






Tighe&Bond

Town of Vernon

# Final Wastewater Facilities Plan

## Volume 1 – Overview and WPCF Evaluation

Prepared For:

Town of Vernon, CT
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Tighe&Bond

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# SECTION 1

# Section 1 Introduction

## 1.1 Project Goals

Most of Vernon's Water Pollution Control Facility (WPCF) was built in the 1970's, and the majority of the treatment processes and structures which are now 40 years old are still in use today. Designed to meet the treatment objectives that were in effect at the time, the WPCF cannot remove the additional pollutants of concern today; namely nitrogen and phosphorus. Recently, the Town received a stringent new phosphorous limit in its National Pollutant Discharge Elimination System (NPDES) permit that approaches the limits of technology (Appendix A). The Town recognizes that the structural, mechanical, and electrical systems of the WPCF and pump stations are aging and that the current facilities must be upgraded in order to meet its new permit obligations while providing reliable, cost-effective service to residential, commercial, industrial, and inter-municipal users. Although the WPCF is not currently overcapacity, it does experience a significant increase in wastewater flow during wet weather or periods of high groundwater, indicating that infiltration and inflow (I/I) are present in the collection system. Further evaluation is needed to determine where I/I should be removed.

Given all of these factors, the Town initiated a Wastewater Facilities Plan to evaluate the condition and capacity of the WPCF, the municipal pump stations, and the collection system infrastructure with the goal of developing a plan to address the Town's wastewater infrastructure needs over the next 20 years.

## 1.2 Project Drivers

The main project drivers to need to address:

- New phosphorus limit
- Nitrogen trading program costs
- Zimpro PACT-WAR long term viability
- Aging and obsolete infrastructure
- Energy efficiency
- Resiliency
- Infiltration and inflow (I/I)

### 1.2.1 New Phosphorus Limit

The Connecticut Department of Energy and Environmental Protection (DEEP) is adding new or more stringent phosphorus limits to a number of municipal and industrial NPDES permits as they are renewed, including Vernon's WPCF permit. Vernon's NPDES permit was renewed in 2015 and prior to the renewal, the NPDES permit did not contain a limit for phosphorus. The Town will need to comply with the seasonal phosphorus limit of 4.56 lbs/day, and associated average monthly and maximum daily concentration limits of 0.22 mg/L and 0.44 mg/L, respectively by November 2020.

Once the final limits become effective the WPCF will need to achieve low levels of effluent phosphorous that are near the limits of treatment technology, and a new tertiary treatment process will be required.

### 1.2.2 Nitrogen Trading Program Costs

The WPCF is required to comply with the Connecticut General Permit for Nitrogen Discharges (included in Appendix B) which regulates 80 of the publicly owned treatment facilities in the state. Under this General Permit, each treatment facility is issued an average annual mass-based nitrogen discharge limit. Because all of the treatment facilities are party to the same general permit, overall compliance is determined by their cumulative performance. This allows the treatment facilities that have the capability to remove more nitrogen than necessary to achieve compliance with their portion of the General Permit to "trade" their excess nitrogen removal with other treatment facilities within the state that may not be able to meet their goals through the sale and purchasing of credits.

The cost to participate in the nitrogen trading program is based on the plant's equivalency factor (0.19 for Vernon) and the nitrogen trading credit costs, which have generally increased each year as new projects come on-line. Nitrogen credit costs are projected to continue rising as more projects come on-line and become factored into the equation to determine the credit price.

In 2014, the Nitrogen Credit Advisory Board voted to move the trading program to achieve self-sufficiency. This scenario results in a revenue-neutral status in the following manner: WPCFs that are not meeting their Nitrogen General Permit (NGP) limit ("the buyers") will continue to buy credits calculated in the usual manner; WPCFs that are meeting their NGP limit ("the sellers") will divide the funds paid by the buyers proportionally, based on the seller's relative performance. This scenario is meant to address a situation caused by the Nitrogen Trading Program's success, where significantly more credits were produced than were needed. Projections showed the State subsidization of the program's credits growing to over $5 million by 2018, which was deemed unsustainable.

The nitrogen general permit was renewed effective January 1, 2016 and will expire on December 31, 2018. The current general permit continues with the same permit limits as listed in the General Permit for 2014. It is possible that the nitrogen general permit could be discontinued in the future. Should this happen, total nitrogen limits would be included in individual NPDES permits (similar to phosphorus limits). It is also possible that limits in the NGP could be further reduced based on the outcome of ongoing research on nitrogen impacts in Long Island Sound.

For Vernon, the 2016 goal is an annual average effluent load of 184 lbs/day of total nitrogen. This represents the following effluent concentrations:

- 7.5 mg/L at the plant's current average flow of 2.95 MGD
- 4.6 mg/L at the 20-year projected average flow of 4.8 MGD
- 3.1 mg/L at the plant's permitted average flow of 7.1 MGD

The Town has purchased credits through the nitrogen trading program since 2002. Historical and projected costs to participate in the program are discussed further in Section

3, as well as the potential savings expected by providing additional levels of treatment for nitrogen removal.

The Town commissioned a nitrogen removal facilities plan in July 2006 (revised December 2007). The study recommended converting the four aeration tanks to the Modified Ludzack-Ettinger process (discussed in Section 6), which was determined to be the most feasible and lowest cost approach for nitrogen removal at the time, when compared to the cost of purchasing nitrogen credits. This recommendation was not implemented and the town elected to purchase nitrogen credits.

### 1.2.3 Zimpro PAC-WAR Long Term Viability

Vernon operates one of the few remaining municipal Zimpro powdered activated carbon treatment – wet air regeneration (PACT-WAR) process wastewater treatment plants in the United States. The reason for installing this process in the 1970's was to treat both municipal wastewater and colored industrial wastewater from the town's textile/dye mills. However, over the last two decades the mills that contributed colored wastewater to the system were closed and the problem no longer exists. Therefore, the town must now make the decision to reinvest in and maintain this process for the next 20 or more years or invest in another treatment process technology that will be necessary to eliminate the process. This decision will have a significant impact on how the plant is upgraded to meet regulatory requirements and the replacement of aging infrastructure.

### 1.2.4 Aging Infrastructure

The Vernon WPCF was designed to treat a combination of residential, commercial and industrial wastewater. We understand that there has been a WPCF at this site since the early 1900s, but that the major structures at the plant and most of the process equipment were constructed/installed during the last three major plant upgrades:

- **1959 Upgrade**. This date is based on the date of the design drawings. Construction started during or after 1959, with the majority of the upgrade coming online in the early 1960s. There is no major equipment left from this upgrade and the majority of the structures from this upgrade have since been repurposed or abandoned. For the balance of this report, this upgrade will be referred to as the 1959 upgrade.
- **1973 Upgrade**. This date is based on the date of the design drawings. Construction started during or after 1973, with the majority of the upgrade coming online in the mid-1970s. During this major plant upgrade, the plant was converted from a trickling filter plant to most of the current facility (e.g. primary clarifiers followed by an activated sludge treatment system using the Zimpro PACT-WAR process). For the balance of this report, this upgrade will be referred to as the 1973 upgrade.
- **1993 Upgrade**. This date is based on the date of the design drawings. Construction started during or after 1993, with the majority of the upgrade coming online in the mid-1990s. In this upgrade, the plant capacity was expanded by adding a Headworks Building; an influent pump station; two aeration tanks; a clarifier; a Return Sludge Pump Building; upgrades to the Zimpro-PACT-WAR system, including construction of a new DSE equalization tank; and a Process Control (Administration) Building. For the balance of this report, this upgrade will be referred to as the 1993 upgrade.

Other than routine maintenance and a few equipment replacements, the WPCF has not experienced a significant overhaul of its mechanical equipment since the last upgrade that was performed more than two decades ago. Most of the equipment is reaching or has exceeded its normal and expected service life. Generally, the WPCF is still able to meet its current NPDES permit requirements, but aging infrastructure and equipment require continuing repairs or replacement to maintain performance of the WPCF.

The Town's seven municipal wastewater pump stations were constructed between 1968 and 1995 and are all more than 20 years old. With the exception of the Talcottville and Dart Hill Road Pump Stations, no significant upgrades of these pump stations have occurred since they were constructed. In comparison, the expected service life of pumping equipment is typically about 20 years. As such, improvements are expected to be required over the next 20 years to replace aging equipment at these facilities.

The Vernon wastewater collection system consists of approximately 120 miles of sewers ranging in size from 6-inches to 36-inches in diameter with some of the system dating to in the late 1890s as will be discussed in later sections. Although the actual service life of a sewer can vary depending on the pipe material, jointing system, soil conditions, proper installation, and the characteristics of the wastewater flow, the expected service life of a sanitary sewer is typically assumed to be 50 years or greater. A significant portion of Vernon's wastewater collection system is older than this. Based upon the age of the collection system, some sewer rehabilitation and/or replacement may be required over the next 20 years.

### 1.2.5 Energy Efficiency

Due to the age and condition of equipment at the WPCF and pump stations, many of the motors and drives are inefficient compared to the newer equipment available today. Energy efficiency upgrades provide an opportunity to reduce the amount spent on operation of the WPCF and pump stations. Aeration is typically the largest consumer of energy at a wastewater treatment plant, followed by pumping and building HVAC systems. Several aspects of the WPCF's Zimpro PACT-WAR system also have significant energy demands that are relatively unique to the Vernon plant. Pumping and HVAC costs tend to consume the majority of the energy at pump stations.

Energy improvements often target the above equipment/systems in order to most cost-effectively reduce the overall energy use at the Town's wastewater facilities. Also, sometimes the energy cost of complying with modern code requirements for ventilation increases energy costs.

Several past projects completed at the WPCF that reduced energy costs are described below:

- Around 2006, new air compressors were installed for the Zimpro WAR system.
- In 2009, the coarse bubble diffusers were replaced with fine bubble diffusers in four of the six aeration tanks.
- New condensing boilers were installed in 2015

### 1.2.6 Resiliency

As a result of recent severe weather, most notably hurricane Sandy in 2012, there has been a new emphasis placed on improving the resiliency of water and wastewater

infrastructure. This has included a federal executive order, revised federal flood risk management standards, and other directives that have resulted in the 2016 revision to TR-16 -Guides for The Design of Wastewater Treatment Works. This update to TR-16 describes in detail new more rigorous standards to be used in New England when upgrading treatment plants so that they can operate longer without their primary source of power, successfully treat flow during flooding up to the 100-year floods, and also prevent damage to critical equipment so that they can quickly recover from floods exceeding the 100-year flood.

### 1.2.7 Infiltration/Inflow

Infiltration is the extraneous water that enters a sewerage system from the ground through pipe defects (cracks, holes, etc.), pipe joints, connections, manhole walls, etc. Infiltration is, in most cases, directly related to the elevation of the groundwater table in relation to the pipe invert.

Inflow is the extraneous water discharged into a sewerage system from a distinct source, such as sump pumps, roof leaders, cellar drains, foundation drains, surface drains, drains from springs and swampy areas, manhole covers, catch basins, cross-connections with storm drains, cooling water discharges, etc. Inflow is, in most cases, directly related to the quantity and intensity of rainfall.

Wastewater flow data to be discussed later in this report will illustrate that:

1. Dry weather wastewater flows are highest in the spring, when groundwater levels are typically highest, which is an indication that infiltration is entering the wastewater collection system.

2. When it rains, wastewater flows at the WPCF increase significantly which is an indication that inflow is entering the wastewater collection system.

Due to the collection system's age and condition, considerable infiltration and inflow (I/I) is present in the system. The materials and construction methods used to install many older systems do not meet current standards.

## 1.3 Facilities Planning Process

Facilities planning is a process used to identify the wastewater infrastructure needs over a 20-year planning period. The Facilities Plan provides the basis for subsequent design and construction, substantiates the need for those facilities, provides a cost-effective analysis of a number of feasible alternatives, and demonstrates that the selected alternatives are implementable from a legal, financial and management perspective. The selection of the best alternatives to meet the future wastewater treatment needs of the service community is the goal of the Facilities Planning process.

## 1.4 Scope of Work

The scope of work includes a comprehensive condition and capacity assessment of the collection system, pump stations, and WPCF. Major elements of the scope include:

- **Collection System**

- Perform an Infiltration/Inflow (I/I) Analysis (Phase 1 study) to quantify I/I flows throughout the system, and determine where I/I is of greatest concern. The I/I Analysis report will include recommendations for a Sewer System Evaluation Survey (Phase 2 study) to identify and locate specific I/I sources in the areas of greatest concern, including rehabilitation methods and costs.

- Update the Town's Sewer Service Area map and develop a Water Pollution Control Plan, both of which are used together to define areas for sewer expansion and avoidance based on the needs analysis and economic development that is consistent with the local and State Conservation and Development Plan

- Develop a 20-year future flow projection

- Perform a capacity analysis using a hydraulic model created in SewerGEMS that will include the major trunk sewers

- **Pump Stations**

  - Perform a condition assessment of the seven town-owned pump stations, including mechanical, electrical, HVAC, instrumentation and other ancillary systems

  - Conduct an energy efficiency evaluation at the two largest pump stations (Talcotville and Dart Hill Road)

  - Perform a capacity analysis using current and projected future flows

  - Provide upgrade recommendations including opportunities for standardization

- **WPCF**

  - Perform a condition assessment of process equipment, structures, systems, site, and buildings, including mechanical, structural, electrical, HVAC, instrumentation and controls, and site/civil evaluations

  - Evaluate the resiliency, vulnerability, and emergency preparedness of the treatment plant

  - Perform a capacity analysis using current and projected flows and loads, and unit process analysis based upon published criteria

  - Perform a phosphorus upgrade analysis, screening and evaluation of available technologies for phosphorus removal, process modeling, and developing detailed cost estimates and a list of advantages and disadvantages for select alternatives

  - Perform an energy efficiency and renewable energy evaluation

  - Develop upgrade alternatives and recommendations regarding the Zimpro PACT-WAR system and other alternatives to meet the current and projected

future flow and load projections and the anticipated regulatory requirements

- **Recommended Plan/Public Participation**
    - Develop opinions of probable cost for recommended upgrades to the collection system, pump stations, and WPCF
    - Perform a collection system and WPCF staffing evaluation
    - Perform an environmental impact analysis
    - Develop an implementation schedule
    - Perform a funding and financing evaluation, including a determination of potential rate impacts
    - Develop a draft Facilities Plan report for Town and DEEP review
    - Conduct Town workshops, Water Pollution Control Authority (WPCA)/public presentations, and a public hearing
    - Prepare a final Facilities Plan Report
    - Prepare the proposed Sewer Service Area Map and Water Pollution Control Plan

## 1.5 Report Organization

This Facilities Plan has been organized into two Volumes: Volume 1 – Overview and WPCF Evaluation, and Volume 2 – Pump Stations and Collection System. A brief description of the sections contained in each Volume of this Plan and their content is described below.

**VOLUME 1 – Overview and WPCF Evaluation**

**Section 1:** Provides the purpose of this Facilities Plan as well as background information relative to the Facilities Planning process, public participation, and organization of the Plan.

**Section 2:** Provides an overview of existing wastewater infrastructure and provides a summary of previous studies.

**Section 3:** Includes information on the existing physical, organizational, and demographic conditions for Vernon. This information is used to establish current conditions, determine possible development potential, and predict future conditions that are pertinent to future wastewater management requirements. The updated sewer service area map and proposed Water Pollution Control Plan are presented in this section. Current and future wastewater flows and nutrient loadings at the WPCF for the planning period are projected in this report section.

**Section 4:** Establishes the capabilities and deficiencies of the current liquid treatment processes at the WPCF and provides preliminary recommendations for upgrades to the treatment processes.

**Section 5:** Establishes the solids handling capabilities and deficiencies of the WPCF and provides preliminary recommendations for upgrades.

**Section 6:** Establishes the capabilities and deficiencies of the buildings, ancillary systems, and controls at the WPCF and provides recommendations for upgrades. Energy efficiency and opportunities for renewable energy are also evaluated and discussed.

**Section 7:** Discusses treatment technologies available for nitrogen and phosphorus reduction at the WPCF. A preliminary screening is performed to develop a short list of alternatives for nutrient removal.

**Section 8:** Provides a detailed evaluation of short-listed alternatives selected for upgrading the WPCF. These include an evaluation of nutrient removal technologies, sludge dewatering vs. disposal of liquid sludge, chlorination/dechlorination vs. UV disinfection, and an evaluation of anaerobic digestion.

**Section 9:** Presents the recommended improvements for the water pollution control facility. A description of recommended improvements, including preliminary layouts and discussions of hydraulic and O&M impacts associated with the recommended improvements are presented in this section. WPCF staffing is analyzed based on the recommended plan. Finally, opinions of probable capital construction costs and operating costs for the recommended plan are provided, with funding sources identified and a schedule for implementation.

**Section 10:** Provides an assessment of the potential environmental impacts of the proposed wastewater improvements.

**VOLUME 2 – Pump Stations and Collection System**

**Section 1:** Includes a brief summary of the pump stations and collection system discussion provided in Volume 1.

**Section 2:** Provides a summary of the work performed during the Phase 1 I/I Analysis, which includes: a review of existing data; rainfall, groundwater, and continuous flow monitoring to determine I/I rates during various groundwater conditions and precipitation events; a determination of the composition of the I/I (infiltration, inflow, or rainfall-induced infiltration); inspection of select manholes; and identification and prioritization of sewer drainage areas with excessive I/I. Recommendations for Phase 2 investigation work through a sewer system evaluation survey (SSES) are presented in this section.

**Section 3:** Provides a capacity evaluation of the collection system under existing and projected future conditions using a SewerGEMS model analysis. Sewer capacities are compared to projected flows in order to identify sewers that may require improvements to convey those flows. Recommendations for upgrades and future studies are provided.

**Section 4:** Includes an evaluation of the seven Town-owned pump stations and recommends upgrades to address condition and capacity concerns identified as well to improve energy efficiency.

**Section 5:** Presents the recommended improvements for the wastewater collection system and pump stations. A description of recommended improvements is presented in this section. Collection system staffing is analyzed based on the recommended plan. Finally, capital and operating cost estimates for the recommended plan are provided with funding sources identified.

## 1.6 Public Participation

Throughout the Facilities Planning process, regular meetings and workshops were held with the WPCF staff, Town officials, as well as members of various other Town departments and representative from CT DEEP. The purpose of these meetings was to provide updates on project progress and receive information and feedback on tasks and deliverables.

Regular progress updates were provided to plant staff (who updated the Vernon WPCA).

The following workshops were held with Town staff on various dates:

- Water Pollution Control Plan Workshop: October 28, 2016
- Collection System Future Flow and Load Workshop: January 10, 2017
- WPCF Evaluation of Technologies Workshop: April 3, 2017
- Recommended Plan Workshop: April 29, 2017. A copy of the presentation is included in Appendix C.

### 1.6.1 Public Meetings

Meetings with the Town's public were held to present the project results on the following date:

- June 20th, 2017 – Public Hearing for the Vernon Wastewater Facilities Plan and Water Pollution Control Plan

See Appendix C for a copy of the presentation used for the public hearing.

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# SECTION 2

# Section 2
# Existing Wastewater Infrastructure Overview

This section presents a summary of the current wastewater infrastructure in use in sewered and unsewered areas of Town and summarizes previous wastewater studies and projects.

A collection system assessment and evaluation is being conducted as a separate phase of this study. These results are presented in Volume 2 of the Wastewater Facilities Plan.

## 2.1 Wastewater Infrastructure

The wastewater infrastructure in Vernon consists of the following:

- Centralized collection and treatment system consisting of gravity sewers, seven Town-owned pump stations and associated force mains, and a Water Pollution Control Facility (WPCF) permitted for 7.1 million gallons per day (mgd)
- Privately owned and maintained pump stations
- Privately owned decentralized systems consisting primarily of on-site septic tanks and leachfields

The current wastewater infrastructure is shown in Figure 2-1 (a larger scale map sized 34-inches by 22-inches is also attached at the end of this report).

Sanitary sewers are also located in the southeastern corner of the Town, in the Bolton Lakes region. This collection system flows to the Town of Manchester WPCF for treatment, and is owned and operated by the Bolton Lakes Regional Water Pollution Control Authority. Evaluation of this collection system is not a part of this project.

### 2.1.1 Wastewater Collection System

Collector sewers within the Town discharge to main interceptor sewers by gravity or through pump stations. Flow is then conveyed to the Vernon WPCF. The first sewers in Vernon were constructed in the Rockville area around 1896 with additional expansion taking place in the 1940s. Gravity sewers flowing to the Talcottville, Dart Hill Road, and Phoenix Street Pump Stations were constructed in the late 1960s/early 1970s. Sewers to the Warren Avenue and Brookview Pump Stations were constructed in the early 1980s. Finally, collection systems flowing to the Campbell and Tankherhoosen pump stations were constructed in the early 1990s. There are approximately 10,900 customers connected to the collection system.

Specific data on the Town's collection system exists in GIS format and is actively maintained by the Town. Based upon the GIS data, the collection system consists of approximately 599,000 linear feet (113 miles) of gravity sewers and 13,815 linear feet of force mains. There are also four siphons within the collection system: one on West Main Street, one on East Main Street, and two on Windsor Avenue.

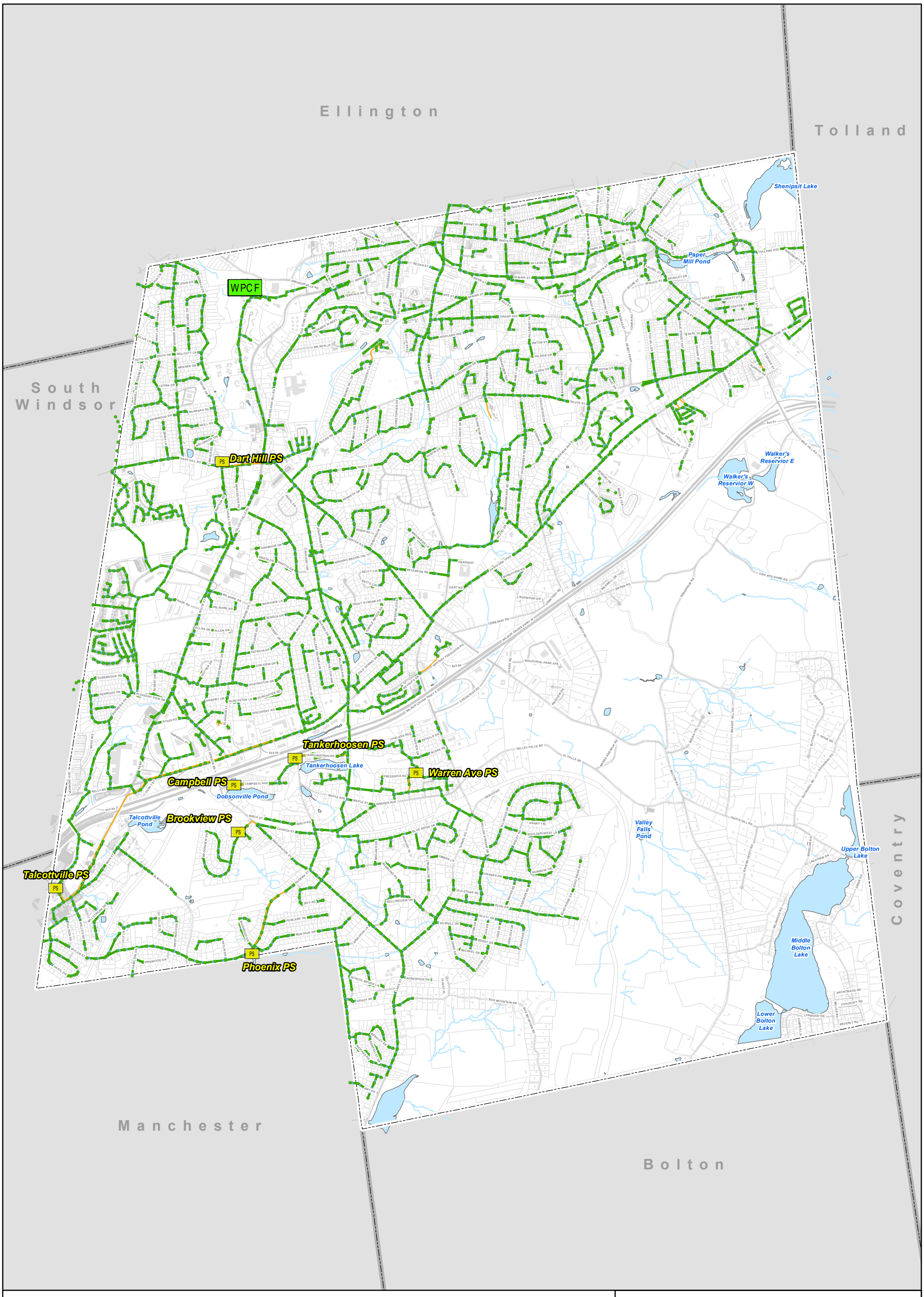
Summaries of the Town's collection system are provided in Tables 2-1 and 2-2. It should be noted that GIS data for pipe size and material is not currently available for all pipe segments. These are included in the "unknown" category in each table. Pipe sizes will be confirmed to the extent possible prior to submission of the final report.

**TABLE 2-1**
Town-Owned Gravity Sewers

| Diameter (inches) | Approximate Length (lineal foot) |
|---|---|
| 8 | 449,600 |
| 10 | 30,350 |
| 12 | 40,900 |
| 15 | 11,200 |
| 16 | 1,300 |
| 18 | 20,200 |
| 24 | 8,100 |
| 26 | 5,200 |
| 27 | 16,800 |
| 28 | 4,000 |
| 30 | 4,200 |
| 32 | 2,650 |
| 36 | 4,500 |
| **Total** | **599,000** |

**TABLE 2-2**
Town-Owned Force Mains

| Pump Station | Diameter/ Material | Approximate Length (lineal foot) |
|---|---|---|
| Brookview | 4" DIP | 750 |
| Campbell | 2" PVC | 1,242 |
| Dart Hill | 12" DIP | 1,235 |
| Phoenix | 8" DIP | 2,074 |
| Talcottville | 16" DIP | 6,100 |
| Tankerhoosen | 4" PVC | 1,654 |
| Warren | 8" DIP | 760 |
| **Total** | | **13,815** |




## Legend

- Sewer MH
- Pump Station
- Water Pollution Control Facility
- Forced Main
- Sewer Pipes
- Buidings
- Water Bodies
- Parcel Boundary
- Town Boundary

0 625 1,250 2,500 Feet

N

# Figure 2-1
# Existing Sanitary Sewer Collection System

Wastewater Facilities Plan
Vernon, Connecticut

February 2017

Tighe&Bond
Engineers | Environmental Specialists

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W-0037

### 2.1.2 Pump Stations

Vernon has seven Town owned pump stations throughout the collection system, as shown on Figure 2-1 and summarized in Table 2-3.

**TABLE 2-3**
Summary of Municipally-Owned Pump Stations

| Pumping Station | Year Put into Service | Capacity[1] (gpm) | Description |
|---|---|---|---|
| Talcottville | 1968[2] | 1,180 | Three-story, built-in-place, wet pit/dry pit |
| Dart Hill Road | 1973[3] | 1,000 | Three-story, built-in-place, wet pit/dry pit |
| Phoenix Street | 1974 | 700 | Package wet pit/dry pit |
| Brookview Drive | 1980 | 150 | Submersible |
| Warren Avenue | 1982 | 220 | Package wet pit/dry pit |
| Campbell Avenue | 1995 | 54 | Submersible |
| Tankerhoosen Road | 1995 | 70 | Submersible |

[1]One Pump Running

[2]Upgraded in 1997.

[3]Upgraded in 2008.

The municipal pump stations vary in size, style, and complexity depending, in part, on the size of their service areas. The two largest pump stations, the Talcottville and Dart Hill Road facilities, are multi-level facilities with the following major components:

1. Below-grade concrete wetwells
2. Below-grade concrete drywells where the pumps are located
3. Above-grade masonry buildings where the electrical components and controls are located
4. Standby generators
5. Influent channels with bar rack (at the Talcottville Pump Station only)

The Phoenix Street and Warren Avenue Pump Stations are package wet pit/dry pit facilities that consist of a buried steel drywell, where the pumps and controls are located, and a buried concrete wetwell. At each of these pump station sites, there is a generator in an enclosure that provides standby power. There are no buildings at these facilities.

The Brookview Drive, Campbell Avenue, and Tankerhoosen Road Pump Stations are submersible pump stations. Each station consists of a wetwell in which the pumps are located, a valve vault, and an adjacent pad-mounted control panel in a weather-resistant enclosure. There is a standby generator in an enclosure at the Brookview Drive Station, located adjacent to the wetwell. The Campbell Avenue and Tankerhoosen Road pump stations do not have generators. There are no buildings at these facilities.

There are also numerous privately-owned and operated pump stations that tie-in to the collection system. These submersible stations were constructed to connect individual properties/developments to the Vernon sewer system where a gravity connection is not

feasible. Inspection of these private stations was not included as part of this facilities evaluation.

### 2.1.3 Water Pollution Control Facility

The Water Pollution Control Facility (WPCF) is an advanced treatment plant with a permitted capacity of 7.1 million gallons per day (mgd). The WPCF treats flow from a combination of residential, commercial and industrial sources, as well as septage and some industrial wastes. The WPCF is located in the northwest portion of Town, bordered by the Hockanum River (and multi-use path) to the west, Route 74 (and a small stream/drainage swale) to the north, shopping plaza & Scranton Motors to the west, and Vernon Gardens Apartments to the south. The Hockanum River has a bend and is also present to the north of the plant. An orthophotograph of the Vernon WPCF showing the age and names of the key structures is included as Figure 2-2. Treated effluent is discharged to the Hockanum River which runs past the WPCF and is tributary to the Connecticut River and ultimately discharges to Long Island Sound.

The major treatment processes at the WPCF include: preliminary treatment, influent pumping, primary treatment, secondary treatment, intermediate pumping, tertiary sand filtration, chlorination and dechlorination for disinfection, and post aeration. Solids handling includes primary sludge thickening with offsite disposal and the Zimpro PACT-WAR process for carbon regeneration/recovery with secondary sludge destruction. A simplified process flow diagram for the WPCF is in included as Figure 2-3.

### 2.1.4 WPCF Hydraulic Profile

The hydraulic profile for the current WPCF is shown in Figure 2-4. It was developed for the WPCF based upon the flow paths, elevations and sizing information obtained from record drawings of the 1959, 1973, and 1993 upgrades.

We note that the 1959 drawings reference an assumed elevation, the 1993 drawings reference NGVD 29 elevations (note on Sheet G-2), and the 1973 drawings which do not provide a datum but appears to be NGVD 29. It appears that these documents have elevations consistent with each other given the necessary conversions (from the assumed datum) that we developed by comparing the drawings.

We also reviewed the record drawings before updating our hydraulic profile model to reflect current streamflow conditions as discussed below and new design flood elevations as discussed in Section 2.4. There were several conflicts or confusion between our model results and available references which were resolved as follows:

- The 1993 upgrade drawings show the 48-inch diameter outfall pipe invert at elevation 204.0, typical stream elevations at 204.0, and the stream bottom at elevation 202.0. This conflicts with the flood map which shows the river bottom four feet higher at elevation 206.0. This also conflicts with field observations (both Tighe & Bond's and operator's observations) which suggest that the normal river elevation is such that the outfall pipe is partially submerged at all times with river levels routinely varying from 18-inches below the crown of the pipe (our observation on 10/13/2016 after a dry summer) to 6-inches below the crown of the pipe (operator's recollection). For our hydraulic profile, we used the normal river level as the higher observation and used the invert elevation that was shown on the drawings, this suggests that normal river elevation is at an elevation 2.5 feet higher (48 inches - 18 inches) than the pipe invert or 204.0 + 2.5 = 206.5

feet. This elevation was used for the development of the hydraulic profile. During design of the plant upgrades, a survey should be used to confirm the outfall and river elevations and other critical plant elevations.

- The previous hydraulic profiles do not appear to make any allowances for storm water from drainage area 2 (from the plant's storm water pollution prevention plan – which is about 2.8 acres and 61% impervious) which flow through 88% of the length of the outfall pipe. This impact was likely negligible in past studies but now that resiliency of the plant processes at design river flood elevations of 100-year flood plus three feet (see Section 2.4) are a concern, this impact must be considered when evaluating design river flood elevations because the contribution of storm flow and plant flow can increase the in-plant flooding level above the design river flood elevation due to the losses in the outfall pipe. For the development of our hydraulic profile at design river flood elevation we considered plant peak hourly design flow and peak 25-year storm flow (estimated at 6.7 MGD) flowing through the outfall pipe. This assumption is reasonable as it is unlikely that a larger storm flow, the design river flood elevation, and peak plant flow would all occur at the same time. Our hydraulic profile analysis included the assumption that the current storm water system is not capacity limited and headlosses are negligible in the storm system leading to the outfall pipe but this should be verified during design of the plant upgrade. We also assumed that if overtopping of the chlorine contact tanks were to occur, that the flow would re-enter the storm drain and outfall pipe. Therefore, elevations shown on the hydraulic profile at the storm drain system connection represent the worst case flooding possible in the low lying flood prone areas of the plant. This is discussed further in Section 2.4.

- Our field observations and measurements suggest that river gravel has settled in the bottom of the 48-inch diameter outfall pipe to a thickness of about 15 inches reducing the effective area of the pipe. This suggests that the current river bottom elevation at the outfall is 204.0+1.25 = ~205.3 feet, thus closer to the 206.0-foot elevation indicated in the FEMA Study. Since dredging of the river is an undesirable option, we considered this degree of sedimentation of the effluent pipe in the hydraulic profile development to determine if this sediment is a concern. We concluded during our modeling that this sediment only increases the backwater in the chlorine contact tank (CCT) effluent channel by less than 0.1 feet during the design peak hour flow of 22 MGD at 100-year flood plus three feet river conditions, and 6.7 MGD of storm flow. The added effect of stormwater flow in the pipe will increase the overall loss by about 0.3 feet. At this flow, the water velocities in the constricted pipe would be 3.6 to 4.2 fps (without and with storm flow) and under these conditions the gravel may be also scoured out of the pipe further reducing the effect. Since this impact is negligible, no further corrective action for removing the sediment is recommended. The hydraulic profile includes this minor additional loss at this peak flow condition.

- We note that our hydraulic profile is based upon peak hourly flow assuming all units are in service except for "Future East Aeration Tank No. #7". This assumption is consistent with the hydraulic profile assumptions from the 1993 upgrade drawings and is based upon sending flow to aeration tanks #1 and #2 for treatment which has not been done since the upgrade. As a result of these tanks not having been operated since the upgrade, the blowers and gates dedicated to

these tanks have not been maintained and the aeration system is inefficient. Given the lack of operational experience, it is also not clear how effective the gates to these tanks are in achieving a suitable flow split so that flow to each aeration tank is balanced in proportion to the treatment capacity of that tank. This is not currently a problem because current peak flows do not require that these tanks be operated.

We also developed the hydraulic profile model assuming even flow distribution to all equipment in service using all available flow distribution gates even though current plant operations may not currently operate like this. For example:

- The model is based on flow over the four weir gates available to balance flow to aeration tanks #5 and #6 even though the plant currently balances the flow using only two of the weir gates and operates only one of those two aeration tanks.

- As discussed in Section 4, the flow to the clarifiers does not balance well (with flow favoring #5 clarifier) at current flows and operators must adjust the isolation gates to solve this problem. The hydraulic model ignores this factor and assumes that this will be addressed by the installation of an energy dissipating baffle in the distribution box during the plant upgrade to address this problem as recommended in Section 4.

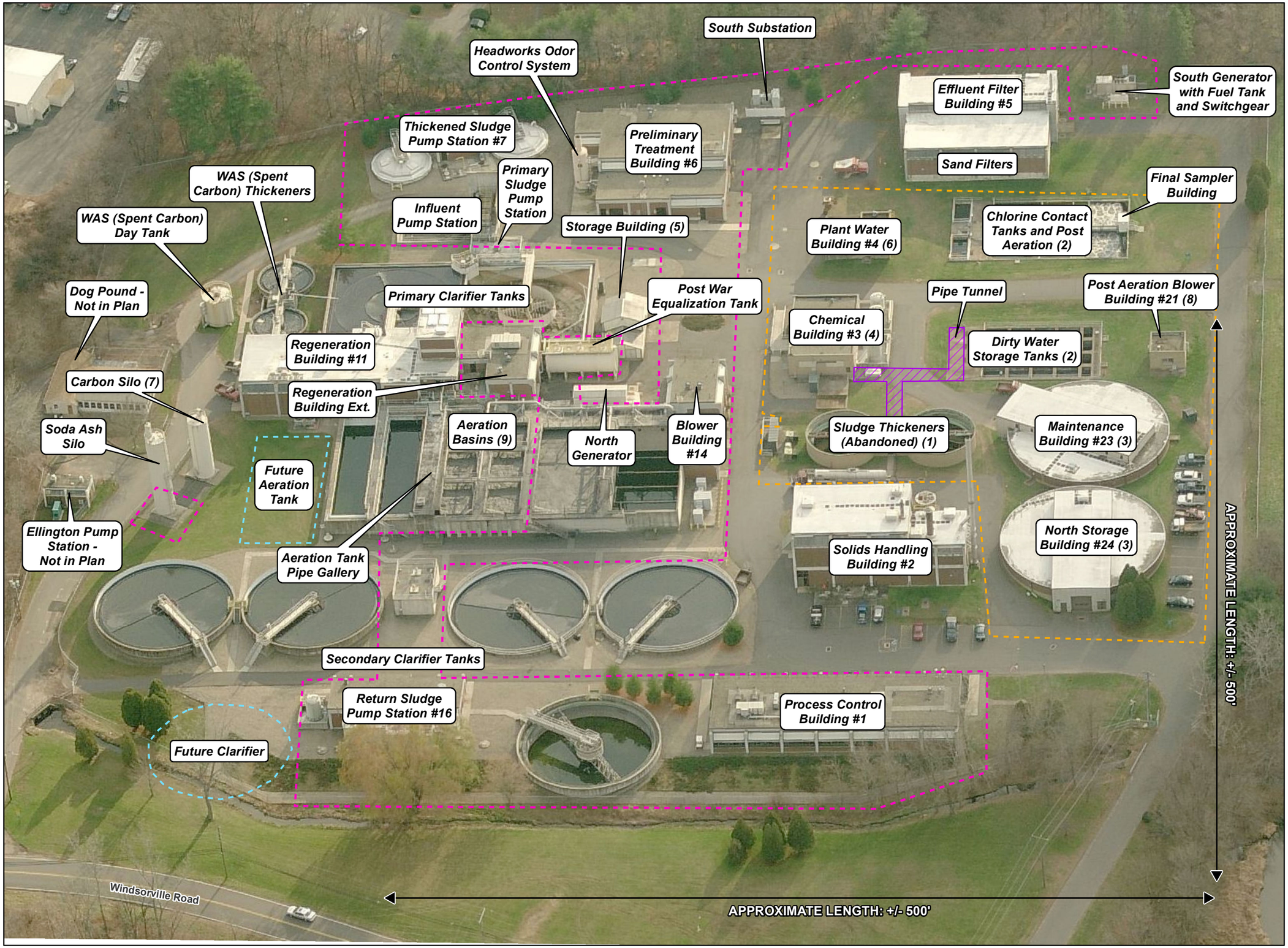


**Figure 2-2**
**Plant Overview and Age of Structures**

**LEGEND**

- Structures from 1959 Plant
- Structures Added in 1993 Upgrade
- Future Clarifier/ Aeration Tank

*All other structures from 1973 upgrade

**LOCUS MAP**




N

Scale: N.T.S.

**NOTES**

(1) Former Digestors
(2) Former Clarifiers
(3) Former Trickling Filters
(4) Former Main Control Building
(5) Former Headworks
(6) Former Chlorine Building
(7) Relocated in 1993
(8) Former Trickling Filter Pump Station
(9) Aeration Tanks #3 & #4 modified in 1993 upgrade

**Town of Vernon, Connecticut**

**Vernon WPCF Facility Plan**

**January 2017**

Tighe&Bond
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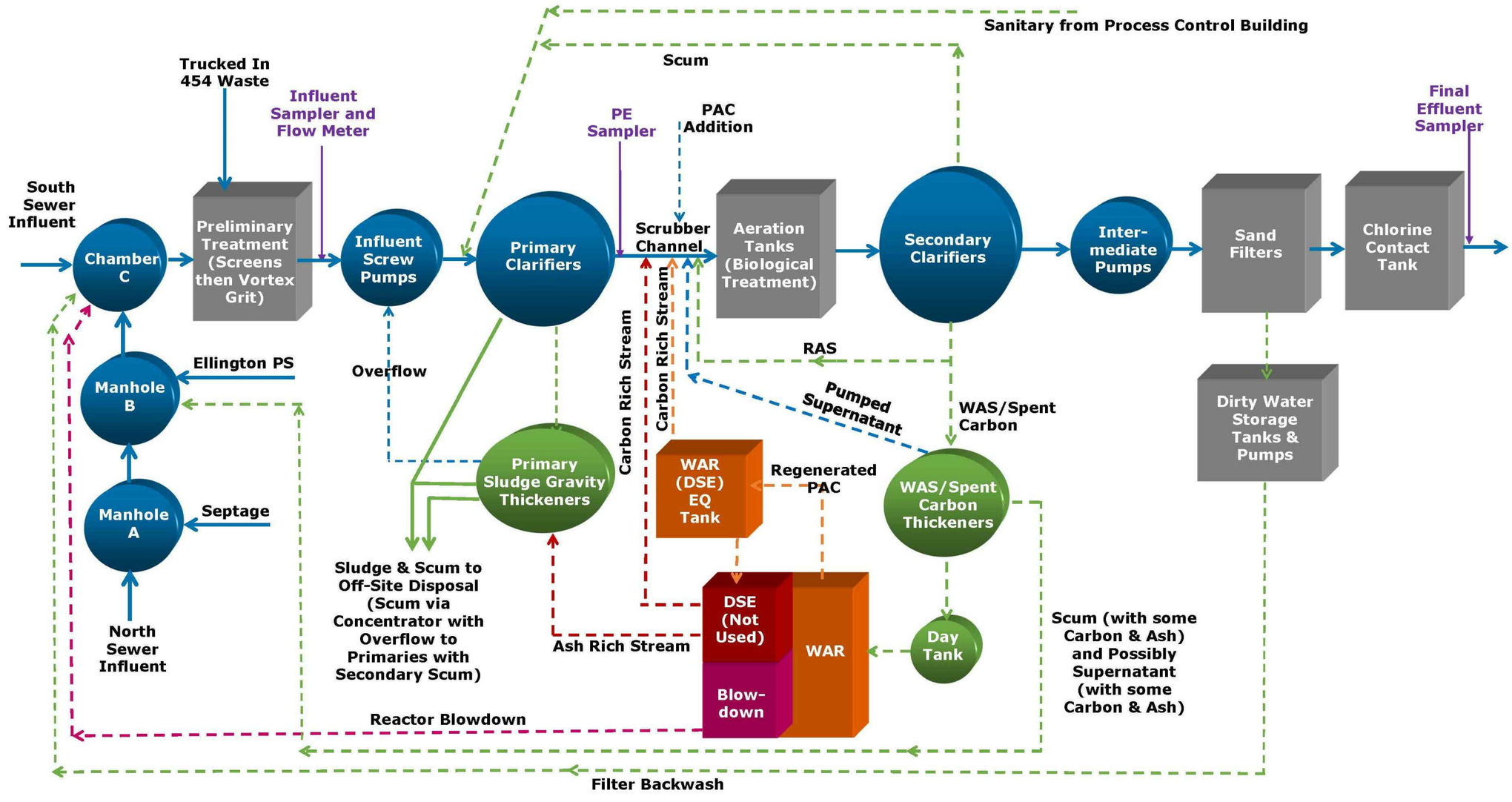
V-0037

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Wastewater Facilities Plan

Town of Vernon, Connecticut

| MARK | DATE | DESCRIPTION |
|---|---|---|

| | |
|---|---|
| PROJECT NO: | V0037 |
| DATE: | MAY 2017 |
| FILE: | V0037Figures 2-3 and 9-3.dwg |
| DRAWN BY: | ADW/FAM |
| CHECKED: | IBC |
| APPROVED: | SES |

SIMPLIFIED PROCESS FLOW DIAGRAM

SCALE: NO SCALE

FIGURE 2-3

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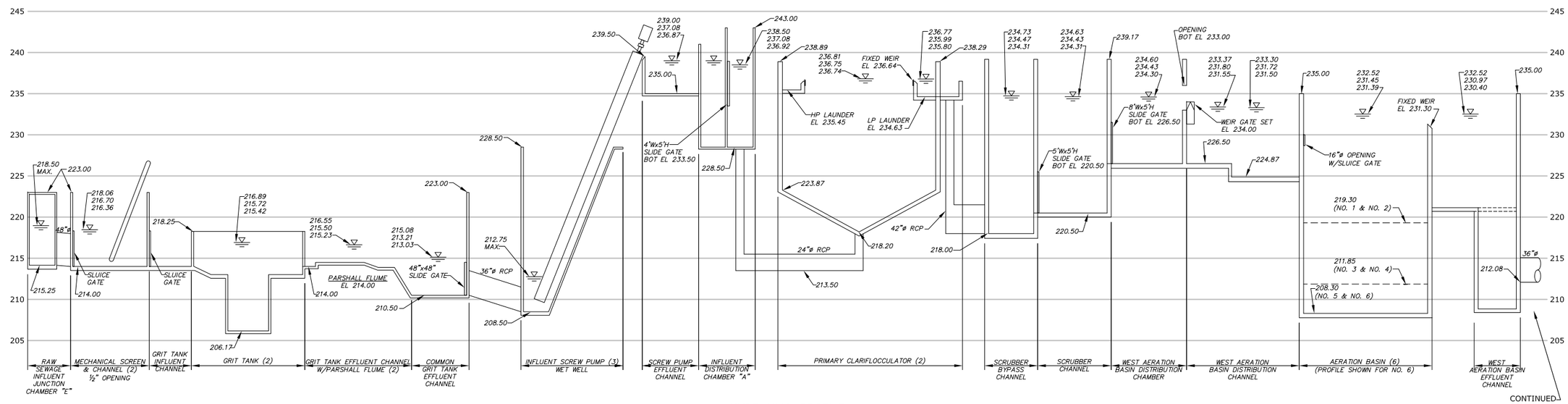
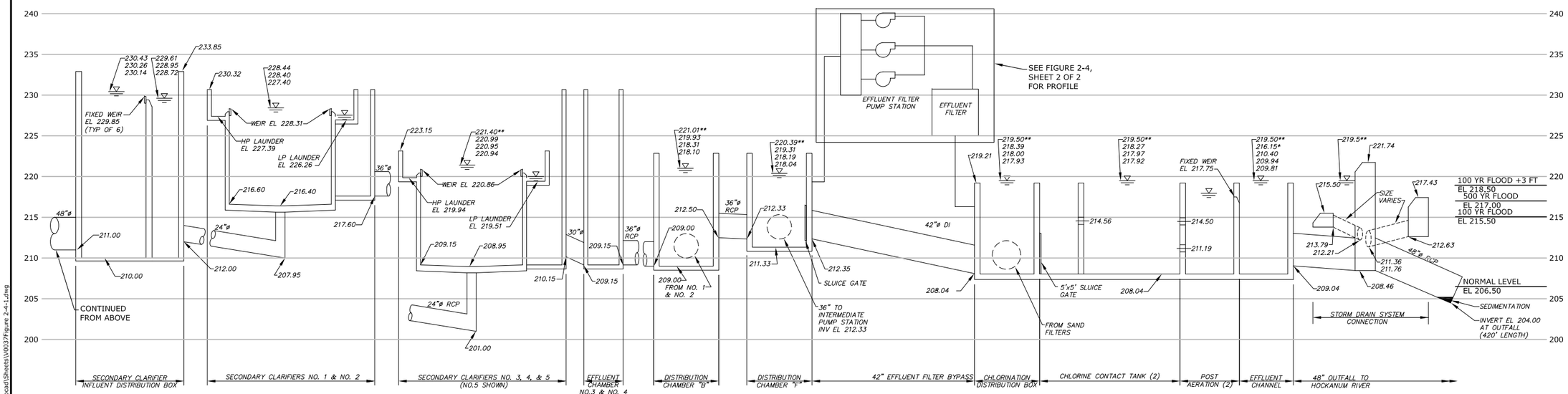



## HYDRAULIC PROFILE

SCALE: HORIZ: NO SCALE
VERT: 3/4"=5'




## HYDRAULIC PROFILE

SCALE: HORIZ: NO SCALE
VERT: 3/4"=5'

LEGEND

EL PEAK HOUR (*, ** SEE NOTES)
EL MAX DAY
EL AVERAGE DAY

BASIS OF HYDRAULIC PROFILE

| FLOW CONDITION | INFLUENT FLOW (MGD) | RETURN SLUDGE FLOW (MGD) | UNITS OUT OF SERVICE |
|---|---|---|---|
| PEAK HOUR | 22.0 | 8.0 | FUTURE EAST AERATION BASIN NO. 7 (1) SECONDARY CLARIFIER |
| MAXIMUM DAY | 9.7 | 8.0 | FUTURE EAST AERATION BASIN NO. 7 (1) SECONDARY CLARIFIER |
| AVERAGE DAY | 7.1 | 3.5 | (1) GRIT TANK, FLUME |

1. AN * INDICATES PEAK PROFILE CALCULATED FROM STARTING WATER SURFACE EL 215.50 IN THE HOCKANUM RIVER.
2. AN ** INDICATES PEAK PROFILE CALCULATED FROM STARTING WATER SURFACE EL 218.50 IN HOCKANUM RIVER.
3. ALL OTHER PROFILES CALCULATED FROM STARTING WATER SURFACE EL 206.50 IN THE HOCKANUM RIVER WITH 6.7 MGD OF FLOW FROM 25-YR STORM AND CCT OVERTOPPING.
4. ALL PROFILES CALCULATED BYPASSING THE EFFLUENT SAND FILTERS.
5. THE VERTICAL DATUM REFERENCES NGVD29.
6. NUMBER OF UNITS FOR EACH PROCESS SHOWN IN PROFILE (#).

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# Wastewater Facilities Plan

Town of Vernon, Connecticut

| MARK | DATE | DESCRIPTION |
|---|---|---|

| | |
|---|---|
| PROJECT NO: | V0037 |
| DATE: | MAY 2017 |
| FILE: | V0037Figure 2-4-1.dwg |
| DRAWN BY: | REJ |
| CHECKED: | SHB |
| APPROVED: | FAM, SES |

EXISTING PLANT HYDRAULIC PROFILE

SCALE: AS SHOWN

FIGURE 2-4
SHEET 1 OF 2

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Plotted: Tuesday, May 09, 2017 - 2:14pm By: CMC
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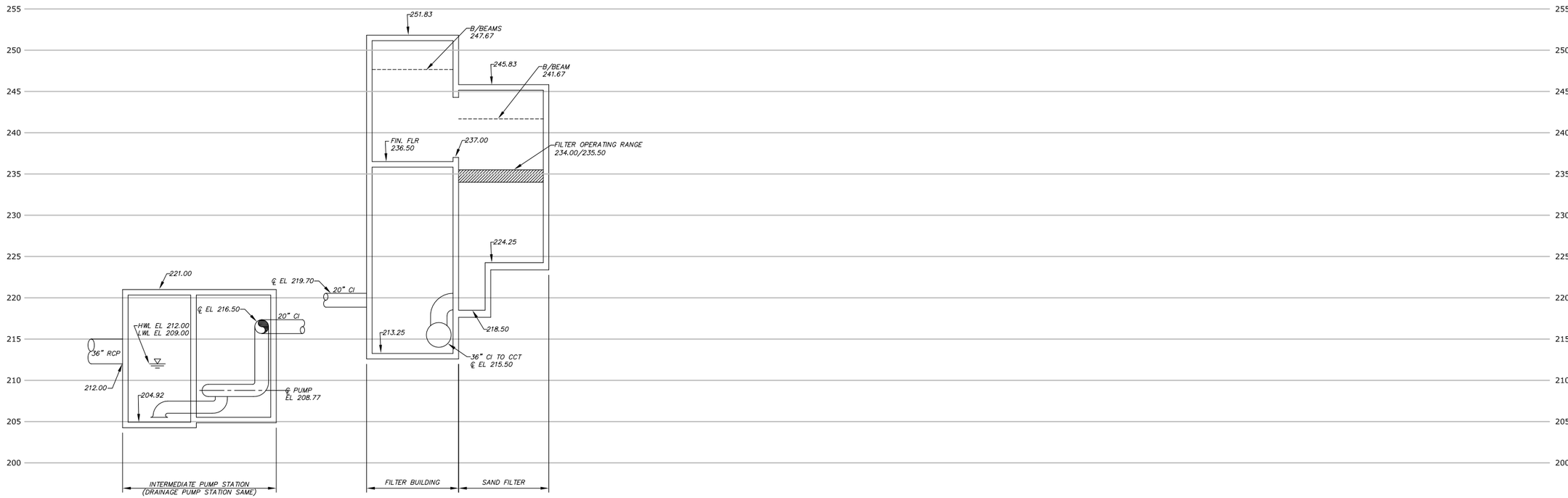


**HYDRAULIC PROFILE**

SCALE: HORIZ: NO SCALE
VERT: 3/4"=5'

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# Wastewater Facilities Plan

Town of Vernon, Connecticut

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| PROJECT NO: | V0037 |
| DATE: | MAY 2017 |
| FILE: | V0037Figure 2-4-2.dwg |
| DRAWN BY: | REJ |
| CHECKED: | SHB |
| APPROVED: | FAM, SES |

EXISTING PLANT
HYDRAULIC PROFILE

SCALE: AS SHOWN

FIGURE 2-4
SHEET 2 OF 2

Last Saved: 5/2/2017
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### 2.1.5 Decentralized Systems

Developed properties outside of the current sewer service area as well as developed parcels within the sewer service area but not yet connected to the sewerage system are served by individual, on-site wastewater disposal systems. On-site systems are typically comprised of septic tanks and leach fields. The North Central District Health Department maintains historical records dating back to 1999 regarding activities associated with on-site wastewater disposal systems within the Town.

### 2.1.6 Bolton Lakes

Sanitary sewers were recently constructed in the southeastern corner of Vernon, around properties that surround Lower Bolton Lake and Middle Bolton Lake. This collection system flows to the Town of Manchester WPCF for treatment, and is owned and operated by the Bolton Lakes Regional Water Pollution Control Authority. Evaluation of this collection system is not a part of this project.

## 2.2 Prior Wastewater Planning Documents – Collection System and Recent Projects

### 2.2.1 Past I/I Study (mid /late 1980s)

Text Under Development – Not to be included in this Preliminary Review

### 2.2.2 Collection System Improvements (early 2000's)

Text Under Development – Not to be included in this Preliminary Review

### 2.2.3 Exit 67 Home Depot Study

Text Under Development – Not to be included in this Preliminary Review

## 2.3 Prior Wastewater Planning Documents – WPCF

The following wastewater planning documents were identified and reviewed to better understand the WPCF's design history. Each document provides clues as to the intended design capacity of the existing plant, but all needed to be considered before we could understand the design capacity of the secondary portion of the plant which was eventually constructed with 2.26 million gallons of aeration tank capacity. Section 2.4.3 contains a similar retrospective discussion of Emergency Preparedness documents.

### 2.3.1 1992 Lombardi Facilities Plan with Addendum 2

AR Lombardi and Associates, Inc. prepared a draft Facilities Plan for the Town of Vernon's Wastewater Treatment Plant in April 1991. The Facilities Plan made recommendations to upgrade the collection system and WPCF to meet the anticipated needs of a planning period ending in 2015. Another major driver of the WPCF upgrade was to provide year round nitrification for ammonia removal. The report included an evaluation of the existing conditions of the collection system and treatment facility; development of projected future flows and loads in 2015; an evaluation of alternatives for nitrification, disinfection, and sludge disposal; and a list of recommendations, including a detailed cost breakdown.

The draft facilities plan was amended in June 1992 and reflects substantial efforts by AR Lombardi and the Town of Vernon to minimize the costs of the upgrade. The most notable

modification to the draft facilities plan was the reduction of the WPCF's design treatment capacity from 7.9 MGD to 7.1 MGD. The final recommendations included the construction of a preliminary treatment building, primary sludge gravity thickeners, two additional aeration tanks for BOD removal, two nitrification towers for ammonia removal, one additional secondary clarifier, improved secondary sludge pumping station, additional tertiary sand filters, and a process control and administration building.

### 2.3.2 1992 Malcolm Pirnie Process Design Confirmation Memorandum

The Town of Vernon selected Malcolm Pirnie to complete the design of the Vernon WPCF's expansion and upgrade following the completion of AR Lombardi's Facilities Plan. Malcolm Pirnie submitted a Process Design Confirmation Memorandum first in October 1992 and a final version in December 1992 following revision based on the Town's feedback. This memorandum defines the major process design criteria for the Vernon WPCF upgrade and expansion from which the final design was based. The memorandum represented the most complete documentation of the design criteria for the most recent plant upgrade, and therefore was valuable to understanding the WPCF's design capacity as documented later in this report.

Malcolm Pirnie maintained a majority of the upgrade recommendations in AR Lombardi's Facilities Plan with only minor adjustments; however, they deviated significantly by designing a single-stage PACT-WAR activated sludge system to achieve full nitrification instead of the nitrifying towers. The document included revised future projected flows and loads and process design calculation for SRT which were used to size tankage and set the design capacity. In summary, the design criteria for the activated sludge system required an SRT of 10 days, and 6 aeration tanks with a total volume of 2.4 MGD. This memorandum also contained solids loading rate design criteria developed for the clarifiers based on past experience in operating the Zimpro PACT-WAR process. The memorandum also noted that construction will be phased "whereby certain facilities will be expanded to match the projected flow increase."

### 2.3.3 1993 WPCF Upgrade Value Engineering Documents

As part of the design process, the Town and Malcolm Pirnie engaged a third party engineer, Havens and Emerson, Inc., to complete two value engineering sessions, one after 30% design and one at 60% design. The goal of the value engineering reports was to find ways to reduce the cost of the project while maintaining the process integrity. The 30% VE report included 16 recommendations. Malcolm Pirnie responded to the feasibility of each recommendation in their Response to VE Analysis report, and ultimately accepted six recommendations to be implemented into the design, which will reduce the project cost by an estimated $1.1 million. Similarly, the VE team recommended 12 design alternatives in their 60% VE report dated April 1993. Malcolm Pirnie responded to the VE Analysis accepting six recommendations. It is important to note that Malcolm Pirnie clearly stated that their design for two new aeration tanks would result in a total of 2.1 MG of aeration volume, not 2.4 MG as noted in the Preliminary Design Report. The 2.4 MG total volume would be necessary to treat the 7.1 MGD design flow and would be constructed later.

### 2.3.4 1999 Malcolm Pirnie PACT Cost Evaluation

Malcolm Pirnie completed a cost analysis evaluation of the recent upgrade to justify the decision to maintain the PACT-WAR system in the upgrade even though there are significantly fewer dye factories within the Town that require color treatment by the PACT-WAR system. This question was raised by the surrounding communities, who believed

they should not have to pay for the upgrade fees since they no longer have dye facilities. Malcolm Pirnie's findings concluded that although an alternative treatment technology may have saved $56,000 in capital costs, the Town saves an estimated $730,000 per year in operations and maintenance costs by maintaining the PACT-WAR system compared to the alternative. The majority of these O&M savings were attributed to not having to dispose of secondary waste sludge.

This report confirmed several aspects of the completed WPCF expansion and upgrade that were unclear because the only design reports available were preliminary and did not reflect several changes through the design process. Notably, the report indicated that the actual constructed volume of the aeration tanks was 2.26 MG, which was intended to provide an average day treatment capacity of 6.8 MGD. In order to reach the design treatment capacity of 7.1 MGD using the flows and loads presumably presented in the 1992 process design confirmation memo, a seventh aeration tank the same size as #5 and #6 for a total aeration tank volume of 2.8 MG was planned to be constructed later.

### 2.3.5 2004 Fuss & O'Neill Metals Mass Balance

As per the requirements of the Town's NPDES permit, Fuss & O'Neill, Inc. conducted an evaluation to determine the sources of metals, specifically copper and lead, that contribute to the influent wastewater load. Using historic data along with supplemental sampling, they were able to estimate WPCF influent loads for each metal. Loadings were then allocated to six potential sources: source water, corrosion from water supply piping, domestic contributions, hauled wastewater, significant industrial users, and uncontrolled point source loadings. They then conducted a mass balance around the WPCF, by measuring the metals loads removed in the sludge and passing through the WPCF into the effluent, to determine the fate of metals through the WPCF.

### 2.3.6 2006 Malcolm Pirnie BNR Study

In 2007, Malcolm Pirnie completed a nitrogen removal facilities plan to determine the short-term and long-term needs for the WPCF to remove nitrogen in accordance with the Long Island Sound TMDL for nitrogen. Malcolm Pirnie completed an extensive sampling program to determine the current and future flows and loads and created and calibrated a computer model, which was used to analyze process alternatives. The recommended alternative was to convert the existing aeration tanks to a Modified Ludzack-Ettinger process, which would be capable of providing year-round nitrogen removal at the projected future flows and loads of approximately 5.5 MGD in 2014. The recommendation included consideration of a seventh aeration tank or denitrification filters to accommodate the WPCF's treatment capacity of 7.1 MGD in the future.

## 2.4 Vulnerability, Storm Resiliency, and Emergency Preparedness Assessment

The Vernon WPCF is bordered by the Hockanum River (and multi-use path) to the west, Route 74 and a small stream/drainage swale to the north, shopping plaza & Scranton Motors to the west, and Vernon Gardens Apartments to the south. The Hockanum River has a bend that is also present to the north of the plant.

### 2.4.1 Vulnerability

Access to the site is restricted by a chain link fence with barbed wire around the full perimeter with two sets of vehicles gates and access roads from Route 74. There are also

two man-gates on the southern portion of the plant that provide access to the plant via private property if needed. A third man-gate on the west side of the plant provide access to the lawn area outside the fence for maintenance. These man gates are chained and locked and opened only when needed. Each access road crosses a small storm drainage swale with culvert pipes that are in good condition. Given that there are two access roads to the WPCF, the consequence of failure of one set of the culvert pipes is low. The west access road is used for routine access to the WPCF. The east access road also serves the adjacent dog pound and the Ellington pump station and is used primarily by septic haulers to gain access to the WPCF. There are two sets of gates on the east access road, an outer gate, which is left open at all times to provide access to the dog pound and the Ellington Pump Station, and the inner gate which provides access to the WPCF. The east inner gate and west gate are open from 6 a.m. to 6 p.m. Monday through Friday when the plant is fully staffed.

The fence is in good condition and the area around the fence is maintained. Security and break-ins have not been an issue or concern at the site and the WPCF is currently manned 24 hours a day, seven days a week (with reduced staffing at night – a watchman shift from 4 PM to 7 AM weekdays) so significant improvements to security do not appear to be warranted. However, this facility plan anticipates that WPCF improvements and process modifications will be made that could enable this to become a one shift operation, so adding security cameras in key areas tied to a digital video recorder and monitor in the building may be warranted. Cameras should be considered to monitor the following locations:

- East inner access gate
- West access gate
- Septage receiving area – if it is continued to be used
- 454 Waste Receiving Area

We considered and after discussion with the plant staff rejected the need to add automated gates with key card access to the west and inner east vehicle gates. They require significant maintenance and do not appear justified at this time.

There are many buildings at the plant as well as outdoor electrical equipment and generators. Direct access to the buildings and electrical equipment is controlled by lockable doors in most buildings. Because the WPCF is continuously manned, the staff generally leave the doors unlocked. They can however lock the doors during times of heightened security. Some structures, like the primary sludge pump station do not have lockable doors. All exterior doors replaced during the next upgrade should be provided with lockable doors.

The current SCADA system is not accessible from offsite and is secure.

### 2.4.2 Storm Resiliency

Potential flooding from the Hockanum River is a concern regarding access to the site. To assess the potential impacts we reviewed the Flood Insurance Study and FIRM Map and identified the following:

- Just west of the WPCF – near the outfall and low lying portions of the plant:

  - The 500-year flood elevation is 217.0
  - The 100-year flood elevation is 215.5
  - The 10-year flood elevation is 213.4

- To the north of the WPCF – across from Route 74 the flood elevations in the river are essentially unchanged from the elevations to the west.

For comparison purposes, the flood elevations used for the hydraulic profiles in the 1993 and 1973 designs were 217.5 and 216.0; respectively, and both assumed a normal river elevation of 204.0 feet. See Section 2.1.4 on the hydraulic profile for more discussion on the river and outfall elevations.



Although the FEMA maps show the 100-year flood zone impacting mainly Route 74 and the west access road to the WPCF, our review of the grade elevations shown on drawings from the 1993 upgrade suggest that a 100-year flood will come up to and slightly beyond both entrance gates at the north end of the plant.

Under new guidance from the CT DEEP and EPA under Executive Orders 13690 and 11988, and as adopted by TR-16 the following measures are required:

- Improving the resiliency of the WPCF should be considered when planning upgrades.

- New pump stations, new facilities within a WPCF, and new WPCFs should 1) provide for uninterrupted operation of all units during conditions of a 100-year (1% annual chance) flood, and 2) be placed above or protected against structural, process, and electrical equipment damage that might occur in an event that results in a water elevation above the 100-year (1% annual chance) flood.

- The level of protection depends on how critical a component of the facility is to operation of the facility and compliance with its NPDES permit.

  - Critical equipment of these facilities should be protected against damage up to a water surface elevation that is 3 feet above the 100-year flood elevation. (Elevation 218.5)

  - Non-critical equipment should be protected against damage up to a water surface elevation that is 2 feet above the 100-year flood elevation. (Elevations 217.5)

- In circumstances where the level of protection noted above for new pump stations and treatment facilities (i.e., 2 or 3 feet above the 100-year flood elevation) exceeds the 500-year flood elevation, the more restrictive elevation should be used.

- All SCADA system components and instrumentation used to monitor and control facility operation should be protected from flood conditions to the maximum extent practical.

- Critical equipment, which includes conveyance and treatment system components identified for protection including, but not limited to, all electrical, mechanical, and control systems associated with pump stations and treatment facilities that are responsible for conveyance of wastewater to and through the treatment facility to maintain primary treatment and disinfection during the flood event. *Other equipment that, if damaged by flood conditions, will prevent the facility from returning to pre-event operation after cessation of flood conditions is also critical equipment.*

- The Backup/emergency power source should have enough fuel to run under full loading conditions (e.g. peak flow, peak load) for at least 48 hours or under normal operating conditions for at least 96 hours, whichever requires the greater amount of fuel to supply power to critical equipment in the event of a power outage at the WPCF, pump stations, and facilities in the system responsible for conveying flow to the plant.

- Existing pump stations or treatment facilities that are planned for upgrade or expansion should be improved to the maximum extent possible to meet the flood protection criteria noted herein for new facilities. However, existing facilities may present significant challenges to implementing increased levels of protection. The possible vulnerability and the differential cost of increasing the level of protection above the 100-year flood elevations for uninterrupted operation and protection from damage, respectively, should be weighed against replacement cost in selecting the level of flood protection implemented when upgrading existing facilities.

The goal of this new guidance is to design facilities to be upgraded in a manner that will enable these plants to quickly recover from a flood condition and get up and running as soon as possible. Refer to Figure 2-5 for an outline of the areas impacted by the 100-year flood, 100 year+3 feet flood, and the 100- year+3 feet flood if occurring during peak plant and storm water flows (see Section 2.1.4 and below for more discussion on this).

Fortunately, the Vernon WPCF is well protected from damage during flooding as the majority of the plant is located well above the 100-year flood + 3 feet elevation of 218.5. Refer to the Plant Hydraulic Profile in Figure 2-4 as well as Figure 2-5 as part of the following evaluation. During a flood of such magnitude, the WPCF will experience the following issues as river levels rise:

1. At a river flood elevation of 213.0 +/-, Route 74 and the plant access road will flood. The plant staff can use a boat if needed to access the plant (current plans call for parking employees along Windsorville Road or if needed at Stop and Shop) and the boat is located in the North Storage Building.

2. At the river 100-yr flood elevation of elevation 215.5, water will back-up into the effluent channel of the chlorine contact tank but it will not overtop the weir from the post aeration channel. This means that the treatment processes including disinfection will not be impacted during a 100-year flood condition.

3. At flood elevation 215.8+/-, the storage and maintenance buildings will flood due to backflow through the storm drain system. There is no critical process equipment in these locations and important equipment can be relocated if needed if flooding was imminent.

4. At flood elevation 217.7, the dirty water storage tank will be submerged. This tank has submersible electrical equipment and should not be impacted. If impacted, the existing sand filters would not be operated. This is not critical equipment and the plant can meet its permit without the filters.

5. At flood elevations 217.7+, there are currently openings in the top of pipe gallery at the dirty water storage tank that would allow flood water to enter into the basement level pipe galley (finished floor elevation at the dirty water tanks of 207.4 feet) and tunnel to the basement of the Chemical Building (at finished floor elevation of 210.1 feet and the Sludge Thickener Building (finished floor elevation of 211.0 feet). Should this flood (it would likely overwhelm the small sump pumps that handle these areas) then the following equipment will be impacted:

a. The dirty water backwash pumps (these will likely be eliminated in the upgrade).

b. The boiler and hot water circulation pumps for the Chemical Building. This will lead to loss of heat in the building – which is not a major concern because disinfection is not performed during freezing weather.

c. An abandoned scum plunger pump – no impact.

d. The electrical wiring and controls feeding the Post Aeration Blower Building (Non-critical equipment) – which if damaged should be easily reparable.

e. The chemical transfer pumps for the sodium hypochlorite (2 pumps) and sodium bisulfite (2 pumps) bulk storage tanks. This is critical equipment and it will be damaged if flooded. Under the new standard, consideration should be given to improving the resiliency of this existing equipment. Options include:

i. Flood proofing the tunnel by closing up openings in the tunnel at the dirty water storage tank – This however may not be effective as there could be other less obvious pathways for water to enter. There is also limited ventilation in the tunnel so that it would make the space less safe. When the sand filters are eliminated in the upgrade, the need of the dirty water storage tanks is eliminated so further investment in improving these areas is not warranted. Sealing off the tunnel and partially backfilling the tunnel should be considered in this scenario

ii. Eliminating or relocating the transfer pumps when these chemical feed systems are renovated. This may not a viable option given the limited space available in this building and relocating these pumps into the containment areas outside does not make sense due to hydraulics, freezing, weather, and safety concerns.

iii. Eliminating the day tanks and need for chemical transfer pumps.

iv. Rebuilding the chemical feed systems in another location.

v. Eliminating the chemical feed systems by switching to UV disinfection –the UV system would be designed to operate at floods up to the 100-year floods and the equipment would be protected from damage at floods up to the 100-year flood plus three feet.

6. At a river flood elevation 218.5, (100-year plus three feet) both the post aeration channel and the chlorine contact tanks (CCT) will be surcharged. If this occurs at the plant peak flow of 22 MGD along with high storm water flows, the flow through the outfall pipe will further backup the storm sewers in the low lying areas, and the CCT will overtop at a total combined flow of 25-26 MGD (but this un-disinfected flow will re-enter the outfall through the storm sewers), and the flow will also surcharge the lower clarifiers weir by about 0.8 feet. See the discussion on the hydraulic profile in Section 2.1.4 for further discussion on this and key assumptions related to river sediment impacting the outfall pipe capacity and elevations. The next result is that this added flow through the outfall pipe will back-up the storm system and increase the water elevation in the plant to elevation 219.5 which is the highest elevation depicted on Figure 2-5.

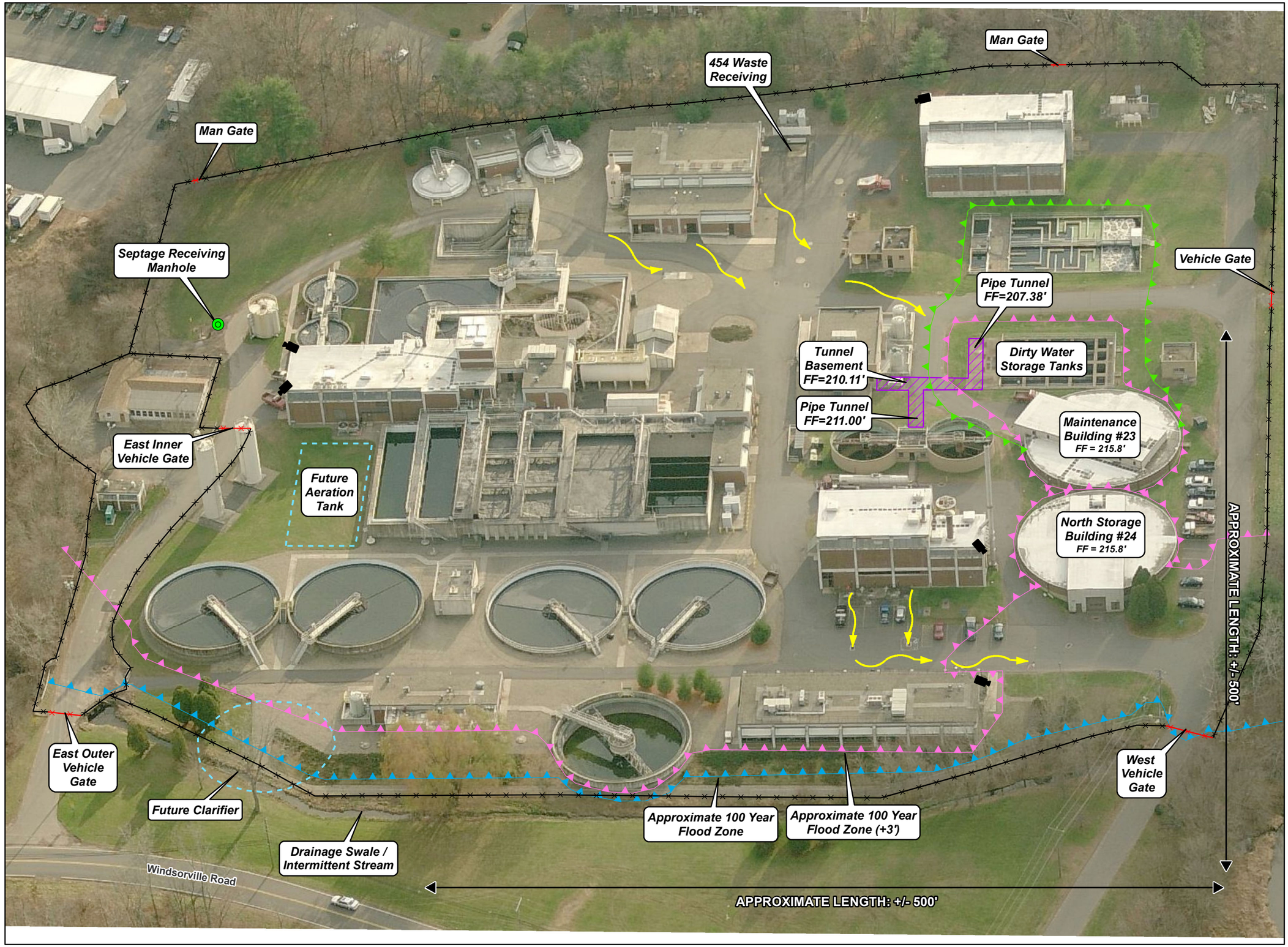
The above analysis is based upon the FEMA 1999 Flood Study (with elevations provided based on the NGVD 29 datum) as well as a 1993 survey by DTC and plant drawings for the 1959 plant, 1973 upgrade, and the 1993 upgrade. Refer to the discussion on the hydraulic profile in Section 2.1.4 for additional discussion.

During the upcoming plant upgrade, the modifications will be designed so that

- Critical equipment will be protected from damage at flood elevations no less than the 100-year flood plus 3 feet. (Elevation 218.5)
- Non-critical equipment will be protected from damage at flood elevations no less than the 100-year flood plus 2 feet. (Elevation 218.5)

The new structures and the equipment to be considered will likely include the following:

- New electrical distribution equipment (critical)
- Phosphorus removal system (non-critical)
- Chemical feed systems (non-critical)
- UV disinfection system (critical)




# Figure 2-5
# WPCP Resiliency and Security Overview

**LEGEND**

- Manhole
- Gate
- Perimeter Fence
- Overland Flooding Route to Storm Drain
- 100 Year Flood Zone (Elevation: 215.5')
- 100 Year Flood Zone (+3') (Elevation: 218.5')
- Spill Zone (See Note 1)
- Proposed Security Camera Location
- Pipe Tunnel
- Future Clarifier/ Aeration Tank

**LOCUS MAP**




N

Scale: N.T.S.

**NOTES**

FF = Finished Floor Elevation
Note 1: Spill zone is due to overtopping of chlorine contact tank at 100-year flood plus three feet, peak hour plant flow, and 25 year storm water drainage through combined outfall resulting in ponding estimated to elevation 219.5.

**Town of Vernon, Connecticut**

**Vernon WPCF Facility Plan**

**January 2017**

Tighe&Bond
Engineers | Environmental Specialists

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### 2.4.3 Emergency Preparedness Assessment

Emergency Power

The WPCF has two fuel tanks associated with its emergency generators:

- A 5,000-gallon underground diesel near (and used to fuel) the North Generator. A tank was originally installed during the 1970's upgrade but it was replaced in 1995. This generator was installed during the 1970's upgrade and it provides emergency power to a majority of the 1970s (with some exceptions discussed below). The 1050 kW North Generator is estimated to consume fuel at a rate of 75 gph when operating at a full load. The 5,000-gallon fuel tank holds enough fuel for the generator to run at full load for approximately 65 hours, or 90 hours at ¾ load. This suggests that the tank size may be adequate.

- A 1,000-above ground diesel fuel tank next to (and used to fuel) the South Generator. This tank and generator was installed during the 1990's upgrade. This generator provides emergency power to preliminary treatment and primary treatment equipment including the influent pump station. The 500 kW South Generator is estimated to consume fuel at a rate of 36 gph when operating at a full load, and about 26 gph at ¾ load. The 1000-gallon fuel tank holds enough fuel for the generator to run at full load for approximately 28 hours, or 38 hours at ¾ load. This suggests that the tank size is not adequate and the size must be increased.

There are no other fuel (fuel oil, diesel, or propane) tanks onsite. The fuel tanks are approaching the end of their useful life and replacement is needed.

Natural gas is used for heating and startup of the Zimpro WAR unit. Interruptions in natural gas can be tolerated by delaying the operation of the Zimpro WAR unit.

The current electrical distribution system provides backup power to all major systems at the plant except for the following:

- Carbon regeneration system (including the carbon thickener tanks)
- Aeration blowers for tanks 1 and 2
- Certain equipment in the Solids Handling Building including the multi-hearth furnace (unused), vacuum filters (unused), and intermediate pumps (required to feed the sand filter)
- Sand filters (backwash pumps, etc.)
- The portion of the Chemical Feed Building that is not associated with disinfection.
- The Primary Clarifier Drives, Sludge Pumps
- The Thickened Sludge Pump Station include thickener drives, sludge pumps, grinders, scum pumps.
- The post aeration building and blowers
- Some lighting in the solids handling building

- Heating, ventilating, and air conditioning equipment in the Process Control Building (Backup power is available but this equipment can be taken off line by opening a breaker in MCC-PCB if necessary)

This means that during a power outage the following functions must be suspended:

- Tertiary treatment (intermediate pumps and sand filters must be bypassed – secondary effluent will flow by gravity to disinfection).
- Processing of carbon (Waste sludge from secondary clarifiers and operation of the WAR system).

To be consistent with current TR-16 requirements, the WPCF should be upgraded to provide sufficient backup power for full secondary treatment. In addition, if UV disinfection is included in the upgrade, then backup power for it must also be provided. It is also likely that plant hydraulics will require intermediate pumping (with backup power) if both UV disinfection and a phosphorus removal treatment system are installed. For planning purposes, we recommend that emergency power be provided to operate the entire upgraded WPCF, but that the generator be sized such that high-power non-critical processes are locked out if the plant is on emergency power and insufficient capacity (the plant is experiencing high flows or aeration loads) is available. This means that the generator sizing will not include the loads for the WAR system – should it be retained in the future. If the WAR system is replaced with another system, the loads should be small enough such that they would have a significant impact on generator sizing, and backup power should be provided.

Other Emergency Plans

The WPCF's Spill Prevention, Control and Countermeasure Plan (SPCC- dated April 2011) as well as the WPCFs, Storm Water Pollution Prevention Plan (SWPPP – dated June 2011) were reviewed as part of this emergency preparedness assessment. Pertinent finding are as follows:

- The SPCC plan covers oil storage and usage on site and the plant upgrade will likely significantly impact these areas as equipment and fuel storage tanks are replaced.
- The SPCC Plan and related logs did not document any spills related to oil storage in the plant in recent years.
- The SPCC does not document the materials of construction of the underground fuel tank or the containment provisions or spill prevention associated with the tank but based upon the date of the tank upgrade, we assume that the tank meets current standards.
- The SPCC plans recommendations have been implemented
- The SWPPP states that the disposal of sludge and scum from the WPCF involves pumping (or gravity flowing) into a truck with a storm drain nearby and that the current procedures are to cover the storm drain as a spill protection measure to prevent the release of scum or sludge to the storm drain in the event of a pipe, hose, or connection failure during these loading operations. Since the potential elimination of the Zimpro system will increase the volume of sludge disposed from the site though this location, we recommend consideration be given to

upgrading spill prevention measures at the sludge truck loading station to better prevent the release of sludge to the storm sewers during truck loading operations. This would likely take the form of modified grading for the area and a new storm drain with a valve located in it that can be closed during sludge loading operations. Consideration could also be given to the addition of an overflow pipe (and used a three-way valve) to direct any storm water (or spilled sludge) from the manhole to the nearby drainage wet well which is part of the Solids Handling Building.

- The SWPPP does not discuss the discharge of septage to the manhole at the east side of the WPCF. Similar to the sludge truck loading area, this location has the potential to release spilled septage to the storm sewers. We recommend consideration be given to upgrading spill prevention measures at the septage receiving manhole to better prevent the release of septage to the storm sewer during septage truck unloading operations if this location is to be used in the future. This would likely take the form of a containment pad that fits the rear of a septage truck and drains to the manhole.

- In the years preceding the development of the SWPPP, there was one minor spill event at the primary sludge thickener tank involving 50 gallons of sludge and water. Other reported events were related to bypassing part of the treatment process (intermediate pump station and the sand filters) which appear to have resulted in mostly treated wastewater (disinfected secondary effluent) spilling onto the ground and making its way to the Hockanum River via the storm sewers instead of the plant outfall pipe.

- Since the development of the SWPPP, other minor spills were recorded, most were again related to bypassing part of the treatment process (the intermediate pump station and sand filters) which appear to have resulted in mostly treated wastewater (disinfected secondary effluent) spilling onto the ground and making its way to the Hockanum River via the storm sewers instead of the plant outfall pipe.

- The SWPPP required storm water sampling program reportedly has not identified any major concerns with storm water from the site.

Critical Equipment Failures

Due to the history of bypassing the sand filter building due to failures at the intermediate pump station, we evaluated the risk of failures in pumping system at both the influent and intermediate pump stations.

The influent pump station has three pumps, two fed from one MCC and another fed from a different MCC. Each MCC has two power feeds, one from the south generator and one from the utility via the main service switchgear so the probability of a single point of failure disabling the influent pump station is very low. If the automatic control system fails, the pumps can be run in manual if needed. However, if there was a failure that led to the loss of all pumps or only one pump at high flows, then the low lying grit room portion of the Preliminary Treatment Building would flood (operators have reported that this has happened in the past) potentially damaging low lying electrical equipment in this area. During the upgrade of any equipment in this room, care must be given to avoid electrical equipment that can be damaged by flooding and spare motors should be provided for the equipment for quick replacement in case of flooding. The water will rise until it results in

a bypass in the collection system and/or overflow of the grit room onto the site outside the building where it will run across the site before entering the storm drains in the low lying areas. For the purposes of this resiliency analysis, we have assumed that the site's storm drain system has adequate capacity to accept this flow without flooding as the site is above the 100-year plus three feet flood elevation as discussed previously. If it does not, then the critical electrical distribution equipment located on a concrete pad could be threatened. Because the upgrade of the plant as recommended in this plan will likely impact the storm drain system with the construction of new structures, this needs to be verified during the design of the WPCF upgrades after a topographical survey has been completed and a reasonable contingency included in the estimated project cost to make these improvements.

The intermediate pump station has three pumps, all fed from the same MCC currently without backup power. In the event of power loss, the sand filters are bypassed. This is done by manually opening a sluice gate at the distribution (bypass) Chamber F and sending the flow to the chlorine contact tank. As discussed above, there have been other failures that have led to bypassing as well. Since this gate must be manually opened, there is the potential for bypassing during the intervening time. Secondary effluent will collect in the wet well until it overtops the wetwell at elevation 221.0 (and possibly at upstream structures depending on flows) where it will run across the site to the north (away from critical equipment), enter the storm drainage basins to the north of the building and flow to the river. During the upgrade of the WPCF, consideration should be given to either modifying this bypass chamber by adding an overflow weir or by automating the gate to open the gate in the event of an intermediate pump station failure. The goal would be to reduce the likelihood of un-disinfected secondary effluent reaching the river. Each improvement (as well as doing nothing) has risks and each option should be carefully evaluated while other improvements are considered in this upgrade and their effect on the hydraulic profile.

The overland flood route of the spill waters from a potential pumping system failure at the either of these locations is illustrated in Figure 2-5. In the case of the influent pumping station the water would pound around the "spill zone" previously discussed as part of the flooding analysis at levels that should not exceed those shown during a river flooding event.

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# SECTION 3

# Section 3
# Current and Future Planning Conditions

This section provides an overview of current conditions throughout the Town, including geographic profile, Town organization and demographics, and it presents the current and future flow and loading projections for the WPCF and anticipated regulatory requirements for wastewater management. The updated sewer service area map and Water Pollution Control Plan are presented in this section.

## 3.1 Current Demographic Data and Land Use – Vernon

### 3.1.1 Geographic Profile

The Town of Vernon is located within Tolland County in the central area of Connecticut as shown on the regional locational map in Figure 3-1. The Town is bordered to the north by Ellington, to the south by Manchester and Bolton, to the east by Tolland and Coventry, and to the west by South Windsor. The nearest urban population centers include Hartford, 14 miles to the west; Springfield, MA, 20 to the north; New Haven, 42 miles to the southwest; and Providence, 56 miles east of Vernon.

The Town was incorporated in 1808. The total land area of Vernon is approximately 181 square miles. The Town is largely a modern residential, commercial, and industrial community, and the majority of the remaining undeveloped areas are zoned for residential development.

Interstate 84 connects with I-90, I-384, I-91, and I-291 near Vernon and provides regional access. This convenient access has contributed to Vernon's development as a suburban community and commercial center for neighboring towns. Interstate 84 bisects the Town from east to west. Interstate 384 traverses south of Vernon where it splits into Route 44 and Route 6.

### 3.1.2 Existing Land Use

The land in Vernon is comprised mostly of residentially zoned areas, with large areas of open space land located in the southeast portion of the Town. High density residential areas and commercial/industrial development is concentrated along the I-84 corridor.

### 3.1.3 Zoning

Vernon has enacted Zoning Regulations that enable it to regulate uses and dimensional criteria for development within the Town. These regulations were adopted and amended by the Vernon Planning and Zoning Commission under the authority of Chapters 124 and 126 of the Connecticut General Statutes.

The Town has several residential, business, industrial, and other districts including:

**Residential Districts**

- R-10 – Single Family Residential
- R-15 – Single Family Residential

- R-22 – Single Family Residential
- R-27 – Single Family Residential
- R-40 – Single Family Residential
- MHP – Mobile Homes Parks
- PRD – Planned Residential Development

**Business Districts**

- C – Commercial
- PC – Planned Commercial
- SED – Special Economic Development

**Industrial Districts**

- I – Industrial

**Historic District**

- RC – Residential Commercial
- NR-10 – Neighborhood R-10
- RW – Restricted Watershed
- DBR – Downtown Business & Residential
- PND – Planned Neighborhood Development
- HD-I – Historical District Industrial

**Other Districts**

- PDZ Exit 67 – Planned Development Zone: I-84 Exit 67 Area
- PDZ Gerber – Planned Development Zone: Gerber Farm Area
- SFZ-GZ – Special Floating Zone – Garden Zone
- OS – Open Space

These districts are shown on the Zoning Map as Figure 3-2.

