City of Rutland

Wastewater Treatment Facility
Phosphorus Removal Planning Study

October 2014

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WATER RESOURCE ENGINEERS

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Appendices

1. EXECUTIVE SUMMARY

1.1. Regulatory Update

The United States Environmental Protection Agency (EPA) is completing the modeling of the Lake Champlain watershed for reissue of the Lake Champlain phosphorus total maximum daily load (TMDL) which will require the State of Vermont to evaluate and implement changes in the NPDES discharge limits for phosphorus. While future limits for each facility are being evaluated, but have not yet been determined, it is anticipated that the imposed limits will range from 0.2 mg/l to 0.1 mg/l in specific lake segments. The updated TMDL is scheduled to be issued in late November/early December, 2014.

Upgrades that will be required to comply with the more stringent phosphorus limits will not be funded by the EPA, and the costs to meet the new limits will be the responsibility of the State and local municipalities affected by the new limits. Further, the requirements and associated costs will vary greatly depending on the final limit imposed. For this reason, it is important that the requirements and costs associated with the new discharge limits be fully understood to allow for political discussion at the local and legislative level, and for short and long term financial planning.

1.2. Operating Data

The 2013 operating data was summarized and reviewed for the facility as described below:

- Average annual flows are 5.07 mgd, utilizing about 63% of the permitted capacity, so adequate hydraulic capacity is available.
- The influent organic loadings for biochemical oxygen demand (BOD_5) and total suspended solids (TSS) are both less than the original design loadings. The current loading for the BOD_5 is at 56% and for TSS at 71%.
- An average of 2,580 gpd of septage is received which is 34% of the original design septage load of 7,500 gpd. Septage is typically very high in TSS and total phosphorus, so the volumes received need to be carefully monitored to understand the impacts of the sidestream (digester supernatant, dewatering filtrate) flows on the phosphorus removal.
- Influent total phosphorus concentrations are typical at 1.2 to 4.3 mg/l. With only chemical treatment and clarification, the removal is very effective as effluent phosphorus concentrations average 0.23 mg/l. This facility discharges about 22% of the total annual lbs limit allowed by permit.
- Sodium aluminate is the primary coagulate used for chemical treatment to remove phosphorus. An average of 99 gpd of sodium aluminate is added at the rapid mix tanks upstream of the secondary clarifiers.

1.3. WWTF Assessment

An assessment of the existing WWTF was performed as it is important to document the age and condition of major process components before evaluating the phosphorus removal alternatives. This comprehensive assessment is provided in Section 4.0 for each process element. Several items were identified as short-term, less than 2 years, and the staff continues to address these items as funds become available.

The primary focus of the assessment was on the components constructed during the 1986 upgrade as these items are about 28 years old and have exceeded the useful life. To continue to provide reliable, effective, and efficient operation, the specific upgrades at the following major process elements will be required in the next 2 to 5 years are:

- Aeration blowers
- Secondary clarifiers
- Anaerobic digestion system

Estimated costs were developed to upgrade the equipment with similar size components and in the same locations to reuse existing tankage, buildings, etc. The preliminary estimated construction cost for the WWTF refurbishment is $7,000,000 (ENR 9800, August 2014).

1.4. Process Modeling Results

Computer based process modeling was conducted using BioWin™ software to confirm the capacity of the existing treatment process as well as alternatives to meet future effluent TP limits. Conclusions from the process modeling are as follow:

1. At this point in time we are of the opinion that the facility is currently performing at or near its limit for TP removal and that the absolute best performance, without filtration, is in the 0.2 to 0.3 mg/L range given present day flows;
2. The modeling verification confirms the ability of the model to predict annual average effluent quality supports its utility and general applicability.
3. Process modeling indicates there is insufficient VFA in the primary effluent to support biological phosphorus removal at the Rutland WWTF. This indicates little if any benefit to converting to biological phosphorus removal unless the City was to construct primary sludge fermenter facilities. The cost of these facilities would likely be in excess of $4M and would not eliminate the need for effluent filtration.
4. The existing facility has significant reserve capacity and should be able to easily meet treatment requirements with one bioreactor out of service at both present and design flows.

5. Effluent filtration is required to meet an effluent total phosphorus limit of either 0.2 mg/L or 0.1 mg/L.
6. A TSS removal efficiency of between 50 and 75% (typical of a 10 micron disk filter) is required to consistently meet an effluent TP limit of <0.2 mg/L. A TSS removal efficiency of over 90% is required to consistently meet an effluent TP limit of <0.1 mg/L.
7. The City will need to construct filtration facilities with a capacity of at least two times the average dry weather flow. The final filtration capacity determination should be confirmed during preliminary design based upon sampling conducted during wet weather events.

1.5. P Removal Alternatives

If a new phosphorus limit at 0.2 to 0.3 mg/L or greater is implemented, it is likely that the Rutland WWTF could meet this limit with the existing chemical addition scheme used at the facility using sodium aluminate. No modifications to that process would be required.

If a new phosphorus limit of ≤0.2 mg/L is implemented, a tertiary treatment process will be required for the Rutland WWTF. Disk filters could be installed adjacent to the existing chlorine contact tanks to allow for gravity flow. A new rapid mix chemical addition and flocculation tank would be required upstream of the filters to agglomerate solids for removal. A small backwash return pump station would also be required to return filter backwash water to the head of the facility. We estimate that the present day cost of a disk filter system at approximately $6M.

If a new phosphorus limit at ≤0.1 mg/L is implemented, a tertiary treatment process for low-level phosphorus removal will be required for the Rutland WWTF. We estimate that the present day cost of a tertiary membrane treatment process to handle present day flows is $18M, which could vary depending on what process is utilized (membranes, disk filters CoMag and other available processes which could be considered) and where it can be located on the site. A membrane system and appurtenant equipment could be installed adjacent to the existing chlorine contact tanks to allow for gravity flow, taking advantage of the available head between the secondary clarifiers and the contact tanks. A new 2mm fine screen upstream of the membranes would be required to protect them from large solids. Operating costs are estimated to increase ranging from $200,000 to $250,000 per year.

1.6. Recommended Next Steps

The following are some basic next steps that can be completed to better refine the present process modeling conclusions:

1. A sampling program should be developed to characterize the various sidestreams generated at the WWTF. We would be particularly be interested in dewatering filtrate

and digester supernatant. This information can be used in the future with the BioWin™ model to better refine the bioreactor capacity and upgrade options.

2. Consideration should be given to conducting a facilities planning level study to develop projections of wastewater flows and loadings in the future base on the anticipated growth in the community, planned sewering of additional areas in the City that may be on septic systems, infiltration and inflow programs anticipated and other possible considerations.

2. INTRODUCTION AND PURPOSE

2.1. Introduction

The United States Environmental Protection Agency (EPA) is completing the modeling of the Lake Champlain watershed for reissue of the Lake Champlain phosphorus total maximum daily load (TMDL) which will require the State of Vermont to evaluate and implement changes in the NPDES discharge limits for phosphorus. While future limits for each facility are being evaluated, but have not yet been determined, it is anticipated that the imposed limits will range from 0.2 mg/l to 0.1 mg/l. The date of implementation of the updated TMDL is still pending but the updated TMDL is anticipated to be issued in the fall of 2014.

