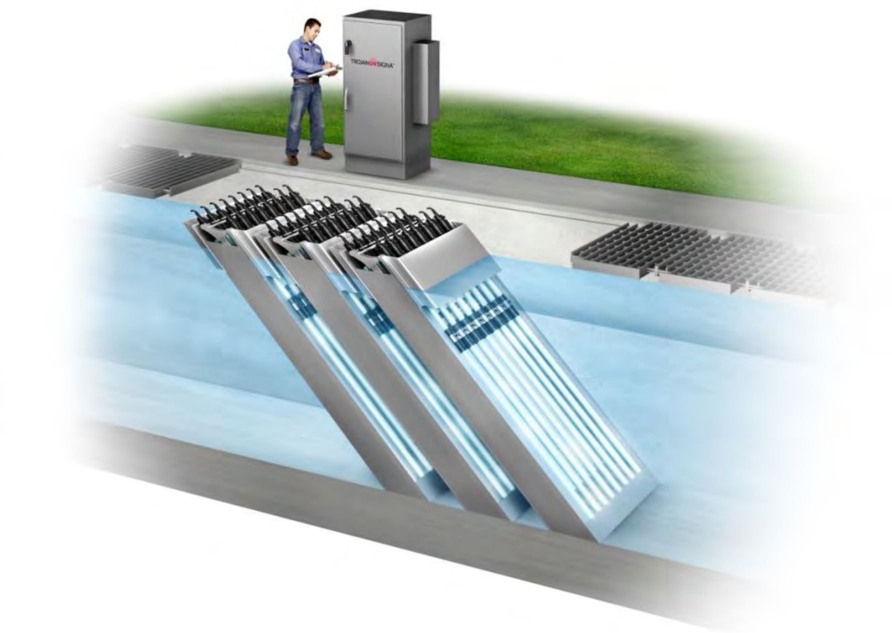
Supersedes C.P.U.C.A. No. 801
Effective July 1, 2015
Decision dated June 25, 2015
Docket No. 15-03-02

ATTACHMENT B

Trojan Design Proposal

TROJANUVSIGNA™

PROPOSAL FOR FAIRFIELD CT,
QUOTE: 209886
04/05/2016



TrojanUVSigna™ incorporates revolutionary innovations, including TrojanUV Solo Lamp™ technology, to reduce the total cost of ownership and drastically simplify operation and maintenance. It is the ideal solution for facilities wanting to upgrade their disinfection system easily and cost-effectively.

We are pleased to provide the enclosed TrojanUVSigna proposal. Please do not hesitate to contact us if you have any questions regarding this proposal. We look forward to working with you.

With best regards,
Una Duncan

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TROJAN UV SIGNA™

DESIGN CRITERIA

Peak Design Flow:	**33 MGD(US)**
UV Transmittance:	**65%** (minimum)
Total Suspended Solids:	**30 mg/l (30 Day Average,** grab sample)
Disinfection Limit:	**88 Fecal Coliform per 100 ml and 35 Enterococci per 100 ml**, 30 day Geometric Mean of consecutive daily grab samples

DESIGN SUMMARY

CHANNEL	
Number of Channels:	**1**
Minimum Channel Length Required:	**6.9m**
Channel Width at UV Banks:	**1.6m**
Channel Depth Recommended:	**2.3m**
UV BANKS	
Number of Banks per Channel:	**5**
Number of Lamps per Bank:	**22**
Total Number of UV Lamps:	**110**
Maximum Duty Power Draw:	**115.8 kW**
UV PANELS	
Power Distribution Center Quantity:	**3**
Hydraulic System Center Quantity:	**1**
System Control Center Quantity:	**1**
ANCILLARY EQUIPMENT	
Level Controller Quantity and Type:	**1 Motorized Weir Gate**
Integral Bank Walls:	**Included**
ELECTRICAL REQUIREMENTS	
1. Each Power Distribution Center requires an electrical supply of one (1) 480 / 277V, 50/60 Hz, 3 Phase, 4 Wire + GND, kVA	

2. Electrical supply for Hydraulic System Center will be (1) 380-480V, 50/60 Hz, 3 Phase, 3 Wire + GND, 2.5 kVA
3. Electrical supply for System Control Center will be (1) 110-240V, 50/60 Hz, 1 Phase, 2 Wire + GND, 1.8 kVA
4. The On-line UVT monitor requires (1) 120 Volts, 1 phase, 2 wire + ground, 1A
5. Electrical disconnects are not included in this proposal. Refer to local electrical codes

COMMERCIAL INFORMATION

Total Capital Cost: $783,150 (USD)

This price excludes any taxes or duties that may be applicable.
Standard equipment warrantees and start up by Trojan-certified technicians are included.

Operating Conditions

Average Flow: **8.5 MGD(US)**
UV Transmittance: **65%**
Annual Operating Hours: **8750 hours - assumed**
Average Number of Lamps Online: **44**