## 3.2 Wastewater Management - Vernon

Vernon operates under a mayor-council form of government subject to approval by the Town's electorate at Town Meetings on certain appropriations and the Annual Budget. The Town also has several Boards, Committees and Departments of both elected and appointed members that carry out municipal activities, set policies, and hold public forums to solicit resident and business input. An Annual Town Meeting is held on the fourth Tuesday in April to approve the budget and other warrant articles.

The Town department which oversees wastewater management is the Water Pollution Control Department. The Water Pollution Control Department makes recommendations to the Water Pollution Control Authority regarding utility/infrastructure improvements, maintenance and development, and sewer rates. The Water Pollution Control Department is also responsible for day-to-day wastewater responsibilities including collector sewers, pumping stations and wastewater treatment.

East Windsor

Ellington

Tolland

South Windsor

Vernon

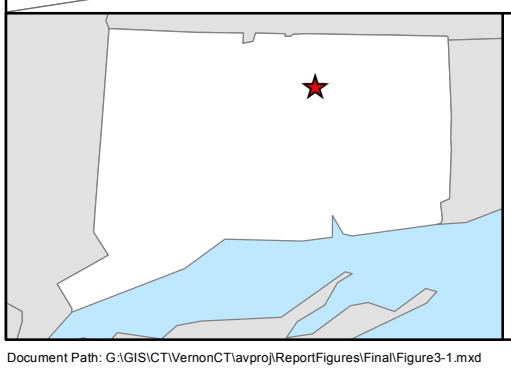
Coventry

Manchester

Bolton

Andover

Glastonbury



0 1,250 2,500 5,000 Feet

N

# Figure 3-1
# Site Location Map

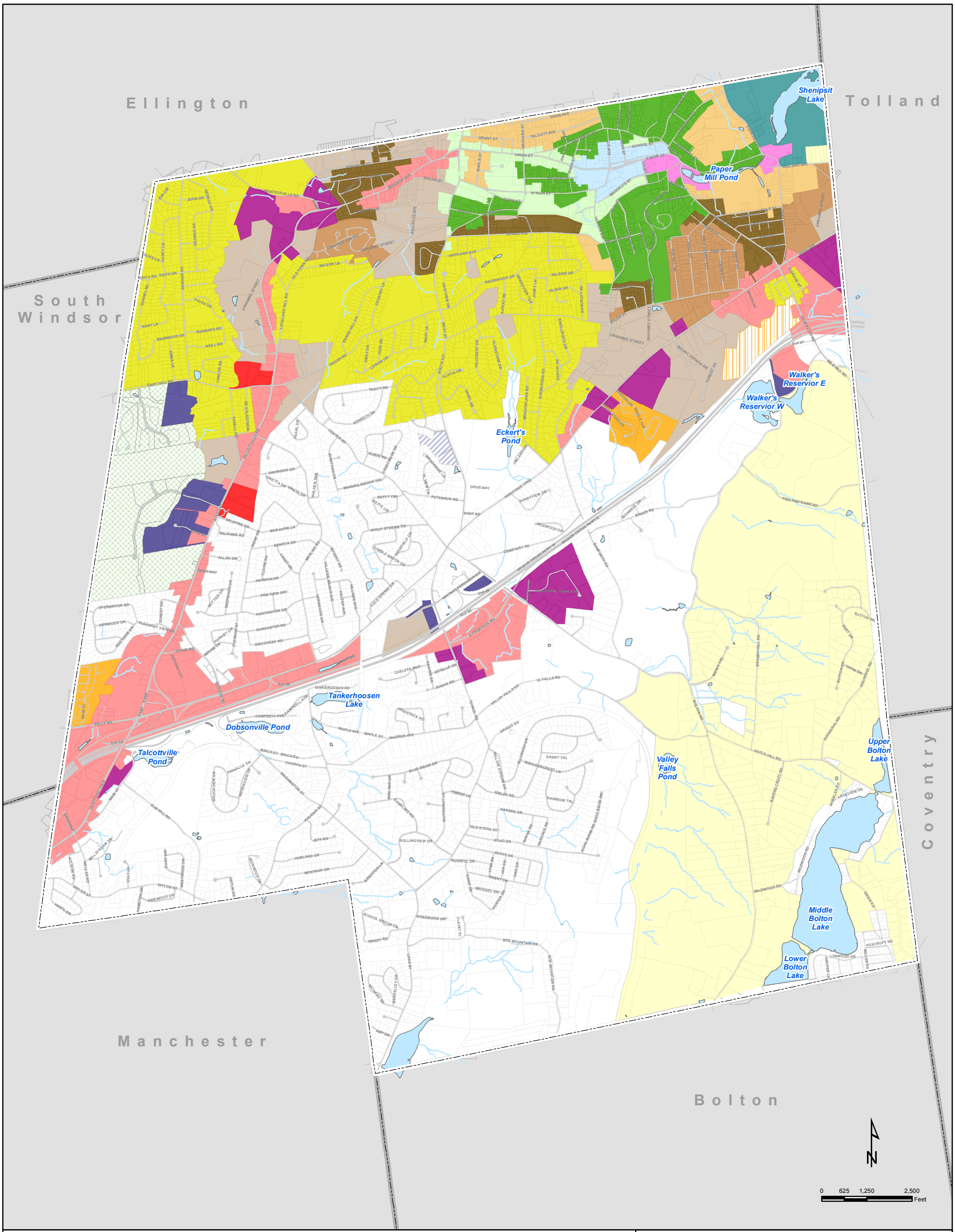
Wastewater Facilities Plan
Vernon, Connecticut

May 2017

Tighe&Bond
Engineers | Environmental Specialists

Document Path: G:\GIS\CT\VernonCT\avproj\ReportFigures\Final\Figure3-1.mxd

W-0037




## Legend

- Water Bodies
- Parcel Boundary
- Town Boundary

**Rockville Area**

- NR-10 (Neighborhood NR-10)
- RW (Restricted Watershed)
- RC (Residential Commercial)
- RDBR (Rockville Downtown Business & Residential)
- PND (Planned Neighborhood Development)
- HD-RC (Historic District Residential Commercial)

**Business**

- SED (Special Economic Development)
- PC (Planned Commercial)
- C (Commercial)
- HD-I (Historic District Industrial)
- I (Industrial )

**Residential**

- R-10 (Single Family Residential)
- R-15 (Single Family Residential)
- R-22 (Single Family Residential)
- R-27 (Single Family Residential)
- R-40 (Single Family Residential)
- PRD (Planned Residential Development)
- MHP (Mobile Home Parks)

**Other**

- PDZ-EXT 67 (I-84 Exit 67 Area)
- CMFD (Comprehensive Multi-Family Dwelling)
- PDZ (Planned Development Zone Gerber Farm)
- SFZ-GZ (Special Floating Zone - Garden Zone)

# Figure 3-2
# Zoning Map

Wastewater Facilities Plan
Vernon, Connecticut

May 2017

Tighe&Bond
Engineers | Environmental Specialists

Document Path: G:\GIS\CT\VernonCT\avproj\ReportFigures\Final\Figure3-2_Zoning.mxd

W-0037

Vernon has established sewer rules and regulations. These regulations also guide sewer system construction and the use of the sewerage system, including provisions prohibiting illicit connections. The Town periodically updates these regulations.

# 3.3 Planned Growth and Economic Development - Vernon

## 3.3.1 Population Projection

The University of Connecticut (UCONN) State Data Center provides population projections to assist various entities in their planning efforts. These projections take into account multiple data sources, and are funded by the Office of Policy and Management (OPM). According to the Data Center, Vernon's population is projected to grow to 31,172 by the year 2030, and then drop slightly, reaching a population of 30,878 by the year 2037. A graph of this population data is provided as Figure 3-3.

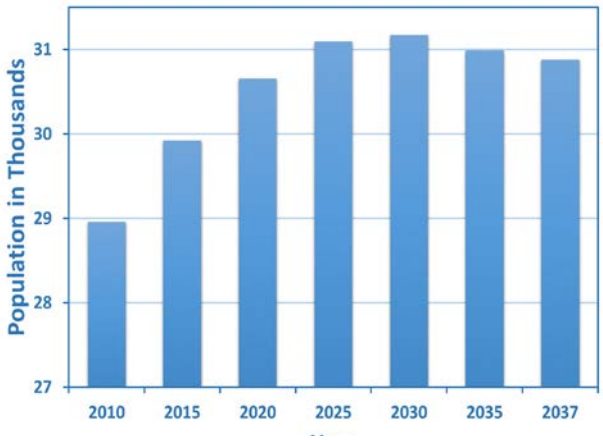



**Figure 3-3**
UCONN Population Projections

## 3.3.2 Town of Vernon Plan of Conservation and Development

Town-wide planning efforts identify the vision for a community and future growth. This information is important in determining current and future infrastructure needs. The Vernon Planning and Development Department develops and implements planning initiatives for the Town. The Town Planner works with the Mayor, Town Administrator, and other Town Boards and Commissions on a range of issues including providing review and zoning compliance advice on proposed development to ensuring Vernon's interests are incorporated into regional plans.

Vernon's Plan of Conservation and Development was most recently adopted on November 17, 2011 and became effective on January 30, 2012. The State of Connecticut requires that the Town's Planning and Development Department prepare and maintain the Plan as a framework for development decision-making in terms of land use, densities and design standards, and as a guide to identifying public improvements, facilities and services. The 2012 Plan identified key land use and planning issues and opportunities in Vernon, and it outlined a vision for each issue area as well as strategies to achieve the vision.

The Town Planner and Economic Development Coordinator were included in a Water Pollution Control Plan Workshop held as part of this Facilities Planning process. They also reviewed the future sewer service area map and development projections presented in this study. The sewer service area boundary was developed to include all applicable residential, commercial and industrial zoned areas in Town to support the Town's goal of economic growth and development.

### 3.3.3 Connecticut Plan of Conservation and Development

Public Act 10-138 required the Office of Policy and Management to develop an update to the State Plan of Conservation and Development (C&D Plan), and CGS Section 16a-31 requires that certain state agency actions (including but not limited to funding growth-related projects) be consistent with the State C&D Plan. The updated state plan *Conservation and Development Policies: The Plan For Connecticut, 2013-2018* (State C&D Plan) contains six growth management principles that seek to balance regional growth priorities with environmental and conservation priorities. In addition to the six growth management principles, the State C&D Plan includes a "Locational Guide Map" (LGM) which contains various land classifications and criteria to assist state agencies in determining the consistency of their proposed actions with the State C&D Plan and LGM. A copy of the LGM for Vernon is presented as Figure 3-4. The Office of Policy and Management (OPM) is responsible for revising and administering the State C&D Plan on a recurring 5-year cycle. The current State C&D Plan was reviewed and is summarized below. The State C&D Plan was taken into consideration as the sewer service area was updated during this facilities planning process.

The plan's main focus is on six "Growth Management Principals" (GMPs), each with a corresponding map which presents specific information related to the individual GMP. Each of the six GMPs was reviewed to determine how they may impact the growth of future sewer extensions within the Town. A discussion of each GMP follows:

1. "Redevelop and Revitalize Regional Centers and Areas with Existing or Currently Planned Physical Infrastructure" – This GMP focuses on maintaining/upgrading existing infrastructure to promote development in these existing areas. The map for this GMP indicates a "Sewer Service and/or Water Service Area" that covers a similar area to where the Town's existing sewer system is located. This GMP does relate to the maintenance and upgrade of the Vernon's WPCF.

2. "Expand Housing Opportunities and Design Choices to Accommodate a Variety of Household Types and Needs" – This GMP discusses ways to promote development of a variety of housing options. One subsection of this GMP focuses on the identification of innovative mechanisms utilizing decentralized small-scale water and sewage treatment systems to support increased housing density in village centers and conservation subdivisions that lack supporting infrastructure. This GMP is focused on innovative methods of providing sewer service, and any expansion of the sewerage system to accommodate future development can be accomplished using traditional means. Therefore, this GMP is not specifically relevant to expansion of the existing collection system. Consideration of sewer collection system expansion however, will take into consideration needs to support housing choices in Town.

3. "Concentrate Development Around Transportation Nodes and Along Transportation Corridors to Support the Viability of Transportation Options" – This GMP is focused on discussions surrounding roads, highways, ports, and pedestrian/bike paths, greenways, etc. As such, this GMP is not relevant to Facilities Planning in terms of sewer service.

4. "Conserve and Restore the Natural Environment, Cultural and Historical Resources and Traditional Rural Lands" – This GMP focuses on the protection of natural resources. It discourages sewer expansion in the following areas: critical habitats,

local historic districts, protected lands, wetland areas, preserved farmland, 100-year flood zone, and core forest areas. It does allow for "the introduction or expansion of public water and/or sewer services or advanced wastewater treatment systems only when there is a demonstrated environmental public health, public safety, economic, social or general welfare concern, and then introduce such services only at a scale which responds to the existing need without serving as an attraction to more extensive development." Consideration of sewer collection system expansion will take into consideration important resources while balancing targeted economic growth areas.

5. "Protect and Ensure the Integrity of Environmental Assets Critical to Public Health and Safety" – This GMP discusses the protection of public water supplies and water resources, discouraging development in floodway and floodplain areas, and minimizing impacts of development in floodway and floodplain areas, and minimizing impacts of development on drinking water sources. Sewer expansion is discouraged in the following locations: aquifer protection areas, existing and future/potential watershed areas, and areas of contribution to public supply wells.

6. "Promote Integrated Planning Across All Levels of Government to Address Issues on Statewide, Regional and Local Basis" – This GMP talks about how the LGM was developed as a basis for establishing Priority Funding areas and encourages municipalities to incorporate utility service areas developed as part of the wastewater facilities planning process into the local plan of conservation and development. To maintain consistency with the State C&D Plan, any modifications to the Sanitary Sewer Service Area Map created as part of this project will be incorporated as part of the next update to the Town of Vernon Plan of Conservation and Development.

Ellington

Tolland

South Windsor

Manchester

Bolton

Coventry

**Legend**

**Priority Funding Areas**
- 1-2 Criteria
- 3-4 Criteria
- 5 Criteria
- Local Historical District

**Conservation Areas**
- 1-3 Factors
- 4-5 Factors
- 6-7 Factors
- Protected Lands

- Balanced Priority Funding Area
- Water Bodies
- Parcel Boundary
- Town Boundary

0 625 1,250 2,500 Feet

N

# Figure 3-4
## OPM Locational Guide Map

Wastewater Facilities Plan
Vernon, Connecticut

May 2017

Tighe&Bond
Engineers | Environmental Specialists

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W-0037

### 3.3.4 Potential for Development and Redevelopment – Mill Conversions and Others

The Town of Vernon contains several industrial mills that are no longer in use. There are also a number of vacant parcels located in both commercial and residential zones that have the potential for development over the 20-year planning period.

As part of the Facilities Planning process, the Vernon Planning and Economic Development Department was consulted to determine known or potential uses for abandoned mill sites, as well as any other proposed developments within the Town on vacant lots. Town staff indicated the projects listed below. The location of each site is presented in Figure 3-5:

1. Talcottville Mill, 47 Main Street. This site has been approved as an 84-unit apartment complex with some light commercial development (offices).

2. Amerbelle Mill/Daniels Mill, 5 Brooklyn Street/98 and 104 East Main Street. This complex originally consisted of 240,000 sf of manufacturing use, of which 150,000 sf has been torn down. The site is currently not being used, and there are a number of ways that development could take place on this site. There is speculation that it could be used for a combination of residential and commercial development. It is not possible to install a development that consists solely of residential use.

3. Loom City Lofts, 215 East Main Street. This site contains a 64-unit residential complex. Construction was completed in the Spring of 2016.

4. Hockanum Mill, 200 West Main Street. This facility contains 140,000 sf of space. It is being proposed to be used as a motorcycle repair shop/museum and some type of large scale restaurant and/or catering facility.

5. Exit 67 Area, commercial parcel north of 84 behind McDonalds (14 Hyde Avenue on Town GIS). There is the potential for a hotel and 200 apartments to be constructed as well as at least 1 restaurant.

6. Residential parcels on Mile Hill Road just south of Interstate 84 in the vicinity of Exit 67. A number of Assisted Living facilities have inquired about this area, and the property owner is actively trying to sell them. Lack of sewers has been an issue. Development can only be in the form of an assisted living facility or residential use.

7. Gerber Farm Planned Development, located at 243 Talcottville Road. A 300-unit multifamily housing project has been approved with 4 pad sites upfront which are expected to contain a mix of retail and restaurant establishments.

Town staff further indicated that at this time, there are no changes proposed to the current zoning map. In addition, there are no known projects under consideration that would require a zoning change. However, the Town also reserves the right to change the zoning map if needed to accommodate a project that would be of benefit to the Town. Based on this input from the Town, future flows will be developed based upon the current zoning map.

Ellington

Tolland

South Windsor

Coventry

Manchester

Bolton

Daniels Mill
98 East Main Street
104 East Main Street

Loom City Lofts
215 East Main Street

Hockanum Mill
200 West Main Street

Amerbelle Mill
5 Brooklyn Street

WPCF

Commercial Parcel
14 Hyde Avenue

Residential Parcel
Mile Hill Road

Gerber Farm
Planned Development
243 Talcottville Road

Talcottville Mil
47 Main Street

84

## Legend

- WPCF — Water Pollution Control Facility
- Vernon Sevice Area
- Bolton Lakes Service Area
- Converted Mill Properties
- Parcel Boundary
- Town Boundary

0 625 1,250 2,500 Feet

N

# Figure 3-5
# Proposed Development Projects

Wastewater Facilities Plan
Vernon, Connecticut

May 2017

Tighe&Bond
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W-0037

## 3.4 Significant Industrial Users and Over the Road Wastewater

Significant Industrial Users (SIU) and Over the Road Wastewater impacts on the plant's flows and loads were reviewed.

### 3.4.1 Industry

In order to identify significant industrial users that discharge to the Vernon WPCF, the CTDEEP was contacted to identify commercial and industrial establishments that are required to obtain an industrial permit from the CTDEEP. A review of existing permits found that most permits were for relatively small commercial establishments such as gas stations, car washes, and vehicle maintenance facilities. Known significant industrial users are discussed individually in more detail below.

Pure Country Foods - This company is located in Ellington and it produces food/beverage projects (e.g. juice) and flows go to Vernon plant. The facility has a state discharge permit.

Anocoil, LLC, Vernon CT: This company is located on East Main Street in Vernon, and it specializes the development and manufacturing of printing plates for the newspaper and commercial printing markets. A review of discharge reports from December 2014 - August 2016 yielded the following observations on wastewater discharges from this facility:

- Daily flows vary widely from less than 2,000 gpd when the facility is shut down for maintenance to greater than 200,000 gpd when the facility is in operation. The highest single daily flow was 256,620 gallons, noted to take place in August, 2016.
- Effluent pH values typically ranged from 6.0 – 8.0. However, on one occasion a very high pH reading of 9.68 was observed.
- Total Suspended Solids average readings generally ranged between 1,200 - 1,600 mg/l with a maximum value noted of 2,560 mg/l.
- Aluminum readings typically ranged between 100 - 200 mg/l, with a maximum value noted of 401 mg/l.

Anocoil, LLC does not currently have a total phosphorus (TP) limit in their discharge permit, so no actual TP data is available. However, it is understood that they use phosphoric acid in their industrial process. Although they do not discharge concentrated phosphoric acid from their process tank directly to the sewer, there is believed to be phosphorus carry over from the phosphoric acid process tank into the rinse water tank via acid that remains on the product surface. The rinse water is then discharged. Estimations of phosphoric acid loss via this pathway range from 50-100 lb/d as P. All waste streams at Anocoil are mixed together and treated for pH adjustment prior to discharging to the WPCP. During this process, it is believed that the phosphoric acid reacts specifically with the aluminum metal it is treating to form particulate aluminum-phosphorus salts, not unlike the process of chemical phosphorus removal using aluminum based coagulants. The result of this reaction is that the phosphorus discharged from Anocoil is primarily a stable, non-reactive particulate, and not as a dissolved ortho-phosphorus form. Therefore, although the WPCP observes a high TP load in the influent, it is believed that a significant portion of this load is removed in the primary clarifiers by settling of the TP precipitate.

Anocoil is currently in the process of applying for a discharge permit renewal. The Town is working with CT DEEP during this process to minimize excessive loads to the WPCP. As a result, the Town is confident that the renewed permit will include a limit for TP, thereby significantly reducing the TP load from Anocoil in the future. The future TP design loads will be adjusted accordingly to eliminate this load. See Section 3.9 for details on how the future design loads were adjusted.

### 3.4.2 Septage

Over the past three years the Vernon WPCF accepted approximately 9,400 gallons of septage per day on average, and 25,700 gallons per day during the observed maximum month. Accepting septage at the WPCF is a significant revenue source for the Town. As part of the 1993 upgrade, a septage receiving station was constructed within the Preliminary Treatment Building; however, as the Town accepted more septage, the daily flow exceeds the receiving station's capacity. Currently septage is received in Manhole A on the North Sewer interceptor coming into the plant. Septage is processed along with the municipal wastewater through the WPCF's preliminary treatment equipment. There is no mechanism to equalize the flow and load associated with receiving septage at this location.

### 3.4.3 Other Trucked-In Wastewater

In addition to septage, the Vernon WPCF also accepts industrial waste commonly referred to as 454 wastes because they are regulated by Connecticut DEEP in accordance with Connecticut General Statues Section 22a-454. On average, the WPCF accepts approximately 300 gallons of 454 waste per day; however, this average quantity is misleading since the plant actually accept approximately 2,300 gallons of waste once every few weeks, on average. Over the past year, the quantity of 454 waste accepted by the Town has decreased significantly. The WPCF utilizes the septage receiving station built in 1993 to accept and process these 454 wastes. This waste stream provides the Town with another revenue source.

## 3.5 Needs in Areas Served by Decentralized Wastewater Systems – Vernon

The adequacy of existing on-site disposal systems in unsewered portions of Vernon was evaluated to determine if there is a compelling need to extend sewers in order to alleviate failing systems. The North Central District Health Department maintains historical records dating back to 1999 regarding activities relating to existing on-site wastewater disposal systems within the Town, and relevant information was gathered and presented at the Water Pollution Control Plan Workshop held on October 28, 2016.

Records of on-site wastewater disposal system failures, repairs, and repairs granted with variances where code requirements cannot be met are indicative of not only past problems but of potential future problems.

Based on correspondence with members of the Health Department at the Workshop, there are several areas in Vernon that should be considered for future inclusion into the sewer service area. These include residential parcels along Box Mountain Road, Bamforth Road, Maxwell Drive, Bolton Road and Industrial Park Road. Documentation provided by the Health Department shows a number of septic system repairs, as well as repairs that had to be completed with an exception from the Public Health Code.

These areas of need (except for Box Mountain Road) as identified by the Health Department have been incorporated in the future sewer service area as discussed in Section 3.6. Box Mountain Road was not included in the system expansion area at this time due to the high cost of providing sewers to this area. One area that includes parcels along Bolton Road south of Indian Trail was determined to be in closer proximity to the Bolton Lakes Sewer District. It is recommended that the Bolton Lakes Sewer District be contacted if sewers are ever requested on this street as flow from this area was not included in this planning effort.

An email documenting onsite system condition and maps prepared by the Health Department are included as Appendix D.

## 3.6 Future Sewer Service Area Map and Water Pollution Control Plan – Vernon

As part of this Facilities Plan, a future Sewer Service Area was defined for the Town of Vernon taking into consideration population projections, the Town's plans for growth and development, the State C&D Plan, and the ability to accommodate potentially failing on-site systems that may be served in the future. The updated Sewer Service Area is shown on the map in Figure 3-6. The boundaries include the current sewerage system, selected unsewered areas in the southern area of town with poor soils as discussed in Section 3.5, and parcels in the vicinity of Exit 66 and 67 off of Interstate 84 that have been identified for future growth and economic development. Two parcels listed as open space in the Town of Vernon's Plan of Conservation and Development have also been omitted from the Sewer Service Area. The Sewer Service Area Map was used as the basis for developing 20-year future flow projections and capacity analyses as part of this Facilities Plan.

The Sewer Service Area map has been reviewed by the Town staff, the Vernon Water Pollution Control Authority, and the CT DEEP.

Figure 3-7 presents an overlay of the existing and proposed Sanitary Sewer Service Area onto the OPM Legislative Guide Map. As shown, all extensions of the service area are proposed to take place within Priority Funding Areas. Therefore, there are no conflicts with the proposed Sanitary Sewer Service Area and the OPM Legislative Guide Map.

GIS information in layer format was obtained from the CTDEEP website for aquifer protection areas, prime agricultural farmland, and wetland soils (based upon the national wetland inventory). Figure 3-8 presents an overlay of the existing and proposed Sanitary Sewer Service Area onto these 3 GIS layers of information. Differentiation has also been made between parcels connected to the sewer system, and both developed and undeveloped parcels within the Sewer Service Area which are not yet connected.

As shown in Figure 3-8, while some of the proposed sewer area expansion is located within farmland areas, all parcels in these areas are already developed and there are no farmland soil parcels greater than 25 acres in size. Wetland soils are also present, however, all lots in wetland areas are already developed and any sewer extensions within these areas will be subject to review and approval from the Town of Vernon Inland Wetlands Commission.

There are two Level B aquifer protection areas shown on Figure 3-8 which overlap the sewer area. A majority of parcels in these areas are already developed and either

connected to the sewer or have available access to connect. No Level A aquifer protection areas exist within the Town of Vernon.

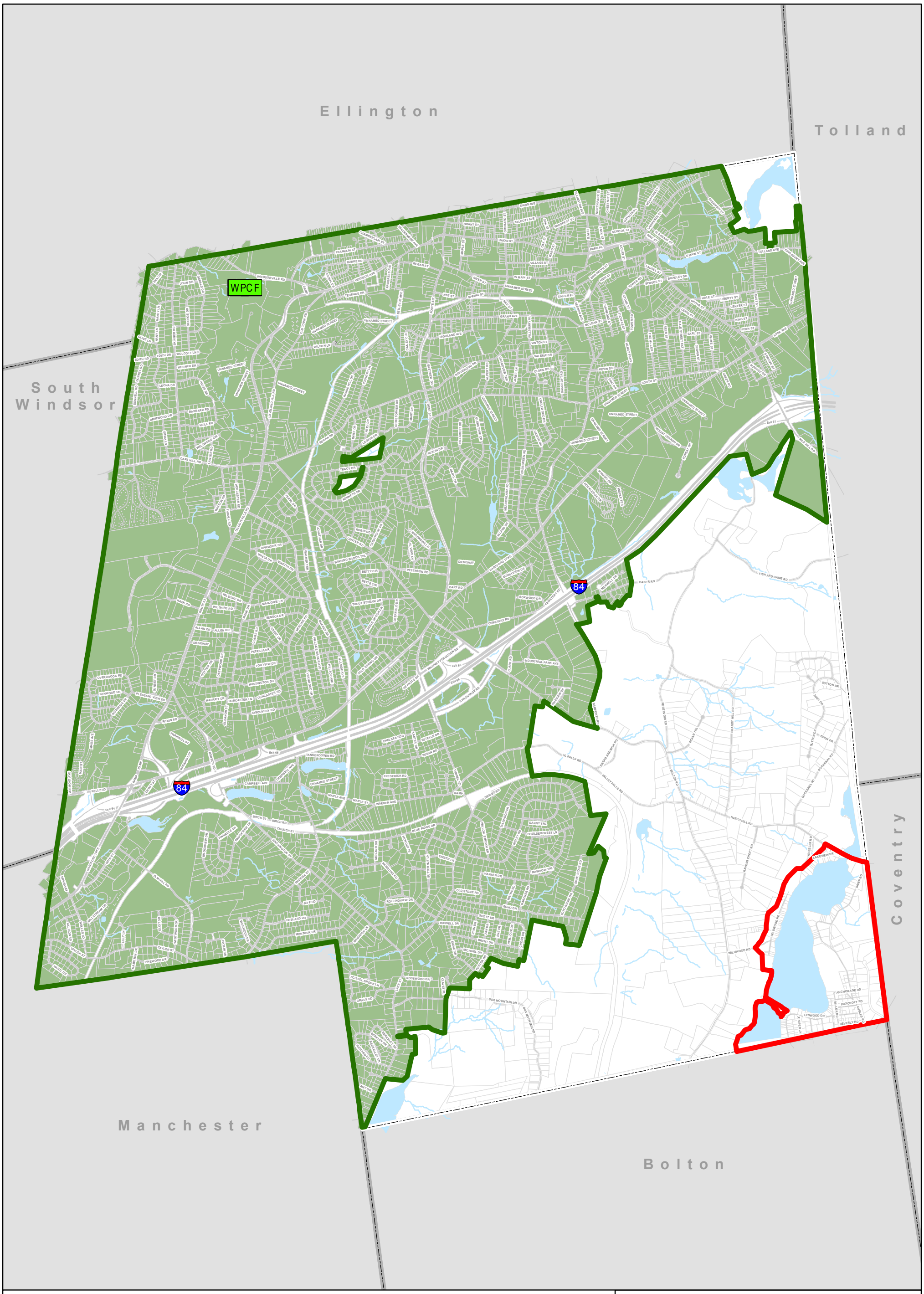
The locations of the mill conversations/known potential developments discussed in Section 3.3.4 were identified in Figure 3-5. Table 3-1 lists each property, as well as a discussion of other specific parcels proposed for future sewer service located in aquifer protection areas, wetland soils and/or farmland areas. Justification for the inclusion of each area/parcel within the sewer service area is also included in the table.

**TABLE 3-1**
Proposed Developments/Sewer Extension Areas

| Map Identification Number | Parcel Name/ Address | Conflicts | Justification for Inclusion into Service Area |
|---|---|---|---|
| 1 | Talcottville Mill, 47 Main Street | None | Existing parcel connected to sewer system. Former mill site being converted to apartment complex w/commercial offices |
| 2 | Amerbelle Mill/Daniels Mill, 5 Brooklyn Street, 98 and 104 East Main Street | None | Existing parcel connected to sewer system. Former mill site proposed for residential and commercial development |
| 3 | Loom City Lofts, 215 East Main Street | None | Existing parcel connected to sewer system. Parcel contains 64 residential units. |
| 4 | Hockanum Mill, 200 West Main Street | None | Existing parcel connected to sewer system. Former mill site being converted to motorcycle repair shop/museum and possible restaurant/catering facility |
| 5 | Exit 67 Area, 14 Hyde Avenue | Prime Farmland Soils (16.49 acres) | Existing commercial parcel connected to sewer system. Significant development is possible. |
| 6 | Exit 67 Area, just south of I-84 (3 areas: Developed Parcels adjacent to highway and large undeveloped parcel) | Prime Farmland Soils on developed parcels | Development proposed in the form of residential and/or assisted living Facility |
| 7 | Gerber Farm Development, 243 Talcottville Road | Prime Farmland Soils on eastern portion of parcel (10.38 acres) | Approved 300-unit housing complex with mix of retail and restaurants. |
| 8 | Residential Lots south of Interstate 84: Maxwell Drive, Bamforth Road, Pineview Drive | Prime Farmland Soils on some lots | Health Department has recommended sewer expansion due to history of septic system repairs. |
| 9 | Commercial/Industrially zoned lots south of Interstate 84 in the vicinity of Exit 66 | Prime Farmland and Wetlands Soils in some areas | Town would like to see sewer expansion to promote growth in this area. Most lots are already developed. |

Note: All parcels listed in Table 3-1 are consistent with the State of Connecticut Plan of Conservation and Development

The Water Pollution Control Plan is a written document that establishes the sewer service area (as shown on the map), areas where sewers are to be avoided, identifies the capacity of the sewerage system, and includes any other miscellaneous wastewater or related issues specific to the municipality. The draft Water Pollution Control Plan is provided as Appendix E. It is expected that the Vernon Water Pollution Control Authority will formally adopt this plan following a public hearing.




## Legend

- WPCF — Water Pollution Control Facility
- Vernon Sevice Area
- Bolton Lakes Service Area
- Parcel Boundary
- Town Boundary

*This map is intended to serve as a companion to the Town of Vernon Water Pollution Control Plan. Refer to the Plan for more information.*

0 625 1,250 2,500 Feet

N

# Figure 3-6
# Sanitary Sewer Service Area

Wastewater Facilities Plan
Vernon, Connecticut

June 2017

Tighe&Bond
Engineers | Environmental Specialists

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W-0037

Ellington

Tolland

South Windsor

Coventry

Manchester

Bolton

**Legend**

- Vernon Sevice Area
- Bolton Lakes Service Area
- Balanced Priority Funding Area

**Priority Funding Areas**

- 1-2 Criteria
- 3-4 Criteria
- 5 Criteria
- Local Historical District

**Conservation Areas**

- 1-3 Factors
- 4-5 Factors
- 6-7 Factors
- Protected Lands

- Water Bodies
- Parcel Boundary
- Town Boundary

0 625 1,250 2,500 Feet

N

# Figure 3-7
# OPM Legislative Guide Map & Sewer Service Area Overlay

Wastewater Facilities Plan
Vernon, Connecticut

June 2017

Tighe&Bond
Engineers | Environmental Specialists

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W-0037

Ellington

Tolland

South Windsor

Coventry

Manchester

Bolton

WPCF

1

2

3

4

5

6

7

8

9

Shenipsit Lake

Paper Mill Pond

Open Space

Walker's Reservior W

Walker's Reservior E

Dart Hill Park

Eckert's Pond

Tankerhoosen Lake

Dobsonville Pond

Talcottville Pond

Valley Falls Pond

Upper Bolton Lake

Middle Bolton Lake

Lower Bolton Lake

84

## Legend

- Sewer MH
- WPCF Water Pollution Control Facility
- Sewer Pipes
- Level A Aquifer Protection Area
- Level B Aquifer Protection Area
- 1 Proposed Development/Sewer Extension Area ID *See Table 3-1 for details*
- Vernon Sevice Area
- Bolton Lakes Service Area
- Prime Farmland Soils
- NWI Wetlands
- Water Bodies
- Undeveloped Parcel, Not connected to sewer
- Developed Parcel, Not connected to sewer
- Sewer Connected Parcel
- Outside Sanitary Sewer Service Area
- Town Boundary

0 625 1,250 2,500 Feet

N

**Figure 3-8**
**Sanitary Sewer Service Area Overlay: Aquifer Protection Areas, Farmland Soils, and Wetlands**

Wastewater Facilities Plan
Vernon, Connecticut

June 2017

Tighe&Bond
Engineers | Environmental Specialists

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W-0037

# 3.7 Coordination with Contract Communities Served by Vernon

## 3.7.1 Summary Existing Inter-Municipal Agreements

The Town of Vernon accepts flow at the Vernon WPCF from the Towns of Manchester, Tolland, South Windsor, and Ellington. Maps showing the extent of sewered areas within each of these communities are included in Appendix F.

Inter-municipal agreements exist between the Town of Vernon and each of these communities. A summary of the terms of each agreement is as follows:

Town of Manchester: Original Agreement dated July, 1981, amended on August 26, 1996. Total flows from Manchester are limited to an average daily flow of 0.090 MGD with a peak hourly flow of 0.36 MGD. Capital costs are to be repaid based upon a ratio of the average daily flow allocation to Manchester divided by the "average daily design flow" of the Vernon WPCF.

Town of Tolland: Original Agreement dated April 6, 1989. Total flows from Tolland are limited to an average daily flow of 0.40 MGD with a peak hourly flow of 1.6 MGD until the design year of any proposed expansion at the Vernon WPCF. The agreement allows for an ultimate flow contribution of 1.0 MGD, with a peak hourly flow of 3.8 MGD. Capital costs are to be repaid based upon a ratio of the average daily flow allocation to Tolland (0.4 MGD) divided by the "permitted average daily flow" at the Vernon WPCF.

Town of South Windsor: Original Agreement dated October 13, 1983, amended on September 17, 1985, and further amended on August 26, 1996. Total flows from South Windsor are limited to an average daily flow of 115,280 gallons per day, with a peak hourly flow of 461,120 gallons per day. Capital costs are to be repaid based upon a ratio of the average daily flow allocation to South Windsor divided by the "average daily design flow" of the Vernon WPCF.

Town of Ellington: Original Agreement dated July 1, 2003, modified on June 27, 2005 and April 12, 2013. Ellington is limited to an allowable maximum flow of 1.4 MGD. There is also an Agreement dated August 7, 2002 which gives Ellington the right to maintain a pump station on the Town of Vernon WPCF property. The 2013 modification states that Ellington will be responsible for 19.72% of any future capital costs at the Vernon WPCF. This percentage is equal to 1.4 MGD /7.1 MGD.

## 3.7.2 Summary of Requests to Communities on Updating Agreement

As part of the development of future flows, the WPCA of each community was notified that Vernon was in the process of undergoing a facilities plan, and a request made as to whether or not they would like additional flow capacity as part of the upgraded treatment plant. The Towns of South Windsor and Manchester stated that no increase in flow capacity would be requested. The Town of Ellington requested a slight increase from 1.4 to 1.42 MGD, or 20% of Vernon's plant capacity.

The Town of Tolland confirmed that the existing flow limit of 0.4 MGD should be used as the flow contribution from Tolland for the 20-year planning period associated with this study. It is noted that Tolland's Agreement does allow them to request an additional 0.6

MGD of capacity, but the agreement is silent on the timeframe for this request. Based upon discussions that have been initiated between the two towns, it is anticipated that the agreement will be modified to delete this additional 0.6 MGD allocation.

### 3.7.3 Consistency with Plans of Conservation and Development

Reviewing the sewer service area mapping of the other communities for consistency with the State and Local POCD was not included as part of this facilities planning process. Rather, the towns were notified as part of this planning process that any expansion to their sewer service areas needed to be consistent with the State and Local POCD.

## 3.8 Existing and Future Flow Projections

### 3.8.1 Existing Flows

Wastewater flow to the Vernon WPCF is comprised of sanitary flow (residential, commercial and industrial) and I/I. I/I contributions to flows at the WPCF are typically higher during high groundwater and wet weather periods. Current design flows, as well as average and peak observed flows from 2013-2016 are summarized in Table 3-2.

**TABLE 3-2**
Comparison of Existing WPCF Influent Flows to Design

| | WPCF Design Flows[1] | Existing[2] | % of Design Flow |
|---|---|---|---|
| Average Annual Day | 7.1 | 2.95 | 42% |
| Maximum Month | 8.3 | 4.91 | 59% |
| Peak Hour | 22.0 | 12[3] | 54% |

[1]Based on Malcolm Pirnie's 1992 design criteria. See Table 3-8 for further discussion
[2]Three Year average of WPCF data (September 2013 – August 2016).
[3] The plant has historically operated only one of the two grit systems and Parshall flumes, and each Parshall flume flow meter records flows up to 12 MGD. During the three-year period, there were three events where the flow reached 12 MGD, however, flows may have been higher.

Flow readings are taken from the plant's SCADA system and data base which are based upon flow measured by the plants' two parshall flumes located in the Pretreatment Building following grit removal and just prior to the influent pump station. Annual average flows fluctuated between three and five million gallons per day (mgd). The flow fluctuates seasonally and contains several sizeable peaks which indicates the collection system receives a considerable amount of I/I.

#### 3.8.1.1 Sanitary Flows

Vernon bills both Vernon customers and out of Town users for sewer use based upon water use. Water use data for each customer is obtained from either the Connecticut Water Company (Vernon, South Windsor and Tolland customers), or the Manchester Water Company (Manchester customers). Sewer customers who use wells for their water supply are billed on an assumed minimum water usage.

Tighe & Bond used a variety of data to estimate current and future sewage flows to the Vernon WPCF. Specific data used for this evaluation included:

- GIS data provided by the Capital Region Council of Governments (CRCOG), last updated in 2013 including parcel data and sewer infrastructure (pipes, service lines, and manholes)
- GIS zoning information provided by the Town of Vernon
- Tabular data provided by the Vernon Water Pollution Control Department included:
    - Water consumption data from the Connecticut Water Company – September 30, 2016 billing containing 4 quarters worth of water use, (includes customers in Vernon, Ellington, and Tolland)
    - Town of Vernon Sewer Customer lists – these include customers served by CT Water and sewer customers on well water
    - Town of Vernon Condo and Apartment charges list

Tighe & Bond used this information to identify parcels connected to the sewerage system, the total number of sewer customers, and those parcels within the sanitary sewer service area that are not connected to the sewer. The specific methodology used is as follows:

- Water usage data for Vernon customers from the September 30th 2016 billing was separated out from other Towns. It was noted that several meters were listed more than once, possibly due to property transfers that took place during the year. The data was therefore sorted by meter number and duplicate meter numbers combined as one entry to represent a single customer.
- The lists of sewer customers served by CT Water Company and well customers were combined and individually joined to parcels in GIS, using property address values as a basis for determining a match.
- In some cases, modifications were made to the data to establish common address values and create consistency between the sewer billing data and the parcel GIS (i.e. changing “Street” to “ST”). This yielded an approximately 73% match of the sewer customers on the first attempt.
- Customers on the billing list that were not matched to a parcel on the first attempt were reviewed individually and connected to parcels manually, where possible, by a GIS analyst. This method was used primarily for multi-unit condominium properties, where each unit receives its own sewer bill. In these cases, each sewer billing record was matched to an associated condo parcel, where one existed in GIS.
- A GIS point was created at the center of each GIS condo parcel. After matching individual condo units to a sewer billing record, the GIS points were counted and the total number of condo units was assigned to the overall condo parcel. This yielded a count of sewer customers per parcel.
- A number of parcels contain several apartments, condominiums or mobile homes that are not billed individually. The Town of Vernon maintains a list of condominiums and apartments which lists the number of units in each association in its Condo and Apartment charge list. For these accounts, the total number of sewer customers as indicated on the Condo and Apartment charge list was assigned to the overall apartment or condo parcel.

- There were some addresses that could not be located within the GIS database. These were reviewed and resolved with the Town on a case by case basis, and customer counts adjusted accordingly.
- After completing the process described above, a GIS parcel layer containing a sewer customer count for each parcel was created. Single family homes have a count of 1, condominium, apartment, and trailer parcels have a count based on either value listed in the Condo and Apartment charge list, or the number of condo units that are billed individually.
- The parcels were overlaid with the Town provided zoning layer to assign a zoning classification to each parcel. This allowed parcels to be separated into residential, commercial and industrial customers.

This analysis concluded that there are a total of 10,918 sewer customers within the Town of Vernon. This represents sewer services provided to a total of 6,144 parcels within the sewer service area.

There are also a total of 1,234 parcels within the boundaries of the sewer service area without sewer service. These include vacant or open space parcels, as well as developed lots that have not yet connected to the sewer system.

Sewer users from the various zones within the Town were broken down into residential, commercial and industrial customers per discussions with the Vernon Planning and Zoning Department as follows:

> Residential customers include parcels located in the Historic District Residential/Commercial/Business, Mobile Home Parks, Planned Neighborhood Development, Planned Residential Development, Rockville Downtown Business/Residential, and Single Family Residential zones.
>
> Commercial customers include parcels located in the Commercial, Planned Commercial, and Special Economic Development zones.
>
> Industrial customers include parcels located in the Industrial and Historic District industrial zones.
>
> No future sewer service was assumed to take place in zones listed as Open Space, Restricted Watershed and Garden zones. Customers located in the Gerber Farm and PDZ-Exit 67 zones were assumed to be sewered in the future as discussed in Section 3.3.4.

Quarterly water consumption data was separated into residential, commercial, and industrial customer classes. In some cases, a full four quarters worth of water usage was not listed, likely due to new customers. Where applicable, a full four quarters worth of water usage was approximated using the available data. The water consumption data was summarized and averaged to establish an average daily water usage for each class (residential, commercial, and industrial customers).

Typically, 100% of the residential water use does not enter into the sanitary sewer system, especially during the summer months when water is used for lawn watering and irrigation. On average, irrigation accounts for approximately 10-15% of the measured annual water use. In New England irrigation is seasonal, typically occurring between May and September. The quarterly billing in Vernon does not align with these seasonal fluctuations

to allow elimination of one specific quarter of water usage as an approximation for wastewater flow. Therefore, residential wastewater flows were estimated as 85% of the residential water usage, and wastewater flows for both commercial and industrial customers were estimated at 100%.

A summary of average water use for residential, commercial and industrial customers is summarized in Table 3-3.

**TABLE 3-3**
2016 Annual Average Water Use for Water Customers that Discharge to the Vernon Wastewater Collection System

| | Average Customer Water Use (gallons/day/customer) |
|---|---|
| Residential | 153 |
| Commercial | 378 |
| Industrial | 567 |

The calculated average wastewater flows for each class of sewer customer were then applied to those customers on private wells to estimate the total domestic flows. Table 3-4 summarizes the results of these calculations.

**TABLE 3-4**
Estimated Current Domestic and Commercial/Industrial Wastewater Flows

| | Number of Sewer Users | Wastewater Flow per User (gallons/day) | Estimated Wastewater Flow (gallons/day) |
|---|---|---|---|
| Residential | 10,552 | 153 | 1,610,435 |
| Commercial | 336 | 378 | 127,076 |
| Industrial | 30 | 567 | 17,014 |
| **Total** | **10,918** | | **1,850,658** |

### 3.8.1.2 Flows from Outside Communities

The Vernon WPCF receives wastewater flows from the Towns of Ellington, Manchester, South Windsor, and Tolland. Flow from Ellington is pumped to the Vernon WPCF through a pump station, at which flow records are kept. It should be noted that flow values measured at the pump station include both wastewater flow and infiltration/inflow from Ellington.

Flows from the remaining three communities are not metered within the collection system. Users are billed based upon water use. Water usage data for each of these three communities was used as a basis for the development of current flows. When water use data was used as a basis for estimating sewer flows, 85% of actual water usage was used to account for water used that may not enter the sewerage system. Examples of such use include lawn/garden watering and car washing. The resulting flow value is assumed to be entirely comprised of wastewater flow.

Current flows for each community were estimated as follows:

- Flows from Ellington were based upon the pump station flow records for 2015. Daily flows were estimated based upon one years' worth of data.
- Flows from Manchester were estimated based upon 4 quarters (1 year) worth of water usage data for sewer customers, divided by 365 days/year to identify an average daily flow to the Vernon WPCF.
- Flows from South Windsor were estimated based upon 4 quarters worth of water usage data for all water customers within the town, divided by the number of water customers to determine an average flow rate per customer. This average was then multiplied by the total number of customers connected to the Town of Vernon sewer system to identify an average daily flow to the Vernon WPCF.
- Flows from Tolland were based upon a review of an existing invoice to Tolland from the Town of Vernon for sewer service. This invoice summarized the total amount of water usage within one quarter for sewered customers. This total was divided by 91 days (3 months), to arrive at an estimated average daily flow.

#### 3.8.1.3 Flows from Anocoil, LLC

Twelve months of flow data from Anocoil, LLC was reviewed and averaged to determine the average daily flow sent to the Vernon WWTP. This value, 96,132 gpd, was used to help determine overall existing flows to the treatment plant.

#### 3.8.1.4 Infiltration and Inflow

Infiltration and inflow (I/I) rates were based on the difference between three-year average flow to the WPCF of 2.95 mgd and a sanitary flow of 2.54 mgd. Subtracting sanitary flows from average flows results in an average I/I contribution of 0.415 mgd, which equates to 20.4% of the total flow to the Vernon WPCF. A Phase 1 I/I study is scheduled to be completed in the Spring of 2017 to confirm I/I rates in the collection system.

I/I flows from Ellington were assumed to be equal to the same percentage of I/I noted at the Vernon WPCF, or 20.4% of total pumped flows.

### 3.8.1.5 Current Flow Summary

Table 3-5 summarizes the current flows for Vernon's collection system and WPCF.

**TABLE 3-5**
Current WPCF Wastewater Flows

| Flow Source | Flow (mgd) |
|---|---|
| Residential Sanitary Flow | 1.610 |
| Commercial Sanitary Flow | 0.127 |
| Industrial Sanitary Flow | 0.017 |
| Anocoil, LLC Sanitary Flow | 0.096 |
| Ellington Sanitary Flow | 0.399 |
| Manchester Sanitary Flow | 0.055 |
| South Windsor Sanitary Flow | 0.089 |
| Tolland Sanitary Flow | 0.043 |
| I/I Flow all except Ellington[1] | 0.415 |
| I/I Flow from Ellington[2] | 0.102 |
| **Total Current Flow [3]** | **2.95** |

[1] Estimated as the difference between the domestic flows and the three-year average WPCF flow (September 2013 – August 2016) = 20.4% of total flow
[2] Estimated as 20.4% of total flow from Ellington
[3] Three-year average WPCF flow (September 2013 –August 2016)

## 3.8.2 20-Year Future Flows

Future flow calculations were based upon the boundaries defined on the Sewer Service Area Map, which was updated as part of this Facilities Plan. This is presented as Figure 3-6. Flow contributions into Vernon's sanitary sewer system can be expected to come from the following sources:

- Infilling/Extensions – connection of existing parcels within the updated sewer service area which are currently either serviced by septic systems or undeveloped. This can include both developed and undeveloped parcels in industrial, commercial or residential areas.

- Subdivisions/Mill Conversions – existing parcels of land and/or former industrial mill sites that have the potential to be subdivided into a greater number of parcels at some point in the future. A specific list of expected projects is discussed in Section 3.3.4.

- Outside Communities – Current flows from the Towns of Ellington, Manchester, South Windsor and Tolland are expected to all increase over the planning period.

### 3.8.2.1 Infilling/Extensions

Future flows from infilling were based upon the assumption that all parcels within the boundaries defined on the Sewer Service Area Map (except those designated as Open

Space, Restricted Watershed and Garden Zones) that are currently not connected to the sewer system will connect at some point over the 20-year planning period.

As stated in Section 3.8.1.1, 1,234 parcels are not connected to the sewerage system at this time. Thirteen of these are either open space, garden zone or restricted watershed. One parcel is within the Exit 67 development zone which is discussed in the next section. The remaining parcels were broken down into residential/commercial/industrial customer based upon zoning of each lot, and future flow estimated based upon average flows for residential (153 gpd), commercial (378 gpd), and industrial (567 gpd) customer classes.

A breakdown of parcels by zoning and estimated future flows is presented in Table 3-6.

**TABLE 3-6**
Summary of Unsewered Parcels and Future Wastewater Flows

| Zoning Category | Unsewered Parcels | Wastewater Flow per User (gallons/day) | Estimated Wastewater Flow (gallons/day) |
|---|---|---|---|
| Residential | 1,071 | 153 | 163,455 |
| Commercial | 97 | 378 | 36,686 |
| Industrial | 52 | 567 | 29,490 |
| Other* | 14 | -- | -- |
| **Total** | **1,234** | | **229,631** |

*Watershed/Open Space/Exit 67

As shown in Figure 3-3, population projections for Vernon estimate the population increasing from 30,233 in 2017 to 31,172 residents in 2035, which equates to an increase of 939 residents. Using the 2010 U.S. Census data of 2.2 people/house, this results in a net increase of 426 homes. As shown in Table 3-5, there are 1,071 unsewered parcels within residential areas that are within the sewer service area. Therefore, it is considered a conservative assumption that all unsewered parcels will connect to the sewer system within the 20-year planning period.

### 3.8.2.2 Subdivisions/Mill Conversions

As stated in Section 3.3.4, the Town of Vernon has identified the following known development projects, many of which include the conversion of former mill sites.

1. Talcottville Mill, 47 Main Street. This site has been approved as an 84-unit apartment complex with some light commercial development (offices).

2. Amerbelle Mill/Daniels Mill, 5 Brooklyn Street/98 and 104 East Main Street. This complex originally consisted of 240,000 sf of manufacturing use, of which 150,000 sf has been torn down. The site is currently not being used and there are a number of ways that development could take place on this site. There is speculation that it could be used for a combination of residential and commercial development. It is not possible to install a development that consists solely of residential use.

3. Loom City Lofts, 215 East Main Street. This site contains a 64-unit residential complex. Construction was completed in the Spring of 2016.

4. Hockanum Mill, 200 West Main Street. This facility contains 140,000 sf of existing space. It is being proposed to be used as a motorcycle repair shop/museum and some type of large scale restaurant and possibly a catering facility.

5. Exit 67 Area, commercial parcel north of 84 behind McDonalds (14 Hyde Avenue on Town GIS). There is the potential for a hotel and 200 apartments to be constructed, as well as at least 1 restaurant.

6. Residential parcel on Mile Hill Road just south of Interstate 84 in the vicinity of Exit 67. A number of Assisted Living facilities have inquired about this parcel, and the parcel's owner is actively trying to sell it. Lack of sewers has been an issue. This can only be used for an assisted living facility or residential use.

7. Gerber Farm Planned Development, located at 243 Talcottville Road. A 300 Unit multifamily housing project has been approved with 4 pad sites upfront which are expected to contain a mix of retail and restaurant establishments.

Future flows were estimated for each of these projects using established average flow rates for residential, commercial and industrial customers. Flow estimates for restaurants, hotels and assisted living facilities were made using established design standards.

The total sanitary future estimated from these facilities is 236,888 gpd.

### 3.8.2.3 Flows from Outside Communities

Future flow estimates from other communities that discharge to the Vernon WPCF were based upon the flow limits included within each inter-municipal agreement. These flows were assumed to be comprised of both wastewater and infiltration/inflow components as discussed previously. Specifically, the future flows from outside communities include:

- Town of Manchester: future average daily flow of 0.090 MGD with a peak hourly flow of 0.36 MGD.
- Town of Tolland: average daily flow of 0.40 MGD, with a peak hourly flow of 1.6 MGD. The agreement allows for an ultimate future flow of up to 1.0 MGD. However, given the fact that existing flows are currently less than 50,000 gpd, it is assumed that any increase in flow from the Town of Tolland greater than 0.40 MGD would take place beyond the 20-year planning period for this study. It is our understanding that it is Vernon's intention is to discuss revising the inter-municipal agreement with Tolland to limit its average daily flow to 0.40 MGD.
- Town of South Windsor: average daily flow of 115,280 gallons per day, with a peak hourly flow of 461,120 gallons per day

**Town of Ellington: average daily flow of 1.42 MGD3.8.2.4 Infiltration/Inflow**

For the purpose of estimating infiltration and inflow, it was assumed that the I/I flows within the Town of Vernon would remain constant at 0.415 mgd. Additional I/I from sewer extensions and development should be minimal given current design standards, and it is reasonable to assume that some I/I reductions will take place through sewer rehabilitation once the I/I study work has been completed.

I/I flows from outside communities were assumed to be equal to 20.4% of the total future wastewater flow for each community (consistent with estimated of current levels of I/I entering the Vernon plant. We have also interpreted the inter-municipal agreements to include I/I in the flow limits that exist in each agreement as discussed in paragraph 3.8.2.3.

### 3.8.2.5 20-Year Future Flow Summary

As indicated in Table 3-7, the projected future average daily flow is 4.76 mgd.

**TABLE 3-7**
20-Year Projected Wastewater Flows

| | |
|---|---|
| **Current Sanitary Flow from Vernon** | |
| Residential | 1.61 |
| Commercial | 0.127 |
| Industrial | 0.017 |
| Anocoil, LLC | 0.096 |
| *Current Sanitary Flow from Vernon* | *1.85* |
| **Future Sanitary Flows from Vernon** | |
| Infillling: Residential/Commercial/Industrial | 0.230 |
| Developments/Mill Conversions | 0.237 |
| *Future Sanitary Flow from Vernon* | *0.467* |
| **Sanitary Flows from Outside Communities (Current and Future)** | |
| Town of Ellington WW flow[1] | 1.13 |
| Town of Manchester WW flow[1] | 0.08 |
| Town of South Windsor WW flow[1] | 0.110 |
| Town of Tolland WW flow[1] | 0.327 |
| *Sanitary Flows from Outside Communities* | *1.65* |
| **Wastewater Flow Summary** | |
| Total Current and Future Sanitary Flows | 3.967 |
| Vernon I/I[2] | 0.415 |
| I/I from outside communities[3] | 0.375 |
| ***Total 20-Year Projected Flow*** | ***4.76*** |

[1] Future wastewater flows assumed to be difference between current flows and flow limit in the inter-municipal agreement for each community less 20.4% I/I allowance on difference.

[2] Estimated as the difference between the domestic flows and the three-year average WPCF flow (September 2013 – December 2016). Assumed to remain constant under future flow conditions.

[3] Equals current Ellington I/I of 0.102 mgd plus allowance of 20.4% of difference between current flows and flow limit as stated in inter-municipal agreement for each outside community

# 3.9 Current and Future Loads Projection

## 3.9.1 Current Loads

Design loads and observed loads from 2013-2016 are summarized in Table 3-8. Current influent loads at the WPCF have been estimated based upon three full years (September 2013 – August 2016) of data. Wastewater influent samples are taken from the influent channel prior to the grit separation tanks. The wastewater at this location includes flow from the collection system, septage receiving, and several intermittent recycle flows from within the plant, including filter backwash from the sand filters, scum from the WAS gravity thickeners, and reactor blowdown from the WAR system.

**TABLE 3-8**
Current and Design Influent Loads

| | Lombardi Facilities Plan (1992) [1] | Malcolm Pirnie Design Criteria (1992) [2] | | Current Study Period (2013-2016) [3] | | % of Malcolm Pirnie Design |
|---|---|---|---|---|---|---|
| | Load | Load | PF | Load | PF | |
| ***Wastewater Flows (mgd)*** | | | | | | |
| Average Annual Day | 7.1 | 7.1 | | 2.95 | -- | 42% |
| Maximum Month | 8.3 | 8.3 | 1.2 | 4.91 | 1.7 | 59% |
| Maximum Day | -- | 9.7 | 1.4 | 7.64 | 2.6 | 79% |
| Peak Hour [4] | 22 | 22 | 3.1 | 11.98 | 4.1 | 54% |
| ***Plant Wastewater Loads (lbs/day)*** | | | | | | |
| Average Day | | | | | | |
| BOD | 15,800 | 16,500 | -- | 8,765 | -- | 53% |
| TSS | 16,600 | 16,200 | -- | 10,235 | -- | 63% |
| NH3 | 1,300 | 1,140 | -- | 519 | -- | 46% |
| TKN | 2,500 | *2,280* | -- | 1,022 | -- | 45% |
| TP [5] | -- | -- | -- | 295 | -- | -- |
| Temperature (ºF) | -- | -- | -- | 61.3 | -- | -- |
| Maximum Month | | | | | | |
| BOD | 21,100 | 22,500 | 1.4 | 12,097 | 1.4 | 54% |
| TSS | 22,100 | 22,000 | 1.4 | 14,324 | 1.4 | 65% |
| NH3 | 1,700 | 1,300 | 1.1 | 657 | 1.3 | 51% |
| TKN | 3,400 | *2,600* | 1.1 | 1,283 | 1.3 | 49% |
| TP [5] | -- | -- | -- | 420 | 1.4 | -- |
| Temperature (ºF) | -- | -- | -- | 51.2 | -- | -- |
| Maximum Day [6] | | | | | | |
| BOD | 8,800 | 33,020 | 2.0 | 14,888 | 1.7 | 45% |
| TSS | 8,600 | 39,600 | 2.4 | 19,233 | 1.9 | 49% |
| NH3 | -- | 1,440 | 1.3 | 707 | 1.4 | 49% |
| TKN | 1,000 | *2,880* | 1.3 | 1,513 | 1.5 | 53% |
| TP [5] | -- | -- | -- | 492 | 1.7 | -- |
| Temperature (ºF) | -- | -- | -- | 46.8 | -- | -- |

(1) Based on design criteria provided in AR Lombardi Associates 1992 Facilities Plan. Presumed to include allocation for septage and recycle streams to the head of the plant.
(2) Based on Malcolm Pirnie Design Report (December 1992). Presumed to include allocation for septage and recycle streams to the head of the plant. This design capacity based on construction of the 7th aeration tank which was not constructed, thereby effectively reducing the secondary treatment capacity to 6.8 MGD as reported in the design report.

(3) Consists of observed data at the WPCF from September 1st, 2013 through August 31st, 2016.

(4) Peak Hour Flow observed at the treatment plant is limited to 12 MGD due to capacity of the Parshall Flumes that measure influent flow.
(5) Current observed TP data excludes outliers that skewed results and we attributed to one-time events. It also includes a significant phosphorus load from an industrial user, Anocoil, LLC, as discussed in Section 3.4.2. See Appendix G for more details.
(6) Maximum day loadings based on 98$^{th}$ percentile during the period of study.
Key: PF = Peaking Factor; BOD = Biochemical Oxygen Demand; TSS = Total Suspended Solids; TKN = Total Kjeldahl Nitrogen; TP = Total Phosphorus; Italicized numbers indicate that data was assumed using a TKN:NH3 ratio of 2 which is consistent with other studies and historical data.

In addition, original design loadings developed prior to the plant upgrade in 1993 by Malcolm Pirnie are included in Table 3-8 for comparison. Based upon the data analyzed, the Vernon WPCF is approximately at half of its designed future loading. The TSS loading is slightly higher than the other loadings, which is likely due to the fact that the internal recycle streams are higher in TSS than the other constituents.

### 3.9.2 20-Year Future Loads

The average annual projection of the WPCF's future mass loading is based upon current wastewater constituent concentrations and flows, and then projected to account for the additional loading at future flows and population growth using load per capita factors for each constituent, which were calculated based upon current data. In this evaluation, septage and internal plant recycle flows were estimated and removed from the loadings prior to estimating the current load per capita factors, and these load factors were found to be consistent with typical values. We also assumed that the phosphorus discharged from Anocoil, LLC would be significantly reduced (on the order of 100 lb/d as P) as a result of a process change or permit limit issued by the CT DEEP. The projected future flows and loads represent both the future flows and loads from the collection system and septage receiving. They do not include loads related to plant recycles which will depend on how the plant is upgraded. The future maximum month and maximum day loads were calculated using load peaking factors assumed to be equivalent to the current peaking factors based upon the current flows and loads data. A more detailed explanation of how the future loads were calculated can be found in Appendix G. Results of the loading projection and the load peaking factors used are included in Table 3-9.

We note that the projected "20-year future planning period" average loads to the WPCF represents about approximately 75-80% of the original planned average daily design loads for CBOD and TKN and 90% for TSS. Maximum month capacities are generally within the same proportion as the average annual loads. There was no original phosphorus design capacity. Note also that the actual original design capacity as constructed is less than the planned design capacity, since a 7$^{th}$ aeration tank and additional clarifier were planned but never built. This discrepancy suggests that the actual design capacity may be somewhat lower and therefore closer to the future projected capacity calculated for this facilities planning period.

Based upon our review of the plant flows and loads, we recommend that upgrades of the secondary and tertiary systems to be installed at the plant be designed in a manner consistent with the projected 20-year (2040) flows and loads indicated in Table 3-9.

**TABLE 3-9**
Current and Projected Influent Loads

| | Peak Factor (6) | Current Study Period (2013-2016) (1) | *20-Year Future Planning Period (2040)* (2) | Original Design Capacity (Comparison Purposes Only) (3) | Units |
|---|---|---|---|---|---|
| ***Wastewater Flows (mgd)*** | | | | | |
| Average Annual Day | | 2.95 | *4.8* | 7.1 | mgd |
| Maximum Month | 1.7 | 4.91 | *7.9* | 8.3 | mgd |
| Maximum Day | 2.6 | 7.64 | *12.3* | 9.7 | mgd |
| Peak Hour (4) | 4.1 | 12.0 | *22.0* | 22.0 | mgd |
| ***Biochemical Oxygen Demand (CBOD5)*** | | | | | |
| Average Annual | | 8,765 | *13,000* | 16,500 | lb/d |
| Maximum Month | 1.4 | 12,097 | *17,943* | 22,500 | lb/d |
| Maximum Day | 1.7 | 14,888 | *22,081* | 33,020 | lb/d |
| Avg Annual EQ Conc. | | 356 | *327* | 279 | mg/L |
| Max Month EQ Conc. | | 295 | *272* | 325 | mg/L |
| ***Total Suspended Solids (TSS)*** | | | | | |
| Average Annual | | 10,235 | *14,600* | 16,200 | lb/d |
| Maximum Month | 1.4 | 14,324 | *20,433* | 22,000 | lb/d |
| Maximum Day | 1.9 | 19,233 | *27,435* | 39,600 | lb/d |
| Avg Annual EQ Conc. | | 416 | *368* | 274 | mg/L |
| Max Month EQ Conc. | | 350 | *309* | 318 | mg/L |
| ***Total Kjeldahl Nitrogen (TKN)*** | | | | | |
| Average Annual | | 1,022 | *1,630* | *2,280* | lb/d |
| Maximum Month | 1.3 | 1,283 | *2,046* | *2,600* | lb/d |
| Maximum Day | 1.5 | 1,513 | *2,413* | *2,880* | lb/d |
| Avg Annual EQ Conc. | | 42 | *41* | 39 | mg/L |
| Max Month EQ Conc. | | 31 | *31* | 38 | mg/L |
| ***Ammonia Nitrogen (NH3)*** | | | | | |
| Average Annual | | 519 | *850* | 1,140 | lb/d |
| Maximum Month | 1.3 | 657 | *1,076* | 1,300 | lb/d |
| Maximum Day | 1.4 | 707 | *1,157* | 1,440 | lb/d |
| Avg Annual EQ Conc. | | 21 | *21* | 19 | mg/L |
| Max Month EQ Conc. | | 16 | *16* | 19 | mg/L |
| ***Total Phosphorus (TP)*** (5) | | | | | |
| Average Annual | | 295 | *310* | -- | lb/d |
| Maximum Month | 1.4 | 420 | *441* | -- | lb/d |
| Maximum Day | 1.7 | 492 | *516* | -- | lb/d |
| Avg Annual EQ Conc. | | 12 | *8* | -- | mg/L |
| Max Month EQ Conc. | | 10 | *6* | | mg/L |

(1) Observed data at the WPCF from September 1st, 2013 through August 31st, 2016. Includes recycle streams (filter backwash, WAR blowdown, and spent carbon thickener scum and septage.

(2) Projections based on existing loads per capita and expected system increase due to additional development. Flows assumes the inter-municipal agreements with surrounding communities increase to full permitted flow with related I/I. Loads includes assumed future septage receiving; however, they exclude internal WPCF recycle streams. This column of data will be used as the basis of design for upgrading the WPCF.

(3) Based on Malcolm Pirnie, Inc.'s Initial Design Report (December 1992). Presumed to include allocation for septage and internal recycle streams that are sent back to the plant influent. This secondary treatment design capacity is based on the construction of a 7th aeration tank, which was not constructed. Actual constructed capacity is 6.8 MGD annual average flow; however actual constructed design loads were not available.

(4) Peak Hour Flow observed at the treatment plant is limited to 12.0 MGD due to capacity of the Parshall Flumes that measure influent flow. Since this limitation is likely capping the historic peak hour flow observed at the plant, the resulting peaking factor was not deemed reliable enough for the purposes of projecting the future peak hour flow. Instead, the current WPCFs peak hour flow capacity of 22 MGD was maintained to conservatively design the future upgrade.
(5) Current observed TP data excludes outliers that skewed results and we attributed to one-time events. It also includes a significant phosphorus load (100 lb/d as P) from an industrial user, Anocoil, LLC, as discussed in Section 3.4.2. Future design TP loads assumed approximately 100 lb/d as P on an average day basis is removed by Anocoil, LLC. We also assumed that the current peaking factors for total phosphorus would remain unchanged as they appear to be consistent with current peaking factors for TSS and BOD. See Appendix G for more details.
(6) Peaking Factors were calculated from observed historic data. It was assumed that the future peaking factors for the loads will remain the same as existing. It was assumed that the future peaking factors for the flows will also remain the same as existing, except for the Peak Hour Flow as discussed in Note 4.
*Italicized* numbers indicate that data was assumed using a TKN:NH3 ratio of 2.00 which is consistent with other studies and historical data.

# 3.10 WPCF Discharge Limits

## 3.10.1 Current NPDES Permit

Vernon's WPCF has a National Pollution Discharge Elimination System (NPDES) permit which allows for the discharge of flow to the Hockanum River. The WPCF is required to achieve secondary treatment standards and seasonal ammonia and phosphorus removal and disinfection. Vernon is also subject to the General Permit for Nitrogen Discharges in Connecticut which is discussed in the next subsection.

The Connecticut Department of Energy and Environmental Protection (DEEP) is adding new or more stringent phosphorus limits to a number of municipal and industrial NPDES permits as they are renewed, including Vernon's. The limits are based upon the *Interim Nutrient Management Strategy for Non-Tidal Waste Receiving Streams*, which DEEP rolled out in February 2011. The strategy is a revision to an earlier strategy that EPA rejected in 2009. The revised strategy is based upon restoring and maintaining water quality using in-stream algae as the main indicator of phosphorus enrichment. Phosphorus is often the limiting nutrient in fresh water, and excessive phosphorus can lead to eutrophication and algae blooms.

DEEP's revised approach was accepted by EPA. However, this approach is titled an "interim" approach and lower limits may be assigned to the Town and other communities across the State in future permit renewals. Therefore, DEEP has suggested that wastewater facilities planning studies consider how WPCF's can be upgraded to accommodate future phosphorus limits that may be more stringent.

Under DEEP's current strategy, the WPCF's primary phosphorus permit limit is a mass-based, seasonally averaged limit of 4.56 lbs/day beginning in April 2021.

Once this limit becomes effective, the WPCF is required to meet a target equivalent effluent concentration of 0.18 mg/L at the current average flow (2.95 MGD) to achieve its 4.56 lbs/day limit. However, to maintain compliance with the effluent load limit as average flows to the treatment facility increase to the WPCF's rated capacity at 7.1 mgd, the WPCF effluent phosphorous concentration will need to be reduced to below 0.08 mg/L. This means that eventually the WPCF will need to achieve low levels of phosphorous that are near the limits of current treatment technology.

Average monthly and maximum daily phosphorus concentration limits are included. These concentration-based limits were intended to be less stringent than the mass-based limit but included in order to guide the operators to maintain consistent treatment performance to achieve the mass-based seasonal limit. The current NPDES permit contains average monthly and maximum daily concentration-based limits based upon WPCF design flows rather than current flows to maintain design capacity. The average monthly and maximum daily phosphorus concentration limits included in the permit are 0.22 and 0.44 mg/l, respectively.

The current NPDES permit was issued on November 10, 2015, and will expire on November 9, 2020. The NPDES permit limits are summarized in Table 3-10, and a copy of the permit is included as Appendix A.

**TABLE 3-10**
Vernon WPCF NPDES Permit Limits (2015-2020)

| Effluent Characteristics | | Unit | Monthly Average | Maximum Daily |
|---|---|---|---|---|
| Flow | | mgd | Report | Report |
| $BOD_5$ | July 1-Sept 30 | mg/L | 15 | 30 |
| $BOD_5$ | Oct 1-June 30 | mg/L | 20 | 40 |
| TSS | | mg/L | 20 | 35 |
| DO[1] | | mg/L | --- | ≥7.0 |
| pH[2] | | --- | --- | 6 to 9 |
| Chlorine[3] | | mg/L | 0.05 | 0.10 |
| Copper | | kg/day | 0.583 | 0.923 |
| Lead | | kg/day | 0.033 | 0.060 |
| Zinc | | kg/day | 1.40 | 2.40 |
| Nitrogen, Ammonia (Total as N)[4] | April | mg/L | 5.2 | |
| | May | | 4.5 | |
| | June | | 3.1 | --- |
| | July | | 1.7 | |
| | August | | 1.5 | |
| | September | | 2.0 | |
| | October | | 10.0 | |
| Total Phosphorus[5] | April 1-Oct 31 | mg/L | 0.22 | 0.44 |
| E. coli | May 1-Sept 30 | cfu/100 ml | 126 | 410[6] |
| Fecal Coliform | May 1-Sept 30 | cfu/100 ml | 200 | 400[7] |

[1] This limit is a minimum instantaneous limit.
[2] This limit is a required range.
[3] Chlorine has an instantaneous limit of 0.20 mg/L in addition to the Avg. Monthly and Max. Daily limits.
[4] Monthly reporting is required for total nitrogen, total Kjeldahl nitrogen, nitrate and nitrite.
[5] This limit becomes effective beginning April 1, 2021. Discharge shall not exceed the total phosphorus Average Seasonal Load Cap of 4.56 lbs/day. The Average Seasonal Load shall be calculated by adding all samples results during each April 1st through October 31st in pounds per day and dividing by the total number of those samples in that season.
[6] This limit is a maximum instantaneous limit.
[7] This limit is a maximum weekly limit.

Table 3-11 summarizes the WPCF effluent characteristics discharged to the Hockanum River between January 2013 and August 2016.

**TABLE 3-11**
WPCF Effluent Values for January 2013 – August 2016

| Effluent Characteristics | Unit | Average | Maximum Daily |
|---|---|---|---|
| Flow | mgd | 2.95 | 7.64 |
| $BOD_5$ [July 1-Sept 30] | mg/L | 2.40 | 4.35 |
| $BOD_5$ [Oct 1-June 30] | mg/L | 4.19 | 15.0 |
| TSS | mg/L | 5.04 | 38.4 |
| DO | mg/L | 9.37 | 7.00 |
| pH | --- | 7.11 | 7.85 |
| Chlorine | mg/L | 0.02 | 0.16 |
| Copper | kg/day | 0.21 | 0.57 |
| Lead | kg/day | 0.01 | 0.04 |
| Zinc | kg/day | 0.58 | 1.49 |
| Nitrogen, Ammonia (Total as N) April | mg/L | 0.43 | |
| May | | 0.16 | |
| June | | 0.12 | |
| July | | 0.11 | --- |
| August | | 0.12 | |
| September | | 0.10 | |
| October | | 0.08 | |
| Total Phosphorus | mg/L | 3.69 | 25.5 |
| Fecal Coliform | cfu/100 ml | 3.20 | 44.0 |

### 3.10.2 Current Nitrogen General Permit

The Vernon WPCF is part of the General Permit for Nitrogen Discharges in Connecticut. Collectively, the 80 publicly owned treatment facilities are required to reduce nitrogen to meet the Year 2016 goal as set by the Total Maximum Daily Load (TMDL). For Vernon, the goal for 2016 and beyond is 184 lbs/day of total nitrogen. This represents the following effluent concentrations:

- 7.5 mg/L at the plant's current average flow of 2.95 MGD
- 4.6 mg/L at the 20-year projected average flow of 4.8 MGD
- 3.1 mg/L at the plant's permitted average flow of 7.1 MGD

#### 3.10.2.1 Historical Cost to Participate

The WPCF's current annual average discharge is about 400 lbs/day (2013 to 2016 average). Because this is higher than the permit limit, the Town purchases credits through the nitrogen trading program and paid $60,692 in 2013, $109,033 in 2014, and $104,479 in 2015. Figure 3-8 illustrates Vernon's historical nitrogen trading program costs.

#### 3.10.2.2 Projected Cost to Participate

The Connecticut Nitrogen General Permit provides the opportunity for communities that are included in the program to evaluate the cost of physical improvements and increased operating costs to achieve nitrogen removal versus purchasing nitrogen credits to comply with the requirements of the General Permit.

Figure 3-9 illustrates Vernon's projected nitrogen trading program costs, based upon:

- An equivalency factor of 0.19 for Vernon (this factor is fixed for any particular facility in the state).
- Average credit cost increase of $0.43/year-EQ lb TN, based on the average of actual credit cost increases from 2012 to 2013 ($0.60), 2013 to 2014 ($0.86), 2014 to 2015 ($0.67), and 2015 to 2016 (-$0.42). The cost of credits was last determined at $6.72 for 2016, which is a decrease from $7.14/EQ lb TN for 2015. DEEP has estimated that in 2018 the cost to purchase nitrogen credits will be $8.08/EQ lb TN.
- No change in the facility's current day performance of 16.4 mg/L on average of effluent total nitrogen.
- Average daily flows increasing from the current average of 2.95 mgd to a projected 20-year ADF of 4.8 mgd (discussed elsewhere in Section 3).

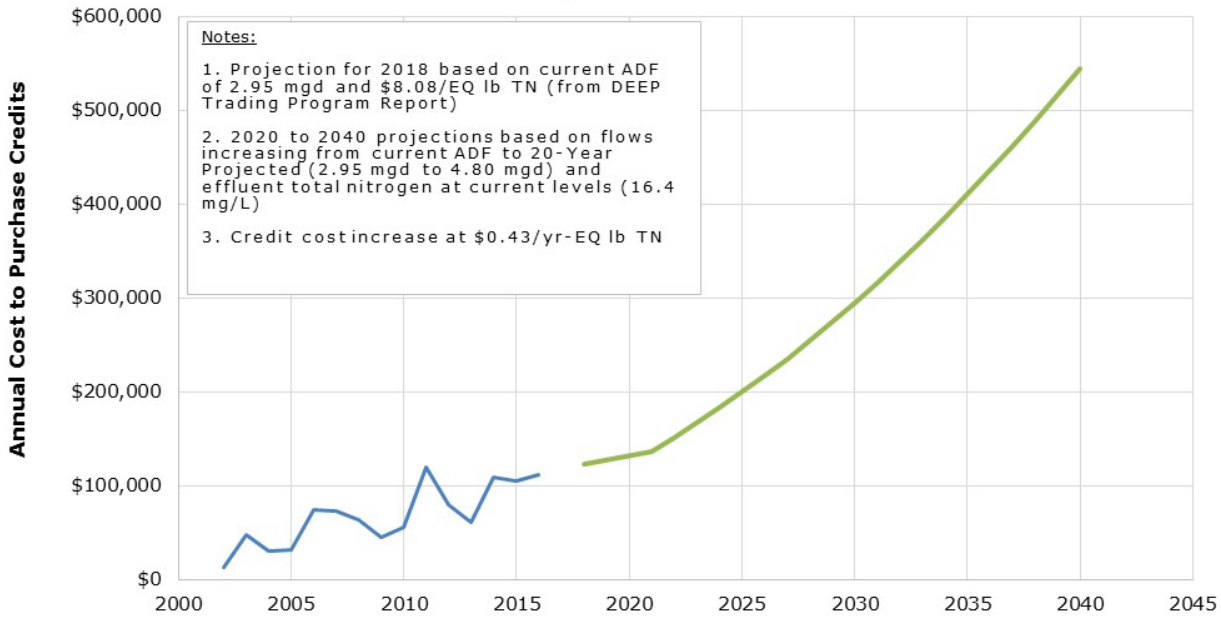


**Figure 3-9**
Historical and Projected Nitrogen Credit Costs with No Change in Treatment – Increased Flow

Figure 3-10 presents the 20-year present worth of participating in the trading program for providing various levels of treatment. Present worth costs are based on the assumptions described above, an inflation rate of 1.5%, and construction upgrades being completed in 2020. This comparison illustrates the potential savings that could be achieved by upgrading the WPCF to remove total nitrogen (TN) versus having to purchase nitrogen credits under a variety of treatment process upgrades to lower effluent TN, ranging from no upgrade (with effluent total nitrogen at the current average of 16.4 mg/L and assuming no growth) to a full upgrade capable of meeting the load limit of 184 lbs/day at the projected 20-year flow of 4.8 mgd (or an equivalent effluent concentration of 4.6 mg/L). Calculations are provided in Appendix B.

As noted previously, because the sellers of credits in the trading program will divide the funds paid by the buyers proportionally, based on the seller's relative performance, the potential sale value of credits is expected to decrease as more facilities complete upgrades to remove TN. DEEP estimates that the sale value of credits in 2018 will be $2.13/ EQ lb TN. Although Vernon would be able to sell any excess credits should the WPCF be upgraded for TN removal, we have conservatively assumed no revenue stream in our analysis.

However, even assuming no payback from the sale of credits, the evaluation indicates that the present value of the savings generated by not having to purchase nitrogen credits could potentially be as much as $5.2 million dollars if the plant is upgraded to achieve an effluent nitrogen level of 4.6 mg/L at the 20-year projected flow. Future changes in the nitrogen trading program and the receipt of grants (if available) to complete the nitrogen improvements will alter the economic analysis.

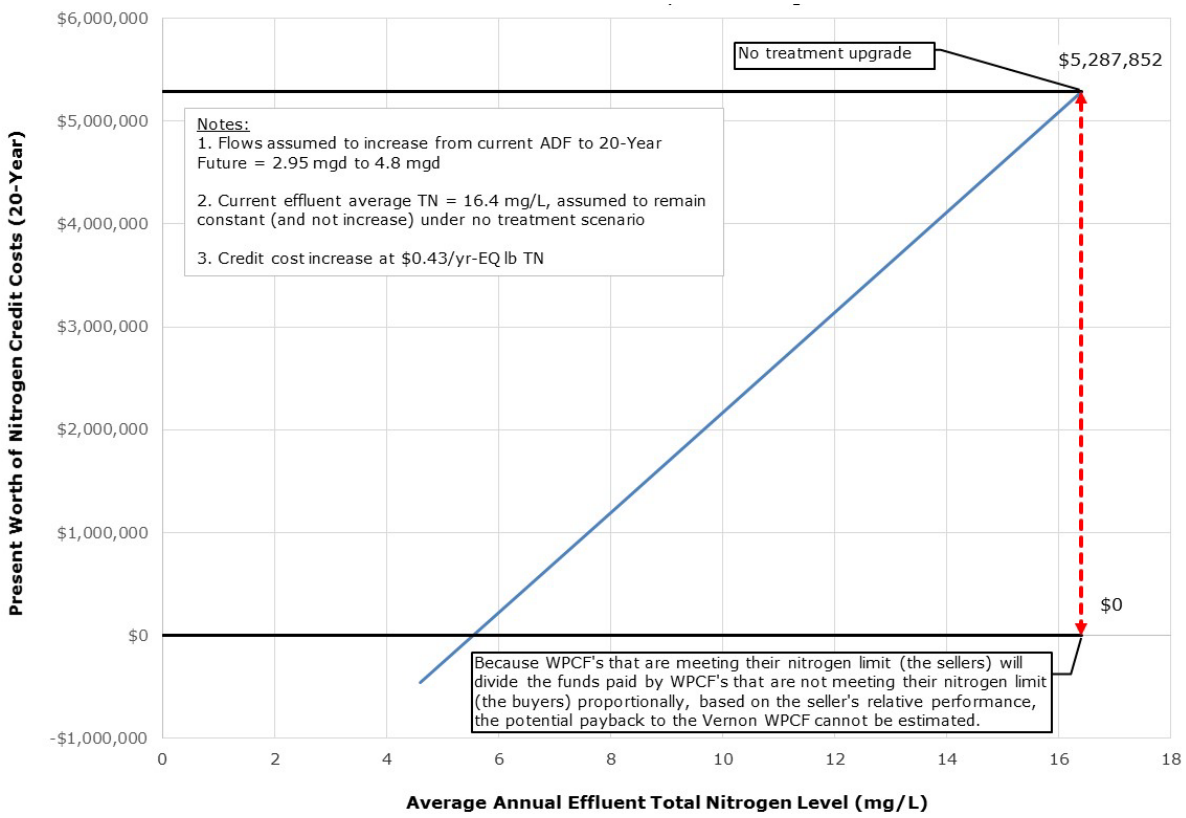


**Figure 3-10**
20-Year Present Worth Analysis of Nitrogen Credit Costs

## 3.10.3 Anticipated Future Permits

### 3.10.3.1 Metals

Looking beyond nutrients, DEEP is planning to develop numeric criteria for metals that will be included in Connecticut's water quality regulations. Aluminum and iron salts in the form of aluminum sulfate (alum), polyaluminum chloride (PACL), and ferric chloride are the three most common coagulants used in chemical phosphorus removal at wastewater treatment facilities. A limit on aluminum could reduce or hinder the use of alum or PAC for phosphorus removal. Planning for flexibility in Vernon's chemical dosing approach to phosphorus removal will allow Vernon to readily adapt to new metals limits.

### 3.10.3.2 Endocrine Disrupters

Endocrine disrupters are an emerging contaminant of concern, however there is no consensus on how these will be regulated or treated. While there is no information from DEEP that suggests these will be regulated in the future, there are a few approaches that can be considered now to help prepare the WPCF to treat them should the need arise:

- Consider secondary treatment designs that maximize sludge residence times which can help treat these compounds
- Consider UV disinfection which may help oxidize some of these compounds

- Provide hydraulic capacity and leave space at the WPCF to insert an additional treatment process, if needed.

#### 3.10.3.3 Possible Lower Nitrogen Level

While the EPA has been pushing other areas of New England with impaired waters for limit of technology based total nitrogen limits (~3 mg/l), Connecticut is a delegated state and discussions with DEEP have suggested that lower nitrogen limits in the next few permitting cycles are not currently being considered. Current focus on alleviating the impairments in Long Island sound seems to be focused on embayments (not an issue for Vernon). That said, this plant upgrade should attempt to maximize nitrogen removal during this upgrade given the other (space and financial) constraints. Practically speaking, this means converting the aeration tanks to 4 or 5 stage bardenpho process.

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# SECTION 4

# Section 4
# WPCF Liquid Treatment – Evaluation of Existing Processes

The WPCF's liquid treatment train, solids handling, buildings, ancillary systems, and controls, were analyzed to assess their condition and ability to serve the Town's current and projected needs. Section 4 focuses on the liquid treatment processes. Section 5 summarizes the solids processing system, Section 6 summarizes the evaluations of WPCF buildings, ancillary systems, controls and energy efficiency, and Section 7 summarizes the nutrient removal technology evaluation.

## 4.1 Overview

The collection system delivers wastewater to the Town's WPCF which is located adjacent to the Hockanum River. There has been a water pollution control facility at this site since the early 1900's, but the major structures and processes in use today are from plant upgrades that occurred in 1959, 1973, and 1993. The existing structures used for liquid treatment from the various upgrades are as follows:

- 1959 Upgrade
    - Chlorine Contact and Post Aeration Tanks
    - Chemical Building
    - Plant Water Building
    - Post Aeration Blower Building
- 1973 Upgrade
    - Primary Clarifier Tanks
    - Aeration Tanks #1-#4
    - Secondary Clarifier Tanks #1-#4
    - Sand Filters
    - Sand Filter Building
    - WAS (Spent Carbon) Thickeners & WAS Day Tank
    - Regeneration Building including the scrubber channel, Zimpro PACT-WAR process and carbon silo.
    - Intermediate Pump Station Wet Well
- 1993 Upgrade
    - Preliminary Treatment Building
    - Influent Pump Station
    - Regeneration Building Extension including the DSE system
    - Post Wet Air Regeneration (WAR) Equalization Tank
    - Soda Ash Silo

- Secondary Clarifier Distribution Chamber
- Secondary Clarifier Tank #5
- Aeration Basins #5-#6 and distribution channel
- Aeration Basins #3-#4 (wall height increased)
- Final Sampler Building (prefabricated shed)
- Return Sludge Pump Station

The WPCF has a permitted average daily flow of 7.1 million gallons per day (MGD) from a combination of residential, commercial and industrial sources. The basis of design of the current WPCF is summarized in Table 4-1.