It is likely that wastewater treatment facility (WWTF) upgrades required to comply with the more stringent phosphorus limits will not be funded by the EPA, and the costs to meet the new limits will be the responsibility of the State and local municipalities affected by the new limits. Further, the requirements and associated costs will vary greatly depending on the final limit imposed. For this reason, it is important that the requirements and costs associated with the new discharge limits be fully understood to allow for political discussion at the local and legislative level, and for short and long term financial planning.

2.2. Purpose

The purpose of this study is to assist the City of Rutland in developing an understanding of the required wastewater treatment facility improvements that may be necessary to meet the new phosphorus discharge permit limits. The scope of services for this study is described below:

1. Document and Assess Existing Conditions:
    a. Analyze the latest twelve months of facility operating data via the WR 43 monthly operations reports provided by facility staff.
    b. Identify additional characterization data needs for the optimization effort. This will likely include influent volatile fatty acid (VFA) concentrations.
    c. Assess the current vs design influent organic loadings of the facility to include the septage received.
    d. Prepare a general needs assessment of the facility.
2. Develop Facility Specific Analysis Model:
    a. Prepare a conceptual analysis for a process optimization/ modernization program for the facility based on the potential anticipated phosphorus limits and needed general upgrades for the facility.
    b. Characterize the impacts of the septage and other side stream flows (thickening and dewatering) on the phosphorus removal process. This assessment may

include recommendations for sampling and documenting the concentrations and specific types of phosphorus at various locations in the liquid stream.

3. Monitor Regulatory Information:
    a. Check the status of the existing facility discharge permit and contact various State and Federal regulators to determine a general sense of when the upcoming new phosphorus limits may impact the facility.
4. Develop a capital and operation and maintenance cost estimate for the following total phosphorus (TP) limit scenarios:
    a. TP Permit limit @ 0.2 to 0.3 mg/l at current flows
    b. TP Permit limit @ 0.2 to 0.3 mg/l at the permitted flow of 8.1 mgd
    c. TP Permit limit @ 0.1 mg/l at the permitted flow of 8.1 mgd
    d. Identify the potential impacts on the solids train; anaerobic digestion, thickening, and dewatering.
5. Identify various funding sources and potential grant opportunities.

2.3. Regulatory Update

A series of six (6) public discussions were conducted in December 2013 about the Lake Champlain phosphorus total maximum daily load (TMDL) and proposed restoration plan. Presentations at these meetings were provided by State of Vermont and EPA Region 1 staff. Handouts were provided for the meeting presentation and a draft document was distributed entitled "State of Vermont Proposal for Clean Lake Champlain".

A summary of some of the "key" points presented at these meetings are:

- Nonpoint sources were the focus of the discussion as the primary sources of pollution; stormwater, river channel stability, forest management, and agricultural practices.
- If more stringent phosphorus limits are only imposed for wastewater treatment point sources to the limits of the best available technology, the standards would not be achieved in 8 of the 13 lake segments.
- Wastewater treatment facilities are permitted to discharge up to 56 mt/yr and in 2012, the actual discharge was 17 mt/yr.
- The modeling has been completed, and the Vermont portion of the TMDL will be decreased from 533 to 343 mt/yr, about 36%.
- For the sources of phosphorus, wastewater treatment facilities contribute about 3.1% of the total load.
- Of the maximum of 343 mt/yr, about 95% of phosphorus load is contributed from non-point sources.

Some of the critical 2014 deadlines issued for development of the Lake Champlain Restoration Plan are as follows:

- By January 17, 2013: State receives comments from public and EPA on Draft Proposal
- Winter 2013/2014: EPA prepares pollution load allocations
- Spring 2013: State submitted a draft Phase 1 Plan to EPA on March 31, 2014
- Spring 2013: State submitted a Phase 1 Plan and Governor's Commitment Letter to EPA on May 29, 2014
- Fall 2014: EPA issues Draft TMDL and opens public comment period
- Winter 2014/2015: EPA issues final TMDL, State begins implementation

To further assess the impacts of the TMDL changes, EPA retained Tetra Tech to evaluate the costs of implementing the phosphorus improvements. Our understanding is that this study evaluated options for reducing the phosphorus limit for larger facilities to either 0.2 mg/l or 0.1 mg/l and for smaller facilities to 1.0 mg/l. A draft of this report was provided to the State for review back in September 2013 and the final document was released by EPA on January 13, 2014. State DEC staff have expressed concerns that this report doesn't accurately reflect the cost of implementing the more stringent phosphorus limits.

3. OPERATING DATA

3.1. Original Design Criteria

The design criteria for the 2002 Basis for Final Design is summarized below in Table 3.1, and shows the flows and influent organic loadings for biochemical oxygen demand (BOD_5) and total suspended solids (TSS). This facility is permitted for an annual average flow of 8.1 mgd.

Table 3.1
Original Design Criteria

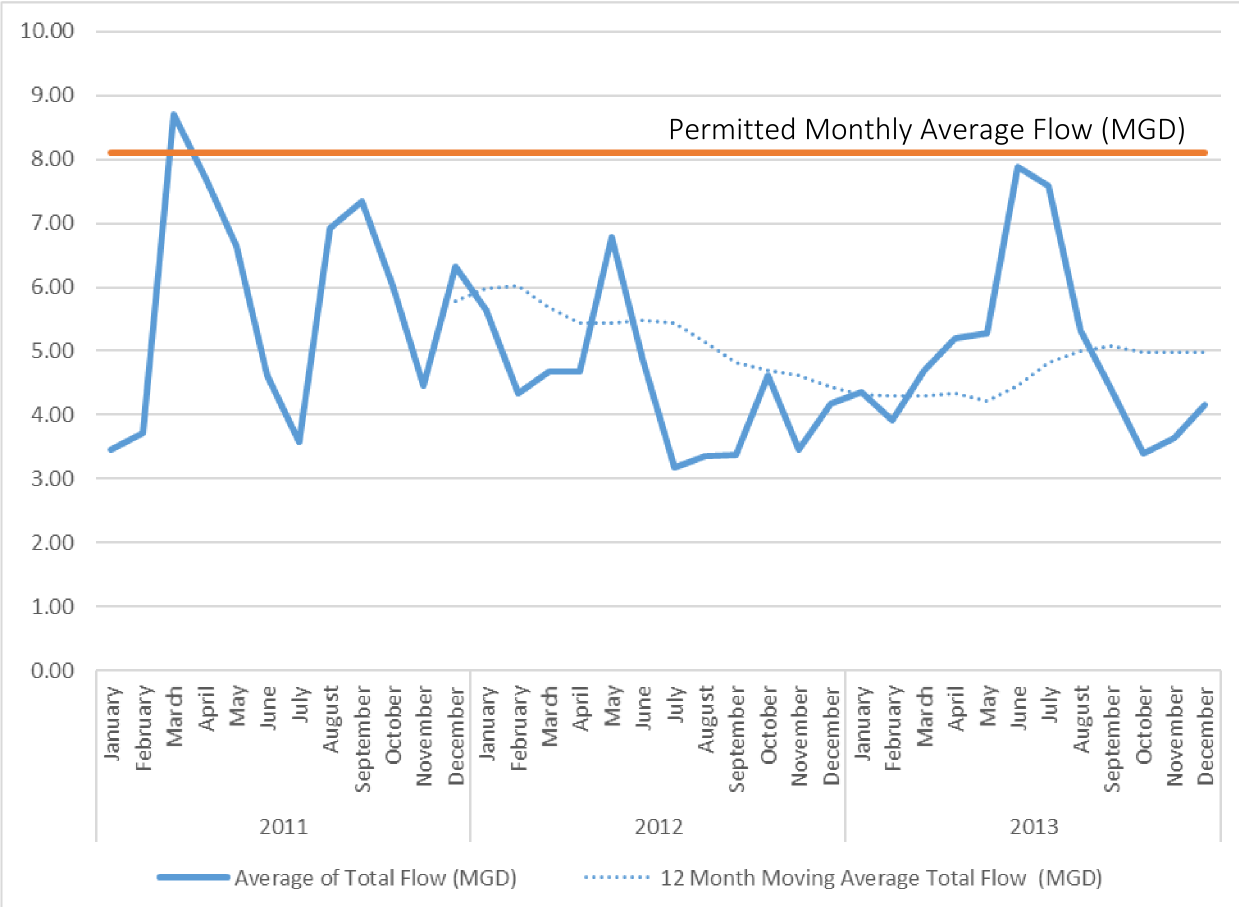
Item			Plant Influent
Flows		Average Daily	8.1 MGD
		Peak Daily	15.0 MGD
		Peak Hourly	22.5 MGD
Organic Loadings(1)	BOD_5	Average Daily	8,100 lbs/day
		Maximum Month	16,200 lbs/day
	TSS	Average Daily	7,420 lbs/day