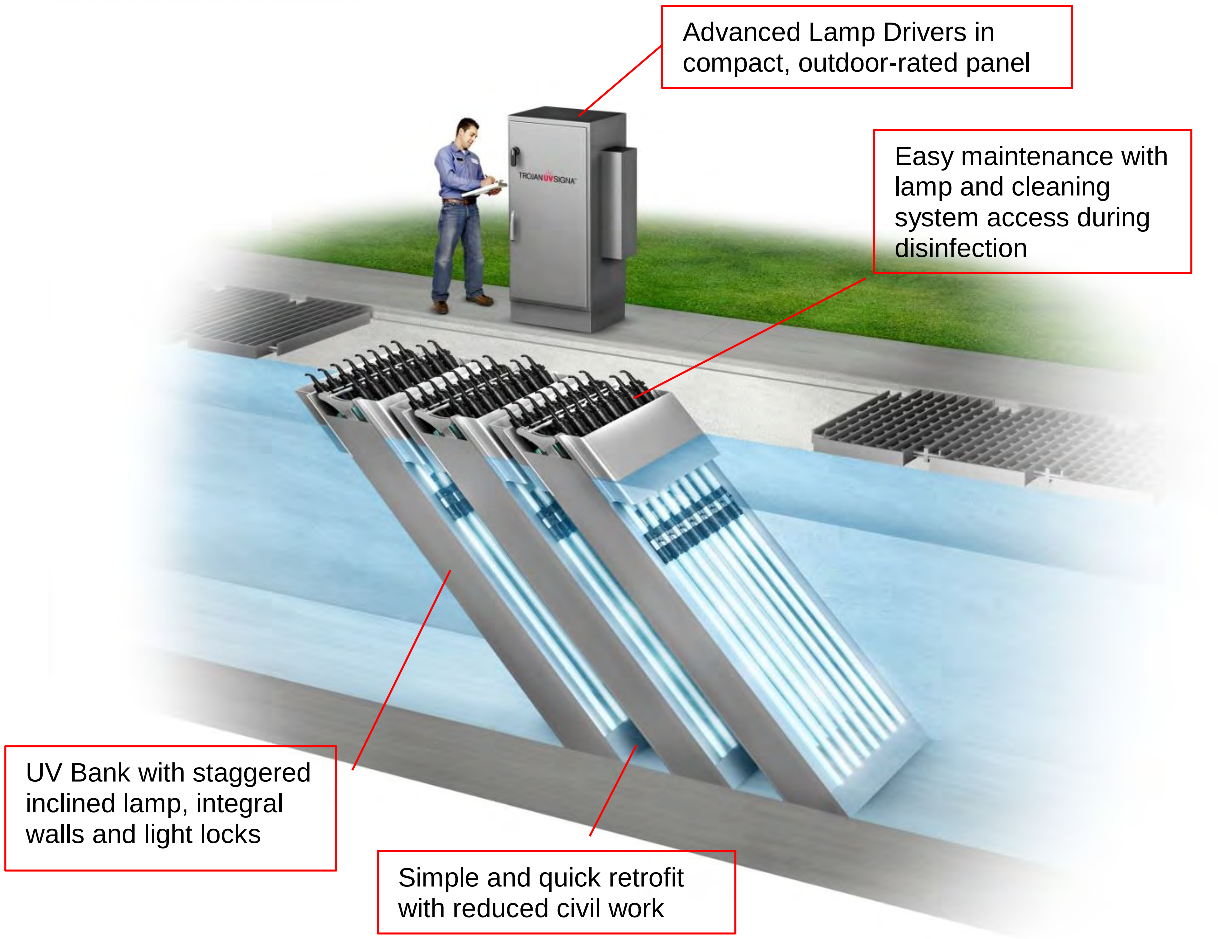
Power Requirements		**Lamp Replacement**	
Average Power Draw:	**28.4 kW**	Lamps Replaced per Year:	**26**
Cost per kW Hour:	**$0.10**	Price per Lamp:	**$550**
Annual Power Cost:	**$24,850**	**Annual Lamp Replacement Cost:**	**$14,300**
Total Annual Operating Cost Estimate: $39,150			

This cost estimate is based on the average flow and UV transmittance listed above. Actual operating costs may be lower with the TrojanUVSigna automatic dose pacing control system. As UV demand decreases by a change in operating conditions, the number of lamps online and power level of the lamps decreases accordingly. The dose pacing system minimizes equipment power levels while ensuring the target UV dose is maintained at all times.

Easy and Cost-Effective Maintenance

- The 1000 watt TrojanUV Solo Lamp combines the benefits of both low pressure and medium pressure lamps
- Fewer lamps, long lamp life and easy change-outs save time and money
- Lamp change-outs and cleaning solution replacement are done while the UV system is in the channel – minimizing downtime and simplifying maintenance
- Routine maintenance can be performed while banks are in the channel, but an Automatic Raising Mechanism (ARM) makes other tasks, such as winterization, simple, safe and easy
- Lamp plugs with LED status indicators and integral safety interlock prevent an operator from accidentally removing an energized lamp
- ActiClean WW™ chemical/mechanical cleaning system to keep sleeves clean during operation

SYSTEM OVERVIEW



Simple to Design and Install

- Light locks on the UV banks control water level within the channel, reducing dependence on downstream weirs and preventing short-circuiting above the lamp arc
- UV Banks include integral reactor walls to make installation easy and prevent short circuiting at the channel walls
- Stringent tolerances on concrete channel walls are not required – making retrofits simple and cost-effective

Supported by Trojan Technologies

- Trojan Technologies warrants all components of the system (excluding UV lamps) against faulty workmanship and materials for a period of 12 months from date of start-up or 18 months after shipment, whichever comes first.
- UV lamps are warranted for 15,000 hours of operation or 3 years from shipment, whichever comes first. Lamp warranty is pro-rated after 9,000 hours of operation. This means that if a lamp fails prior to 9,000 hours of use, a new lamp is provided at no charge.
- Trojan offers an unparalleled Lifetime Performance Guarantee. The spirit of this guarantee is simple: the Trojan equipment, as sized for the project, will meet the disinfection requirements for the life of the system.

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