**TABLE 4-1**

WPCF Design Flows and Loads[1]

| Parameter | Average | Peak |
|---|---|---|
| Flow | 7.1 MGD | 22.0 MGD |
| $BOD_5$ | 16,500 lbs/day | - |
| TSS | 16,200 lbs/day | - |
| $NH_3$ | 1,140 lbs/day | - |
| TKN | 2,280 lbs/day | - |

[1]Based on Malcolm Pirnie's 1992 design criteria
BOD – biochemical oxygen demand
TSS – total suspended solids
$NH_3$ – ammonia (reported as nitrogen)
TKN – total Kjeldahl nitrogen (reported as nitrogen)

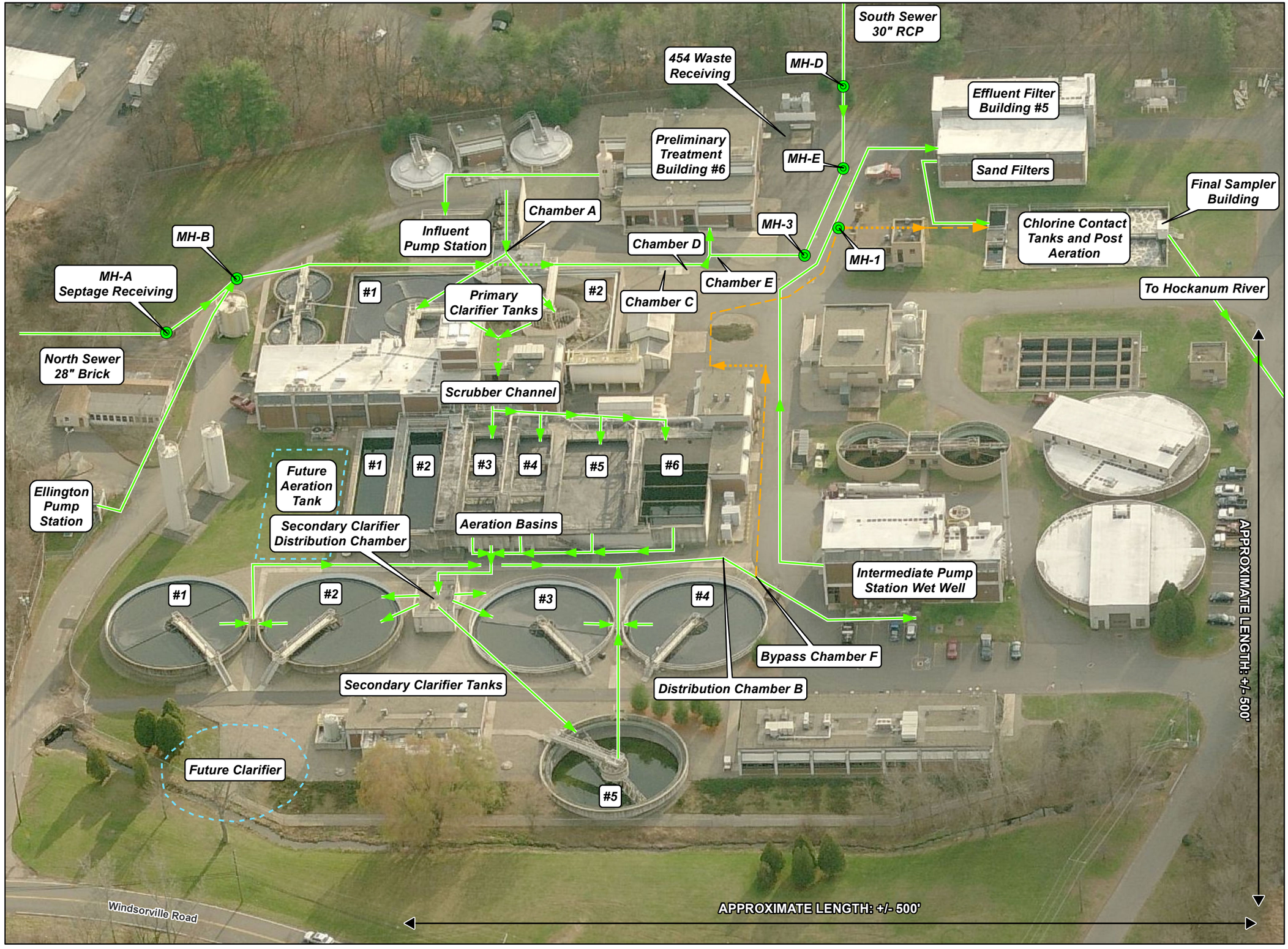
As discussed in Section 3:

- The WPCF is currently operating at about 42% of its design flow capacity. From 2013 through 2016, the WPCF's daily flow averaged 2.95 MGD.
- The WPCF is currently operating at about 53% of its design load capacity for BOD, 63% of its design load capacity for TSS and 45% of its design load capacity for TKN.

The WPCF is designed to provide BOD, TSS, and ammonia removal using a combination of primary treatment, secondary treatment and nitrification by means of an activated sludge process that includes the addition of powdered activated carbon, and sand filtration. Seasonal disinfection of the treated effluent using sodium hypochlorite followed by dechlorination and post aeration is provided prior to final discharge to the Hockanum River. An overview photo of the plant indicating liquid treatment process flows is shown in Figure 4-1, and a simplified process flow diagram was presented in Section 2 of this report as Figure 2-3.

Raw wastewater from the sewerage system enters the Vernon WPCF via two influent lines into a common junction box. Septage discharged at the WPCF is combined with the raw wastewater in a manhole on the north influent sewer. Although it comprises a much smaller waste stream, "454" transported non-domestic wastewater is also received and processed at the WPCF.

The condition assessment of the WPCF's liquid treatment train followed the methodology and service life of equipment assumptions that are discussed in Appendix H.




# Figure 4-1
# WPCF Liquid Process Flow Diagram

**LEGEND**

- Manhole
- Liquid Flow
- Liquid Flow (Obscured by Building)
- Bypass
- Bypass (Obscured by Building)
- Future Clarifier/ Aeration Tank

**LOCUS MAP**




N

Scale: N.T.S.

**NOTES**

**Town of Vernon, Connecticut**

**Vernon WPCF Facility Plan**

**March 2016**

Tighe&Bond
Engineers | Environmental Specialists

# 4.2 Preliminary Treatment Building

## 4.2.1 Overview

The Preliminary Treatment Building is located at the south end of the WPCF site adjacent to the Filter Building and Primary Sludge Thickeners. It was constructed as part of the 1993 upgrade and contains the septage receiving station (currently used to process 454 transported non-domestic wastewater), odor control system, influent screens, grit separation, and influent flow measurement.

The odor control system treats odorous air from the Preliminary Treatment Building. It consists of a cylindrical FRP scrubber tower 9 feet in diameter by 24.5 feet tall; a 25,000 CFM scrubber fan; two 530 GPM recirculation pumps; a sodium hypochlorite system consisting of a 2,500-gallon hypochlorite storage tank and 29.5 gallons per hour (GPH) feed pumps; a caustic soda system consisting of a 500-gallon sodium hydroxide storage tank with 2.0 GPH feed pumps; and a makeup water line.

The scrubber tower contains a plastic media which is wetted with the sodium hypochlorite and sodium hydroxide scrubber solution. This solution is circulated through the tower by the recirculation pumps which draw it from the sump at the base of the tower to misters at the top which continually spray the plastic media. The scrubber fan blows the odorous air into the scrubber tower where it passes through the media and then out the top of the unit. Sodium hypochlorite is added to the scrubber solution to oxidize odorous components into non-odorous forms. The sodium hydroxide raises the pH of the scrubber solution to increase odor removal effectiveness. Makeup water is added to the scrubber solution via the sump of the scrubber tower to replace solution that is lost to evaporation and to help keep the solution “fresh”. The addition of this water causes a portion of the scrubber solution to continually discharge to the drain at the scrubber sump overflow.

The Preliminary Treatment Building has three influent wastewater channels, two of which include mechanical bar screens and the third serves as a bar screen bypass channel. There is an influent wastewater distribution structure in the building that has four slide gates, one of which is the main shut off for influent wastewater into the building, and each of the other three influent channels has a dedicated slide gate. Each of the slide gates is equipped with automated electric actuators that are operated to divert wastewater flows into the channels desired by the WPCF staff. The two bar screen channels are designed to handle flows up to 11 MGD each. Under normal flow conditions only one bar screen channel is in operation, and the second bar screen channel is only put online if high influent flows are reaching the capacity of a single bar screen.

Influent screening removes large material that might otherwise clog or harm pumps and downstream treatment processes. The screens included in the 1993 upgrade project consisted of manually cleaned coarse bar racks upstream of mechanically cleaned bar screens. The manually cleaned coarse bar racks had 7-inch bar spacing in the screen channels (3-inch bar spacing in the bypass channel) and were set at a 60-degree angle to the bottom of the channel. The manually cleaned coarse bar racks in the screen channels have since been demolished and removed by the WPCF as the bar racks were not capturing much material due to the wide bar spacing and were difficult to clean. The manually cleaned bar rack with a 3-inch bar spacing located in the screen bypass channel is still in place and utilized to capture large debris from the influent wastewater when the mechanically cleaned bar screens are being bypassed for repairs and/or maintenance activities. The two mechanically cleaned bar screens have a screening area that is 9-feet

tall by 4-feet wide with a bar spacing that provides 0.5-inch openings. The bar screens are set at an 80-degree angle to the bottom of the channel and are equipped with a rake arm cleaning mechanism that travels at 20 feet per minute (FPM).

The screenings removed from the mechanically cleaned bar screens are deposited into a 25 cubic feet per hour (CFM) screenings washer and compactor. There are two screenings washer and compactors, one dedicated to each of the mechanically cleaned bar screen. The screenings are deposited by the bar screens into the screw conveyor trough of the washer and compactor which rotates and drains excess water from the screenings, transports the screenings into a conical section where a water jet washes the screenings and removes the organic material, and the screenings are then compacted and dewatered before being stored in the Preliminary Treatment Building for off-site disposal.

Downstream of the mechanically cleaned bar screens and the manually cleaned screen the three influent channels combine into a single channel, and the wastewater is directed to the grit separation system. There are slide gates in the influent channels downstream of the screens and prior to the channels being combined. Each of these slide gates is equipped with automated electric actuator and is operated by the WPCF staff based upon which channel is on-line and which ones are off-line.

The grit separation system removes grit from the screened wastewater to reduce downstream pipe clogging and wear on the equipment. There are two cyclonic grit chambers in parallel, and typically only one of the grit chambers is in use at a time. There is a manually operated slide gate at the influent of each grit chamber which allows the WPCF staff to choose which grit chamber is in use. Each of the grit chambers consist of a separation mechanism designed for 7.1 MGD average flow and 9.7 MGD peak flow, a paddle mixer, a 250 GPM grit pump, and a 75 SCFM grit blower which is only used if the grit gets to heavy or is allowed to settle and sit in the bottom of the chamber.

Screened wastewater enters the chamber of the grit chamber, and the mixer agitates the grit enabling the organics to wash out of the tank and continue to the next treatment process. The grit settles to the bottom of the chamber and, when required, the blower provides air to further separate the grit and organics and keep the material from becoming too heavy to pump. A pump then removes the grit from the grit chamber and sends it to one of two grit classifiers. Each of the grit classifiers consist of a grit concentrator where centrifugal force removes lighter material. The grit is discharged from the base of the concentrator to the grit classifier, where a screw conveyor dewaters the grit and transports it into a collection bin in the Preliminary Treatment Building for storage prior to its off-site removal.

After the screenings and grit have been removed from the influent, the wastewater passes through a 24-inch Parshall flume which directly measures the wastewater flow rate. There are two Parshall flume channels, each with a manually operated slide gate to control the flow to them. After passing through the Parshall flumes the wastewater flows to the wet well of the influent pump station.

### 4.2.2 Evaluation

The odor control system is over 20 years old and the major equipment has not been replaced or had a major rebuild in that time. The scrubber tower, scrubber fan, recirculation pumps, and all piping appear to be in fair condition for its age, but it is unlikely that this equipment will provide reliable service over the next 20-year planning

period. The sodium hypochlorite and sodium hydroxide feed systems including the bulk storage tanks, metering pumps and piping systems are all showing signs of their age and are approaching the end of their useful service life. Currently, there is only one hypochlorite pump in service, the back-up hypochlorite pump was removed and never replaced. The chemical storage tanks and metering pumps are located in a recessed area of the Preliminary Treatment Building. This recessed area provides secondary containment volume for chemical spills, but there is no sump within this containment area which makes it difficult for WPCF staff to clean up after spills. The containment area concrete has a chemical resistant coating which is failing and peeling. The 1993 upgrade lacked adequate and safe access into the containment area for the WPCF staff. Since the upgrade, the WPCF staff have installed stairs into the containment area that are constructed of pressure treated lumber which should be replaced with more permanent stairs constructed of a chemical resistant material such as fiberglass reinforced plastic. The odor control fan is located in an unclassified space which is not appropriate under current standards since it is handling air being removed from hazardous areas. The odor control fan needs to be relocated outdoors adjacent to the odor control scrubber tower in order to meet current standards for odor control fans handling air from classified areas.

There are 11 slide gates in the Preliminary Treatment Building used for directing wastewater flows within the channels. Of these 11 slide gates, seven of them are equipped with electric actuators for automated gate operation and four of them are equipped with hand crakes for manual operation. Evaluation of the slide gates was limited to the above grade features of the gate frames, stems and actuators. Gate frames and sliding members below the floor level or within the wastewater flows were not evaluated due to a lack of safe entry. All gate features visible during the evaluation appear to be in good condition. A WPCF operator noted that all gates are currently operating properly, and only minor leakage is observed on some of the gates when they are fully closed. Minor leakage past a gate of this style and age is not uncommon and could be due to worn seals or material buildup in the seals. The electric actuators on the automated gates are currently operating properly, but due to their age it is unlikely that these actuators will provide reliable service over the 20-year planning period and should be replaced.

WPCF staff have noted that the influent channels upstream and downstream of the mechanical bar screens and manual bar screen accumulate grit, and grit is periodically removed upstream of the mechanical screens. However, cleaning of the manual bar screen channel and the channel sections downstream of the mechanical screens does not occur due to a lack of access into the channels for cleaning. Grit accumulation in the influent channels is exacerbated due to the current septage receiving practice of discharging grit laden septage into Manhole A which then flows into the influent channels where grit can settle out. It is recommended that all influent channels be cleaned of grit and other material that has built up over time. While cleaning the influent channels, it is recommended that the WPCF staff inspect the seals, remove any material buildup, and replace any worn seals on the slide gates.

The WPCF staff stated the two mechanically cleaned bar screens have had their rake arms and the rake arm A-frames replaced since the screens were installed during the 1993 upgrade. They also noted that the chain and sprockets are currently showing signs of wear due to the years of operation. Although both screens are currently operating properly, both screens should be replaced based on age and worn features. Each of the screenings washer and compactors are also currently working properly, but it is recommended that both be replaced due to the age of the equipment and the associated service conditions

of this equipment. The plant water supply piping and appurtenances associated with the washers and compactors are in poor condition and should be replaced when the equipment is replaced.

The condition of the cyclonic grit chambers and paddle mixers is unknown due to these items being located below the floor level and the lack of safe entry for evaluation. The WPCF staff noted the grit pumps typically last between 3 to 5 years due to the extreme service conditions for this equipment. The staff replaced Grit Pump #1 (southern pump) in June 2016 and Grit Pump #2 is currently due for replacement. The grit pump's discharge check valves were both replaced within the last few years. The grit blowers are not used often and the motors have been replaced multiple times since their original installation due to flooding of the grit floor that occasionally submerges the blower motors. It is recommended that the grit separation systems be replaced as they are nearing the end of their expected service life. The air control panel ("PT-G-PP") for the grit separation system, provided by the system manufacturer, is outdated and contains many parts that are no longer available.

The two grit classifiers are in poor condition due to their age and service conditions. The augers and troughs are worn and the equipment is near the end of its useful life. Both grit classifiers should be replaced. The WPCF staff has noted that the single common grit discharge force main between the grit pumps and grit classifiers has had to be replaced in the past due to erosion/wear of the piping. Due to it being a common grit force main this requires the staff to shut down both grit separation systems in order to repair the piping. As part of the upgrade, a secondary discharge force main should be installed to provide redundancy when a section of grit piping is out of service.

The Parshall flume liners are in good condition and there are no known issues with their operation. The ultrasonic level transducers and transmitters are showing signs of their age and should be replaced as part of the upgrade.

### 4.2.3 Recommendations

Based upon our observations, we recommend the following replacements and improvements be made to the equipment housed within the Preliminary Treatment Building, excluding items related to the septage and industrial/commercial wastewater receiving unit, which are discussed in Section 4.3:

- Replacement of the odor control system including the scrubber tower, scrubber fan, recirculation pumps, related piping and appurtenances and system controls. The scrubber fan location does not meet current standards for fans handling air from hazardous locations. To meet the current standards, the scrubber fan should be relocated to the exterior of the building adjacent to the scrubber tower.
- Replacement of the sodium hypochlorite and sodium hydroxide chemical feed systems associated with the odor control system including the bulk chemical storage tanks and metering pumps. If the odor control system capacity remains the same, it is expected the capacities of the bulk storage tanks and metering pumps will remain the same. If the odor control system is upsized to treat odorous air from other nearby improvements, then the odor control chemical system may need to be upsized. Apply chemical resistant coating to entire secondary containment area. Install permanent FRP access stairs into the secondary containment area. Install a sump in the containment area to help with clean up.

- Replacement of the seven electric actuators on the automated slide gates.
- Remove accumulated grit and material from all influent channels. During this activity check all slide gate seals and replace any damaged or worn seals.
- Replacement of the two mechanically cleaned bar screens and replacement of the bypass channel's manual bar screen with a mechanically cleaned screen. The upgrades to the secondary treatment system will require the influent to be screened at all times, therefore, the influent screening bypass channel will need to include a mechanically cleaned screen. The three new mechanically cleaned screens will need to be of the fine screen type to provide proper protection for the downstream equipment and treatment processes.
- Replacement of the two screening washers and compactors and their related instruments and addition of a third washer and compactor for the new mechanical fine screen that will be installed in the existing bypass channel. The layout of the washer and compactors should be such that they interface properly with the new mechanically cleaned screens, and the discharge chutes convey the screenings into the storage bin within the building. New plant water piping and necessary appurtenances should be installed to satisfy the requirements of the new washers and compactors.
- Replacement of the mechanical equipment associated with the two cyclonic grit chambers, pumps, blowers and grit classifiers. Consider moving the blowers to higher ground to prevent flooding of the motors. Consider replacing the grit classifiers with grit washers if space permits.
- Installation of a redundant grit force main to connect the grit pumps to the grit classifiers with valves installed to allow either grit pump to discharge to either of the grit classifiers (or washers).
- Replacement of the two ultrasonic level transducers and transmitters associated with the two Parshall flumes.
- Consider installation of access hatches downstream of the fine screens to provide the staff with a means for access into the influent channels for cleaning.

## 4.3 Septage and Industrial/Commercial Wastewater Receiving

### 4.3.1 Overview

The septage receiving station and related equipment is located in the southwest section of the Preliminary Treatment Building and was installed during the 1993 plant upgrade. Following this upgrade, septage was discharged at the WPCF via the septage receiving station, however, septage is no longer received there as the septage pumps are too small for the volume received. Septage is now discharged into the North sewer at MH-A located on the east end of the WPCF and the septage receiving station is currently utilized for processing "454" transported non-domestic wastewater. The septage receiving station is designed to handle a maximum flow of 0.57 MGD (395 gpm) and consists of a screen with a rake arm, screw conveyor, and two septage holding tanks with a mixer and a submersible pump each.

The screen is a cylindrical fine screen inserted diagonally to the direction of the liquid flow. A 2-HP drive unit is used to turn the screen. A rotating rake arm removes the screenings and deposits them into the screw conveyor. The screw conveyor transports the screenings out of the incoming flow into a waste bin and compacts and dewaters the materials as they travel the length of the conveyor.

The screened liquid flows to one of two 7,500-gallon concrete holding tanks where a 4-HP submersible mixer maintains the solid particles in suspension and then a 2-HP end suction submersible pump routes the screened liquid through a magnetic flowmeter and to a channel where it is mixed with the screened plant influent.

### 4.3.2 Evaluation

The WPCF staff noted that the septage receiving system was utilized for receiving septage for approximately 10 years after its installation, but since then it has been used only for receiving "454" transported non-domestic wastewater. It is our understanding that the volume of septage received at the WPCF is more than the septage receiving system can accommodate, in particular the submersible pumps in the holding tanks, which is why septage haulers were directed to discharge septage directly into manhole A as shown on Figure 2-3.

The disadvantage of the current practice of discharging septage directly into Manhole A is that grit and debris contained in the septage settles out in the influent sewer and in the influent channels. The WPCF staff have noted the accumulation of this material in the influent channels of the Preliminary Treatment Building, and periodic cleaning of the channel sections upstream of the mechanical bar screens is performed. However, cleaning of the bypass channel and the channel sections downstream of the mechanical screens does not occur due to a lack of access into these channels.

### 4.3.3 Recommendations

The existing septage receiving system, now used for processing "454" transported non-domestic wastewater should be upgraded to be able to process both septage and "454" wastewater. As noted above, the current septage handling practices has resulted in the deposition of grit and debris in the influent sewer and mechanical screen channels. This recommendation is particularly important if fine screening for a high biomass process (such as IFAS or BioMag) is needed for the upgraded biological treatment process as an accumulation of septage debris and grit may hamper performance and/or increase maintenance costs. It is therefore recommended that the existing septage screen be replaced with a self-contained, pre-packaged stainless steel septage acceptance plant that includes both fine screening and grit removal. Following septage receiving and processing, the septage should be discharged to the two existing 7,500-gallon tanks. The two submersible centrifugal pumps should be replaced with two positive displacement pumps sized for 200 gpm each to empty the tanks within a reasonable timeframe and pump the flow to the influent channel ahead of the influent mechanical screens.

## 4.4 Influent Pumping

### 4.4.1 Overview

The influent pumping station was constructed as part of the 1993 upgrade. Screened and de-gritted wastewater from the Preliminary Treatment Building and effluent from the primary sludge thickeners flows by gravity to the influent pumping station wet well where

it is diverted to the inlet chambers of the three influent wastewater pumps. Each of the three chambers has a slide gate equipped with an electric actuator for automated operation. The three influent pumps are of the enclosed inclined screw pump type, each of which have the following design criteria:

- Pump Manufacturer: Evoqua Internalift® Screw Pumps
- Capacity: 7,500 gpm (10.8 MGD)
- Motor Size: 100 HP
- Lift Height: 28.3 feet
- Screw Diameter: 66 inches
- Screw Speed: 41 RPM
- Screw Angle (install angle): 45 degrees

Typically, only one of the influent screw pumps is required to handle the current WPCF flows, but during high flows two screw pumps are required. Each of the three screw pumps discharge the wastewater into a channel where it flows by gravity to the distribution box of the primary treatment system.

### 4.4.2 Evaluation

Each of the influent pump screws have been replaced during the past 10 years, which indicates that they had a service life of less than 15 years. It is our understanding that the short service life of the pump screws was due to corrosion of the painted metal steel screw. Based upon the current age and the anticipated service life of the existing pumps, it is recommended that the three influent pumps be replaced in-kind in their entirety (screws, motors, gear boxes, etc.) as part of the upgrade project. WPCF staff have noted that the current pump type meets the plant's operational needs but they are difficult to work on due to the size of the equipment. The WPCF staff also reported that the alarms associated with the influent pump station are not working properly and it may be due to faulty underground alarm wiring somewhere onsite.

Evaluation of the three slide gates associated with the inlet chambers of the influent pumps was limited to above grade sections of the gate frames, stems and actuators. The gates appeared to be in good condition, but due to their age the electric actuators should be replaced to ensure proper operation over the next 20-year planning period.

### 4.4.3 Recommendations

It is recommended that the three existing influent screw pump be replaced in-kind in their entirety. The replacement pumps should be provided with measures to reduce the potential for corrosion from wastewater trapped in the screws when they are not in use. The control and alarm systems associated with the influent pump station should be upgraded. It is recommended the electric actuators be replaced on the three influent pump station slide gates.

# 4.5 Primary Treatment

## 4.5.1 Overview

The primary treatment system structures were constructed as part of the 1973 upgrade. Wastewater discharged from the influent pump station flows by gravity into a flow distribution box that contains two manually operated slide gates which enable the flow to be diverted into one or both of the square primary clariflocculators. The wastewater enters the center feed well of the clariflocculators and then flows into the flocculator zone where it is slowly agitated by vertical paddles. The wastewater then flows from the flocculation zone into the clarifier zone where the heavier solids settle to the bottom of the tank and the clarified wastewater overflows V-notch weirs located around the entire square perimeter of the tanks. The settled solids (primary sludge) are swept into a hopper at the center of the tank via the sludge rake arms where they are removed from the tanks by the primary sludge pumps and pumped to the primary sludge thickeners. There are no corner sweeps on the sludge rake arms, rather steep concrete fill is located in the corners of the tanks to help prevent sludge from collecting in the tank corners.

Material that floats to the surface (scum) of the primary clarifiers is collected by the full diameter scum skimmers that push the scum along the surface of the clarifier until it is discharged over the scum beach of the scum removal system. Scum that is discharged from the primary clarifiers is piped to a primary scum pit where it is concentrated by occasionally decanting off the bottom of the pit. Once the scum has accumulated in the pit it is mixed within the pit using a 3 HP mixer, sent through an in-line grinder and pumped to a scum holding tank located in the Solids Handling Building where it is stored until it is removed off-site.

The clarified effluent is discharged over the V-notch weirs into channels located around the outside of each primary clarifier tank. The channels combine the effluent discharged from both primary clariflocculators into a single pipe where the wastewater flows by gravity to the powdered activated carbon treatment (PACT) and activated sludge processes for secondary treatment and nitrification. A composite sample of the primary effluent is collected before the effluent enters the secondary treatment system.

Dimensional details for the primary clariflocculators are as follows:

- Primary Clariflocculator Overall Dimensions: 80 feet x 80 feet
- Flocculator Diameter: 36 feet
- Clarifier Diameter: 80 feet
- Sidewall Depth of Clarifier: 12 feet

Additional information regarding the primary sludge and primary scum handling processes is located in Section 5.

## 4.5.2 Evaluation

The slide gates installed in the primary clariflocculator distribution box are in poor condition and are at the end of their useful life. These 44-year-old slide gates are fiberglass in construction and have leaking seals. The WPCF staff have noted they operate these gates as infrequently as possible due to their poor condition.

The components of the primary clariflocculators are also in poor condition and beyond their normal service life. The metal components of the clariflocculators including the flocculator mechanism, clarifier mechanism and scum collection system have failed paint systems and are corroding. The primary clariflocculator tanks are constructed of concrete and originally had a protective paint coating which has failed in most locations and is either peeling off or completely missing.

The scum pit is an open top tank design that has a grated walking surface. The WPCF staff report that the scum pit is susceptible to having the scum layer freeze during the winter months. The staff added the decanting system to help concentrate the scum in the scum pit by adding a submersible pump that discharges the non-scum liquid at the bottom of the pit to the effluent troughs of the primary clariflocculators. The submersible decanting pump system is difficult to service and maintain as the pump is not on a slide rail system, and the staff currently has to install and remove the pump using a rope. The scum pit does not have proper access to the top of the pit where the mixer, pump and level instrumentation are located. Another feature that has caused the staff problems in the past is clogging of the long force main from the primary scum pumps to their discharge point in the Solids Handling Building.

The following comments have also been noted by staff:

- The flocculator sections of the primary clariflocculators are not operated as chemical addition at this location is not currently required to meet treatment objectives. The plant has removed the flocculator arms from primary clariflocculator #1 (east primary) due to failure and condition of the equipment. The flocculator in primary clariflocculator #2 is only exercised occasionally in order to keep the equipment in an operating condition.
- The access/interconnecting walkways for the primary clariflocculators are covered with solid diamond plate walking surfaces which become slippery during the winter months with snow and ice. The staff noted that grating would be preferred over the existing solid diamond plate walking surface.
- WPCF staff added flushing water to the scum beach which is activated each time scum is discharged into the beach in order to help flush the scum piping to the scum collection pit. New clarifier mechanisms should also consider this design feature.
- The plant water hydrant located on the access walkway between the two primary clariflocculators needs replacement along with the piping from the building to the hydrant. The hydrant location meets the needs of the WPCF staff.

The performance of the primary clariflocculator tanks over the past three years is shown in Table 4-2 below. In general, 50% of the influent BOD and 75% of the influent TSS was removed by the primary clarifiers. These percent removals are greater than typical removal efficiencies (35% BOD and 50% TSS, as per TR-16). It is believed that recycle streams that are returned to the headworks, most notably the WAR blowdown, skew the primary clarifier removal efficiency data. The WAR blowdown occurs in approximately 30 second intervals, which is likely too quick to be picked up by the influent flow meter; however, due to mixing of the WAR blowdown with the influent and the long detention times in the clarifiers, its impacts are picked up in the primary effluent sampler, skewing the results. Evidence of the impacts from the WAR blowdown can be seen in the ammonia data. Since the blowdown has a high ammonia concentration and ammonia is mostly

soluble (so not likely to be removed in the clarifiers), the primary effluent ammonia load is higher than the influent.

The total phosphorus percent removal (32% on average) is also higher than expected when compared to primary clarifier data from more conventional treatment plants; however, this large removal is related to the high particulate phosphorus concentrations of the recycle streams being reintroduced and subsequently removed in the primaries rather than actual removal of influent total phosphorus. At the Vernon WPCF, the recycle stream total phosphorus is quite high because phosphorus accumulates within the secondary system; the only method by which particulate phosphorus can be removed from the secondary system is via the recycle streams (other forms of phosphorus removal are simply reintroduced once the WAS is destroyed by the WAR system).

The perceived impact of the WAR blowdown not being sampled in the influent suggests that the actual BOD and TSS percent removals in the primary clarifiers may be even higher than observed; however, this potentially large removal is related to the high BOD and TSS concentrations of the recycle streams being reintroduced and subsequently removed in the primaries rather than actual removal of influent total BOD and TSS (similar to the TP discussion above). Since it is difficult to quantify these impacts of the WAR blowdown recycle stream on TSS and BOD, we decided not to take this credit in the design evaluation of the upgraded primary clarifiers and instead used the more conservative observed data.

**TABLE 4-2**

Current Treatment Performance of Primary Clariflocculators (2013 - 2016)

| | **Wastewater Loads (lb/d) [1]** | | **Net Removal (lb/d)** | **Percent Removal (%)** |
|---|---|---|---|---|
| | **Influent [2]** | **Primary Effluent** | | |
| Average Day | | | | |
| BOD | 8,765 | 4,486 | 4,279 | 48.8% |
| TSS | 10,235 | 2,642 | 7,593 | 74.2% |
| NH3 | 519 | 578 | -59 | -11.4% |
| TKN | 1,022 | 858 | 164 | 16.1% |
| TP [3] | 295 | 201 | 94 | 31.8% |
| Maximum Month | | | | |
| BOD | 12,097 | 5,674 | 6,423 | 53.1% |
| TSS | 14,324 | 3,820 | 10,504 | 73.3% |
| NH3 | 657 | 686 | -29 | -4.4% |
| TKN | 1,283 | 1,325 | -42 | -3.3% |
| TP [3] | 420 | 276 | 144 | 34.3% |
| Maximum Day | | | | |
| BOD | 14,888 | 7,185 | 7,703 | 51.7% |
| TSS | 19,233 | 4,453 | 14,780 | 76.8% |
| NH3 | 707 | 785 | -78 | -11.1% |
| TKN | 1,513 | 1,207 | 306 | 20.2% |
| TP [3] | 492 | 431 | 61 | 12.4% |

(1) Data observed at the Vernon WPCF from September 1, 2013 through August 31, 2016.

(2) Influent Load includes septage and some plant recycle loadings from the regeneration blowdown, tertiary filter backwash, and WAS gravity thickener scum. The influent load does not include loads from the overflow of the primary sludge thickeners – but these loads are sent to the primary clarifiers so actual loadings and removal rates are even higher then shown in this table.
(3) Primary Effluent TP data was only collected from December 1, 2015 through the August 31, 2016, so the data is subject to small sample size bias.
BOD = Biochemical Oxygen Demand; TSS = Total Suspended Solids; TKN = Total Kjeldahl Nitrogen; TP = Total Phosphorus

### 4.5.3 Recommendations

Based upon our observations, we recommend the following related to the Primary Treatment System. Refer to Section 5 for recommendations for the primary sludge and scum pumps.

- Replace the two slide gates in the distribution box.
- Replacement of primary clariflocculator mechanisms. If the flocculator sections are not required to meet the future permit limits with the secondary and tertiary treatment processes selected, then it is recommended that the new primary clarifiers not include a flocculator section.
- It is recommended that the areas of peeling/failing paint on the concrete interior and effluent troughs of the primary clariflocculators be sand blasted off. Due to the age of the existing structures and coatings, a hazardous materials survey should be conducted prior to sand blasting efforts. Any areas of concrete that need minor surface repairs/resurfacing a mortar clad type product such as Tnemec's Series 218 MortarClad should be applied. Applying a protective paint coating to the entire interior walls and floors of the primary clariflocculators would be expensive and is not necessary. However, it is recommended that the interior surfaces of the concrete effluent launders be painted with a smooth protective epoxy paint product, such as Tnemec's Series 436 Perma-Shield FR, which will reduce the surface tension and adhesion available for algae growth and would help the WPCF staff when cleaning the launders.
- Replace all solid diamond plate walking surfaces on the access walkways with a grated surface to provide a safer access walkway in the winter months.
- Replace the plant water hydrant located between the two primary clarifier tanks and its associated piping.
- Consider upgrades to the to the primary scum pit to make it more operator friendly and reliable including a permanent pull out rail system for the submersible decanter pump, a solid cover for the open top tank to help reduce freezing potential in the winter months and enlarge the access area around the top of the tank by adding some additional grating off the side of the primary clarifier and adjacent concrete wall of the scum pit. Another option may be to add a valve and pipe to the discharge of the primary scum pump to allow the pump to be used to draw off the bottom of the scum pit and pump the water back to the influent of the primary clarifiers. Refer to Section 5 for further discussions on scum pumping and handling.

# 4.6 Secondary Treatment

## 4.6.1 Overview

The effluent from the primary clariflocculators flows by gravity to the scrubber channel bypass chamber located in the northwest corner of the Regeneration Building where two original 1973 slide gates either direct the wastewater to the scrubber channel or to the scrubber channel bypass pipe. Normally (since the 1993 upgrade) the wastewater flows into the scrubber channel and the bypass channel is not used. However, if the WPCF staff need to bypass the scrubber channel, then the bypass pipe can direct flow past the scrubber channel into the distribution channel for Aeration Tanks #1, #2, #3 and #4. At scrubber channel bypass, the effluent from the primary clariflocculators mixes with the following other liquid streams which are pumped to this location:

- Return activated sludge (RAS) from the secondary clarifiers
- Effluent from the Wet Air Regeneration (WAR) system equalization tank (discussed in Section 5)
- Overflow from the spent carbon tanks (discussed in Section 5)
- Soda ash from the soda ash silo (discussed in Section 6.3.3)
- Backwash water from the Dirty Water Storage Tanks (note that this flow stream is typically diverted back to the head of the plant as discussed in Section 5).
- Effluent from the Differential Separation and Elutriation System (note that this system is no longer operated as discussed in Section 5)

The secondary treatment and nitrification processes include the Zimpro PACT-WAR process which is discussed in detail in Sections 5 and 6. For the purpose of this section, it is noted that the PACT (Powdered Activated Carbon Treatment) and WAR (Wet Air Regeneration) Processes have the following impact on liquid treatment:

- The PACT process uses powdered activated carbon (PAC) to adsorb difficult to treat organics including color. Colored wastewater discharged to the WPCF from now defunct factory dyeing operations was the reason that the PACT-WAR process was installed in 1973.
- The PACT process allows much higher mixed liquor suspended solids (MLSS) concentrations to be used in the aeration tanks and clarifiers than in conventional activated sludge systems because the presence of PAC acts like a ballast allowing better settling rates in clarifiers when compared to rates for conventional activated sludge.
- The WAR process regenerates the carbon on-site and destroys the majority of the waste activated sludge from the process. In theory, this process eliminates/mineralizes 100% of the waste activated sludge from the process and sends the mineralized material back into the secondary treatment process. In theory, this process thereby precludes the removal of phosphorus from the secondary process. In practice, the transformation is not 100% complete and high levels of acetic acid (and other byproducts) are sent back. In addition, high levels of ammonia (from the nitrogen in the sludge), phosphorus (from phosphorus in the sludge) and inert solids are also sent back. This creates an added load to the aeration tanks, and these inert solids (called ash) built up in the secondary process until they are at a high enough level where they are removed from the process by

eventually ending up in the primary clarifiers either by overflowing the secondary clarifier weirs (and becoming trapped in the effluent filters where they are backwashed to the primary clarifiers) or being recycled to the head of the plant in one of the solids handling processes as discussed in Section 5.

After flow enters and mixes in the scrubber bypass chamber, the wastewater is directed to the main scrubber channel through a slide gate. In the scrubber channel, odors (high ammonia, acetic acid, etc. from the WAR system) that can be released from the recycle stream are collected by a low pressure blower and blown into an aeration tank for treatment as discussed later. A sluice gate at the end of the scrubber channel sends the flow to the distribution chamber for the aeration tanks. There are a total of six aeration tanks at the WPCF. The original distribution chamber was constructed during the 1973 upgrade, and an additional (west) distribution chamber was constructed and the original was modified during the 1993 upgrade. The 1973 distribution chamber section has two slide gates that were originally used for splitting flows to aeration tanks #1, #2, #3 and #4. The 1993 upgrade added two larger aeration tanks, and the use of aeration tanks #1 and #2 was discontinued. The west distribution chamber added during the 1993 upgrade contains six slide gates that are used to distribute the flow among the currently active aeration tanks #3, #4, #5 and #6. The original slide gates in the 1973 distribution chamber are still in place, but they are in poor condition. However, they could be used if the WPCF staff needed to put aeration tanks #1 and #2 back into service.

Two slide gates on the north side of the 1993 west distribution chamber route wastewater to the old west distribution channel (constructed during 1973 upgrade) where the wastewater flows by gravity to aeration tanks #3 and #4. The wastewater enters these tanks through an inlet channel that separates the two tanks. Two gated openings, located in the inlet channel toward the head of the aeration tanks #3 and #4 allow for an even distribution of flow into each tank. The other four slide gates located on the west side of the 1993 distribution chamber route wastewater to the newer west distribution channel (constructed during 1993 upgrade) where the wastewater flows by gravity to aeration tanks #5 and #6. The wastewater enters aeration tanks #5 and #6 through four 16-inch slide gates, two per tank, that are located at the head of the aeration tanks.

Aeration tanks #1, #2, #3 and #4 were constructed as part of the 1973 upgrade and aeration tanks #5 and #6 were added during the 1993 upgrade. During the 1993 upgrade, aeration tanks #3 and #4 were modified by increasing the wall height of the tanks to provide additional aeration volume in these tanks. Aeration tanks #1 and #2 were not modified during the 1993 upgrade. Aeration tanks #1 and #2 have a 201,000-gallon capacity, tanks #3 and #4 have a 330,000-gallon capacity, and tanks #5 and #6 have a 610,000-gallon capacity.

There are three 400-HP centrifugal blowers located in the Blower Building that are currently in use for supplying air to the aeration tanks for biological treatment. The aeration blowers were installed during the 1993 upgrade, and each is capable of providing up to 6,800 ACFM of air to the aeration tanks (at 14.4 PSIA inlet, 25.6 PSIA discharge, 100 deg F inlet and 0.98 SG) via above grade stainless steel air distribution piping. The three aeration blowers in use are dedicated to providing air to aeration tanks #3, #4, #5 and #6. Aeration tanks #1 and #2 which currently are not in use are connected to the old 250 HP centrifugal blowers installed during the 1973 upgrade which are located in the Regeneration Building. These older blowers are no longer in use.

The WPCF's aeration tanks were originally set up with coarse bubble diffusers for distribution of air evenly within each of the aeration tanks. In 2009, the WPCF replaced the coarse bubble diffusers in aeration tanks #3, #4, #5 and #6 with fine bubble diffusers. The coarse bubble diffusers in aerations tanks #1 and #2 were left as-is and were not replaced during the 2009 upgrade.

### 4.6.2 Evaluation

Aeration tanks #1 and #2 have not been used for treatment other than scrubbing odors collected from the scrubber channel (when filled with plant water) for over 20 years and if either tank is placed back into operation a full rehabilitation will be needed including, but not limited to, the slide gates in the distribution chamber, slide gates within the influent channels for flow distribution to each aeration tank, aeration tank diffusers and aeration piping.

The WPCF staff noted that entering the aeration tank distribution chamber has never been needed, so the condition of the chamber and the slide gates mounted within the chamber are unknown. The staff noted there are no known issues with the operation of the six slide gates for flow distribution to aeration tanks #3, #4, #5 and #6, but it is not known if any of the gates have leakage or seating issues since the distribution chamber and aeration tank distribution channels are always in service with liquid flowing through them. The slide gates at the head of each aeration tank appear to be in reasonably good shape, but the evaluation was limited to inspection from afar on the aeration tank walkways. The WPCF staff note there are no known issues with operation of these slide gates, but there is likely leakage given their age.

Some known operational and maintenance deficiencies of the active aeration tanks include the following:

- The tanks have no slope and no sump which makes the process of draining the tanks difficult. Submersible pumps were added to enable pumping between tanks #3 and #4 and between tanks #5 and #6 to help the staff drain these tanks and switch which tanks are on-line. The WPCF currently does not have the ability to pump between tanks #4 and #5.
- The effluent channel of each tank is difficult to drain, and a submersible pump must be placed in the channel when needed.
- The plant water spray nozzles for foam control in the aeration tank effluent troughs are dangerous to service and maintain. There is no means for safe access to clean or replace the spray nozzles. The staff modified the spray header pipe in tank #5 to make it removable and help with safe cleaning and replacement of the nozzles.
- The dissolved oxygen probes are in working condition but are aging.
- There are a limited number of plant water hydrants around the aeration tanks limiting the staff's ability to clean the tanks.
- Dissolved oxygen levels in the aeration tanks are higher than the typical 2.0 mg/L required. This is believed to be due to the switch from coarse bubble diffusers to fine bubble diffusors. The blowers cannot operate at a lower air flow rate since they were designed for the coarse bubble diffusers.
- The air valves located on the blower distribution piping are located overhead above the concrete walk adjacent to the aeration tanks and are difficult to access.

Currently, movable metal stairs are in place for access. Leaky gaskets occur periodically on the blower distribution piping, and it is difficult to replace the gaskets due to the height overhead of the air piping.

Of the four active aeration tanks (#3, #4, #5 and #6) the staff typically have three of them on-line. For treatment capacity, the WPCF requires one of the larger aeration tanks (#5 and #6) to be on-line. Additionally, carbon regeneration vapors are discharged to aeration tank #3 via a dedicated diffuser system for odor control, which requires this tank to almost always be on-line. If this tank is taken off-line, the odors can be sent to aeration tank #2 which is kept full of plant water. This odor control system and the aerated mixing system in the channels (used to suspend the PAC and MLSS) increases the dissolved oxygen levels in the first stages of the aeration system which is suitable for nitrification only systems. It is not suitable for nutrient removal systems where low levels of oxygen are required in the first stages of treatment.

The performance of the secondary treatment and nitrification system (which includes both the aeration tanks and the secondary clarifiers) over the past three years is shown in Table 4-3. As noted therein, this table presents data in terms of percent removal of the main pollutants of concern. Note that the secondary effluent loads for each parameter, except for TSS, reflect the final plant effluent since actual secondary effluent data was not available, and the filters were assumed to have a negligible impact in removing these constituents since they are primarily soluble in the secondary effluent. The TSS removal performance of the sand filter is discussed in the next subsection.

On an average day the secondary system removes greater than 97% of BOD and NH3, which is effective for meeting the WPCF's effluent permit limits for these parameters. The TSS percent removal was observed at 90.6% on an average day; however, it decreases to 80.4% at the maximum day. This drop is consistent with the general understanding of secondary clarifier state point analysis theory: as the flow increases, solids removal capabilities decrease. It is also indicative of the challenge that operators have in maintaining acceptable levels of ash (inert solids) in the secondary process. It is noted that TSS data collected at the secondary clarifier effluent will meet the plant's permit limit for effluent TSS in mg/L as summarized in Table 4-3.

The secondary system was successful in removing 62.5% of the TP on an average day basis. This high phosphorus removal was unexpected as the secondary treatment process generates little to no sludge and phosphorus can only be removed as a solid. This is discussed further in Sections 5 and 6.

**TABLE 4-3**

Current Treatment Performance of Secondary Treatment System (2013 - 2016)

| | Wastewater Loads (lb/d) [1] | | Net Removal (lb/d) | Percent Removal (%) | Secondary Effluent Concentration (mg/L)[4] |
|---|---|---|---|---|---|
| | Primary Effluent | Secondary Effluent [2] | | | |
| Average Day | | | | | |
| BOD | 4,486 | 102 | 4,384 | 97.7% | 4 |
| TSS | 2,642 | 248 | 2,395 | 90.6% | 9.2 |
| NH3 | 578 | 9 | 569 | 98.5% | 0.3 |
| TKN | 858 | 74 | 784 | 91.4% | 2.8 |
| TP [3] | 201 | 75 | 126 | 62.5% | 3.1 |
| Maximum Month | | | | | |
| BOD | 5,674 | 246 | 5,428 | 95.7% | 9 |
| TSS | 3,820 | 696 | 3,124 | 81.8% | 23.6 |
| NH3 | 686 | 121 | 565 | 82.4% | 4.1 |
| TKN | 1,325 | 214 | 1,112 | 83.9% | 8.6 |
| TP [3] | 276 | 132 | 144 | 52.0% | 6.2 |
| Maximum Day | | | | | |
| BOD | 7,185 | 357 | 6,828 | 95.0% | 11 |
| TSS | 4,453 | 871 | 3,582 | 80.4% | 26.2 |
| NH3 | 785 | 98 | 687 | 87.5% | 3.0 |
| TKN | 1,207 | 286 | 921 | 76.3% | 9.1 |
| TP [3] | 431 | 158 | 273 | 63.4% | 7.5 |

(1) Data observed at the Vernon WPCF from September 1, 2013 through August 31, 2016.

(2) Secondary effluent data assumed to be equivalent to plant effluent data for all parameters except TSS, which is the only parameter assumed to be removed by tertiary sand filters.

(3) Primary effluent TP data was only collected from December 1, 2015 through the August 31, 2016, so is partial to small sample size bias.

(4) Secondary effluent concentrations are based on observed data, while loads are based on flow weighted concentrations. The actual concentrations were used since it is reflective of the current NPDES permit requirements. Note, the actual concentrations will not match the equivalent concentrations based on the loads and respective design flows.

BOD = Biochemical Oxygen Demand; TSS = Total Suspended Solids; TKN = Total Kjeldahl Nitrogen; TP = Total Phosphorus

### 4.6.3 Recommendations

The final recommendations and improvements for the secondary treatment system will be directly related to the process selected to meet the WPCF's nutrient permit limits. Section 7 discusses the various nutrient removal technologies screened during the Facilities Plan process, Section 8 presents the treatment alternatives analysis, and Section 9 summarizes the recommended plan. Refer to these other sections for the recommended improvements to the secondary treatment system. The design of these improvements should take into consideration and address the operational and maintenance deficiencies discussed previously in Section 4.6.2.

# 4.7 Secondary Clarifiers

## 4.7.1 Overview

The mixed liquor effluent from the aeration tanks flows by gravity to the distribution chamber of the secondary clarifiers where the flow is split among the online clarifiers. Polymer is mixed into the mixed liquor at a target dose of 1 to 2 parts per million (ppm) in the distribution chamber to enhance settling of the solids in the clarifiers. From the distribution chamber the mixed liquor flows by gravity and is discharged into the center feed well of the secondary clarifiers. The solids (sludge) settle to the bottom of the clarifiers and is removed by a full radius suction header mechanism (Envirex's "Tow-Bro" unitube system) on the rotating sludge arm. Surface scum is collected by a full diameter ducking scum skimmer mechanism and is removed from the clarifiers by a full radius automated scum tipping trough. Both the sludge and scum flow to the Return Sludge Pump Station where dedicated scum and sludge pumps transport the liquids. More information regarding the secondary sludge and secondary scum handling processes is presented in Section 5. The clarified effluent overflows the secondary clarifier V-notch weirs and is combined and flows by gravity to the intermediate pump station (or it is bypassed to the chlorine contact tanks during a power outage or high flows).

There are five secondary clarifiers, four of which were constructed in 1973, and an additional secondary clarifier (#5) was constructed during the 1993 upgrade. Typically, the WPCF has three of the five clarifiers in use at any time. Each clarifier is equipped with density current baffles to assist in reducing the potential for short circuiting of mixed liquor over the clarifier weirs. Dimensional details for the secondary clarifiers is as follows:

- Clarifier Diameter: 75 feet
- Sidewall Depth of Clarifier: 12 feet

The distribution chamber of the secondary clarifiers was constructed during the 1993 upgrade. The distribution box inlet chamber has a horizontal influent pipe entering at the bottom of the chamber and two 2-HP mixers which stir the mixed liquor and the polymer together. Both mixers are typically in operation. From the distribution box inlet chamber, water can be distributed to each of the five clarifiers (with provisions for a sixth future clarifier) by passing through a port with a stop plate (manually removed if clarifier is in service– no operator), then over a fixed weir, then into a drop chamber, and then at the bottom of the chamber through a sluice type slide gate into the pipe to the clarifier.

## 4.7.2 Evaluation

The evaluation of the components of the secondary clarifier distribution chamber was limited due to the lack of visibility since the chamber has a concrete top, and the chamber is always on-line and full of mixed liquor. At the time of the evaluation, the staff noted that there were no known issues with the two mixers or the slide gates. They also noted that tape was added to the clear stem covers of the slide gates to assist them in opening the gates to the proper height in order to get even flow distribution among the online clarifiers. However, with no means for measuring the influent flow to each of the five clarifiers, it cannot be confirmed if the flow is actually being distributed evenly among all clarifiers. The operators believe that flow preferentially flows to secondary clarifier #5, due to short circuiting in the distribution box, and they modulate the slide gate accordingly as discussed in Section 2.1.4. It is noted that this slide gate is located after the fixed weir that presumably was designed to balance the flow. Because this weir is fixed, operators

have no choice but to operate the slide gate to reduce the flow even though the gate would need to backup the water several feet in the drop box prior to backing up the weir. Options for resolving this problem include:

- Installing a baffle in the distribution box inlet chamber to limit the upwelling of flow in the chamber in front of the #5 clarifier inlet.
- Replacing the fixed weirs with new adjustable weirs. In this case, the existing slide/sluice gates could possibly be eliminated.

We considered and then rejected the idea of adding flow meters to estimate flow to each of the clarifiers for the following reasons:

- Flow meters would not solve the problem; they would only measure the extent of the problem. The extent of the problem can be better measured in other ways such as monitoring sludge blanket levels in the clarifiers.
- The distribution box inlet chamber and weirs would not accommodate a weir based flow meter.
- The cost to provide magnetic flow meters on the existing buried lines would be high and not address the problem.

All five secondary clarifiers are showing signs of age and are at the end of their normal service life. All clarifier mechanisms have failing paint systems and are corroded. All clarifiers are center pier supported and have an access bridge leading to it from the tank's wall. The walkway of Clarifiers #1, #2, #3, and #4 have a solid diamond plate walking surface which becomes slippery during the winter months with snow and ice. Clarifier #5 has a grated walking surface on its full radius access bridge. The automated full radius scum tipping troughs are showing signs of age on all clarifiers and should be replaced.

The interior concrete walls of clarifier #5 are unpainted whereas the walls of clarifiers #1 thru #4 were originally painted but the paint is currently peeling with sections missing in all four clarifiers.

The following are additional staff observations:

- The clarifier mechanisms are not equipped with effluent launder covers to reduce or eliminate algae from growing on the effluent weirs. The WPCF staff have installed access stairs that allow operators to enter the tanks and to walk the entire circumference of the effluent troughs to clean the troughs and brush off algae growth.
- The automated scum tipping troughs are a useful feature of the secondary clarifiers and clears the scum over the full radius vs. the small area that a standard scum beach system clears. Although the automated actuators have a manual override system, if the current actuators installed have a piston failure the manual override system cannot be utilized.
- The clarifier mechanisms are equipped with full diameter scum skimmer arms. Previous clarifier mechanisms at the WPCF were equipped with full radius scum skimmer arms, and the WPCF would occasionally experience freezing issues of the clarifier surfaces. Freezing of the clarifier surfaces has not been an issue with the full diameter scum skimmer arms.

- The tank drain system for the clarifiers is difficult to operate and requires the staff to drain the clarifier down to a water depth of approximately 2 feet using the sludge pumps, and then an operator will enter the tank to pull open the tank drain that is located at the floor near the center of the clarifier. The tank drain system lacks a way to open the tank drain cover from the access walkway of the clarifiers.

### 4.7.3 Recommendations

Based upon our observations, we recommend the following related to the secondary clarifiers, and refer to Section 5 for recommendations for the secondary sludge and scum pumps:

- All five secondary clarifiers are at the end of their normal service life, and a complete replacement of all secondary clarifier mechanisms including the automated scum tipping troughs is recommended to ensure the WPCF continues to have reliable service from the clarifiers. It is recommended that all clarifiers be replaced in-kind with similar internal mechanisms for sludge removal. Replacement in-kind will minimize modifications required to the clarifier structures.
- Fiberglass covers should be installed over the clarifier effluent launders to significantly reduce the growth of algae and reduce O&M costs. This would reduce the need for the staff to enter the tanks and walk around the perimeter of the tank on the concrete effluent troughs.
- Provide the new automated scum tipping trough equipment with an actuator that can be manually overridden during electric actuator failures.
- It is recommended that the areas of peeling/failing paint on the concrete interior and effluent troughs of secondary clarifiers #1 thru #4 be sand blasted. Due to the age of the structures and coating a hazardous material survey should occur prior to sand blasting activities. Any areas of concrete within the five clarifiers that need minor surface repairs/resurfacing a mortar clad type product, such as Tnemec's Series 218 MortarClad, should be applied. Applying a protective paint coating to the entire interior walls and floors of the secondary clarifiers would be expensive and is not necessary.
- Replace all solid diamond plate walking surfaces on the access walkways of clarifiers #1 thru #4 with a grated surface to provide a safer access walkway in the winter months.
- Consider improvements/replacement of all clarifier tank drain systems with a drain valve that can be operated from the access walkways to eliminate the need to enter the tanks during the draining process.
- Install a baffle in the secondary clarifier distribution chamber to reduce the short circuiting believed to be causing preferential flow to secondary clarifier #5.
- Replacing the fixed weirs with new adjustable weirs. In this case, the existing slide/sluice gates could possibly be eliminated.

At this time, there are no known issues with the secondary clarifier distribution chamber mixers or slide gates, and no improvements are being recommended to these items.

# 4.8 Intermediate Pumping

## 4.8.1 Overview

The effluent from the secondary clarifiers is combined and flows by gravity through Distribution Chamber "B", Bypass Chamber "F" and then into the intermediate pump station wet well located at the exterior of the northeast corner of the Solids Handling Building. Distribution Chamber "B" is a concrete vault structure installed in 1973 that contains two slide gates which enabled the staff to bypass the sand filters. During the 1993 upgrade, the bypass pipe leaving Chamber "B" needed to be permanently plugged due to the placement of the new Blower Building and aeration tanks added during the upgrade. Therefore, during the 1993 upgrade, a new concrete bypass chamber called Bypass Chamber "F" was added. Bypass Chamber "F" has two manual slide gates which enable the staff to operate the gates in order to bypass the intermediate pump station and sand filters and send secondary effluent directly to the disinfection process. Under normal operating conditions, the bypass slide gate in Bypass Chamber "F" is in the closed position, and the secondary effluent flows into the wet well of the intermediate pump station where the intermediate pumps lift the wastewater to the sand filters in the Effluent Filter Building.

The intermediate pumping structures were constructed as part of the 1973 upgrade. The wet well for the intermediate pumps consist of five manually operated slide gates for flow distribution and pump isolation. Three of these gates are located in the influent to each of the inlet chambers for the intermediate pumps, and two of the gates are located on the common walls between the three suction chambers. There are three extended shaft centrifugal pumps located in the Solids Handling Building each with a dedicated 24-inch diameter suction pipe into the suction inlet for each pump. The intermediate pumps are located in the northeast corner of the lower floor of the Solids Handling Building and the motors are located on the intermediate (ground level) floor of the building. The intermediate pump motors were replaced during the 1993 upgrade.

The three intermediate pumps are of the extended shaft centrifugal type, each of which have the following design criteria:

- Pump Manufacturer: Crane Deming Pumps
- Capacity: 6,000 gpm (8.64 MGD) at 55 feet of total dynamic head
- Motor Size: 150 HP equipped with VFD (replaced during the 1993 upgrade)
- Speed: 710 RPM
- Pump Size: 14x12
- Diameter: 22 3/8 inch

Typically, only one of the intermediate pumps is required to handle the WPCF flows but during high flows two pumps are required. The discharge pipe from each pump is combined into a common discharge force main that directs wastewater to the sand filters for further treatment. Note that the capacity of this pump station with one pump out of service is less than the design peak hourly flow of the plant requiring bypassing be performed during peak flows with one pump out of service. The staff must manually operate the slide gates in Bypass Chamber "F" in order to bypass the intermediate pumps during high flows. While bypassing the sand filter during high flows has not received

scrutiny from the CTDEEP in the past due to long-standing hydraulic limitations at the plant, eliminating the need for bypassing will need to be addressed during the upgrade.

### 4.8.2 Evaluation

The intermediate pumps are in poor condition with extensive rust throughout. Valves and check valves are aged and in similar condition to pumps. Pump No. 2 was in operation and exhibited a high pitched whine from the motor and leaking valve. The paint/coating on the pipes is failing. Wet well slide gates are aged and at end of life.

The intermediate pumps have been in service since the 1973 upgrade and are in poor condition and showing signs of their age including rust, leaking seals, and operational noises. The valves associated with the intermediate pumps including suction and discharge shut off valves and discharge check valves are all original to the 1973 upgrade and based on their age are well beyond their expected service life.

Evaluation of the five manually operated slide gates associated with the wet well of the intermediate pumps was limited to above grade sections of the gate frames, stems and actuators. The gates are original to the 1973 upgrade and are well beyond their expected service. It is unconfirmed if the gates leak, but it is likely that they do similar to those at the primary clarifier distribution chamber.

The manual gates at Bypass Chamber “F”, the limited capacity of the pumps, and lack of backup power for the pumps require that the plant be manned during times where power may go out or high flows may occur in order to immediately address the problem and open the bypass gate in Bypass Chamber “F”.

### 4.8.3 Recommendations

The three intermediate pumps and drives should be replaced to provide the WPCF with a reliable pumping system capable of handling the peak hour flow for the plant. Currently the pumps cannot handle the plant’s design peak hourly flow and the sand filters must be bypassed. The size of these pumps will need to be increased to provide tertiary treatment and disinfection at flows up to the plant’s design peak hourly flow. They could be replaced in-kind or with dry pit submersible pumps. Each pump type has its pros and cons associated with it, and the choice should take multiple factors into consideration including life cycle costs, pump layout, pump suitability for flows and heads, pump operation and maintenance needs, and staff preferences.

It is recommended that all suction and discharge shut off valves and discharge check valves be replaced. The piping between suction and discharge valves should also be replaced to assist with fit up of the new valves and pumps.

It is recommended that the five manual slide gates located in the wet well be replaced in-kind. It is recommended for the two slide gates in Bypass Chamber “F” be equipped with electric actuators to assist the plant with reacting to needs for bypassing the intermediate pump station and tertiary treatment system. The actuators power source should be serviced by a back-up generator for use of the actuators during power outages.

# 4.9 Sand Filters

## 4.9.1 Overview

The Effluent Filter Building was constructed in 1973 and houses all of the effluent rapid sand filter items including four down-flow sand filters, backwash pumps, surface wash pumps, and the electrical and controls equipment for the sand filter system. The sand filters are each 38-feet long by 16-feet wide. They are comprised of three layers of media which includes 8-inches of graded stone, 12-inches of filter sand, and 18-inches of anthracite. There are three 100-HP backwash pumps each rated for 6,000 gpm at 42-feet of total dynamic head. There are two 30 HP surface wash pumps supplying wash water at 70 psi to the surface agitators.

Wastewater pumped from the intermediate pumps enters the inlet channels of the sand filters and rises in the channel until it overflows through four ports into the backwash troughs located over each filter. The wastewater overflows the troughs onto the surface of the filter. It then passes downward through the filter media into the underdrain system and is collected in the discharge flume while any solids are retained within the filter media. From the flume, the filtered wastewater is passed through a rate of flow controller and discharged in a filtered water pipe where the filter effluent flows by gravity to the chlorine contact tanks for disinfection. The filter media is periodically cleaned by washing (one filter per day typically for about six minutes), which includes both backwashing and surface washing.

The backwash cycle consists of taking water from the chlorine contact tanks and washing the filters in a counter-current fashion (up flow). During the backwash cycle, the flow through the filters is reversed passing from the backwash line, into the discharge flume, up through the media into the backwash trough, and into the inlet channel. The dirty backwash water flows by gravity into the dirty water storage tanks where it is stored and periodically pumped back into the WPCF process either at Junction Chamber “C” (headworks so that solids can be removed in the primary clarifiers) or at the scrubber channel (influent to aeration tanks with the intent to return any captured PAC to the process). The plant has operated for years by returning the solids to Junction Chamber C.

The surface wash devices consist of nozzles mounted on revolving agitators which during backwashing, water is pumped through the nozzles rotating the agitators and spraying water into the expanded bed. The wash water flow causes the media grains to rub against one another creating a scrubbing effect to further enhance cleaning the filter media. The wash water carrying released solids overflows into the wash water troughs located above the filter bed.

## 4.9.2 Evaluation

The sand filter system including all filter media, pumps, valves and controls are original to the 1973 upgrade and are at the end of their normal service life. In addition to their age, the sand filter system also has limited hydraulic capacity and cannot handle the design peak flows of the plant.

The effluent sand filters were designed to improve TSS removal efficiency since the secondary system was designed to be run at a high MLSS concentrations that could lead to poor clarifier performance at higher flows. The performance of the sand filters is shown Table 4-4 below. The average annual TSS percent removal was 43%. As the flows and

loads increased the percent removal decreased to approximately 35%. The solids that are removed are typically recycled to the WPCF's headworks but can also be sent to the scrubber channel if desired.

**TABLE 4-4**

Current TSS Treatment Performance of Tertiary Sand Filters (2013 - 2016)

| TSS | Wastewater Loads (lb/d) [1] | | Net Removal (lb/d) | Percent Removal (%) |
|---|---|---|---|---|
| | Secondary Effluent | Plant Effluent | | |
| Average Day | 248 | 141 | 107 | 43% |
| Maximum Month | 696 | 451 | 244 | 35% |
| Maximum Day | 871 | 574 | 297 | 34% |

(1) Data observed at the Vernon WPCF from September 1, 2013 through August 31, 2016.

### 4.9.3 Recommendations

It is anticipated that the sand filters will be abandoned, demolished, or converted into a new use as part of the proposed WPCF upgrades needed to meet the Town's NPDES requirements. However, were it to be recommended that the sand filters be retained as-is, a replacement of all equipment, valves, and controls would be required and steps would need to be taken to address the hydraulic limitations of the filters, such as adding additional units, in order to have the system be able to treat the peak design flows of the plant.

## 4.10 Disinfection and Post Aeration

### 4.10.1 Overview

The chlorination/dechlorination and post aeration structures were constructed as part of the 1959 upgrades, and they were originally the WPCF's secondary clarifiers. During the 1973 and 1993 upgrades the secondary clarifier structures were converted and modified into the current chlorination/dechlorination and post aeration structures which consist of two parallel trains. Each train consist of a chlorination/dechlorination contact chamber and a post aeration zone, with overall dimensions of 110.5-feet long by 29-feet wide by 9.75-feet deep (overflow weir height at end of tank). The equipment associated with this system includes two 850 gpm submersible injector jet pump mixers, a 500 gpd capacity jet disinfection system, two sodium hypochlorite feed systems, a sodium bisulfite feed system, and a post aeration system with 198 coarse air diffusers and two 300 scfm positive displacement air blowers.

Wastewater from either the sand filters or bypassed secondary effluent flows into one of two chlorine contact chambers. In the first pass of each tank, part of the incoming flow is pumped by a submersible pump to a jet mixing chamber where it mixes liquid sodium hypochlorite into the flow. The plume from each jet mixing chamber creates a turbulent zone within the reactor tube to force the hypochlorite into contact with the flow. A target baffle located at the far end of the reactor tube aids mixing in the tube and disperses the mixture in all directions. The chlorinated wastewater then flows through the serpentine flow path of the contact chamber allowing a sufficient amount of time required for an effective kill.

At the end of the contact chamber, liquid sodium bisulfite is pumped into the wastewater which dechlorinates the effluent. Prior to being discharged to the Hockanum River, the dechlorinated effluent flows through a post aeration zone to increase the dissolved oxygen levels which is required per the facilities NPDES discharge permit.

### 4.10.2 Evaluation

The contacts tanks are in poor condition, the concrete is spalling and failing in some locations. The influent gates, which are from the 1973 upgrade no longer operate and the staff have recently (within past 5 years) installed a slide gate at the inlet end of the tanks to allow isolation of the two chlorine contact chambers. The submersible hypochlorite injector pumps have never been serviced since installation during the 1993 upgrade and the condition of them are unknown. The staff noted the buried plant water valves at the northwest corner of the tanks are broken.

The post aeration blower units were installed during the 1993 upgrade and are in fair condition but are approaching 25 years old and nearing the end of their normal service life. Both post aeration trains were on-line during the evaluation site visits so the condition of the coarse bubble diffuser systems could not be assessed. The staff noted the post aeration valves located under the grating near the discharge end of the contact tanks are not operating properly.

### 4.10.3 Recommendations

The concrete chlorination/dechlorination and post aeration structures need repairs, refer to Section 6 for structural discussions for these structures and the recommended improvements.

The recommendations for the disinfection and post aeration systems will vary based on the final design for disinfection (i.e. keep liquid sodium hypochlorite or change to ultraviolet light for disinfection). Refer to Section 8 for the alternatives analysis of liquid chlorination vs. ultraviolet light for disinfection. If the current method of chlorination, de-chlorination and post aeration are maintained, it is recommended that the hypochlorite feed system and injector/mixer system be fully replaced to provide continued reliable service. The non-operable influent slide gates should be replaced to allow for proper operation and isolation of the tanks. The broken plant water and post aeration valves should be replaced. The post aeration blowers and coarse bubble diffuser system should be replaced based on their age and more energy efficient diffusers should be provided. A dissolved oxygen control system should also be considered (dissolved oxygen sensors and blowers equipped with VFDs) to conserve energy. It is recommended for the blowers to be relocated to the filter building and new piping be installed. This will allow for the abandonment of the post aeration blower building.

Tighe&Bond

# SECTION 5

# Section 5
# WPCF Solids Handling – Evaluation of Existing Processes

The WPCF's liquid treatment train, solids handling, buildings, ancillary systems, and controls, were reviewed and analyzed to assess their condition and ability to serve the Town's current and projected needs. This section focuses on solids handling processes.

## 5.1 Overview

The solids handling processes include the pumps and equipment necessary to remove solids or sludge from the various liquid treatment systems and process them prior to off-site disposal. The WPCF is designed with flexibility in its solids handling processes. A WPCF overview showing the solids handling processes and sludge flow through the WPCF site is provided in Figure 5-1.

The 1973 upgrade to the WPCF included the addition of sludge dewatering and a multiple hearth incinerator located in the Solids Handling Building. The facility operated the dewatering equipment and incinerator for approximately a decade prior to abandoning the equipment in place and switching from incineration to hauling liquid sludge off-site for disposal. This experience is common at many older plants that were constructed with on-site incineration. The equipment that has been abandoned in place includes a multiple hearth incinerator, two dewatering vacuum filters, the associated cake conveyors used to transport the cake solids from the filters into the incinerator, and scum handling equipment including pumps that were used originally to transport scum from the heated storage tank (still in use) into the incinerator. None of the abandoned equipment is operable nor could it be placed back into operation without a full replacement or an extensive and expensive overhaul to get the equipment operating reliably and meeting all current air pollution control regulations. It is noted that some control wiring related to the thickened sludge pumps still goes through control panels on the upper floor of the Solids Handling Building, which allowed the WPCF to send thickened sludge to the dewatering vacuum filters when they were previously utilized.

The WPCF currently hauls liquid sludge off-site for disposal. This section discusses current WPCF solids production, solids pumping processes, and the solids handling unit processes and associated equipment located onsite. The condition assessment in the following subsections follows the methodology and service life of equipment assumptions that are discussed in Appendix H.

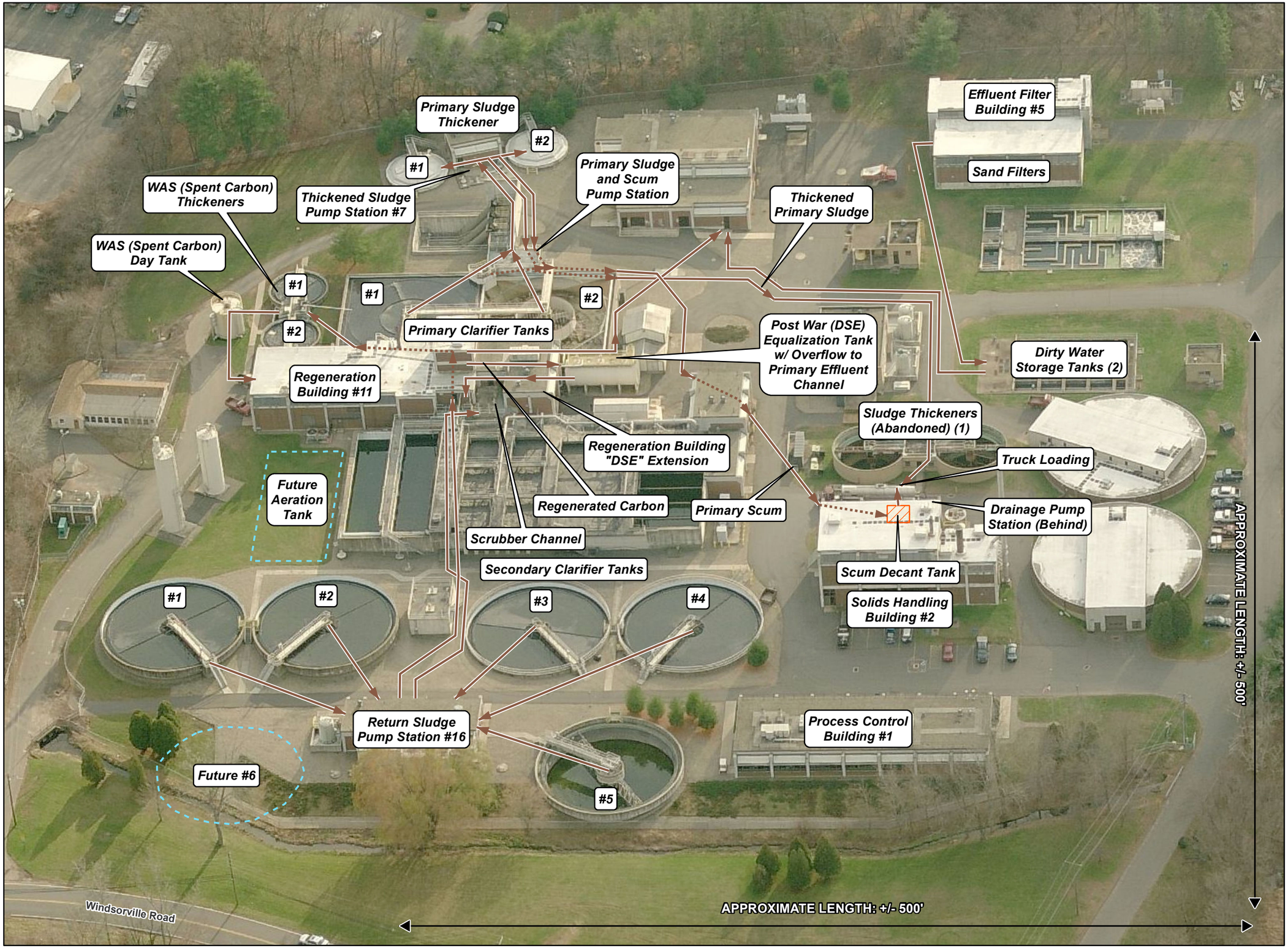



**Figure 5-1**
**WPCF Solids Process Flow Diagram**

**LEGEND**

- Soilds Flow
- Solids Flow (Obscured by Building)
- Future Clarifier/ Aeration Tank

**LOCUS MAP**




Scale: N.T.S.

**NOTES**

Some Scum Returns Not Shown
(1) Secondary Clarifier Scum to Chamber A via Drainage Pump Station
(2) Was (Spent Carbon) Thickened Scum to Plant Influent via MH-B

See Liquid Process Flow Diagram for Location of Chamber A MH-B

**Town of Vernon, Connecticut**

**Vernon WPCF Facility Plan**

**March 2016**

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## 5.2 Current Solids Production

Facility records were reviewed to determine the current solids generation at the WPCF. Operations data was evaluated between September 1, 2013 through August 31, 2016, which is consistent with the data range used elsewhere in this report for evaluating other WPCF operations. The following is a summary of solids generation rates for the period noted based upon the WPCF's monthly operating report data. All this data represents primary sludge that has been thickened in the gravity thickeners. While the WPCF does not generate secondary sludge, the amount of primary sludge generated and its ability to be thickened is influenced by recycles from the Zimpro PACT-WAR system as discussed later in this report.

- Average volume of liquid sludge hauled off-site per day was approximately 13,500 gallons
- Max month volume of liquid sludge hauled off-site per day was approximately 18,200 gallons
- The liquid sludge hauled off-site was on average 6% solids by weight with a typical range of 4% to 8%
- Based upon a 6% solids concentration, the average and max month pounds of solids hauled per day was approximately 6,750 lbs and 9,100 lbs; respectively
- The WPCF typically hauled liquid sludge off-site 6 days per week with an average of 2.4 trucks per day

In the future, the solids generation and handling practices at the WPCF will be directly influenced by the secondary and tertiary treatment technologies selected for meeting future nutrient permit limits. Section 8 of this report presents the alternatives analysis for treatment technologies to meet future permit limits and the corresponding solids handling improvements recommended for each of the alternatives.

## 5.3 Solids Pumping

The WPCF has the following pumping systems for removing solids from the liquid treatment processes:

1. Primary sludge and scum pumps
2. Secondary sludge and scum pumping (both of which include spent powdered activated carbon)
3. Sand filter dirty water pumps
4. Drainage pumps

### 5.3.1 Primary Sludge and Scum Pumping

#### 5.3.1.1 Overview

The primary sludge pumps and primary scum pump transfer sludge and scum from the primary clariflocculators which were installed during the 1993 upgrade. The settled solids (sludge) are removed from the primary clariflocculators via the primary sludge pumps and pumped to the primary sludge thickeners. There are three primary sludge pumps located in the Primary Sludge Pump Station which is adjacent to the south wall of Primary

Clariflocculator #2. The discharge pipes from the three primary sludge pumps are combined into a common discharge force main before exiting the Primary Sludge Pump Station. There is a flow meter and a sludge sample tap on the common discharge force main in the pump station. Piping and valves are also located in the pump station which enable the staff to direct the discharge from the primary sludge pumps to several locations, including the primary sludge thickeners, the distribution chamber of the primary clariflocculators, or (via flexible hose running across the ground) to the WAS (spent carbon) thickeners. This flexibility is necessary as the plant occasionally needs to store WAS in an offline primary clariflocculator if the WAS thickeners are full and the Zimpro regeneration system is offline for maintenance. Once the regeneration system is back online and the thickeners are no longer full, the primary sludge pumps can be used to transfer the WAS stored in a primary clariflocculator to the WAS thickeners for processing. Whereas this piping is not used very often, only the piping to the primary sludge thickeners is shown on Figure 5-1 and the process flow diagram in Figure 3-2.

The three primary sludge pumps are of the progressing cavity type and are belt driven with a piggyback mounting configuration of the pump and motor (motor above pump) due to space constraints in the Primary Sludge Pump Station. Each of the primary sludge pumps have the following design criteria:

- Pump Manufacturer: Moyno
- Capacity: 250 GPM at 93 feet of total dynamic head
- Motor Size: 25 HP
- Speed: 249 RPM

The WPCF typically operates one of the primary sludge pumps for approximately 1 hour every 6 hours. The WPCF's monthly operating reports for the last three years are based on a primary sludge flow of 115 gpm (less than design flow due to known pump wear) when a pump is in operation, and they indicate that on average the primary sludge pumps run approximately 1,582 hours per year (or 4.33 hours per day). The WPCF believes the gallons pumped listed in the operating reports is an over estimate of the actual volume pumped because one of the sludge pumps is known to be excessively worn and is believed to be pumping much less than 115 gpm.

Material that floats to the surface (scum) of the primary clariflocculators is collected and gravity discharges to a primary scum pit located adjacent to the east wall of the Primary Sludge Pump Station. Scum is concentrated in the scum pit by occasionally decanting off the bottom of the pit via a submersible pump. Once the scum has accumulated in the pit it is mixed using a 3 HP mixer, sent through an in-line grinder, and pumped by a primary scum pump to a heated double-walled scum decant tank located in the Solids Handling Building. Here it is further concentrated (by heating tank and separating water from the scum) and stored until it is removed off-site with the sludge trucks. Scum flows by gravity from the storage tank to the trucks.

The primary scum pump and in-line sludge grinder on the suction side of the pump are in the Primary Sludge Pump Station. The primary scum pump is of the progressing cavity type and is belt driven with a piggyback mounting configuration of the pump and motor (motor above pump) due to space constraints in the Primary Sludge Pump Station. The primary scum pump has the following design criteria:

- Pump Manufacturer: Moyno
- Capacity: 50 GPM at 93 feet of total dynamic head
- Motor Size: 10 HP
- Speed: 250 RPM

The WPCF staff currently operate the heated scum holding tank (and related steam boiler and water softening system) in the Solids Handling Building once every three months to separate the scum and water and to send the concentrated scum off-site for disposal. Previously, when the WPCF received larger quantities of septage, which contains higher concentrations of scum, they would need to operate the system and send scum off-site monthly.

#### 5.3.1.2 Evaluation and Recommendations

The primary sludge and scum pumping equipment were installed during the 1993 upgrade and are approaching the end of their normal service life. The primary sludge pumps are all currently worn and pumping much less flow than their original design capacity. The primary scum pump is operated less frequently but per the WPCF staff has not had any major work or repairs done since installation. Based upon the age and condition of the primary sludge pumps and scum pump it is recommended that they all be replaced. Due to space limitations within the Primary Sludge Pump Station, the replacement pumps will need to match the current belt driven piggyback pump configuration (motor above pump) and be compact. The in-line grinder on the suction side of the primary scum pump should be replaced when the primary scum pump is replaced. The suction and discharge valves of the sludge and scum pumps were installed during the 1993 upgrade and currently have no known issues with their operation. If the replacement pumps can fit within the existing space without the need for piping rework it is likely the existing suction and discharge valves can remain in place and provide reliable service. The WPCF staff noted that the valves in the force main that discharges to either the primary clarifier distribution chamber or the WAS thickeners are from the 1973 upgrade. If this force main remains in service after the WPCF upgrade, it is recommended that the valves installed in 1973 be replaced. The flow meter on the primary sludge pump force main that discharges to the primary thickeners should be replaced.

The evaluation and recommendations for the primary scum pit located adjacent to the east wall of the Primary Sludge Pump Station are presented in Section 4.5.3. The current scum handling practice of pumping scum from the scum pit to the heated scum holding tank located across the site in the Solids Handling Building is not ideal due to the occasional issues the WPCF staff have with unplugging this long force main. The heated scum holding tank and the associated steam boiler and water softener equipment is old and nearing the end of their normal service life. It is recommended that the WPCF's scum handling practices be reconsidered during the WPCF upgrade and a new handling practice be implemented that can reduce the issues with plugging of the long primary scum force main. The scum handling recommendations will be influenced by the selected plant upgrades and solids handling improvements which are discussed in the alternatives analysis presented in Section 8. If the existing dirty water storage tanks are converted to aerated WAS storage tanks as presented in Section 8, it is recommended as part of that upgrade a new primary scum force main be tied into the existing scum force main to allow the WPCF to send primary scum either to the WAS storage tanks for further processing or to the existing heated scum holding tank in the Solids Handling Building.

## 5.3.2 Secondary Sludge and Scum Pumping

### 5.3.2.1 Overview

The secondary sludge pumps (WAS and RAS) and secondary scum pumps for handling sludge and scum from the secondary clarifiers were installed during the 1993 upgrade. The solids (sludge) settle to the bottom of the secondary clarifiers and is removed by a full radius suction header mechanism (Envirex's "Tow-Bro" unitube system) on the rotating sludge arm. Surface scum is collected by a full diameter ducking scum skimmer mechanism and is removed from the clarifiers by a full radius automated scum tipping trough. Both the sludge and scum flow by gravity to the Return Sludge Pump Station where dedicated RAS pumps, WAS pumps, and scum pumps transport the liquids.

The removal rate of sludge from each of the five secondary clarifiers is controlled by Return Sludge Control Box structures located on the north side of the Return Sludge Pump Station. Each secondary clarifier has a dedicated Return Sludge Control Box structure box which contains a downward opening slide (weir) gate equipped with a motorized actuator. The flow rate of sludge from each of the clarifiers can be controlled by raising or lowering the slide gate, lowering the gate will increase the rate of sludge withdrawal from the clarifier. After flowing over the slide gate, the sludge flows by gravity into the suction chambers for the RAS and WAS pumps. There are two suction chambers on the north side of the Return Sludge Pump Station. The east chamber is typically dedicated to Secondary Clarifiers #1 and #2 (upper clarifiers which are at a higher elevation than the other clarifiers) and the west chamber is typically dedicated to Secondary Clarifiers #3, #4 and #5 (lower clarifiers). There is a slide gate on the divider wall between the two suction chambers to allow sludge to flow between both chambers.

There are five RAS pumps located in the lower level of the Return Sludge Pump Station which pump the return sludge from the suction chambers to the scrubber channel of the secondary treatment system. RAS Pumps #1 and #2 have individual suction pipes to the west suction chamber, RAS Pumps #4 and #5 have individual suction pipes to the east suction chamber and RAS Pump #3 is a "swing" pump that has suction piping and valves in place to allow it to draw suction from either the west or east suction chamber. The discharge from each of the RAS pumps combine into a common 14" diameter force main in the lower level of the Return Sludge Pump Station which has a 14" magnetic flow meter to measure total RAS flows from the five RAS pumps.

The five RAS pumps are of the horizontal end suction centrifugal pump type each equipped with a VFD for control of pumping rates. Each of the RAS pumps have the following design criteria:

- Pump Manufacturer & Model: Goulds Pump Inc., Model NC, Size 6x8-15
- Capacity: 1,400 GPM at 53 feet of total dynamic head
- Motor Size: 30 HP (equipped with VFD)
- Speed: 1180 RPM

Operations data for RAS pumping was evaluated between September 1, 2013 through August 31, 2016, which is consistent with the data range utilized elsewhere in this report for evaluating other WPCF operations. During this time, the average daily total RAS flow pumped by the RAS pumps was 6.39 MGD which was approximately 228% of the average day plant forward flow during this period. The max month average daily total RAS flow

pumped during this period was 7.18 MGD. The average daily RAS solids concentration and max month solids concentration was 1.91% and 2.26%; respectively.

There are two WAS pumps located in the lower level of the Return Sludge Pump Station which pump the WAS from the sludge suction chambers on the north side of the Return Sludge Pump Station to the Waste Activated (PAC) Sludge Thickeners located to the south of the Regeneration Building. WAS Pump #1 has an individual suction pipe into the west suction chamber, and WAS Pump #2 has an individual suction pipe into the east suction chamber. The discharge from the two WAS pumps combine into a common 6-inch diameter force main in the lower level of the Return Sludge Pump Station which has a 6-inch magnetic flow meter to measure total WAS flows from the two WAS pumps.

The two WAS pumps are of the progressing cavity type and are belt driven with a piggyback mounting configuration of the pump and motor (motor above pump) due to space constraints in the Return Sludge Pump Station. Each of the WAS pumps have the following design criteria:

- Pump Manufacturer: Moyno
- Capacity: 125 GPM at 93 feet of total dynamic head
- Motor Size: 15 HP
- Speed: 204 RPM

Operations data for WAS pumping was evaluated between September 1, 2013 through August 31, 2016, which is consistent with the data range utilized elsewhere in this report for evaluating other WPCF operations. During this period, the average daily weight of solids sent to the Waste Activated (PAC) Sludge Thickeners was 7,122 pounds and the max month wasting rate was 11,220 pounds per day. These solids numbers include both microorganisms that have grown in the aeration tank as well as PAC and high levels of inert solids (ash) that are part of the Zimpro PACT-WAR process.

There are two scum wells located on the south side of the Return Sludge Pump Station. Scum Well #1 is in the southeast corner and Scum Well #2 is located on the southwest corner of the exterior of the pump station. Scum from the upper clarifiers, Secondary Clarifiers #1 and #2, combine into a single pipe and flows by gravity into Scum Well #1 via a 16-inch diameter pipe. Scum from the lower clarifiers, Secondary Clarifiers #3, #4 and #5, flows by gravity into Scum Well #2. Scum from clarifiers #3 and #4 combine into a single pipe and flows by gravity into the scum well via a 16-inch diameter pipe and the scum from clarifier #5 flows by gravity into the scum well via a dedicated 16-inch diameter pipe.

There is a total of four scum pumps, two of which are dedicated to each scum well (duty and stand-by), located in the lower level of the Return Sludge Pump Station which pump the scum from the scum wells to the wetwell of the drainage pumps located in the Solids Handling Building. This configuration was selected because of the two different clarifier elevations require two different scum boxes to prevent scum or water from flowing from the upper clarifiers to the lower clarifiers through the scum handling system if the scum collectors in the upper clarifiers are surcharged. The discharge from each pair of scum pumps combine into a common 4-inch diameter force main in the lower level of the Return Sludge Pump Station which has a 4-inch magnetic flow meter to measure total scum flows.

The four scum pumps are of the progressing cavity type and are belt driven with a piggyback mounting configuration of the pump and motor (motor above pump) due to

space constraints in the Return Sludge Pump Station. Each of the scum pumps have the following design criteria:

- Pump Manufacturer: Moyno
- Capacity: 125 GPM at 93 feet of total dynamic head
- Motor Size: 15 HP
- Speed: 204 RPM

Each scum well is equipped with a paddle mixer used to mix the content of the scum well prior to it being pumped by the scum pumps. Each mixer is manufactured by Philadelphia Mixers and is equipped with a 2 HP motor and a gear box with an output speed of 56 RPM.

#### 5.3.2.2 Evaluation and Recommendations

All secondary sludge (which contains powdered activated carbon) and scum pumping equipment was installed during the 1993 upgrade and are at the end of their normal service life. A complete replacement of all secondary sludge pumps (RAS and WAS) and secondary scum pumps is recommended to ensure the WPCF continues to have reliable service from these pumps. Reducing the number of scum pumps from four (two per scum well) to three (one dedicated per scum well with a common standby that can draw suction from either scum well) was considered but was discarded as a viable option because of the long suction pipe that would be required on the standby pump to enable this pump to draw suction from either scum well. The long suction piping would be prone to clogging and is not recommended.

It is recommended that all pumps be replaced in-kind with similar pump and motor configurations due to space limitations in the lower level of the Return Sludge Pump Station. Replacement in-kind will minimize piping modifications required in the lower level of the pump station.

It is also recommended that the mixer mounted on the top of each scum well be replaced in-kind to ensure reliable service for years to come. The magnetic flow meters located on each of the common discharge force mains (RAS, WAS and scum) should be replaced in-kind.

### 5.3.3 Sand Filter Dirty Water Pumps

#### 5.3.3.1 Overview

The dirty water from the backwashing process of the sand filters is sent to the dirty water storage tank where it is stored and then pumped by the two (duty and stand-by) dirty water storage tank pumps to either Junction Chamber C (head of the WPCF treatment process) or the scrubber channel (ahead of aeration). Normally it is send to Junction Chamber C. The dirty water storage tank is located to the north of the chlorine contact tanks and east of the Chemical Building. The dirty water storage tank was originally the WPCF's primary clarifiers but was repurposed during previous upgrades for storage of the backwash water from the sand filters. The dirty water storage tank pumps are in the lower level of the Chemical Building.

The two dirty water storage tank pumps are of the horizontal end suction centrifugal pump type. Each of the dirty water storage tank pumps have the following design criteria:

- Pump Manufacturer & Model: Goulds Pump Inc., Model NC, Size 6x6-15

- Capacity: 580 GPM at 60 feet of total dynamic head
- Motor Size: 15 HP
- Speed: 1180 RPM

#### 5.3.3.2 Evaluation and Recommendations

The dirty water storage tank and dirty water storage tank pumps are associated with the operation of the WPCF sand filters. If the sand filter process remains, the storage tank and pumps will need to remain in service. If the sand filters remain it is recommended for the dirty water storage tank pumps be replaced in-kind to provide reliable service for years to come. If the sand filter process is replaced and the dirty back wash water storage tank is no longer needed, then the tank and pumps will not be needed and replacement of the pumps is not necessary. However, if the tank remains as is, the pumps will need to stay online and be available for use to drain rain water and snow melt water that will collect over time in the open top dirty water storage tank. If this is not acceptable, then the tanks should be abandoned and filled in. This latter option may not be eligible under the clean water fund unless a need to use this area is identified.