Notes:
1) Organic loadings are based on the 2002 Basis for Final Design values prorated for 8.1 mgd.

3.2. Flows

For 2011 through 2013, the average annual flow was 5.07 mgd and the average monthly flow ranged from 3.19 to 8.70 mgd. As shown on Figure 3.1, the current annual average flow of 5.07 mgd is lower than the permitted flow of 8.1 mgd, utilizing about 63% of the hydraulic capacity. This annual flow will vary from year to year based on weather conditions but the facility has adequate hydraulic capacity available for future growth. In 2013, peak daily flows ranged from 8.6 to 23.2 mgd with all but one month over 18.0 mgd. The facility receives flow from the City of Rutland combined sewer system collecting residential, commercial, industrial, and stormwater flows and also receives sewage flows from the adjacent communities, Town of Rutland and Town of Killington.

Figure 3.1 Average Monthly Flows

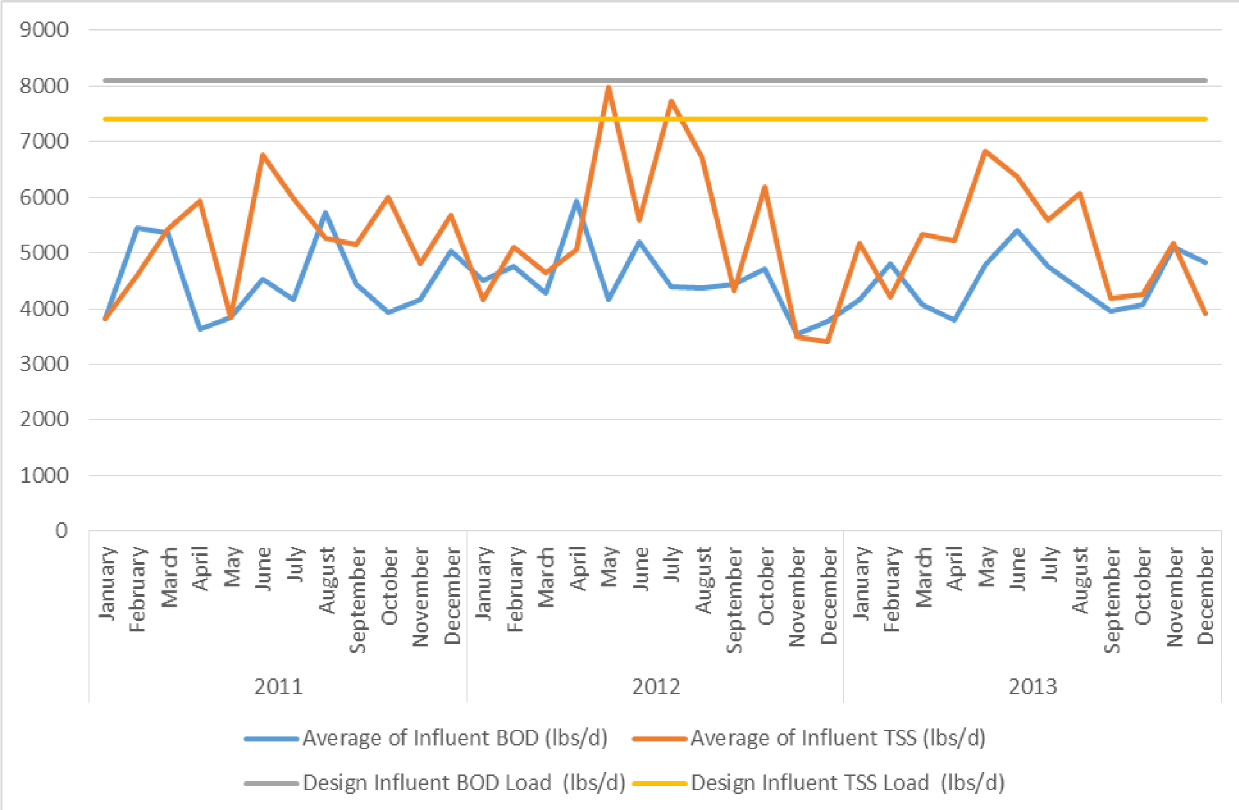


3.3. Influent Data

A summary of the influent data for 2011 through 2013 is provided in Figure 3.2.

- Biochemical Oxygen Demand: The average concentration was 114 mg/l, which is lower than the original design concentration of 155 mg/l. The average loading is shown at 4,509 lbs/day which about 56% of the original design loading.
- Total Suspended Solids: The average concentration was 133 mg/l, which is also lower than the original design concentration of 168 mg/l. The average loading is shown at 5,278 lbs/day which is about 71% of the original design loading.

Figure 3.2 Influent BOD and TSS



3.4. Septage

Septage Characterization

For assessment of the impacts of septage on the wastewater treatment facility influent organic loadings, the EPA averages were used for the septage characterization and are summarized below in Table 3.5. This information was used for the analysis as actual sampling data was not available for the septage.

Table 3.2
Septage Characterization

Parameter	EPA Average (mg/l)	Typical Design Value (mg/l)
Biochemical Oxygen Demand	6,500	7,000
Total Suspended Solids	12,900	15,000
Total Kjeldahl Nitrogen	590	700
Ammonia	97	150
Total Phosphorus	210	250

Septage Received

The volumes of septage received for 2012 through 2013 are summarized in Table 3.3. A total of 940,500 gallons were received in 2013 for treatment. The 2002 Basis for Final Design included a septage design load of 7,500 gpd. The facility averaged 2,580 gpd during this period with a maximum month of 5,030 gpd. Volumes received tend to be higher in late spring, summer and early fall when access to private septic tanks is easier for pump outs. Overall the volumes of septage are relatively low compared with design.

Table 3.3
2012-2013 Septage Volumes

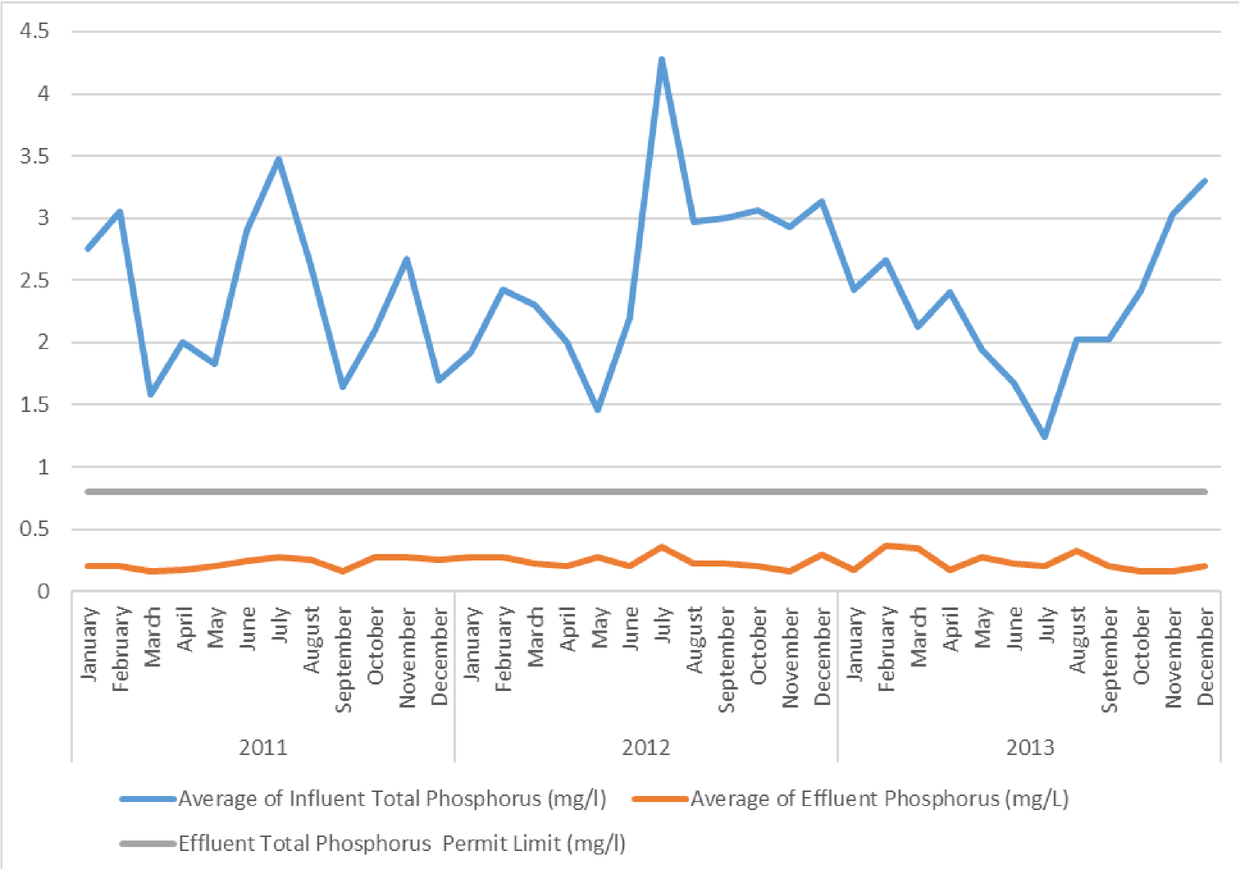
Month	2012 Total (Gallons)	2013 Total (Gallons)
January	6,000	37,000
February	10,000	19,500
March	8,000	35,500
April	2,200	87,500
May	4,500	124,500
June	58,100	94,400
July	79,800	95,500
August	80,900	76,600
September	79,900	111,000
October	156,000	135,000
November	101,500	82,500
December	48,000	41,500
Total	634,900	940,500

3.5. Phosphorus Levels

The influent total phosphorus concentrations average 2.4 mg/l which is lower than the typical influent strength for this type of municipal treatment facility. On a monthly basis, the influent total phosphorus concentrations are relatively consistent and range from 1.2 to 4.3 mg/l.

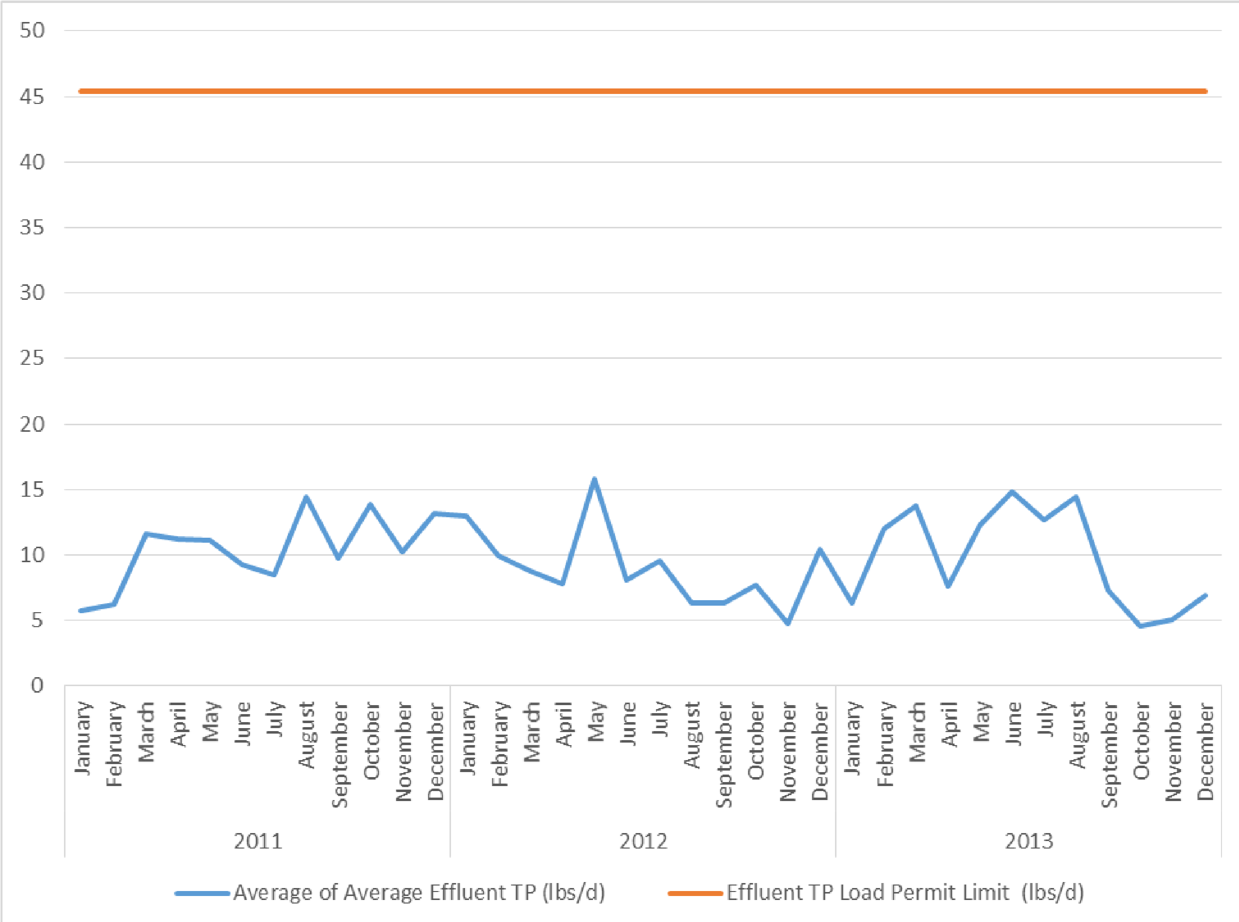
As shown in Figure 3.3, effluent concentrations average about 0.23 mg/l (9.8 lbs/day) and range from 0.16 to 0.37 mg/l, so average removals are about 90%. With only chemical treatment and clarification it can be difficult to operate consistently under 0.5 mg/l. However, the Rutland WWTF consistently achieves low effluent phosphorus concentrations. The total phosphorus permit limit is specified at 0.8 mg/l and a monthly average load of 45.4 lbs/day.