### 5.3.4 Drainage Pumps

#### 5.3.4.1 Overview

The drainage pumps are in the Solids Handling Building with the wetwell for the pumps located adjacent to the south exterior wall of the building. The drainage pumps and associated wetwell were originally installed during the 1973 upgrade and served as the WPCF's influent pumps and have since been repurposed for pumping miscellaneous plant flows. The following are the miscellaneous plant flows that are currently discharged into the wetwell to the drainage pumps:

- Sanitary flow from the Process Control Building (sanitary flows are conveyed by gravity from the Control Building to the Return Sludge Pump Station where sewage pumps pump the sanitary flow to the wetwell of the drainage pumps)
- Decant from the heated scum holding tank located on the upper level of the Solids Handling Building
- Sump pump discharge from the Solids Handling Building, Process Control Building and Return Sludge Pump Station
- Aeration blowers cooling water
- Scum from the secondary clarifiers
- Drain line from the sludge truck loading area (during the 1993 upgrade a complete loading station spill containment system was going to be installed but was value engineered out of the project and only a small concrete pad with a drain was installed as part of the project which currently cannot contain sludge truck spills and only sends rain water and snow melt into the wetwell)

The wet well for the drainage pumps consist of five manually operated slide gates for flow distribution and pump isolation. Three of these gates are in the influent to each of the three suction chambers for the drainage pumps, and two of the gates are located on the common walls between the three suction chambers. There were originally three drainage pumps but one of the pumps (western most pump) has since been removed from service and partially dissembled and the suction chamber associated with this pump is no longer

used. The drainage pumps are extended shaft centrifugal pumps, with the pumps located in the southeast corner of the lower floor of the Solids Handling Building and the motors are located on the intermediate (ground level) floor of the building. The motors are equipped with an old variable speed technology for flowrate control called "Flowmatcher®"

The two drainage pumps currently in use have the following design criteria:

- Pump Manufacturer: Crane Deming Pumps
- Capacity: 6,000 gpm (8.64 MGD) at 55 feet of total dynamic head
- Motor Size: 150 HP equipped with Flowmatchers
- Speed: 710 RPM
- Pump Size: 14x12
- Diameter: 22 3/8 inch

Each pump has a dedicated 24-inch diameter suction pipe into their corresponding suction chamber and a dedicated 18-inch diameter discharge pipe. The discharge pipes from each pump is combined into a common 20-inch diameter discharge force main that directs the miscellaneous plant flows to the distribution box of the Primary Clariflocculators.

The two active suction chambers for the drainage pumps are equipped with a top mounted mixer, manufactured by Philadelphia Mixer, to mix the contents of the chamber prior to pumping. The mixers were installed during the 1993 upgrade and are each equipped with a 3 HP motor and a gear box with an output speed of 45 RPM.

### 5.3.4.2 Evaluation and Recommendations

The drainage pumps are old and past their normal service life. In addition to being old, the pumps are grossly oversized for their current pumping application for miscellaneous plant flows. The drainage pumps will continue to be needed for miscellaneous plant flows following the recommended upgrades. It is recommended as part of the upgrade that the drainage pumps be replaced with smaller pumps appropriately sized for the required miscellaneous plant flows.

We recommend the following upgrades related to the drainage pump system:

- Install two new submersible pumps (one in each of the two active drainage pump suction chambers). It is suggested a pump equipped with a mixing valve system be installed to allow the contents of the wet wells to be mixed prior to pumping. A small valve chamber will also be needed outside of the station. These modifications will keep raw wastewater (from the Control Building) piping and pumps out of the basement of the Solids Handling Building which will allow for reduced ventilation requirements in the building and energy savings because there will be no raw sewage piping or pumps in the building.
- Install a new, smaller 6-inch or 8-inch force main to convey the flows discharged from the new submersible pumps to the head of the plant so that all flows pass through the upgraded headworks facility.
- Demolish the drainage pump motors on the ground level of the Solids Handling Building and repair the floor area to provide more working space. The old pumps and piping in the lower level of the Solids Handling Building are not required to be demolished. However, piping will be flushed and cleaned and the suction piping

and discharge piping will be disconnected where it leaves the building to isolate pumps and prevent wastewater from entering the pump room in the future.

- For the sludge truck loading station, there are two storm water catch basins next to where the tanker trucks typically park. To prevent sludge spills from truck loading operations entering the storm sewer, it is recommended that the area be regraded and a new drain for just the truck loading area be constructed and into the drainage pump station wet well. This objective can be achieved by increasing the size of the pumps in the drainage pump station to manage high storm flows that will be intercepted while minimizing the drainage area to minimize storm flows. A conservative storm flow design must be used for sizing the pumps because if the wet well is inundated, then secondary scum (if continued to be sent here and not new aerated WAS holding tank as discussed in Section 8) and raw sewage will spill out of the wet well. It will also likely require adding new storm catch basins and extending the storm sewer to the east of the loading area because of the regrading required.
- If the existing dirty water storage tanks are converted to aerated WAS storage tanks and new rotary drum thickeners are installed in the Solids Handling Building as presented in Section 8, then the new drainage pumps will need to be appropriately sized to handle the liquid filtrate discharged from the RDTs that would be sent to the drainage wet wells.

## 5.4 Sludge Thickening and Storage

Current and recommended sludge thickening processes are discussed in this section.

### 5.4.1 Existing Primary Sludge Thickeners

#### 5.4.1.1 Overview

There are two circular primary sludge gravity thickeners located on south end of the facility adjacent to the influent pumps which are utilized to thicken primary sludge prior to the sludge being hauled off-site for disposal. Each primary sludge thickener is 30-feet in diameter and has a side water depth of 12-feet 9-inches. The primary sludge gravity thickeners and associated pumping equipment were installed during the 1993 upgrade. The primary sludge thickeners are covered to help contain odors and odor control ductwork is connected to the preliminary treatment building's odor control scrubber. The gravity thickeners are equipped with surface scum collectors which have never been utilized due to the collection system not working as intended. The WPCF staff reported that they believe the surface scum collector beach was installed at too low of an elevation because the beach is always flooded causing a continuous flow of sludge to the primary thickener scum well. For this reason, the WPCF staff have never used the primary thickener scum collection system since the thickeners were installed during the 1993 upgrade.

The primary sludge pumps (discussed earlier in this section) discharge primary sludge into the distribution box for the primary sludge thickeners. The distribution box contains two stop gates (blocks) and two weir plates which allow the WPCF to control flows to one or both gravity thickeners. Thickener dilution water (plant effluent that is supplied by dedicated pumps in the Plant Water Building) can also be discharged into the distribution box of the gravity thickeners. These pumps are not used now as the WPCF staff feel dilution water is not necessary for the current operation of the gravity thickeners.

However, dilution water is a typical design aspect and feature for the operation of gravity thickeners. Sludge enters the thickeners by gravity through the center feed well where sludge settles and thickens and decant overflows the thickener weirs. The overflow from the primary sludge thickeners is combined and flows by gravity to the influent pump station. As noted previously, each thickener is equipped with an improperly installed scum collection system. The design intent was to have the scum from each thickener collected and discharged into a scum well equipped with a mixer where the scum would be briefly stored and then pumped to the heated scum decant tank (discussed previously) where eventually after decanting it would be sent offsite for disposal.

There are three thickened primary sludge pumps located in the lower level of the Thickened Sludge Pump Station. The thickened sludge is drawn off the bottom of the thickeners and is pumped directly into sludge trucks for disposal offsite. The discharge from the three pumps is combined into a common 6-inch diameter thickened sludge force main prior to leaving the building. This force main enables the thickened sludge to be pumped across the WPCF site to the sludge truck loading area located south of the Solids Handling Building. The WPCF has installed fittings on the common discharge force main in the lower level of Thickened Sludge Pump Station to allow for a means to temporarily have a secondary discharge point from the common force main which allows a hose to be hooked up and routed outside of the building for direct discharge into a sludge loading truck. This secondary discharge is used if the primary force main gets plugged and needs to be flushed. Originally there were in-line sludge grinders installed on each of the sludge pump suctions, but the WPCF has since removed the grinders as they were excessively worn, and the cost of replacement/rehabilitation exceeded their benefit.

The three thickened primary sludge pumps are of the progressing cavity type and are belt driven with a piggyback mounting configuration of the pump and motor (motor above pump) due to space constraints in the lower level of the Thickened Sludge Pump Station. Each of the thickened primary sludge pumps have the following design criteria:

- Pump Manufacturer: Moyno
- Capacity: 125 GPM at 93 feet of total dynamic head
- Motor Size: 15 HP (equipped with VFD)
- Speed: 204 RPM

There are two scum pumps installed in the lower level of the Primary Sludge Pump Station that were originally installed to enable scum from the primary sludge gravity thickener scum well to be pumped to sludge trucks for offsite disposal. The discharge from the two pumps is combined into a 4-inch diameter common discharge force main prior to leaving the building. These scum pumps have never been operated as designed due to the improperly installed scum collection system, as noted earlier. The two scum pumps are of the progressing cavity type and are belt driven with a piggyback mounting configuration of the pump and motor (motor above pump) due to space constraints in the lower level of the Thickened Sludge Pump Station. Each of the scum pumps have the following design criteria:

- Pump Manufacturer: Moyno
- Capacity: 50 GPM at 93 feet of total dynamic head
- Motor Size: 10 HP (equipped with VFD)
- Speed: 250 RPM

The primary sludge gravity thickener scum well is equipped with a top mounted mixer, manufactured by Philadelphia Mixer, to mix the contents of the scum well prior to pumping. The mixer has a 2 HP motor and a gear box with an output speed of 68 RPM.

#### 5.4.1.2 Evaluation and Recommendations

The two circular primary sludge gravity thickeners and associated pumping equipment were installed during the 1993 upgrade and are at the end of their normal service life. A complete replacement of the gravity thickener mechanisms, gravity thickener weirs and baffles, gravity thickener covers, thickened sludge pumps, and dilution water pumps is recommended to ensure the WPCF continues to have reliable service from this equipment. It is recommended that all pumps be replaced with similar compact pump and motor configurations due to space limitations in the lower level of the Thickened Sludge Pump Station. As noted previously in Section 5.1, some control wiring for the thickened sludge pumps goes through the control panels on the upper floor of the Solids Handling Building which allows the WPCF to control the sludge pumps to send thickened sludge to the dewatering vacuum filters (abandoned). Recommended upgrades to the solids handling practices (discussed in detail in Section 8) and SCADA and control systems (Section 6) should take into consideration the current and future control wiring configurations and simplify and improve reliability of them to the extent practical.

It is also recommended that new sludge grinders be re-installed on the suction of each thickened sludge pump to help reduce the potential for clogging of the common discharge force main. It is recommended that a permanent secondary discharge pipe be installed on the common discharge force main equipped with a coupling on the exterior of the building to attach a hose to a sludge truck during instances where the common discharge force main gets clogged.

The dilution water pump system should be replaced to allow for dilution water addition to the gravity thickeners. The current dilution water pumps are in the Plant Water Building. It is recommended that the plant water system be moved to the Filter Building as part of the upgrade (discussed further in Section 6), and it is recommended that the dilution water pump system be relocated to the tertiary filter building as well (this will allow the Plant Water Building to be abandoned). It is recommended only one dilution water pump, properly sized for the gravity thickener operation, be installed in the filter building and piping provisions be provided to enable the plant water system to be used as a backup if the single dilution water pump needs to be taken out of service for maintenance. This recommendation will require discharge piping from the new dilution water pump to be installed to connect to the existing dilution water yard piping adjacent to the Plant Water Building that feeds the thickeners.

### 5.4.2 WAS (Spent Carbon) Thickeners & WAS Day Tank

#### 5.4.2.1 Overview

There are two circular waste activated (spent carbon) sludge gravity thickeners located to the south of the Regeneration Building and to the east of the Primary Clariflocculators. Each WAS (spent carbon) gravity thickener is 30-feet in diameter and has a side water depth of 12-feet. These gravity thickeners are used to thicken the waste activated sludge containing spent carbon prior to the sludge being processed by the Zimpro Wet Air Regeneration (WAR) process that is associated with the WPCF's secondary treatment system, the Zimpro Powdered Activated Carbon Treatment system (Zimpro PACT). The Zimpro PACT-WAR treatment system is discussed in detail in Section 5.5, Section 8 and in the manufacturer's inspection and evaluation report contained in Appendix I.

The Zimpro PACT process uses powdered activated carbon (PAC) in the WPCF's secondary treatment system. This process was installed in the 1970s because it was effective in removing color from the WPCF's effluent that was attributable to dye wastes from former industries in town. PAC is added to the aeration tanks where it acts as a ballast enabling higher mixed liquor suspended solids (MLSS) concentrations to be maintained. The ballast effect helps improve the capacity of the secondary clarifiers.

The Zimpro WAR process does not generate a secondary sludge requiring off-site disposal, and regeneration of the spent PAC reduces the cost of purchasing virgin PAC. This process is described in Section 5.5.

The WAS (spent carbon) thickeners and associated equipment were installed during the 1973 upgrade and had some minor modifications in the 1993 upgrade. The WAS thickeners are open top tanks. The secondary WAS pumps (discussed earlier in Section 5.3.2) discharge WAS into the distribution box for the WAS thickeners. The distribution box splits the flow to both thickeners or to a single thickener if one is offline. Thickener dilution water (derived from plant water) is injected into the WAS force main just prior to it discharging into the distribution box of the thickeners. The WPCF staff noted the dilution water flowrate is approximately 5-10 GPM and is added to keep the thickeners "fresh."

From the distribution box, the WAS enters the thickeners by gravity through the center feed well where sludge settles and thickens and decant overflows the thickener weirs. The overflow supernatant from the WAS thickeners flows by gravity into a wet well located between the two thickeners. Two submersible pumps in the wet well pump the thickener supernatant back into the secondary treatment process via the scrubber channel. If the wet well overflows, the supernatant will flow by gravity to the plant influent via Manhole B. The WAS thickeners are equipped with surface scum collectors. Scum that is discharged from the thickeners is piped by gravity to the plant influent via Manhole B. It should be noted that there is a lot of carbon and solids in the supernatant and scum lines.

The thickened sludge is withdrawn from the WAS thickeners or the WAS day tank via the first stage sludge pumps of the WAR system. Thickened sludge is typically withdrawn from the WAS day tank as the WPCF has found that the day tank contains a more homogenous thickened WAS mixture. If the WAR system is online, the first stage pumps discharge the thickened sludge into the suction side of the second stage pumps (high pressure pumps) of the WAR system which inject the sludge into the WAR system for PAC regeneration. If the WAR system is not in operation, piping and valves on the discharge side of the first stage pumps allow the WPCF to send to the thickened sludge from the WAS thickeners into the WAS (spent carbon) day tank for storage of the thickened sludge until the WAR system is put back into operation. The WAS day tank is located to the east of the WAS thickeners. If the WAS day tank is overfilled it is equipped with an overflow pipe that connects to the influent sewer at Manhole A.

#### 5.4.2.2 Evaluation and Recommendations

The two circular WAS (spent carbon) gravity thickeners and associated equipment were installed during the 1973 upgrade and are at the end of their normal service life. The recommended improvements for the WAS thickeners will depend on the upgrades to the WPCF's secondary treatment system and solids handling procedures. If the Zimpro PACT-WAR system remains in service then a complete replacement of the gravity thickener mechanisms, scum collection system, supernatant pumps and WAS (spent carbon) day tank is recommended. In addition to these items, additional recommendations for equipment replacement of the Zimpro WAR system is discussed in detail in Section 5.5.

If the Zimpro PACT-WAR system is replaced with a different secondary treatment system, then the WPCF's solids handling practices will be influenced by the selected treatment system. Section 8 of this report presents the alternatives analysis for treatment technologies to meet future permit limits and the corresponding solids handling improvements recommended for each of the alternatives.

### 5.4.3 Abandoned Sludge Thickeners (originally digesters)

#### 5.4.3.1 Overview

There are two circular abandoned sludge thickeners located to the south of the Solids Handling Building. These abandoned thickeners were originally covered sludge digesters installed during the 1959 upgrade. During the 1973 upgrade the covered digesters were converted to primary sludge gravity thickeners. During the 1993 upgrade, new primary gravity thickeners were installed (discussed earlier in this section) and these two thickeners south of the Solids Handling Building were abandoned and have yet to be re-used or repurposed.

#### 5.4.3.2 Evaluation and Recommendations

The two abandoned sludge thickeners south of the Solids Handling Building are in poor condition. If these thickener tanks are needed to meet the needs of the future solids handling processes, discussed in Section 8, then a complete replacement of the thickener mechanisms, associated equipment including pumps and renovation of the tanks will be required.

## 5.5 Zimpro PACT-WAR System

### 5.5.1 Overview

During the 1973 upgrade, the WPCF was designed as one of the few Zimpro PACT-WAR activated sludge facilities for municipal wastewater in the country.

- The Zimpro PACT process uses a 300-mesh powered activated carbon (PAC) in the WPCF's secondary treatment system mixed liquor suspended solids to help remove color, adsorb difficult to treat organics, produce a high-quality effluent, and reduce process tank sizes by quickly adsorbing contaminates and acting as a ballast and allowing higher inventories of biology to be carried in the aeration tanks. The ballast effect of the PAC also helps improve the capacity of the secondary clarifiers, especially during high flows. Although the PACT process is part of the liquid treatment process discussed in Section 4, it is discussed in this section because the WAR process has impacts how the two systems operate together.
- The WAR system also includes a Differential Settling and Elutriation (DSE) system to help remove ash from a portion of the WAR effluent. It should be noted that the WPCF does not currently operate the DSE system as it was deemed unnecessary to meet current plant operations.

The PACT and WAR systems are separate systems (that work together), but the PACT system can be used as a standalone system without the WAR system. The Zimpro PACT-WAR Process is now owned by Siemens, but we will continue to refer to it as the Zimpro process in this report. Siemens no longer markets this process for municipal wastewater treatment but it does actively market it to industrial facilities with hard to treat wastes.

The major components of the Zimpro PACT-WAR process (excluding the related DSE system) are shown below in the simplified process flow diagram in Figure 5-2.

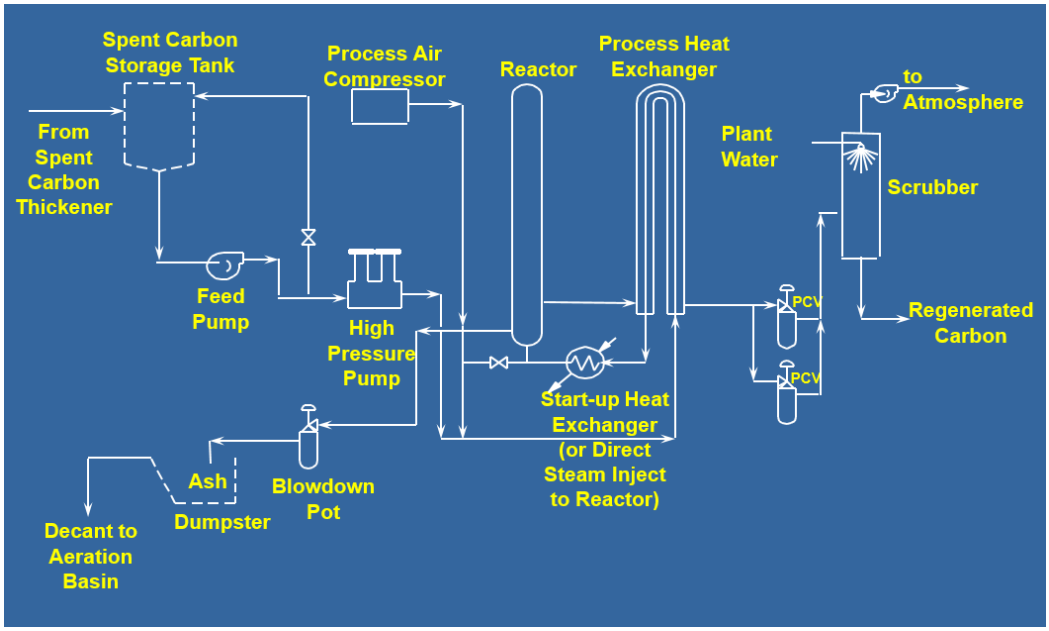


**Figure 5-2**
Zimpro PACT-WAR Simplified Process Flow Diagram

The major system components of the Zimpro PACT-WAR system include the following:

- A virgin PAC storage silo and related feed system to add virgin PAC into the secondary treatment process where it is incorporated into the mixed liquor suspended solids (MLSS).
- Provisions such as mechanical mixers, coarse bubble diffusers, careful pipe and channel sizing, steep slopes on collection channels, etc. to keep the PAC and MLSS suspended (in channels, splitter boxes, and pipes), and operational procedures to maintain the PAC at the proper levels. These are located throughout the plant and most of these have been discussed in other sections.
- Two gravity thickeners and a day tank (discussed in detail in Section 5.4.2) to thicken and store the WAS with spent carbon prior to processing the sludge through the WAR system (PAC regeneration).
- Two stages of pumping, low pressure and high pressure. The first stage being made up of two centrifugal pumps (discussed briefly in Section 5.4.2.1). The second stage being includes two (one duty, one standby) Zimpro tubular diaphragm type pumps to deliver the WAS at the high pressures needed in the process.
- Three stages of air compression to deliver air (oxygen) at the high pressures needed. These are provided by two (one duty, one standby) set of compressors. Each set having a single stage compressor followed by a two-stage compressor.
- Three sets of Type 316 stainless steel heat exchangers to recover heat from the oxidized sludge while simultaneously preheating the sludge to be treated.

- A Type 316 stainless steel reactor where the oxidation of the WAS takes place under high temperature conditions of 450 to 460° F and high pressures conditions of 600 to 700 PSIG.
- Two high pressure steam boilers to heat up the sludge and equipment during startup.
- Reactor blowdown system.
- Two pressure control valves to reduce the WAS pressure prior to it being reintroduced into the secondary treatment system via the scrubber channel.
- A 50,000-gallon post equalization tank to reduce the impact of the recycle stream (which contains some unrecovered PAC, ash, and some organic load) on the secondary processes
- The DSE equipment (most of which is not currently operated) to help remove ash from a portion of the WAR effluent.

All the Zimpro PACT-WAR equipment is either located in the Regeneration Building (1973), Regeneration Building Extension (1993), or located outside adjacent to the Regeneration Building.

### 5.5.2 Evaluation and Recommendations

To assess the current condition of the WAR system, Siemens Energy, Inc. Water Solutions (Siemens), current owners of the Zimpro PACT-WAR system, performed an onsite inspection (November 7-9, 2016) and evaluation. The WAR unit was placed into service in 1978 and has been in service for nearly 40 years. The PACT equipment, including the virgin carbon storage silo and feed system, were not inspected nor evaluated by Siemens. Also, the DSE system equipment, which is not currently in use, was not inspected nor evaluated.

Siemens provided a report that documents their observations made during their site visit. The complete Siemens report and clarifying correspondence is included in Appendix I. The main discussion points are as follows:

- The Zimpro system has received periodic inspections over its service life with the most recent in October 2013.
- Lower pressure feed pumps to Zimpro pumps - Two different brand pumps, one is an Ingersoll-Rand and the other is a Summit pump. The main purpose of these pumps is to supply the Zimpro High Pressure pumps with adequate spent carbon slurry to pump to the WAR unit. These pumps can also be used to fill the day tank. These pumps will need to be either replaced or rebuilt as they are approaching the end of their expected service life.
- Zimpro high pressure pumps - There are two Zimpro High Pressure pumps, one installed in 1983 and the other was installed in 1995. The pump installed in 1995 is the one used predominantly by the WPCF because it has a high flow output. The older pump is still occasionally used to ensure proper operation and function. Siemens noticed that was there were some pipes on the pump that appeared to have been replaced due to erosion which is not uncommon due to the age of the pumps and the nature of carbon slurry that is being pumped through them. There have been periodic checks on the pumps for wear of the pipe walls. This is done every 3-5 years by Siemens. Routine maintenance is done by changing the suction and discharge check balls/ seats and the pump bags. Oil checks are also done

periodically. These pumps can continue to be run for an undetermined period. It is possible that there are more pipes in the future that need replacing.

- Air compressors - The plant added two new high pressure compressors and booster compressors in 2005. Since 2005, both compressors have about 15,000 service hours. Both compressors are 11 years old with an expected service life of 20 years. In the event of breakdown or failure, there is a backup compressor which will maintain operation until a repair can be completed.
- Steam boilers - The two boilers are the most dated pieces of process equipment and Siemens recommended replacement. Both are original to the system. The plant has replaced the coils and some instrumentation on the boilers, but it will be increasingly difficult to source replacement parts for these boilers. It is more cost effective to replace the boilers.
- Stainless steel heat exchangers – Siemens reviewed the results of the most recent inspection report and noted that based on the thickness of the U-bends, there were no apparent issues with the heat exchangers There are three bundles of heat exchangers. Two bundles are original from start-up and the third was added in the 1993 upgrade (circa 1994). The third bundle is about one and one-half times bigger than the other two. Going forward, routine thickness checks on the U-bends is recommended if the Zimpro system remains. Siemens would also highly recommend removing all the insulation and going over the entire body of each heat exchanger to make sure the wall thickness is in good condition.
- Stainless steel reactor - The reactor has been routinely inspected for wear on the stainless steel cladding inside the reactor. Siemens reviewed the latest inspection report from 2013 and found no issues with the cladding. To continue using this reactor into the future, Siemens recommends a complete check of the cladding thickness. Siemens also recommends removing the insulation and checking the integrity of the outer carbon steel walls.
- Reactor blowdown system - Siemens recommends the reactor blowdown unit be upgraded. The plant is currently performing manual blowdowns. When it's time for a blowdown, the operator must operate a manual block valve opening it so the control valve can blow the reactor down. This is done about 3 times per shift per the WPCF. Siemens recommends putting in automated valves to make the blowdowns open via timers.
- Pressure control valves (PCV) - The PCV's are Fischer valves and are original to the WAR unit. The plant has replaced the stems and seats throughout the years. If the Zimpro process remains, the WPCF expects to replace the valves with valves that are compatible with the new control system being considered. The PCV pots that are below the control valves should also be replaced. These are original and Siemens expects them to be worn out from the years of service.
- System instrumentation and controls - Siemens would strongly recommend an upgrade of all instrumentation and control systems most of which is original to the system. The new instrumentation and control system would increase the system's reliability and efficiency.

The Zimpro PACT-WAR system went online 40 years ago, and it is well beyond its normal service life. Siemens notes in its recent inspection report that the WAR system is beyond its life expectancy, and states, "It is difficult to determine the remaining service life expectancy of a unit that has exceeded its designed service life. Using an analogy, it would

be as much as asking my mechanic to determine when my 40y/o pick-up truck will stop working".

One of the goals of this Facilities Plan is to evaluate treatment technology alternatives (discussed in detail in Section 6 and 8) for the WPCF best suited to meet future nutrient permit limits, including the total estimated costs for the various alternatives. One of the alternatives discussed in Section 8 is to keep the Zimpro PACT-WAR system in operation at the WPCF. To evaluate the alternatives, it cannot be assumed that existing 40-year-old Zimpro PACT-WAR system will continue to provide reliable service over the next 20-year planning period. Therefore, the cost analysis for the alternative to retain the Zimpro system includes the capital costs for a full replacement of all Zimpro PACT-WAR system. Although system failure may occur sooner, for the purposes of comparing alternatives only, it is assumed that the Zimpro equipment can last another ten years.

Other related equipment that was not reviewed by Siemens in their report or reviewed elsewhere in this report will also require replacement if the Zimpro PACT-WAR system were to be retained. This includes the following:

- The carbon silo (from 1973 upgrade)
- The scrubber channel odor control blower and related piping and tank diffusers (50 HP blower from 1973 upgrade)
- The following components of the 1993 upgrade to the DSE System which are currently operated:
    - The DSE Room vapor blower
    - The 50,000-gallon post equalization tanks and three 10 HP mixers
    - Two post equalization pumps
    - Related controls (integrated into the new WAR system controls)
- The following components of the 1993 Upgrade DSE System which are currently not operated but will likely need to be operated in the future as flows and loads increase. This is because even though operators now operate with higher blow downs (and slightly higher carbon replacement costs), this will likely not be cost effective in the future:
    - The three related chemical feed systems and related piping
    - A new control panel (integrated into the new WAR control panel) and related electrical wiring
    - The feed pumps
    - The mixers on the elutriation tank.

    (Note: We have assumed that the painted steel elutriation tank can continue to be used in the future without replacement.)

## 5.6 Dewatering

### 5.6.1 Overview

As noted Section 5.1, the 1973 upgrade to the WPCF included installation of sludge dewatering equipment and a multiple hearth incinerator located in the Solids Handling Building. The facility operated the dewatering equipment and incinerator for approximately

a decade prior to abandoning the equipment in place and switching from incineration to hauling liquid sludge off-site for disposal. The dewatering equipment, that has been abandoned in place, includes two dewatering vacuum filters, associated chemical feed systems (ferric chloride, lime and polymer) related outdoor storage tanks (ferric chloride, and lime) for conditioning of the sludge for dewatering, and the associated cake conveyor used to transport the cake sludge from the filters into the incinerator.

### 5.6.2 Evaluation and Recommendation

It is expected that all the abandoned dewatering equipment is no longer operable and could not be placed back into operation without a full replacement or an extensive and expensive overhaul to get the equipment operating reliably and efficiently. It is recommended that the equipment be left in place and not demolished unless the floor or outdoor space is required for process equipment associated with the recommended upgrades. We recommend that the wooden access platforms constructed around the vacuum filters (to aid in the operation and maintenance of the filters) be demolished as they have been constructed in a way that blocks safe egress paths from the room.

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# SECTION 6

# Section 6
# WPCF Buildings, Ancillary Systems, Controls, and Energy Evaluation

## 6.1 Overview

The WPCF's liquid treatment train, solids handling, buildings, ancillary systems, and controls were reviewed and analyzed to assess their condition and ability to serve the Town's current and projected needs. This section focuses on the evaluation of the WPCF buildings, ancillary systems, controls, and energy efficiency.

## 6.2 Plant Water System

### 6.2.1 Overview

The plant water system was last upgraded in 1993 and is located in the lower level of the Plant Water Building (former chlorine building). The plant water system draws suction from the effluent end of the chlorine contact tanks and supplies plant water for various uses around the WPCF site (e.g., plant water yard hydrants, seal water systems, spray water, etc.). The plant water system consists of an 8-inch suction header (connected to the chlorine contact tanks), three horizontal end suction centrifugal pumps, an 8-inch discharge header (connected to the plant water piping network) and an 8-inch magnetic flow meter on the discharge header. Each of the plant water pumps is equipped with a VFD, and the WPCF currently operates the system to maintain a plant water discharge pressure of 90 PSI.

Each of the plant water pumps have the following design criteria:

- Pump Manufacturer & Model: Goulds Pump Inc., Model 3755
- Capacity: 550 GPM at 180 feet of total dynamic head
- Motor Size: 40 HP
- Speed: 3550 RPM

### 6.2.2 Evaluation and Recommendations

The plant water system is 24 years old, oversized for current operations, inefficient and needs to be replaced with new plant water pumps with VFDs and integral pressure control system. The new plant water pump system should be sized to appropriately meet the plant water demands of the upgraded plant processes while providing energy efficient operation. This will include plant water needed for new sludge processing equipment (rotary drum thickeners) and froth spray water for the aeration tanks. Even with this usage, it appears that reductions in the plant water system sizing can be achieved. The plant water system was included in the energy evaluation discussed later in this section.

It is recommended that the plant water system be relocated to the Filter Building when the WPCF is upgraded, and it is also recommended that the dilution water pump (currently located in the Plant Water Building) be relocated to the Filter Building as well which will

enable the Plant Water Building to be abandoned. The primary sludge thickener dilution water pump system is discussed in further detail in Section 5.4.

It is recommended that the new plant water system and an inlet basket strainer be installed in the west side of the lower level of the Filter Building. This will require new plant water suction piping installed from the plant water pump system to the discharge side of the proposed UV disinfection system discussed later in this report. Locating the plant water system in the Filter Building will also require new discharge piping installed from the plant water system pumps to existing plant water system yard piping adjacent to the existing Plant Water Building.

## 6.3 Chemical Feed Systems

Various chemical feed systems are located at the WPCF to aid in the treatment process. The chemical feed systems discussed in this section are in the Chemical Building, Return Sludge Pump Station, and in a storage silo located to the east of the aeration basins. The chemical feed systems associated with the headworks odor control system are discussed in Section 4.2. The chemical feed systems associated with the Zimpro PACT-WAR system are discussed in Sections 4.6, 5.5, and 8.5.

### 6.3.1 Chemical Building Systems

The Chemical Building was originally the WPCF's Operations Building which was built during the 1959 upgrade and retrofitted into the Chemical Building during the 1993 upgrade. The following chemical feed systems and their associated equipment are located in and around the Chemical Building:

- Sodium hypochlorite for effluent disinfection (currently in operation)
    - One 4,000-gallon FRP bulk storage tank located outside on the west exterior elevation of the building
    - 500-gallon FRP day tank and three 21.7 gallon per hour (GPH) metering pumps located in the Sodium Hypochlorite Room
    - Two chemical transfer pumps located in the basement, of unknown capacity (1.5 HP), to transfer sodium hypochlorite from the bulk storage tanks to the day tank
- Sodium bisulfite for effluent de-chlorination (currently in operation)
    - One 4,500-gallon FRP bulk storage tank, heat-traced and insulated, located outside on the west exterior elevation of the building
    - 500-gallon FRP day tank and four 42.7 GPH metering pumps located in the Sodium Bisulfite Room
    - Two chemical transfer pumps located in the basement, of unknown capacity (1.5 HP), to transfer sodium bisulfite from the bulk storage tank to the day tank
- Alum for injection into the influent to the sand filters (abandoned in place)
    - One 500-gallon open top polyethylene tank with top mounted mixer for batching alum and two 4.5 GPH metering pumps located in the Alum Feed and Storage Room

- Polymer for injection into the influent to the sand filters (abandoned and partially disassembled for parts)
    - One polymer batching and preparation unit and two metering pumps located in the Polymer Room

All chemical feed equipment described above is approaching 25 years old and at the end of its normal service life. If these chemical systems remain in use or go back online (in the case of the abandoned systems), a full replacement of the equipment including tanks and metering pumps would be required.

An alternatives analysis for disinfection, namely chlorination/de-chlorination versus ultraviolet (UV) light, is presented in Section 8.2. This analysis resulted in a recommendation to switch to UV light for disinfection which would make the sodium hypochlorite and sodium bisulfite chemical feed systems used for disinfection unnecessary. If the switch to UV light is made, then serious consideration should be given to demolishing the Chemical Building or reusing it for another purpose since all of the feed systems housed in and around the building will be obsolete. The available real-estate that can be gained by eliminating and demolishing the Chemical Building is valuable and can be utilized for new electrical infrastructure as discussed in Section 6.6.

### 6.3.2 Return Sludge Pump Station Systems

The Return Sludge Pump Station was constructed as part of the 1993 upgrade and houses the major pumping equipment associated with WPCF's secondary treatment process. In addition to the pumping systems, the Return Sludge Pump Station also houses the chemical feed systems associated with the secondary treatment process. The following chemical feed systems and their associated equipment are located in and around the Return Sludge Pump Station:

- Sodium hypochlorite for injection into the secondary system's RAS force main, scum force main and aeration tank spray water for filament/nocardia control (abandoned and partially disassembled)
    - One 4,000-gallon FRP bulk storage tank, heat-traced and insulated, located outside on the east exterior elevation of the building
    - 500-gallon FRP day tank and originally six metering pumps (some pumps have since been disassembled), of unknown capacity, located in the Sodium Hypochlorite Room
    - Originally two chemical transfer pumps located in the basement (disassembled and removed), of unknown capacity, to transfer sodium hypochlorite from the bulk storage tank to the day tank
- Polymer for injection into the secondary clarifier distribution chamber (currently in operation)
    - One dry polymer batching and preparation unit and two metering pumps located in the Polymer Room

All chemical feed equipment described above is approaching 25 years old and at the end of its useful life. If the polymer system remains in use or the sodium hypochlorite chemical feed system goes back online, a full replacement of the equipment including tanks, metering pumps and batching/preparation unit would be required.

### 6.3.3 Soda Ash

There is a soda ash storage silo and soda ash feed system located to the east of the aeration basins that was installed during the 1993 upgrade. Soda ash is used to maintain proper alkalinity levels in the single-stage secondary and nitrification treatment processes. The soda ash storage silo is a metal silo with a storage capacity of approximately 4,000 cubic feet. The silo is equipped with a dust collector for dust control during operation and filling of the silo. Soda ash is discharged at a controlled rate from the silo using a vibratory bin activator and a variable rate rotary feeder. Soda ash discharged from the silo drops into a soda ash dissolving tank where it is mixed with water into a soda ash solution. The soda ash solution is pumped into the scrubber channel bypass which is upstream of the aeration basin distribution chamber.

All soda ash storage, batching and feed equipment described above is approaching 25 years old and at the end of its useful life. If soda ash remains in use at the WPCF, a full replacement of the equipment would be required. The plant currently adds approximately 900 to 1000 pounds of soda ash per day to add alkalinity for nitrification. The amount needed will be reduced if the plant is upgraded for denitrification. However, chemical addition used for phosphorus removal under the plant new permit will also consume alkalinity. Both factors are discussed in subsequent chapters.

## 6.4 Samplers

The Vernon WPCF has three automatic samplers installed at various sampling points. They are used for confirm permit compliance as well as process control. The sampling locations are shown on Figure 2-3 and are listed below:

- Plant Influent (just prior to the grit chambers)
- Primary Effluent (from the primary settling tank effluent launder)
- WPCF Effluent (after disinfection and reaeration prior to discharge to Hockanum River)

The influent sampler was recently replaced, and the other two are due to be replaced in the near future.

## 6.5 SCADA and Controls

### 6.5.1 Overview

This section covers the supervisory control and data acquisition (SCADA) and related control systems which enable the functions of the WPCF to be centrally monitored from the control room of the Process Control Building. The control systems related to the collection system pump stations are presented in Volume 2 of this Facilities Plan and will not be discussed in this Section.

An overview of the WPCF's SCADA and control systems is provided in Figure 6-1. Much of the WPCF is monitored using the original control systems from the 1993 plant upgrade. During the 2009 aeration system energy efficiency project, the "Aeration System Master Controller" panel appears to have been reprogrammed. The approach was to have dedicated Local Control Panels (LCPs), some with Programmable Logic Controllers (PLCs)

perform process control and then use a dedicated SCADA based control panel located nearby (these have been called I/O panels and each has their own PLC) to monitor these other control panels and report general equipment status, alarms, and major control variables back to the Process Control Building where the four SCADA personal computers (PCs) are located and a central graphics board displays basic plant status information. All connections between the SCADA I/O panels and the other LCPs around it are discrete or analog wiring. These SCADA I/O panels are also used for monitoring general alarms from the automatic temperature control (ATC) panels associated with the buildings HVAC control system. This allows the HVAC system alarms to be centrally reported.

The SCADA system is now only used as a data acquisition system for central monitoring and reporting purposes and to send a few plant flow signals and some interlocks to other LCPs located through the plant for process control purposes. It is not used to remotely control any process equipment which is how modern SCADA based control systems are commonly used.

The 1993 upgrade included an alarm printer in the Process Control Building to centrally report alarms, but it did not show any indication of alarms outside of the WPCF using an alarm dialer. This is consistent with the design philosophy for a WPCF that is manned continuously and therefore relies on the operator or watchman to recognize and then call in the necessary resources to address major alarms.

Vernon's SCADA control systems are only using a fraction of the capabilities of a modern SCADA based control system. As a result, Vernon is not benefiting from the efficiency improvements that such a control system can provide. Examples of the inefficiencies include the following:

- A modern dial out alarm system can be used in a plant to call in the necessary resources if there is a failure at a time when the plant is not manned. When set up with the necessary level of detail, the on-call supervisor or operator receiving the call may be able to detect if additional resources are needed and call them in while responding to the plant. This type of system is needed should Vernon wish to eliminate the evening shifts and reduce personnel costs if the Zimpro WAR system is eliminated.
- The layered levels of control panels require additional effort to maintain and also reduces reliability due to the increased number of systems present that can fail.
- The SCADA system does not trend the major process variables in the secondary treatment system. This data is only available at the local control panel. This makes troubleshooting and conserving energy at the plant's most energy intensive process more difficult, and it will also make optimizing the plant operations for biological nutrient removal more difficult.
- Timers for wasting sludge from the primary clarifiers or the secondary system must be adjusted at the local control panels in different buildings. With a modern SCADA system, the timers could be adjusted by the appropriate operator after consulting with the lab on the appropriate process control measurements – all located in the process control building.

During the 1993 upgrade, hardware needed to network power meters at many of the WPCF's motor control centers was installed to allow central monitoring of the power usage

via the plant's SCADA computers. We understand that the software needed to perform this monitoring function is not currently being used, and it is not clear if it was ever made operational. During the next upgrade, this power monitoring capability should be integrated directly into the SCADA system for a simplified monitoring system.

### 6.5.2 Evaluation and Recommendations

Most of the SCADA I/O panels and other control panels are based on Allen Bradley SLC-5/03 or SLC-5/04 programmable logic controllers (PLC), and they communicate over Allen Bradley Data Highway (Blue Hose) cable which was the standard at that time. Some of the PLC based control panels have operator interface terminals (OIT) to allow operators to locally control the process set point variables.

The WPCF has been experiencing an increasing number of control system failures in recent years indicating that the equipment is aging. OIT panels were installed after the 1990's upgrade as system components became obsolete. I/O #3 had to be rebuilt in 2013 with a new OIT, a recent failure in the Local Control Panel for the WAR regeneration system caused that system to be shut down for some time in 2016. The SLC PLC processors are no longer being produced and can only be purchased at great expense on the second-hand market.

Given the age of the control systems equipment (SCADA Monitoring, and Local Control Panels), recent equipment failures, and the lack of modern functionality that is limiting the efficiency of the plant operations, the control systems are beyond their normal service life and should be upgraded with the latest SCADA based control systems in each of the main process areas. The following general philosophies should be used:

- Since the existing SCADA system is based on Allen Bradley PLCs, we recommend that the new control panels and the existing control panels be upgraded to incorporate Allen Bradley Compactlogix, or where appropriate micrologix PLCs.
- SCADA-based operator interfaces require periodic replacement of Windows based personal computers (PCs) and the related SCADA HMI software upgrades. We assume that this will be performed during this upgrade.
- Integrate the controls of all WPCF (and collection system pumping systems – see Volume 2 of this plan) into new SCADA based control panels installed locally. To distinguish these from the existing Local Control Panels (LCP) we will refer to these as Local SCADA Control Panels (LSCPs). Allow operators to make control selections through the SCADA system PCs or OITs in new SCADA based control panels. Eliminate or minimize related control panels by integrating backup controls into VFDs, Chemical Feed Pump Drives, and/or New SCADA based Control Panels. Do similar with automated gates.
- Utilize Vendor supplied control panels where appropriate. If complex enough, specify that they be Allen Bradley based and that they be setup to communicate with the New SCADA system for both limited control and monitoring purposes.
- Use Ethernet communication between PLCs within a building. Use fiber optic cables and Ethernet communication between buildings for PLC and SCADA communications installed in existing conduit. This approach can handle longer runs and more data at faster rates than the current "blue hose" allowing for more versatile, user-friendly controls.

A summary of the recommendations to upgrade the WPCF's major SCADA System and other control panels to modern standards is provided in Table 6-1. Note that Figure 6-1 indicates only the SCADA based panel listed first for each building/location in Table 6-1. These recommendations are based on adopting the recommended plan of this report and the conclusions of subsequent chapters.

**TABLE 6-1**

Recommended SCADA System & Control Systems Upgrades

| Location | Existing Control Panels | Recommendation |
|---|---|---|
| Process Control Building | SCADA I/O#1<br>Graphics Board<br>4 SCADA PCs | Replace I/O Panel and Graphics Board with New SCADA Node #1 and Large Screen Monitor to function as graphics and status board. Replace three other existing SCADA PCs: Lab, Shift Supervisor, and either Assistant Directors office, or other secure remote plant location to provide local access such as at the Preliminary Treatment Building.<br>Upgrade All SCADA software to latest version of HMI Software. Setup at least one SCADA Node with alarm software (e.g. Win 911) to call in plant operators in the event of critical alarms.<br>Provide a new (small) SCADA Control Panel LSCP#1 to pick up alarms in the process control building (possibly existing HVAC systems consistent with existing strategies) and generate one or more common alarms to trigger a separate backup dialer operating on a different phone line for a backup. |
| Solids Handling Building | SCADA I/O#2<br>Intermediate Pump Station Control Panel<br>Vacuum Filter Control Panel<br>Truck Loading Control Panel | Replace first two control panels with New Local SCADA Control Panel LSCP#2 to control all intermediate and the proposed new drainage pumps in the building. Intermediate pumps to have a backup controller. LSCP#2 to provide inputs to relay control signals from truck Loading Control Panel to sludge truck loading pumps located elsewhere to facilitate truck loading operations<br>Demolish Vacuum Filter Control Panel. New Vendor Control Panel for Solids Handling System (Rotary Drum Thickeners).<br>LSCP#2 to also pickup signals related to Scum thickening. |

**TABLE 6-1**
Recommended SCADA System & Control Systems Upgrades

| Location | Existing Control Panels | Recommendation |
|---|---|---|
| Chemical Building | SCADA I/O#3<br>LCP1 (Hypo)<br>LCP3 (Poly)<br>LCP5 (BiSulf)<br>LCP7 (Alum)<br>Dirty Backwash Pump Control Panel<br>Jet Pump 1*<br>Jet Pump 2* | Abandon or Demolish. New control panel(s) located near replacement or new chemical feed systems located elsewhere and new UV System with provide needed controls and monitoring. |
| Filter Building | Common Filter Control Panel<br>Effluent Filter Control Panels #1 #2 #3 #4 | Demolish. Replace with new SCADA Control Panel LSCP#3 to control/monitor the new chemical feed equipment, Post Aeration Blowers, and plant water system in that building and provide Ethernet access point to UV System Vendor control panel, Disk Filtration Vendor Control Panel to be installed in the upgrade. |
| Preliminary Treatment Building | SCADA I/O#4<br>Influent Pump Control Panel<br>Grit Control Panel*<br>Bar Screen Control Panel*<br>Septage Control Panel<br>Odor Control Panel* | Replace SCADA I/O #4, Influent Pump Control Panel with new Local SCADA Control Panel LSCP #4 to control Influent Pumps and motorized gates in bldg. Also, more fully integrate with new or existing vendor control panels for Grit System, Mechanical Screens, Odor Control System and Septage Receiving. |
| Thickened Sludge Pump Station | SCADA I/O#5<br>Primary and Thickened Sludge Control Panel | Replace both with one New SCADA Based Control Panel (LSCP#5) to control all equipment in the Building and nearby Primary Clarifiers/Sludge Pumps. |

**TABLE 6-1**
Recommended SCADA System & Control Systems Upgrades

| Location | Existing Control Panels | Recommendation |
|---|---|---|
| Regeneration Building | SCADA I/O#6<br>WAR Control Panel*<br>DSE System Control Panel*<br>EQ Tank Control Panel<br>Virgin Carbon Control Panel*<br>Soda Ash Control Panel* | Abandon or demolish. New Soda Ash Vendor Control Panel with PLC to be tied into SCADA |
| Return Sludge Pump Station | SCADA I/O #7<br>LCP#2 (Hypo)<br>LCP#4 (Poly)<br>RAS Control Panel<br>WAS/Scum Control Panel | Replace all panels with one (or possibly two) new SCADA Control Panel LSCP#6 to control all equipment in the Building and nearby clarifiers. If second panel is used (possibly LSCP#7), it should be dedicated to the chemical systems retained in the design. Develop advanced controls for automating weir gates on return sludge lines from clarifiers to help reduce high RAS flow problems. Add sludge blanket indicators to each clarifier. |
| Blower Building | Aeration System Master Controller<br>Blower Control Panel #1 #2 #3* | Replace with a new Vendor Control Panel for the replacement blowers and aeration system control panels.<br>New SCADA Control Panel LSCP#7 to monitor/control all other equipment in the nearby building and aeration tanks such as MLSS recycle pumps, mixers, any other alarms in nearby buildings |

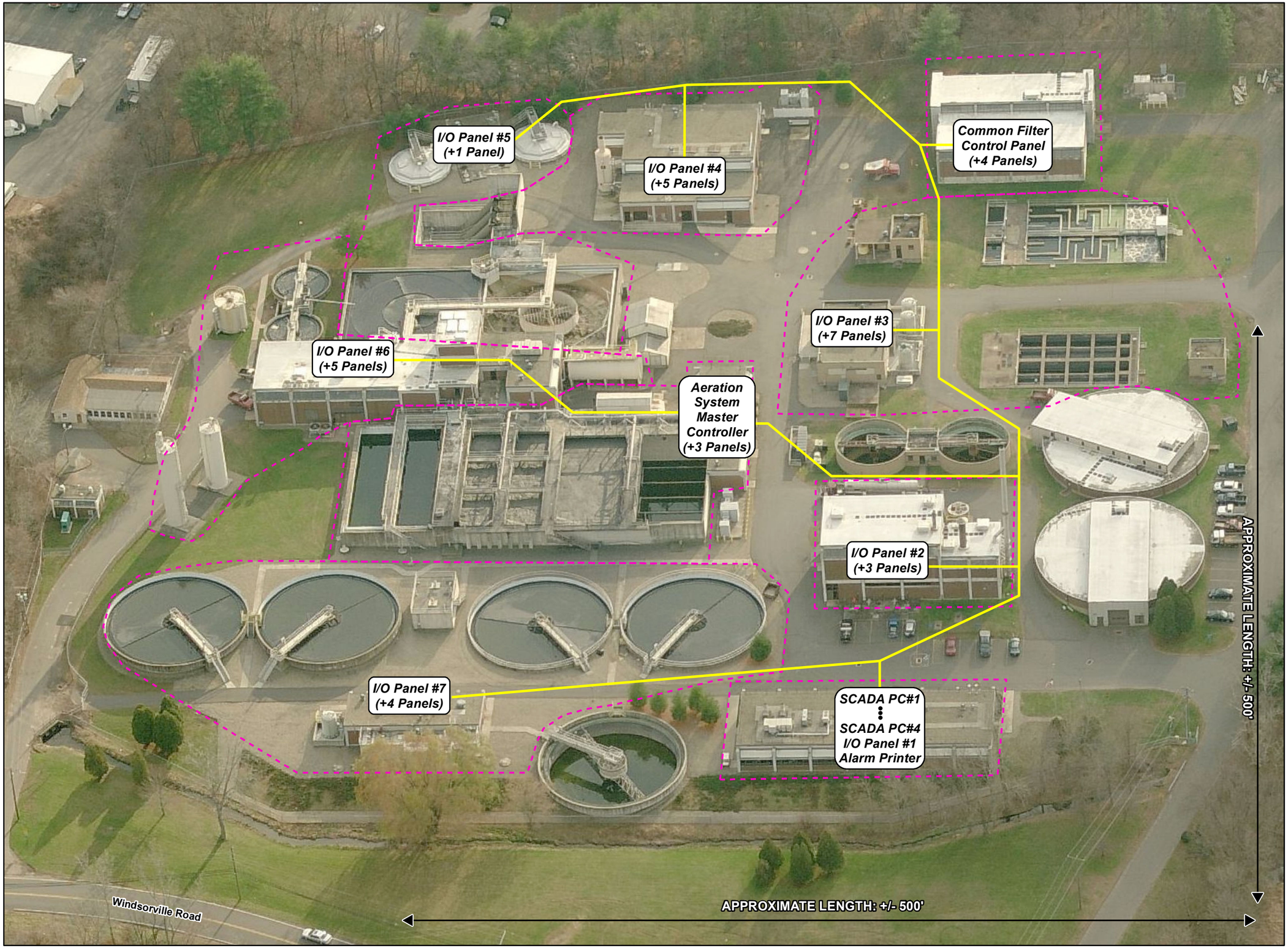
(1) Vendor Control Panel provided with equipment. Provided here for reference only. Control panel replaced with the equipment. See discussion on and costs for equipment for more information. Not all vendor control panels are listed here.

The costs provided in the recommended plan for the above recommended upgrades assume the following:

- Temporary controls during construction and changeover of the control system
- The electrical systems associated with the equipment being upgraded are also upgraded in that area at the same time
- Existing electrical conduit is available between the control panel location and the Process Control Building main control room can be reused to run fiber-optic cable for communications between the SCADA systems PLCs and PCs. To address

potential problems with existing underground conduit we included a $50,000 allowance for repairs or modifications.

- All new controls are Allen Bradley PLC-based for compatibility with existing equipment during upgrade
- Existing SCADA software is upgraded to the latest version for compatibility with existing system to minimize impact to plant operations during the upgrade
- The cost of Vendor supplied control panels (smaller control panels exist that serve specific equipment such as a replacement plant water system) and the integration of those panels into the SCADA system will be included in the cost of that equipment replacement in the recommended plan. Therefore, replacement of these panels and the integration of those panels into the SCADA system is not included in the costs provided for SCADA and Control System Upgrades even though it will be work performed by the SCADA systems integrator.




# Figure 6-1
# SCADA and Control System Overview

**LEGEND**

Data Connection

Approximate Area Monitored by SCADA Panel

**LOCUS MAP**




N

Scale: N.T.S.

**NOTES**

1. The number of local or vendor Control Panels is shown in ( ) after the SCADA Control Panel. Refer to Table 7-X of the report for their names.

**Town of Vernon, Connecticut**

**Vernon WPCF Facility Plan**

**May 2017**

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V-0037

# 6.6 Electrical

## 6.6.1 Overview

The WPCF power is derived from overhead electrical poles entering the plant from Windsorville Road which after being primary metered (at 13.8 KV) at the pole, it transitions underground to the main service transformers and switchgear. Here the voltage is dropped to 4.8 Kilovolts (KV) and then distributed to eight medium voltage substations located around the WPCF. The North Generator also produces backup power for some of the plant and distributes backup power at 4.8 Kilovolts to three of those eight substations. The North generator and most of the plant that is fed from it was installed in the 1973 upgrade and this electrical equipment is now approaching 45 years of age. Refer to Figure 6-2 for a representation of the medium voltage distribution diagram and the ages of each piece of equipment.

The South Generator produces 480-volt power and it is used to provide backup power to other critical areas of the plant. The South generator and most of the plant that it feeds was installed in the 1993 upgrade, and it is now approaching 25 years of age. Its fuel storage tank size is too small to meet current standards for runtime during power outages. Between the North Generator and the South Generator, backup power is provided to the entire plant except for the following critical and non-critical areas of the plant that do not currently have emergency power:

- Carbon regeneration system (including the carbon thickener tanks)
- Aeration blowers (unused) for tanks 1 and 2
- Certain equipment in the Solids Handling Building including the multi-hearth furnace (unused), vacuum filters (unused), and intermediate pumps (required to feed the sand filter)
- Sand filters (backwash pumps, etc.)
- The portion of the Chemical Feed Building that is not associated with disinfection
- The primary clarifier drives and sludge pumps
- The Thickened Sludge Pump Station including the primary sludge thickener drives, sludge pumps, grinders and scum pumps
- The post aeration building and blowers
- Some lighting in the Solids Handling Building
- Heating, ventilating, and air conditioning equipment in the Process Control Building (Backup power is available but this equipment can be taken off line by opening a breaker in MCC-PCB if necessary)

The eight substations and the South Generator provide 480-volt power to the WPCF. Refer to Figure 6-3 for a representation of the 480-voltage distribution diagram and the ages of the distribution equipment which include the following:

- 22 Actively used Motor Control Centers (MCCs).
    - Five were installed in the 1973 upgrade,
    - Sixteen were installed in the 1993 upgrade and one 1993 MCC was replaced in 2006.

    - This count for MCCs does not include MCCs related to abandoned equipment in the Solids Handling Building.
- Three additional MCCs (not included in the count above) from the 1973 upgrade are now used as junction boxes and/or lighting/power panels and are fed from newer MCCs.
- Two Switchboards from the 1993 upgrade.
- 208 Volt distribution to the Maintenance Building and the North Storage Building.

Although not shown on the drawing, the plant still relies on approximately sixteen electrical panel boards from the 1973 plant.

### 6.6.2 Evaluation, Alternatives, and Recommendations

As indicated previously, some of the electrical equipment at the plant is approaching 45 years of age, and it is not expected to reliably operate for another 20 years. The balance of the plant's electrical equipment is approaching 25 years old.

The primary concern for maintaining reliability of the WPCF over the next 20 years is the 45-year old medium voltage distribution equipment including the North Generator which has already suffered from a fire, the main emergency distribution panel, the Main Service Switchgear and transformers, medium voltage underground cables, the six 1973 substations, and the MCCS from 1973.

General concerns about this equipment include the following:

- The large number of electrical substations and other electrical items require expensive and specialized periodic inspections and preventative maintenance.
- Aging medium voltage cable is susceptible to degradation and failure and has reached and exceeded its normal service life.
- Equipment is not designed to comply with or make safer with respect to correct arc flash standards and worker safety standards. Arc Flash hazard labelling is not provided in any of the electrical distribution equipment per NFPA 70E.
- Most of the 1973 substations are fed at 4800V have delta connected primary and secondaries. This requires the use of ground fault lights to detect a potential ground fault path and is not as safe as wye connected systems. In addition, these systems can produce higher fault currents which increases the risk during maintenance activities.
- Indoor installation of substations in open rooms containing process equipment (as is the case in all substations except SS-DBA) is no longer allowed. This will have to be resolved under current codes by constructing a dedicated electrical room with one-hour fire rating (assuming dry type transformer up to 1500 kva), three-hour fire rating (assuming oil filled transformer) or moving the substation outside like the North and South substations from the 1993 upgrade. These rooms would require at least 10 feet of working space in-front of the unit. It does appear that there may be space to construct such a room in the Effluent Filter Building and Solids Handling Building but a structural review of the elevated floor slabs would be required to confirm that the walls could be supported. The old blower room in the Regeneration Building may also be a suitable location for a substation (if the doors and some building features are upgraded to meet a one-hour fire rating. The

outdoor option will need to avoid locating the electrical equipment in flood prone areas.

- There are code issues in some electrical areas where there is insufficient working space in front of electrical equipment.
- The Town has reported that they have experienced electrical supply issues with some of the 1993 equipment. Most notably that the influent pumps seem to slow down during wet weather. These pumps operate with across-the-line motor starters, and running slow may be related to a voltage sag that could be related to the delta wired medium voltage distribution system having a ground fault on one of the delta connected phases.

It is recommended that the 1973 vintage electrical equipment be eliminated and replaced with new equipment based on the new needs of the plant upgrades in the recommended plan.

The equipment served by the 1973 substations and 1973 MCCs will change significantly under the plan recommended in this Facility Plan further underscoring the need for replacement to meet the new plant needs. It should be noted that during the alternatives evaluations discussed in Chapter 8 that develop the recommended plan, no consideration was given to replacing the substations powering the major equipment being considered in the evaluation. If consideration was given, then the impact on the analysis would have been either negligible or more in favor of making the recommended process change. These changes and the recommended plan to address them are summarized below:

| | |
|---|---|
| SS-DPA | The Chemical Building will be abandoned as the process equipment will be replaced elsewhere as discussed in Section 8. Demolish the building and feed remaining structures currently fed from this substation from a nearby location. |
| SS-DPB, DPBE | The Solids Handling Building will retain the two (intermediate and drainage) pump stations but now this building will require backup power (to operate at least the intermediate pump stations) to provide for low level phosphorus treatment. With all the other loads being relatively small, the equipment should be provided with backup power except for the abandoned multiple hearth incinerator. There is no longer a need for two separate substations. Provide with one new substation (Northwest Substation) located in the building or nearby the building outside. The new sludge storage tanks process equipment located nearby will also likely need to be fed from this building.<br><br>MCC-7E powers the drainage pumps which include old Flowmatcher liquid rheostat drives which are obsolete and the entire MCC needs replacement. |
| SS-DPC | The Filter Building will be converted for use as a phosphorus removal system and related chemical feed system to provide low level phosphorus treatment. In addition, the new UV disinfection system should be powered from this building as well as other processes (plant water system, post aeration |

blowers, and other pumps) to be located in the building so that the Post Aeration Blower and Plant Water Buildings from the 1959 plant can be abandoned and/or demolished. Provide with one new substation (Southwest Substation) sized for these loads and located in the building or nearby the building outside.

This substation should be sized for the new equipment to be located in and around this building. The two 1973 MCCs (MCC-10, MCC-11) power old pumps which will no longer be utilized and therefore the MCCs should be replaced with new MCCs needed for the new equipment.

SS-DPD, DPDE — The equipment associated with the existing Zimpro WAR and DSE systems in the Regeneration Building will no longer be needed in the future. Power for the nearby aeration tank mixing and pumping equipment required for nutrient removal will need a power source, and a new substation may be required here only if the adequate power cannot be derived from the power at the Blower building for this new equipment. Since secondary treatment should be provided with emergency power and the new solids handling process equipment energy needs are low, backup power should be provided to all equipment and there is no longer a need for two separate substations. If required, provide with one new substation (East Substation) sized for these loads and located in the old blower room. If a new substation is not required, the lighting and building power panels should be re-fed from a new power source so that the existing substations can be demolished.

The two 1973 MCCs (MCC-1E, MCC-2B) as well as the newer MCC power old Zimpro WAR and DSE equipment which will no longer be utilized, and therefore these MCCs should be abandoned.

Based upon the above, the following minimum recommendations for upgrading the WPCF's electrical equipment include the following:

- New Outdoor Utility Switchgear and Transformers capable of feeding power to five medium voltage substations and one spare for possible future substation. This will replace the existing Main Service Switchgear and now one end of the double feed North Substation can be fed directly from the Outdoor Utility Switchgear improving the reliability of power fed to the north side of the plant. This will replace the existing Main Service Switchgear and two transformers.
- Consolidate the six 1973 substations down to three new substations all with backup power as discussed above. The two substations from the 1993 upgrade (North and South) will remain leaving a total of 5 medium voltage substations.
- New outdoor emergency generator with belly tank and/or auxiliary above ground fuel tank designed to meet the resiliency requirements discussed in Section 3.

Generator to include 5 KV alternator or 480-volt alternator with transformer. This will replace the existing North Generator and its underground fuel storage tank.

- New backup power switchgear capable of feeding power to the five new substations and one spare for a future substation. This will replace the existing Main Emergency Distribution Panel adjacent to the North Generator.
- Replace at least the three 1973 vintage MCCs with MCCs sized for the new equipment to be installed in those locations.
- Increase the size of the fuel storage tank for the South Generator (which would be retained under this minimum upgrade alternative) to at least a 2,000-gallon tank.

The New Outdoor Utility Switchgear and transformer(s), should be located near the center of the site consistent with the current Main Service Switchgear and Transformers to take advantage of existing conduit runs. Similarly, the new Outdoor Emergency Generator and fuel tank should be located near the center of the site but a safe distance away from the utility switchgear. Given the need to maintain plant operations during construction, consideration should be given to demolishing the Chemical Building. This should have minimum impact on plant operations as the need for the Chemical Building will be eliminated with the construction of the UV disinfection system.

The new substations for the Solids Handling Building, renovated Effluent Filter Building, and Regeneration Building will be double ended and fed on one side from a new 5 KV Emergency Generator and one from a new set of switchgear fed by the Utility. This approach provides a similar level of reliability as is now provided at the North Substation and will require new conduit to cross the site. Based upon these recommendations, the number of medium voltage substations at the site can be reduced from eight to five while the number of medium voltage generators and medium voltage switchgear will remain at one and two, respectively.

The new MCCs for the new equipment locations will be double fed with tie breakers and fed from each side of the double ended substations. This approach provides a similar level of reliability as is now provided at the other 1993 MCCs at the plant.

The above minimum recommendations to upgrade the electrical distribution system (exclusive of MCC replacements) are summarized in the Recommended Plan in Section 9. These minimum recommendations will not address all the aging equipment concerns at the WPCF. If only these minimum recommendations are made, then at the completion of the upgrade in late 2020, the WPCF will still have the following:

- Electrical distribution equipment that is 25 years old including two substations,
- One 480-volt generator and undersized fuel tank,
- 8-12 MCCs (some will likely be replaced with other recommended equipment upgrades). Consideration should also be given to replacing this equipment.

If the renovation of the 1993 upgrade medium voltage electrical distribution equipment is done at the same time during this upgrade, then consideration could be given to further consolidating substations and generators, distributing power at 13.8 KV, eliminating the utility substations (and energy losses associated with it), improve worker safety with arc flash safety protection and improve reliability. This will leave the plant with a modern electrical distribution system.

We considered pursuing this goal and recognized that based on some of the distances present, the large quantities of underground utilities in the area and high cost of copper wiring, that:

- Reducing the number of generators down to one is feasible (if done as a 13.8 KV generator) and cost effective.
- Reducing the number of substations down to two or three substations (a North, a South, and possibly an east station) is feasible and cost effective.

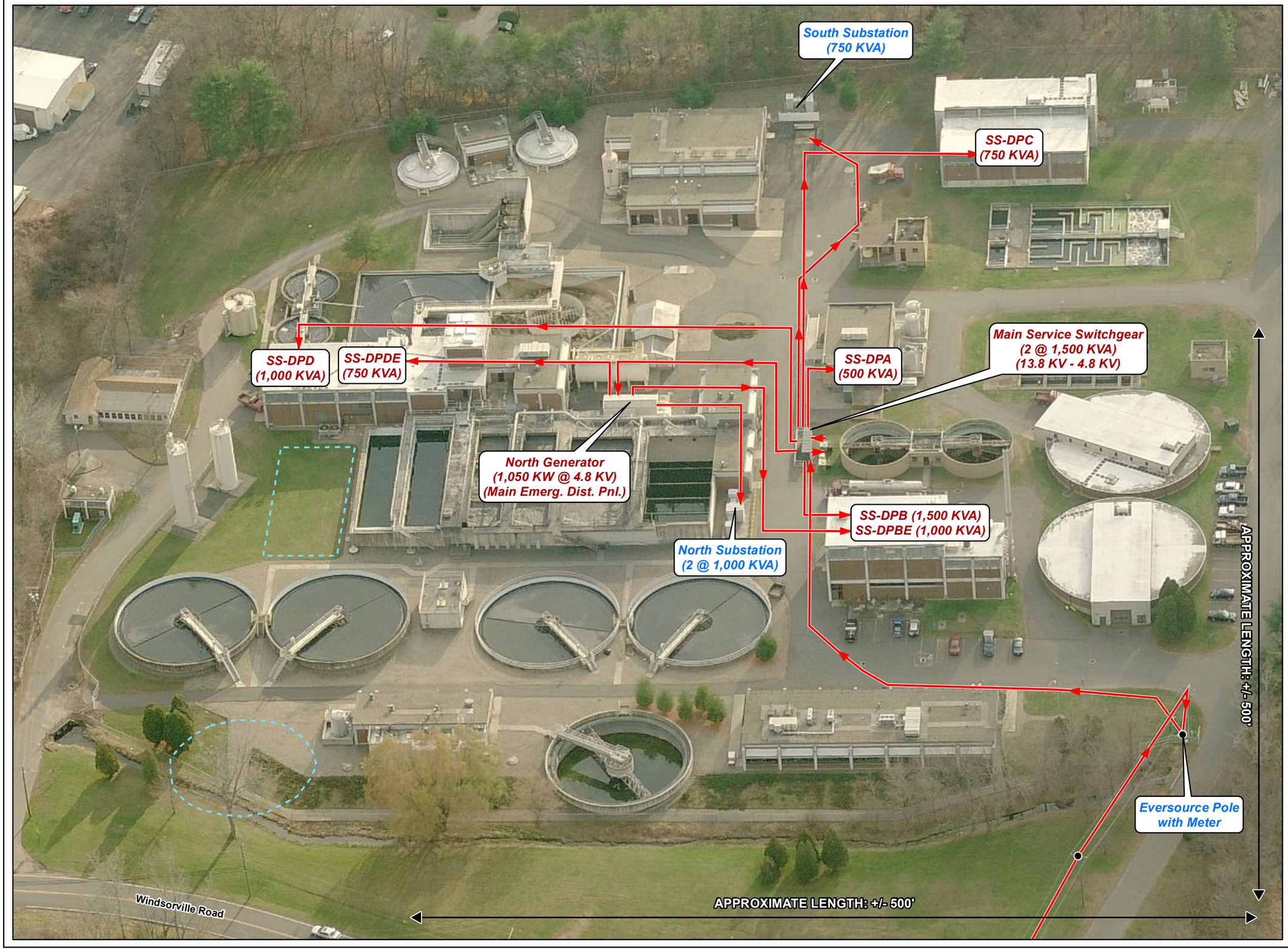
This option is also included in our recommended plan as an alternative to do doing just the bare minimum upgrade of the 1973 equipment. Due to the small increase in cost (<10% - See Table 9-2 Items 15A and 15B), the recommended plan includes replacing all 1973 and 1993 electrical distribution equipment.

The recommended electrical distribution system changes will reduce transformer losses at the plant because the number of large medium voltage transformers at the WPCF (and downstream of the utility meter) will decrease from eleven to an estimated four transformers. This change will reduce the losses from these transformers by about 20 kW, which over the period of a year will account for a savings of $22,000 at $0.13/kW-hr.

### 6.6.3 Other Electrical Recommendations

Other electrical recommendations include the following:

- Aging panel boards and transformers that are associated with the 1973 upgrade should be replaced to maintain reliability.
- The plant needs to upgrade or in some cases provide missing emergency and egress lighting. The backup generator at the plant is, per code, not suitable for providing emergency lighting to the facility. While some areas have the required battery powered emergency lighting, it is not present in all buildings. Some of the buildings also have tritium based egress (exit signs) which appear to have exceeded their life expectancy. These type of exit signs last from 10 to 20 years and must be disposed of properly with the necessary documentation. We recommend that during the upgrade design that the buildings be reviewed for egress compliance and the emergency and egress lighting be upgraded. This will likely impact every building. An allowance for this work based upon our preliminary review of the systems during our inspections is included in the recommended plan. A detailed review of the fire alarm system was not completed. Smoke detectors, hand pull stations, and alarm annunciators are present in most buildings with Fire Alarm Control Panels located in the Chemical Building and Process Control Building. It is recommended that an allowance of $275,000 be provided for upgrading the fire alarm system.
- A detailed review of the plant intercom system was not completed. Paging loud speakers and desk or wall mount pagers are present in most buildings throughout the plant. It is recommended that an allowance of $50,000 be provided for upgrading the plant intercom system.
- It is recommended that an allowance of $200,000 be provided for general lighting replacements.




# Figure 6-2
# WPCF Medium Voltage Electric Distribution Diagram

**LEGEND**

| | |
|---|---|
| ● | Utility Pole |
| → | Medium Voltage Electric Flow |
| XXX | 1973 Upgrade |
| XXX | 1993 Upgrade |
| SS | Substation 4.8 KV to 480 KV |
| DP | Distribution Panel |
| ▭ | Future Clarifier/ Aeration Tank |

**LOCUS MAP**




N

Scale: N.T.S.

**NOTES**

1) All equipment shown has a 1,200A bus except for SS-DPB which has a 2000A bus

2) KVA - Tranformer rating at location

**Town of Vernon, Connecticut**

**Vernon WPCF**

**Facility Plan**

**May 2017**

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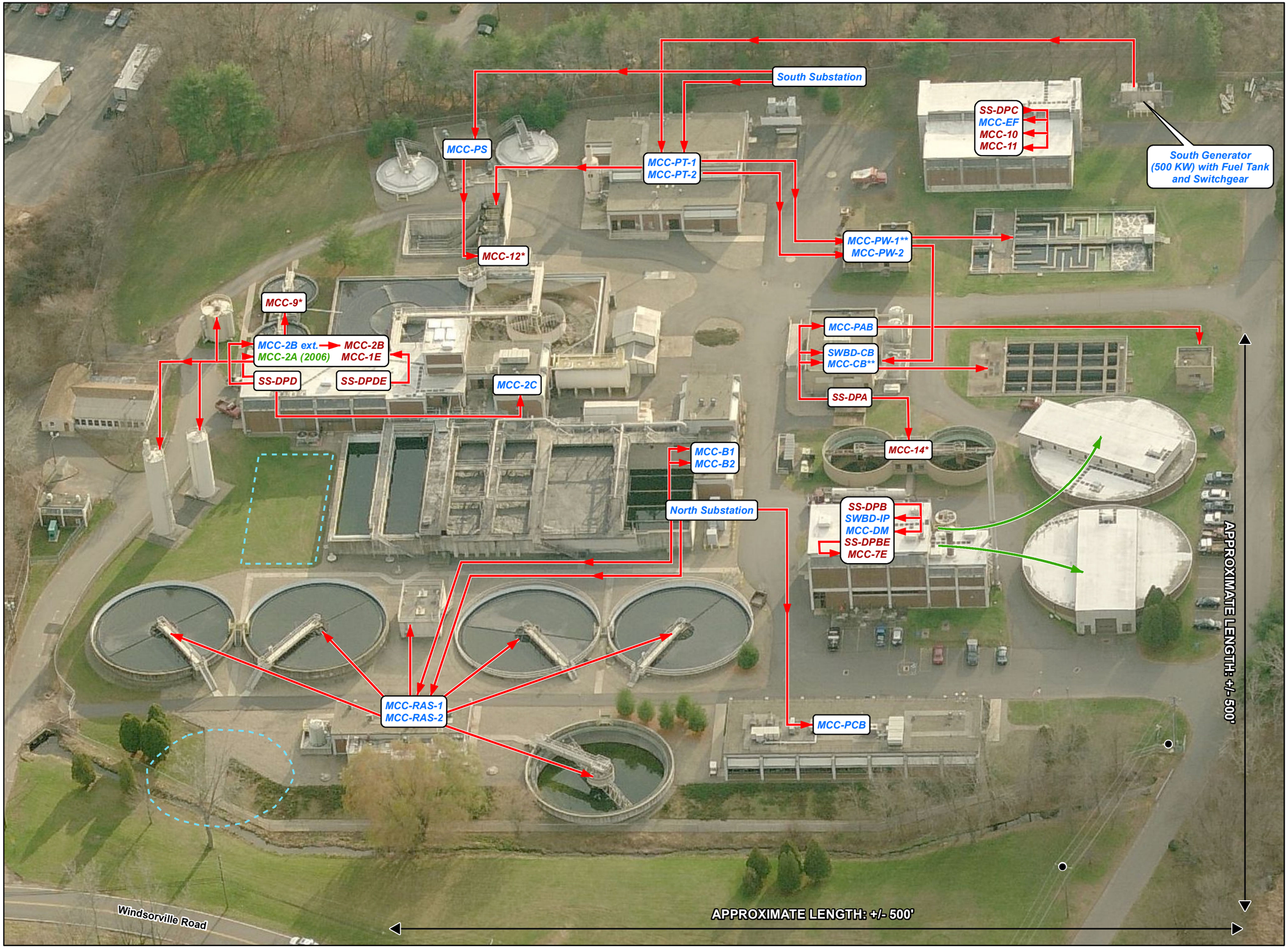


# Figure 6-3
# WPCF 480V/208V Electric Distribution Diagram

**LEGEND**

- Utility Pole
- 208V Electric Distribution
- 480V Electric Distribution
- Future Clarifier/ Aeration Tank
- XXX 1973 Upgrade
- XXX 1993 Upgrade
- XXX Other Renovations (Date Noted)

**LOCUS MAP**




N

Scale: N.T.S.

**NOTES**

* Now mostly a junction box.
** Back-up power feed from MCC-PW1 to MCC-CB for disinfection chemical feed equipment.

**Town of Vernon, Connecticut**

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# 6.7 HVAC

Most of the HVAC equipment was installed in 1993 with some equipment dating back to 1973. The age of the equipment ranges between 24 and 44 years old, resulting in most equipment exceeding its service life expectancy. Equipment that was recently upgraded are gas fired boilers that were replaced in the Process Control Building, Return Sludge Pump Station, Preliminary Treatment Building, and Primary Sludge Thickening Building.

## 6.7.1 Overview

The facility is heated with a decentralized heating system approach, with dedicated heating systems in each building. The following buildings contain high efficiency, natural gas fired, condensing hot water boilers that were recently installed:

- Process Control Building – One 600 MBH Lochinvar FTXL
- Return Sludge Pump Station - One 400 MBH Lochinvar FTXL
- Preliminary Treatment Building – Two 1,500 MBH Lochinvar Crest
- Primary Thickened Sludge Building - Two Lochinvar Knight KHN-155 FTXL

The following buildings contain natural gas fired, hot water boilers that were installed in 1993 or 1973.

- Regeneration Building and Extension – Three 1,000 MBH Aerco KC series (1993)
- Chemical Building - One 1,000 MBH Aerco KC series (1993)
- Effluent Filter Building – One 1,300 MBH Peerless 7FD Series (1973)
- Solids Handling Building - One 1,300 MBH Peerless 7FD Series (1973)

Hot water is distributed throughout each building with constant volume, base-mounted or inline heating pumps. Each building contains two pumps, except the Solids Handling Building and the Effluent Filter Building which only have one pump. The pumps and other boiler plant appurtenances, such as expansion tanks and air separators, date back to 1993 or 1973. The pump serving the Effluent Filter Building was replaced in 2014.

Hot water is pumped through overhead piping distribution systems to air handlers containing hot water heating coils, hydronic unit heaters, and cabinet unit heaters. In addition, the Process Control Building is heated with finned tube radiation and variable air volume (VAV) boxes containing reheat coils. Air handler coils contain 3-way control valves, VAV boxes and finned tube radiation contain 2-way control valves and unit heaters have no control valves. Hot water piping in the Solids Handling Building and Effluent Filter Building dates to 1973. The Regeneration Building contains a mixture of piping installed in 1973 and 1993. The piping in the remaining buildings was installed in 1993. There are approximately 30 unit heaters and 5 cabinet unit heaters at the WPCF.

The North Storage Building is heated with natural gas fired infrared radiant heaters that were recently installed. The Maintenance Building and Blower Building are heated with older natural gas fired unit heaters and electric unit heaters, which are in fair to poor condition.

The buildings listed below are heated solely with electric heat. There are approximately 18 electric unit heaters and one electric baseboard heater.

- Plant Water Building
- Sludge Thickener Pump Room (between tanks)
- Post Aeration Blower Building
- Primary Sludge Pump Station
- WAS/Spent Carbon Thickener Pump Room (between tanks)
- Carbon & Soda Ash Silos
- Pipe Tunnel
- Aeration Tank Pipe Gallery
- Final Sampler Building (electric baseboard)

Ventilation air is provided by air handlers, exhaust fans, and outdoor air intake louvers throughout the WPCF. Air handlers provide heating only or heating and cooling to the spaces they serve. Heating with air handlers is achieved with either hot water coils, electric heat, or are indirect gas fired. Cooling is provided by refrigerant condensers (DX). The following is a list of buildings and their associated air handlers:

- Process Control Building
    - 11,300 CFM Rooftop Unit (hot water heating & remote 40 ton DX cooling)
    - 3,200 CFM Rooftop Unit (hot water heating & remote 20 ton DX cooling)
    - 1,200 CFM Rooftop Make-up Air Unit (MAU) (gas fired heating only)
- Preliminary Treatment Building
    - 22,000 CFM Indoor AHU (hot water heating only)
- Chemical Building:
    - 3,500 CFM Indoor AHU (hot water heating only)
    - 3,500 CFM Rooftop Unit (hot water heating only)
- Thickened Sludge Pump Station
    - 1,200 CFM Indoor AHU (hot water heating only)
- Return Sludge Pump Station:
    - 4,200 CFM Indoor AHU (hot water heating only)
    - 2,000 CFM Indoor AHU (hot water heating only)
- Regeneration Building & Extension
    - 8,000 CFM Rooftop Unit (hot water heating only)
    - 1,200 CFM Rooftop Unit (electric heat & integral 3 ton DX cooling for control room only)
    - (2) 9,500 CFM Indoor AHU (hot water heating only)
- Solids Handling Building
    - 13,600 CFM Indoor AHU (hot water heating only)
    - 7,400 CFM Indoor AHU (hot water heating only)

  - 6,500 CFM Indoor AHU (hot water heating only)
- Effluent Filter Building
  - 19,200 CFM Indoor AHU (hot water heating only)
  - 9,000 CFM Indoor AHU (hot water heating only)

All air handlers operate as constant volume systems except the 11,300 CFM RTU serving the Process Control Building. This air handler supplies air to an air distribution system containing VAV boxes which vary the airflow in each zone based upon space temperature. As the system airflow changes, variable frequency drives (VFDs) vary the speed of the fan in the RTU.

All air handlers and associated ductwork distribution systems, dampers and actuators were installed in 1993, except for the air handlers serving the Solids Handling Building, Effluent Filter Building and the two indoor AHUs serving the Regeneration Building. Those units and the associated ductwork, dampers and actuators were installed in 1973.

Centrifugal roof exhaust fans, inline exhaust fans, and wall propeller exhaust fans serve buildings throughout WPCF. In total, there are approximately 55 exhaust fans ranging from 250 CFM to 16,000 CFM. There are also two 2,200 CFM laboratory mixed flow exhaust fans and five 21,000 CFM destratification paddle fans. Almost all exhaust fans were installed in 1993 except for a few fans in the Solids Handling Building, Regeneration Building and Effluent Filter Building which were installed in 1973.

There is little to no ventilation or make up air equipment serving in the following locations, which are below grade and can potentially trap hazardous gasses:

- WAS (spent carbon) Thickened Sludge Pump Room (contains sludge piping).
- Pipe Tunnel (contains sludge piping)

A Barber-Colman electric HVAC control system was installed in all buildings 1993. Some of the control panels communicates alarms to the SCADA system I/O Panel for control alarm reporting. See Section 6.5 for more information on the SCADA system.

### 6.7.2 Evaluation

Most of the HVAC systems are almost 25 years old and the equipment is reaching the end of its normal service life. Considering the goal of the facility plan is to upgrade equipment so it will last for the next 20 years of operation, most equipment should be replaced. The equipment service life spans referenced below are based on estimates by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).

The fire tube boilers, hot water pumps and boiler room appurtenances in the Regeneration Building, Thickened Sludge Pump Station, and the Chemical Building are approximately 24 years old. The cast iron boilers in the Effluent Filter Building and the Solids Handling Building are approximately 44 years old. The hot water pump in the Solids Handling Building is 44 years old and the pump in the Effluent Filter Building was replaced in 2014. Fire tube and cast iron boilers have a typical life expectancy of 25 and 35 years, respectively. All boilers in these buildings are either at the end or have exceeded their life expectancy. The condensing boilers in the Process Control Building, Return Sludge Pump Station, Preliminary Treatment Building, and Primary Thickened Sludge Building that were recently installed are high efficient boilers and do not need replacement. Pumps have an

average life expectancy of 20-30 years. The construction cost estimate includes the replacement of all hot water pumps.

Most hydronic unit heaters, cabinet unit heaters, and gas fired unit heaters are approximately 24 years old. Unit heaters located in the Solids Handling Building (hydronic), Regeneration Building (hydronic), Primary Sludge Pump Station (electric), and the Plant Water Building (electric) are 43 years old. Electric unit heaters in the Blower Building and Post Aeration Building are 24 years old. The average life expectancy of hydronic unit heaters is 20 years. Electric unit heaters and gas fired unit heaters have a life expectancy of 15 years. All unit heaters have exceeded their service life.

Most control valves and actuators serving air handler and hydronic terminal equipment are 24 years old and should be replaced.

Air handlers in the Process Control Building, Preliminary Treatment Building, Chemical Building, Thickened Sludge Pump Station, Return Sludge Pump Station, and one air handler in the Regeneration Building were installed in 1993 and are 24 years old. Air handlers in the Solids Handling Building, Effluent Filter Building and the remaining two air handlers in the Regeneration Building were installed in 1973 and are 44 years old. Air handlers that are 24 years old may last another 10 plus years, but may require replacement of parts and increased maintenance over time. To be conservative, we assumed all air handlers will be replaced in our construction cost estimate.

The 40-ton air cooled condenser serving the Process Control Building air handler (11,300 CFM) is nine years old and the 20-ton condenser is four years old. Neither unit needs to be replaced at this time.

Most of the exhaust fans in most buildings are 24 years old. Fans serving the Solids Handling Building, Regeneration Building and Effluent Filter Building are 43 years old. The life expectancy of an exhaust fan is 20-25 years. All fans are at the end of or have exceeded their service life.

Variable air volume (VAV) boxes serving the Process Control Building are 24 years old and have exceeded their average life expectancy of 20 years. The life expectancy of dampers and damper actuators is approximately 20 years. All dampers and actuators have exceeded their life span. Two units in the Process Control Building had to be replaced because they sprung leaks.

Most ductwork is in fair condition with some being in poor condition.

The spaces within the Preliminary Treatment Building and the outdoor areas in and around the Influent Pump Station and the Primary Clarifiers are classified areas. Equipment serving classified areas (Class 1, Division 1 or Class 1, Division 2) must be explosion proof and fans must be fabricated in accordance with AMCA Type A or B spark resistance construction. Exhaust from the process areas in the Preliminary Treatment Building is handled by the odor control system described in Section 4.

NFPA 820 is the standard for “Fire Protection in Wastewater Treatment and Collection Facilities”. Although this standard is not specifically adopted in Connecticut and it does not require retrofitting existing spaces with increased ventilation, it is good engineering

practice to incorporate ventilation practices outlined in this standard. Such practices are outlined below,

- Tie ventilation systems into combustible gas detection systems to increase the ventilation rate if gases are detected. This approach will help reduce harmful gases in the air and help make the space safer for occupant.
- Supply and exhaust air from hazardous areas in a manner to encourage scavenging of all portions of spaces. This will ensure proper ventilation effectiveness to adequately ventilate all areas of a space.
- Provide a positive pressure in unclassified rooms adjacent to classified rooms. Provide a negative pressure in classified rooms adjacent to unclassified rooms.
- Reduce ventilation rates and recirculate air under certain conditions.
- Provide supply and exhaust fans serving process spaces.
- Design ventilation systems serving unclassified below grade dry well pumping stations for at least six air changes per hour.
- Serve classified areas with explosion proof fans and unit heaters.

### 6.7.3 Recommendations

The recommendations for upgrading HVAC equipment at the WPCF to increase energy efficiency and extend operations for the next 20 years include the following:

- Replace the boilers in the Regeneration Building, Chemical Building (if retained for use), the Effluent Filter Building, and the Solids Handling Building with high efficiency, gas fired condensing boilers. Replace all boiler room appurtenances such as expansion tanks, air separators and chemical feeders. Provide new chemical water treatment.
- Replace all hot water pumps and pump valves and strainers.
- Convert the constant volume hot water systems to variable flow systems.
    - Install variable frequency drives to control pump speed.
    - Install differential static pressure sensors in the hot water systems to maintain system pressure.
    - Replace all 3-way control valves with 2-way control valves. Install 2-way control valves on terminal devices that contain no control valves, mostly on unit heaters. Install new valve actuators.
    - Replace all 2-way control valves and actuators with new 2-way control valves and actuators on terminal equipment.
- Re-pipe boiler rooms as required to accommodate the new equipment.
- Replace all hot water, electric and gas fired unit heaters and hot water cabinet unit heaters (This does not include the newer infrared heaters in the North Storage Building).
- Replace all air handlers and associated control dampers and actuators, hot water valves and reconnect to the existing hot water piping and ductwork systems.

  - Convert most air handling systems to variable flow systems to save on fan energy costs.
  - In the Solids Handling Building,
    - Provide an 8,000 CFM, 650 MBH air handler with an integral face and bypass hot water coil to provide 6 air changes per hour to declassify the proposed RDT room on the second floor. Provide a ductwork distribution system and controls.
    - Reduce the ventilation in the incinerator room, which is no longer in use, primarily the second floor and incinerator room.
  - Reduce the ventilation in the Solids Handling Building basement after the drainage pumps are abandoned and raw sewage and scum are no longer pumped through this room as discussed in Section 5.3.4.