Figure 3.3 Influent and Effluent Total Phosphorus Concentration



As shown on Figure 3.4, this facility discharges 9.8 lbs/day which is about 22% of the monthly average pounds limit of 45.4 lbs/d. From 2011 through 2013, the average monthly effluent total phosphorus load ranged from 4.8 lbs/d to 15.8 lbs/d.

Figure 3.4 Effluent Total Phosphorus Load



3.6. Chemical Usage

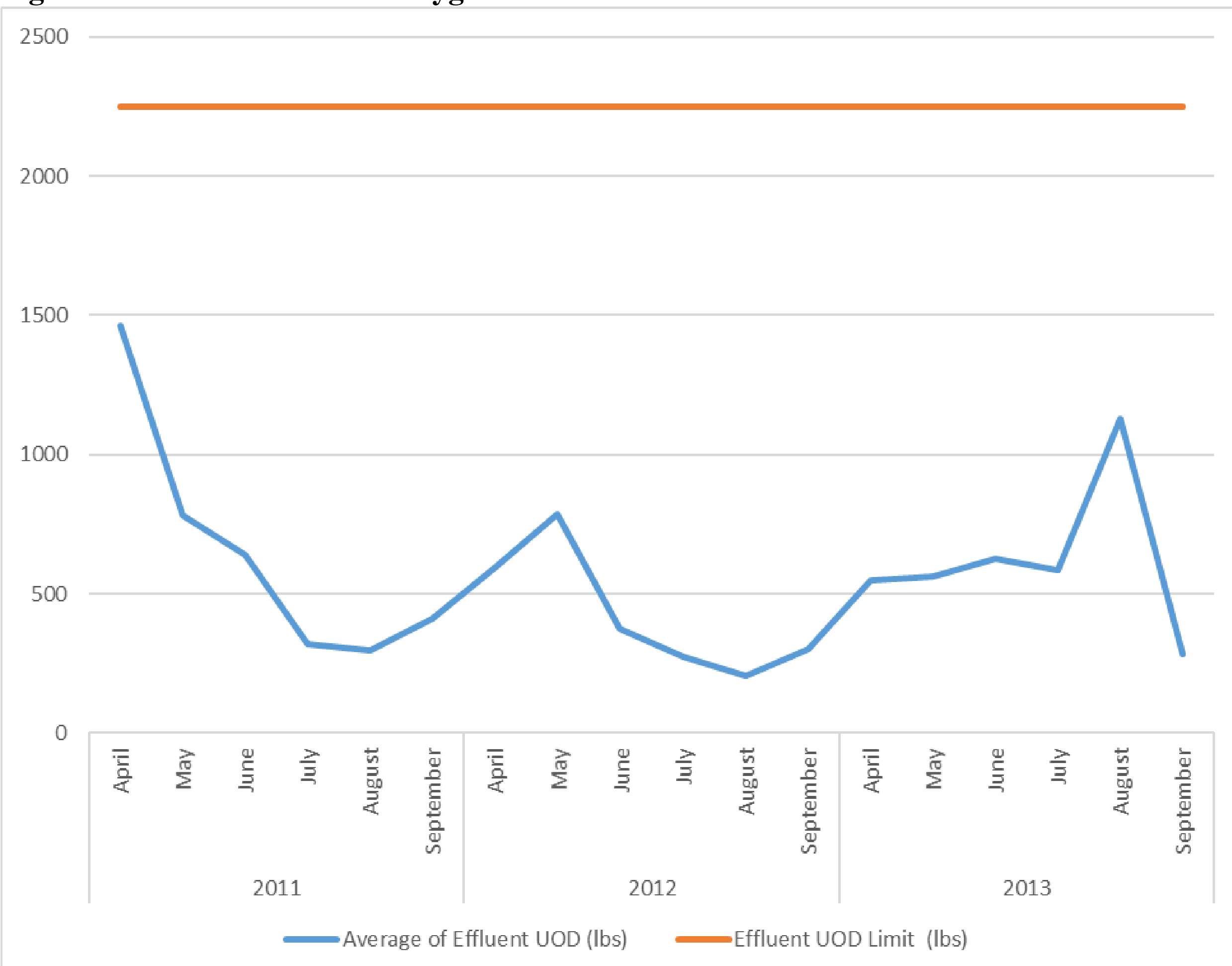
The chemical usage data was reviewed as it relates to the phosphorus removal. Sodium aluminate is used as the primary coagulant for chemical treatment. Single point dosage is utilized by adding the sodium aluminate upstream of the secondary clarifiers at the rapid mix tanks.

In 2013, the average daily usage ranged from 75 to 120 gpd and averaged 99 gpd. The feed rates at each dosage point remain relatively consistent and are not changed significantly to track with changing flows and other operating parameters.

3.7. Ultimate Oxygen Demand

The Rutland WWTF has a seasonal ultimate oxygen demand (UOD) effluent maximum day permit limit of 2,250 lbs effective June 15th through September 30th. UOD is calculated using effluent BOD and total Kjeldahl nitrogen (TKN) to sum the biological and nitrogenous oxygen demands. As shown in Figure 3.5, the UOD load from 2011 to 2013 the maximum day was less than 1,500 lbs which is approximately 67% of the permit limit.

Figure 3.5 Effluent Ultimate Oxygen Demand



4. WASTEWATER TREATMENT FACILITY ASSESSMENT

On March 18, 2014 a site visit was performed at the wastewater treatment facility and included observation of each of the individual unit processes to perform a preliminary assessment. Attending the site visit were the following as assisted by City operations staff:

- Aldrich + Elliott; Wayne Elliott, PE and Jennie Auster, PE
- Stantec; Joe Uglevich, PE and Michael Headd, PE

This assessment was performed to determine the adequacies and deficiencies of each process component based on age and condition. The deficiencies and adequacy of each component are discussed in the following narratives. An inventory was prepared for the existing equipment to document the type, age, condition (poor, fair, good) and operability.

The original wastewater treatment facility was constructed on this site in 1963 and this facility was upgraded to secondary treatment in 1984. Since then, several upgrades of individual process elements have been completed but some structures and equipment are now over 30 years old. Table 4.1 summarizes the timeline of major upgrades at the facility. Figure 1 in Appendix A shows the existing site plan.

Table 4.1
City of Rutland Wastewater Treatment Facility
Timeline of Major Upgrades

Date	Contract No./Project Name
1963	Original Construction WPCP
1984	WWTF Upgrade
1986	WWTF Upgrade
1993	CSO Abatement Facility
1993	Phosphorus Removal Upgrade
2005	CSO Abatement – Phase 2A

Assessment of the major process elements is described in the following sections.

4.1. Headworks

Description

Flow pumped from the River Street Pump Station enters the Influent Valve Vault where influent is directed to the original Headworks or the CSO Headworks. When influent flow is less than 16 MGD, all influent enters the original Headworks constructed in 1984 which consists of an E&I Corporation mechanical screen with a bar rack bypass and two detritors for grit removal with a Wemco grit pump and two Krebs Cyclone grit washing/dewatering units. Flows from the Headworks continue by gravity to the primary influent channel.

The E&I Corporation screen was installed in 2005. The grit tanks were constructed in 1984 and were originally Dorr Oliver units. However, the original equipment has been replaced with Hi-Tech units. The Wemco Torque Flow grit pump was installed in 1984 and serves both grit tanks. The two Krebs Cyclone grit dewatering units were installed in 2005. These units discharge into dumpsters on the exterior of the Headworks Building. Operators noted that weather conditions impact operations of these units. The Headworks building also houses the MCC which was installed in 1984. The septage receiving pump is also located in the lower level of the Headworks Building.

Assessment

For the assessment of the Headworks, a summary is provided in Table 4.2 and the major items of concern over the next 10 years are described below.

- Influent valve pit wiring and electrical manholes taking on water.
- Replace electric heat in Headworks Building.
- Enclose exterior portion of grit dewatering equipment.
- Grit pumps are original and require replacement.

Table 4.2
Headworks Assessment

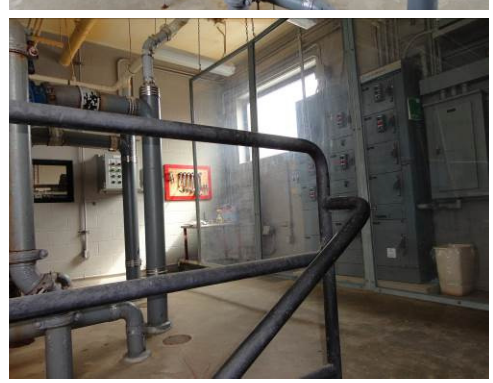
Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Bar Racks			✓			1984	10+	
Handrails			✓			1984	10+	
Fine Screen				✓		2005	10+	
Grit Washing/ Dewatering			✓			2005	10+	Exterior is exposed.
Grit Removal System			✓			1984/ 2005	10+	Upgraded in 2005
Grit Pump		✓				1984	5+	
Piping and valves		✓				1984	5+	
Building			✓			1984	10+	Doors and frames rusted
Heating/ventilation			✓			1984	< 5	Electric heat.
Electrical			✓			1984	5+	
MCC			✓			1984	5+	

4.2. CSO Headworks

Description

The CSO Headworks was added in 1993 and treats influent wastewater in parallel with the original Headworks when flows are greater than 16 mgd. When influent flows are less than 16 mgd, the CSO Headwork is not in use and flow enters the original Headworks. The CSO Headworks consists of a mechanical bar screen with an available bar rack bypass, two Grit King grit removal units, two grit pumps, and two grit washer/dewatering units. All equipment is from 1993 with the exception of the second Grit King unit and associated grit pump which were added in 2005. Flows from the CSO Headworks continue by gravity to the primary influent channel. The rails have been replaced on the mechanical screen.

The Allen Bradley MCC is located in the room with the grit washer/dewatering units. A splash guard was installed to protect the MCC.



Assessment

For the assessment of the CSO Headworks, a summary is provided in Table 4.3 and the major items of concern over the next 10 years are described below.

- Operators indicated operational issues with the grit washing/dewatering units.

Table 4.3
CSO Headworks Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Bar Racks			✓			1993	10+	
Fine Screen			✓			1993	10+	
Grit Washing/ Dewatering		✓				1993	5+	Operational issues
Grit Removal Units				✓		1993/ 2005	10+	
Grit Pumps			✓			1993/ 2005	5+/10+	
Piping and valves			✓			1993	10+	
Building			✓			1993	10+	
Heating/ventilation			✓			1993	10+	New heater installed.
Electrical			✓			1993	10+	
MCC			✓			1993	10+	

4.3. Septage Receiving

Description

The septage receiving is adjacent to the original Headworks Building. It provides coarse screening with a manual bar rack. The grit pump located in the lower level of the original Headworks Building pumps the septage to grit removal. The septage receiving is designed for 10,000 gpd.

Assessment

For the assessment of the septage receiving, a summary is provided in Table 4.4 and the major items of concern over the next 10 years are described below.

Table 4.4
Septage Receiving Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Dumping Station			✓			1984	10+	
Septage holding tank/mixer			✓			1984	10+	

4.4. Primary Clarifiers

Description

Flow from the primary influent channel continues to the three (3), 36' x 100', chain and flight rectangular primary clarifiers with an 8' sidewater depth. Two of the concrete tanks are original and were constructed in 1963. The third concrete tank was added as part of the 2005 CSO Abatement upgrade. The rakes, chains and drives for the original two clarifiers were also replaced in the 2005 upgrade.

A new building was added in the 2005 upgrade to house the Penn Valley primary sludge pump.

Primary sludge is collected in the tank adjacent to the primary clarifiers enclosed in a building. The exterior of the building has an area of exposed styrofoam insulation.

Assessment

For the assessment of the primary clarifiers, a summary is provided in Table 4.5 and the major items of concern over the next 10 years are described below:

- Effluent weirs are original and require replacement.
- Primary Sludge Building repairs.
- Concrete tank repairs.

Table 4.5
Primary Clarifiers Assessment

Item	Ranking of Existing Condition: Poor 1	Poor 2	Fair 3	Good 4	Good 5	Year Installed	Projected Remaining Life (years)	Notes
Influent Distribution Box/Gates				✓		2005	15+	
Grating and handrails			✓			2005	15+	
Drive units			✓			2005	15+	
Sludge chains and flights			✓			2005	15+	
Weirs		✓				1963, 2005	10+	Weirs in tanks #2 and #3 are original
Concrete tanks #1 and #2			✓			1963	20+	
Concrete tank #3				✓		2005	20+	
Primary Sludge Pump #1 Building			✓			1963	10+	
Primary Sludge Pump #2 Building			✓			2005	15+	
Electrical/controls			✓			2005	15+	

4.5. Aeration Tanks/Blower Building

Description

Primary effluent flows via gravity to the aeration basin influent box where it is directed to the two aeration tank trains operated in parallel. Each tank consists of three aerated cells. Each tank is 160.5' long by 50' wide with a 20.3' sidewater depth. Fine bubble diffusers distribute air to the tanks. The membrane diffusers and distribution air piping were replaced in 2005. There are three blowers, two 200 hip, 3000 scfm, Roots Whispair positive displacement blowers operated with VFDs installed in 1986 and one Neuros NX150 Turbo blower installed in 2011. Dissolved oxygen (DO) concentrations in the aeration tanks are controlled manually based on once daily samples processed in the lab.