- Replace all exhaust fans and associated control dampers.
- Replace all VAV boxes in the Process Control Building.
- Clean all existing ductwork systems that are in fair condition. Replace ductwork in poor condition.
- Provide new HVAC Control Systems.
  - Provide a new Building Management System (BMS) to remotely control and monitor HVAC equipment in the following buildings:
    - Process Control Building
    - Preliminary Treatment Building
    - Return Sludge Pump Station
    - Regeneration Building
    - Thickened Sludge Pump Station
    - Chemical Building (if retained for use)
    - Effluent Filter Building
    - Solids Handling Building
  - Provide new stand-alone, local electric control systems in the following buildings:
    - Blower Building
    - Plant Water Building
    - Sludge Thickener Building
    - Post Aeration Blower Building
    - Primary Sludge Pump Station
    - WAS Spent Carbon Tanks Pump Room
    - Carbon & Soda Ash Silos (if retained for use)
    - Pipe Tunnels (if not demolished)
    - North Storage Building

        - Maintenance Building
- Provide testing and balancing of all hydronic and air systems.
- NFPA 820 best practice:
    - Tie ventilation systems into combustible gas detection systems.
    - Modify ductwork in hazardous areas to encourage scavenging and increase ventilation effectiveness.
    - Negatively pressurize classified areas. Positively pressurize unclassified areas adjacent to classified areas.
    - Primary Sludge Pump Station:
        - Provide an explosion proof electric unit heater
        - Provide an air handler to ventilate the space at 6 air changes per hour
    - Reduce ventilation rates when:
        - Outside air is below 50°F
        - Space is unoccupied
        - Safe limits of combustible gas are detected by combustible gas detection systems

## 6.8 Structural/Architectural

Building structures and process structures (i.e. tanks, clarifiers, etc.) located at the WPCF were visually reviewed to assess their current structural/architectural conditions and their ability to serve the WPCF's current and projected needs. The visual review of all WPCF building structures and process structures was conducted by a Senior Structural Engineer employed by Diversified Technologies Consultants, Inc. (DTC) of Hamden, CT.

This section briefly summarizes the structural/architectural evaluations conducted by DTC. Appendix J contains the full structural/architectural evaluation report that DTC produced based on the findings of their visual review of the buildings and process structures onsite. DTC's evaluations were limited to visual reviews of the existing conditions of the structures onsite. Detailed structural analysis of the structures onsite was not within the scope of DTC's work. Evaluations were limited to the visible interior and exterior portions of the various structures onsite. Review of process tanks that were online at the time of the site visits were limited to the exposed portions of the tanks above the liquid level. Confined space entry was not within the scope of DTC's evaluations.

DTC completed structural/architectural evaluations of the following WPCF buildings and process structures:

- WPCF Buildings:
    - Process Control Building
    - Solids Handling Building
    - Chemical Building

  - Plant Water Building
  - Preliminary Treatment Building
  - Primary Thickened Sludge Pump Station
  - Regeneration Building and Regeneration Building Extension
  - Blower Building
  - Return Sludge Pump Station
  - Post Aeration Blower Building
  - Maintenance Building (Bldg. #23)
  - North Storage Building (Bldg. #24)
- WPCF Process Structures:
  - Influent Pump Station
  - Primary Sludge Pump Station
  - Primary Clarifier Tanks (#1 and #2)
  - Secondary Clarifier Tanks (#1 thru #5)
  - Aeration Tanks (#1 thru #6)
  - Aeration Tank Pipe Gallery (between #2 and #3 Aeration Tanks)
  - Sand Filter (and Building)
  - Chlorine Contact Tanks and Post Aeration Tanks
  - Dirty Water Storage Tanks
  - Pipe Tunnel from Chemical Building to Sludge Thickener Tanks
  - Abandoned Sludge Thickener Tanks and Building

DTC's complete report detailing their findings and recommendations for the above buildings and structures is included in Appendix J. Based on a review of DTC's report, no major structural deficiencies were found during their evaluations of the buildings and structures that would require complete demolition or rehabilitation of structures onsite to allow continued use of the facilities. Some of the common recommendations from DTC's evaluations are as follows, note these are not all of their findings just some that are common amongst the buildings and structures onsite:

- Roof replacements including flashings, walk pads and insulation
- Clean and repoint brick veneer masonry and reseal exterior joints
- Clean and recoat exposed exterior concrete with architectural cementitious coating
- Resurface exterior concrete slabs
- Structural repairs to exterior/interior concrete at spalling/deteriorated locations
- Route and seal concrete cracks and concrete joints
- Sealing and waterproofing of structures
- Guard rail installation along roof edges and roof access hatches

- Grating replacement
- Door and window replacements
- Interior/exterior painting

DTC's scope of work included the development of an OPCC for the recommendations from their structural/architectural evaluations of the WPCF buildings and structures. The project team reviewed in detail with DTC the costs proposed in their OPCC for the various recommendations. After a thorough review of the proposed recommendations and the related costs, the project team organized all of DTC's recommendations and related costs into two categories of work, immediate items and deferred (to be completed 10+ years from now) items. The recommended plan presented in Chapter 9 summarizes the costs of the immediate and deferred items.

## 6.9 Security and Fire Protection

Site security and vulnerability were discussed in detail in Section 2.4.

During the 1993 Upgrade, a fire alarm control panel, smoke detectors and flame detectors were installed in various buildings onsite including the Preliminary Treatment Building, Thickened Sludge Pump Station, Regeneration Building and Regeneration Building Extension, Chemical Building, Blower Building, Return Sludge Pump Station and Process Control Building. The central fire alarm control panel is in the Process Control Building.

The WPCF currently has no fire sprinkler systems in any of the buildings. As part of the improvements included in the recommended plan of Section 9 of this report, it is likely that fire sprinkler systems will be required in the proposed chemical storage areas of the Filter Building and Regeneration Building Extension. During design the need for sprinklers in these areas should be reviewed with the local fire department.

### 6.9.1 Cameras

As discussed and presented in Section 2.4, the existing facility is continuously manned and is not equipped with security cameras. However, this facility plan anticipates that WPCF improvements and process modifications will be made that could enable the WPCF to become a one shift operation, and such adding security cameras in key areas tied to a digital video recorder and monitor in the Process Control Building may be warranted. Cameras should be considered to monitor the following locations:

- East inner access gate
- West access gate
- Current septage receiving area (currently Manhole A – to be used in an emergency)
- Upgraded 454 Waste Receiving Area to be used for septage in the Future

We considered and after discussion with the plant staff rejected the need to add automated gates with key card access to the west and inner east vehicle gates. They require significant maintenance and do not appear justified at this time.

## 6.10 Energy Efficiency

An energy/efficiency evaluation of the Vernon WPCF was conducted by JK Muir, LLC. The objectives of the evaluation were the following:

- Summarize the baseline energy usage and billing rates for the facility, and demonstrate how energy is being used;
- Define the energy usage of the existing Zimpro System; and
- Identify specific operational and capital improvements for process equipment at the facility, and estimate the energy savings and cost for each project.

As described in the WPCF Energy Evaluation report dated May 2017 based on data from 2015 and 2016, the facility's approximate annual costs for energy were as follows:

Electrical: $805,868 (at about $0.13 per kilowatt hour)

Natural Gas: $87,400 (at about $1.65 per hundred cubic feet)

For planning purposes, a current electrical cost of $0.13 per kilowatt hour is used in the following alternatives analysis. Based upon the U.S. Energy Information Administration (EIA), electricity costs are projected to increase by 3.0% by 2040 as indexed to 2015 costs (see Appendix K for yearly projected energy prices used to determine the 20-year life cycle costs).

Details regarding the review of energy consumption, rate structures, and procurement options were investigated, and it was determined that there are opportunities at the Vernon WPCF to reduce energy usage and costs by adjusting operations as discussed below. Major energy consuming equipment (pumping, aeration, Zimpro system, etc.) at the WPCF were also evaluated (using physical and electrical measurements) to determine efficiencies of the existing process and identify potential energy improvements.

Based on the analyses, one (1) Operating Measure (OMs, or projects that can be completed at a minimal cost) and fourteen (14) Energy Conservation Measures (ECMs, or projects that require a capital investment) were developed with the potential to reduce energy costs at the WPCF. Of these measures, Table 6-2 summarizes those that would be applicable following the recommended plant upgrades. Additionally, Table 6-2 also includes savings associated with a reduction in the service charge by switching to Rate 56 from Rate 58 as discussed in J.K. Muir's report.

**TABLE 6-2**
Potential Operating and Energy Conservation Measures

| Energy Conservation Measures | Approximate Annual Energy Savings (kWh) | Approximate First Year Annual Dollar Savings |
|---|---|---|
| ECM1: Reaeration Blower Control | 14,980 | $1,925 |
| ECM2b: Future Aeration Blower Replacement | 370,369 | $47,592 |
| ECM3: RAS Pump Modifications | 104,213 | $13,391 |
| ECM4: Odor Control Fan VFD | 53,760 | $6,908 |
| ECM5a: Plant Water System Modifications: Pressure Reduction | 24,680 | $3,171 |
| ECM5b: Plant Water System Modifications: Pump Replacement (maintain pressure setpoint) | 108,348 | $13,923 |
| ECM6: Intermediate Pump Rebuild | 96,882 | $12,449 |
| ECM7a: Influent Screw Pump: Gear Box | 9,482 | $1,218 |
| ECM7b: Influent Screw Pump: VFD | 18,206 | $2,340 |
| ECM8: Lighting | -- | -- |
| ECM9: HVAC | -- | -- |
| ECM10: Energy Monitoring System | -- | -- |
| ECM11: Demand Reduction | -- | -- |
| Reduction in Service Charge | -- | $8,000 |
| **Potential Energy Program Savings** | **800,920** | **$110,917** |

A full copy of the energy evaluation performed by JK Muir is included as Appendix L. The report develops capital costs and payback periods for implementing the ECMs that are preliminary opinions on capital costs based on certain assumptions. The Odor Control Fan recommendation may also have the potential for additional energy savings with natural gas usage for heating the building in the winter that are not accounted for here.

The energy evaluation demonstrates that the WPCF has many opportunities for upgrading its old and inefficient equipment with new modern equipment that has the potential to significantly reduce energy costs. Our recommended plan includes the equipment and process upgrades appropriate to make these improvements. In addition, a portion of the capital costs to make these improvements is likely eligible for utility grants.

## 6.11 Renewable Energy

For many wastewater facilities across the United States, energy costs make up the majority of an annual operating budget. A best practice for communities is to look for opportunities to incorporate on-site renewable energy at their facilities. After energy efficiency, renewable energy is another effective way to save money by reducing energy purchases. All renewable resources available (wind, solar, water, and anaerobic digestion of wastes and cogeneration) may be considered as potential energy sources. These renewable systems are selected and installed to maximize energy production and may not

be appropriate for all locations. An evaluation of renewable energy alternatives at the Vernon WPCF was conducted by JK Muir, LLC. The purpose of the evaluation was to determine the feasibility of installing wind, solar, or hydroelectric power generation on-site. A copy of the evaluation is included in Appendix L. The conclusions are summarized in the following subsections.

### 6.11.1 Wind

Under the correct conditions there are several advantages associated with the use of wind power to generate electricity. Disadvantages include the need for more land space and the difficulty in having a location with enough wind to produce maximum efficiency and power. The placement of turbines in areas of higher population density can also result in aesthetic problems.

In terms of land-based wind power, the state of Connecticut as a whole is classified as "poor," with some higher elevation and shoreline areas possessing a "marginal" classification. Historically, the winds speeds available in the Vernon Plant area will likely not produce enough power for a viable wind energy project. Based on the low energy output, limited space for installation, limited wind speeds, JK Muir's report did not recommend the implementation of wind power at the Vernon WPCF.

### 6.11.2 Hydroelectric

Small hydropower applications are possible at treatment plants where significant head is available to drive a turbine and produce small amounts of electrical energy, based on vertical distance of hydraulic elevation change and flow that can be captured through the turbine.

Based on the current average daily flow and the head available between the post aeration tank fixed weir elevation and the median water elevation of the Hockanum River, hydro turbine energy generation could be feasible for energy production, assuming the total average flow could be captured. However, based on the anticipated cost to implement and maintain this technology, the potential energy production (and equivalent annual revenue) does not make this an economically feasible alternative. Therefore, JK Muir's report did not recommend implementation of hydroelectric power at the Vernon WPCF.

### 6.11.3 Solar (Photovoltaic Array)

A solar photovoltaic (PV) system at the WPCF could produce a small amount of power relative to what the WPCF uses. According to the National Renewable Energy Laboratory (NREL) solar maps, the available solar energy in Connecticut is between 4.0 and 5.0 kilowatt hour per day per square meter ($kWh/day/m^2$) based on solar data collected from 1998 to 2009. Available energy may be reduced based on specific site location and conditions.

Though there is minimal unused area at the plant, two locations at the WPCF were evaluated for installation of PV arrays: one site to the north of the clarifiers, between the clarifiers and Windsorville Road (approximately 3,000 square meters), and another site to the west of the plant's main access road (approximately 2,000 square meters). Based on an evaluation of the available sun exposure, the site to the north of the clarifiers was retained for further analysis, while the second site was not evaluated further due to low available exposure.

Estimates of potential power generation indicate that the installation of solar panels at the site north of the clarifiers could produce approximately 436,000 kWh per year, or approximately 7% of the total energy use of the WPCF. This represents a potential energy production of $56,025 per year.

However, a challenge of this potential site is that it is located in the 100-year flood plain of the Hockanum River. While PV systems can, and have been, installed within the floodplain, such an installation would result in higher equipment, permitting, and insurance costs. A recent installation in Massachusetts is shown in Figure 6-4, in which the entire site is located in the floodplain. A similar installation would require elevated equipment pads and electrical design considerations to ensure all equipment and conduit are watertight in accordance with TR-16 guidelines.

Additionally, it is possible that the equipment may not be insurable in this case. If the solar project was developed by a private developer, then the developer would need to have funds for the project and be willing to take on the risk of damage in the event of a flood event. If the solar project was developed by the site owner (the WPCF), the consultation with the insurance company would be required. Ownership options and the benefits of each are discussed in detail in JK Muir's report.



**Figure 6-4:** PV Array Installed in a Floodplain (Holyoke, MA)

Based on J.K. Muir's Analysis and some of Tighe & Bond's experience regarding developing solar systems in flood plains, we recommend that solar production not be considered a priority for the town. If the Town is interested in pursuing on-site solar production further, consideration should be given to developing a request for proposals (RFP) for solar developers the next time the WPCF purchases electricity. This will allow the Town to achieve their renewable energy goals without increasing the capital costs for the WPCF Upgrade project.

### 6.11.4 Anaerobic Digestion and Cogeneration

An anaerobic digestion and cogeneration evaluation of the Vernon WPCF was conducted by JK Muir, LLC. The purpose of the evaluation was to determine the feasibility of installing anaerobic digestion on-site to reduce the amount of sludge that must be hauled off-site for disposal and generate power. A copy of the evaluation is included in Appendix L.

Anaerobic digestion converts a portion of the organic material in the sludge (and other organic materials) into methane gas (which can be combusted in an engine, microturbine, or fuel cell to generate electricity) and waste heat (which is used to heat the sludge in the digester). The type of technology used to convert the gas to electricity dictates the level of gas treatment to removed moisture, H2S gas, and contaminants such as siloxanes. Engines require the least treatment and fuel cells require the most treatment. For this project, J.K Muir considered both internal combustion engines and microturbines as potential technologies in the evaluation to produce electric and heat energy by utilizing excess digester gas as fuel.

Digestion can also reduce the mass of sludge that must be disposed of and when coupled with dewatering, it can reduce the volume of sludge and related sludge transportation costs. Both of these can help reduce sludge disposal costs.

The advantage of this cogeneration process is that gas generated in the digesters can be utilized year-round through the creation of electricity, as well as using the gas to heat sludge entering the digesters. Grant incentives are also available for this type of project.

The analysis concluded that anaerobic digestion is not cost effective for the plant. This is due to the relatively small size of the plant and the availability of low cost sludge disposal facilities nearby. In general, anaerobic digestion is more feasible at larger plants and plants with higher sludge disposal costs.

Significant factors considered in the analysis include the following:

1. There are significant costs associated with treating nutrients recycled back from the digesters (for example, energy to nitrify ammonia).

2. The suitable site available at the WPCF for installation of anaerobic digesters and a process building is located adjacent to wetlands, which may result in increased costs for permitting and design/construction (assuming a wetland evaluation and buffer zone delineation concludes the digesters can be located there).

3. Based on a cost-benefit and simple payback analysis, the payback period is well beyond the expected life of the proposed equipment.

4. Although additional revenue is available to some facilities through organic waste tipping fees and improved biogas production, current regulations (Federal 40 CFR 503) discourage sending food waste to wastewater treatment plants for anaerobic digestion, as compared to food waste only digesters which are much less regulated when it comes to handling the resultant solids. If food waste is mixed with the WWTP waste, it all becomes classified as WWTP waste and is then not able to be land applied in CT. In addition, the food waste stream

would need to be steadily added to prevent any biological disruptions to the anaerobic digesters.

Based on the above factors, we do not recommend implementing anaerobic digestion at the WPCF.

Tighe&Bond

# SECTION 7

# Section 7
# WPCF Nutrient Removal Technology Screening

This section describes various biological and physical/chemical treatment processes commonly used for nitrogen and phosphorus removal. A preliminary screening of the technologies was performed to develop a short-list of potential alternatives for further evaluation.

## 7.1 Overview

With respect to nutrients in the treated effluent, the WPCF must meet water quality standards as defined in its NPDES permit and as provided under the General Permit for Nitrogen Discharges, as discussed in Section 1.

### 7.1.1 Nitrogen General Permit

Vernon's nitrogen waste load allocation for 2016-2020 is 184 lbs/day. The WPCF's annual average nitrogen discharge is about 400 lbs/day (2013 to 2016 average). Because this is higher than the 184 lbs/day limit, the Town purchases credits through the nitrogen trading program. To decrease or eliminate the cost of purchasing credits, improvements would have to be made at the WPCF such that:

- At the current average flow of 2.95 mgd, the effluent total nitrogen concentration must be less than 7.5 mg/L.
- At the future average flow of 4.80 mgd, the effluent total nitrogen concentration must be less than 4.6 mg/L.
- At the permitted design flow of 7.1 mgd, the effluent total nitrogen concentration required to meet the mass loading limit is 3.1 mg/L.

An evaluation of nitrogen removal options was performed to identify the recommended approach to meet lower nitrogen effluent limits, recognizing that treating to lower effluent levels requires additional capital and O&M costs. Therefore, as discussed in Section 3, the capital costs of proposed improvements can be weighed against the present worth costs of purchasing nitrogen credits assuming the trading program continues in the future. If the trading program were to be discontinued, these limits would be inserted into the Town's NPDES permit.

### 7.1.2 NPDES Permit Phosphorus Limit

On or before April 1, 2021, Vernon's NPDES permit requires achieving compliance with its new effluent phosphorus limit of 4.56 lbs/day between the months of April 1st through October 31st. This phosphorus limit is a mass-based seasonal average limit for total phosphorus.

To maintain compliance with the effluent phosphorus limit of 4.56 lbs/day, the WPCF's effluent phosphorous concentration must decrease as wastewater flow increases.

- At the plant's current average day flow of 2.95 mgd, the effluent total phosphorus (TP) concentration must be less than 0.19 mg/L

- At the plant's future average day flow of 4.80 mgd, the effluent TP concentration must be less than 0.11 mg/L

- At the plant's permitted design flow of 7.1 mgd, the effluent TP concentration must be less than 0.08 mg/L

An evaluation of phosphorus removal options was performed to identify the recommended approach to meet the NPDES permit limits for phosphorus. Treating to any of these effluent levels will require the addition of chemical and/or biological treatment, as well as a tertiary low level phosphorus removal process. Extrapolating the permit limit to the permitted design flow (<0.08 mg/L effluent TP) approaches the removal limit of many tertiary treatment technologies.

## 7.2 Nitrogen Removal Treatment Processes

Total nitrogen is composed of organic and inorganic forms of nitrogen, and it is typically measured as the sum of organic nitrogen, ammonia, nitrite and nitrate. Biological nitrogen removal is a two-step process and depends on the conversion of ammonia and organic nitrogen to nitrate (nitrification) in an aerobic environment and subsequent conversion of nitrate to nitrogen gas (denitrification) in an anoxic environment.

Because the microorganisms performing biological denitrification require an energy source (e.g., BOD), denitrification is typically practiced in a pre-anoxic zone to take advantage of the readily available carbon source in the influent ahead of the aerated zone where most of the BOD removal and nitrification occurs. Because nitrification is the first step in the nitrogen removal process, the nitrate rich recycle stream from the aerobic zone is recycled to the pre-anoxic zone to achieve denitrification. With most treatment processes that include a post-anoxic zone, an external source of carbon like methanol or glycerin is added as an energy source. Nitrogen removal can also occur endogenously, but this occurs at a much slower rate and requires larger process tanks.

The amount of biological denitrification that occurs is impacted by the concentration of microbes in the treatment system. An increase in the mixed liquor suspended solids (MLSS) concentration will also tend to increase the amount of nitrification, denitrification, biological phosphorus removal and BOD removal. However, there is typically a maximum MLSS concentration that a given WPCF can operate under, while still maintaining proper operation of its secondary clarifiers without losing solids in the clarifier effluent.

In some cases, simultaneous nitrification and denitrification (SND) can occur within the same tankage. This situation can be encountered when the dissolved oxygen concentration is sufficiently low and nitrates are present in the MLSS. Anoxic zones or pockets can form within the aerated tanks where denitrification is possible. Typically, SND will only occur with measured DO concentrations below 0.5 mg/L or if there are large floc particles. Balancing these requirements in a single aerated tank to provide the potential ability for SND to occur is difficult from an operational standpoint. If the DO is too low, the WPCF risks incomplete nitrification. If the DO is too high, denitrification may be inhibited and the effluent TN concentration will increase. Additionally, poor settling sludge is a risk at low dissolved oxygen concentrations.

### 7.2.1 Biological Nitrogen Removal Processes

Nitrogen removal is a biological process that converts organic nitrogen and ammonia to nitrate (nitrification) and converts nitrate to nitrogen gas (denitrification). Different configurations for nitrogen removal are described below.

#### 7.2.1.1 Modified Ludzack-Ettinger (MLE)

The modified Ludzack-Ettinger (MLE) process is an activated sludge configuration consisting of an anoxic tank located upstream of the aeration basins, and it incorporates an internal recycle of MLSS from the aeration basin to the anoxic zone. The recycle flow is mixed with the primary effluent, and the return activated sludge is brought from the secondary clarifiers. Nitrification is carried out in the aerobic zone where ammonia is first oxidized to nitrite and then nitrate.

The nitrate-rich recycle from the aerobic zone provides nitrate as an oxygen source, and the primary effluent and return activated sludge provide readily biodegradable organic matter and microorganisms, all of which drive denitrification in the anoxic zone. The extent of denitrification depends on the recycle flow and availability of BOD.

Because only two types of zones are needed, the required tank volumes are often less than for other nitrogen removal processes such as 4-stage Bardenpho. However, the MLE process typically achieves an effluent concentration of around 8 mg/L of total nitrogen, which is higher than other processes. Achieving lower nitrogen levels can be accomplished by adding additional treatment zones or treatment processes downstream of this process (discussed further below).

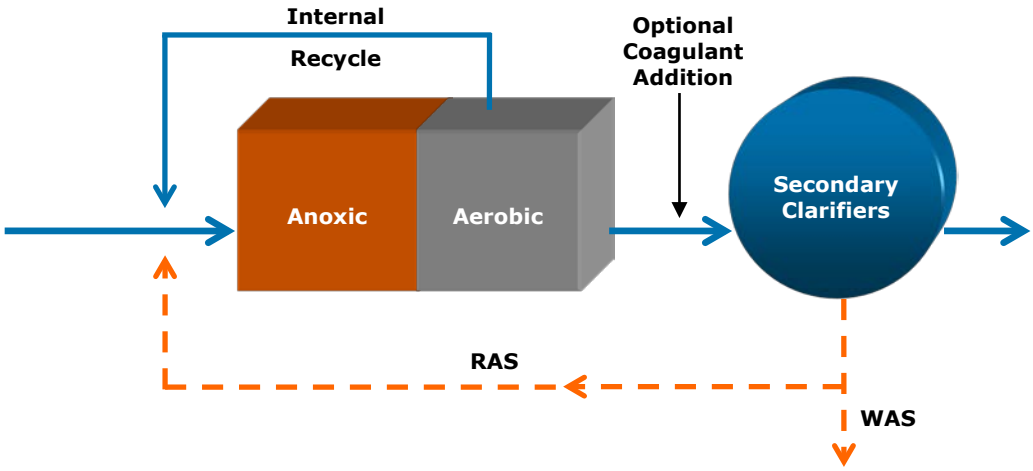



**FIGURE 7-1:** Modified Ludzack Ettinger (MLE) Process with Optional Chemical P Removal

### 7.2.1.2 4-Stage Bardenpho

The 4-stage Bardenpho process is an activated sludge configuration consisting of four alternating anoxic (stages 1 and 3) and aerobic (stages 2 and 4) zones in series. The aeration tanks are followed by secondary clarifiers.

A nitrate rich MLSS stream is recycled from the end of the aerobic zone to the beginning of the first anoxic zone and return activated sludge is also brought from the secondary clarifiers to the first anoxic zone. A supplemental carbon source such as methanol or glycerin can be added to the second anoxic zone to achieve additional denitrification. The second aerobic zone is designed to remove residual BOD and nitrogen gas entrained in the sludge prior to clarification.

Because of the additional anoxic and aerobic zones required, a 4-stage Bardenpho system will require larger tank volumes than some other nitrogen removal processes, such as the MLE process. However, total nitrogen effluent concentrations of about 3 mg/L with carbon addition (or about 5 mg/L without carbon addition) can be reliably achieved with this configuration. The process has a higher life cycle cost compared to an MLE process because of the additional equipment (mixers and air diffusers), additional zones, and supplemental carbon that is needed to achieve lower effluent nitrogen levels.

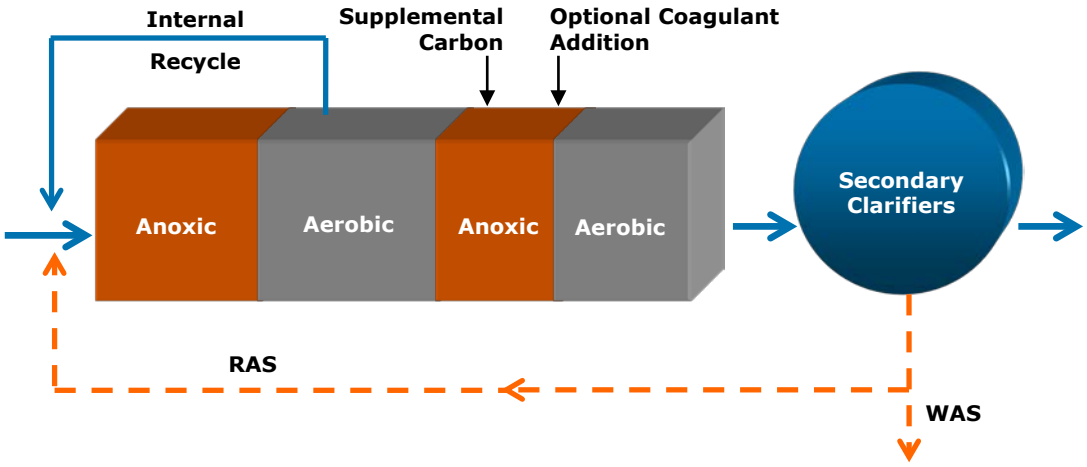



**FIGURE 7-2:** 4-Stage Bardenpho with Optional Chemical P Removal

### 7.2.1.3 BioMag in a 4-Stage Bardenpho Configuration

The ballasted biological sludge (flocculation) process (BioMag) is an activated sludge system that incorporates a ballast (magnetite) into the MLSS floc to improve secondary clarifier settling rates. A shearing process is used to separate the magnetite particle from the waste sludge stream which enables recycling of the magnetite back to the aeration tank.

The sludge settles much better with the addition of magnetite, and the MLSS can run at very high concentrations (8,000 – 10,000 mg/L not including the ballast), resulting in a smaller footprint for the system and more treatment capacity per tank volume compared to conventional activated sludge. Compared to the conventional activated sludge process, BioMag has smaller tank volume requirements. The limiting factors in implementing this technology are: the maximum solids loading capacity of the secondary clarifiers (which is still about double that of conventional activated sludge), and, to a lesser extent, the oxygen transfer capability of the aerobic zones. Although the BioMag process can also be configured in an MLE process (not discussed further here), it is most applicable at WPCFs where tank volumes are limited and higher levels of treatment are required, such as in Vernon. Therefore, the 4-stage Bardenpho configuration is considered in this plan.

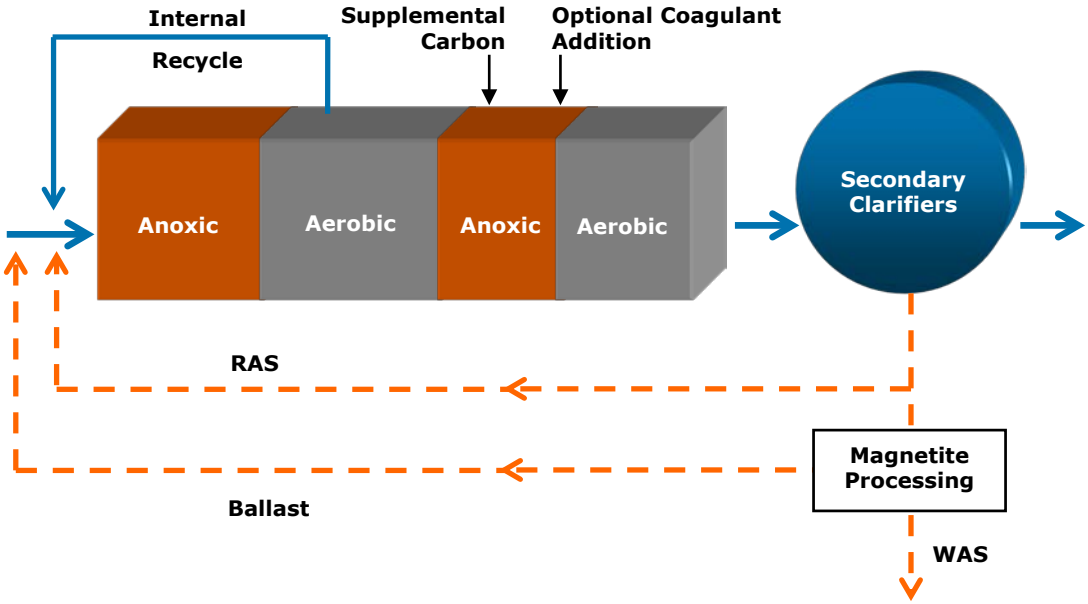



**FIGURE 7-3:** BioMag Process in a 4-Stage Bardenpho Configuration with Optional Chemical P Removal

### 7.2.1.4 IFAS in a 4-Stage Bardenpho Configuration

The integrated fixed film activated sludge (IFAS) process incorporates the positive elements of two fundamental biological treatment processes, namely fixed-film technology and suspended growth technology, into one hybrid system. Typical MLSS concentrations are 3,000 to 3,800 mg/L. Relative to conventional activated sludge, the IFAS process has significantly smaller aeration tank volume requirements.

IFAS can also be configured as an MLE process (not discussed further here), but it is most applicable where tank sizes are limited and higher levels of treatment are required. Therefore, the 4-stage Bardenpho configuration is considered in this plan.

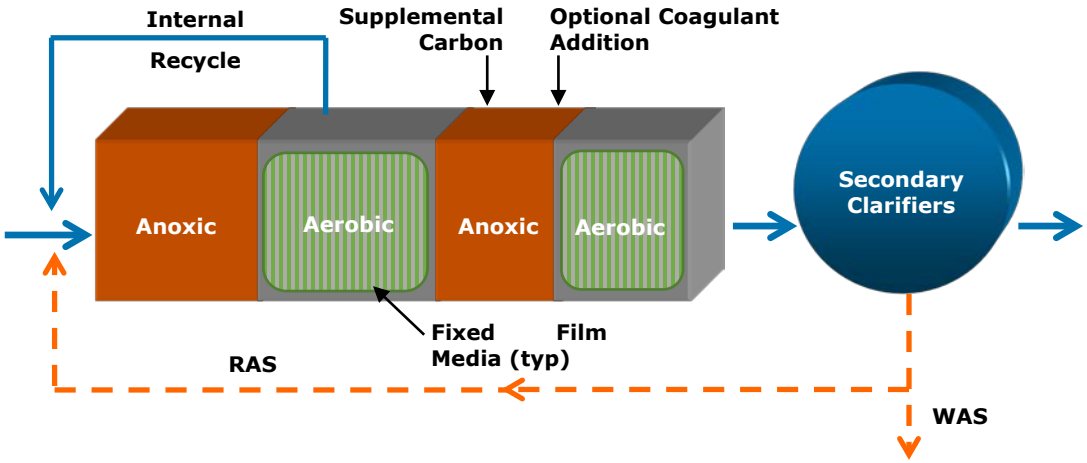



**FIGURE 7-4:** IFAS in a 4-Stage Bardenpho Configuration with Optional Chemical P Removal

### 7.2.1.5 Denitrification Filters

A denitrification filter is an anoxic fixed-film filter with supplemental carbon addition for denitrification, typically used as a tertiary polishing step to remove nitrates following secondary treatment and nitrification.

Denitrification filters incorporate a conventional deep-bed sand media filter along with the addition of supplemental carbon (usually methanol) to facilitate the growth of denitrifying bacteria on the filter media. These bacteria utilize methanol as a food source and nitrate as the oxygen source, resulting in nitrogen gas and biomass.

Denitrification filters must be periodically backwashed using a combination of water and air. Tanks must be provided to store the water used for the backwash and the wastewater generated by the backwash process. A brief intermittent aeration step is also incorporated to strip nitrogen and excess biomass from the media and to oxidize remaining methanol in the effluent.

Methanol is considered the best carbon source for this application because it contains no nitrogen compounds, is of consistent quality, and is toxic to bacterial growth at storage concentrations. The shortcomings of methanol use are high cost, health hazards to workers, and the potential for fire and explosion.

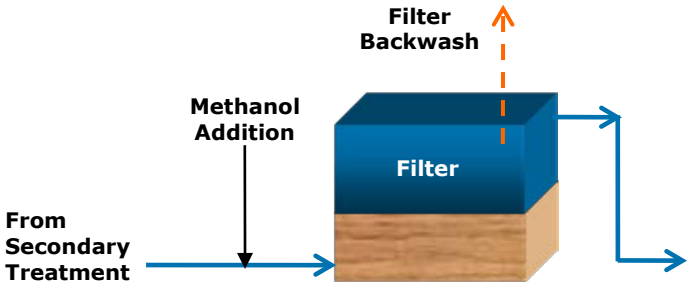



**FIGURE 7-5:** Denitrification Filter

### 7.2.1.6 Sequencing Batch Reactor

Sequencing batch reactors (SBRs) are a single sludge process that function in a fill and draw mode versus a continuous flow process. Continuous flow processes use separate tanks to perform different physical or biological processes. SBRs perform all the same operations in several parallel tanks by varying the time of each operation instead of the tank volume. This allows for some flexibility with regard to nitrogen removal, as multiple anoxic and aerobic time periods are possible.

Nitrification and denitrification can occur simultaneously in the same basin, allowing for additional nitrogen removal capacity. However, the denitrification process does not occur at as high a rate as in some other process; therefore, somewhat larger tank volumes are required. Biological phosphorus removal can also be performed in SBRs by sizing the tanks properly and allowing time for anaerobic conditions.

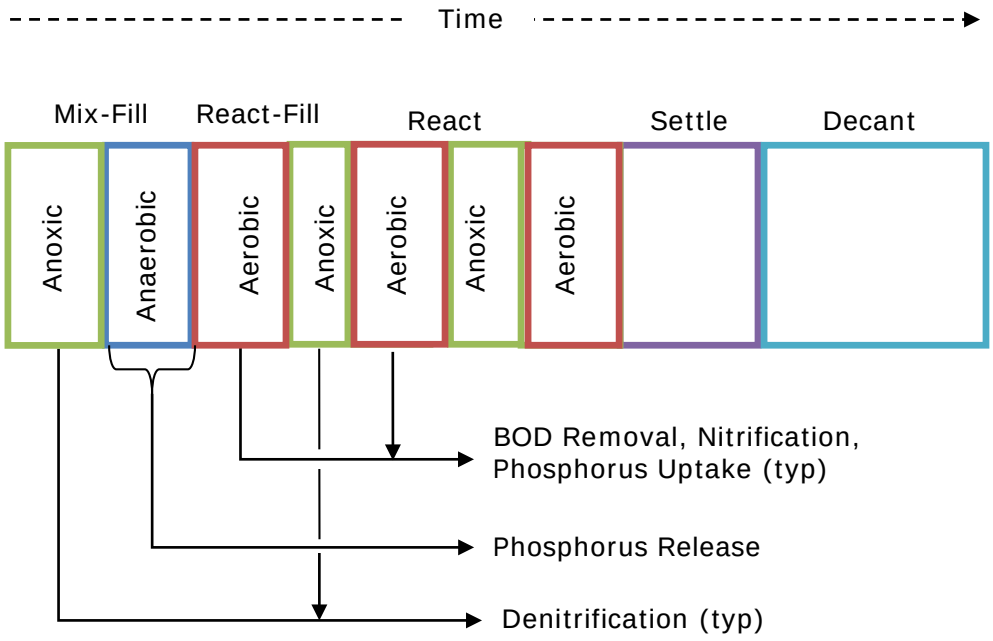



**FIGURE 7-6:** SBR Cycle Structures with Biological P Removal

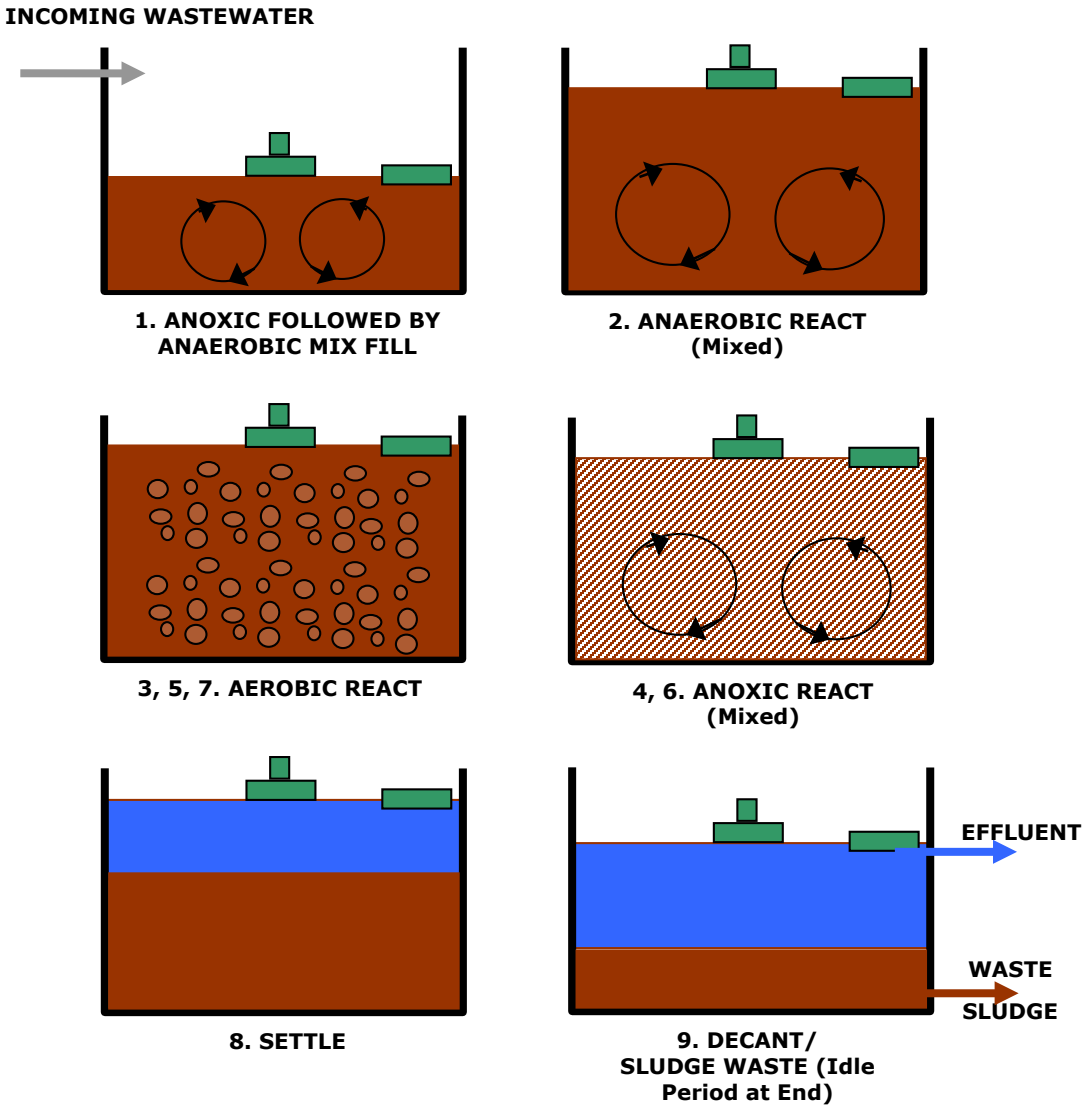



**FIGURE 7-7:** SBR with Cycles Modified for Biological P Removal

### 7.2.1.7 Oxidation Ditch

An oxidation ditch is a modified activated sludge configuration that relies on long solids retention times (SRTs) to provide BOD removal and nitrification, typically in the range of 12 to 24 days. Typical systems consist of a single or multi-channel configuration within a ring, oval, or horseshoe shaped basin. Nitrification occurs at design SRT's suitable for growing nitrifying bacteria.

The oxidation ditch channels can be modified for additional nitrogen removal by creating conditions that cycle between anoxic and aerobic states to drive denitrification and nitrification; respectively. Biological phosphorus removal can also be performed in oxidation ditches.

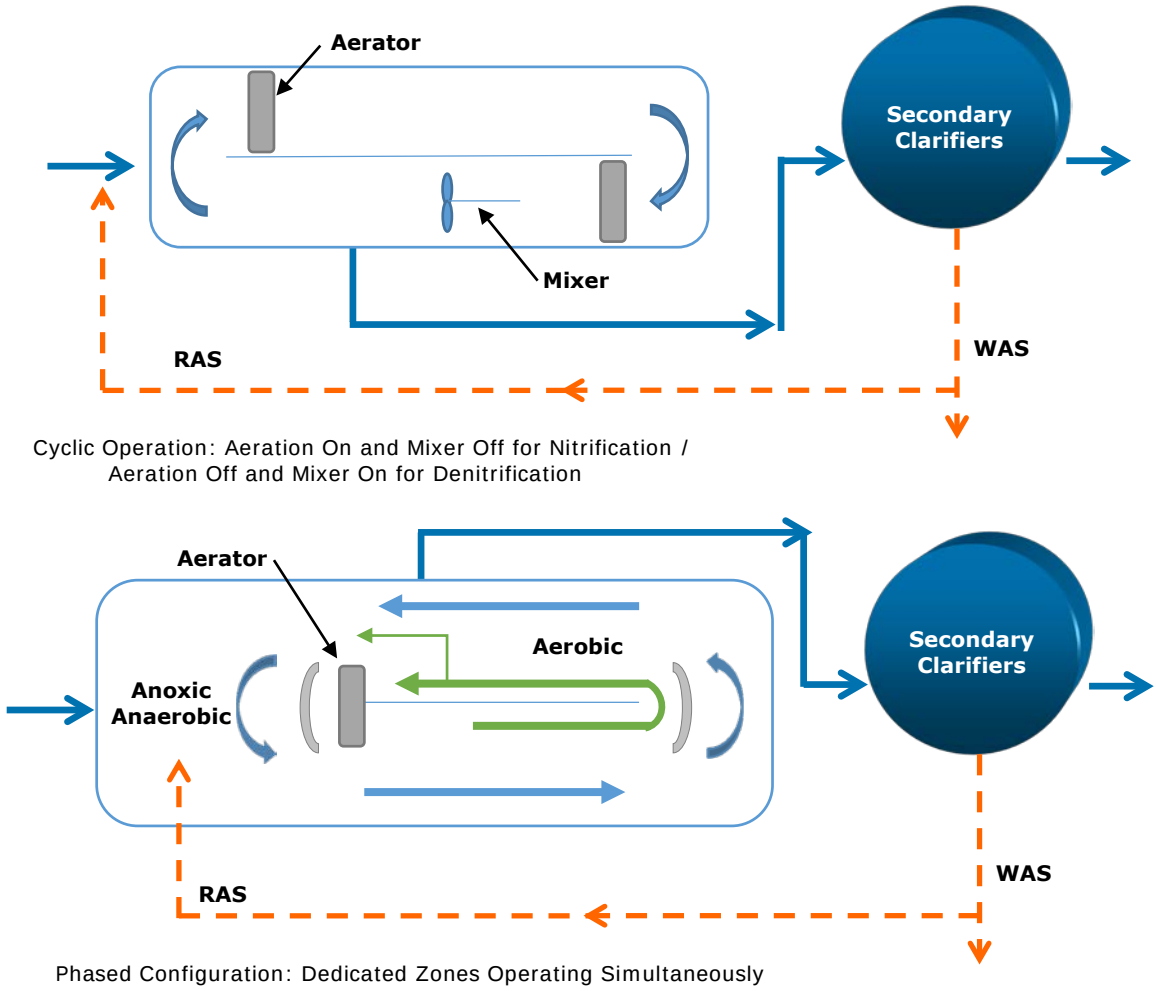



**FIGURE 7-8:** Oxidation Ditch, Cyclic and Phased Configuration

## 7.3 Phosphorus Removal Treatment Processes

Phosphorus removal typically occurs through chemical treatment via addition of a coagulant (generally an iron or aluminum salt), biological treatment, or a combination of both and subsequent solids removal (physical treatment step). Generally, biological phosphorus removal has been shown to reliably achieve effluent values of 1.0 mg/L or less depending on conditions, while chemical phosphorus removal alone or in combination with biological phosphorus removal has been shown to achieve effluent TP values down to approximately 0.5 mg/L without a tertiary treatment process. Effluent concentrations less than 0.5 mg/L would typically require a tertiary treatment process, and effluent concentrations at and below 0.1 mg/L approach the limit of technology for phosphorus removal. To achieve these very low concentrations, physical/chemical tertiary phosphorus removal processes in combination with very effective solids removal is required.

Key to phosphorus removal processes is the conversion of soluble phosphorus (generally considered to be reactive phosphate which is measured as ortho-phosphorus) into an insoluble or particulate form that can be removed. Total phosphorus is the measurement of the soluble (ortho-phosphorus) and particulate forms of phosphorus.

### 7.3.1 Chemical Precipitation

Chemical phosphorus removal consists of precipitating soluble phosphorus through the addition of coagulating chemicals and formation of settleable particles. Coagulants typically consist of metal salts, particularly aluminum and iron salts such as aluminum sulfate (alum), polyaluminum chloride (PACL,) and ferric chloride. The ability of coagulants and soluble phosphorus to form precipitates depends on factors such as pH and coagulant dose. Insoluble metal-phosphate precipitates are subsequently removed in the clarifiers. Additional solids separation processes (settling and filtration) can also be added downstream of the secondary clarifiers for additional phosphorus removal. This is referred to as tertiary phosphorus removal and is described further below.

Coagulants can be dosed into the treatment process in a variety of ways and locations, including to the wastewater flow before or after biological treatment, and/or to the internal plant recycle flows. Ideally, dosing locations should facilitate mixing and dispersal of the coagulant throughout the wastewater. Dosing of coagulant ahead of biological treatment can lead to removal of too much phosphorus resulting in phosphorus limiting conditions that can affect the secondary biological treatment process. Chemical phosphorus removal requires a chemical storage and feed systems for the coagulants. Chemical storage and feed systems are available in a variety of configurations designed to receive and store either bulk quantities of chemical or smaller portable containers.

#### 7.3.1.1 Coagulant Types and Doses

The extent of phosphate precipitation with aluminum and iron will depend on the dose of the coagulant. Due to competing chemical reactions and the effects of alkalinity, pH, and other trace elements found in wastewater, recommended dosages are established based upon the results of testing. In general, as lower and lower effluent concentrations of soluble phosphorus are targeted, the required chemical dose typically increases exponentially. Also as lower effluent concentrations of total phosphorus are required, solids removal becomes more important.

Each coagulant product is available at different concentrations of active metal complex. Coagulant products are typically available at bulk solution concentrations of 48.5% of

active metal complex for alum, 40% for ferric chloride, 10.5% to 17% for PACL. Ferric chloride supplies more active coagulant than either of the aluminum products at similar volumetric doses.

Alum is the one most frequently used and is generally considered the least expensive coagulant compared to PACL and ferric chloride. Aluminum compounds can be subject to limits in NPDES permits.

Iron salts such as ferric chloride are typically used as precipitants as well as to thicken biosolids. Liquid solutions of these salts are highly corrosive. Iron compounds can also be subject to NPDES permitting.

The addition of a coagulant will decrease alkalinity in the wastewater and decrease the effluent pH. Ferric chloride generally has the greatest impact, followed by alum, and then PACL, which consumes the least alkalinity and has the least impact on pH. For every gallon of coagulant added to every million gallons of wastewater treated:

- Ferric chloride (at a typical bulk solution concentration of 40% of active metal complex ($FeCl_3$) by weight) consumes approximately 0.54 mg/L of alkalinity as $CaCO_3$.
- Alum (at a typical bulk solution concentration of 48.5% of active metal complex ($Al_2(SO_4))_3*14H_20$) by weight) consumes approximately 0.33 mg/L of alkalinity as $CaCO_3$.
- PACL (at a bulk solution concentration of 17% of active metal complex ($Al_2O_3$) by weight with 45% basicity- meaning that the product is partially neutralized during manufacture) consumes approximately 0.37 mg/L of alkalinity as $CaCO_3$. Since PACL is a much more concentrated product, it consumes considerably less alkalinity than alum.

Addition of other chemicals may be required to provide supplemental alkalinity for maintaining a proper pH in the effluent and /or residual alkalinity for nitrification to occur.

The coagulants also have different physical properties. Freezing or crystallization temperatures of the chemical can be a concern, especially if year round phosphorus removal is required in the future and a portion of the chemical feed equipment is located outdoors. These chemicals have the following generally recognized freezing/crystallization temperatures:

- Alum: 2°-25° F
- PACL: <0° F,
- Ferric: -4°-14° F.

#### 7.3.1.2 Dosing Locations

Points of chemical addition for phosphorus removal include before primary sedimentation, after biological treatment, after biological treatment and the secondary clarifiers if there is a tertiary solids removal step, or any combination of these locations (multi-point chemical addition). The addition of coagulants should occur at a location with adequate turbulence to ensure rapid and thorough mixing of the coagulant with the wastewater.

Chemical application points can also be located downstream of the plant's solids handling systems where higher levels of phosphorus may be present in internal recycle streams.

### 7.3.1.3 Sludge Production

Chemical treatment also results in increased sludge production, depending on the dose of the coagulants. This can impact solids handling and disposal operations and costs. In addition, if the coagulant is added ahead of or directly to the activated sludge treatment system, the additional inert solids produced will impact the composition of the MLSS by increasing the amount of non-volatile solids and lowering the percent of volatile solids in the mixed liquor. This requires maintaining a higher concentration of MLSS to maintain the active biomass equivalent to a system without coagulant addition.

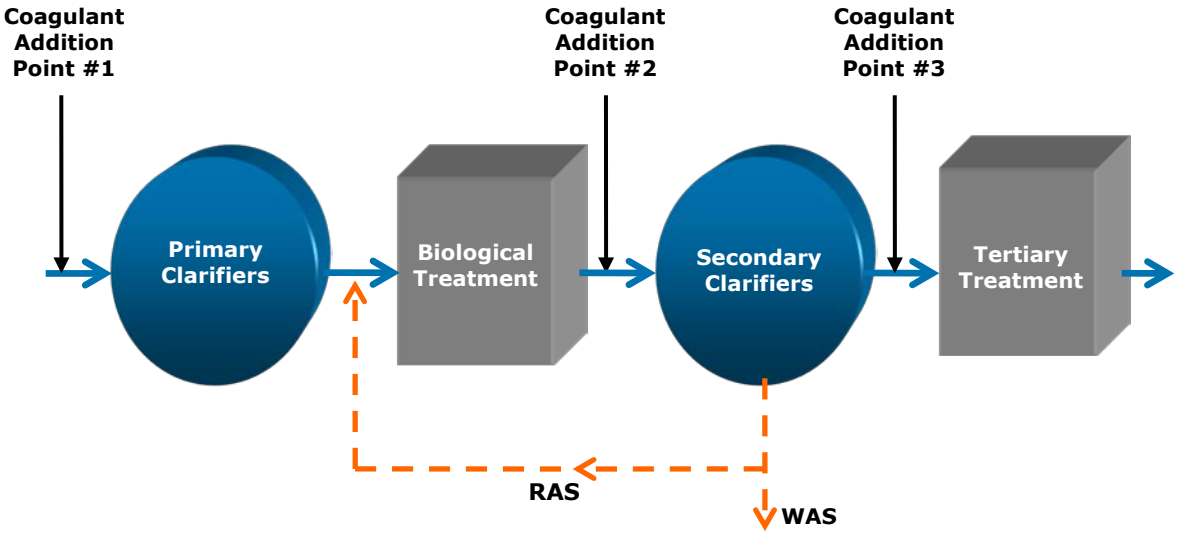



**FIGURE 7-9:** Conceptual Multi-Point Chemical Addition for Phosphorus Removal

### 7.3.2 Biological Phosphorus Removal Processes

Biological phosphorus removal is a two-step activated sludge process requiring an anaerobic zone followed by an aerobic zone. In the anaerobic zone, phosphate accumulating organisms (PAOs) will release phosphorus. The released phosphorus, as well as much of the influent phosphorus, is subsequently taken up by PAOs in the aerobic zone as a means of storing energy for future growth that occurs under anaerobic conditions. The phosphorus is removed when the phosphorus-rich PAOs are settled/filtered and subsequently removed from the system with the waste solids.

As noted, PAOs release phosphorus under anaerobic conditions. Therefore, the waste sludge containing PAOs removed from the activate sludge process and any solids handling processes must be maintained under aerobic conditions or the decant from any thickening or dewatering processes must be treated chemically to remove the released phosphorus.

Variations of the biological phosphorus removal process are described below. All of the following processes offer some degree of combined nitrogen and phosphorus removal, except for the AO process. Technologies available for combined nitrogen and phosphorus removal consist of biological nitrogen removal processes that incorporate biological phosphorus removal by adding an anaerobic step. These combined biological processes can typically achieve an effluent phosphorus concentration of 1 mg/L or less depending on the conditions.

In most applications, biological phosphorus removal is combined with chemical phosphorus removal to improve performance and reliability. In addition, coagulants can be added ahead of the secondary clarifiers to aid in floc formation and settling. An external readily degradable carbon source can be added ahead of the anaerobic zone to provide additional BOD for biological phosphorus removal.

Typically, enhanced biological phosphorus removal does not significantly increase sludge production. However, process optimization for nutrient removal can include adjustments to the solids retention time and waste activated sludge rates which can impact sludge generation rates.

### 7.3.2.1 AO Process – Anaerobic / Oxic

An A/O process is commonly used for biological phosphorus removal, but this process does not provide significant nitrogen removal. The process consists of an anaerobic zone followed by an aerobic zone, with no internal recycle other than the return activated sludge from the secondary clarifiers. Nitrate and DO concentrations in the RAS must be reduced prior to the onset of anaerobic fermentation. This requires an anaerobic zone of sufficient size to provide the required hydraulic detention time. This process can reduce total nitrogen to some degree because the nitrate returned in the RAS stream will be denitrified.

Nitrogen removal can be more difficult with this process. Nitrification occurring in the aerobic zone will return nitrates to the anaerobic zone and impact biological phosphorus removal. This may require increasing the size of the anaerobic zone or minimizing the nitrate recycle (RAS) to the anaerobic zone.

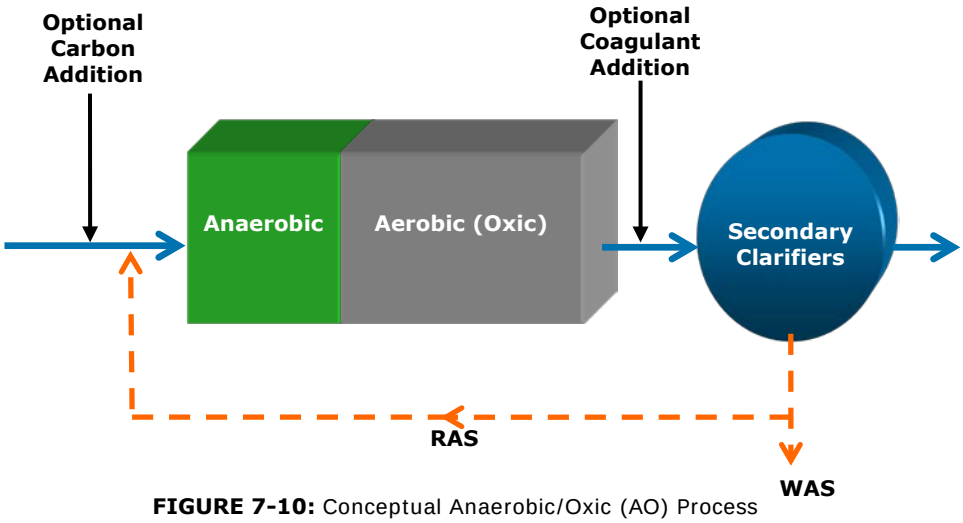



**FIGURE 7-10:** Conceptual Anaerobic/Oxic (AO) Process

### 7.3.2.2 A2O Process – Anaerobic / Anoxic / Oxic

The A2O process is a modification of the AO process with an anoxic zone for denitrification between the anaerobic and aerobic zones. The process also includes an internal recycle from the end of the aerobic zone to the beginning of the anoxic zone (downstream of the anaerobic zone), which provides chemically bound oxygen in the form of nitrate or nitrite to the anoxic zone. The anaerobic zone receives wastewater to be treated and RAS recycle only. Denitrification occurring in the anoxic zone reduces nitrate concentrations in the RAS recycle feeding the anaerobic zone, thereby improving the reliability of the anaerobic zone.

As with the AO process, additional nitrogen removal can be accomplished with this configuration by providing additional tertiary treatment processes downstream of the secondary clarifiers, such as denitrification filters.

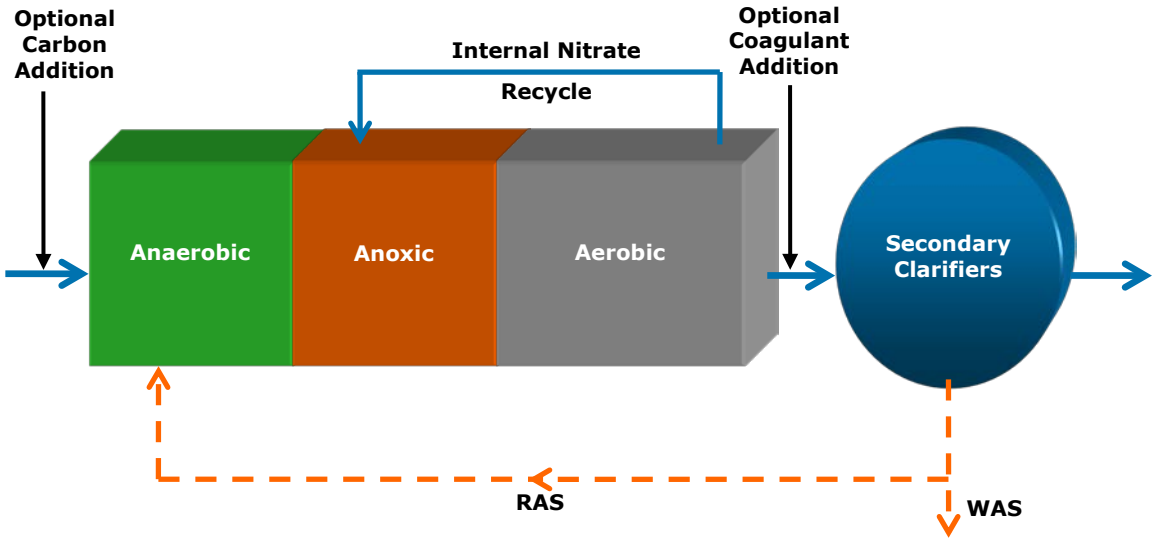



**FIGURE 7-11:** Conceptual Anaerobic/Anoxic/Oxic ($A^2O$) Process

### 7.3.2.3 5-Stage Bardenpho Process

The 5-stage Bardenpho process consists of the 4-stage Bardenpho configuration plus an anaerobic zone ahead of the four-alternating anoxic and aerobic zones in series for combined nitrogen and phosphorus removal. The aeration tanks are followed by secondary clarifiers.

A nitrate rich MLSS stream is recycled from the end of the aerobic zone to the beginning of the first anoxic zone and return activated sludge (RAS) is brought from the secondary clarifiers to the anaerobic zone. A supplemental carbon source (e.g., methanol, glycerin, etc.) can be added to the second anoxic zone to achieve additional denitrification.

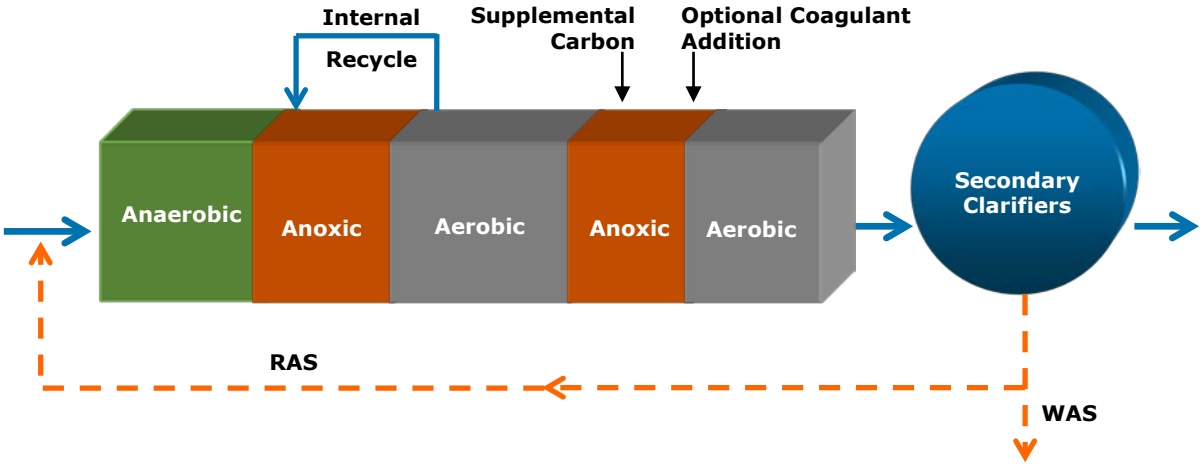



**FIGURE 7-12:** 5-Stage Bardenpho with Optional Chemical P Removal

### 7.3.3 Tertiary Phosphorus Removal Technologies

Advanced phosphorus removal (also referred to as Tertiary Removal because it is typically located downstream of primary and secondary treatment) refers to additional chemical and physical removal processes downstream of other treatment processes. The purpose of a tertiary treatment step is to chemically convert soluble phosphorus to a solid particulate and then provide enhanced solids removal by capturing particulate phosphorus that escapes the upstream treatment processes to achieve low effluent phosphorus levels.

Although there are many variations of tertiary phosphorus removal processes, some of the most common technologies are described below. These technologies are most often considered and required if treating to very low effluent phosphorus levels.

#### 7.3.3.1 Coagulation-Flocculation with Disc Filtration

This process consists of a dedicated coagulation and flocculation step followed by solids removal through a 5 to 10-micron pore size disc filters. Such filter products include the Hydrotech Discfilter by Kruger and the AquaDisk by Aqua-Aerobic Systems.

The coagulation/flocculation process tanks and equipment are in addition to the disc filtration packaged system. Typically, the disc filters can treat peak flow with at one spare disc filter unit out of service. Additional space within a building footprint can also be provided for installation of future units.

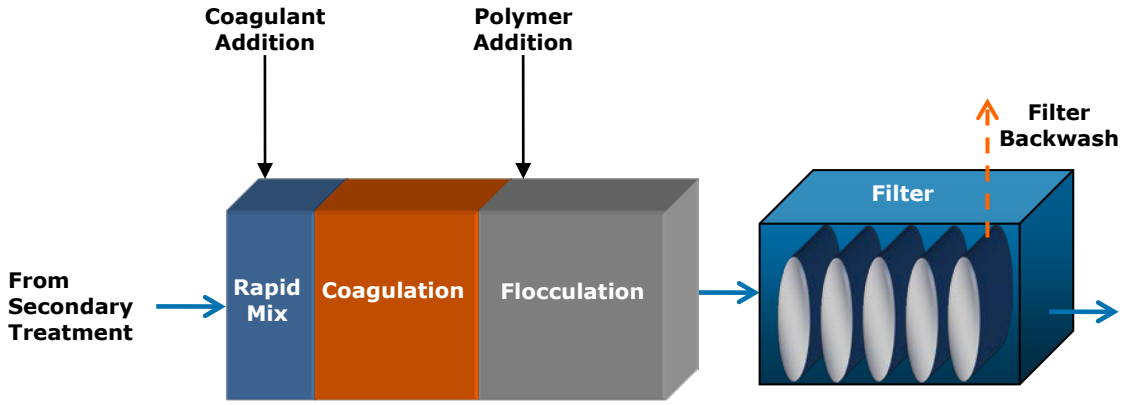



**FIGURE 7-13:** Coagulation-Flocculation with Disc Filters

### 7.3.3.2 Coagulation-Ballasted Flocculation with Clarifiers

In this process, a ballast (sand or magnetite) and polymer are incorporated into multiple coagulation and flocculation steps to improve the settling of solids in a downstream high rate clarifier. Proprietary ballasted flocculation systems include CoMag by Evoqua Water Technologies and Actiflo by Kruger.

Typically, sufficient duty treatment trains are provided capable of treating the peak flow with provisions for spare coagulation/flocculation mixers for the process tanks.

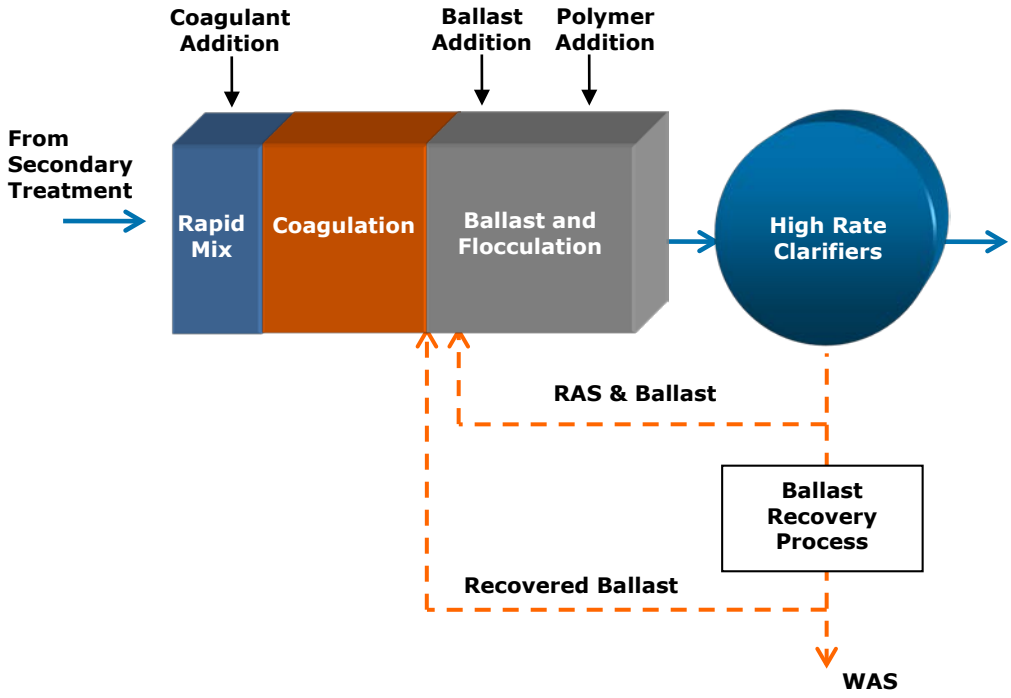



**FIGURE 7-14:** Coagulation/Ballasted Flocculation with Clarification

#### 7.3.3.3 Deep-Bed Up-Flow Sand Filtration

In this process, phosphorus removal is achieved by coagulation and filtration via adsorption of phosphorus onto sand particles. Phosphorus solids are removed as the filter media is continuously backwashed using an air lift pump. Several filters can be operated in series for additional phosphorus removal. Proprietary products include DynaSand by Parkson and Blue PRO by Blue Water Technologies.

Typically, sufficient airlift pumps (one airlift per filter bed/module) are provided to treat the peak flow, with about 2 to 4 airlifts out of service. Airlifts are arranged in modules of 4 airlifts per cell (BluePro) or 8 airlifts per cell (Dynasand).

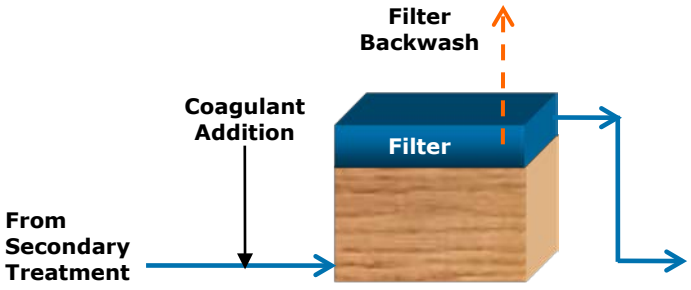



**FIGURE 7-15:** Deep-Bed Upflow Sand Filtration

### 7.3.4 Solids and Phosphorus Removal

Overall, the goal of phosphorus removal treatment processes is to convert phosphorus to a solid particle and then remove the phosphorus containing solids. Therefore, effective solids removal is necessary for achieving very low effluent phosphorus concentrations.

The relationship between effluent TSS and particulate phosphorus concentrations in the effluent is shown in Figure 7-16. Assuming the activated sludge makeup has 2% phosphorus by weight (which is typical for treatment plants without phosphorus removal processes) the concentration of particulate insoluble phosphorus at an effluent TSS of 5 mg/L is 0.1 mg/L. When chemical removal or biological removal of phosphorous is implemented in an activated sludge process, the phosphorus concentration in the sludge must increase. For planning purposes, when these processes are implemented, the concentration of phosphorus in the activated sludge can be expected to increase to approximately 4% and 6%; respectively. See Appendix M, which includes a presentation on Process Control Impacts of Phosphorus Removal for additional information.

The Vernon WPCF has a current average effluent TSS of 5 mg/L (Table 3-10), which suggests very good solids removal is accomplished by the clarifiers and sand filters. Based on this, the following conclusions can be made from Figure 7-16:

- Current effluent phosphorus levels with the sand filters online are likely approximately 0.1 mg/L of particulate phosphorus with the balance being soluble.

- If chemical removal of phosphorus is implemented and effluent TSS levels with sand filters online do not change, allocating 0.2 mg/L for particulate phosphorus in

the effluent (with the balance of the phosphorus assumed to be soluble) appears to be appropriate for planning purposes.

- If biological removal of phosphorus is implemented and effluent TSS levels with sand filters online do not change, allocating 0.3 mg/L for particulate phosphorus in the effluent (with the balance of the phosphorus assumed to be soluble) appears to be appropriate for planning purposes.

- The sand filters will not provide the level of solids removal required to meet the new permit.

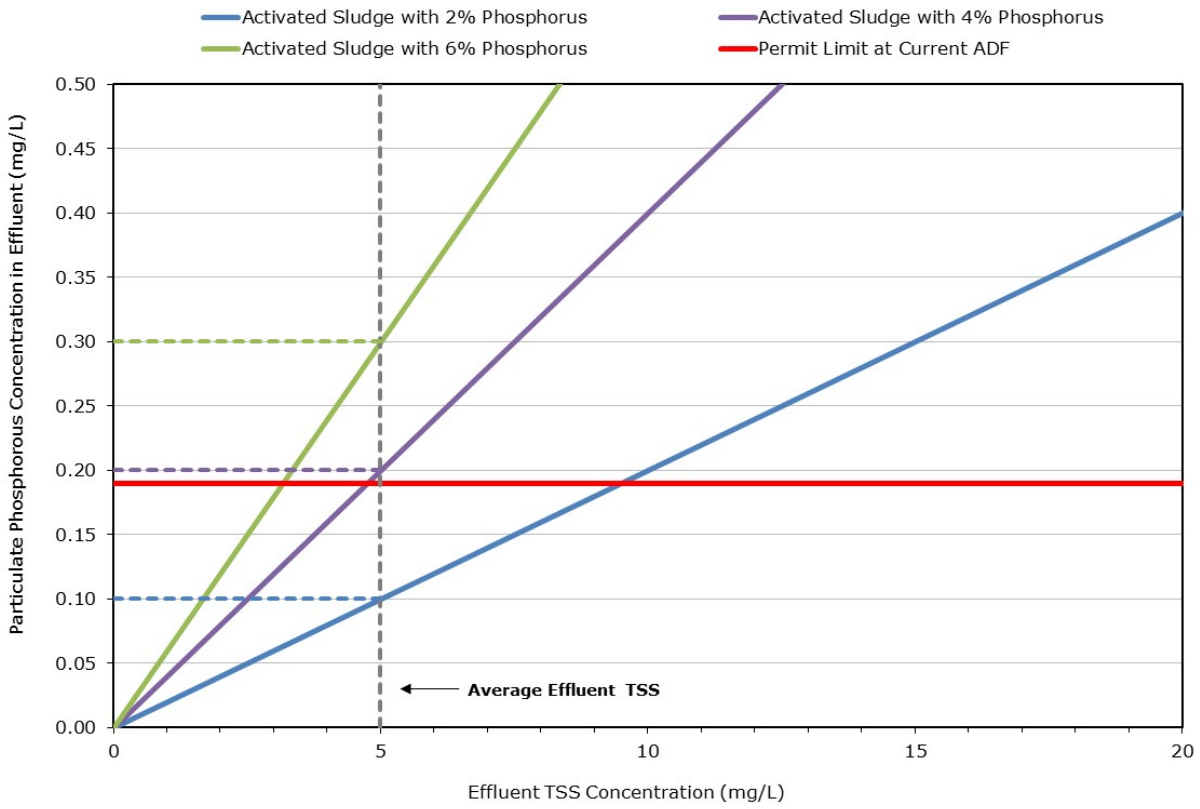



**Figure 7-16:** Relationship between Effluent TSS and Particulate Phosphorus Concentrations

We note that the above discussion ignores the impact of the Zimpro PACT-WAR system on phosphorus levels in the secondary clarifier effluent, which is discussed in detail in Section 8.

## 7.4 Initial Secondary and Tertiary Treatment Screening

The available treatment technologies for nutrient removal described above are screened in this section to develop a short list of technologies for further evaluation to meet the project goals. These goals include selecting a cost-effective approach and technology that can meet the proposed total phosphorus effluent permit limit of less than or equal to 0.08

mg/L and achieve a lower effluent total nitrogen concentration to the extent that space and financial constraints allow.

### 7.4.1 Secondary Treatment Process Alternatives

As discussed in previous sections, the Zimpro PACT-WAR Process is currently an integral part of secondary treatment, but the need for the Zimpro PACT WAR system (color removal) no longer exists. However, certain aspects of the system's unique design, such as its smaller than normal aeration tanks and its limited sludge thickening equipment present certain challenges when considering treatment process alternatives.

The Zimpro PACT-WAR process can be used in any of the nitrogen removal processes discussed above, and, in some respects is like the BioMag process (Figure 7-3). Whereas the Zimpro PACT-WAR process does not generate a secondary sludge, it cannot be used to reliably remove phosphorus in the secondary treatment process (because phosphorus is removed in the secondary sludge). If the WAR process were eliminated (and replaced with a new solids handling system), then the Zimpro PACT-only process would generate a secondary sludge and could be used to reliably remove phosphorus.

Because the plant currently operates the Zimpro PACT-WAR process, keeping this process as an alternative is retained for further analysis to determine if it meets the goals for the WPCF upgrade. Also, keeping the Zimpro PACT process and eliminating the WAR process is also retained for further analysis.

If the Zimpro PACT process is eliminated, then the loss of the ballast effect from powdered activated carbon addition will reduce the capacity of the secondary clarifiers to handle the high levels of MLSS that are currently handled. If the MLSS concentration is decreased in response, this will significantly decrease the treatment capacity of the existing aeration tanks, which will in turn require constructing new aeration tanks. This option is not consistent with the goals of the upgrade due to the high cost of constructing additional aeration tanks.

For the purposes of comparing alternatives, we developed the following preliminary design criteria for screening the activated sludge process based on the need to provide year round nitrification and denitrification without overloading the existing secondary clarifier capacity during high flows:

- Winter design temperature of 10° C (50° F) based on existing winter temperatures.
- Winter design solids residence time based on the aerated (oxic) volume of 12 days (includes a safety factor of 2 and nitrifier growth rate at 10°C).
- Clarifier state point analysis based on a design sludge volume index (SVI) of 150 mL/g (not including ballast such as powdered activated carbon (PAC) or magnetite) and maximum RAS pumping capacity of 8 mgd, as follows (analysis included in Appendix N):
    - Maximum MLSS of 4,500 mg/L to pass a peak hour flow of 12 mgd
    - Maximum MLSS of 3,200 mg/L to pass a peak hour flow of 22 mgd

  - The state point analysis indicates the clarifiers are solids flux limited, and increasing the number of clarifiers from 5 to 6 or increasing the RAS pumping capacity above 8 mgd has only a marginal impact on the ability to carry higher MLSS in the aeration tanks. Therefore, increasing the RAS capacity or constructing a sixth clarifier are not considered further.

- Gross yield coefficient 0.8 pounds of TSS (sludge) generated per pound of $BOD_5$ removed in the oxic zones. This gross yield factor does not account for additional solids generated due to phosphorus removal (discussed later in this Section); if phosphorus solids were to be accounted for, then the gross yield factor can be estimated to be about 10% higher, such that tank volumes would need to be 10% larger.

- Aeration tank volumes considered:

  - Using the existing tanks only (#1 through #6): 2.37 MG total

  - Construct new tanks (#7 and #8) in space available: 3.2 MG total (35% increase over existing total tank volume)

  - Construct new tanks (#7 and #8) in space available and rebuild two existing tanks (#1 and #2) by making them deeper: 3.4 MG total (43% increase over existing total tank volume)

- Based on the above criteria, the aeration tanks would need to be sized as follows:

  - Assuming peak flows remain under 12 mgd, then a MLSS concentration of 4,500 mg/L could be carried in the aeration tanks. The required aeration tank volume would be 5% larger than the existing aeration tank volume. The existing tank sizes would need to be increased by 40% to accomplish nitrogen removal in an MLE process.

    Passing peak flows greater than 12 mgd would require configuring the plant to operate in step feed mode during peak flows by constructing new tanks. Nitrogen removal would not be possible during step feed. This presents the risk of losing nitrification during wet weather winter flows and possibly violating effluent permit limits.

  - Assuming peak flows remain under 22 mgd, then a MLSS concentration of 3,200 mg/L could be carried in the aeration tanks. The required aeration tank volume would be 50% larger than the existing aeration tank volume. The existing tank sizes would need to be increased by 95% to accomplish nitrogen removal in an MLE. There is not enough space available at the plant to accommodate this option at design flows and loads, even if the plant is not configured for biological nutrient removal.

Therefore, due to space constraints and high cost for new tankage, eliminating Zimpro PACT-WAR and converting the plant to a conventional activated sludge process (regardless of the biological nutrient removal configuration) is not considered further.

If the Zimpro PACT-WAR process is eliminated, then a non-conventional activated sludge treatment technology that increases the treatment capacity of the existing aeration tanks

without overloading the clarifiers is viable. Of the technologies discussed above, this includes the BioMag process and IFAS, which were short-listed for further analysis. These alternatives would require a new secondary sludge solids handling system.

Demolishing the existing aeration tanks and constructing new tanks to implement sequencing batch reactors or oxidation ditches was not considered further due to high construction costs, space constraints, and the inability of the WPCF to comply with the its NPDES during the prolonged construction period.

Alternatives for phosphorus removal in the secondary treatment process depend on whether the Zimpro PACT-WAR process is eliminated as discussed above and in Section 8. Therefore, both chemical phosphorus removal and biological phosphorus removal options were retained for further analysis for the secondary treatment process. The goal of enhanced biological phosphorus removal (EBPR), if possible to implement, would be to reduce the need and costs for chemical addition.

Several coagulants for chemical phosphorus removal were screened for selecting treatment chemicals and doses that would be appropriate for chemical phosphorus removal in the secondary treatment process. This screening is discussed in Section 7.5 below.

### 7.4.2 Tertiary Treatment Process Alternatives

To meet the stringent phosphorus limit, a low-level phosphorus removal technology will be required. A tertiary, low level phosphorus process is an additional chemical and physical treatment process that follows secondary treatment, and it would replace the existing sand filters. The purpose of a low-level phosphorus treatment step is to precipitate residual dissolved reactive phosphorus and provide enhanced solids removal.

Of the tertiary treatment technologies previously discussed, the following technologies were retained for further analysis:

1. Coagulation-flocculation with disc filtration

2. Coagulation ballasted-flocculation with clarifiers

Deep bed up-flow sand filters were not retained for further analysis due to the large footprint required compared to the other technologies and lack of significant experience with these systems in the Northeast.

As discussed above and later in Section 8, the phosphorus concentrations entering the tertiary system will depend on whether the Zimpro PACT-WAR process is eliminated or retained. Therefore, the following design criteria for the tertiary treatment process alternatives are considered in this analysis for achieving low level phosphorus removal (less than or equal to 0.08 mg/L total phosphorus):

1. If the Zimpro PACT-WAR process is retained, then the total phosphorus entering the tertiary system may be as high as 3.2 mg/L. This will require a more robust tertiary treatment and sludge processing systems designed to handle the larger quantities of solids that will be generated in the process.

2. If the Zimpro PACT-WAR process is eliminated, the total phosphorus entering the tertiary system will be less than 1.0 mg/L. This is the typical target level and design criteria for tertiary system influent.

### 7.4.3 Summary of Process Alternatives

Based upon the above analysis, the following alternatives were retained for further analysis:

- Secondary Treatment within existing aeration tanks (possibly with low level nitrogen removal and/or enhanced biological phosphorus removal):
    - Retain Zimpro PACT-WAR processes
    - Retain Zimpro PACT process and eliminate WAR process
    - Eliminate the Zimpro PACT-WAR processes and replace them with a ballasted sludge flocculation system (BioMag)
    - Eliminate the Zimpro PACT-WAR processes and replace them with an IFAS activated sludge process
- Tertiary Treatment to meet new phosphorus permit limit:
    - Coagulation-flocculation with disc filtration
    - Coagulation ballasted-flocculation with clarifiers

To assist in evaluating these above alternatives, we developed a request for proposal that was send to manufacturers of the above processes to solicit their input and cost information. An abbreviated version of this request for proposals is included in Appendix N, including a summary of the information described above.

## 7.5 Coagulant Screening for Chemical Phosphorus Removal

For the purposes of screening different coagulants and selecting a chemical(s) and dosing rates for single-point and multi-point chemical addition for phosphorus removal, chemical addition to the primary and secondary processes is evaluated under current flow and load conditions, and assuming the Zimpro PACT-WAR process is eliminated. This simplifies the calculations for the purposes of comparing the annual chemical costs and sludge production associated with the different coagulants.

A preliminary discussion of the chemicals to be used for the tertiary processes is also provided. Based upon previous experience, coagulants that perform well in primary and secondary treatment processes may not perform as well in a tertiary low-level phosphorus removal process. Therefore, it is recommended that at least two chemical feed systems be provided so that more than one chemical can be used throughout the plant.

### 7.5.1 Phosphorus Removal Strategy

For the purposes of screening different coagulants, the evaluation is based upon the following assumptions:

- Current average day flows and loads.

- Elimination of Zimpro PACT-WAR (a comparison of chemical usage rates with and without the Zimpro PACT-WAR processes is included in Section 8).

- No enhanced biological phosphorus removal. If EBPR can be implemented, this can potentially reduce chemical usage and sludge production.

- Adjusted the plant influent load to 195 lbs/day total phosphorus, based upon current average total plant influent load of 295 lbs/day (Table 3-8) minus 100 lbs/day of phosphorus loads from industrial user Anocoil. Anocoil currently uses phosphoric acid in its metal finishing process, which accounts for approximately 100 lbs/day of the influent phosphorus loading to the WPCF. It is expected that Anocoil will modify its production process to stop using phosphoric acid.

- A 5% removal efficiency of particulate phosphorus in primary clarifiers before coagulant addition. This is consistent with removals typically observed at other wastewater treatment plants, but less than the removal rates currently observed at the Vernon WPCF. As discussed above and in Section 3, Anocoil is currently discharging a significant load of phosphorus to the plant. Anecdotal evidence suggests that Anocoil's discharges are high in particulate phosphorus, and thereby impact the observed phosphorus removal efficiencies. However, this data is not conclusive and further investigation is not warranted since Anocoil's wastewater will change after phosphoric acid is no longer used. The overall benefit to the plant of Anocoil's change will be a reduction of incoming soluble and particulate phosphorus loads, and a reduction in the phosphorus loading to the secondary clarifiers.

- Phosphorus removal in aeration tanks and secondary clarifiers due to biomass assimilation and growth. Removal efficiency is based upon an estimated mass of sludge generated due to 98% removal of BOD secondary influent load, effective gross yield of 0.8 lb MLSS (WAS) generated per lb BOD removed, 80% volatile MLSS, and assuming 2% phosphorus is assimilated in the volatile portion of the WAS.

- Resultant total phosphorus load of 115 lbs/day, equivalent to 4.67 mg/L total phosphorus at the current average flow of 2.95 mgd.

- Multi-point chemical addition strategy based upon achieving a total phosphorus concentration of 1.0 mg/L in the secondary clarifier effluent, with an allowance of 0.2 mg/L of particulate (insoluble) phosphorus carried over in the effluent TSS (see Section 7.3.4). This should provide operational flexibility for consistently meeting concentrations below 1.0 mg/L in the influent to the tertiary system.

### 7.5.2 Coagulant Doses and Previous Jar Tests

Coagulants for chemical phosphorus removal were screened based upon the results of previous jar tests conducted at the Vernon WPCF, as well as Tighe & Bond's experience developing phosphorus removal plans at other municipal wastewater treatment plants.

Jar tests were conducted by Evoqua on June 27 and July 11, 2014 on the secondary effluent to evaluate the effectiveness of ballasted coagulation-flocculation with addition of

an anionic polymer for flocculation, magnetite for sedimentation, caustic soda for pH adjustment, and three coagulants - alum, PACL, and ferric chloride. The testing procedure consisted of coagulant addition with a range of doses (35 to 200 ppmv) across the two days of testing, magnetite addition with a 5 g/L constant dose, caustic soda addition with a range of doses, and polymer addition with a range of doses. Measurements were taken of the influent and final (post sedimentation) total phosphorus, pH, turbidity, and TSS. Results of the jar tests are included in Appendix O. All three coagulants were successful at reducing total phosphorus below 1.0 mg/L.

Jar tests were also conducted by Holland Chemical Company on March 8, 2016 on the aeration basin effluent prior to polymer addition. Three coagulants were tested – alum, PACL as Epic 58, and PACL as Epic 70 – with a range of doses from 15 to 150 ppmv to achieve a target final reactive phosphorus concentration of <1.0 mg/L. Results of the jar tests are included in Appendix O. All three coagulants were successful at reducing total phosphorus below 1.0 mg/L.

The results of both jar tests appear to indicate that phosphorus removal rates occurred at values close to the theoretical (stoichiometric) molar ratio (one mole of metal to react with and remove one mole of phosphorus). Typically, a dose of at least 150% to 200% of the theoretical amount is required. The discussion presented below provides a prudent argument for not projecting future chemical doses based on the results of previous jar tests.

Section 4 documented that some phosphorous removal is occurring across the secondary processes. These removal rates are on the same order of magnitude as typically observed at conventional treatment plants, where phosphorus is assimilated into the MLSS, removed from the process as waste sludge, and ultimately disposed (and not returned to the secondary process).Because Vernon's Zimpro PACT-WAR process oxidizes the waste sludge and the phosphorus it contains and returns it to the secondary process, phosphorus removal should effectively be impossible.