The electrical room in the Blower Building has the RAS pump VFDs and the Westinghouse MCC, all installed in 1986. The heat recovery unit for the Building was installed in 1986 as well.

Assessment

For the assessment of the aeration tanks, a summary is provided in Table 4.6 and the major items of concern over the next 10 years are described below:

- Aeration Blowers: The Roots aeration blowers are original equipment and require replacement to improve the reliability and reduce operating conditions.
- Leaks in the air piping were observed at the site visit.
- Automated DO control and monitoring is not provided.
- MCC is original.

Table 4.6
Aeration Tank/Blower Building Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Aeration Tanks			✓			1986	20+	
Diffusers				✓		2005	10+	
Air piping				✓		2005	10+	
RAS Piping/Valve			✓			1986	5+	
PD Blowers		✓				1986	< 5	
Turbo Blower				✓		2011	15+	
Gates		✓				1986	< 5	
Hand rails			✓			1986	5+	
Building			✓			1986	10+	
HVAC			✓			1986	< 5	
Blower Controls			✓			1986	< 5	Not used.
Electric/VFDs						1986	< 5	
MCC			✓			1986	< 5	

4.6. Flocculation Tanks

Description

Aeration effluent flows by gravity to the two (2) flocculation tanks constructed in 1993, one dedicated to each secondary clarifier. A Lightning Series 10 mixer is provided for each tank. Sodium aluminate for chemical phosphorus precipitation is added to the flocculation tanks.

Assessment

For the assessment of the flocculation tanks, a summary is provided in Table 4.7 and the major items of concern over the next 10 years are described below:

- Mixers are original and require replacement.

Table 4.7
Flocculation Tank Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Flocculation Tanks				✓		1993	10+	
Mixers		✓				1993	5+	

4.7. Secondary Clarifiers

Description

Mixed liquor from the aeration tanks flows to the two (2) 110-foot diameter secondary clarifiers. Each tank has a 15'-10" sidewater depth, and was constructed in 1984. The drives were replaced in 2005.

Return activated sludge (RAS) is pumped from the secondary clarifiers to the aeration tanks. The three (3) RAS pumps installed in 1984 are located in the Blower Building lower level. Each pump has a capacity of 1,800 gpm.

Waste activated sludge (WAS) is pumped from the secondary clarifiers to the gravity belt thickener. The three (3) WAS pumps were installed in 1984 are located in the Blower Building lower level. Each pump has a capacity of 150 gpm.

The VFDs for the RAS and WAS pumps are located in the main level of the Blower Building.

Assessment

For the assessment of the secondary clarifiers, a summary is provided in Table 4.8 and the major items of concern over the next 10 years are described below:

- Clarifiers: Refurbish interiors and superstructure.
- RAS Pumps: These RAS pumps are original and require replacement.
- WAS Pumps: The WAS pump is original and requires replacement.
- Electrical/Controls; The electrical and controls for the pumps should be upgraded to new VFD's, etc to provide improved efficiency and better process control.

Table 4.8
Secondary Clarifier Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Grating and Handrails			✓			1984	10+	
Gates		✓				1984	< 5	
Weirs			✓			1984	5+	
Drive units		✓				2005	10+	
Scraper arms and other interior equipment		✓				1984	< 5	
Concrete tanks			✓			1984	10+	
RAS Pumps		✓				1984	< 5	
WAS Pumps		✓				1984	< 5	
Electrical/controls		✓				1984	< 5	

4.8. Chemical Feed

Description

Sodium aluminate is used for both chemical phosphorus precipitation and pH adjustment. Sodium aluminate is stored in the Chemical Building using two (2) 5,000 gallon fiberglass bulk storage tanks installed in 1993. There are two (2) Watson Marlow chemical feed pumps installed in 2005. Sodium aluminate feed rates are manually adjusted, flow pacing is not provided. One pump is dedicated to each secondary clarifier.

A lime slurry system installed in 1993 located in the lower level of the Blower Building is also provided for pH adjustment. However, this system has never been used.

Standby power is provided for the chemical feed and disinfection systems by an exterior CAT 40KW generator.

Assessment

For the assessment of the chemical feed system, a summary is provided in Table 4.9 and the major items of concern over the next 10 years are described below:

- Flow pacing of sodium aluminate is not provided

Table 4.9
Chemical Feed System Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Metering pumps				✓		2005	10+	
Bulk storage tanks			✓			1993	30+	
Building			✓			1993	10+	
Heating/ ventilation			✓			1993	5+	
Electrical/controls			✓			1993	5+	Flow pacing is not provided
Standby Generator			✓			1993	5+	

4.9. Disinfection

Description

Disinfection with sodium hypochlorite and dechlorination with sodium bisulfite occurs in the two chlorine contact tanks in series. Both tanks were constructed in 1984 and expanded in 2005. Tank No. 1 has a volume of 166,647 gallons, and Tank No. 2 has a volume of 146,000 gallons. A Flygt mixer is provided in the rapid mix zone in Tank No. 1 where sodium hypochlorite is added.

The bulk storage tanks and chemical feed pumps for the sodium hypochlorite and sodium bisulfite are located in the Chemical Building which was added in 1993. For each chemical there are two HDPE tanks and two Watson Marlow chemical feed pumps.

Effluent flow measurement is provided with a Parshall flume. The chart recorder is located in the Blower Building.

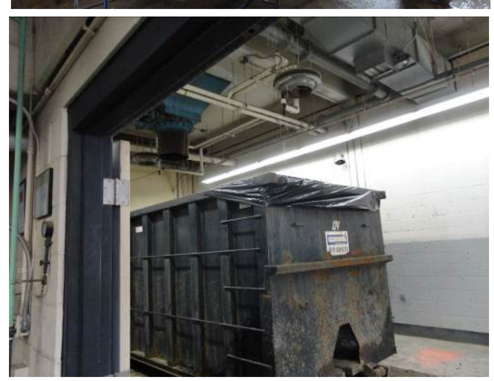
Assessment

For the assessment of the disinfection system, a summary is provided in Table 4.10 and the major items of concern over the next 10 years are described below.

Table 4.10
Disinfection Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Bulk storage tanks			✓			1993	< 5	
Metering pumps			✓			1993	< 5	
Mixer			✓			2005	10+	
Chlorine contact tanks				✓		1984/ 2005	15+	
Effluent flow measurement			✓			2005	10+	

4.10. Sludge Thickening and Dewatering



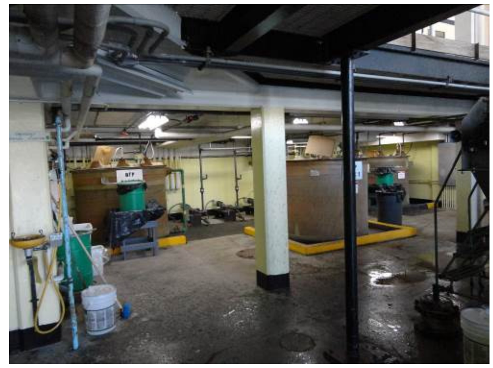
Description

WAS is pumped to the two (2) gravity belt thickeners (GBT) located in the Dewatering Building. One gravity belt thickener unit was installed in 1996, and the other in 2005. Currently, waste sludge thickening is operated 7 days per week using one of the GBT units. Thickened waste activated sludge (TWAS) from the GBTs flows to the TWAS holding tanks.