However, the plant's operating data and our review of the Zimpro PACT-WAR process suggests that phosphorus removal is occurring. Although the oxidization of the WAS, should yield, in theory, soluble phosphates, in reality, these species are absorbed/accumulated within the ash fraction of the MLSS (discussed in more detail in Section 8) to form inert, particulate phosphorus that is then recycled into the aeration tanks. The eventual loss of this ash to the primary clarifiers (via various mechanisms, as discussed in Section 8) may be the mechanism contributing to the overall phosphorous removal in the secondary processes.

Additionally, the carry-over of ash solids to primary treatment may also have a small impact on phosphorus removal rates at the primary clarifiers. This "ash effect" present in the secondary process may also have helped reduce the chemical doses required to convert soluble ortho-phosphorus to a particulate form during the previous jar scale testing. If coagulants were to be added for phosphorus removal in the secondary clarifiers, then ash concentrations in the MLSS would rise significantly. This could potentially lead to operational problems at the plant and an increase in operating costs due to the limitations for managing ash levels.

In Section 8, we assume that the "ash effect" discussed above would continue if the Zimpro PACT-WAR system were to be retained. We further assumed that chemical addition to the secondary process would not be performed in the Zimpro PACT-WAR alternative.

Based on the discussion above, Table 7-1 summarizes the coagulant doses selected to achieve a concentration of less than 1.0 mg/L for the purposes of screening the coagulants. These doses are based on molar ratios that are higher than theoretical, as observed in published correlations and in our experience at other plants (also summarized in Table 7-1).

As lower phosphorus concentrations are targeted, the amount of metal required to react with and remove each mole (or pound) of phosphorus increases. Therefore, to achieve a final concentration less than 0.08 mg/L in the low-level phosphorus removal system effluent, higher coagulant doses are required than if targeting a final concentration less than 1.0 mg/L. We have based the coagulant doses for the tertiary system on the recommendations provided by the tertiary system manufacturers, published correlations, and our experience at other plants. These doses are also summarized in Table 7-1.

The recommended doses presented in Table 7-1 are based on the removal strategy discussed above. Doses are presented as pounds of coagulant metal (aluminum or iron) required to react with and remove one pound of phosphorus. We also compare these doses to the theoretical (stoichiometric) doses and to average doses we have seen used at other treatment plants for similar target reactive (soluble) phosphorus levels.

Typically, less coagulant can be added to primary clarifiers compared to secondary clarifiers, because of the higher availability of reactive phosphorus resulting in potentially higher removal rates on a molar basis. However, for planning purposes, the same doses are assumed for multi-point chemical addition to the primary and secondary clarifiers.

**TABLE 7-1**

Comparison of Theoretical and Observed Coagulant Doses
(as lb Metal Added / lb P Removed)

| | | Typical Doses to Reach Final Phosphorus Concentration of: (1) | | Recommended Doses (2) | |
|---|---|---|---|---|---|
| **Coagulant Metal** | **Theoretical Dose** | **<1.0 mg/L** | **<0.08 mg/L** | **<1.0 mg/L** | **<0.08 mg/L** |
| Alum | 0.87 | 1 – 2 | 4 – 9 | 1.7 | 6.1 |
| PACL (Epic58) | 0.87 | 1 – 2 | 4 – 9 | 1.7 | 8.7 |
| PACL (Epic70) | 0.87 | 1 – 2 | 4 – 9 | 1.7 | 8.7 |
| Ferric Chloride | 1.80 | 2 – 4 | 10 – 16 | 3.6 | 12.6 |

(1) Based on past experiences and published correlations. In practice, larger doses (more pounds of coagulant metal) are required to remove each pound of phosphorus as the target effluent phosphorus concentration is lowered. This is also impacted by the plant' particular wastewater characteristics, treatment process, and chemical application points.

(2) Based on past experience at other plants, PACL has not always been successful at treating low influent phosphorus concentrations observed in tertiary treatment.

To compare costs associated with dosing each different coagulant to the secondary system, we extrapolated the results to full scale conditions at current average day flows (2.95 mgd) using the doses summarized above. For these conditions, chemical feed requirements and dry solids production for each coagulant under current average day flows are summarized in Table 7-2 (detailed calculations are included in Appendix P). This table also includes estimates of caustic soda quantities and costs that would be required at these coagulant doses to fully counteract the alkalinity consumed by the addition of each coagulant. Chemicals other than caustic soda can also be used to replace the lost alkalinity (reviewed in Section 8). Table 7-2 does not include chemical addition required for tertiary treatment (discussed in Section 8).

Yearly chemical usage quantities and sludge production quantities are based on a 7.2-month operation period (April-October plus startup/shutdown). Estimated chemical costs are as follows:

- Alum at $0.87 per gallon purchased in 5,000-gallon bulk quantities
- PACL (Epic 58) at $1.89 per gallon purchased in 5,000-gallon bulk quantities
- PACL (Epic 70) at $2.15 per gallon purchased in 5,000-gallon bulk quantities
- Ferric chloride at $1.79 per gallon purchased in 2,000-gallon bulk quantities

**TABLE 7-2**
Estimated Chemical Feed Requirements and Sludge Production for Chemical Phosphorus Removal under Current Average Day Flows and Loads (1)

| | | |
|---|---|---|
| Estimated Secondary Effluent TP Before Chemical Addition | mg/L | 4.67 |
| Target Secondary Effluent TP (2) | mg/L | 1.0 |
| Current Average Day Flow | mgd | 2.95 |
| Pounds of P Removed | lbs/day | 90 |

| Coagulant | | Alum | PACL as Epic58 | PACL as Epic70 | Ferric Chloride |
|---|---|---|---|---|---|
| Average Coagulant Dose | lb Metal / lb P Removed | 1.74 | 1.74 | 1.74 | 3.61 |
| Daily Volume of Solution to Treat Average Day Flow | gpd | 321 | 271 | 154 | 202 |
| Yearly Volume of Solution (3) | gal/yr | 70,353 | 59,381 | 33,710 | 44,284 |
| Cost per Season (3) | $/yr | $61,207 | $112,229 | $72,476 | $79,269 |
| Additional Solids Generated | lbs dry solids / day | 583 | 583 | 583 | 751 |
| Alkalinity Consumed | lbs CaCO3 / day | 875 | 262 | 481 | 875 |
| 25% Caustic Soda Required (3) | gpd | 110 | 33 | 60 | 110 |
| | $/yr | $61,247 | $18,374 | $33,686 | $61,247 |
| Total Chemical Cost | $/yr | $122,455 | $130,603 | $106,162 | $140,516 |

(1) Not including EBPR or low level phosphorus removal and assuming Zimpro PACT-WAR is eliminated.
(2) With an allowance of particulate phosphorus of 0.2 mg/L in effluent TSS, the balance assumed to be ortho-phosphorus at <0.8 mg/L.
(3) 7.2-month operation period (219 days, April through October plus start-up/shutdown).

The coagulants are evaluated further below under current conditions, based upon the items listed:

- Size of Facilities and Chemical Usage

    - Daily chemical usage is highest for alum and PACL (Epic 58). PACL (Epic 70) would require the least daily amounts. Alum would require the largest chemical storage tanks, nearly twice the size required for Epic 70.

    - The cost to purchase alum is much less than the other coagulants, which may offset the capital costs for larger storage tanks. The cost to purchase Epic 58 is the highest out of the coagulants.

- Sludge Generation Rates

    - With respect to additional solids produced, the estimated average daily quantity is the highest for ferric chloride and similar for the aluminum based coagulants.

- Alkalinity and pH Impacts

    - Potentially, PACL as either Epic 58 or Epic 70 consumes the least alkalinity. The caustic soda quantities in Table 7-2 are based on the alkalinity required to counteract the addition of the coagulant. Calculations are included in Appendix P.

    - Implementing coagulation for phosphorus removal presents the risk of further decreasing the pH, reducing alkalinity, and potentially interfering with the nitrification process (because nitrification typically occurs over a limited pH range and because nitrifiers consume alkalinity). It is important to maintain adequate alkalinity to provide pH stability and to provide alkalinity for nitrifiers.

    - Based on the available MOR data, the effluent alkalinity is generally at the recommended minimum of 50-75 mg/L (TR-16): on average, final effluent alkalinity is 77 mg/L as $CaCO_3$. This is due to the daily addition of soda ash upstream of the aeration tanks to provide the alkalinity needed for nitrification. It is anticipated that once nitrogen removal is included in the process, the need for alkalinity addition prior to the aeration tanks will be significantly reduced. However, after accounting for alkalinity consumption due to coagulation for phosphorus removal, the plant will likely need to continue to supplement alkalinity, especially if the effluent pH is at risk of dropping below the permit limit of 6 to 9. On average the plant's influent pH is 7.6 and effluent pH is 7.1.

    - For planning purposes, we have assumed that one or two chemicals to adjust pH and supplement effluent alkalinity will be needed, regardless of the coagulant used. For the annual cost comparisons of coagulant, we assumed that costs would be based upon using 25% caustic soda (sodium hydroxide) at a cost of $2.55/gallon, and if all alkalinity consumed by the coagulant must be replaced. This will depend on the actual pH and alkalinity and may not always be required. This is evaluated further in Section 8.

Based upon the discussion presented above and data summarized in Table 7-2, chemical treatment with either alum or PACL as Epic 70 is recommended due to lower yearly coagulant costs compared to the other coagulants. Of these, Epic 70 would have the least impact on alkalinity.

Epic 58 is not recommended now due to higher yearly coagulant costs. Although Epic 58 potentially consumes the least alkalinity, thus requiring the least supplementary chemical to counteract the alkalinity loss, the total cost for both coagulant and caustic soda is the highest for the different chemicals.

Ferric chloride is not recommended now due to higher costs and other non-economic factors that make ferric chloride an unattractive alternative. Namely, ferric chloride is a corrosive chemical requiring special handling and it easily stains most materials it contacts. The plant may receive an aluminum permit in the future and if it cannot be met while using PACL, or alum, then the plant may need to switch to ferric chloride.

We therefore would propose sizing and designing the tanks to accommodate any of the three chemicals.

Alum and PACL (Epic 70) have comparable yearly chemical costs and similar sludge generation rates, though because of higher usage rates alum would require larger chemical storage tanks to store the recommended minimum 30-day supply (per TR-16). Lower usage rates for Epic 70 indicate that chemical deliveries will be somewhat less. Although PACL potentially consumes the least alkalinity, such that the need to supplement alkalinity by dosing a second chemical is reduced, a second chemical feed system is recommended to adjust pH should it be needed to meet permit limits.

For the purposes of this screening, the alternatives analysis considers multi-point chemical addition to the primary clarifiers and secondary clarifiers with PACL (Epic 70). The chemical storage tanks and feed equipment sizes should be sized for either alum, PACL, or ferric chloride, and a second chemical feed system can be included to feed another coagulant with minimal capital cost impacts.

Based upon our experience at other plants, PACL may not perform as well in tertiary low-level phosphorus removal systems, in which case either alum or ferric chloride may be more appropriate for that process. As discussed above, we recommend that two chemical feed systems be provided to allow the flexibility to use two different chemicals: one for influent to the primary and secondary clarifiers, and one for the tertiary system.

Tighe&Bond

# SECTION 8

# Section 8
# Alternatives Analysis

## 8.1 Overview

The following section presents a detailed evaluation of the short-listed alternatives for secondary treatment and nutrient removal, including low level phosphorus tertiary treatment, as well as disinfection alternatives and solids handling alternatives. The recommended WPCF upgrades are summarized in Section 9. Because the later treatment processes influence the evaluation of preceding unit operations, the following discussion begins with disinfection and proceeds upstream to the secondary treatment process, as summarized below.

- Detailed analysis of disinfection alternatives consisting of chlorination/ dechlorination versus UV disinfection.

- Detailed analysis of tertiary low-level phosphorus removal systems consisting of coagulation and flocculation with disc filters versus coagulation and ballasted-flocculation. The evaluation includes an analysis of chemical phosphorus removal at the primary and/or secondary clarifiers which is required to reduce the plant influent total phosphorus concentration to the design influent concentration for the tertiary system. For this analysis, we made the conservative assumption that any phosphorus removal upstream of the tertiary system will be accomplished using chemicals. If enhanced biological phosphorus removal (EPBR) is achieved, this will reduce the chemical and sludge disposal costs.

- Detailed analysis of secondary treatment alternatives consisting of 1) upgrading the Zimpro PACT-WAR process; 2) eliminating the WAR process and upgrading the Zimpro PACT only process; 3) eliminating the Zimpro PACT-WAR process and replacing it with a BioMag based activated sludge process; and 4) eliminating the Zimpro PACT-WAR process and replacing it with an IFAS based activated sludge process.

  From the outset of this study, a key issue has been whether it is cost-effective and prudent to retain or replace the Zimpro PACT-WAR process. This is a significant decision that impacts capital, life-cycle, and O&M costs as well as a number of non-monetary considerations.

  Secondary treatment alternatives were evaluated based upon achieving treatment objectives of 4.6 mg/L total nitrogen and 1 mg/L total phosphorus in the secondary effluent prior to the tertiary phosphorus removal system. As discussed in Sections 3 and 7, 4.6 mg/L total nitrogen is the equivalent concentration of Vernon's nitrogen waste load allocation for 2016-2020 of 184 lbs/day at the projected design average flow of 4.80 mgd. For comparison, the WPCF's current annual average discharge (2013 to 2016) is about 400 lbs/day of total nitrogen, or 16.3 mg/L at the current average flow of 2.95 mgd. At the WPCF's permitted flow of 7.1 mgd, the effluent total phosphorus must be reduced to 3.1 mg/L.

  An influent phosphorus concentration of 1.0 mg/L is recommended for the tertiary system, and this can be achieved through chemical phosphorus removal at the

primary and/or secondary clarifiers. As noted, if EBPR is successful, chemical usage and sludge generation can be reduced.

### 8.1.1 Basis for the Alternatives Analysis

The alternatives analyses presented below are based upon the following assumptions:

1. **Hydraulic Impact:** For the purposes of evaluating the WPCF's hydraulics, the plant's existing design peak hourly flow of 22 mgd was assumed to remain unchanged. The capacity of the aeration tanks and secondary clarifiers is based upon this peak hourly flow and the projected maximum month flows and loads.

2. **Non-Cost Analysis:** In evaluating the alternatives, consideration was given to non-monetary factors such as process reliability, operational ease and flexibility, proven existing installations, impact of backwash return rates on the WPCP's treatment capacity, staffing impacts, and hydraulic impacts.

3. **Life Cycle Cost Analysis:** A life-cycle (present worth) cost analysis was performed for each alternative based upon a 20-year service life, including capital costs, equipment replacement costs, and annual O&M costs. O&M costs are based upon flows, loads, and estimates of labor, energy, chemical use, and sludge disposal. For the purposes of the analyses, it was assumed that flows and loads will increase linearly over the 20-year period from the current to the future 20-year design flows and loads as discussed in Section 3.9. Performing these analyses also illustrates the sensitivity of the alternative to impacts of increasing flows, loadings, and O&M and replacement costs.

   The present worth costs are determined at an effective interest rate of 0.759%, which is based upon a 2.875% discount rate (Department of Interior Federal Water Resources Planning published rate for FY2017) and an assumed inflation rate of 2.1% (latest inflation rate for the 12 months ended December 2016). This method allows the use of current O&M costs in the present worth calculations.

4. **Energy and Sludge Disposal Costs:** Current energy usage and costs for the Zimpro PACT-WAR system are discussed in Appendix L, and in Section 8.5 below. Current sludge generation and disposal costs for the existing system and for the proposed alternatives are discussed below.

   The costs for energy and sludge disposal will increase over the next 20 years as flows and loads increase. For the life-cycle cost analysis, the following assumptions were made:

   a. Based upon the U.S. Energy Information Administration (EIA), costs for natural gas are projected to increase by 16.3% by 2040 as indexed to 2015 costs (see Appendix K for yearly projected energy prices used to estimate the 20-year life cycle costs).

   b. Based on the EIA, electricity costs are projected to increase by 3.0% by 2040 as indexed to 2015 costs (see Appendix K for yearly projected energy prices used to determine the 20-year life cycle costs).

c. Energy consumption for different systems were divided into two categories: fixed energy usage, assuming the equipment will be run independent of flows and loads and variable energy costs, which will vary based on flows and loads.

d. As referenced in Section 8.4, sludge disposal costs are anticipated to increase over the next 20 years due to regulations that will require operators of incinerators to invest in new equipment and increased transportation fuel costs. For Vernon, sludge disposal costs will also increase if the WAR system is eliminated because the WPCF will produce secondary sludge in addition to primary sludge. It should be noted that sludge disposal costs (the gate price for disposal at the incinerator) have remained steady over the last 20 to 25 years with only minimal increases. For this analysis, it is assumed that:

   i. For planning purposes, a current sludge disposal cost of $0.0948/gallon is used for the alternatives analysis. This is based upon the Town's current sludge hauling contract price through June 30, 2018. At a primary sludge concentration of 6% (Section 5), this is equivalent to $375/dry ton.

   ii. For planning purposes, we assumed that the sludge disposal costs for secondary sludge (if generated) will be the same as the primary sludge disposal costs based on the existing town contract as discussed above.

   iii. Future sludge disposal costs will increase by 3% per year over current costs. Note that the Town's current sludge hauling contract prices increase approximately 2.5% per year. We rounded up to 3% per year to account for the new regulatory costs discussed above.

5. **Staffing Impacts:** Labor costs and staffing needs depend on whether Zimpro PACT-WAR is eliminated or retained:

   a. If the Zimpro PACT-WAR system is retained, the WPCF will need to be staffed around the clock (second and third shifts) as is the current practice.

   b. If the Zimpro PACT-WAR system is eliminated and the WPCF's SCADA system is upgraded, the second and third shifts can be eliminated and staffing reduced by two operators through retirements and/or attrition. The first shift operator dedicated to the PACT-WAR system could be reassigned to operate the sludge processing system that will replace the Zimpro PACT-WAR system and only need to operate during first shift.

### 8.1.2 Computer-Based Process Modeling

Computer modeling was utilized to verify that the secondary treatment alternatives would be able to achieve the target performance goals, especially with respect to nitrogen removal at the future 20 year flows and loads. The process models for the non-Zimpro alternatives were developed by the equipment manufacturers. For example, Kruger, Inc. provided a BioWin model with their IFAS proposal (see Appendix R). These vendor models were reviewed to confirm that the values assumed for biological kinetics were reasonable.

Whereas the vendors will be responsible for the system's performance guarantees and have significant expertise with these unique treatment technologies, their model results were deemed sufficient and reasonable. The model used to confirm Zimpro PACT-WAR alternatives was developed as part of a previous study which evaluated potential interim nitrogen removal process alternatives. We believe that those findings are reasonable and still valid.

## 8.2 Disinfection Evaluation

The following section discusses alternatives for disinfection. Two alternatives were identified. The first alternative, presented in Section 8.2.1, is to continue with chlorine disinfection using sodium hypochlorite and dechlorination using sodium bisulfite. The second alternative, presented in Section 8.2.2, is to convert to ultraviolet (UV) disinfection. Section 8.2.3 compares the two alternatives and concludes with reasons for recommending UV disinfection.

### 8.2.1 Chlorine Disinfection and Dechlorination

The existing chlorine contact tanks are each 29 feet wide by 73 feet long. The weir in the reaeration tank controls the depth of water in the chlorine contact tank, which is 9.75 feet at minimum conditions, and 10.2 feet at peak hour flow conditions. This results in a volume of approximately 150,000 gallons per tank, which provides about 20 minutes of chlorine contact time at the peak hourly flow rate of 22 mgd.

TR-16 section 8.3.1.10 specifies that "the minimum contact period for chlorine disinfection at peak flow rate should be 30 minutes unless specific testing can demonstrate the ability to achieve the discharge limit at lower contact times. When evaluating whether an expansion of contact tank volume is required, it is permissible to "grandfather" an existing chlorine contact chamber providing less than 30 minutes of contact time at peak flow if historical plant data justifies sufficient, reliable disinfection at lower contact times. If increased flow is anticipated, field testing should be performed to demonstrate how the existing chlorine contact tank will permit reliable disinfection at the expected flow."

Since TR-16 requires 30 minutes of contact time at peak hour flow, and only 20 minutes is available, a decision must be made as to whether the existing chlorine contact tanks can be grandfathered or expanded, or replaced with an entirely different system.

Regarding grandfathering the existing chlorine contact tanks, there is insufficient data to justify that reliable disinfection can be achieved in accordance with TR-16 requirements. And at current flows, it would be very difficult or impossible to demonstrate compliance. Therefore, to comply with TR-16, continuing with chlorine disinfection would require constructing a third identical chlorine contact tank.

As described in Chapter 4, if chlorination is retained the existing equipment needs to be replaced including the sodium hypochlorite feed system, bisulfite feed system, the submersible hypochlorite injector pumps and related eductors for mixing, and the influent slide gates as well as concrete repairs.

In addition, due to the resiliency issues discussed in Section 2.4, the chemical feed systems and related structures housing them would need to be relocated or be significantly reconstructed.

Advantages

- Operators are experienced with sodium hypochlorite disinfection and sodium bisulfite dechlorination
- After initial capital construction cost, requires lower routine equipment replacement cost

Disadvantages

- Requires construction of a new chlorine contact tank
- Balancing flow between three tanks will be challenging which could result in short circuiting and reduced treatment
- Annual chemical costs for both sodium hypochlorite and sodium bisulfite
- Safety hazard to WPCF staff in handling chemicals
- Requires replacement of chemical storage and metering systems
- Requires significant modifications to the chemical storage and metering systems for flood resiliency
- Requires ongoing use of chemical building or relocation to another facility to address resiliency concerns discussed in Section 2.4.

Refer to Section 8.2.3 for capital costs and present worth operation and maintenance costs associated with this alternative.

### 8.2.2 Ultraviolet Disinfection

For pricing and conceptual design purposes, budgetary proposals from two different UV manufacturers (Suez and Trojan) were solicited and received. Both manufacturers proposed vertical bulb systems with two trains, each designed for half of the peak hour flow rate and a minimum ultraviolet transmittance (UVT) of 65%. Each train consists of three modules: two duty and one standby for full redundancy. Each train requires a channel that is approximately 25 feet long, 3 feet wide, and 7.5 feet deep, as well as room for a control panel, power distribution centers, a canopy overhead, and a crane for lifting the modules.

A new UV disinfection system could either be installed in a new structure located near the reaeration tank or in a new structure constructed within the existing chlorine contact tanks.

As long as the UV system can be protected from damage during flooding events as discussed in Section 2.4, it can be placed hydraulically at any elevation between the effluent of the tertiary phosphorous system and the influent of the reaeration system. Then during the phosphorus removal season and disinfection seasons, the upgraded intermediate pump station can be used to convey flow to both systems. However, if the UV system could be placed low enough to allow flow by gravity from Bypass Chamber F, this would be advantageous because it would enable disinfection even if the intermediate pump station failed or the tertiary phosphorus system were bypassed.

Based upon TR-16 and as discussed in Section 2.4, the UV system must be designed to operate during a 100-year flood and to avoid damage due to flooding during a 100-year flood plus 3 feet. Near the reaeration tank, this flood elevation is 219.50 as indicated in Figure 2-4-1. This is about 1 foot higher than the water elevation at peak hour flow rate without flooding conditions (which is the maximum condition that the system must be able to treat). We have confirmed that the UV systems can be designed to protect the system from damage at a flood elevation of at least 12-inches higher than the maximum elevation that the bulbs can treat. Therefore, the UV system can be placed within the chlorine contact tanks and meet of the TR-16 requirements. Since this approach is more reliable because the hydraulics are such that intermediate pumping is not required and the system meets the required resiliency requirements, this approach is more advantageous than raising the UV system to a higher elevation.

A sketch of the proposed UV system within the chlorine contact tanks is included in Figure 8-1. Some features of the proposed system include:

- The system should be configured to reuse the influent channel and reaeration tanks, which will minimize modifications to influent and effluent piping as well as the reaeration system.
- To avoid unnecessary head loss, the reaeration weir should be used to control both the hydraulic grade of the UV system and the depth of water in the reaeration channel. Preliminary calculations suggest that the existing straight weir is not long enough to pass peak hour flow within the tight hydraulic range of a typical UV system, so the weir will need to be modified with weir troughs to extend the length of the weir.
- Plant water suction should be located after UV disinfection but before reaeration to provide seasonal disinfection of the plant water, provide convenient suction pipe paths to the relocated plant water pump system in the filter building, and to utilize some of the former volume of the chlorine contact tanks for plant water storage. To address these goals, the UV channels should be constructed to preserve about 10’ to 15’ of the length of the existing chlorine contact chamber prior to the post aeration tanks baffle wall. This space will provide the needed storage and include baffles to help spread the UV effluent across the existing reaeration tank wall, facilitating uniform entry to the reaeration tanks. This space will also provide storage volume to allow plant water to continue running when there is minimal flow into the UV system, such as when the tertiary system is turned on for the season.
- Portions of the chlorine contact tanks that are not needed should be filled with compacted sand or gravel and then topped with a 6” concrete slab.
- UV system electronics including power distribution centers and control panel should be mounted above the hydraulic gradient during a 100-year flood plus 3 feet, which will require the equipment to be mounted on a 12-inch concrete pad above the concrete slab. No platform or stairs are anticipated.
- The entire UV system should be housed beneath a canopy with a hoist and monorail system mounted high enough to facilitate removal of the modules from the channels.

- Provisions for routine cleaning and maintenance of the lamps should be included
- Provisions for draining one of the UV channels and related post aeration channels at a time should be included to allow for maintenance. This can be achieved to some degree using the new plant water system or new thickener dilution water pumps being proposed to draw from the bottom of these tanks. Due to the low elevation of the tank bottom, we assume that removal of all water from the tanks and/or channels will be by means of a portable sump pump, with a dedicated power receptacle and discharge connection, and a sump built into each channel.

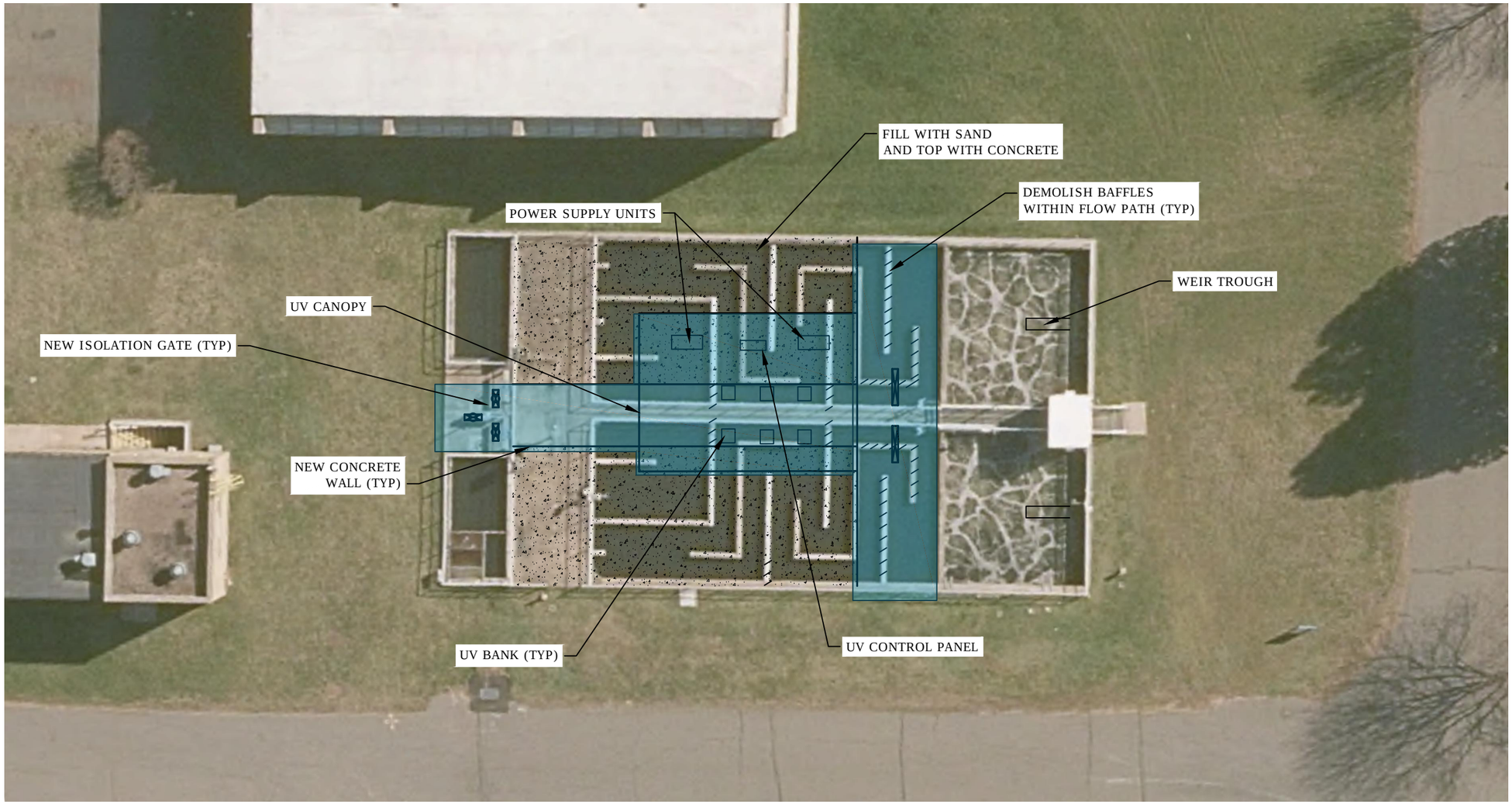
Advantages

- System fits within chlorine contact tanks facilitating reuse of existing influent piping, influent channel, post aeration system, and effluent piping
- Initial capital cost is lower due to reuse of existing infrastructure
- Total operation and maintenance cost is significantly lower due to eliminating chemical costs
- Allows the chemical building to be abandoned

Disadvantages

- Lamps and ballasts require periodic replacement
- Increased electrical costs and electrical demand during periods of high flow
- Increased operations and maintenance effort required to clean bulbs more frequently only if ferric chloride is used in the future as a coagulant for phosphorus removal.

Refer to Section 8.2.3 for capital costs and present worth operation and maintenance costs associated with this alternative.

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GRAPHIC SCALE

Tighe&Bond
www.tighebond.com

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Wastewater
Facilities Plan

Town of Vernon,
Connecticut

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| DATE: | MAY 2017 |
| FILE: | V0037 Phos-UV Concept.dwg |
| DRAWN BY: | CMC/PAM |
| CHECKED: | FAM |
| APPROVED: | IBC/SES |

UV DISINFECTION SYSTEM
CONCEPTUAL LAYOUT

SCALE: AS SHOWN

FIGURE 8-1

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### 8.2.3 Disinfection System Economic Evaluation

This section summarizes capital costs as well as the present worth of the O&M costs associated with each alternative. Capital costs include general conditions, contractor overhead and profit, contingency, and engineering, in 2017 dollars. Capital costs are presented in Table 8-1. Refer to the previous sections for a description of the scope of facility modifications required for each alternative.

**TABLE 8-1**

Disinfection Alternatives – Summary of Capital Cost Analysis

| Description | Chlorination/ Dechlorination | UV |
|---|---|---|
| Disinfection Equipment | $536,396 | $741,440 |
| Modifications to Existing Facilities | $474,000 | $488,000 |
| New Chlorine Contact Tank | $581,000 | $0 |
| Support Systems | $83,000 | $114,000 |
| **Subtotal** | $1,674,396 | $1,343,440 |
| General Conditions at 10% | $167,000 | $134,000 |
| **Subtotal** | $1,841,396 | $1,477,440 |
| Contractor OH&P at 15% | $276,000 | $222,000 |
| **Subtotal** | $2,117,396 | $1,699,440 |
| Contingency at 30% | $635,000 | $510,000 |
| **Total Construction Costs** | $2,752,000 | $2,209,000 |
| Engineering at 20% | $550,000 | $442,000 |
| **Total Project Costs (2017)** | **$3,300,000** | **$2,700,000** |

Operation and maintenance costs are presented in Table 8-2.

**TABLE 8-2**

Disinfection Alternatives – Summary of Present Worth of O&M Costs

| Description | Chlorination/ Dechlorination | UV |
|---|---|---|
| Power | $125,000 | $187,000 |
| Chemicals | $1,855,000 | $0 |
| **Present Worth O&M Total** | **$1,980,000** | **$187,000** |

The chlorination/dechlorination disinfection alternative power cost consists of the power cost for operating the two existing hypo jet pumps for mixing chlorine at the beginning of each contact tank. This assumes that during normal operation, the third tank will not be online; if the third tank is always online, this power cost would be 50% higher. The jet pumps are assumed to operate only during the disinfection season (May 1 through September 30) plus one week for startup and shutdown. Since the jet pumps are not impacted by flow rate, the annual power demand is assumed to be constant over the 20-year life cycle.

The chlorination/dechlorination disinfection alternative chemical costs are based on actual historical chemical costs from 2013 through 2016 for sodium hypochlorite and sodium bisulfite. Unit costs for chemicals is assumed to increase proportional to inflation. The chemical demand is assumed to increase linearly with flow from the present average annual flow rate to the future design average flow rate.

UV equipment power costs are based upon current average flow rates adjusted linearly over 20 years. In addition, in the months outside of the disinfection season, one of the UV system manufacturers recommends that the lamps remain in-place with the module heaters on, requiring about 2.6 kW.

A life-cycle cost analysis was performed as a present worth analysis based on a 20-year life cycle, including capital costs, major equipment replacement costs, and annual O&M costs. Major equipment replacement costs include material costs for equipment that needs to be periodically replaced due to normal wear.

The UV equipment replacement costs include routine replacement of lamps, ballasts, sleeves, sensors, and wipers. It was conservatively estimated that each part will replaced when the warranty expires. The annual replacement cost is based upon equipment unit prices and warranty lengths recently submitted in a bid by Suez for a similar system at the Southington WPCF, adjusted based on the equipment quantities required for Vernon.

**TABLE 8-3**

Disinfection Alternatives – Summary of Life Cycle Costs Analysis

| **Description (2017 Dollars)** | Chlorination/ Dechlorination | UV |
|---|---|---|
| Capital Cost | $3,300,000 | $2,650,000 |
| Major Equipment Replacement Cost | $0 | $372,000 |
| Operational Cost | $1,980,000 | $187,000 |
| **Present Worth Total** | **$5,280,000** | **$3,209,000** |

Based upon the above considerations, the UV disinfection alternative is recommended and will be assumed to be the selected alternative in the remainder of this report.

## 8.3 Phosphorus Evaluation

The following section discusses the goals and strategies for chemical phosphorus removal in the primary and/or secondary clarifiers (referred to as multi-point chemical addition) based upon whether the Zimpro PACT-WAR process is retained or replaced. It also evaluates tertiary low-level phosphorus removal alternatives and chemical feed requirements to achieve an effluent concentration of 0.08 mg/L. A life cycle cost evaluation of the different alternatives for multi-point chemical phosphorus removal and the tertiary phosphorus removal systems is presented.

For the purposes of comparing chemical phosphorus removal strategies and the tertiary systems, these analyses conservatively assume no benefit from enhanced biological phosphorus removal (EBPR) or PAC adsorption. Implementing EBPR would reduce the need for chemical addition and result in less sludge generated. Biological phosphorus removal is discussed further under the secondary treatment evaluation.

### 8.3.1 Goals for Phosphorus Removal

The goal for phosphorus removal in the primary and/or secondary clarifiers is to lower the phosphorus level entering the tertiary phosphorus removal system, which provides additional low-level phosphorus removal to achieve an effluent concentration of 0.08 mg/L. The design of the tertiary phosphorus removal system depends on whether Zimpro PACT-WAR is retained or eliminated.

Phosphorus mass balances for scenarios with and without Zimpro PACT-WAR are summarized in Table 8-4 (under current average daily flows and loads) and in Table 8-5 (under design flows and loads). These phosphorus removal strategies are based upon the following assumptions, as discussed previously in Section 7:

1. Under either scenario, a typical removal efficiency of 5% of total phosphorus is assumed in the primary clarifiers due to settling of TSS and related particulate phosphorus.

2. If the Zimpro WAR process is eliminated, phosphorus removal ahead of the tertiary system can be accomplished through multi-point chemical addition to the primary and secondary clarifiers, with the goal of reducing phosphorus to less than 1.0 mg/L, without EBPR. However, EBPR can also be achieved if the tanks are configured with anaerobic zones. In this case, chemical addition will be reduced, resulting in less chemical usage and lower sludge production.

   Chemical dosing at the primary clarifiers to remove no more than 20% of the incoming phosphorus is recommended to avoid adversely affecting the biomass in the secondary processes.

   Chemical dosing at the secondary clarifiers would be selected to target a concentration of less than 1.0 mg/L entering the tertiary system. Sludge in the secondary treatment process is generated due to BOD removal (98% of secondary influent loads), cell growth (0.8 lbs MLSS per lb BOD removed), and phosphorus assimilation in the volatile portion of the waste sludge (2% phosphorus assimilation and 80% volatile MLSS). Phosphorus removal occurs when sludge is wasted.

3. If Zimpro WAR process is retained, the approach for removing phosphorus will rely on adding a coagulant to the primary clarifiers and installing a tertiary system.

Chemical phosphorus removal in the secondary process would not be attempted because it would result in higher levels of ash in the MLSS due to coagulant addition and the recycle of those ash solids right back into the secondary process from the WAR unit, and the added difficulty that this would create in managing ash levels in the secondary process. In addition, there is the potential for coagulants to negatively impact the high temperature metallic processes of the WAR unit. Under this scenario, there would not be the opportunity to reduce coagulant costs using EBPR.

The amount of phosphorus that could be removed in the primary clarifiers would be limited to avoid adversely affecting the biomass in the secondary biological treatment process. Chemical dosing to target no more than 20% of the incoming phosphorus is recommended.

Phosphorus removal in the secondary process (at levels similar to those currently observed) is based upon sludge generated due to BOD removal (98% of secondary influent loads), cell growth (0.8 lbs MLSS per lb BOD removed), phosphorus assimilation in the volatile portion of the waste sludge (2% phosphorus assimilation and 80% volatile MLSS), and removal of this phosphorus in the waste sludge, which, when processed through the WAR unit, appears to be adsorbed onto the ash and subsequently removed through blow down and other ash loss mechanisms as discussed in Section 7.5.2 and Section 8.5.2. BOD loads to the secondary clarifiers are based on a BOD removal rate of 45% in the primary clarifiers plus BOD loads from the WAR recycle. This removal rate is higher than for a conventional clarifier to reflect the impact of the “ash-effect” discussed in Section 7.5.2.

Based on these assumptions, the phosphorus concentration in the influent to the tertiary system can be expected to be 3 mg/L or higher. The balance of phosphorus removal (down to 0.08 mg/L) would be accomplished at the tertiary system.

**TABLE 8-4**

Phosphorus Mass Balance and Removal Strategy for Current Average Daily Flows and Loads [1]

| | | *With Zimpro PACT-WAR* | | *Without Zimpro PACT-WAR* | |
|---|---|---|---|---|---|
| | | Phosphorus | | Phosphorus | |
| Row | Condition | mg/L [2] | lbs/day | mg/L [2] | lbs/day |
| 1 | Plant Influent Concentration [3] | 7.9 | 195 | 7.9 | 195 |
| 2 | Plant Effluent Concentration [3] | 0.08 | 2.0 | 0.08 | 2.0 |
| 3 | Difference (Row 1- Row 2) | 7.8 | 193 | 7.8 | 193 |
| | *Amount Removed in Primary Clarifiers [4]* | | | | |
| 4 | From Settling TSS [5] | 0.4 | 10 | 0.4 | 10 |
| 5 | From Chemical Dosing [6] | 1.6 | 39 | 1.6 | 39 |
| 6 | Entering Secondary Treatment (Row 1 - Row 4 - Row 5) | 5.9 | 146 | 5.9 | 146 |
| | *Amount Removed in Aeration Tanks and Secondary Clarifiers* | | | | |
| 7 | From MLSS Growth and Assimilation [7] | 2.86 | 70 | 2.86 | 70 |
| 8 | From Chemical Dosing [8] | 0.0 | 0.0 | 2.09 | 51 |
| 9 | Leaving Secondary Clarifiers (Row 6 - Row 7 - Row 8) | 3.09 | 76 | 1.00 | 25 |
| 10 | Amount Removed in Future Tertiary System [4][9] | 3.01 | 74 | 0.92 | 23 |
| 11 | Effluent Concentration (Row 9 - Row 10) | 0.08 | 2.0 | 0.08 | 2.0 |

(1) Permit Limit at design ADF should be less than 4.56 lbs/day. Assumes no enhanced biological phosphorus removal. Existing and potential future recycle loads are ignored for simplicity.

(2) Based on Current Average Daily Flow of 2.95 mgd.

(3) Plant influent concentrations based on historical data for Sept-2013 through Aug-2016 MORs (Table 3-8), but excluding phosphorus load from industrial user Anocoil (100 lbs/day average). Plant effluent concentrations based on calculations in rows 4 through 11.

(4) Solids from the low-level phosphorus removal system will also be removed in the primary clarifiers, but this has been ignored in the above analysis for simplicity.

(5) Based on assumed 5% removal efficiency of particulate phosphorus in primary clarifiers. If Zimpro PACT-WAR system is retained, some additional removal in the primary clarifiers might occur (see Section 7), but this is inconclusive and not considered in this analysis.

(6) Chemical dose was selected to target 20% removal of incoming phosphorus. Additional removal at the primary clarifiers is not recommended.

(7) Row 7 based on the estimated mass of sludge generated due to 98% BOD removal, effective gross yield of 0.8 lb MLSS (WAS) generated per lb BOD removed, 80% volatile MLSS, 2% phosphorus assimilated in the volatile portion of the WAS, and removal of particulate phosphorus by sludge wasting (without Zimpro PACT-WAR) or ash loss/blowdown (with Zimpro PACT-WAR). BOD primary effluent average annual load is 4,820 lbs/day with Zimpro PACT-WAR and 5,700 lbs/day without Zimpro PACT-WAR. However, WAR recycle loads add approximately 800 lbs/day of BOD to the secondary clarifiers. Therefore, total secondary load of 5,600 lbs/day is assumed for either scenario.

(8) For the scenario with Zimpro PACT-WAR, dosing the secondary clarifiers is not recommended. For the scenario without Zimpro PACT-WAR, this was selected to target less than 1.0 mg/L entering tertiary system (0.2 mg/L particulate (insoluble) and 0.8 mg/L soluble).

(9) For both scenarios, chemical dosing is selected to target 0.08 mg/L in the plant effluent, which is the equivalent concentration of the permit load limit at the design ADF of 7.1 mgd.

**TABLE 8-5**

Phosphorus Mass Balance and Removal Strategy Under Future Average Day Flows and Loads [1]

| Row | Condition | *With Zimpro PACT-WAR* Phosphorus mg/L [2] | *With Zimpro PACT-WAR* Phosphorus lbs/day | *Without Zimpro PACT-WAR* Phosphorus mg/L [2] | *Without Zimpro PACT-WAR* Phosphorus lbs/day |
|---|---|---|---|---|---|
| 1 | Plant Influent Concentration [3] | 7.7 | 310 | 7.7 | 310 |
| 2 | Plant Effluent Concentration [3] | 0.08 | 3.2 | 0.08 | 3.2 |
| 3 | Difference (Row 1- Row 2) | 7.7 | 307 | 7.7 | 307 |
| | *Amount Removed in Primary Clarifiers [4]* | | | | |
| 4 | From Settling TSS [5] | 0.4 | 16 | 0.4 | 16 |
| 5 | From Chemical Dosing [6] | 1.5 | 62 | 1.5 | 62 |
| 6 | Entering Secondary Treatment (Row 1 - Row 4 - Row 5) | 5.8 | 233 | 5.8 | 233 |
| | *Amount Removed in Aeration Tanks and Secondary Clarifiers* | | | | |
| 7 | From MLSS Growth and Assimilation [7] | 2.66 | 107 | 2.66 | 107 |
| 8 | From Chemical Dosing [8] | 0.0 | 0.0 | 2.14 | 86 |
| 9 | Leaving Secondary Clarifiers (Row 6 - Row 7 - Row 8) | 3.14 | 126 | 1.00 | 40 |
| 10 | Amount Removed in Future Tertiary System [4][9] | 3.06 | 123 | 0.92 | 37 |
| 11 | Effluent Concentration (Row 9 - Row 10) | 0.08 | 3.2 | 0.08 | 3.2 |

(1) Permit Limit at design ADF should be less than 4.56 lbs/day. Assumes no enhanced biological phosphorus removal. Existing and potential future recycle loads are ignored for simplicity.

(2) Based on Future Average Daily Flow of 4.8 mgd.

(3) Plant influent concentrations based on projected influent loads from Section 3. Plant effluent concentrations based on calculations in rows 4 through 11.

(4) Solids from the low-level phosphorus removal system will also be removed in the primary clarifiers, but this has been ignored in the above analysis for simplicity.

(5) Based on assumed 5% removal efficiency of particulate phosphorus in primary clarifiers. If Zimpro PACT-WAR system is retained, some additional removal in the primary clarifiers might occur (see Section 7), but this is inconclusive and not considered in this analysis.

(6) Chemical dose was selected to target 20% removal of incoming phosphorus. Additional removal at the primary clarifiers is not recommended.

(7) Row 7 based on the estimated mass of sludge generated due to 98% BOD removal, effective gross yield of 0.8 lb MLSS (WAS) generated per lb BOD removed, 80% volatile MLSS, 2% phosphorus assimilated in the volatile portion of the WAS, and removal of particulate phosphorus by sludge wasting (without Zimpro PACT-WAR) or ash loss/blowdown (with Zimpro PACT-WAR). BOD primary effluent average annual load is 7,150 lbs/day with Zimpro PACT-WAR and 8,450 lbs/day without Zimpro PACT-WAR. However, WAR recycle loads in the future will add approximately 1,280 lbs/day of BOD to the secondary clarifiers. Therefore, total secondary load of 8,500 lbs/day is assumed for either scenario.

(8) For the scenario with Zimpro PACT-WAR, dosing the secondary clarifiers is not recommended. For the scenario without Zimpro PACT-WAR, this was selected to target <1.0 mg/L entering tertiary system (0.2 mg/L particulate (insoluble) and 0.8 mg/L soluble).

(9) For both scenarios, chemical dosing is selected to target 0.08 mg/L in the plant effluent, which is the equivalent concentration of the permit load limit at the design ADF of 7.1 mgd.

### 8.3.2 Chemical Feed Requirements and Sludge Production

Chemical phosphorus removal is evaluated under current and future (20-year) average daily flows and loads for the purposes of estimating chemical usage and sludge generation rates, and comparing proposed chemical feed system sizes and capital and O&M costs depending upon whether the Zimpro PACT-WAR system is retained or replaced.

Based upon the coagulant screening in Section 7, chemical phosphorus removal should be accomplished using PACL (as Epic 70) for multi-point chemical addition and alum for low-level phosphorus removal, with provisions for accommodating ferric should the WPCF receive an aluminum permit limit in the future. As discussed, PACL is not always optimal for low-level phosphorus removal. Therefore, for this evaluation, the chemical storage tanks, feed equipment sizes, and capital and yearly operating costs discussed below are based on using PACL (as Epic 70) for multi-point chemical addition and using alum for the low-level phosphorus removal system.

The evaluation is based upon providing new chemical storage and feed systems sized for chemical addition at the primary and/or secondary clarifiers (as applicable) as well as for chemical addition at the tertiary phosphorus removal system. The proposed chemical systems would be sized for phosphorus removal at the projected future (20 year) average day flows and loads.

#### 8.3.2.1 Full Scale Conditions at Current and Future Average Daily Flows and Loads

Estimated chemical feed requirements (for coagulant, to counteract loss of alkalinity, and for polymer usage at the tertiary system based upon manufacturers recommendations) and sludge production rates are summarized in Table 8-6 for current conditions and Table 8-7 for future conditions (calculations are included in Appendix P). For comparison, it is assumed that all alkalinity lost due to coagulation must be replaced (using soda ash), but this depends upon the actual pH and alkalinity and may not always be required. As discussed further in the tertiary system evaluation, a higher dose of polymer is required as the influent total phosphorus concentration to the tertiary system increases.

Sludge generation rates at the primary and/or secondary clarifiers are based upon solids produced due to coagulant addition only and do not include biological solids. Sludge generation rates at the tertiary system are based on additional TSS reduction and coagulant and polymer addition, and they do not include make-up ballast (sludge generation rates for the different tertiary systems are compared in Section 8.3.3).

The tertiary phosphorus removal system will replace the existing sand filters. However, operation of the tertiary system and all chemical addition (for coagulation and alkalinity replacement) will only be required during the phosphorus treatment season (approximately 219 days from April through October including start-up/shutdown time).

**TABLE 8-6**
Estimated Chemical Feed Requirements and Sludge Production under Current Average Daily Flows and Loads [1]

| | | With Zimpro PACT-WAR | Without Zimpro PACT-WAR |
|---|---|---|---|
| *Coagulant Addition for Chemical Phosphorus Removal* | | | |
| To Primary and/or Secondary Clarifiers [2] | gpd as Epic70 | 66 | 154 |
| To Tertiary System | gpd as Alum | 922 | 282 |
| Combined Yearly Cost of Coagulant [3] | $/yr | $206,902 | $126,178 |
| | | | |
| *Polymer Addition at Tertiary System [4]* | | | |
| Volume of Polymer | lbs/day | 30 | 18 |
| Yearly Cost of Polymer | $/yr | $25,216 | $15,760 |
| | | | |
| *Additional Solids Generated Due to Chemical Phosphorus Removal* | | | |
| At Primary and/or Secondary Clarifiers | lbs/day | 250 | 583 |
| At Tertiary System [5] | lbs/day | 1,520 | 523 |
| Combined Yearly Cost for Solids Disposal [3] | $/yr | $72,490 | $46,831 |
| | | | |
| *Soda Ash Required to Counteract Alkalinity Consumed due to Chemical Phosphorus Removal* | | | |
| Volume of Soda Ash | lbs/day | 2,881 | 1,323 |
| Yearly Cost of Soda Ash [3] | $/yr | $145,112 | $66,658 |
| | | | |
| Total Yearly Costs | $/yr | $449,720 | $255,427 |

(1) Phosphorus season equal to 7.2-month operation period (219 days, April through October plus start-up/shutdown). Assumes no enhanced biological phosphorus removal.

(2) With Zimpro PACT-WAR: single-point dosing to primary clarifiers. Without Zimpro PACT-WAR: multi-point dosing to primary and secondary clarifiers.

(3) Unit prices as discussed previously. Based on 2017 dollars.

(4) Based on a polymer dose of 1.20 mg/L (at 3 mg/L TP in the tertiary system influent) and 0.75 mg/L (at 1 mg/L TP in the tertiary system influent), per manufacturer recommendations.

(5) Based on coagulant addition, polymer addition, and additional TSS reduction (does not include sand or ballast; sludge generation rates for different tertiary systems are compared in Section 8.3.3).

**TABLE 8-7**
Estimated Chemical Feed Requirements and Sludge Production under Design Average Daily Flows and Loads (1)

| | | With Zimpro PACT-WAR | Without Zimpro PACT-WAR |
|---|---|---|---|
| *Coagulant Addition for Chemical Phosphorus Removal* | | | |
| To Primary and/or Secondary Clarifiers (2) | gpd as Epic70 | 106 | 252 |
| To Tertiary System | gpd as Alum | 1,525 | 459 |
| Combined Yearly Cost of Coagulant (3) | $/yr | $340,438 | $205,949 |
| | | | |
| *Polymer Addition at Tertiary System (4)* | | | |
| Volume of Polymer | lbs/day | 48 | 30 |
| Yearly Cost of Polymer | $/yr | $41,030 | $25,643 |
| | | | |
| *Additional Solids Generated due to Chemical Phosphorus Removal* | | | |
| At Primary and/or Secondary Clarifiers | lbs/day | 400 | 954 |
| At Tertiary System (5) | lbs/day | 2,500 | 852 |
| Combined Yearly Cost for Solids Disposal (3) | $/yr | $119,197 | $76,466 |
| | | | |
| *Soda Ash Required to Counteract Alkalinity Consumed due to Chemical Phosphorus Removal* | | | |
| Volume of Soda Ash | lbs/day | 4,753 | 2,158 |
| Yearly Cost of Soda Ash (3) | $/yr | $239,396 | $108,688 |
| | | | |
| Total Yearly Costs | $/yr | $740,061 | $416,747 |

(1) Phosphorus season equal to 7.2-month operation period (219 days, April through October plus start-up/shutdown). Assumes no enhanced biological phosphorus removal.

(2) With Zimpro PACT-WAR: single-point dosing to primary clarifiers. Without Zimpro PACT-WAR: multi-point dosing to primary and secondary clarifiers.

(3) Unit prices as discussed previously. Based on 2017 dollars.

(4) Based on a polymer dose of 1.20 mg/L (at 3 mg/L TP in the tertiary system influent) and 0.75 mg/L (at 1 mg/L TP in the tertiary system influent), per manufacturer recommendations.

(5) Based on coagulant addition, polymer addition, and additional TSS reduction (does not include sand or ballast; sludge generation rates for different tertiary systems are compared in Section 8.3.3).

Because different coagulants are recommended for multi-point chemical addition and for the tertiary system, a minimum of four bulk chemical storage tanks (two tanks for each chemical to provide for redundancy) are recommended to accommodate the estimated daily chemical consumption in Tables 8-6 and 8-7 and storage volumes discussed below. The tanks should all be similarly sized to accommodate different chemicals (for example, to switch to ferric should the plant receive an aluminum permit limit in the future).

Although coagulant usage quantities are different for the scenarios summarized in Table 8-7, for the purposes of the life cycle cost evaluation, the four chemical bulk storage tanks are based on a nominal storage volume of 6,000 gallons per tank for either scenario. This is based on the daily usage quantities for the scenario with Zimpro PACT-WAR, and providing storage equal to 7-days' worth of supply plus 4,000 gallons to accommodate the minimum bulk delivery plus additional 10% (assuming 90% usable storage volume). For the scenario without Zimpro PACT-WAR, this same bulk storage volume provides additional storage time, or the storage tanks can be sized smaller.

### 8.3.3 Tertiary (Low Level Phosphorus Removal) System

The goal for the tertiary system is to reduce effluent total phosphorus to 0.08 mg/L. While either of the tertiary treatment technologies retained for further analysis can achieve this level of phosphorus, influent phosphorus concentrations to the tertiary system will be different if the Zimpro PACT-WAR process is retained or not. Therefore, the following tertiary treatment process alternatives are considered in this analysis for achieving the low-level phosphorus removal goal of 0.08 mg/L total phosphorus in the final effluent:

1. If the Zimpro PACT-WAR process is retained, then the total phosphorus entering the tertiary system can be expected to be 3 mg/L or higher (see Tables 8-4 and 8-5)

2. If the Zimpro PACT-WAR process is not retained, then the total phosphorus entering the tertiary system will be less than or equal to 1.0 mg/L

Preliminary design proposals were received from vendors of each of the treatment technologies (disc filtration and ballasted flocculation), for the two treatment scenarios: total influent phosphorus of 3.2 mg/L and 1.0 mg/L. The preliminary system design concepts were based upon an effluent total phosphorus concentration of 0.08 mg/L and passing the future (20-year) peak hour flow of 22 mgd with all systems in service. This is consistent with design standards (TR-16 2011 edition, revised 2016). The specific system redundancies for the purposes of these analyses are discussed further in the following sub-sections.

#### 8.3.3.1 Coagulation-Flocculation with Disc Filters

This alternative consists of two trains having a dedicated flash mix and flocculation step followed by solids removal through disc filters. The flash mix and flocculation tanks would be sized to handle half of the future peak daily flow, and both trains in operation able to treat the peak hourly flow of 22 mgd. Following flash mix and flocculation, four disc filters would be provided. Three filters would be able to treat the peak hourly flow (22 mgd) and a fourth unit would be provided as a spare.

The following items will be impacted if the Zimpro PACT-WAR system is retained:

- More discs per filter unit to handle the additional solids generated

- Reduced peak hydraulic loading rate
- Larger backwash water pumps
- More coagulant, polymer, and energy consumption, and higher sludge production

The advantages and disadvantages of this technology for tertiary phosphorus removal are summarized below:

Advantages

- System can be retrofitted within the existing Sand Filter Building
- Does not require purchase of a media that can be lost over time or that requires daily additions
- Offers the simplest control systems
- System can be set up to be self-cleaning
- Disc filters are available as a packaged system in stainless steel tanks that are pre-fabricated and tested off-site and installed on a concrete slab
- Requires the least operator attention and the least routine maintenance. Therefore, should not impact current staffing requirements
- Smaller footprint than ballasted flocculation

Disadvantages

- Requires construction of larger flash mix and flocculation tanks than other technologies
- Recycle flow rates vary with the filter backwash rates and are dependent upon the solids loadings. At peak flow and nominal solids loading rates, manufacturers advise that this can be up to 2% of plant forward flow
- Capacity is limited by solids loading rate. If significant solids carry over from upstream processes during peak flows were to occur, it could reduce available treatment capacity

For the disc filter system, we evaluated several options for installing the disc filters within the existing Sand Filter Building:

1. Install the disc filters within pre-fabricated stainless steel tanks that would then be installed as a system within the existing filter bays.
2. Construct new concrete tanks within the existing filter bays and then install the disc filters mechanisms within these new tanks.

Available space within the filter room is maximized if the interior filter walls are demolished, as there is sufficient room to fit the four recommended disc filter units in steel tanks (units operating in parallel) and four flocculation tanks (two trains of two stages each) within the existing filter bay area. In this configuration, a splitter box and rapid mix

tanks would be located outside and adjacent to the filter building north-facing wall. New interior walls can be used to stiffen the existing exterior walls, particularly for the portions of exterior walls that will be partially submerged (flocculation tanks and effluent channel).

If the interior filter walls are not demolished, the rapid mix and flocculation tanks would have to be located outside, possibly in the existing dirty water storage tanks or in new tankage. These options were not considered further due to higher costs (for new tanks) and because the dirty water storage tanks can potentially be retrofitted as sludge holding tanks.

Under all configurations, the existing pipe gallery/control room can be retrofitted to accommodate the chemical bulk storage tanks and secondary containment curbs, as well as new piping from the flocculation tanks to each individual disc filter unit and filter bypass piping. Based on these conclusions, a concept layout for disc filters in the recommended configuration is included in Figure 8-2.

Therefore, for the purposes of the alternatives analysis, it is assumed that the disc filter system would require the following capital improvements:

- Demolish existing interior filter walls, design new interior walls to stiffen existing exterior walls, temporarily remove the pre-cast roof planks to install the disc filter units, and replace the built-up roof.

- Install disc filter units in stainless steel tanks in the filter room.

- Build new interior walls to create four stages of coagulation/flocculation tanks (two trains each consisting of one coagulation stage and one flocculation stage). Interior gates would be included to allow any one stage to be taken offline.

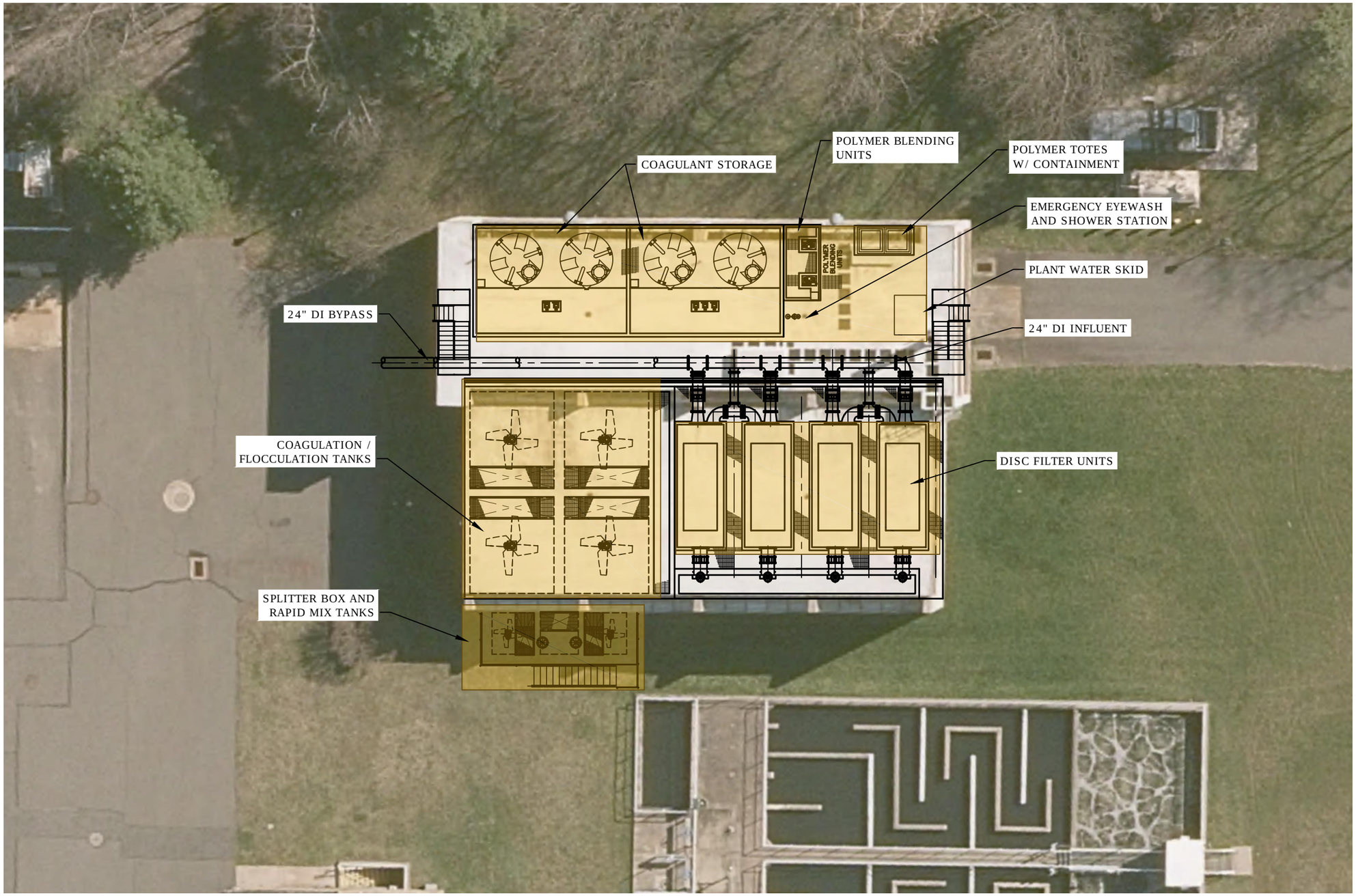
- New splitter box and rapid mix tanks located outside and directly adjacent to the filter building north-facing wall.

- New bulk chemical storage, chemical feed system and containment areas, control panels, and other ancillary and electrical equipment installed in the pump gallery in the southern half of the sand filter building.

- Related phosphorus treatment system piping: phosphorus system influent from the intermediate pump station effluent to the new splitter box; phosphorus system effluent from the system discharge to the new disinfection system; backwash/sludge piping from the phosphorus system to the preliminary treatment facilities; utilities (potable water and sewer/drain piping); and support systems (plant water). Potentially, some of the existing piping in the filter building can be reused.

- Process tanks and the low-level phosphorus removal system would be designed to fit into the plant's hydraulic profile in a manner that is very similar to the sand filters.

- Minimal bypass pumping or special effort to maintain plant operations during construction is needed to construct or start-up the low-level phosphorus removal system, because the plant can meet its permit with the sand filters offline.




NOTES:
1. CHEMICAL STORAGE AND PIPING IN BASEMENT LEVEL.
2. ELECTRICAL EQUIPMENT AND POST-AERATION BLOWERS IN FIRST FLOOR LEVEL.

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Wastewater Facilities Plan

Town of Vernon, Connecticut

| MARK | DATE | DESCRIPTION |
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| PROJECT NO: | V0037 |
| DATE: | MAY 2017 |
| FILE: | V0037 Phos-UV Concept.dwg |
| DRAWN BY: | CMC/TMP |
| CHECKED: | FAM/PAM |
| APPROVED: | IBC/SES |

DISC FILTERS CONCEPTUAL LAYOUT

SCALE: AS SHOWN

FIGURE 8-2

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#### 8.3.3.2 Coagulation Ballasted-Flocculation

This alternative consists of adding a ballast (sand or magnetite) during flash mix and flocculation steps to improve settling in a downstream high rate clarifier.

For the analyses, we included two duty treatment trains capable of treating the peak hour flow (22 mgd) with both trains in operation, with provisions for spare (not installed) flash mix/flocculation mixers for the process tanks, standby pumps, and standby ballast/sand recovery systems. This is consistent with design standards (TR-16), which do not require standby process tanks but which do recommend providing sufficient pumps and mechanical equipment, including solids handling systems, to handle peak flow with one standby unit.

Treatment trains are slightly different between the two main treatment systems (Evoqua's CoMag and Kruger's Actiflo). The CoMag treatment train consists of two coagulation reaction tanks, one ballast reaction tank, one polymer reaction tank, and one clarifier. A common rapid mix chamber is provided for both treatment trains, for chemical injection and flow splitting. The equipment includes standby waste/return sludge pumps, magnetic recovery drum separator, and sludge shear mixer. The Actiflo treatment train consists of a coagulation tank, a maturation tank, and a settling tank with lamella plates. A common distribution tank is provided for both treatment trains, also for chemical injection and flow splitting. The equipment includes standby sand/sludge recirculation pumps, and standby hydrocyclone.

Because of its higher effluent phosphorus concentration (3.2 mg/L), the following items will be impacted if Zimpro PACT-WAR is retained:

- Additional magnetic recovery drum separator and sludge shear mixer (CoMag)
- More coagulant consumption and more sludge production

<u>The advantages and disadvantages of this technology for tertiary phosphorus removal are summarized below:</u>

<u>Advantages</u>

- Ability to accommodate high flows and solids loadings
- Good recovery of ballast material
- Ballast allows the use of smaller process tanks including coagulation/flocculation

<u>Disadvantages</u>

- The process tanks will not fit within the existing Sand Filter Building
- The Actiflo and CoMag systems require replacement of ballasted media that is lost over time (sand for Actiflo and magnetite for CoMag)
- The process tanks are not available as packaged systems in this size range and require field constructing tanks for the treatment processes
- Additional sludge generated compared to filters due to loss of ballast/sand material

- Potential for additional wear on equipment and system components due to mildly abrasive ballast material

- More operationally complex (more process equipment such as pumps, motors, VFDs, control valves that operate continuously) than the filtration technologies

- Recycle flow rates depend on the number of units online but are generally fixed. Actiflo recycle flow rates represent almost 3% of the plant's peak design forward flow

- Lamella tube clarifiers in some designs require periodic (every week or so) hosing and cleaning to remove accumulated solids on the tubes

For the CoMag and Actiflo systems, we evaluated the feasibility of installing either system within the existing Sand Filter Building or in a new building located at the location of the existing dirty water storage tank. We evaluated installing the process tanks and clarifiers within the existing filter bay area of the Sand Filter Building, and the chemical, mechanical, electrical, and sludge pump rooms within the existing pump/pipe gallery/controls room. The Sand Filter Building is not a feasible location for installing either the CoMag or Actiflo systems, for the following reasons:

- The recommended process tank sizes are approximately 16.5 feet tall, compared to 17.4 feet available below the bottom of the roof beams and above the filter bay tank floor. Because adequate room is required to walk above the tanks for access and maintenance, the roof structure and vertical walls would have to be raised by several feet.

- The existing roof beams are cast-in-place, which would result in difficult and costly modifications to raise the structure.

- The additional water depth (approximately 16 feet compared to 9 feet in the existing filters) would add significantly to the loading of the existing structure. The additional loading to the structure raises geotechnical concerns related to soil settling.

Therefore, for the purposes of the alternatives analysis, it is assumed that the ballasted-flocculation systems would require the following capital improvements. A concept layout is included in Figure 8-3 (based on Evoqua's CoMag system).

- New structure/building to house new at-grade process tanks, chemical feed system, control panels, and other ancillary and electrical equipment. The new building would be located at the site of the dirty water storage tanks and post-aeration building, both of which would be demolished/backfilled.

- The size of the process tanks is different for CoMag and Actiflo (approximate tank sizes for CoMag shown in Figure 8-3). However, the sizes of the chemical feed system and related containment areas are the same for either alternative.

- The proposed building would consist of:

    - A concrete chemical containment area for the chemical bulk storage tanks.

  - Separate area for the polymer feed system, sludge pumps, and electrical equipment.

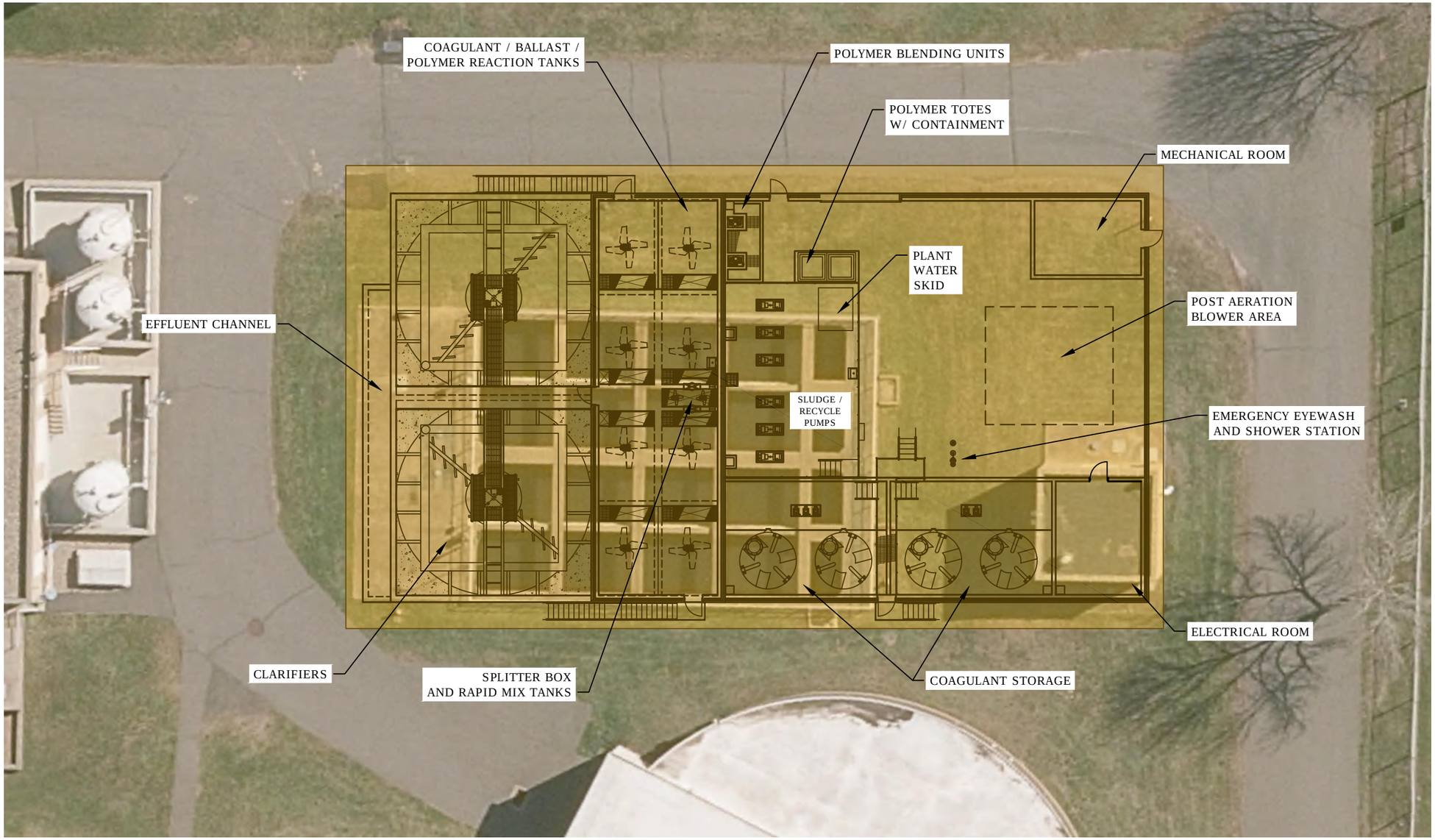
  - Separate space for the post-aeration blowers.

- Potential disruptions to the current treatment plant operations consisting of providing temporary post aeration blowers due to demolition of the post-aeration building and the need to construct added space in the new building for the blowers.

- Related phosphorus treatment system piping: phosphorus system influent from the intermediate pump station effluent located behind the chemical building; phosphorus system effluent from the system discharge to the new disinfection system; backwash/sludge piping from the phosphorus system to the preliminary treatment facilities; utilities (potable water and sewer/drain piping); and support systems (plant water).

- Bulk chemical storage and chemical feed system.

- Hydraulic impacts due to implementation of a low-level phosphorus removal system will be similar for CoMag and Actiflo. Process tanks would be above grade to fit into the existing hydraulic profile and the intermediate pump station would still be required and the level of water in the rapid mix tank will be similar to the existing sand filters and/or cloth disc filters.

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# Wastewater Facilities Plan

Town of Vernon, Connecticut

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| PROJECT NO: | V0037 |
| DATE: | MAY 2017 |
| FILE: | V0037 Phos-UV Concept.dwg |
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| APPROVED: | IBC/SES |

BALLASTED FLOCCULATION CONCEPTUAL LAYOUT

SCALE: AS SHOWN

FIGURE 8-3

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#### 8.3.3.3 Tertiary System Economic Evaluation

Detailed capital and operating cost estimates were developed for the two tertiary phosphorus treatment technologies that were short-listed for this analysis. The analysis includes the requirements for multi-point chemical addition at the primary and/or secondary clarifiers needed to meet the design criteria for the tertiary system influent.

For each alternative, we evaluated the proposals provided by the different system manufacturers in terms of equipment supply and, where appropriate, included additional equipment (motor drives, additional process tanks, and additional chemical feed systems including polymer and ballast material if needed) that would be required to install a complete system.

The opinions of probable capital costs include related site work, new construction, and modifications to existing structures necessary to accommodate the proposed systems. The capital costs below also include costs for chemical systems related to coagulant addition, and piping and support systems (such as electrical and SCADA work related to the phosphorus treatment system).

Capital costs are provided for the different tertiary system configurations based on whether the Zimpro PACT-WAR process is retained or eliminated, namely for the tertiary systems designed to treat different influent total phosphorus concentrations.

Capital costs include general conditions, contractor overhead and profit, contingency, and engineering, in 2017 dollars. A summary of capital costs for each alternative is included in Table 8-8.

**TABLE 8-8**

Tertiary Phosphorus Removal System – Summary of Capital Cost Analysis

| | With Zimpro PACT-WAR | | Without Zimpro PACT-WAR | |
|---|---|---|---|---|
| **Description** | **Disc Filters** | **Ballasted-Floc** | **Disc Filters** | **Ballasted-Floc** |
| Packaged Low Level Phosphorus Removal Treatment System | $2,790,760 | $3,202,810 | $2,589,300 | $2,555,310 |
| Additional Phosphorus Removal Equipment | $281,000 | $377,000 | $223,000 | $320,000 |
| Modifications to Existing Infrastructure and/or New Construction | $1,703,000 | $2,875,000 | $1,664,000 | $2,770,000 |
| Chemical Feed Systems | $718,000 | $718,000 | $718,000 | $718,000 |
| Piping and Support Systems | $1,020,000 | $962,000 | $1,020,000 | $962,000 |
| **Subtotal** | $6,512,760 | $8,134,810 | $6,214,300 | $7,325,310 |
| General Conditions at 10% | $651,000 | $813,000 | $621,000 | $733,000 |
| **Subtotal** | $7,163,760 | $8,947,810 | $6,835,300 | $8,058,310 |
| Contractor OH&P at 15% | $1,075,000 | $1,342,000 | $1,025,000 | $1,209,000 |
| **Subtotal** | $8,238,760 | $10,289,810 | $7,860,300 | $9,267,310 |
| Contingency at 30% | $2,472,000 | $3,087,000 | $2,358,000 | $2,780,000 |
| **Total Construction Costs** | $10,711,000 | $13,377,000 | $10,218,000 | $12,047,000 |
| Engineering at 20% | $2,142,000 | $2,675,000 | $2,044,000 | $2,409,000 |
| **Total Project Costs (2017)** | $12,900,000 | $16,100,000 | $12,300,000 | $14,500,000 |

An analysis of annual operation and maintenance (O&M) costs was performed based upon costs for operator labor, power use, sludge disposal, chemical use, and equipment maintenance. Costs for coagulant chemicals and sludge disposal also includes chemical usage and solids generated at the primary and/or secondary clarifiers. Costs were determined by extrapolating linearly from the current average flow of 2.95 mgd to the future flow of 4.80 mgd. PACL as Epic 70 (multi-point chemical addition) and alum (low level tertiary system) were used as the coagulant chemicals for comparison purposes. A summary of the O&M costs for each alternative is included in Table 8-9.

**TABLE 8-9**

Tertiary Phosphorus Removal System – Summary of Present Worth of O&M Costs (1)

| | With Zimpro PACT-WAR | | Without Zimpro PACT-WAR | |
|---|---|---|---|---|
| **Description** | **Disc Filters** | **Ballasted-Floc** | **Disc Filters** | **Ballasted-Floc** |
| Labor (2) | $285,000 | $331,000 | $284,000 | $301,000 |
| Power | $503,000 | $425,000 | $456,000 | $397,000 |
| Sludge from Tertiary System (3) | $2,220,000 | $2,263,000 | $760,000 | $803,000 |
| Chemicals/Consumables at Tertiary System (4) | $8,598,000 | $8,680,000 | $2,810,000 | $2,892,000 |
| Sludge from Multi-Point Chemical Addition (3) | $360,000 | $360,000 | $899,000 | $899,000 |
| Chemicals for Multi-Point Chemical Addition (4) | $1,062,000 | $1,062,000 | $2,505,000 | $2,505,000 |
| **Present Worth Total** | **$13,028,000** | **$13,121,000** | **$7,714,000** | **$7,797,000** |

(1) Based on a treatment season of 219 days.

(2) Labor includes costs to operate the phosphorus treatment system.

(3) Includes disposal of solids generated in primaries and/or secondaries due to coagulant addition only and disposal of solids generated in the tertiary system during the phosphorus treatment season.

(4) Includes coagulant use (PACL as Epic 70 in primaries and/or secondaries, alum in tertiary system), soda ash use (to replace alkalinity lost due to coagulant addition only), polymer use in tertiary system, and ballast (if applicable).

A life-cycle cost analysis was performed as a present worth analysis based upon a 20-year life cycle, including capital costs, major equipment replacement costs, and annual O&M costs.

Major equipment replacement costs include material costs for equipment that needs to be periodically replaced due to normal wear and tear. This only includes equipment related to each packaged treatment system (at the respective equipment replacement periods listed below) and does not consider existing plant equipment:

- Disc filters: includes replacing 5% of filter media each year in years 6, 7, and 8, and 7% of filter media each year in years 9 through 20 (all filter media replaced once by year 20).

- Ballasted Flocculation: includes replacing shear mixer packing and bearings every 5 years, and shear mixer and reaction tank mixer motors, recycle/waste pump seals, seal flushing units, and mag drum chains every 10 years.

The annual O&M and capital costs were compared using a present worth analysis as discussed previously in Section 8.1. A summary of the life cycle cost analysis for the alternatives is included in Table 8-10.

**TABLE 8-10**

Tertiary Phosphorus Removal System – Summary of Life Cycle Cost Analysis

| | With Zimpro PACT-WAR | | Without Zimpro PACT-WAR | |
|---|---|---|---|---|
| **Description (2017 Dollars)** | **Disc Filters** | **Ballasted-Floc** | **Disc Filters** | **Ballasted-Floc** |
| Capital Cost | $12,900,000 | $16,100,000 | $12,300,000 | $14,500,000 |
| Major Equipment Replacement Cost | $237,000 | $99,000 | $189,000 | $96,000 |
| Operational Cost | $13,028,000 | $13,121,000 | $7,714,000 | $7,797,000 |
| **Present Worth** | **$26,200,000** | **$29,300,000** | **$20,200,000** | **$22,400,000** |

### 8.3.3.4 Tertiary System Alternatives Discussion and Recommendations

Based on present worth costs shown in Table 8-10 and the advantages and disadvantages of each system, disc filtration is recommended for tertiary, low-level phosphorus removal whether the Zimpro PACT-WAR process is retained or eliminated. Disc filtration is a proven technology and has demonstrated its ability to meet effluent total phosphorus concentrations of 0.08 mg/L.

In addition to the new disc filtration system and the proposed upgrades described in Section 8.3.3.1, new chemical feed systems will be needed to enable multi-point chemical addition, including:

- Dosing at the primary and/or secondary clarifiers to achieve a total phosphorus concentration to the tertiary system per the phosphorus removal strategies discussed previously.

- Dosing the tertiary phosphorus removal system to achieve a final plant effluent of 0.08 mg/L total phosphorus.

- Two new chemical storage systems located with the tertiary phosphorus removal system, including two coagulant systems for different coagulant chemicals. Chemical storage in concrete containment area consisting of bulk storage tanks, metering pumps, and secondary containment designed for chemicals in accordance with TR-16 guidelines:

    - Bulk storage tanks: designed to store a minimum of 7 days of supply under average design conditions plus 4,000 gallons to accommodate minimum bulk delivery, plus an additional 10% (assuming 90% usable bulk storage volume).

  - Concrete containment area consisting of 125% of the total storage volume per TR-16 requirements.

  - Number of flow-paced metering pumps sized to supply 100% of the maximum coagulant doses at the average daily flow and provide 100% redundancy with the largest unit out of service.

- Continued use of soda ash to supplement alkalinity lost due to coagulant addition, as needed. The replacement of the existing soda ash storage and feed equipment is discussed in Section 6.6.3 and Section 9.

- Although ferric was not retained for further analysis, it is recommended that the chemical feed systems be designed to be compatible with both aluminum based coagulants and ferric chloride. This will provide a flexible system that can be used for chemical phosphorus removal if the plant has difficulty meeting effluent aluminum limits in the future and must switch to ferric chloride. This means avoiding steel and stainless steel supports and fastening components which can be dissolved by ferric chloride and relying on titanium fasteners and fiberglass supports.

## 8.4 Solids Handling Evaluation

Improvements for sludge handling will depend on whether the Zimpro PACT-WAR process is retained or eliminated:

1. If the Zimpro PACT-WAR process is retained, then the current method for sludge handling and disposal would be continued:

    a. Primary sludge would continue to be thickened to an average of 4% to 6% solids in the primary sludge gravity thickeners and disposed of off-site. In the future, primary sludge will also include sludge recycle from the tertiary phosphorus system and the additional solids generated in the primary clarifiers due to chemical phosphorus removal.

    b. Waste activated sludge containing spent carbon would continue to be thickened in the WAS (spent carbon) gravity thickeners prior to processing the sludge through the WAR system.

2. If the Zimpro PACT-WAR process is eliminated, then:

    a. Primary sludge would continue to be thickened to an average of 4% to 6% solids in the primary sludge gravity thickeners and disposed of off-site. Again, primary sludge would include solids from the tertiary system and from chemical addition to the primary clarifiers.

    b. Unthickened secondary sludge (or WAS) from any of the treatment options replacing Zimpro PACT-WAR is expected to have a percent solids concentration ranging approximately 0.8% to 1.6%, based upon MLSS concentrations, RAS rates, and PAC addition (if retained). For example, a solids concentration of 0.8% is typical if using an IFAS process at 4,000 mg/L MLSS and 100% RAS return, while 1.6% is typical for both the BioMag process (at 8,000 mg/L MLSS and 100% RAS return (excluding ballast)) and the Zimpro PACT only process (assuming a 1:1 PACT to biomass ratio and similar MLSS levels excluding ballast).

    It is recommended that systems be installed to produce a thickened waste activated sludge (or TWAS) to a solids concentration of 5-6% (like the primary sludge), as this is economical for disposal. Sludge handling improvements will be required to mechanically thicken secondary sludge, as it will not be possible to thicken secondary sludge in the primary sludge gravity thickeners to 6% and co-thickening the sludge is not recommended due to odor concerns.

    Mechanical thickening can be accomplished by installing rotary drum thickeners (RDTs), which are commonly used in similar applications, are easy to operate, and are enclosed to contain odors. Because secondary sludge is wasted intermittently, covered, aerated unthickened sludge holding tanks are recommended to enable feeding the RDTs at a uniform rate and concentration. A covered, mixed thickened sludge storage tank and truck loading pumps would be required to quickly load a truck for periodically hauling the sludge off-site.

    If the Zimpro WAR process is eliminated, the secondary treatment alternatives can be configured for EBPR. In this case, any sludge handling improvements (for

example, the sludge holding tanks) require provisions for aerating the sludge to prevent the release of phosphorus to the secondary process from recycle streams. This suggests that air can be used to mix the sludge holding tanks.

Solids handling improvements (number of RDT units and sludge storage volumes) for secondary sludge will vary for the different secondary treatment alternatives replacing Zimpro PACT-WAR, due to different solids generation rates and solids concentrations. This is discussed in detail below for the recommended alternatives.

### 8.4.1 Solids Generation Estimate

The baseline solids production for the WPCF was reviewed and discussed in Section 5. Additional solids will be generated as flows and loads increase, and from chemical sludge that results from both multi-point chemical addition and the tertiary phosphorus removal system, whether the Zimpro WAR process is retained or eliminated. If the WAR process is eliminated, secondary (biological) sludge will be generated.

Future solids generation rates estimated for each unit process are summarized in Tables 8-11 and 8-12 with and without Zimpro PACT-WAR, respectively. Estimated rates are based upon current flows and loads, the anticipated increase in flows and loads, the additional solids generation due to phosphorus removal as discussed above, and new secondary sludge stream.

Table 8-12 is based upon secondary solids due to the IFAS process. Table 8-13 contrasts the secondary solids generation rates for IFAS with the other alternatives assuming the Zimpro WAR unit is not retained. The BioMag process would generate additional secondary solids due to magnetite replacement (at a rate of approximately 146 lbs/MG, based upon vendor supplied information). The Zimpro PACT only process would generate additional secondary solids due to the addition of PAC (for example, at a ratio of 1:2 PAC to biomass, the secondary solids increase 50%, at a ratio of 1:1 PAC to biomass, the secondary solids would double).

**TABLE 8-11**
Current and Future Solids Generation Rates, With Zimpro PACT-WAR

| | Units | Current Conditions | | Future (20-Year) Conditions | |
|---|---|---|---|---|---|
| Flow | mgd | 2.95 | 4.91 | 4.8 | 7.9 |
| Primary Only Solids (1) | lbs/day | 7,160 | 10,030 | 10,220 | 14,300 |
| Chemical Phosphorus Removal Solids (2) | lbs/day | 250 | 420 | 400 | 660 |
| Tertiary Phosphorus System Solids (3) | lbs/day | 1,520 | 2,520 | 2,500 | 4,120 |
| Primary Solids Sub-Total to Primary Thickener | lbs/day | 8,930 | 12,970 | 13,120 | 19,080 |
| Primary Sludge Volume @ 6% (4) | gal/day | 17,669 | 25,663 | 25,959 | 37,752 |

Notes

(1) Estimated based on assumed TSS removal of 70% in the primaries with Zimpro-PACT-WAR. Accounts for solids from septage receiving.

(2) Estimated based on dosing the primary clarifiers, at a coagulant dose (with PACL as Epic70) of 1.7 lb Al/lb P removed (from Table 7-1) and TP reduction according to the phosphorus removal strategies in Tables 8-4 and 8-5. Assumes some phosphorus removal occurs due to assimilation and through ash loss/blowdown, based on 80% MLVSS and 2% phosphorus content in WAS before chemical addition.

(3) Tertiary phosphorus removal system solids co-settled in primaries. Solids estimated based on disc filters (no ballast/sand used), assumed TSS reduction of 3 mg/L, polymer dose of 1.20 mg/L (dry), coagulant dose (with alum) of 6.1 lb Al/lb P removed (from Table 7-1), and TP reduction according to the phosphorus removal strategies in Tables 8-4 and 8-5.

(4) Primary % Solids to and from primary thickeners based on historical MOR data (average). Volume based on specific gravity of primary sludge of 1.01.

**TABLE 8-12**
Current and Future Solids Generation Rates, Without Zimpro PACT-WAR (1)

| | Units | Current Conditions | | Future (20-Year) Conditions | |
|---|---|---|---|---|---|
| Flow | mgd | 2.95 | 4.91 | 4.8 | 7.9 |
| Primary Only Solids (2) | lbs/day | 6,140 | 8,590 | 8,760 | 12,260 |
| Tertiary Phosphorus System Solids (3) | lbs/day | 523 | 870 | 850 | 1,400 |
| Primary Solids Sub-Total to Primary Thickener | lbs/day | 6,663 | 9,460 | 9,610 | 13,660 |
| Primary Sludge Volume @ 6% (4) | gal/day | 13,184 | 18,718 | 19,014 | 27,028 |
| Secondary (Biological System) Solids (5) | lbs/day | 4,340 | 6,160 | 6,620 | 9,140 |
| Chemical Phosphorus Removal Solids (6) | lbs/day | 580 | 970 | 955 | 1,570 |
| Secondary Solids Sub-Total out of RDTs (7) | lbs/day | 4,920 | 7,130 | 7,575 | 10,710 |
| Secondary Sludge Volume @ 5.5% (8) | gal/day | 10,726 | 15,544 | 16,514 | 23,349 |

Notes

(1) Based on eliminating Zimpro PACT-WAR and replacing with IFAS (does not include sludge generated from make-up ballast (BioMag alternative) or PAC usage (Zimpro PACT only alternative)); based on using RDTs for secondary sludge thickening. Assumes no enhanced biological phosphorus removal (EBPR). If EBPR is successful, chemical usage and solids production will be less.

(2) Estimated based on assumed TSS removal of 60% in the primaries without Zimpro-PACT-WAR. Accounts for solids from septage receiving.

(3) Tertiary phosphorus removal system solids co-settled in primaries. Solids estimated based on disc filters (no ballast/sand used), assumed TSS reduction of 3 mg/L, polymer dose of 0.75 mg/L (dry), coagulant dose (with alum) of 6.1 lb Al/lb P removed (from Table 7-1), and TP reduction according to the phosphorus removal strategies in Tables 8-4 and 8-5.

(4) Primary % Solids to and from primary thickeners based on historical MOR data (average). Volume based on specific gravity of primary sludge of 1.01.

(5) Estimated based on BOD removal in secondaries (98%) and overall gross yield factor of 0.8 lbs Waste Sludge per lb of BOD removed prior to chemical addition. Volume based on specific gravity of secondary sludge of 1.0.

(6) Estimated based on dosing the secondary clarifiers only (some reduction in solids generation is possible if dosing both the primary and secondary clarifiers, but that approach is less conservative for sizing the solids handling process), at a coagulant dose (with PACL as Epic70) of 1.7 lb Al/lb P removed (from Table 7-1), and TP reduction according to the phosphorus removal strategies in Tables 8-4 and 8-5. Assumes some phosphorus removal occurs in secondary (biological) solids due to assimilation and sludge wasting, based on 80% MLVSS and 2% phosphorus content in WAS before chemical addition.

(7) Does not include solids due to make-up ballast or PAC usage (see Table 8-13 for these additional secondary solids).

(8) Thickened 5.5% solids considered typical for RDTs.

**TABLE 8-13**
Secondary Solids Generation Rates of Short-Listed Secondary Treatment Alternatives to Replace Zimpro PACT-WAR

| | IFAS (1) | | | PACT Only (2) | | | Ballasted Flocculation (3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | lbs/day | gal/day @0.8% | gal/day @5.5% | lbs/day | gal/day @1.6% | gal/day @5.5% | lbs/day | gal/day @1.6% | gal/day @5.5% |
| At Current Average Day Conditions | 4,920 | 73,741 | 10,726 | 7,380 | 55,306 | 16,089 | 5,351 | 40,098 | 11,665 |
| At Current Max Month Conditions | 7,130 | 106,865 | 15,544 | 10,695 | 80,148 | 23,316 | 7,847 | 58,804 | 17,107 |
| At Future Average Day Conditions | 7,575 | 113,534 | 16,514 | 15,150 | 113,534 | 33,028 | 8,276 | 62,019 | 18,042 |
| At Future Max Month Conditions | 10,710 | 160,522 | 23,349 | 21,420 | 160,522 | 46,697 | 11,863 | 88,904 | 25,863 |

(1) Based on biological solids and chemical phosphorus removal solids determined in Table 8-12; 0.8% solids concentration expected at 4,000 mg/L MLSS and 100% RAS return.

(2) Based on biological solids and chemical phosphorus removal solids, plus solids from PAC addition at a ratio of 1:2 PAC to Biomass under current conditions, and increasing to 1:1 PAC to Biomass under future conditions to achieve settling at future flows and loads (see Section 8.5.4); 1.6% solids concentration expected at 4,000 mg/L MLSS, 100% RAS return, and PAC addition.

(3) Based on biological solids and chemical phosphorus removal solids, plus magnetite loss at approximately 146 lbs/MG; 1.6% solids concentration expected at 8,000 mg/L MLSS and 100% RAS return.

### 8.4.2 Secondary Sludge Handling Options

The current primary sludge handling practices of thickening primary sludge in the gravity thickeners and hauling thickened liquid sludge off-site for disposal are recommended to be continued. Recommendations for improvements to the primary sludge handling equipment is discussed in Section 5. Similarly, if the Zimpro PACT-WAR process were to be retained, recommendations for its continued long-term use are discussed in Section 5.

Several options for secondary sludge handling improvements were considered for the secondary treatment alternatives under consideration to replace the Zimpro PACT-WAR process, including:

1. Waste activated sludge (WAS) will be pumped to a sludge storage tank. The existing dirty water storage tank will be modified for this purpose. The tank will be covered, and the sludge will be aerated. The WAS will be thickened to approximately 5.5% solids using a minimum of two RDTs. Following thickening, the thickened waste activated sludge (TWAS) will be stored in the abandoned sludge thickeners (originally sludge digesters) which will be covered, and the sludge will be mixed prior to disposal off-site.
2. WAS will be pumped directly to a minimum of two RDTs, without providing unthickened sludge storage; thicken to 5.5% solids; and store thickened sludge in the WAS (spent carbon) gravity thickeners which will be covered, and the sludge will be mixed prior to disposal.

### 8.4.3 Secondary Sludge Handling Recommendations and Variations

The recommended improvements for secondary sludge handling includes retrofitting the existing dirty water storage tank into unthickened WAS storage, installing RDTs in the upper level of the Solids Handling Building (where the abandoned vacuum filters are currently located) and converting the abandoned gravity thickeners (originally digesters) into TWAS storage.

The following is a detailed summary of the required modifications, equipment, and proposed improvements needed to meet the recommended secondary sludge handling practices, as well as a description of how the recommendations vary between the secondary treatment alternatives (*in italics*).

- Retrofitting the existing dirty water storage tank into two identical unthickened WAS storage tanks will include the following key items:
    - The capacity of the dirty water storage tanks is approximately 0.292 MG. This assumes 1 foot of freeboard to the top of the existing tanks walls. *This provides the following unthickened sludge storage time (at future max month and at current average day, respectively) for the different secondary treatment alternatives based on the volumes summarized in Table 8-13*
        - *If using the IFAS process: 44 to 95 hours*
        - *If using the BioMag process: 79 to 175 hours*
        - *If using the Zimpro PACT only process: 44 to 127 hours*

- Raise the exterior perimeter walls of each tank by approximately 2' to make the tank resilient to flooding at the 100-year flood plus 3 feet water elevation (218.5'). The interior tank dividing walls/beams will remain at their current elevations.
- Demolish concrete elevated slabs over the tank on the east and west ends of tank which is original to when the tanks were the WPCF's primary clarifiers.
- Place fill concrete in old primary clarifier sludge removal sumps on east end of tank to make the tank floor uniform.
- Install a cover system over the storage tanks to mitigate concerns with odors and to prevent dilution of the stored sludge by rain and snow. An aluminum or FRP cover system will be mounted at the elevation of the interior tank walls/beams that run north-south and east-west.
- Install an odor control system adjacent to the WAS storage tanks that will draw air from the head space from the WAS tanks. The odor control system will also serve the new TWAS tanks, drainage wet well, and RDTs to control odors from these tanks as well.
- Install coarse bubble air diffuser grids in the WAS storage tanks to prevent phosphorus release from the sludge and to help keep the contents of the tank well mixed. Install three outdoor aeration blowers in sound attenuating enclosures, one dedicated per tank and one common back-up, to supply air to the coarse bubble diffuser grids.
- Install a metal sloped roof only structure over the three aeration blowers to provide operator comfort when operating and maintaining the blowers in inclement weather.
- Miscellaneous concrete work and concrete repairs and installation of handrail around the exterior perimeter tank walls.
- Installation of a new WAS/secondary scum force main that will connect to the existing WAS force main piping (somewhere between the Return Sludge Pump Station and the aeration tank pipe gallery) and extend it to the new WAS storage tanks. Connect existing WAS and secondary scum piping in the lower level of the Return Sludge Pump Station as discussed in Section 5.3.2 so that WAS and secondary scum can be sent via the new WAS/scum force main to the new WAS storage tanks. Valves for selecting which tank WAS/scum is discharged into will be in the RDT feed pump gallery adjacent to the east end of the WAS tank which is discussed below.
- Install a new primary scum force main (connecting to the existing force main passing nearby) that will provide the operators the option of allowing the primary scum pump to send scum to the new WAS storage tanks. Valves for selecting which tank primary scum is discharged into will be in the RDT feed pump gallery.

- Retrofit the existing abandoned gravity sludge thickeners into two identical TWAS storage tanks will include the following key items:

- The capacity of the existing gravity sludge thickeners is approximately 0.320 MG (both tanks). *This provides the following thickened sludge storage time (at future max month and at current average day, respectively) for the different secondary treatment alternatives based upon the dry pounds summarized in Table 8-13 and 5.5% solids:*
  - *If using the IFAS process: 14 to 30 days*
  - *If using the BioMag process: 12 to 27 days*
  - *If using the Zimpro PACT only process: 7 to 20 days*
- Remove vegetation that has grown over the years since the tanks were abandoned.
- Allow for concrete repairs and coating systems to protect the tank interior.
- Provide an insulated finish system on the exterior of the tank to help insulate the tank from freezing conditions, protect the concrete, and improve the aesthetics of the tank.
- Demolish existing gravity thickener related mechanisms and access bridges and make any necessary miscellaneous concrete repairs.
- Install a single top mounted mixer per TWAS tank that will keep the contents of the tank well mixed. It is anticipated that the mixers would be installed on new structural beams that will span the full diameter of the tank. These new beams would also be designed to interface and support the proposed tank covers.
- Install a cover system over each of the TWAS tanks to mitigate odors from the tanks. An aluminum cover system will be used because it is more cost competitive for circular tanks of this size when compared to FRP cover systems.
- Install odor control ductwork to each of the tanks from the odor control system mentioned previously that is proposed to be installed adjacent to the WAS storage tanks.
- Install handrail around the perimeter of each tank.
- Install two positive displacement (rotary lobes) truck loading pumps in the space (lower level) between the TWAS tanks that can draw suction from either of the TWAS tanks and discharge TWAS through a common force main up to the truck loadout connection.

- Retrofit the abandoned vacuum filter area of the Solids Handling Building into an RDT room will include the following key items:
  - Demolish existing vacuum filters and all related items in the space including but not limited to chemical feed systems, access platforms, cake conveyors, etc. Note that we do not recommend demolishing the heated scum holding/decant tank and related equipment (e.g. steam generator, water treatment) as this equipment will be retained so that the operators have an option other than sending primary scum to the WAS holding tanks.

- Make miscellaneous concrete repairs after demolition activities.
- Install a minimum of two RDTs for thickening WAS to 5.5% while providing partial redundancy. Different RDT processing rates and configurations were considered for the different secondary treatment alternatives, based on:
  - Future solids generation rates summarized in Table 8-13
  - Ability to process unthickened WAS in an 8-hour shift or less, at the future average annual / max month generation rates
  - Ability to run the RDTs for 4 days per week at the future average annual / max month generation rates, allowing the system to be offline during a long weekend or holiday
  - Longer shifts or more operating days per week may be possible at future max month flows on a higher than typical wasting day (i.e. if applying a peaking factor to the future max month rates)

  *Based upon these criteria, the following RDT sizes and configurations are feasible for the different secondary treatment alternatives:*

  - *If using the IFAS process: two RDTs each rated for 400 gpm and processing 0.8% solids to 5.5% solids*
  - *If using the BioMag process: two RDTs each rated for 400 gpm and processing 1.6% solids to 5.5% solids; at this higher solids concentration, the RDT capacity is reduced from 400 gpm to 200 gpm, requiring longer RDT run times*
  - *If using the Zimpro PACT only process: three RDTs each rated for 400 gpm and processing 1.6% solids to 5.5% solids; an additional RDT is recommended due to high solids concentration and high sludge generation rate; at this higher solids concentration, the RDT capacity is reduced from 400 gpm to 200 gpm, requiring longer RDT run times*
- Install the necessary ancillary items for operation of the RDTs including but not limited to plant water piping and spray water booster pumps, polymer batching and dosing equipment, and access platforms around the RDTs for operator access, filtrate drain piping to the drainage pump station.
- Install odor control ductwork to each of the RDTs and the drainage wet well from the odor control system previously mentioned that is proposed to be installed adjacent to the WAS storage tanks.
- Install TWAS transfer pumps, minimum of one pump dedicated to each RDT, that will transfer the TWAS discharged from the RDTs to the TWAS storage tanks. This will require piping to be installed to get the TWAS from the Solids Handling Building over to the new TWAS storage tanks.
- Allowance for architectural repairs (windows, walls, etc.) and for HVAC equipment for this space.

- Retrofitting the existing pipe gallery adjacent to the east end of the dirty water storage tank into an RDT feed pump gallery will include the following key items:
    - Demolish the existing concrete roof over the existing pipe gallery, raise the exterior perimeter walls of the pipe gallery by 2 feet to make the space resilient to flooding at the 100-year flood plus 3 feet water elevation (218.5') and construct a new concrete roof structure over the space. Install two water tight hatches in the new roof structure to allow install/removal of equipment.
    - Install an access stair only building structure on the south end of the existing pipe gallery to provide an additional means for safe egress into and out of the space.
    - Closeout the pipe tunnel that goes into the basement of the Chemical Building (if this building is demolished as part of the upgrades to provide space for new electrical equipment).
    - Demolish existing pipe and valves in the space that will no longer be required.
    - Install one RDT feed pump for each RDT and suction piping arranged such that either pump can draw WAS from either of the WAS storage tanks. It is recommended that the RDT feed pumps be of the positive displacement type.
    - Install separate discharge piping from each RDT feed pump that is routed through the existing pipe tunnel then below grade to the Solids Handling Building and up to the RDT room. Install valves to allow WAS to be discharged into any RDT or to all RDTs simultaneously.
    - HVAC equipment, concrete repairs, and waterproofing measures for this retrofitted space.

Figure 8-4 shows a depiction of the proposed secondary solids handling improvements discussed above.

An opinion of probable construction (OPCC) cost was completed and is summarized in Table 8-14 for the proposed improvements discussed above for the treatment alternatives with two RDTs (IFAS and BioMag). If a third RDT is required to be installed for the Zimpro PACT only alternative, it would raise the cost by approximately $500,000. In addition, the operations and maintenance costs for operating the recommended solids handling improvements were calculated over a twenty-year life cycle. These capital costs and O&M costs are being carried as part of the secondary treatment alternatives life cycle cost evaluation presented in Section 8.5.

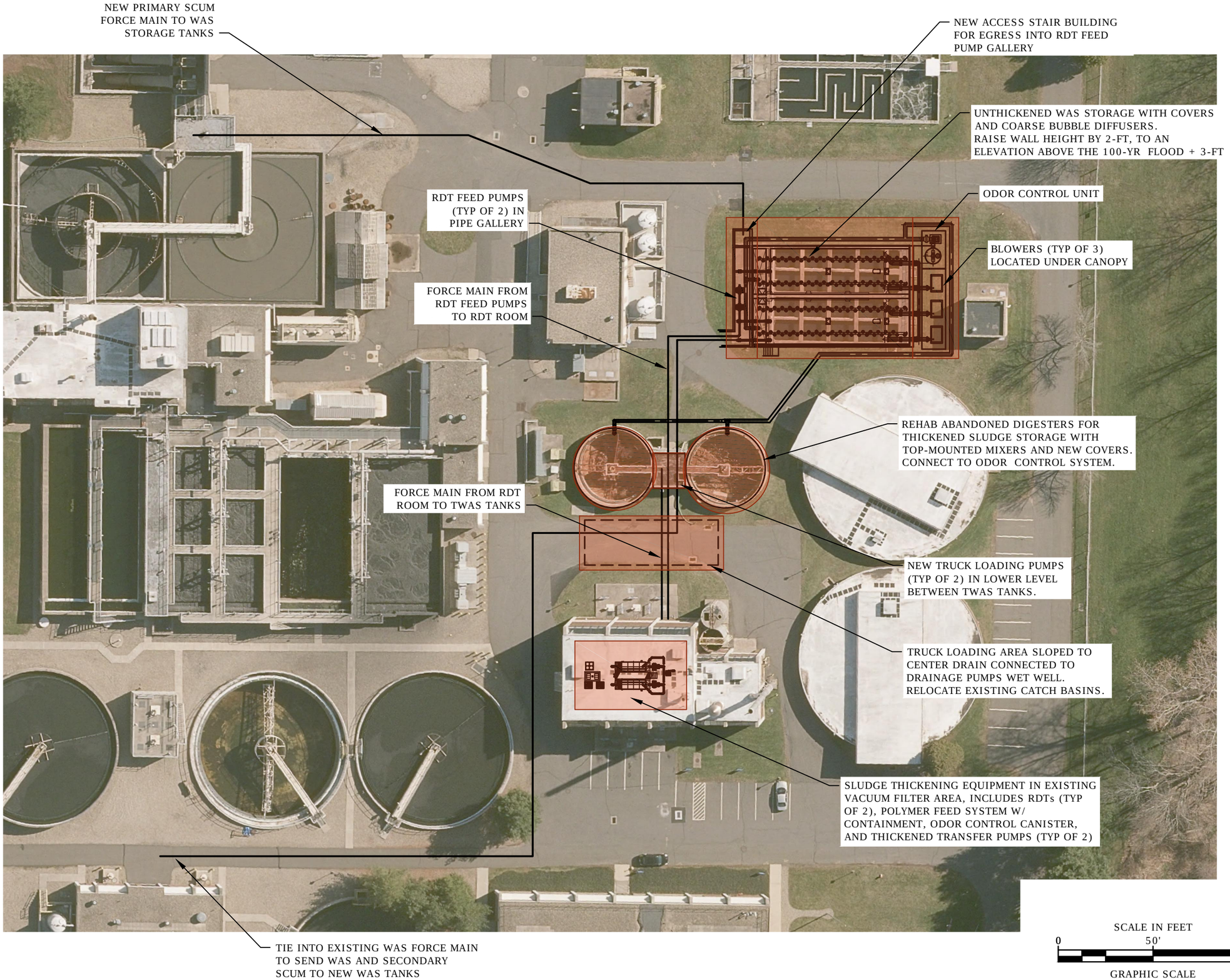
**TABLE 8-14**

Secondary Sludge Handling Improvements – Summary of Capital Cost Analysis

| Description | IFAS and BioMag Alternatives | Zimpro PACT Only Alternative |
|---|---|---|
| Opinion of Capital Costs | $4,178,000 | $4,678,000 |
| General Conditions at 10% | $418,000 | $468,000 |
| **Subtotal** | $4,596,000 | $5,146,000 |
| Contractor OH&P at 15% | $689,000 | $772,000 |
| **Subtotal** | $5,285,000 | $5,918,000 |
| Contingency at 30% | $1,586,000 | $1,775,000 |
| **Total Construction Costs** | $6,871,000 | $7,693,000 |
| Engineering at 20% | $1,374,000 | $1,539,000 |
| **Total Project Costs (2017)** | $8,245,000 | $9,232,000 |

Operational and maintenance costs for the solids handling improvements are also being carried as part of the life cycle cost evaluations and are based on the following assumptions:

- Fixed electricity consumption (independent of increases in sludge volume) were estimated based upon the estimated equipment operating hours and horsepower. The equipment included in the fixed electricity consumption include the unthickened WAS storage tank blowers and odor control equipment and the mechanical mixing equipment for the thickened storage tanks.
- Variable electricity consumption (proportional to the increases in sludge volume) were estimated based upon assumed equipment horsepower and required operating run time to process the volume of sludge generated in the current and future scenarios. The electricity consumption was then linearly interpolated across the 20-year evaluation period. The equipment considered in this variable electricity approach include the thickened primary sludge pumps, rotary drum thickeners, RDT feed pumps, filtrate drainage pumps, thickened sludge pumps, and truck loading pumps.
- Costs associated with hauling sludge were calculated using the sludge generation quantities for the current and future design conditions and unit costs assumptions as described in 8.1.1.
- The proposed RDTs can thicken the secondary sludge to 5.5% solids. This assumption was based on the RDT manufacturers recommendations and experience with similar RDT installations.

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| DATE: | MAY 2017 |
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| DRAWN BY: | CMC |
| CHECKED: | FAM/RLS |
| APPROVED: | IBC/SES |

SOLIDS HANDLING IMPROVEMENTS CONCEPTUAL LAYOUT

SCALE: AS SHOWN

FIGURE 8-4

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# 8.5 Eliminate Zimpro – Change to Conventional Aeration with IFAS

As discussed in Section 7, the following secondary treatment alternatives were retained for further analysis:

- Retain Zimpro PACT-WAR processes
- Retain Zimpro PACT process and eliminate WAR process
- Eliminate the Zimpro PACT-WAR processes and replace with a ballasted sludge flocculation system (BioMag)
- Eliminate the Zimpro PACT-WAR processes and replace with an integrated fixed film, activated sludge (IFAS) process

These four secondary treatment alternatives were evaluated on a life cycle cost analysis (LCCA) basis and compared to determine the alternative that has the lowest overall present worth cost and most desirable non-cost alternatives for the Town of Vernon.

## 8.5.1 Introduction

### 8.5.1.1 General Assumptions

The evaluation of the secondary treatment systems included the following general assumptions which are true for all alternatives.

- The secondary treatment system plays a large role in the overall wastewater treatment facility. To capture the potential differences in the present worth life cycle cost analyses (LCCAs) unique to each alternative, the scope of the secondary system LCCA was expanded to include additional processes such as primary solids handling and secondary solids handling.
    - For primary solids handling, only O&M costs to haul solids offsite for disposal was considered. Operating costs of primary solids processing equipment and equipment costs would be similar for all alternatives and therefore was excluded. Primary solids were assumed to be removed as 6% solids, which is consistent with the performance of the existing primary sludge gravity thickeners observed at the WPCF and assumed to be maintained in the future.
    - Secondary solids handling approaches were significantly different based upon whether the Zimpro PACT-WAR system is retained. The assumptions made to evaluate the Zimpro PACT-WAR system's solids handling costs are detailed in Section 8.5.2. For all other alternatives, the secondary solids handling system is based upon the recommended system detailed in Section 8.4 above. Please see Section 8.4 for assumptions pertaining to the development of the capital and O&M costs which were than carried in the secondary system evaluation for each alternative.
- Operations and maintenance costs associated with the aeration equipment were included in the LCCA evaluation and assumed to be common to all alternatives.

Blower sizing and electricity consumption are determined by the oxygen transfer efficiency (alpha values) and the depth and efficiency of the diffuser systems. The alpha factors can vary depending upon such factors as the MLSS concentrations. The IFAS manufacturers provided specific design criteria and blower requirements and was used as the basis for analysis of the life-cycle costs. The BioMag system and Zimpro processes which operate at much higher MLSS concentrations may have higher power costs, but this information was not considered in our evaluation. In addition, there is also a high recycle load from the Zimpro PACT-WAR process which will further increase the energy load and related costs, which was not considered in this evaluation.

- Capital costs for the aeration systems were only partially included in the LCCA. Aeration blowers and piping were not included because the capital cost is expected to be similar for the alternatives as discussed above. Costs for diffusers, distribution piping within the tanks, meters and valves, and control instrumentation were carried since these costs vary among the different alternatives.

- Capital costs related to upgrading the RAS pumping systems, the WAS pumping systems, and the secondary clarifiers were not included in the LCCA because these recommended improvements are expected to be similar for all alternatives.

#### 8.5.1.2 Goals for Biological Nitrogen Removal

The goals for nitrogen removal are to modify the WPCF's activated sludge process to achieve an effluent total nitrogen of 4.6 mg/L (184 lbs/day at current average flow of 4.8 mgd) and if possible 3 mg/L (184 lbs/day at the plant's permitted flow of7.1 mgd) within the existing tanks or with the addition of more tanks if space is available and it is cost-effective to do so. If space is a constraint, the goal of the secondary process would be to provide for year-round nitrification and to remove as much total nitrogen as possible recognizing that of the plant were ever to receive a total nitrogen permit limit of 3 mg/l or another level not achievable with the selected technology, then expanding tanks or adding another treatment step may be needed in the future to provide additional nitrogen removal.

For all nitrogen removal strategies, the goal will be to provide year-round nitrification and denitrification with wastewater temperatures as low as 10° C and a secondary treatment gross yield factor of 0.8 lbs TSS generated per pound of BOD removed (not including PAC or ballast, which will increase the yield factor). This level of treatment will require a solids residence time (SRT) of at least 12 days in the winter.

The pre-anoxic zone used for nitrogen removal or anaerobic zone used for enhanced biological phosphorus removal (EBPR) will be designed as a selector to improve MLSS settling and allow a design sludge volume index (SVI) of 150 mL/g be used for evaluating the secondary clarifier capacity. Due to the small size of the aeration tanks, it is critical to maximize the clarifier capacity. As discussed in Section 7, a clarifier state point analysis was used to determine the maximum allowable MLSS (assuming no ballast) in the aeration tanks to allow the clarifiers to pass peak flows. For alternatives that use a ballast, higher MLSS loadings can be used (based upon vendor process guarantees), since these processes have the effect of significantly lowering the SVI. For alternatives that retain the PACT-WAR system, past sizing criteria are used.

#### 8.5.1.3 Goals for Phosphorus Removal

A complete evaluation of the phosphorus removal treatment alternatives is discussed in depth in Section 8.3 above. The phosphorus removal evaluation includes both a proposed tertiary treatment technology as well as a multipoint chemical removal approach within the upstream treatment processes. As discussed above, the decision between retaining the Zimpro PACT-WAR system or eliminating it for one of the alternative secondary treatment systems has a significant impact on the phosphorus removal strategy. For the purposes of this evaluation, all phosphorus based life cycle costs were included in the phosphorus system evaluation and not part of the secondary treatment system evaluation. This approach allows us to separate the technology goals. The difference between the LCCAs of the two phosphorus removal alternatives (with or without Zimpro PACT-WAR processes), can be later applied to the LCCAs of the secondary treatment alternatives to determine the overall cost effectiveness of the treatment alternatives. In addition, we point out again that the LCCAs were developed as if there would be no savings in chemicals or sludge disposal costs due to the implementation of EBPR. If savings were to be considered, then the Zimpro PACT-WAR process would be put at a disadvantage because as discussed previously, it would not be able to perform enhanced EBPR.

### 8.5.2 Zimpro-PACT-WAR

The secondary treatment system at the Vernon WPCF includes a unique Zimpro PACT-WAR system. A general overview of the Zimpro PACT-WAR system is provided in Section 4.6 and a detailed overview of the equipment comprising the Zimpro PACT-WAR system is included in Section 5.5. A summary of the advantages and disadvantages are discussed below, as well as characteristics that were considered in the life cycle evaluation.

Advantages

- The PACT process has much higher mixed liquor suspended solids (MLSS) concentrations in the aeration tanks than in conventional activated sludge systems because the presence of powdered activated carbon (PAC) acts as a ballast enabling improved settling rates in secondary clarifiers. This feature increases treatment capacity during high flow periods.
- The WAR process recovers and regenerates the carbon on-site, which reduces the amount of virgin PAC that must be purchased.
- The WAR process destroys most of the waste activated sludge reducing overall sludge processing and disposal costs.
- The system was originally designed to remove color from wastewater discharged to the WPCF from now defunct factory dyeing operations. The PACT process uses PAC to adsorb organics including color.
- The Zimpro PACT-WAR alternative can be upgraded to operate in a MLE configuration which would reduce nitrogen. However, this reduction would be too little to meet Vernon's nitrogen allocation indicated in CT DEEP's General Permit for Nitrogen Discharges. See the additional nitrogen removal impacts discussion in the paragraphs below.

Disadvantages

- As the WAR process regenerates PAC and destroys a majority of the biological waste sludge, it recycles an additional BOD, ammonia, and ortho-phosphorus load to the aeration tanks thereby increasing energy costs and the need for treatment capacity.
- The WAR process generates inert solids (ash) which are recycled to the aeration tanks. This increases both the MLSS concentration and the solid's loading to the secondary clarifiers without providing any treatment benefit.

  Over time the ash concentration builds up in the secondary process until it must be removed from the process via the primary clarifiers as described in Section 5.5. Therefore, although the Zimpro PACT-WAR process produces no secondary sludge, the system produces an additional solids load that must be processed with the primary sludge.
- The WAR system includes a significant amount of mechanically complex and uncommon equipment (outlined in Section 5.5). As Vernon's experienced operators who run it (some since the 1980s) retire, there will be a loss of this process and mechanical knowledge base that will be difficult to replace.

- The WAR equipment is 40 years old and well beyond its normal service life. Such a large amount of aging equipment requires extensive maintenance to keep the system operational. Spare parts are increasingly difficult and costly to replace. Outages can potentially result in significantly higher O&M costs due to the required disposal of secondary sludge and continued PAC addition, or may risk failure to meet NPDES permit requirements if PACT is discontinued during the WAR outage.

- Since there is no secondary sludge, there is limited opportunity to remove phosphorus using the Zimpro PACT-WAR system. Although it might be possible to use the DSE system or other approach to remove some phosphorus solids from the secondary system, this would be inefficient and limited in its effectiveness.

- When in use, the WAR system runs continuously which requires the WPCF to provide staffing for second and third shifts. Therefore, the Zimpro-WAR alternative requires two additional full-time operators. Other treatment system alternatives require operating only a single shift.

- Energy costs for running the process are very high, representing about 20% of the WPCF's electrical and 90% of the WPCF's natural gas consumption. See Appendix L for detailed analysis.

- Virgin PAC must be added to the process daily to replace PAC destroyed in the WAR system and/or otherwise lost in the system.

#### 8.5.2.1 Impacts on Nutrient Removal

The existing secondary system provides some level of nitrogen and phosphorus removal. An evaluation of the existing system's observed nitrogen and phosphorus removal performance was used as the baseline from which further optimization of the system could be achieved.

#### Phosphorus

As discussed in Section 4, WPCF laboratory data suggests that the secondary system removes about 126 pounds per day of phosphorus on average, which is about 63% removal. This finding suggests that ortho phosphorus, which is recycled by the WAR system from the mineralization of the biomass, is being stabilized/converted into a solid which can be later removed. Sampling data from the WAR regeneration stream confirmed that soluble ortho phosphorus makes up less than 1% of the total phosphorus load being recycled. It is believed that the ortho phosphorus is incorporated into the ash that is recirculating within the system. Eventually, these solids are believed to be wasted from by several different avenues which are later removed in the primary clarifiers. The possible places for solids loss include via the secondary clarifier scum, spent carbon thickener scum and supernatant, WAR blowdown, and sand filter dirty water. Since effective DSE testing could not be done, a conservative approach to not consider the DSE system as a method for removing ash from the secondary system was assumed.

Despite the observed phosphorus removal in the secondary system, the average effluent total phosphorus concentration remains 3.7 mg/L, which is still well above the proposed limit. For the future 20-year design evaluation, as detailed in Section 8.3.1 it was assumed that no additional phosphorus removal is possible in the secondary treatment process with the Zimpro PACT-WAR treatment system.

**Nitrogen**

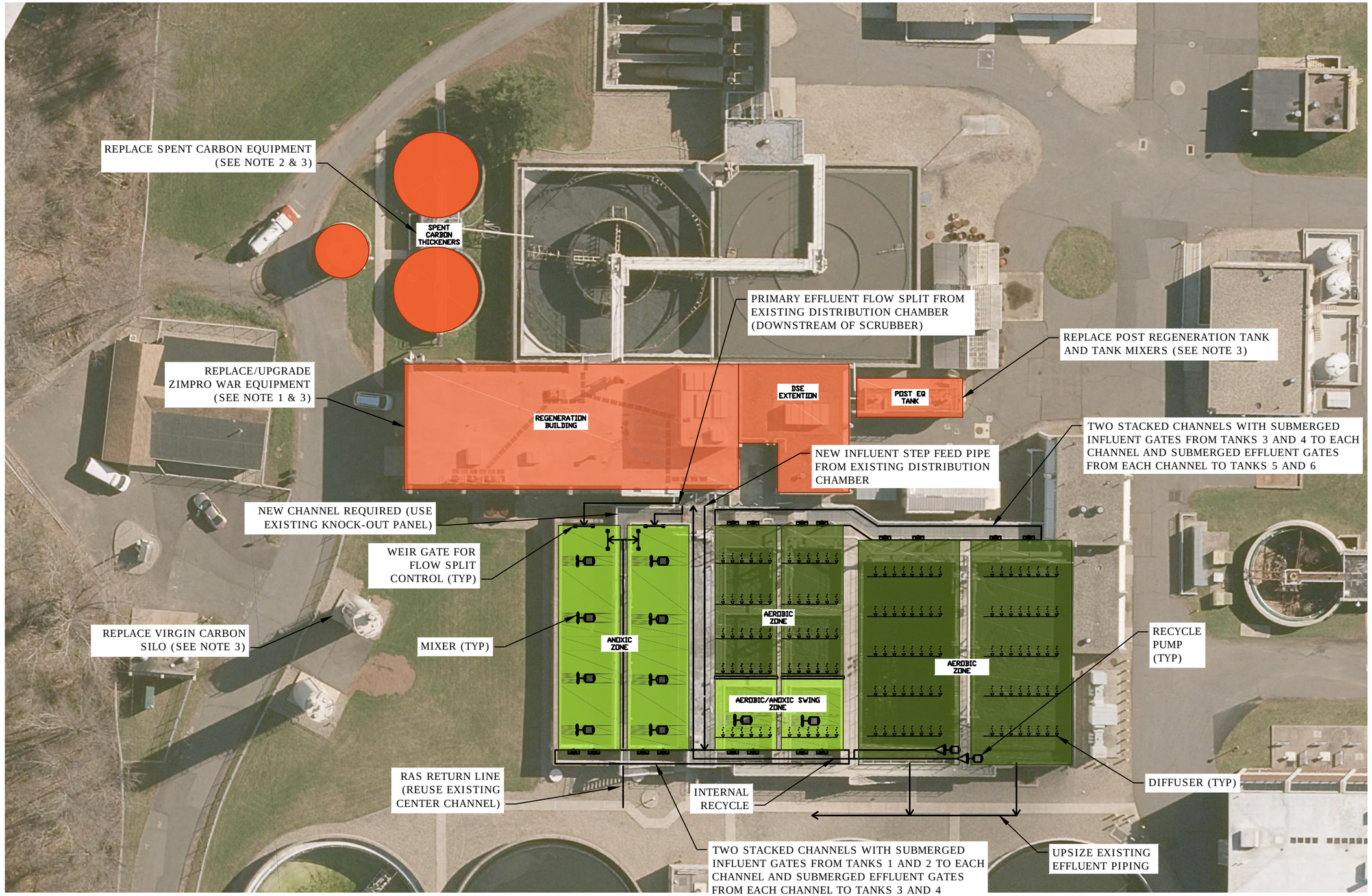
Nitrogen removal in the secondary treatment system is achieved by coupling nitrification and denitrification. As discussed in Section 4, the WPCF has historically observed an average total nitrogen removal across the secondary treatment process of about 54%.

The observed nitrogen removal is likely the result of several factors. First, nitrogen could be removed by biomass being lost via the various recycle streams that go back to the head of the plant where the solids are then captured and removed in the primary clarifiers. Second, denitrification is occurring in the secondary clarifiers. In their 2006 nitrogen facilities plan, Malcolm Pirnie concluded that denitrification in the secondary clarifiers was a significant removal mechanism based on a nitrogen balance across the clarifiers. Since the WPCF has undergone both infrastructure improvements, most notably, converting from coarse to fine bubble diffusers, and operational adjustments in the 2006 report, another mass balance around the clarifiers was conducted in 2017 to confirm these earlier findings. Three grab samples were collected of the secondary clarifier influent, secondary effluent, and RAS. The influent and effluent TN concentration remained virtually identical at 20 mg/L, but the RAS TN concentration fell to 9.5 mg/L on average. This data (coupled with the plant flow rates and the relatively high RAS return rates) suggests that an estimated 700 lb/d of TN is removed by denitrification in the clarifiers further confirming the hypothesis.

Design modifications of the aeration tanks were considered to improve the overall nitrogen removal. A previous study concluded that the available tankage could be configured as an MLE process without additional tankage for average daily flows up to 5.5 MGD, and that more advanced nitrogen removal configurations would not fit within the available tankage. As part of this facilities plan, a spreadsheet model was used to determine tank volumes for nitrogen removal based upon the design future flows and loads. The results confirmed the previous study's conclusions that a MLE configuration was the only layout that can fit within the existing treatment tanks. As discussed in earlier sections, the effluent TN target using an MLE configuration is 8 mg/L. Swing zones that can alternative between aerobic and anoxic zones were considered to optimize nitrogen removal and provide flexibility depending on the flows, loads, and time of year.

### 8.5.2.2 Zimpro PACT-WAR Conceptual Layout

A conceptual layout of an upgraded Zimpro PACT-WAR treatment system is shown in Figure 8-5. This figure illustrates the necessary modifications to the aeration tanks to convert them to an MLE process for nitrogen removal. They also indicate the extent of the WAR equipment that would need to be upgraded.




NOTES:

1. INCLUDES LOWER PRESSURE FEED PUMPS, STEAM BOILERS, REACTOR, HEAT EXCHANGERS, HIGH PRESSURE COMPRESSORS, HIGH PRESSURE FEED PUMPS, REACTOR BLOWDOWN UNIT, PRESSURE CONTROL VALVES, ALL STAINLESS STEEL PIPING, INSTRUMENTATION AND CONTROLS, SCRUBBER CHANNEL ODOR CONTROL BLOWER, DSE ROOM VAPOR BLOWER, DSE CONTROLS, DSE CHEMICAL FEED SYSTEMS, DSE FEED PUMPS, AND ELUTRIATION TANK MIXERS AND ASSOCIATED ELECTRICAL SYSTEMS.
2. INCLUDES GRAVITY THICKENER MECHANISMS, SCUM COLLECTION SYSTEM, SUPERNATANT PUMPS, AND WAS (SPENT CARBON) DAY TANK.
3. RECOMMENDED IMPROVEMENTS ASSUMED TO BE MADE IN 2028 AFTER 50-YR LIFE OF THE ZIMPRO-WAR EQUIPMENT

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ZIMPRO PACT-WAR UPGRADES

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FIGURE 8-5

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### 8.5.2.3 Zimpro PACT-WAR Life Cycle Cost Analysis Assumptions

The life cycle cost analysis (LCCA) for the Zimpro PACT-WAR was conducted based upon the conceptual layout above in Figure 8-5. The LCCA is based upon assumptions that are consistent for all secondary treatment alternatives shown in Section 8.1.1, while specific assumptions for the Zimpro PACT-WAR alternative are outlined below.

Zimpro PACT-WAR system has unique recycle streams that have a significant impact on the loads. Therefore, they were incorporated along with the influent design flows and loads into the LCCA. The two main recycle loads are the WAR regeneration stream and the blowdown. These loads were estimated based upon data collected during a recent sampling program as well as assumptions based upon a theoretical understanding of the Zimpro PACT-WAR system.

- Capital Costs
    - As discussed in Section 5.5, the Zimpro PACT-WAR equipment was installed 40 years ago, and has well surpassed its 20-year design life. Since the longevity of the system is unknown, but well past its expected service life, it was assumed that the Zimpro equipment will have a 50-year service life for the purposes of the cost-effectiveness analysis. For the cost-effectiveness analysis, it is assumed that the PACT-WAR equipment will be replaced in ten years.
    - Capital costs for the main WAR process equipment were provided by the Siemens' evaluation discussed in Section 5. Additional process equipment that was not evaluated by Siemens, but still would require replacement in 2028, were included in the capital costs and estimated by Tighe & Bond. These pieces of equipment include:
        - Two spent carbon gravity thickeners, pumps, and day tank.
        - One virgin PAC silo
        - All DSE system equipment, which includes, the DSE Room vapor blower, 50,000-gallon post equalization tank and three 10 HP mixers, two post equalization pumps, chemical feed systems, and related controls (integrated into the new WAR system controls)
        - Allowances for all electrical upgrades and SCADA integration
    - All equipment and aeration tank modifications proposed on Figure 8-5 for nitrogen removal are carried in the life cycle evaluation as initial capital costs.
- Operations & Maintenance Costs
    - Labor
        - Maintenance and repair costs were assumed to be 1% of the overall equipment costs, which includes both the WAR system and the equipment required based upon the proposed aeration tank

modifications. Maintenance and repair costs over the past 5 years were provided by the WPCF staff and confirmed that this assumption is reasonable.

- The WAR system requires an inspection every 5-years performed by Siemens. The cost of the most recent inspection ($40,000) was carried in the evaluation as an added cost over the maintenance and repair costs.

o Energy Costs

- The current electricity and natural gas consumption demands of the WAR system were evaluated by JK Muir during the energy evaluation discussed in Section 6 and documented in a memorandum attached as Appendix L. This consumption data formed the basis of the evaluation.

- Energy consumed by the WAR system was based on the estimated operating duration of the WAR system. It was assumed that the current operations approach is maintained. That is, start up the WAR system once per week and then run the WAR system at a feed rate of 25 gpm continuously (24/7) until all the stored sludge is processed. The duration of the WAR operation (days of operation per start-up) will increase as flows and loads increase to the WPCF subsequently increasing the amount of WAS to be processed. Equipment subject to these variable energy consumption assumptions include post-equalization tank mixers and pumps, low pressure and high pressure WAR feed pumps, high pressure compressors, and vapor blowers.

- For ancillary systems used in the processing of secondary sludge, assumptions from JK Muir's evaluation (Appendix L) were used to determine operation times (estimated to be like current operations). Equipment falling under this category includes spent carbon gravity thickener drives, spent carbon submersible pumps, spent carbon slurry feed pumps, and virgin PAC silo. This equipment is assumed to consume a fixed power demand independent of sludge volumes.

- Startup of the WAR system (occurs about once weekly) consumes about 90% of the natural gas currently used by the boilers. It is expected that the number of start-ups will be independent of sludge volumes so they will not change significantly over the 20-year evaluation period. However, the boilers are also used periodically if temperatures drop during operation of the WAR system (either due to periodically thinner sludge or WAR blowdowns). Therefore, it is assumed that only 10% of the current natural gas usage for the WAR system will increase in proportion to the increase in sludge to be processed.

o Solids Handling

- Primary clarifier TSS percent removal was assumed to be 70% to reflect the additional solids loading because of the PACT-WAR recycle loads. This percent removal is consistent with the currently observed primary clarifier removal rates as discussed in Section 4.5.2.

- No secondary sludge is being generated.

o Chemical Usage

- Chemicals included as part of the evaluation: virgin PAC, polymer (used to control the settleability of the fine ash in the clarifiers),

- Since the Zimpro PACT-WAR system is only capable of running in an MLE mode, methanol addition was not considered (capital costs for methanol facilities also not included).

o Nitrogen Credits

- Since the Zimpro PACT-WAR system is only capable of running in an MLE mode, and therefore only capable of achieving an effluent TN of 8 mg/L, nitrogen credits need to be purchased to bring the effluent TN concentration down to 4.6 mg/L. This allows all four of the secondary alternatives to be compared on an equivalent basis.

### 8.5.3 Zimpro-PACT Only

The Zimpro-PACT Only alternative is like the Zimpro PACT-WAR alternative with the exception that the PAC is not being regenerated and recycled, but rather is wasted along with the waste activated sludge that will now be produced. This alternative was based upon similar approaches documented in an EPA report about Zimpro PACT-WAR system that were struggling with ash build-up. In this alternative, PAC is added to the mixed liquor to provide organics removals via adsorption and to act as a ballast for better settling in the clarifiers. Because the WAR system will no longer be used, the treatment capacity of the existing tanks can be increased significantly due to the following main reasons:

- The ash content of the MLSS will be reduced from 40% currently with the Zimpro PACT-WAR system running to 20% or less. This allows the volatile solids in the MLSS to increase from 40% of the MLSS to 60% of the MLSS. This is increase of 50% over current levels without changing the load to the secondary clarifiers.

- The high loads from the recycles streams of the WAR system will be eliminated reducing BOD and TKN loads to the secondary process by 15% and 40% respectively.

Since a secondary sludge will now be generated, the solids handling equipment and subsequent costs must be applied.

Advantages

- The PACT process has a higher mixed liquor suspended solids (MLSS) concentrations in the aeration tanks than in conventional activated sludge systems because the presence of powdered activated carbon (PAC) acts as a ballast enabling improved settling rates in secondary clarifiers. This feature increases treatment capacity during high flow periods.
- The PACT process uses PAC to adsorb organics including color.
- The system can be upgraded to operate in a four-stage Bardenpho configuration while utilizing the existing aeration tank volume, which would successfully meet the nitrogen removal target goals.

- Allows EBPR in a 5 stage Bardenpho configuration, potentially reducing chemical costs

- Since the system generates waste activated sludge that must be removed from the system, it enables the removal of total phosphorus, thereby allowing the tertiary process to be designed for an influent TP of 1.0 mg/L TP instead of 3.2 mg/L.

- Compared to the Zimpro PACT-WAR alternative, there are no recycle-streams returning a high BOD and ammonia load to the aeration system to be treated. This reduces energy costs and as discussed above the required treatment volume.

- The amount of equipment required to operate the system would be considerably decreased compared to the PACT-WAR alternative. The WPCF could operate with only one shift.

Disadvantages

- Virgin PAC must be continuously added to the process daily to replace PAC wasted along with the waste activated sludge. The costs for purchasing PAC would be significant.

- Due to the additional PAC in the WAS, the sludge volume would be significantly greater, requiring more equipment for secondary solids processing and greater O&M costs for processing and sludge disposal.

#### 8.5.3.1 Zimpro-PACT Only Conceptual Layout

A conceptual layout of the Zimpro PACT only alternative is provided in Figure 8-6. This conceptual layout was not based on a vendor's proposal, but rather was a modification of the existing system. To keep the comparisons similar, the same 4/5-stage Bardenpho tank configuration used for the IFAS design was mirrored here. This is only possible because of the treatment capacity improvements achieved by eliminating the WAR as discussed above. A discussion of the features of the tank configuration can be found in Section 8.5.5.1. In terms of equipment (aeration systems, mixers, recycle pumps, baffles, etc.), the alternative again mirrors the IFAS design. The main difference is that there is no plastic media associated with this section. Instead, improvements to the existing virgin PAC storage and feed equipment will be included.




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ZIMPRO PACT ONLY
CONCEPTUAL LAYOUT

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FIGURE 8-6

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### 8.5.3.2 Zimpro-PACT Only Life Cycle Cost Analysis Assumptions

The life cycle cost analysis (LCCA) for the Zimpro PACT-only treatment alternative was conducted based on the conceptual layout above in Figure 8-6. The LCCA is based assumptions that are consistent with all secondary treatment alternatives can be found in Section 8.5.1, while specific assumptions for the Zimpro PACT-only alternative are outlined below.

- Capital Costs
    - All equipment and aeration tank modifications proposed on Figure 8-6 are carried in the life cycle evaluation as initial capital costs.
    - Secondary solids processing equipment and infrastructure upgrades were included in accordance with the recommended plan described in Section 8.4.3 above.
- Operations & Maintenance Costs
    - Labor
        - Maintenance and repair costs were assumed to be 1% of the overall equipment costs, which includes the internal recycle pumps, mixers, and control systems.
    - Energy Costs
        - Fixed electricity consumption (independent of flows and loads increases) were provided by the manufacturer. These pieces of equipment include mixers and control and monitoring equipment.
        - Variable electricity consumption (increase as flows and loads increases) were estimated based on HP of the equipment and varied as flows and loads increase, such as blowers and recycle pumps.
    - Solids Handling
        - The amount of secondary solids generated includes both biological solids as well as PAC that is wasted. The quantity of PAC was based upon specific PAC to biomass ratios. Under current conditions, PAC addition occurs at a ratio of 1:2 PAC to biomass (MLSS). As flows and loads increase, PAC addition will need to increase to a ratio of 1:1 PAC to biomass to achieve proper settling at future (20-year) flows and loads and future peak flows. Since the secondary system analysis does not consider solids production from multipoint chemical phosphorus removal, the required PAC quantity may be under estimated compared to a scenario where the phosphorus solids are included.

- Chemical Usage
  - Chemicals included as part of the evaluation: methanol and polymer for the RDTs.
  - As discussed above, if methanol or other carbon addition system is not used with this alternative, then nitrogen credits costs will increase but chemical costs will decrease. This decision is not a major cost driver for this alternative.
  - PAC costs were calculated using the quantity of PAC assumed from the biomass to PAC ratio that is discussed in the solids handling assumptions above.
  - Note that this alternative will enable EBPR and this will reduce chemical and sludge disposal costs already accounted for in the phosphorus evaluation. The potential to reduce these costs was not included in the LCCA for this option.
- Nitrogen Credits
  - Since the IFAS system can achieve the 4.6 mg/L target, no nitrogen credits are needed to be purchased using this alternative.

### 8.5.4 BioMag

BioMag is a ballasted flocculation treatment technology like the Zimpro-PACT only process except that magnetite is used as a ballast instead of PAC, and the magnetite can be partially recovered. Magnetite is $Fe_3O_4$, a readily-available, inert iron ore that is not magnetic itself but is strongly drawn to a magnet. Magnetite has a specific gravity of 5.2 which is approximately twice that of sand. Incorporating magnetite into a biological floc increases the specific gravity of the floc and the settling rate. This allows operators to appreciably increase the mixed liquor concentration, while still maintaining adequate settling and thickening in the secondary clarifiers. The magnetite is recovered from the waste activated sludge using high shear mixing and magnetic drum separation, and is returned to the aeration tank.

Advantages

- Magnetite is much less expensive per unit weight than PAC
- Allows biological nitrogen removal, reducing nitrogen trading program costs
- Allows biological phosphorus removal, potentially reducing chemical costs if successful.
- Creates waste activated sludge that is removed from the process, enabling the tertiary process to be designed for an influent TP of 1.0 mg/L TP instead of 3.2 mg/L

Disadvantages

- The existing aeration tanks are too small to meet the design requirements with BioMag, requiring construction of two additional 450,000-gallon aeration tanks.
- The layout proposed by BioMag requires significantly more internal tank baffles than the other alternatives
- The magnetite recovery process is energy intensive
- Virgin magnetite must be added to the process daily to replace magnetite lost in the WAS
- Some magnetite is not recovered and is lost in the WAS, adding additional waste solids that need to be thickened and disposed of

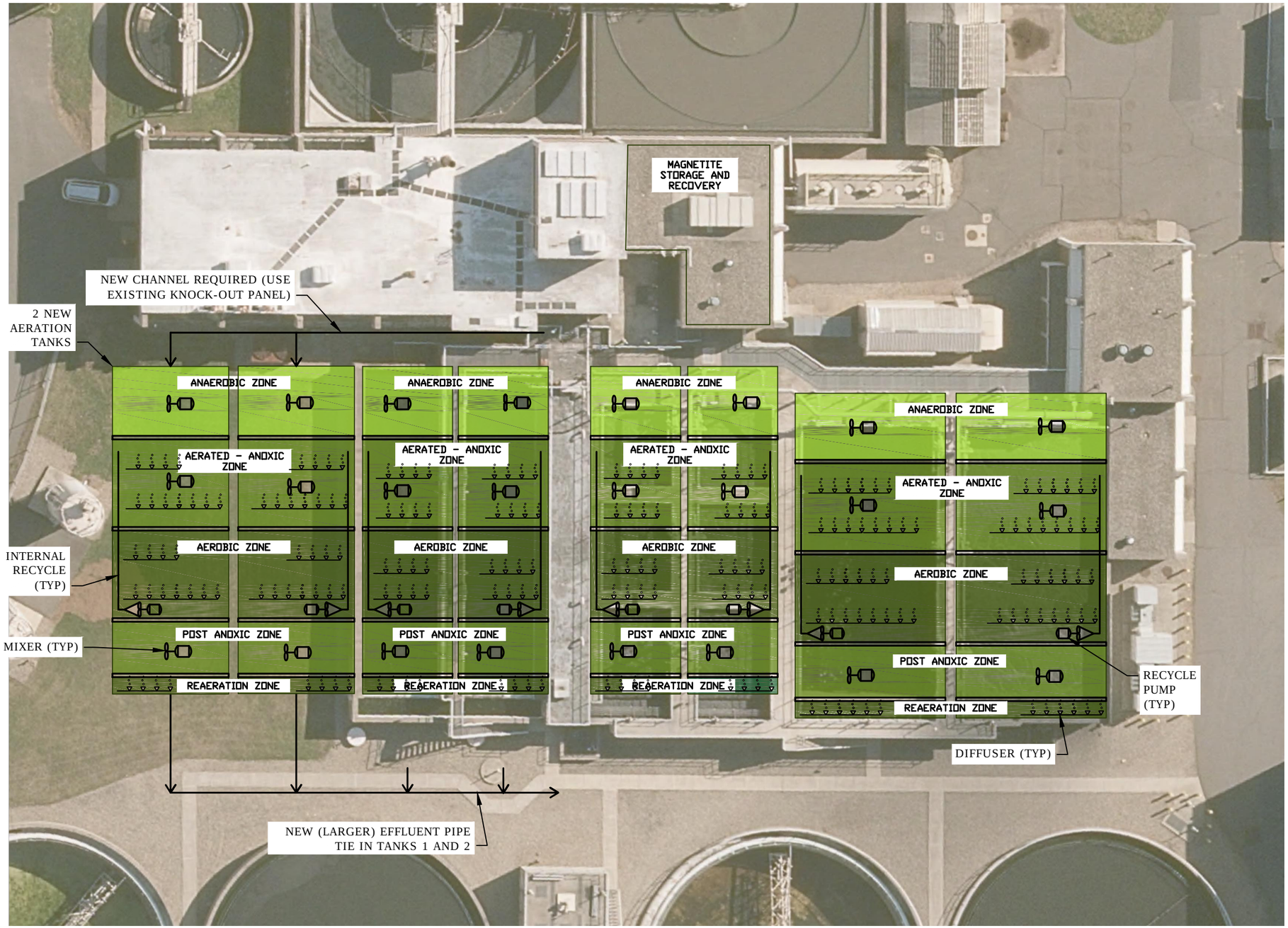
#### 8.5.4.1 BioMag Conceptual Layout

- A conceptual design for the BioMag alternative is provided in Figure 8-8, which is based upon the manufacturer's proposal. Since the manufacturer developed the models from which the design was based, and the manufacturers are held to performance guarantees, major modifications to the design were not considered. The conceptual design of the BioMag system at the Vernon WPCF would consist of the following features: All six existing aeration tanks would be used in parallel with flow being proportioned to each.
- Two additional 450,000-gallon parallel aeration tanks would be added along with a new influent channel and effluent piping connected to the existing system hydraulics, bringing the total number of parallel tanks to eight.

- Baffles, mixers, diffusers, and internal recycle systems would be provided in each tank to create aeration zones for biological nutrient removal

- A new magnetite addition and recovery system would be provided in the existing Regeneration Building consisting of magnetic drum separators, shear mills, a magnetite silo, mix tank, etc.

- Evoqua recommended that a polymer system be provided

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BIOMAG CONCEPTUAL LAYOUT

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FIGURE 8-7

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### 8.5.4.2 BioMag Life Cycle Cost Analysis Assumptions

The following key assumptions were used to calculate the operation and maintenance costs there were used in the Life Cycle Cost Analysis:

- Capital Costs
    - The ballast recovery drums were assumed to be replaced every 5 years at a cost of $100,000 per replacement. This assumption was based on the manufacturer's recommendation to replace the magnetite recovery drums due to excessive wear at a BioMag installation in Sturbridge, MA. The Sturbridge facility was installed approximately 5 years ago and replacement costs were quoted as $77,000.
- Operations & Maintenance Costs
    - Labor
        - Compared to the Zimpro PACT only and IFAS alternatives, the BioMag alternative has significantly more equipment (the entire magnetite recovery system) that needs to be operated and maintained. It is assumed that this additional equipment will add approximately half of a full-time staff person.
    - Energy Consumption
        - BioMag requires significant power cost associated with the magnetite recover equipment. The power cost used in the life cycle cost analysis is based on Evoqua's equipment proposal.
    - Solids Handling
        - BioMag typically results in WAS concentration of about 1.6% solids, which is roughly double that of IFAS and Zimpro-PACT Only. This results in a lower volume of unthickened sludge to be processed.
    - Chemicals
        - BioMag requires constant addition of magnetite to replace magnetite that is lost in the magnetite recovery system. Based on the proposal by Evoqua, approximately 600 to 800 lbs/day of virgin magnetite is anticipated.
        - Polymer usage is based on Evoqua's proposal at a dosage rate of 0.5 mg/L as dry product.
        - Note that this alternative will allow for enhanced biological phosphorus removal and this will reduce chemical and sludge disposal costs already accounted for in the phosphorus evaluation. The potential to reduce these costs was not included in the LCCA for this option.

- Nitrogen Credits
  - As discussed above, if methanol or other carbon addition system is not used with this alternative, then nitrogen credits costs will increase but chemical costs will decrease. This decision is not a major cost driver for this alternative.

### 8.5.5 IFAS

IFAS, integrated fixed-film activated sludge, is a hybrid process that utilizes both conventional activated sludge with fixed film growth to increase the effective mixed liquor concentration without increasing the solids loading to the secondary clarifiers. Plastic media is added to the aeration tanks to provide additional surface area from which biomass can attach and grow. To avoid washout of the media, it is contained within the aeration tanks using baffle walls and screens that allow the mixed liquor to pass through. Mass transfer of nutrients across the fixed-film biomass growth may allow for simultaneous nitrification-denitrification, which further increases the overall treatment capacity for systems designed to remove nitrogen. IFAS systems are often recommended as retrofits for existing treatment plants that need to increase treatment capacity within the same footprint.

Advantages

- The proposed IFAS system can achieve the design requirements while utilizing the existing aeration tank volume. No additional tanks will need to be constructed.

- Since the system generates waste activated sludge that must be removed from the system, it allows for the removal of total phosphorus, thereby allowing the tertiary process to be designed for an influent TP of 1.0 mg/L instead of 3.2 mg/L.

- Allows biological nitrogen removal in a 4-stage Bardenpho configuration, which reduces nitrogen trading program costs.

- Allows EPBR in a 5-stage Bardenpho configuration, potentially reducing chemical costs

- Requires minimal operating equipment compared to other alternatives, reducing the amount of maintenance and energy consumption.

Disadvantages

- Generates a secondary sludge which must be disposed

- Requires supplemental carbon dose to meet the 4.6 mg/L effluent TN design target at 20-year design flows and loads.

#### 8.5.5.1 IFAS Conceptual Layout

Proposals for IFAS systems were received from Kruger, Inc. and Suez Environmental. Both manufacturers provided designs based upon their computer–based modelling software, and were verified as part of the evaluation to confirm the feasibility of the system. The conceptual layout consists of the following features:

- All six existing aeration tanks would be reconfigured into two parallel treatment trains. Each of the three pairs of aeration tanks would be mirrored, such that each treatment train would consist of three identical tanks in series.

- Baffles, mixers, diffusers, and internal recycle systems would be provided in each tank to create designated anaerobic, anoxic, and aeration zones for biological nutrient removal. Swing anaerobic and anoxic zones will be provided to allow flexibility to nitrify in the winter and provide EBPR in the summer.

- Flexibility to switch to a step-feed operation mode to manage the solids loading at higher flow rates.
- Approximately 2,500 cubic yards of plastic IFAS media to be contained within the aerobic zones by the necessary retention screens.
- Surface wasting to allow for the removal of foam and scum buildup as a method of controlling Nocardia.

A conceptual layout of the IFAS secondary treatment system is shown in Figure 8-8. This figure illustrates the necessary modifications to the existing aeration tanks as well as the required additional equipment.




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IFAS CONCEPTUAL LAYOUT

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FIGURE 8-8

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### 8.5.5.2 IFAS Life Cycle Cost Analysis Assumptions

The life cycle cost analysis (LCCA) for the IFAS treatment alternative was conducted based upon the conceptual layout above in Figure 8-8. The LCCA is based upon assumptions that are consistent with all secondary treatment alternatives that can be found in Section 8.5.1, while specific assumptions for the IFAS alternative are outlined below.

- Capital Costs
    - All equipment and aeration tank modifications proposed on Figure 8-8 are carried in the life cycle evaluation as initial capital costs.
    - Secondary solids processing equipment and infrastructure upgrades were included in accordance with the recommended plan described in Section 8.4.3 above.
    - The IFAS manufacturer verified that all the equipment provided by their scope (including the plastic media) has an expected life that would exceed the twenty-year evaluation period. Therefore, no equipment replacement costs were included in the LCCA.
- Operations & Maintenance Costs
    - Labor
        - Maintenance and repair costs were assumed to be 1% of the overall equipment costs, which includes the internal recycle pumps, mixers, and control systems.
    - Energy Costs
        - Fixed electricity consumption (independent of flows and loads increases) were provided by the manufacturer. These pieces of equipment include mixers and control and monitoring equipment.
        - Variable electricity consumption (increase as flows and loads increases) were estimated based on HP of the equipment and varied as flows and loads increase, such as blowers and recycle pumps.
    - Chemical Usage
        - Chemicals included as part of the evaluation: methanol and polymer for the RDTs.
        - Note that this alternative will enable EBPR and this will reduce chemical and sludge disposal costs already accounted for in the phosphorus evaluation. The potential to reduce these costs was not included in the LCCA for this option.

- Nitrogen Credits
  - Since the IFAS system can achieve the 4.6 mg/L target, no nitrogen credits are needed to be purchased using this alternative.
  - As discussed above, if methanol or other carbon addition system is not used with this alternative, then nitrogen credits costs will increase but chemical costs will decrease. This decision is not a major cost driver for this alternative.

### 8.5.6 Secondary System Economic Evaluation

The life cycle cost analyses were conducted for the four secondary treatment alternatives at the Vernon WPCF. This section contains a summary of the O&M costs, capital costs, and replacement costs for each alternative that can be easily compared.

The summary of the capital costs for each alternative are shown in Table 8-15 below (separate page). Capital costs include general conditions, contractor overhead and profit, contingency, and engineering, in 2017 dollars.

The summary of the operations and maintenance costs for each alternative are shown in Table 8-16 below. The O&M present worth costs are summarized into five main categories: labor, energy, chemicals, solids handling, and nitrogen credits. The PACT-WAR system has the highest labor costs primarily because it requires the WPCF to staff two additional operators compared to the other alternatives. The PACT-WAR and BioMag alternatives had the highest energy costs due to the more sophisticated solid's handling systems for these alternatives. The PACT only alternative has the highest overall O&M present worth because it is costly to continuously purchase and dispose of PAC without regenerating it. The PACT-WAR alternative has the lowest solids handling costs because it is only disposing primary sludge and not primary and secondary sludge like the other alternatives. However, the PACT-WAR system is the only one to require the purchase of nitrogen credits because it cannot meet the targeted nitrogen removal goals. Overall, the IFAS system has the lowest projected O&M costs over the 20-year evaluation period.

**TABLE 8-16**

Secondary Alternatives – Summary of Present Worth of O&M Costs

| Description | PACT-WAR | PACT Only | BioMag | IFAS |
|---|---|---|---|---|
| Labor | $5,327,000 | $634,000 | $1,640,000 | $576,000 |
| Power | $9,770,000 | $7,157,000 | $13,269,000 | $7,058,000 |
| Chemicals | $4,016,000 | $38,960,000 | $2,708,000 | $1,262,000 |
| Sludge Disposal | $15,343,000 | $33,070,000 | $25,870,000 | $24,745,000 |
| Nitrogen Credits | $1,198,000 | $0 | $0 | $0 |
| Replacement Equipment | $0 | $0 | $274,000 | $0 |
| **Present Worth Total** | **$35,650,000** | **$79,820,000** | **$43,760,000** | **$33,640,000** |

**TABLE 8-15**
Secondary Alternatives - Summary of Capital Cost Analysis

| Capital cost | PACT-WAR | PACT Only | Ballasted Flocculation | IFAS |
|---|---|---|---|---|
| Package Equipment | $9,800,000 | $872,800 | $5,656,000 | $3,514,000 |
| Additional Process Equipment | $2,776,000 | $630,000 | $284,000 | $580,000 |
| Modified and New Structures | $1,392,000 | $907,000 | $3,328,000 | $897,000 |
| Piping and Support Systems | $2,174,000 | $747,000 | $1,296,000 | $747,000 |
| Solids Handling | $0 | $4,678,000 | $4,178,000 | $4,178,000 |
| **Subtotal** | $16,142,000 | $7,834,800 | $14,742,000 | $9,916,000 |
| General Conditions at 10% | $1,614,000 | $783,000 | $1,474,000 | $992,000 |
| **Subtotal** | $17,756,000 | $8,617,800 | $16,216,000 | $10,908,000 |
| Contractor OH&P at 15% | $2,664,000 | $1,293,000 | $2,432,000 | $1,636,000 |
| **Subtotal** | $20,420,000 | $9,910,800 | $18,648,000 | $12,544,000 |
| Contingency at 30% | $6,126,000 | $2,973,000 | $5,594,000 | $3,763,000 |
| **Total Construction Costs** | $26,546,000 | $12,883,800 | $24,242,000 | $16,307,000 |
| Engineering at 20% | $5,309,000 | $2,577,000 | $4,848,000 | $3,261,000 |
| **Total Project Costs (2017)** | **$31,860,000** | **$15,460,000** | **$29,090,000** | **$19,570,000** |

A life-cycle cost analysis was performed as a present worth analysis based on a 20-year life cycle, including capital costs and annual O&M costs. A summary of the life cycle cost analysis for the alternatives is included in Table 8-17.

**TABLE 8-17**

Secondary Alternatives – Summary of Life Cycle Cost Analysis

| Description | PACT-WAR(1) | PACT Only | BioMag | IFAS |
|---|---|---|---|---|
| Capital Cost (2)) | $31,860,000 | $15,460,000 | $29,090,000 | $19,570,000 |
| Operational Cost | $35,650,000 | $79,820,000 | $43,760,000 | $33,640,000 |
| **Present Worth** | **$67,510,000** | **$95,280,000** | **$72,850,000** | **$53,210,000** |

(1) These costs do not include the added $6,000,000 in additional present worth costs to the tertiary system if the Zimpro PACT-WAR process was retained as documented in Table 8-10. If this was included then the Present Worth Costs would be $73,500,000, which is higher than the BioMag alternative.

(2) Includes equipment replacement costs for the PACT-WAR process.

### 8.5.7 Secondary System Alternatives Discussion and Recommendations

As shown in Table 8-17, the IFAS alternative has the lowest 20-year net present worth. There are significant differences in the overall present worth between each of the alternatives; none of the alternatives is within 10% of each other. This helps confirm that IFAS is in fact the most economical of the secondary treatment alternatives. Even if there are minor refinements in the assumptions made as part of the LCCA, the difference between the alternatives is too significant to impact the overall outcome of the analysis. In addition, the simplifying assumptions discussed previously will not impact the present worth cost of the IFAS system. They will however drive up the costs of the other alternatives. Since the IFAS alternative is the lowest cost alternative, there is no need to complete a more detailed evaluation.

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# SECTION 9

# Section 9
# Recommended Plan

This section presents the recommended capital improvements for Vernon's Water Pollution Control Facility. The improvements are needed to preserve the Town's wastewater infrastructure, maintain reliable service and compliance with its NPDES permit which includes stringent new limits for phosphorus. Most of the WPCF equipment is 25 to 40 years of age or older and has exceeded its reliable service life.

Opinions of probable project costs for the recommendations were developed for use in the Town's capital planning. Working with Town staff, a 20-year capital improvements plan (CIP) with phased implementation of the projects was developed taking into account anticipated grant money from the Connecticut Clean Water Fund (CWF) as well as the financial contributions from the four communities that have inter-municipal agreements with Vernon.

The budgetary estimate includes construction, engineering, and contingency escalated to the midpoint of construction. The planning level budgetary estimates presented in this section are Class 4 estimates, as defined by the Association for the Advancement of Cost Engineering (AACE) International Recommended Practices and Standards. Per AACE International Recommended Practices and Standards, the estimate class designators are labeled Class 1, 2, 3, 4, and 5, where a Class 5 estimate is based on the lowest level of project definition and a Class 1 estimate is closest to full project definition and maturity. The end usage for a Class 4 estimate is a project study. The expected accuracy range of a Class 4 estimate is between +50% to -30%. The budgetary costs are based on the May 2017 ENR 20-City National Average Construction Cost Index of 10,692.17. For the same period, the ENR Construction Cost Index for the City of Boston was 13,787.13, which indicates that regional conditions are outpacing the national average.

The Vernon WPCF serves Manchester, Tolland, South Windsor, and Ellington, in addition to the Town of Vernon. Each community has an inter-municipal agreement with Vernon that dictates each community's cost sharing responsibility. A more detailed discussion of the inter-municipal agreements can be found in Section 2. Table 9-1 summarizes the cost sharing responsibilities for each of the member communities. This table was used to estimate the percent of the total project costs for which the Town of Vernon is responsible.

## 9.1 Water Pollution Control Facility

While the WPCF has adequate capacity, there is a need to replace aging infrastructure and equipment to maintain performance and reliability of the WPCF. Additionally, the WPCF is not currently configured for nitrogen removal or low-level phosphorus removal. To meet the new NPDES permit discharge limits for total phosphorus, the WPCF will require upgrades to enable consistent removal of total phosphorus. To cost effectively meet its general permit limits for total nitrogen, the WPCF will also require upgrades to enable removal of total nitrogen.

### 9.1.1 Recommended Projects

Table 9-2 summarizes the recommended capital improvements for the Vernon WPCF. The improvements were categorized into two phases:

1. **Immediate:** The Immediate recommendations include:

    a. New tertiary rapid mix/flocculation tanks and disc filtration process, and a multi-point chemical addition system for phosphorus removal to meet the new NPDES permit limits. The disc filter system with chemical storage and feed equipment would be installed within the existing Filter Effluent Building, with new rapid mix tanks located immediately adjacent to the building. Additionally, a second chemical storage and feed area would be located within the Carbon Regeneration Expansion Building (to be renamed).

    b. Reconfiguration of the aeration tanks into a 5-stage Bardenpho system with IFAS media. The recommended design will provide for nitrogen removal, achieving an effluent total nitrogen of 4.6 mg/L at the projected design flows and loads. In addition, the design will incorporate a step-feed pipe and swing zones to provide operational flexibility to optimize nutrient removal. Figure 9-1 details these various operational modes. The swing zones will enable the operators to switch between a 4-stage and a 5-stage Bardenpho system depending on the season and flows and loads (Figure 9-1, A & B). The 5-stage Bardenpho system promotes enhanced biological phosphorus removal, which can reduce chemical usage and sludge production. The step-feed mode will enable operators to carry a higher mixed liquor suspended inventory because during high-flow events changing into step feed mode will reduce the solids loading to the clarifier (Figure 9-1, C).

    c. New secondary solids handling equipment to process waste activated sludge. The recommended improvements include conversion of the dirty water storage tanks to unthickened sludge storage tanks, installation of new rotary drum thickeners in the Solids Handling Building, conversion of the abandoned former digesters into thickened sludge storage tanks, new odor control equipment, and new pumps and pipe lines to transport the sludge. The existing Zimpro PACT-WAR equipment will be abandoned.

    d. New ultraviolet disinfection system to replace the chlorination/dechlorination system. As well as replacement and relocation of the post aeration blowers to the Effluent Filter Building, allowing for the abandonment of the Post Aeration Blower Building.

    e. Plant wide repair or replacement of equipment and infrastructure necessary to maintain reliable performance. This equipment includes: septage receiving pumps/equipment, preliminary treatment equipment, influent pumps, primary and secondary clarifier mechanisms, primary and secondary sludge pumps, intermediate pumps, chemical feed equipment, and plant water pumps.

    f. Upgrades to the electrical distribution system for improved resiliency, lower operational costs, and improved worker safety.

    g. Energy efficiency improvements including high-efficiency blowers, an automated dissolved oxygen control system, decommissioning of the energy-intensive WAR system, pumping and control upgrades throughout the WPCF, and a new plant-wide SCADA system.

2. **10+ Year Deferred:** Headworks odor control scrubber and fan, conversion of WAR building into storage garage, primary sludge thickener upgrades, methanol storage and feed system, and certain structural and architectural improvements being deferred because they are of a lower priority.

It is noted that the estimates of grant eligibility shown in Table 9-2 are preliminary and are an opinion of a probable grant amount. CT DEEP cannot make a final eligibility determination until the completion of the design of the project. For those improvements shown above and in Table 9-2 as being deferred to 10+ years, the Town recognizes that it cannot count on receiving future Clean Water Fund assistance as it is not likely that a deferred project would score enough Clean Water Fund Priority Points to be a fundable project. Based upon the magnitude of the estimated project costs, however, the Town feels it necessary to proceed only with the immediate improvements now and postpone the less critical improvements.

**TABLE 9-1**

Summary of Plant Upgrade Cost Sharing Responsbilities Among the Five Communiites

Vernon Wastewater Facilities Plan

| Community | Cost Sharing Responsibilities (From Intermuncipal Agreements) | Facility Plan Average Daily Flow Allocation | | | Cost Sharing Responsibility Based on Strict Interpretation of IMAs [3] |
|---|---|---|---|---|---|
| | | Flow (MGD) | (% of Proposed Design Flow[1,3]) | (% of Permitted Flow[2,3]) | (% Contribution Capital Costs after State Grants) |
| Manchester | Capital costs are to be repaid based upon a ratio of the average daily flow allocation to Manchester (0.09 MGD) divided by the "average daily design flow" of the Vernon WPCF | 0.090 | 1.88% | | 1.88% |
| Tolland | Capital costs are to be repaid based upon a ratio of the average daily flow allocation to Tolland (0.4 MGD) divided by the "permitted average daily flow" at the Vernon WPCF. | 0.400 | | 5.63% | 5.63% |
| South Windsor | Capital costs are to be repaid based upon a ratio of the average daily flow allocation to South Windsor (115,280 gpd) divided by the "average daily design flow" of the Vernon WPCF. | 0.115 | 2.40% | | 2.40% |
| Ellington | The 2013 modification states that Ellington will be responsible for 19.72% of any future capital costs at the Vernon WPCF. This percentage is equal to 1.4 MGD /7.1 MGD. During the Facilites Planning process, Ellington requested a flow increase to 1.42 MGD to represent "20% of Vernon plant's capacity". | 1.420 | | 20.00% | 20.00% |
| Vernon | Host Community - Responsible for the Balance of Costs | 2.775 | | | 70.09% |
| **TOTAL** | | **4.800** | | | **100.00%** |

[1] The Proposed Design Flow for the Vernon WPCF in Million of Gallons Per Day (MGD) is 4.8

[2] The Permitted Average Daily Flow for the Vernon WPCF in Million of Gallons Per Day (MGD) is 7.1

[3] Community percentages are based upon their intermunicipal agreements with Vernon.

**TABLE 9-2**
Engineer's Opinion of Probable Costs
Vernon WPCF Recommended Plan

| Item No. | Item Description | Proposed Improvements | Opinion of Probable Project Cost[1,2] | Recommended Action Category | Anticipated Grant Eligibility for Immediate Upgrade | Recommended Plan and Project Cost for Each Action Category[1,2] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Immediate[3] | 10+ Years |
| **1 Septage Receiving** | | | | | | | |
| 1A | Septage pumps replacement | Replacement of septage pumps | $255,000 | Immediate | 20% | $255,000 | $0 |
| 1B | Septage and 454 Waste Receiving | Replacement of septage acceptance plant, excluding the pumps | $858,000 | Immediate | 20% | $858,000 | $0 |
| **2 Preliminary Treatment & Odor Control** | | | | | | | |
| 2A | Fine Screening System | Replacement of mechanical screens with IFAS compatible fine screens, screening washer/compactors and influent channel slide gate actuators | $2,994,000 | Immediate | 20% | $2,994,000 | $0 |
| 2B | Grit Removal System | Replacement of grit removal equipment | $1,077,000 | Immediate | 20% | $1,077,000 | $0 |
| 2C | Headworks Odor Control System Chemical Feed Systems Replacement | Replacement of chemical feed storage tanks, pump, piping and chemical containment area coating; installation of sump in containment area; odor control fan VFD | $315,000 | Immediate | 20% | $315,000 | $0 |
| 2D | Headworks Odor Control System replacement | Replacement of headworks odor control equipment, excluding chemical feed systems | $1,627,000 | 10+ Years | 20% | | $1,627,000 |
| **3 Influent Pumping System** | | | | | | | |
| 3A | Influent Pumping System | Replacement of influent pumps, motors, drives and controls and replacement of slide gate actuators | $4,244,000 | Immediate | 20% | $4,244,000 | $0 |
| 3B | Chamber A-Primary Clarifier Distribution Chamber | Replacement of slide gates | $142,000 | Immediate | 20% | $142,000 | $0 |
| **4 Primary Treatment** | | | | | | | |
| 4A | Primary Clarifiers | Replacement of primary clarifier mechanisms, drives, effluent weirs, baffles and scum collectors, and improvements to scum pit | $1,079,000 | Immediate | 20% | $1,079,000 | $0 |
| 4B | Primary Sludge and Scum Pumping | Replacement of primary sludge pumps, primary scum pumps, associated motors, drives, valving, and local piping (as needed to accommodate new valves and pumps) | $694,000 | Immediate | 20% | $694,000 | $0 |
| **5 Not used** | | | | | | | |
| | | | | | | | $0 |
| **6 Secondary Treatment** | | | | | | | |
| 6A | Secondary Treatment (IFAS System) | Installation of IFAS system, including aeration blowers, tank modifications, and piping improvements | $11,846,000 | Immediate | *30%* | $11,846,000 | $0 |
| 6B | Secondary Clarifiers Distribution Chamber | Replacement of distribution chamber slide gates and mixers; construction of baffle wall | $367,000 | Immediate | 20% | $367,000 | $0 |
| 6C | Secondary Clarifiers | Replacement of secondary clarifier mechanisms, drives, effluent weirs, baffles, and scum collectors; clarifier recoating; grating improvements; effluent launder covers | $2,690,000 | Immediate | 20% | $2,690,000 | $0 |
| 6D | Secondary Sludge and Scum Pumping | Replacement of 5 RAS pumps, 2 WAS pumps, 4 scum pumps, associated motors, drives, valving, and local piping (as needed to accommodate new valves and pumps) | $1,800,000 | Immediate | 20% | $1,800,000 | $0 |
| 6E | WAR Room Demolition | Demolition of WAR Equipment in Process Building; Lighting, HVAC, and Painting Upgrades; Conversion to Storage Garage | $996,000 | 10+ Years | 20% | | $996,000 |
| **7 Drainage Pumping System** | | | | | | | |
| 7 | Drainage Pumping System | Replacement of drainage pumps with new submersible pumps and force main to Headworks | $313,000 | Immediate | 20% | $313,000 | $0 |
| **8 Tertiary Treatment** | | | | | | | |
| 8 | Tertiary Treatment | Phosphorus removal equipment, including disc filters, chemical feed systems, associated equipment, and modifications to the Filter Bldg and the Regeneration Bldg Ext.; replacement of Intermediate Pumps with new tertiary system feed pumps | $14,386,000 | Immediate | 50% | $14,386,000 | $0 |
| **9 Disinfection System** | | | | | | | |
| 9A | Disinfection-UV | Replacement of disinfection equipment (pumps, tanks, etc.) with a UV disinfection system, and tank modifications. | $2,824,000 | Immediate | 20% | $2,824,000 | $0 |
| 9B | Post Aeration Blowers | New post aeration blowers relocated to Filter Building basement, valving and local piping (as needed) | $398,000 | Immediate | 20% | $398,000 | $0 |

**TABLE 9-2**
Engineer's Opinion of Probable Costs
Vernon WPCF Recommended Plan

| Item No. | Item Description | Proposed Improvements | Opinion of Probable Project Cost[1,2] | Recommended Action Category | Anticipated Grant Eligibility for Immediate Upgrade | Recommended Plan and Project Cost for Each Action Category[1,2] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Immediate[3] | 10+ Years |
| **10 Sludge Thickening and Handling Systems** | | | | | | | |
| 10A | Primary Thickener Upgrades | Replacement of gravity thickener mechanisms and covers | $825,000 | 10+ Years | 27.5% | | $825,000 |
| 10B | Primary Thickened Sludge Pumping | Replacement of primary thickened sludge pumps, and associated valves and piping (as needed); no new scum pumping or mixing equipment | $528,000 | Immediate | 27.5% | $528,000 | $0 |
| 10C | Secondary Solids Handling Improvements | Replacement of gravity thickeners with rotary drum thickeners, conversion of Dirty Water Storage Tanks to unthickened WAS storage tanks, tank covers, pipe gallery rehab, conversion of abandoned thickeners to thickened WAS storage tanks, rehab vacuum filter area for RDTs, and primary scum site piping | $8,088,000 | Immediate | 27.5% | $8,088,000 | $0 |
| **11 Plant Water System** | | | | | | | 0 |
| 11 | Plant Water & Dilution Water Systems | Replacement of plant water and dilution water pumps, valves and piping (as needed) & relocate equipment to Tertiary Filter Building | $688,000 | Immediate | 25% | $688,000 | $0 |
| **12 Distribution Chamber B** | | | | | | | $0 |
| 12 | Distribution Chamber B | Demolition of slide gates | $19,000 | *10+ Years* | 20% | | $19,000 |
| **13 Bypass Chamber F** | | | | | | | $0 |
| 13 | Bypass Chamber F | Replacement of slide gates & addition of electric actuators | $72,000 | Immediate | 20% | $72,000 | $0 |
| **14 Chemical Feed Systems** | | | | | | | $0 |
| 14A | Methanol Feed System | Installation of new methanol feed system, including pumps, piping, storage tanks, outdoor storage area | $687,000 | 10+ Years | 30% | | $687,000 |
| 14B | Polymer and Soda Ash feed systems | Replacement of soda ash feed system and secondary clarifier polymer feed system, including new silo/storage tank, pumps and piping | $1,566,000 | Immediate | 20% | $1,566,000 | $0 |
| **15 Electrical Distribution System** | | | | | | | $0 |
| 15A | Replace primary electrical distribution equipment installed in the 1970s | Install new service, 4,800 V generator, 1-13,800 to 4,800 V transformer, 3-4,800 to 480 V transformers, feeders between generator and transformers, and related equipment. Demolish Chemical Building for space | $5,379,000 | No action | | | |
| 15B | Replace primary electrical distribution equipment installed in the 1970s and 1990s | Install new service, 13,800 V generator, 3-13,800 V to 480 V transformers, feeders between generator and transformers, and related equipment, Demolish Chem Building for Space | $5,715,000 | Immediate | *20%* | $5,715,000 | $0 |
| 15C | Miscellaneous Electrical Improvements | Replace 1970s MCCs and panelboards, exit signs and emergency lights, receptacles, lights, security cameras, intercom system and fire alarm systems | $2,349,000 | Immediate | *20%* | $2,349,000 | $0 |
| **16 Other Building Systems** | | | | | | | 0 |
| 16A | Structural and Architectural Improvements - Immediate Need | Concrete and masonry repair, roof replacment, grating and railing replacement, steel replacement, replacement of doors and windows, and building renovations, including painting | $2,518,000 | Immediate | *20%* | $2,518,000 | $0 |
| 16B | Structural and Architectural Improvements - Deferred 10+ Years | Concrete and masonry repair, roof replacment, grating and railing replacement, steel replacement, replacement of doors and windows, and building renovations, including painting | $4,623,000 | 10+ Years | *20%* | | $4,623,000 |
| 16C | HVAC Upgrades | HVAC Upgrades | $5,350,000 | Immediate | *20%* | $5,350,000 | $0 |
| **17 SCADA System** | | | | | | | 0 |
| 17 | SCADA System upgrades | Upgrades to current SCADA system, New Plant Database Software and Data Migration | $719,000 | Immediate | *20%* | $719,000 | $0 |
| **18 Site/Civil** | | | | | | | 0 |
| 18 | Site Improvements | Replacement/addition of yard hydrants, pavement repairs, site regrading, site piping | $734,000 | Immediate | *20%* | $734,000 | $0 |

**TABLE 9-2**
Engineer's Opinion of Probable Costs
Vernon WPCF Recommended Plan

| Item No. | Item Description | Proposed Improvements | Opinion of Probable Project Cost[1,2] | Recommended Action Category | Anticipated Grant Eligibility for Immediate Upgrade | Recommended Plan and Project Cost for Each Action Category[1,2] | |
|---|---|---|---|---|---|---|---|
| | | | | | | Immediate[3] | 10+ Years |
| **TOTAL** | | | **$83,386,000** | | | **$74,609,000** | **$8,777,000** |
| **TOTAL COST OF IMPROVEMENTS, ESCALATED TO PROJECTED MIDPOINT OF CONSTRUCTION[4]** | | | **$90,891,000** | | | **$81,324,000** | **$12,200,000** |
| Anticipated Grant Amount | | | $25,058,000 | | | $23,002,000 | $0 |
| **VERNON AND MEMBER COMMUNITIES SHARE TO BE FINANCED** | | | **$65,833,000** | | | **$58,322,000** | **$12,200,000** |
| Short-Term Borrowing Costs[5] | | | $3,344,000 | | | $2,963,000 | $388,000 |
| Bond Counsel Costs | | | $100,000 | | | $100,000 | $50,000 |
| **TOTAL VERNON AND MEMBER COMMUNITIES SHARE** | | | **$69,277,000** | | | **$61,385,000** | **$12,638,000** |
| **TOTAL VERNON SHARE** | | | **$48,556,000** | | | **$43,024,000** | **$8,858,000** |
| **PERCENT OF TOTAL PROJECT COST** | | | **53%** | | | **53%** | **73%** |

* Listed grant eligibility percentage only applies if the project is included as part of the "Immediate" Upgrade. If percentage is shown in *italic*, then a portion of the item's cost may be eligible for a higher grant percentage.

[1]Project costs include 15% for Contractor OH&P, 30% for contingency, 20% for design and construction support engineering, hazardous materials management and pilot testing. Project costs do not include Town administrative costs.

[2]Except where noted, costs are based on May 2017 Engineering News Record 20-City average Construction Cost Index (ENR CCI) of 10,692.17. For the same time period, the ENR CCI for the City of Boston was 13,787.13.

[3]The Town and Tighe & Bond collectively reviewed the list of proposed improvements. Those listed in the Immediate action category are critical upgrades needed to maintain NPDES permit compliance and replace/repair aging equipment/structures that are no longer reliable. In addition, many of these upgrades will result in energy savings as noted in the improvements descriptions.

[4]The following factors were used to escalate cost:

For Immediate project costs (shown in the Opinion of Probable Project Cost Column):

Escalation/yr: 3%
No. of yrs to mid point of construction: 3

For deferred (10+ years) project costs:
Escalation/yr: 3%
No. of yrs to mid point of construction: 13

[5]Short term borrowing costs are based on the following:

For "Immediate" improvements: 36 months of construction, annual loan closings, and a 2% interest rate with participation from the Connecticut Clean Water Fund.

This results in a cumulative annualized short-term borrowing costs factor based on the borrowed costs as noted below:

Short-term borrowing costs factor: 5.08%

For "10+ year" improvements: 18 months of construction, one loan closing, and a 4% bonding assumed for local bonds (and No participation from the Connecticut Clean Water Fund)

This results in a cumulative annualized short-term borrowing costs factor based on the borrowed costs as noted below:

Short-term borrowing costs factor: 3.18%

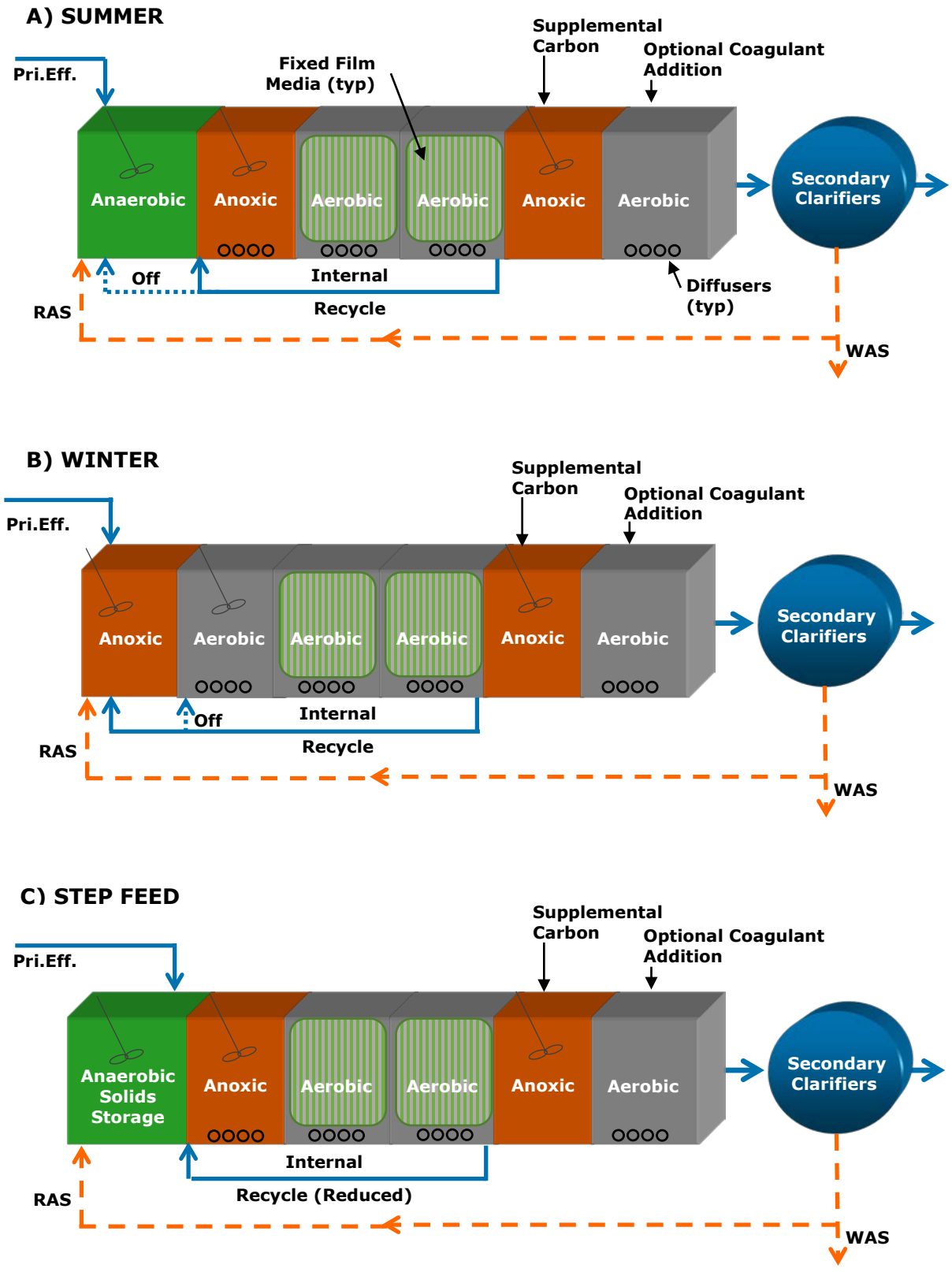



**Figure 9-1:** Schematic for Recommended Plan
4/5 Stage Bardenpho with Swing Zones for Summer and Winter Modes, and Step Feed Mode

### 9.1.2 Preliminary Layout and Hydraulic Impacts

The conceptual site plan of the immediate recommended upgrades is shown on Figure 9-2. A schematic of the updated process flow diagram based upon the recommended improvements is shown in Figure 9-3.

Preliminary layouts of other recommended upgrades are shown in:

- Figure 8-8: conceptual layout for the new aeration tank configuration using IFAS for biological nutrient removal.
- Figure 8-2: conceptual layout for the renovated Filter Effluent Building to include the disc filters and chemical feed systems to achieve low-level phosphorus removal.
- Figure 8-1: conceptual layout for the UV disinfection system retrofitted within the existing chlorine contact tanks.
- Figure 8-4: conceptual layout for solids handling improvements, including unthickened sludge storage retrofitted within the existing dirty water storage tanks, thickened sludge storage retrofitted within the existing abandoned digesters, and sludge thickening equipment retrofitted within the existing vacuum filter area.

The tertiary phosphorus removal system will be located downstream of the reconfigured aeration tanks and secondary clarifiers and prior to the UV disinfection system. Secondary effluent must be pumped at the intermediate pump station to the new flash mix and flocculation tanks and the disc filters before flowing to the UV disinfection system. The existing bypass chamber will be maintained so that the intermediate pump station and tertiary phosphorus system can be bypassed in an emergency.

The proposed improvements will have the following hydraulic impacts, as discussed previously:

- The conceptual layout for the IFAS system consists of reconfiguring all six existing aeration tanks into two parallel treatment trains. Each of the three pairs of aeration tanks would be mirrored, such that each treatment train would consist of three identical tanks in series. In order to place any tank off line for servicing, the trains will be configured so that the remaining tanks in that train can be kept in service.

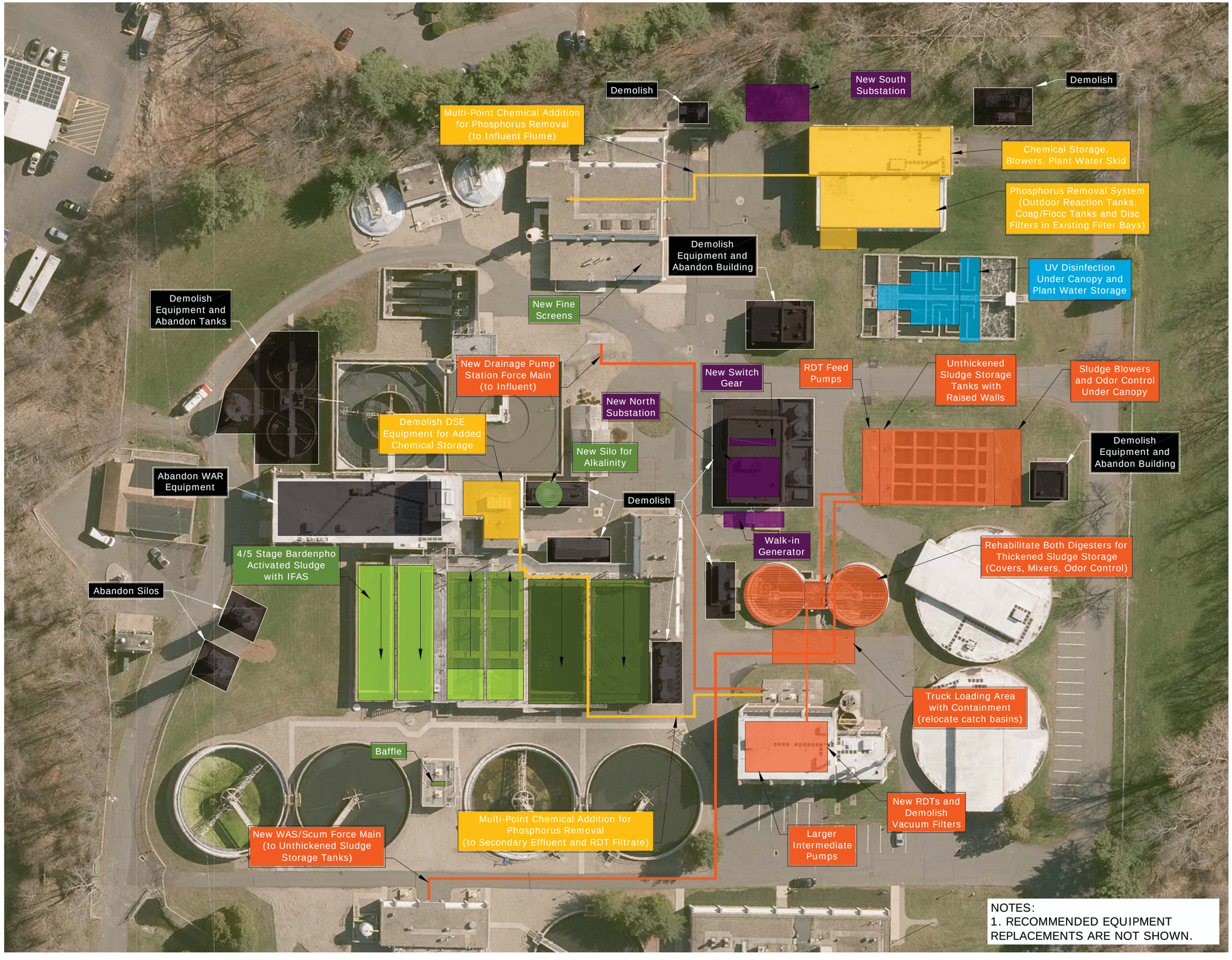
  This will require ensuring an even flow split to each train and even flow distribution to all equipment in service, which will be addressed as part of the upgrades. The upgrades will also address even flow distribution to the clarifiers. See Section 2.1.4 for further discussion.

- The conceptual layout for the disc filters consists of installing the disc filter units within pre-fabricated stainless steel tanks that would then be installed as a system within some of the existing sand filter bays. Additionally, four flocculation tanks would be retrofitted within the remaining existing sand filter bays. In this configuration, a splitter box and rapid mix tanks would be located outside and adjacent to the filter building north-facing wall.

The disc filters and the process tanks will be designed to fit into the plant's hydraulic profile in a manner that is similar to the existing sand filters.

- The UV disinfection system can be fitted within the existing chlorine contact tanks and meet TR-16 resiliency requirements (designed to operate during a 100-yr flood and avoid damage due to flooding during a 100-yr flood plus three feet). This approach is advantageous rather than raising the UV system to a higher elevation because effluent can flow by gravity and enable disinfection, such that intermediate pumping is not required if the pump station fails or the tertiary phosphorus system is bypassed.

  To avoid unnecessary headloss, the reaeration tank weir will need to be extended with weir troughs and used to control the water level of the UV system and the depth of water in the reaeration channel.




NOTES:
1. RECOMMENDED EQUIPMENT REPLACEMENTS ARE NOT SHOWN.

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N

SCALE IN FEET
0 30' 60'
GRAPHIC SCALE

# Wastewater Facilities Plan

Town of Vernon, Connecticut

DRAFT

| MARK | DATE | DESCRIPTION |
|---|---|---|
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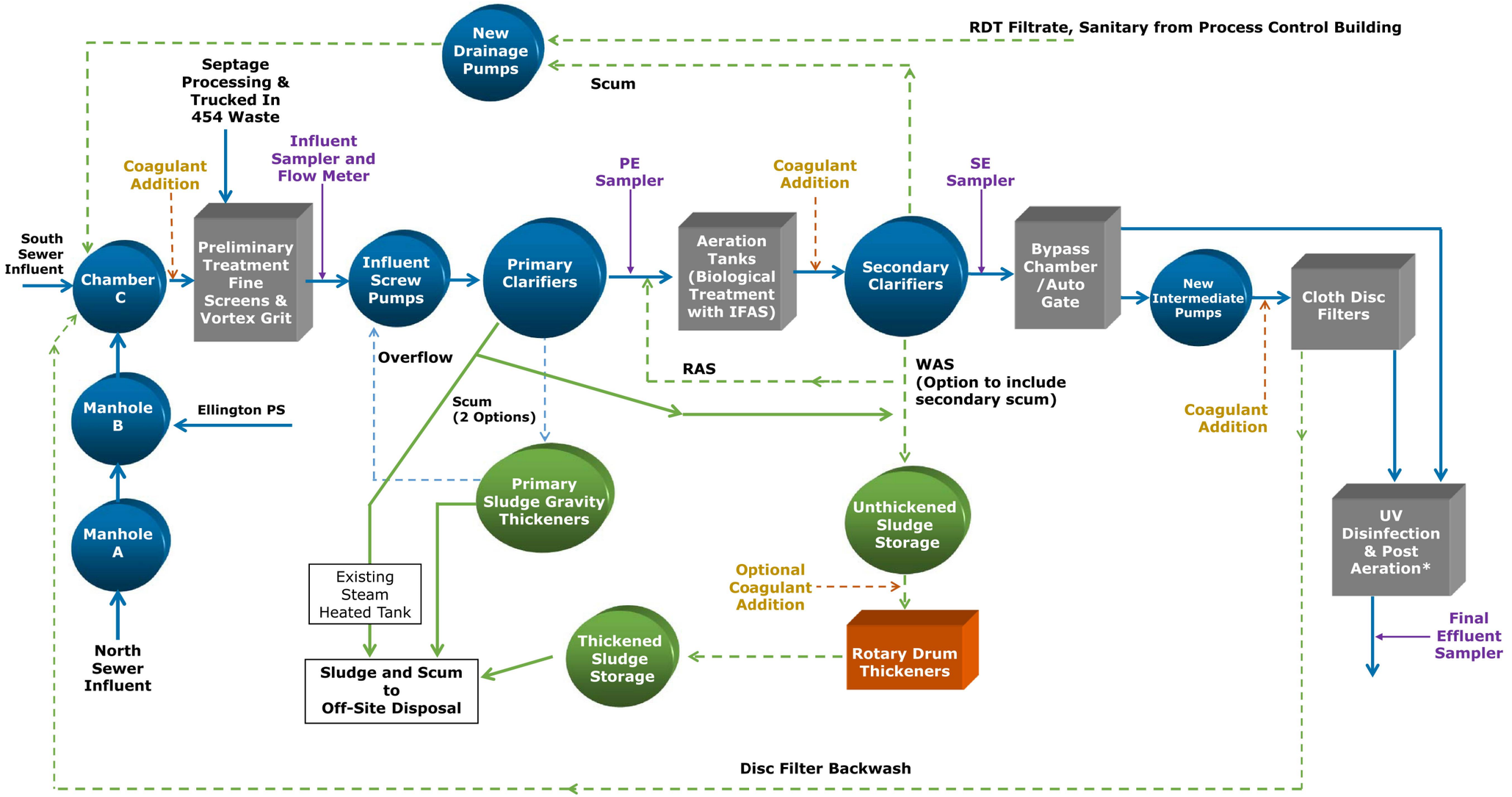
| | |
|---|---|
| PROJECT NO: | V0037 |
| DATE: | MAY 2017 |
| FILE: | V0037 Recommended Improvements.dwg |
| DRAWN BY: | CMC |
| CHECKED: | FAM/IBC |
| APPROVED: | SES |

WPCF MAJOR RECOMMENDED IMPROVEMENTS

SCALE: AS SHOWN

FIGURE 9-2

Last Saved: 4/27/2017
Plotted On: May 05, 2017 - 11:09am By: CMC
Tighe & Bond, Inc. J:\V\V0037 Vernon WWTP\Drawings_Figures\Autocad\Sheets\V0037 Recommended Improvements.dwg

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Wastewater Facilities Plan

Town of Vernon, Connecticut

| MARK | DATE | DESCRIPTION |
|---|---|---|

| | |
|---|---|
| PROJECT NO: | V0037 |
| DATE: | MAY 2017 |
| FILE: | V0037Figures 2-3 and 9-3.dwg |
| DRAWN BY: | ADW/FAM |
| CHECKED: | IBC |
| APPROVED: | SES |

PROPOSED PROCESS FLOW DIAGRAM

SCALE: NO SCALE

FIGURE 9-3

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### 9.1.3 Maintenance of Plant Operations During Construction

The following preliminary strategy has been developed for guidance related to maintenance of plant operations during construction. This will be reevaluated and refined during the design. Applicable costs are included in the recommended plan.

1. Intermediate Pumps, Filter Building, and Dirty Water Storage Tanks:

    a. These can be taken offline immediately and not used, since the plant has demonstrated that it can meet effluent criteria without these under current flows and loads and the current Zimpro operational strategy. Proceed immediately with upgrades related to low level phosphorus removal and required intermediate pumping.

    b. For planning purposes, this upgrade should be completed prior to taking the Zimpro process offline and prior to transitioning to IFAS, since the system will be stressed during transitions when tanks are converted. This will be evaluated further during design.

2. Preliminary Treatment Building (and Odor Control):

    a. Renovate one mechanical screen, screenings wash press, vortex grit chamber, and grit classifier at a time. Renovate septage receiving facility and pumps while using the existing septage receiving manhole to receive septage. Provide bypass piping to receive 454 waste at current location and use only one receiving tank at a time, until new septage receiving system is up and running. If necessary, discontinue (or delay) receipt of 454 wastes. Complete all these changes in the building and start-up the system.

    b. Challenges related to electrical equipment and space within the electrical room include: 1) keeping the old systems running while starting up the new systems within the limited space available in the control room; and, 2) because existing systems (e.g. both mechanical screens, both grit systems) share a common control panel. During design, consider putting new SCADA-based control panels for influent pumps where the septage receiving control panel is located. Start-up that system, then demolish the next system, and continue work on the next system. This may require temporarily relocating one or two control panels. Install new septage panel last. Integrate vendor control panels with SCADA panel that also controls influent pump as the systems are set-up.

    c. Replace odor control system chemical metering pumps and tanks one at a time. Use temporary chemical feed pumps and drum quantities of chemicals on pallets, if needed during change-over. (Note that the new odor scrubber and fan at the headworks is being deferred, and it is not considered now).

3. Influent Pumps:

    a. Renovate one pump at a time. Require one month of trouble-free operation prior to taking the second pump off line.

b. See Preliminary Treatment Building discussion for controls discussion.

4. Primary and Secondary Clarifiers:

   a. Upgrade one at a time. Work should proceed as soon as possible.

   b. Bypass pumping and/or piping will be required to make changes to the isolation gates on the primary influent channel and to install baffles in the secondary clarifier distribution box. If the secondary clarifier distribution box weirs are modified on the downstream side of the stop log, then this can be done when the clarifier is offline. It may be possible to divert flow to an offline primary clarifier or secondary aeration tank to stop flow to the secondary clarifier distribution box for a short period to complete modifications without installing bypass pumping. Temporary stop gates in the primary influent channel may also be feasible during gate replacement. Sludge pump suction piping modifications should be done while the clarifier is offline. Bypass pumping related to the secondary clarifier distribution box should be coordinated with the bypass pumping needed during the modification of the aeration tank effluent piping discussed below.

   c. For planning purposes, all five clarifiers should be completed prior to taking the Zimpro process offline and prior to transitioning to IFAS, since the system capacity will be stressed during transitions when tanks are converted.

5. Thickened Sludge Pump Station and Primary Sludge Thickeners:

   a. Upgrade one pump at a time. Work should proceed as soon as possible.

   b. Note that improvements to the primary sludge thickeners is being deferred and is not considered at this time.

6. Secondary System:

   a. Upgrades to the aeration tanks should be made once other equipment necessary to support the IFAS system and accommodate secondary sludge is installed and functioning (such as fine screens and secondary sludge handling systems). In addition, it is recommended that the secondary clarifiers and tertiary system upgrades be completed and placed online prior to working on the secondary system for additional flexibility and resiliency at the WPCF and ensuring permit compliance should the facility experience a process upset during construction.

   b. The current secondary system operates tanks #3, #4, and one of either #5 and #6. While continuing to operate under the PACT-WAR mode, take Tank #5 (or Tank #6) offline and convert it into the recommended IFAS design. Once complete, put Tank #5 back online while still operating under the PACT-WAR mode. At this point, take Tank #6 offline to complete the necessary conversion to the IFAS configuration.

c. Once the Tank #5 and #6 conversions are completed, it is anticipated that these two tanks with IFAS will be capable of temporarily providing treatment of the current plant flows and loads. Getting the needed capacity out of Tanks #5 and #6 will require relying on higher MLSS levels until the rest of the aeration tanks are placed online. The following options will be considered:

    i. Require all clarifiers to be online when aeration tank work is being completed.

    ii. Require tertiary phosphorus system to be online during transitions.

    iii. Use temporary piping and pumps to enable step feed during high flows.

    iv. Aeration in the post anoxic zone

d. Once Tanks #5 and #6 have both been converted (to be ready for IFAS), place both tanks online and allow a transition period.

e. The effluent piping connecting Tanks #5 and #6 to the secondary clarifier distribution box will require upsizing. This will require bypass pumping and should be completed before taking Tanks #1, #2, #3 and #4 offline. Modifications to the secondary clarifier distribution chamber inlet should be made at the same time.

f. With Tanks #5 and #6 online, Tanks #1 through #4 can all be converted to the new configuration, including construction of a new influent channel to Tank #1, and modifications to the tunnel between Tanks #2 and #3 and to the channel conveying flow from Tanks #1 and #2 to Tanks #3 and #4.

g. At any point prior to directing flow to Tanks #1 and #2, temporary bypassing of the scrubber channel and west distribution chamber will be required to replace the influent slide gates.

h. Once all six tanks have been converted to the new configuration with IFAS and the Tank #1 - #4 channel has been completed, influent flow can be directed to Tanks #1 and #2, while bypass pumping is setup to convey flow from the end of Tanks #3 and #4 to the beginning of Tanks #5 and #6. This will allow for modifications to the channel located to the south of Tanks #3, #4, #5, and #6.

i. Since the DSE equipment is not currently used by the WPCF staff, work to demolish the system and install chemical feed systems for multipoint chemical addition can be completed at any time. However, care must be taken to avoid demolishing existing pumps that are part of the WAR equipment and that need to operate while the WAR system is operating. The contractor will be responsible for providing temporary chemical feed storage and equipment to be added to the secondary system to meet phosphorus permit requirements in the interim.

j. The existing soda ash silo will be maintained and used as needed throughout construction. The new silo cannot be constructed until after the WAR system is permanently offline and the WAR post-EQ tank can be demolished.

7. Unthickened Sludge Storage (Dirty Water Storage Tanks):

   a. Proceed to construct immediately after the dirty water storage tanks are taken out of service. No MOPO coordination is needed except for piping the new tie-in, which can be coordinated with operations for a one-day outage with minimal impact on plant operations.

8. Blower Building:

   a. Replace one blower at a time.

   b. Utilize existing air piping systems to the extent possible.

   c. Control room space is plentiful and as long as there is enough power, use this area for controlling new aeration tank mixers, nitrate return pump controls, etc.

9. Return Sludge Pump Station:

   a. Replace one pump at a time (typical for WAS, scum, and RAS). Complete work prior to making aeration tank renovations. If RAS wet well work or scum well work is required, shift to using upper two clarifiers during dry weather only and three lower clarifiers at other times.

   b. Complete RAS piping modifications prior to the aeration tanks going online.

10. Plant Water System & Post Aeration Tank Blowers:

    a. Install new plant water pumps and post aeration tank blowers in Effluent Filter Building and connect line to new UV/existing reaeration tank. Complete work during disinfection system upgrades discussed below.

    b. Contractor may need to provide temporary pumping during tie-in of the new pumps into the existing plant water distribution system.

11. Disinfection:

    a. Complete most modifications during winter season when disinfection is not required. Start work in summer (dry weather) while operating only 1/2 of the chlorine contact tank. Must maintain post aeration system in service during construction. Keep at least half of this system online year-round.

12. Electrical Distribution System

    a. Construct new medium voltage equipment near center of plant after demolishing Chemical Building (can start after UV system construction is started).

    b. Construct new substations in the plant where required.

c. Provide temporary power to critical equipment as new or existing MCCs are re-fed from the new electrical distribution system.

d. When this is complete, demolish old electrical distribution systems.

## 9.2 WPCF Staffing Assessment

This section contains staffing estimates for the facilities following the completion of the recommended improvements. The Town maintains a separate staff to maintain the collection system and pump stations. Therefore, a staffing analysis for the collection system was not included as part of this analysis.

### 9.2.1 Methodology

A staffing analysis for the Town of Vernon WPCF was developed using the guidance document developed by the New England Interstate Water Pollution Control Commission (NEIWPCC) titled "The Northeast Guide for Estimating Staffing at Publicly and Privately Owned Wastewater Treatment Plants," dated November 2008. NEIWPCC developed this guidance document to update the 1973 EPA staffing guide titled "Estimating Staffing for Municipal Wastewater Treatment Facilities." Wastewater treatment has seen many changes since the publication of EPA's 1973 document demonstrating the need for an up-to-date guide such as NEIWPCC's document. Treatment processes, technologies, control techniques, residual handling and terminology are all examples of changes that have occurred in wastewater treatment since 1973. These changes and others are reflected in NEIWPCC's staffing guide.

The NEIWPCC staffing guide was developed through surveys and pilot studies of plants located throughout New England and New York. The survey results were used to make the staffing estimate tables included in the guidance document. A review was conducted with a substantial group of experienced superintendents, regulators, and consultants drawn from throughout New England to affirm consensus with respect to approach and to confirm that the guidance documents yielded accurate results for estimating staffing at wastewater treatment facilities.

NEIWPCC developed seven charts that help estimate staffing requirements with the following titles:

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

Within these charts NEIWPCC lists various processes, tasks, and activities that are commonly carried out at wastewater treatment facilities. An estimate is given of how many hours a day are required by an employee to conduct these various activities. The amount of time required is directly related to the design flow of the treatment plant.

Charts 1 through 5 were used to establish an estimate of the daily hours required to operate and maintain the Vernon WPCF. Charts 6 and 7 do not give a numerical value of hours but rather give an insight into the extent of automation at the WPCF as well as additional staffing considerations. The daily hours corresponding to Charts 1 through 5 were translated into annual hours required based on the number of shifts operated at the WPCF.

The Vernon WPCF falls under NEIWPCC's "One-Plus Shift Plant" category, which is any facility that has one shift a day, seven days a week or one shift a day, five days a week, with a reduced number of hours on weekends. Although, the Vernon WPCF has 24-hour staffing, it was not considered as a "24/7" plant for the purposes of this evaluation because the 2nd and 3rd shift operators are solely staffed to operate the Zimpro PACT-WAR system. These shifts are also not used over the weekends, so it isn't a true 24/7 operation. Instead, the WPCF was evaluated as a "One-Plus Shift Plant" and additional staffing considerations were made for the Zimpro PACT-WAR process as discussed in Section 9.2.1.2 below. When using the "One-Plus Shift Plant" category, the daily hour estimates for a given task in Charts 1 through 5 were multiplied by 320 to get annual hours. NEIWPCC then recommends dividing the estimated annual hours by 1,500 hours per year (EPA's estimate of the number of hours worked by a single employee a year) to estimate the number of employees required. The number of hours worked a year by an employee assumes a 5-day work week, 29 days of vacation, sick leave, holidays, and 6.5 hours per day of productive work.

Design flows, flow diagrams, unit processes, and other information pertaining to the Vernon WPCF were used by Tighe & Bond when filling out these charts to establish a baseline staffing estimate. Adjustments to the baseline analysis were then made based on NEIWPCC Charts 6 and 7 as well as information obtained during our review of the WPCF. The results of the treatment personnel staffing requirements are included in the following sections.

### 9.2.2 Existing WPCF Staffing Requirements

Analysis of staffing requirements for the current Vernon WPCF in accordance with the NEIWPCC guidance document's charts 1 through 5 indicates a need for approximately 11 operation/maintenance and laboratory staff without accounting for the collection system. The evaluation using Charts 1 through 5, does not include any staffing considerations towards the Zimpro PACT-WAR system. Since the Zimpro PACT-WAR system is such a unique system, the NEIWPCC staffing spreadsheets did not include staffing hour estimates for the system. None of the available categories for solids handling were applicable and therefore left blank. Instead, the Zimpro PACT-WAR staffing was added as an additional consideration for plant staffing in Chart 7. Since the PACT-WAR system runs 24/7 when operating, we assumed that three additional operators were required for its operation. With these operators considered, the total number of operators predicted for the existing WPCF is 14. This is less than current staffing level of 16 personnel at the WPCF which includes: 1 superintendent, 2 foremen, 2 laboratory technicians, 1 office administrator, 2 mechanics, and 8 operators that are responsible for the operations and maintenance activities at the WPCF only. There are also two other personnel dedicated to the collection system but these are not evaluated in this report.

The NEIWPCC guidance document recognizes that staff estimating is not an exact science. To assist with this analysis, the NEIWPCC guidance document includes Chart 6 (automation/SCADA) and Chart 7 (additional considerations for plant staffing) which do

not give numerical staffing estimates but rather point out areas where consideration should be given when refining the baseline estimate from Charts 1 through 5. Presently, the WPCF has only basic automation and a minimal SCADA. It also manages all its own clerical work. Therefore, it is reasonable to assume another staff member be added to Chart 7 to reflect an administrator to fulfill the clerical responsibilities.

The NEIWPCC guidance document also advises maintenance issues will start becoming more prominent and will need to be addressed more often and an increase in maintenance labor hours will be necessary when equipment starts approaching 10-15 years of age. Most of the equipment and structures at the Vernon WPCF are approximately 25 to 40 years old suggesting additional staff hours are required for maintenance. Therefore, it is reasonable to assume another staff member be added to the Chart 7 section to reflect the additional maintenance associated with the old equipment and specialized equipment of the Zimpro PACT-WAR system. These two additional staff members bring the total required plant staff up to 16, which matches the actual WPCF staff. Appendix Q includes the completed NEIWPCC staffing charts.

### 9.2.3 Proposed WPCF Staffing Requirements

The proposed upgrade of the Vernon WPCF will include the abandonment of existing unit processes (Zimpro PACT-WAR system, tertiary sand filters, chlorination/de-chlorination systems), and the addition of new processes (IFAS biological nutrient removal system, sludge storage, mechanical sludge thickening equipment, low level phosphorus removal, and UV system) with higher levels of process monitoring and control being provided (with a new plant-wide SCADA system). Based upon a future estimate using NEIWPCC guidelines, the staffing requirement dropped to 14. This decrease is largely due to the decommissioning of the PACT-WAR system, which allows the plant to move from 3 shifts down to 1 shift. Based upon the analysis, the addition of the new unit processes does not significantly change the base operator responsibilities which is a conclusion consistent with the life-cycle cost evaluations conducted for the secondary process and tertiary phosphorus removal system discussed in detail in Chapter 8.

### 9.2.4 Staffing Conclusions and Facility Classification

Following the upgrade of the WPCF and elimination of the PACT-WAR system, the current WPCF staffing levels can be decreased from 16 personnel to 14 personnel.

The WPCF is classified as a Class IV facility. With the recommended upgrades, the classification will remain unchanged.

## 9.3 Operation and Maintenance Impacts

Implementation of the proposed WPCF Upgrade Project will impact components of the WPCF operating budget, as described in Table 9-3 and detailed in Table 9-4. The impacts described in these tables are related to the proposed process changes only, and do not account for all operating expenses at the WPCF.

Overall, O&M impacts will consist of:

- A decrease in O&M costs due to the abandonment of the PACT-WAR system and installation of an activated sludge system with IFAS media.
- An increase in O&M costs due to improvements recommended for meeting new effluent permit limits for phosphorus.
- A decrease in labor costs due to reduction of the second and third shifts (dedicated to the WAR process).
- Several energy conservation measures will be implemented that will reduce energy consumption, including the installation of more efficient equipment and modifications to control strategies.

**TABLE 9-3**
Projected O&M Impacts from the Immediate WPCF Upgrade Project

| O&M Component | Expected Impact | Description |
|---|---|---|
| Labor | - | Current WPCF staffing levels can decrease as the plant staffing can be reduced to one shift per day. Refer to Section 9.2 for more detail |
| Sludge Disposal | + | Sludge generation will increase with phosphorus removal from chemical sludge that results from both multi-point chemical addition and the tertiary phosphorus removal system.<br>Since the plant currently generates primary sludge only, secondary (biological) sludge will also be generated with the elimination of the WAR process, leading to increased sludge disposal cost.<br>Additional solids will also be generated as flows and loads increase in the future. |
| Chemical | 0, or - | Chemical use will increase or decrease depending on the chemical and purpose:<br>Chemical use will increase with phosphorus removal. The tertiary process will require dosing a metal based coagulant (not currently used at the plant) and a polymer. Coagulant dosing for multi-point chemical phosphorus removal will also be required.<br>Because coagulation can consume alkalinity (to varying degrees based on the coagulant chemical), a second chemical may be required to supplement alkalinity if required to maintain nitrification or to meet effluent permit limits for pH. Soda ash is currently used to add alkalinity for nitrification, but modifications to the aeration system |

**TABLE 9-3**
Projected O&M Impacts from the Immediate WPCF Upgrade Project

| O&M Component | Expected Impact | Description |
|---|---|---|
| | | to accommodate denitrification will reduce the need for this chemical going forward. Soda ash can be considered as the supplemental chemical in the future, but magnesium hydroxide and sodium hydroxide will also be considered during the design.<br>Chemical use will decrease with the installation of UV disinfection to replace chlorination/dechlorination.<br>Polymer will be used at the rotary drum thickeners to mechanically thicken secondary sludge (not currently used).<br>Overall, chemical costs are expected to remain nearly the same or decrease slightly. However, if biological phosphorus removal is successful, this will reduce the amount of chemical required for phosphorus removal and decrease costs even further. Biological phosphorus removal can also decrease the amount of sludge generated due to phosphorus removal. |
| Energy | - | Energy costs are expected to decrease overall with the installation of the IFAS process to replace the Zimpro PACT-WAR processes. This is because the WAR process is energy intensive, and because of the reduced demand for oxygen with denitrification and more efficient blowers. Although the recommended plant upgrades also include the addition of new treatment processes (phosphorus removal, sludge thickening) and replacing chlorination and dechlorination with UV disinfection, energy costs are expected to decrease overall with the elimination of energy intensive processes and from additional energy efficiency improvements (i.e. installation of more efficient equipment and modifications to control strategies that currently use excess energy).<br>New electrical loads will consist of:<br>• Equipment for the secondary treatment system, including mixers, blowers, and recycle pumps (to provide nutrient removal)<br>• Tertiary phosphorus removal system (replacing the Sand Filters)<br>• Chemical feed systems<br>• UV disinfection system<br>• Sludge handling systems, including storage tank mixers, sludge pumping, and rotary drum thickeners (replacing the Zimpro WAR equipment)<br>• Odor control systems<br>Recommended improvements that will offset the new electrical loads:<br>• Abandonment of the Zimpro PACT-WAR system and associated equipment |

**TABLE 9-3**
Projected O&M Impacts from the Immediate WPCF Upgrade Project

| O&M Component | Expected Impact | Description |
|---|---|---|
| | | • Demolition of the centrifugal blowers used for the secondary aeration tanks<br>• Building HVAC and lighting upgrades<br>• New motors and VFDs on pumping equipment<br>• Fewer and new electrical substations, switchgear, and generator<br>• Plant-wide SCADA and control improvements |
| Nitrogen Credits | - | The cost to purchase nitrogen credits will be eliminated with installation of the Bardenpho system, due to higher levels of nitrogen removal. In the near term this could result in a small amount of revenue for the Town as nitrogen credits are sold to the exchange. To be conservative, however, we did not account for this in our analysis. |

Table 9-4 summarizes the estimated O&M impacts of the recommended plant process changes. Current costs with Zimpro PACT-WAR are based on historical plant data. *The comparison is related to the proposed process changes only and does not include all O&M components of the WPCF. Based on these changes alone, O&M costs are expected to decrease at current flows and loads by approximately $145,000 per year*

As discussed in Section 6.10, an energy evaluation at the plant was performed based upon data from 2015 and 2016, which identified several Operating Measures (OMs) and Energy Conservation Measures (ECMs) that could potentially reduce energy costs at the WPCF. Table 6-2 summarizes measures that would be applicable following the recommended plant upgrades. Additionally, Table 6-2 also includes savings associated with a reduction in the service charge by switching to Rate 56 from Rate 58.

The implementation of these energy efficient projects is recommended, as they would further reduce energy usage at the plant. The potential energy savings for the WPCF assuming all ECMs in Table 6-2 are implemented is $110,900 in the first year of implementation (2017 dollars). This does not include potential savings from measures that cannot be quantified at this time, namely HVAC upgrades, lighting efficiency upgrades, energy monitoring system, and demand reduction.

If we combine the above cost savings, then the projected reduction in O&M costs at the plant are approximately $250,000 per year. This estimate does not include savings associated with reducing heating costs (which were not quantified) at the preliminary treatment building by reducing ventilation, and with not heating the three structures that will be abandoned (Plant Water Building, Post Aeration Building) or demolished (Chemical Building).

**TABLE 9-4**
O&M Impacts of Process Changes

| | Current with Zimpro PACT-WAR | After Upgrades |
|---|---|---|
| ***Labor*** | | |
| Second and Third Shift Operator | $180,000 | $0 |
| ***Sludge*** [1] | | |
| Primary | $433,035 | $420,369 |
| Secondary | -- | $327,641 |
| Tertiary (Disc Filters) | -- | $21,496 |
| Multi-Point Chemical Addition | -- | $25,332 |
| **Sub-Total** | $433,035 | $794,838 |
| ***Chemicals*** [1] | | |
| PAC | $108,817 | -- |
| Polymer (Zimpro) | $22,870 | -- |
| Polymer (RDTs) | -- | $13,102 |
| Polymer (Disc Filters) | -- | $15,760 |
| Disinfection | $73,021 | $500 |
| Alkalinity Addition (Nitrification) [2] | $57,094 | $23,303 |
| Alkalinity Addition (Coagulant) [2] | -- | $66,658 |
| Coagulant (Multi-Point) | -- | $72,477 |
| Coagulant (Disc Filters) | -- | $53,729 |
| **Sub-Total** | $261,802 | $245,529 |
| ***Energy*** [3][4] | | |
| Secondary Treatment | $328,854 | $242,464 |
| Disinfection | $6,325 | $7,944 |
| Tertiary (Sand Filters) | $6,710 | -- |
| Tertiary (Disc Filters) | -- | $22,488 |
| Zimpro PACT-WAR | $131,718 | -- |
| RDTs and Sludge Holding | -- | $47,203 |
| Excess Power Transformer Losses | $22,000 | -- |
| **Sub-Total** | $495,608 | $320,099 |
| ***Nitrogen Trading Credits*** | | |
| Projected for 2020 [5] | $135,875 | $0 |
| ***TOTAL*** | **$1,506,320** | **$1,360,466** |

**TABLE 9-4**
O&M Impacts of Process Changes

| | Current with Zimpro PACT-WAR | After Upgrades |
|---|---|---|

(1) To be conservative, sludge generation and coagulant usage following the upgrade does not consider the benefits of enhanced biological phosphorus removal, which can decrease both coagulant and sludge disposal costs.

(2) Based upon soda ash usage. After upgrades, alkalinity addition would be for counteracting alkalinity consumed by coagulants, but may not always be required. Chemicals other than soda ash can also be used for alkalinity addition.

(3) *Comparison of energy usage related to the proposed process changes only, and does not include all energy usage at the plant or account for potential energy efficiency improvements (equipment replacement and modifications to control strategies).* Assumes negligible change in intermediate pumping and influent pumping energy usage, which is not included in the table above. Accounts for electrical distribution upgrades resulting in reduced energy losses reducing the number of medium voltage power distribution transformers (Section 6.6).

(4) Current based on JK Muir Energy Evaluation (Appendix L); Zimpro PACT-WAR includes natural gas usage.

(5) See Section 3.10.2.

## 9.4 Funding Opportunities

Capital costs to implement the recommended improvements are shown in Table 9.2. Potential funding sources include:

- Grants and reduced interest loans through the Connecticut Clean Water Fund (CWF)
- Energy-targeted funding programs

Funding programs are discussed in more detail in the following subsections.

### 9.4.1 Clean Water Fund

The Clean Water Fund is administered by the Connecticut Department of Energy and Environmental Protection (DEEP) and provides grants and 2% loans (for up to 20 years) to fund wastewater projects. Projects are prioritized by need, and the available funding and criteria are updated every two years.

WPCF upgrades completed immediately in the recommended plan are eligible for the following:

- 30% grant for project costs associated with nutrient (nitrogen or phosphorus) removal, including the secondary system upgrades for conversion to IFAS and the phosphorus removal system
- 50% grant for project costs associated with meeting a total phosphorus limit of 0.31 mg/L or less (applicable to Vernon), for all contracts entered into on or before July 1, 2019
- 20% grant on the balance of eligible project costs, and the remainder of costs to be funded with a 2%, 20-year loan

As indicated above, obtaining this funding is contingent upon need and this means receiving a suitable number of priority points for the project which is driven by the nutrient upgrades being proposed.

### 9.4.2 Energy-Targeted Grant & Rebate Programs

Energy efficiency and renewable energy funding programs provide an opportunity to obtain supplemental funding for related projects in the CIP.

Eversource is the electric and natural gas utility for the Vernon WPCF and currently offers incentives in the following general categories: lighting and controls, HVAC systems, compressed air, variable speed drives and custom projects. The WPCF had an energy audit performed, and the identified energy conservation upgrades are likely eligible for the offered incentives. The incentives are obtained through an application process that typically requires backup information to quantify and document the anticipated energy savings. Based on past grant and incentives, it can be expected that grants up to 1-2% of the construction cost may be able available.

## 9.5 Implementation Plan

Table 9-2 contains a summary of the recommended capital improvement projects and proposed phasing plan for the wastewater treatment plant. The implementation is based

on the assumption that the Town will receive funding through the Clean Water Program and a 20-year loan at a 2% interest rate for all projects included in the "Immediate" action category in Table 9-2 due to the nutrient upgrade components of the project. Also, as shown in Table 9-1, the Towns of Ellington, Tolland, South Windsor, and Manchester will collectively contribute approximately 30% to the cost of the project.

The implementation is also based on the assumption that the Town will not receive funding through the Clean Water Program for all projects shown in Table 9-2 as deferred for "10+ years" because these projects on their own will not meet the funding criteria. To complete these projects, the town will have to self-fund them using bonds. For the analysis, we assumed a town bonding rate of 4 %".

### 9.5.1 Immediate WPCF Upgrade Project Schedule

Figure 9-4 illustrates the proposed schedule for the WPCF Upgrade Project, including funding milestones through the Clean Water Program. During design, the Town's energy service provider, Eversource, will be contacted to take advantage of energy efficiency and rebate programs that are available.

### 9.5.2 Financial Analysis

The summary of the recommended capital improvement projects and costs were provided to the Town's Finance Department, for them to use in determining the impact to the Town's mill rate. They have determined that Vernon's mill rate will increase by 1.38 mills.

## 9.6 Recommended Next Steps

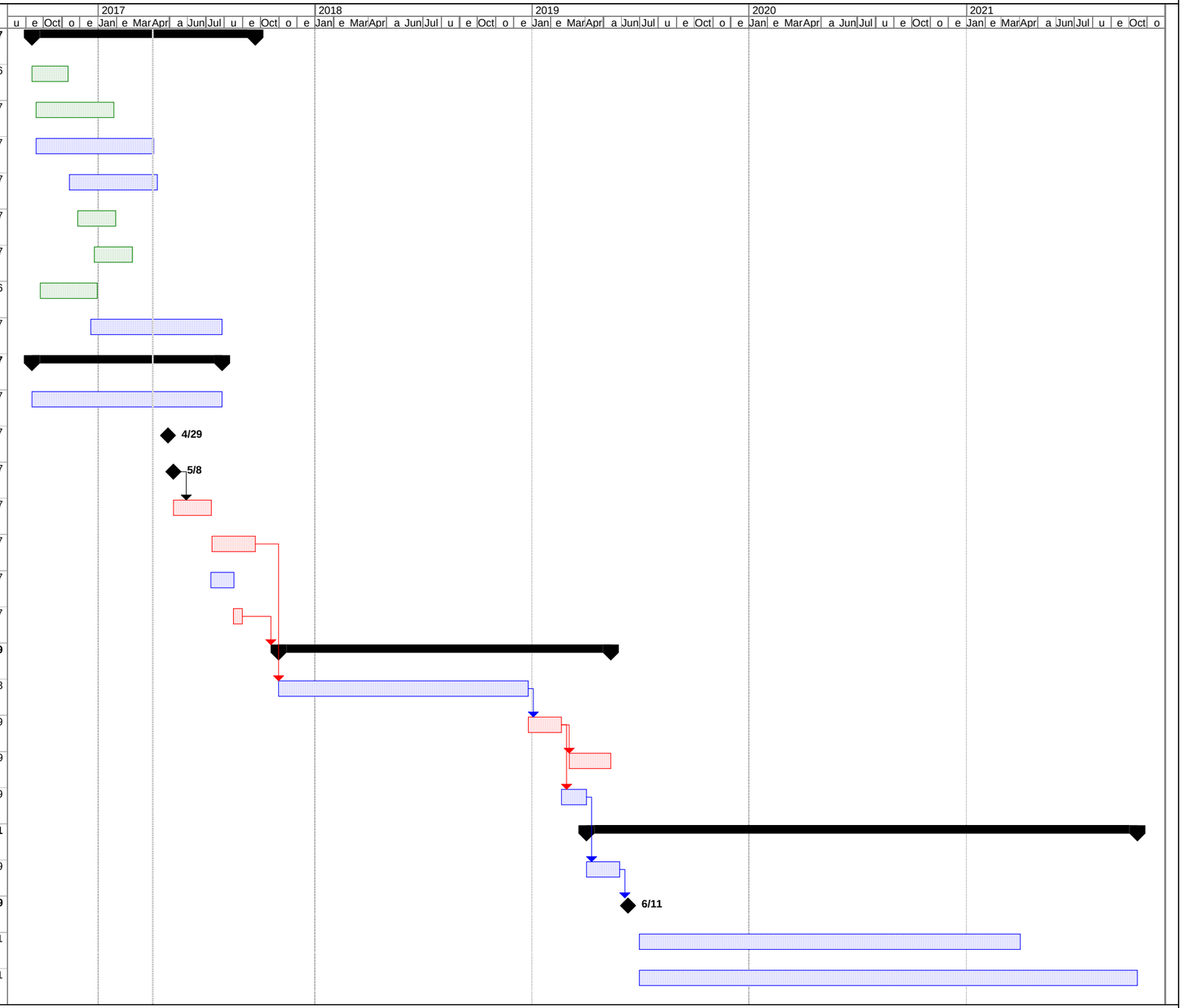
The recommended next steps are to communicate this Wastewater Facilities Plan to Town boards and departments, the rate payers, and the interested public. As part of this public information and education process, a public hearing was conducted at the Town Council meeting of June 20, 2017.

The Town WPCA is expected formally approve the Water Pollution Control Plan and associated Sewer Service Area map (Appendix E) at its regularly scheduled meeting of July 27, 2017.

A draft design phase engineering services agreement prepared by Tighe & Bond has been reviewed by the Town, and subsequently submitted to the CT DEEP on July 13, 2017 for review and approval.

# Figure 9-4: Facility Planning & Upgrade Schedule Vernon WPCF Vernon, CT

| ID | Task Name | Start | Finish |
|---|---|---|---|
| 1 | **Facility Planning Study** | **Mon 9/12/16** | **Fri 9/22/17** |
| 2 | Flow & Load Projections | Mon 9/12/16 | Fri 11/11/16 |
| 3 | WPCF Condition Assessment & Capacity Analysis | Mon 9/19/16 | Fri 1/27/17 |
| 4 | Energy Efficiency Evaluation | Mon 9/19/16 | Tue 4/4/17 |
| 5 | WPCF Alternatives Analysis & Recommendations | Mon 11/14/16 | Mon 4/10/17 |
| 6 | Vulnerability & Emergency Preparedness Assessment | Mon 11/28/16 | Mon 1/30/17 |
| 7 | Severe Weather & Storm Resiliency Evaluation | Mon 12/26/16 | Mon 2/27/17 |
| 8 | Sewer Service Area Map & Water Pollution Control Plan | Mon 9/26/16 | Fri 12/30/16 |
| 9 | Collection System & Pump Station Analysis & Recommendations | Tue 12/20/16 | Fri 7/28/17 |
| 10 | **Public Participation** | **Mon 9/12/16** | **Fri 7/28/17** |
| 11 | WPCA Meetings | Mon 9/12/16 | Fri 7/28/17 |
| 12 | WPCA Workshop | Sat 4/29/17 | Sat 4/29/17 |
| 13 | Draft Report Submittal (Volume 1) | Mon 5/8/17 | Mon 5/8/17 |
| 14 | DEEP Facility Plan Review | Mon 5/8/17 | Mon 7/10/17 |
| 15 | DEEP Design Agreement Review & Approval | Wed 7/12/17 | Fri 9/22/17 |
| 16 | Finalize Report & Submit | Mon 7/10/17 | Thu 8/17/17 |
| 17 | DEEP Facility Plan Approval | Thu 8/17/17 | Thu 8/31/17 |
| 18 | **WPCF Upgrade Design Phase** | **Wed 11/1/17** | **Mon 5/13/19** |
| 19 | Design Development/Final Design | Wed 11/1/17 | Tue 12/25/18 |
| 20 | DEEP Design Review | Wed 12/26/18 | Tue 2/19/19 |
| 21 | DEEP Construction Phase Agreement Review & Approval | Tue 3/5/19 | Mon 5/13/19 |
| 22 | Finalize Design | Wed 2/20/19 | Tue 4/2/19 |
| 23 | **WPCF Upgrade Construction Phase** | **Wed 4/3/19** | **Fri 10/15/21** |
| 24 | WPCF Upgrade Bid Phase | Wed 4/3/19 | Tue 5/28/19 |
| 25 | **Contract Award** | **Tue 6/11/19** | **Tue 6/11/19** |
| 26 | Phosphorous Related Upgrades | Mon 7/1/19 | Thu 4/1/21 |
| 27 | Nitrogen & General Process Upgrades | Mon 7/1/19 | Fri 10/15/21 |




Project: Project Schedule 032217
Date: Sun 4/2/17

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

Tighe&Bond

# SECTION 10

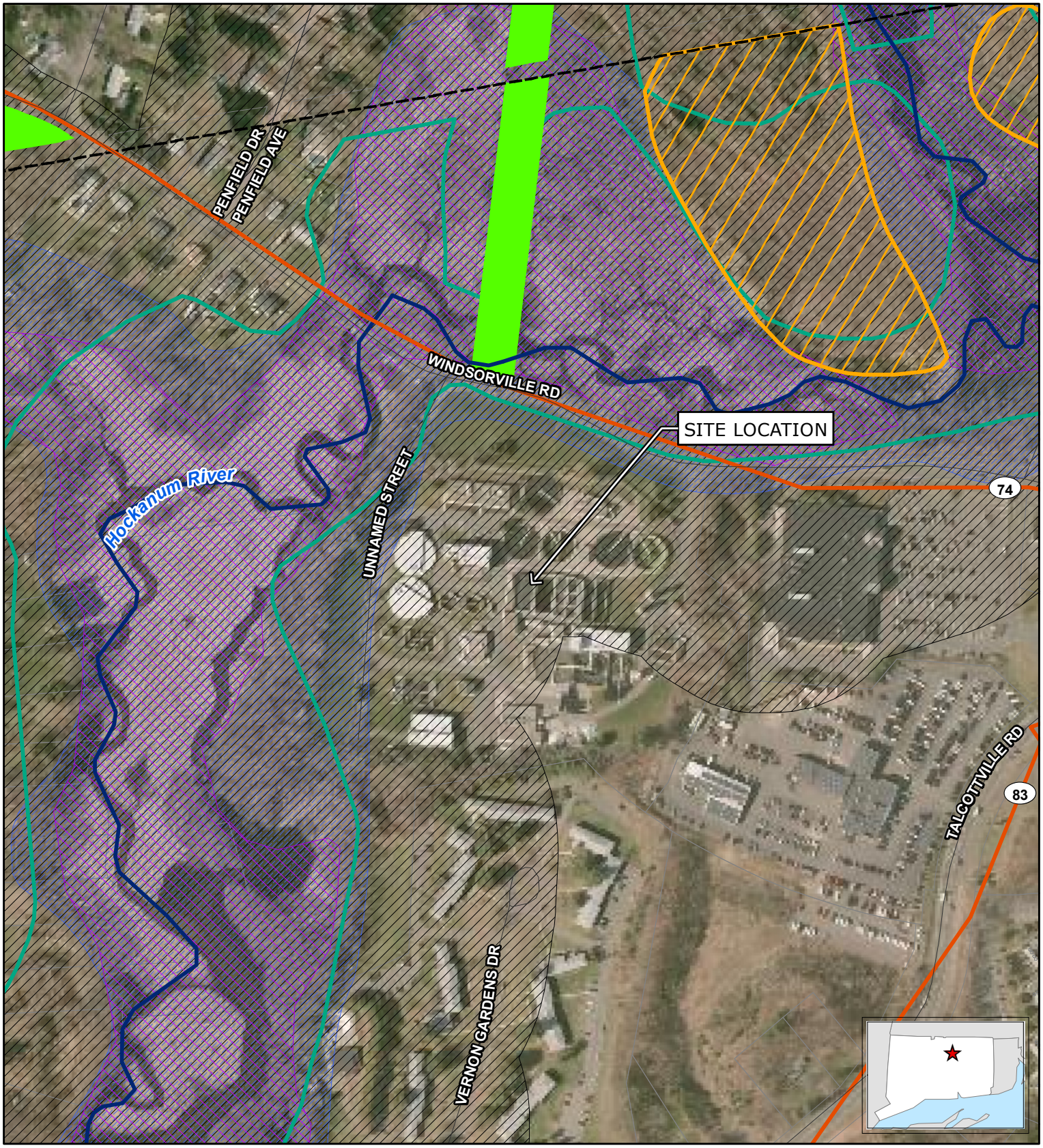
# Section 10
# Environmental Impact Assessment

The recommended plan includes upgrades at the WPCF aimed at utilizing and repurposing existing infrastructure to the extent possible while minimizing the need for new construction. The proposed recommended improvements at the WPCF require retrofitting several existing spaces and process tanks, construction of approximately 200 square feet of new reaction tanks located adjacent to the Effluent Filter Building for the low-level phosphorus removal system, construction of new electrical substations, generators, and switchgear and construction of canopies for weather protection of equipment installed outdoors (UV disinfection and unthickened WAS holding tank blowers).

Chemical feed and storage areas are proposed within the existing Effluent Filter Building, Carbon Regeneration Expansion Building (to be renamed) and Solids Handling Building #2). At these locations, the existing roadways can be used for routine deliveries and equipment access with some additional paving near the Effluent Filter Building. The project also includes the installation of related process piping and demolition of outdated equipment. All of the proposed activities will occur on areas that have been previously disturbed and which are within the current fence line of the WPCF. No new land disturbance is anticipated.

The Connecticut Environmental Policy Act (CEPA) requires a review for each state agency action (an activity or a sequence of planned activities undertaken by or funded in whole or in part by the state) that could have a major impact on the state's land, water, air, or other environmental resources. State agencies use Environmental Classification Documents (ECDs) to determine whether an Environmental Impact Evaluation (EIE) is warranted and if so, the type of study required for a proposed project. Though the project involves a state agency action (CT DEEP's provision of funding for the project via the Connecticut Clean Water Fund), the project will not have Significant Environmental Impacts based on a review of the Generic ECD (revised 2010) and will not require evaluation under the Connecticut Environmental Policy Act (CEPA).

In order to determine the potential environmental impact of the new construction, a review was performed of the information available from state and local GIS data layers and other information sources as noted below. As explained below, environmental impacts are limited due to the siting of the proposed work within existing previously disturbed limits associated with the current WPCF. Priority Resources for the WPCF and a copy of the State of Connecticut's Conservation and Development Policies (C&D Plan) Legislative Guide Map (LGM) are shown in Figures 10-1 and 3-7, respectively. The State C&D Plan figure also includes the Vernon sewer service area.




**Legend**

- Community Well
- Non-Community Well
- US Route
- State Route
- Minor Street or Road
- Watercourse
- 100-Year Flood Zone
- Final Adopted Aquifer Protection
- Final Aquifer Protection
- Preliminary Aquifer Protection
- Inland Wetland Soils
- Protected Open Space
- Critical Habitat
- Natural Diversity Database Area
- Prime Farmland Soils
- Parcel Boundary
- CT Municipal Boundary

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0 100 200 300

Feet

N

Tighe&Bond
Engineers | Environmental Specialists

Based on 2016 Statewide Orthophotography,
Courtesy of University of Connecticut.
Parcel Boundaries are approximate, provided by CTDEEP.

# FIGURE 10-1
# PRIORITY RESOURCE MAP

Vernon WPCF
100 Windsorville Road
Vernon, Connecticut

May 2017

G:\GIS\CT\SiteLocus\VernonCT\Figure10-1_PriorityResource.mxd

V-0037

# 10.1 Environmental Resources

## 10.1.1 Air Quality

The WPCF upgrades and potential extension of sewer service will not create a new stationary source of air pollution, nor will it result in significant increased traffic, which would increase emissions from vehicles. After upgrades are complete, it is anticipated that the truck visits per day would increase by 2 to 3 trucks for a total of 8 to 11 truck visits per day. These additional truck visits would provide chemicals for the secondary treatment process, phosphorus removal treatment process, and solids handling process, and to haul additional sludge generated from the secondary treatment and phosphorus removal processes. Therefore, long term impacts to air quality from the project are not significant.

During construction of the recommended upgrades at the WPCF, air emissions from construction vehicles due to fuel combustion as well as fugitive dust will be generated on a temporary basis. Construction is expected to be completed within thirty months. These temporary air quality impacts will be mitigated by the use of on-site watering (as needed) to address fugitive dust emissions, minimizing equipment idling time, maintaining vehicles/equipment in good working order, and utilizing other best management practices to further minimize vehicular emissions as well as wind and dust erosion. Therefore, although there will be increased air emissions and fugitive dust during construction, these impacts will be mitigated to the extent practicable.

As described in Section 9, the WPCF upgrades include the installation of odor control systems to minimize and treat potential odors that may be emitted during typical treatment and sludge processing. To address potential odor impacts, the unthickened sludge storage tanks and thickened sludge storage tanks will be covered, and the rotary drum thickeners (RDTs) will consist of enclosed units. Air from the headspace of the tanks and from the RDTs will be transported through ductwork to a carbon-based odor control unit for treatment. Based on the proposed design, the project is not anticipated to result in adverse impacts to air quality or odor.

The majority of parcels eligible for connection to sanitary sewer in the expanded sewer service area are already developed (refer to Figure 3-8). There would be minimal impact on air quality due to the future hookup of any parcels in the expanded sewer service area to the sewer system. These impacts would mostly be short-term and construction related.

## 10.1.2 Ambient Noise Levels

The WPCF is located within a suburban area in the Township of Vernon. There are two large commercial plazas abutting the eastern edge of the site, including a large grocery store and a car dealership. An apartment complex is located to the south; the nearest residence is located approximately 150 feet south of the WPCF. The Hockanum River is located to the west and north with additional residential areas beyond. There are wooded areas between the facility and the shopping center, apartment complex, and river. The wooded area acts as a visual screen and a noise buffer.

Current noise is generated by facility processes and truck deliveries. The facility receives approximately 6 to 8 truck visits per day for treatment chemical deliveries, septage deliveries and sludge/solids removal. Truck visits occur during daytime hours.

The increase in noise emissions from the proposed WPCF improvements will be negligible as they will be constructed/installed on site within the footprint of the existing facility. The minimal sound generated from proposed new equipment (blowers, mixers, pumps, phosphorus removal system, etc.) will be dampened by the structures around the equipment as well as the wooded areas along the east, south, and west sides.

Increases in noise during the upgrade to the facility will be temporary in nature and caused by construction activities, vehicle and equipment noise. Construction work are anticipated to occur Monday through Friday from 7am to 6pm, which minimize any potential impacts to nearby residences. Additionally, equipment and vehicles will be maintained to minimize excessive noise. The construction contractor will comply with the Town's noise ordinance by avoiding construction activities during prohibited hours and complying with the state and local noise standards. It is anticipated that any noise emissions during construction would be below local and state regulatory standards at the property line and would not create a nuisance condition.

No long-term changes in noise emissions are anticipated from the recommended collection system and pump station improvements.

The majority of parcels eligible for connection to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact to noise levels. The development of scattered undeveloped parcels in the service area would create short-term noise impacts during construction, but negligible long-term noise impacts in this highly suburban area.

## 10.1.3 Water Resources

### 10.1.3.1 Public Water Supplies

Based on information from the CT ECO online resource viewer, the WPCF is not located within any aquifer protection area (Figure 10-1). Additionally, the WPCF is not located within any wellhead protections areas, nor are there any well head protection areas in the vicinity of the WPCF.

The WPCF has existing chemical storage areas for sodium hypochlorite, sodium bisulfite, powered activated carbon, soda ash, and polymer. The upgrade project will significantly reduce the need to store sodium hypochlorite and eliminate the need for sodium bisulfite and powdered activated carbon. The upgrade project will include an increase in on-site chemical storage associated with the solids handling process and phosphorus removal, including coagulants, polymer, and soda ash. Although the facility is not within an aquifer protection area or a wellhead protection area, the new and existing chemical storage areas to remain will continue to utilize secondary containment and best management practices for storing, handling, and disposal of chemicals associated with the wastewater treatment process as a means of protection public water supplies and groundwater.

The proposed WPCF upgrades and potential extension of sewer service will occur within previously disturbed areas or adjacent to existing roadways and will utilize best management practices to minimize impacts to drinking water. The project will result in improved water quality due to improved water quality of the wastewater effluent discharge from the WPCF.

Therefore, the project is not anticipated to result in adverse impacts to public water supplies.

A small portion of the expanded sewer service area is located in a Level B Aquifer Protection Area. Properties in this small area are predominantly already developed. Therefore, there would be a positive impact on public water supplies when these properties are connected to the municipal sanitary sewer and no longer use septic systems.

#### 10.1.3.2 Ground and Surface Water

The western half of the WPCF and land between the west side of the WPCF and the Hockanum River are classified as GB per the Connecticut Water Quality Standards and Classifications in accordance with Section 22a-426 of the CT General Statutes and Section 303 of the Federal Clean Water Act. Groundwater supplies designated as GB are "suitable for industrial process water and cooling waters and baseflow for hydraulically connected surface water bodies. It is presumed not suitable for human consumption without treatment. Discharges to areas designated as GB are restricted to treated domestic sewage, certain agricultural wastes, certain water treatment wastewaters, discharge from septage treatment facilities subject to stringent treatment and discharge requirements and other wastes of natural origin that easily biodegrade and present no threat to groundwater." This designation is likely due to treated domestic wastewater discharge from the WPCF.

Other areas of the WPCF and adjacent lands have no groundwater classification.

Upgrades to the WPCF will include several modifications inside the fenced area of the WPCF and thus impact impervious surfaces. These changes include: demolition of several small outdoor electrical equipment areas and the chemical building, resulting in a decrease in impervious area; abandonment of several buildings and two tanks; construction of new electrical equipment in several areas (south and north substations, switchgear, generator), and construction of an aeration blower storage area with canopy. Overall there will be additions of small areas (less than 5,000 sq. ft.) of impervious surfaces, and there will be creation of several areas of pervious surfaces. Therefore, there will be no overall impact to groundwater beneath the WPCF from impervious surfaces.

There will be positive impacts on groundwater from the expansion of the sewer service area as more existing properties on a septic system will be connected to the sanitary sewer reducing wastewater discharges to the subsurface.

The Hockanum River is adjacent to the northwestern corner of the WPCF and parallels the north side of Windsorville Road to the north of the WPCF. The Hockanum River is a Class B surface water body in the vicinity of the WPCF. Class B designated uses are habitat for fish and aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. The Hockanum River is also not a designated Wild and Scenic River based on the National Wild and Scenic Rivers System website.

A small man-made stream is located onsite along the northern edge of the buildings at WPCF. The stream connects a small pond adjacent to the northeast corner of the WPCF to the Hockanum River.

Adverse impacts to surface water, especially the Hockanum River, are not anticipated as the project will not increase the WPCF's permitted discharge. The project will actually

result in improved water quality of the river since facility upgrades will result in additional removal of phosphorus and nitrogen from the effluent prior to discharge. These upgrades will achieve compliance with more stringent nutrient removal limits in the WPCF's re-issued NPDES permit. Therefore, there will be a positive impact on surface water quality in the Hockanum River. No impacts to the small stream are anticipated.

There will be positive impacts on surface water from the expansion of the sewer service area as more existing properties on septic systems will be connected to the sanitary sewer reducing wastewater discharges to the subsurface that may be migrating into surface water bodies.

#### 10.1.3.3 Water Quality

New structures (phosphorus reaction tanks, canopies for outdoor equipment, and south electrical substation) and other improvements will be designed and constructed in accordance with applicable stormwater regulations and best management practices. A Sediment and Erosion Control Plan will be prepared for the projects which will provide for the adequate control of erosion and sedimentation. Erosion controls will be installed prior to commencement of any construction/demolition activities and will be inspected regularly thereafter and immediately after each rainfall to minimize potential impacts to proximate wetlands and watercourses.

Additionally, the project will not increase the WPCF's permitted discharge and will result in improved water quality of the river through meeting the more stringent effluent limits for phosphorus and nitrogen. Likewise, expansion of the sewer service area will allow a number of developed parcels currently on septic systems to connect with the WPCF. This will allow groundwater quality to improve over time.

#### 10.1.3.4 Floodplain

Review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) 0901310005C effective August 9, 1999, as also shown on Figure 10-1, the 100-year floodplain in the vicinity of the WPCF project is at approximate elevation 215.50 feet National Geodetic Vertical Datum of 1929 (NGVD29). According to the FEMA FIRM, the 100-year floodplain is located to the north of the WPCF, between the project site and the Hockanum River. Review of the FIRM indicates the proposed construction of new and other improvements are not located within the 100-year floodplain. As such, impacts to the floodplain are not anticipated.

As noted above, if future sewers are constructed outside of the WPCF, the proposed work areas will be assessed, and any work areas close to wetlands, storm drains or watercourses will require that the contractor install and maintain erosion and sedimentation control measures to protect the environment.

The majority of parcels eligible to be connected to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact on floodplains. There are a few undeveloped parcels in the expansion area. Undeveloped parcels should be evaluated for floodplains prior during the site plan approval process, and, if present, appropriate mitigation steps should be implemented.

### 10.1.4 Wetlands

As shown on Figure 10-1, areas west and north of the WPCF contain jurisdictional inland wetland soils (specifically alluvial and floodplain soils). The Town of Vernon wetland map was also reviewed. Town wetland boundaries mirror wetland boundaries shown on Figure 10-1. In addition to wetlands and watercourses, the Town of Vernon Inland Wetland and Watercourses Regulations extend protection to land within 200 feet from the boundary of the Hockanum River and within 100 feet from the boundary of any other wetland. Additionally, any activity that is likely to impact or affect wetlands or watercourses may be considered a regulated activity by the Inland Wetlands Commission of the Town of Vernon.

Work associated with the proposed new structures and with modifications to existing structures may be located within a Regulated Area (200 feet of the Hockanum River). Although the proposed work is within previously disturbed areas, a Town of Vernon Inland Wetland Commission approval is required.

If future sewers are constructed, the proposed work areas will be assessed, and any work areas close to wetlands, storm drains or watercourses will require that the contractor install and maintain erosion and sedimentation control measures to protect the environment. The potential to impact these wetland resource areas is dependent upon the final limit of work.

The majority of parcels eligible to be connected to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact on wetlands. There are a few undeveloped parcels in the expansion area. Undeveloped parcels should be evaluated for wetlands during the site plan approval process, and, if present, appropriate mitigation steps should be implemented.

## 10.2 Historic, Archeological, and Endangered Species

### 10.2.1 Historic and Cultural Resources

Based on the National Park Service's National Register of Historic Places – NPS Focus database (including archeological), there are no federally-listed buildings, sites, or structures on the Site or in the nearby vicinity of the Site.

Although an online database of state-designated historical places from the Connecticut State Historic Preservation Office was not available, an online listing of Town of Vernon historic resources was reviewed and found that the WPCF was not listed as a historic resource. The Town's list of historic resources included those that have local, state, or federal historic designation.

The proposed WPCF project is anticipated to occur in previously disturbed areas. Therefore, there will be no impacts on historic and cultural resources.

If future sewers are constructed, work will primarily occur within or adjacent to existing roadways. Improvements to the existing sewers and pump stations are anticipated to occur in existing alignments and sites. As such, sewer line and pump station work is not anticipated to impact any cultural or historic resources.

The majority of parcels eligible to be connected to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact on cultural or resources. There are a few undeveloped parcels in the expansion area. Undeveloped parcels should be evaluated for cultural and historic resources during the site plan approval process, and, if present, appropriate mitigation steps should be implemented.

### 10.2.2 Rare Species & Habitat

U.S. Fish and Wildlife Service's iPaC online database was reviewed to determine if there were any endangered, threatened, or rare species or habitats on or adjacent to the WPCF. According to USFWS iPaC database, the Northern Long-eared Bat is present in the area. The Northern Long-eared Bat is a federally threatened species and a state threatened species in Connecticut. Their general habitat consists of mines and caves in the winter and a wide variety of forested habitats in the summer.

No critical habitats were identified by USFWS iPaC database. However, a review of the National Diversity Database (NDDB) map for the area that was available from the CT ECO online database viewer indicated that most the WPCF is in an NDDB area (Figure 10-1). Only the southeastern corner of the site is outside of the NDDB area. NDDB maps were developed by the CT DEEP and depict the approximate known locations of state and federally-listed species and significant natural communities regulated pursuant to the CT Endangered Species Act.

Although most of the site is located within an NDDB area, it is not anticipated that the project will have adverse impacts on rare species or habitats since the project is the upgrade of an existing facility with all construction/demolition activities occurring within the existing disturbed footprint of the WPCF. No mines, caves, or forested habitat will be disturbed. However, a request for an NDDB review will need to be submitted to the CT DEEP prior to project construction.

Improvements to existing sewers and pump stations are anticipated to occur in existing alignments and sites, and if future sewers are constructed, work will primarily occur within or adjacent to existing roadways. Therefore, impacts to rare species habitat are not anticipated.

The majority of parcels eligible for connection to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact to rare species and habitats. There are scattered undeveloped parcels in the expansion area. Undeveloped parcels should be evaluated for rare species and habitat during the site plan approval process, and, if present, appropriate mitigation steps should be implemented.

### 10.2.3 Fish & Wildlife

The WPCF was evaluated using the CT ECO online viewer to determine if the project was located within any critical fish or wildlife habitats. No critical habitats were identified on the WPCF. However, a critical habitat is located along the course of the Hockanum River (Figure 10-1).

As discussed above, the project will occur within previously disturbed areas of the WPCF and will not negatively impact the proximate Hockanum River. Additionally, the project will improve the removal of phosphorous and nitrogen from effluent, which is expected to

improve river water quality and, therefore, fish and wildlife habitat associated with the Hockanum River.

Similarly, improvements to existing sewers and pump stations are anticipated to occur in existing alignments and sites, and if future sewers are constructed, work will primarily occur within or adjacent to existing roadways. Based on this, impacts to fish and/or critical animal and plant species and their habitats are not anticipated.

The majority of parcels eligible for connection to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact to fish and wildlife. There are scattered undeveloped properties in the expansion area. Undeveloped parcels should be evaluated for fish and wildlife during the site plan approval process, and, if present, appropriate mitigation steps should be implemented.

## 10.3 Farmlands and Aquifer Protection Zones

### 10.3.1 Farmland Soils

Based on information available on the CT ECO online viewer, there are no farmland soils on the WPCF or adjacent to the facility (Figure 10-1). Additionally, there are no soils of statewide significant importance were mapped in the area.

Since work for the proposed project will be within the footprint of the existing facility on previously disturbed areas, no impacts to farmland and farmland soils are anticipated.

If future sewers are constructed, work will primarily occur within the existing roadway or adjacent Town-owned right of way. There are small isolated areas of farmland soils in the revised Sanitary Sewer Service Area, however, all lots are already developed with the exception of one small area of farmland soils within a single parcel located to the south of Interstate 84. Based on this, the project will not result in impacts to farm land.

The majority of parcels not connected to sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact to prime farmland soils. There are few undeveloped parcels in the expansion area. Undeveloped parcels should be evaluated for prime farmland soils during the site plan approval process.

### 10.3.2 Open Space and Recreational Resources

The WPCF was evaluated for open space using the CT ECO online viewer. No open space was mapped on the WPCF. Several areas of existing preserved open space are located along the river to the northeast of the facility, in a wooded area to the south of the facility, along a utility right of way to the southeast of the facility, and along a utility right of way north of Windsorville Road to the north of the facility (Figure 10-1). None of the preserved open spaces are adjacent to the WPCF.

There are no designated recreational spaces on or adjacent to the WPCF based on a review of Google Earth.

However, the Vernon Hockanum River Trail, a local greenway, exists between the WPCF and the Hockanum River. The trail begins at the small (4 to 5 car) parking area located on the western entrance way to the WPCF. This parking area and trailhead are outside of the fenced perimeter of the WPCF. A canoe/kayak launch is also present at the river by

the trailhead. The Vernon Hockanum River Trail extends southward along the bank of the Hockanum River for 2.8 miles, and, based on literature, is for hiking/walking only.

There will be no physical impact to open spaces or recreational resources from the proposed project since work will occur on a site that is already developed and all work will occur within previously disturbed areas. However, there will be short-term impacts on the public using the Vernon Hockanum River Trail due to noise and increased traffic during the construction period. It is anticipated that any noise emissions during construction would be below local and state regulatory standards at the property line and would not create a nuisance condition. Additionally, construction traffic is expected to be highest during working hours; while the hiking trail would have the highest usage in the evenings and on weekends.

If future sewers are constructed, work will primarily occur within or adjacent to the existing roadway. Improvements to the existing sewers and pump stations will occur in existing alignments and sites.

The majority of parcels eligible for connection to the sanitary sewer in the expanded sewer service area are already developed. Any designated open spaces and recreational resources will remain protected. Therefore, there would be no expected impact to designated open spaces or recreational resources from potential development.

As such, the projects are expected to have minimal short-term and no long-term impacts on these open space and recreational resources.

## 10.4 Population Growth

Figure 3-3 summarizes population projections to 2037. Based on U.S. census data Vernon's population was 29,179 in 2010. According to a population projection by UCONN, the population is projected to grow to 31,172 by the year 2030, and then drop slightly, reaching a population of 30,878 by the year 2037. As noted earlier, this project does not increase the permitted capacity at the WPCF; thus it will not impact population growth.

The majority of parcels eligible for connection to the sanitary sewer in the expanded sewer service area are already developed. There are scattered undeveloped properties in the expansion area. Any additional development would have negligible impacts in this highly developed suburban area.

## 10.5 Other Considerations

### 10.5.1 Water Supplies

The existing water supply infrastructure available to the WPCF site is adequate, and the project will not result in an increased water demand. Additionally, since the project does not involve the creation of residential development or a water intensive industrial process, impacts to water supplies are not anticipated.

The majority of parcels that would be eligible for connection to sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact to water demand. There are scattered undeveloped properties in the expansion area.

Development of these parcels would also require a supply of potable water, which would result in an overall minimal increased demand on water supplies.

### 10.5.2 Aesthetics

The WPCF is in a suburban area in the Township of Vernon. There are two large commercial plazas abutting the eastern edge of the site, including a large grocery store and a car dealership. An apartment complex is located to the south; the nearest residence is located approximately 150 feet south of the WPCF. The Hockanum River is located to the west and north with additional residential areas beyond. There are wooded areas between the facility and the shopping center (east), apartment complex (south), and river (west). A landscaped lawn area with scattered trees is located between the facility buildings and Route 74 to the north. The wooded area acts as a visual screen and a noise buffer.

The proposed project primarily involves the demolition and/or repurposing of existing buildings and structures. The new reaction tanks for the phosphorus removal system are anticipated to be approximately 8 feet by 26 feet (200 square feet) and will be located proximate to the existing Effluent Filter Building. Two new canopies will also be located next to existing structures. New and retrofitted structures will not exceed building heights already at the facility.

Since new structures will be equal to or less than the heights of existing structures no visual impacts are anticipated. Perimeter vegetation will also serve to minimize visual impacts to the surrounding area.

If future sewers are constructed, work will primarily occur within or adjacent to existing roadways, and the pipelines will be located underground. Pump station upgrades are expected within existing buildings or the buildings will be replaced with similar units. Based on this, adverse visual impacts to the surrounding area are not anticipated.

The majority of parcels eligible for connection to sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact to visual aesthetics at these locations. There are scattered undeveloped properties in the expansion area. There would be negligible impacts to aesthetics due to the development of these scattered parcels in the well-developed surrounding suburban area.

### 10.5.3 Traffic

Currently, the WPCF employs 16 workers over three shifts and generates approximately 6 to 8 truck visits per day.

During construction, the project will temporarily generate additional traffic from construction worker's arrivals and departures and construction material and waste delivery/removal. Construction is anticipated to last approximately thirty months. Given the scale of construction activity proposed, it is anticipated that the local road network will accommodate the additional vehicles during the construction of the project.

The number of WPCF employees will not increase following construction. Truck visits to the WPCF are anticipated to increase approximately 2 to 3 visits per day to provide chemicals for the various treatment processes and to remove additional sludge generated, totaling 8 to 11truck visits per day after construction. This minimal increase in trucks per day is not anticipated to impact traffic near the WPCF.

If future sewers are constructed, a traffic management plan will be implemented to minimize construction related traffic impacts.

The majority of parcels eligible for connection to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no impact to traffic. There are scattered undeveloped properties in the expansion area. There would be negligible impacts to traffic from the development of these scattered parcels in the well-developed surrounding suburban area.

### 10.5.4 Human Health & Safety

Hazardous building materials may be encountered during demolition and construction of the proposed modifications and retrofits to existing structures. Structures constructed prior to 1980 may contain lead and/or polychlorinated biphenyls (PCBs). Additionally, asbestos can be present in many types of building materials in both new and older structures, though the likelihood of finding asbestos-containing materials increases in older structures. Hazardous building materials may likely be encountered during the implementation of the improvements and will need to be addressed by appropriate investigations during design. Once the project is constructed, human health and safety will likely be improved due to the removal of older building materials containing lead, asbestos and/or PCBs.

The project site does not contain and will not impact any designated Superfund sites. Based on a review of CT DEEP's "Brownfield Inventory", the project is also not located on a brownfield site. The project will not involve any thermal or explosive materials. The project is anticipated to improve human health and safety as it will result in decreased nutrient loading to the receiving waterway as the project will increase the level of nutrient removal from the WPCF effluent.

The majority of parcels eligible for connection to the sanitary sewer in the expanded sewer service area are already developed. Undeveloped parcels are scattered across the expanded sewer service area. Any additional connections to the sanitary sewer would result in discontinued use of septic systems, thus, there would be a positive impact on human health and safety since the nutrient loading to the groundwater system would decrease.

### 10.5.5 Energy Use

Electrical and natural gas consumption for existing processes will decrease as a result of the recommended upgrades. This is due to the replacement of aging equipment with more energy efficient equipment that will decrease energy requirements significantly based on the energy improvements summarized in Section 6.10.

New or substantially modified processes being proposed, which will improve effluent water quality, and reduce odors will however require additional energy to operate:

- Equipment for the secondary treatment and nitrogen removal system, including mixers and recycle pumps (this will be offset to some degree by reduced aeration requirements due to denitrification and a more efficient diffused aeration system and blowers)

- Tertiary phosphorus removal system

- UV disinfection system (this will be offset by decreased chemical use)
- Sludge handling systems, including storage tank mixers, diffused aeration system, pumping, and rotary drum thickeners (this will be offset by much less energy used compared to the existing Zimpro WAR system to be removed)
- Odor control systems

Therefore, as discussed in detail in Section 9.3, the overall project will result in a decrease in energy usage.

The majority of parcels not connected to the sanitary sewer in the expanded sewer service area are already developed. Therefore, there would be no long-term impact on energy usage. There are scattered undeveloped properties across the expansion area. The development of these parcels would create a short-term and long-term energy usage.

## 10.6 Project Impacts

### 10.6.1 Direct Impacts

Direct impacts, or effects, as defined per RCSA Sec. 22a-1a-3[a] are the primary environmental consequences which would result from the state agency action (CT DEEP's provision of funding for the project via the Clean Water Fund). Potential direct effects of the project include the following:

- Grading and compaction of the project site
- Minor changes in impervious surfaces associated with new structures and tank covers
- Creation of temporary construction staging areas
- Creation of temporary air emissions and fugitive dust during construction
- Earth disturbance related to construction
- Potential for erosion during construction
- Management and disposal of hazardous building materials
- Reduced phosphorus and nitrogen concentration in effluent discharge
- Improved water quality in the Hockanum River

### 10.6.2 Indirect and Cumulative Impacts

**Indirect impacts**, or effects, as defined per RCSA Sec. 22a-1-a-3[a] are the secondary consequences on local or regional social, economic, or natural conditions or resources which could result from additional activities induced or stimulated by the proposed action, both in the short-term and in the long-term. Potential indirect effects of the project are generally positive impacts to the water quality of the Hockanum River due to improved water quality of the wastewater effluent discharge, reduction in I/I, and improved reliability of treatment by replacing equipment that is at the end of its service life. Other potential indirect effects from the availability of sewer connections in the proposed expansion area are increased air emissions, noise, and increased energy usage. Additionally, expansion of the sewer service area is expected to improve water quality,

surface water, groundwater, public water supplies, and human health as sanitary sewer system hookups eliminate the need for a private septic system.

**Cumulative impacts** as defined per RCSA Section 22a-1-a-3[b] are the impacts on the environment which result from the incremental impact of the action when added to other past, present, or reasonably foreseeable future actions to be undertaken by the sponsoring agency. Cumulative impacts include the incremental effects of similar actions with similar environmental impacts and the incremental effects of a sequence of actions undertaken pursuant to an ongoing agency program which may have a significant environmental impact, whereas the individual component actions would not. As no increase in capacity of the WPCF is proposed, and any proposed collection system improvements will be within the existing collection system and pump station alignments, no cumulative impacts are anticipated.

### 10.6.3 Mitigation of Adverse Impacts

As explained above, adverse environmental impacts are limited due to the proposed upgrades to the WPCF within the limits of previously disturbed areas of the WPCF as well as the siting of the potential sewer expansion within or adjacent to the existing roadway. Best management practices, such as erosion control measures, will be implemented during construction to minimize potential construction period impacts. Should work activities be located within a Regulated Area, any potential adverse impacts will be mitigated through review of the project by Vernon's Conservation Commission. Stormwater will be managed in accordance with applicable stormwater regulations and best management practices to minimize construction and post-construction impacts. Air emissions and fugitive dust will be controlled with best management practices during construction activities. Also, hazardous building materials will be managed and disposed of appropriately.

### 10.6.4 Socio-economic Impacts

As noted earlier, the project does not increase the capacity of the WPCF and, therefore, will not increase the ability of the WPCF to accept additional flow from new connections. However, the WPCF is not at capacity, and the project includes the potential expansion of the sewer service area in accordance with Vernon's "Water Pollution Control Plan" and "Sewer Service Area Map".

Therefore, there are potential positive socio-economic impacts due to the potential for sewer service expansion in the Town as well as improved water quality of the effluent discharged by the WPCF.

## 10.7 Consistency with State and Regional Plans

Public Act 10-138 required the Office of Policy and Management to develop an update to the State Plan of Conservation and Development (C&D Plan), and CGS Section 16a-31 requires that certain state agency actions (including but not limited to funding growth-related projects) be consistent with the State C&D Plan. The updated state plan *Conservation and Development Policies: The Plan For Connecticut, 2013-1018* (State C&D Plan) contains six growth management principles that seek to balance regional growth priorities with environmental and conservation priorities. In addition to the six growth management principles, the State C&D Plan includes a "Locational Guide Map" (LGM) which contains various land classifications and criteria to assist state agencies in determining the consistency of their proposed actions with the State C&D Plan and LGM. Additionally, CGS Section 8-23 and 8-35(a) requires municipalities and regional planning

organizations (RPOs) to prepare and update their own respective plans of conservation and development at least every ten years. The remainder of this section summarizes the proposed project's consistency with the State C&D Plan, the Regional POCD, and the Municipal POCD. Based on this information, the remainder of this section summarizes the proposed project's consistency with the State C&D Plan and the regional POCD.

Figures 3-7 and 3-8 show the State LGM as well as the Vernon sewer service area.

### 10.7.5 State Plan of Conservation & Development

A "growth-related project" defined in CGS Section 16a-35c(a)(2) must be located within a Priority Funding Area (PFA) or proceed through the PFA exception process at CGS Section 16a-35d in order to receive funding from any state agency, department, or institution. Review of the State's LGM plan indicates that the WPCF is located in an area designated as a "Priority Funding Area" (PFA 3-4 Criteria).

The proposed project is an environmentally beneficial project and all work is located within the previously disturbed limits of the existing WPCF. Additionally, the proposed WPCF upgrades will result in improved water quality due to enhanced nutrient removal from the wastewater effluent discharge. The project is also consistent with the State C&D Plan growth management principles; specifically, *"[p]rotect and ensure the integrity of environmental assets critical to public health and safety".* The project will contribute to an improvement in the Hockanum River water quality. Specifically, the project will result in improvements to public health and water quality by removing additional phosphorous and nitrogen from the treatment plant effluent prior to discharge.

See Section 3.3.3 for further discussion on consistency with the State's C&D Plan related to the sewer service area.

### 10.7.6 Vernon Plan of Conservation and Development

Vernon's Plan of Conservation and Development was most recently adopted on November 17, 2011 and became effective on January 30, 2012. Based on a review of the "Existing Land Use Map", provided with the Town POCD, the WPCF is located in an area of land use categorized as "Right of Way, Transportation, Utility." The land area where the WPCF is located is zoned for residential use (R-22 Single Family). The WPCF is not a residential use but public utility structures are permitted in this zone by special permit.

The Town Planner and Economic Development Coordinator were included in a Water Pollution Control Plan Workshop held as part of this Facilities Planning process. They also reviewed the future sewer service area map and development projections presented in this study. The sewer service area boundary was developed to include all applicable residential, commercial and industrial zoned areas in Town to support the Town's goal of economic growth and development. See Section 3.3.2 for further discussion on the Town's POCD.

### 10.7.7 Vernon Water Pollution Control Plan

To receive State funding for wastewater projects, a municipality needs to have a Water Pollution Control Plan that is consistent with the State C&D Plan. The Water Pollution Control Plan includes a sewer service area map showing parcels currently served and areas planned for future service along with narrative description of the sewer service area and associated policies. In addition to the State C&D Plan, the sewer service area should be

consistent with the Town's POCD. The sewer service area map, once adopted as discussed in the section below, will be incorporated by reference in the POCD. As discussed in prior sections, the water pollution control plan is consistent with the State C&D Plan and local plans for growth and development.

## 10.8 Permits and Approvals

Based on the current design and proposed construction, the following permits and approval are anticipated for the project:

- In accordance with the re-issued NPDES permit, the engineering report describing the recommended improvements plan for achieving compliance with phosphorus limits must be reviewed and approved by the Commissioner. After approval of the engineering report, contract plans and specifications for the approved remedial actions must also be reviewed and approved by the Commissioner.

- The Water Pollution Control Authority will formally adopt the "Water Pollution Control Plan" with the "Sewer Service Area Map" after a public hearing to maintain eligibility for state funding such as the Clean Water Fund.

- The WPCF is located within the limits of a mapped NDDB area. Therefore, a request for NDDB review must be submitted to the CT DEEP prior to project construction. CT DEEP will determine whether there are species present on the site that could be impacted by the proposed project and how to avoid potential harm to the species. CT DEEP's response will either be a "no impact" letter; include recommendations for project design that will avoid or minimize impacts to species; or require on-site surveys based on the proposed project scope. As the project activities are occurring within previously disturbed areas, impacts to rare species are not anticipated.

- During construction of the approved remedial actions, a General Permit for Stormwater and Dewatering Wastewaters from Construction Activities will be required if the activities disturb more than one acre of land area.

- A permit from Vernon's Conservation Commission will also be required if the project is sited within or has the potential to impact any wetland areas, including Regulated Areas.

- Approval from the Town of Vernon's Inland Wetland Commission for work within 200 feet of the Hockanum River.

- Notification to Planning and Zoning Commission for site plan review approval (though this requirement will need to be determined during design). . Pursuant to the Connecticut General Statutes, Section 8-24, the proposed activities will need to be referred to the Planning and Zoning Commission for approval.

- It is anticipated that local building permits and local Fire Marshall approval will be needed.

- Applicable state and federal requirements (CT DEEP and EPA) for management of hazardous materials encountered in WPCF buildings and structures: To Be Determined.

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