The TWAS is pumped from the TWAS holding tank to the heated primary digester with the two (2) TWAS pumps located in the Dewatering Building basement. One (1) pump is a newer Penn Valley double disc unit.

Anaerobically digested sludge at approximately 2% solids is pumped to the two Komline Belt Filter Presses (BFPs) in the Dewatering Building. The dewatering system was added in 1996. Typically, the facility operates one BFP four days per week. Filtrate from the BFPs flows to the Headworks.

Dewatered sludge discharges through a chute to the lower level where the roll off container is located.



The polymer feed system is shared by the GBTs and belt filter presses (BFPs). There is one polymer mixing tank and two polymer day tanks located in the lower level of the GBT room. The mixers in the tanks were installed in 1984. Three feed pumps are used to convey polymer to either the GBTs or the BFPs. The MCC is located on the upper level and was installed in 1984. Heating and ventilation systems were replaced in 2005.

Assessment

For the assessment of the sludge thickening, a summary is provided in Table 4.11 and the major items of concern over the next 10 years are described below:

- MCC is original and requires replacement.

Table 4.11
Sludge Thickening and Dewatering Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Gravity Belt Thickener No. 1			✓			1996	5+	
Gravity Belt Thickener No. 2				✓		2005	10+	
Belt Filter Press			✓			1996	5+	
BFP Feed Pumps		✓				1996	5+	
Polymer Feed System			✓			2005	10+	
TWAS pumps			✓			2005	5+	
Heating/ ventilation			✓			2005	10+	
Electrical/controls			✓			1996/ 2005	5+/10+	
MCC						1984	<5	

4.11. Anaerobic Digestion

Description

The anaerobic digestion system consists of four primary digesters and a secondary digester tank. The primary sludge and scum from the primary clarifiers is pumped to the primary digesters which are heated and mixed with cannon style mixers. Two of the digesters (#1 and #2) were built in the 1970s, two (#3 and secondary) were built in 1986, and one (#4) was built in 1993. Three of the covers are floating gas holder covers, and two are fixed. Typical operation of the digesters is with three primary digesters and one secondary with one tank off-line. One cover has been replaced for tank #3. This summer, the covers for tank #4 and the secondary are being refurbished. The remaining two fixed covers for #1 and #2 need to be inspected.

Gas compressors for the cannon mixers are located in the Digester Building. There are two 3 hp Wemco/Hydrostal screw centrifugal pumps for transferring sludge between the primary and secondary digesters. These pumps are located in the basement of the Digester Building adjacent to heat exchanger pump #3.

There are two heat exchangers used for heating the primary digesters that are original, one is no longer in use. The operational heat exchanger is an Atara unit stacked with three heat exchangers each with a capacity of 500,000 btu/hr. Two boilers located in the main level of the Digester Building supply hot water to the heat exchangers.

There are four (4) 3 hp Wemco/Hydrostal screw centrifugal pumps each with a capacity of 240 gpm at 24 feet TDH intended to circulate sludge from the primary digesters through the heat exchangers and then returning back to the primary digesters. One heat exchanger pump is located between primary digester #3 and the sludge transfer pump. One is located in the west basement addition. The other two heat exchangers pumps are adjacent to primary digester #1 and #2.

A flare is provided for waste gas burning on the roof of the Digester Building. This does not conform with current NFPA 820 code requirements.

The anaerobic digester sludge (ADS) pumps convey digested sludge to the belt filter press for dewatering. There are two (2) 5 hp, Netzsch progressive cavity pumps, each with a capacity of 90 gpm at 40 psi. These pumps are located in the basement of the Digester Building.

Assessment

For the assessment of the anaerobic digestion system, a summary is provided in Table 4.12 and the major items of concern over the next 10 years are described below. A significant portion of the anaerobic digestion system is original. The City has continued to upgrade the digester tank covers, and are replacing the gas lines and appurtenances. Upgrades will be required in the next 10 years or so as this equipment approaches the end of its useful life. There are also many areas within the anaerobic digester building that are not compliant with current NFPA 820 regulations. For the purposes of this study, it is recommended that a more detailed evaluation be performed of the anaerobic digestion system to determine the future upgrade needs.

- No gas detection is provided for the classified spaces.
- Existing boiler locations are classified per NFPA 820 requirements.
- Existing flare location is classified per NFPA 820 requirements.
- Sludge recirculation and transfer pumps are original and require replacement.
- Many of the gas lines and gas safety appurtenances are original and require replacement.
- Gas compressors for mixing primary digesters are original and require replacement.
- MCC locations are classified per NFPA 820 requirements.

Table 4.12
Anaerobic Digestion System Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Gas mixing system			✓			1986	< 5	
Gas piping & appurtenances		✓				1986	< 5	Some piping has been replaced.
Sludge recirculation pumps		✓				1986	< 5	
Sludge transfer pumps		✓				1986	< 5	
BFP Feed Pumps		✓				1986	< 5	
Digester tanks			✓			1970s, 1986, 1993	10+	
Digester cover #1		✓				1970	< 5	
Digester cover #2		✓				1970	< 5	
Digester cover #3					✓	2012	10+	
Digester cover #4					✓	1986	10+	Upgraded in 2014
Secondary Digester cover #5					✓	1993	10+	Upgraded in 2014
Gas burner	✓					1986	< 5	
Handrails and stairs			✓			1986	5+	
Heat exchanger #1		✓				1986	< 5	
Heat exchanger #2	✓					1986	< 5	Not operable.
Boiler #1		✓				1986	< 5	
Boiler #2		✓				1986	<5	
Building			✓			1970s/ 1986	10+	
Control system		✓				1986	<5	
Gas detection system	✓					1986	<5	
Heating/ ventilation		✓				1986	<5	
Electrical			✓			1986	<5	

4.12. Administration Building and Laboratory

Description

The Administration Building contains the offices, lunchroom, conference room, and the laboratory. The building was constructed in 1986. Operators have refinished some interior rooms, but the roof, windows, doors and laboratory are original.

Assessment

For the assessment of the Administration Building, a summary is provided in Table 4.13 and the major items of concern over the next 10 years are described below. The staff continues to perform needed upgrades on the building using available funds from the wastewater treatment budget.

Table 4.13
Administration Building Assessment

Item	Ranking of Existing Condition					Year Installed	Projected Remaining Life (years)	Notes
	Poor		Fair	Good				
	1	2	3	4	5			
Roof			✓			1986		
Doors and windows			✓			1986		
Laboratory			✓			1986		

4.13. Summary of Major Deficiencies

Those major items identified in the assessment as requiring upgrade in the next 10 years are summarized in Table 4.14 for the liquid stream and Table 4.15 for the sludge processing. The projected date of required upgrade is noted for each item.

Table 4.14
Summary of Major Deficiencies
Liquid Stream

Item Description	**Projected Date of Required Upgrade**		
	< 2 Years	**2 to 5 Years**	**6 to 10 Years**
Influent Valve Pit			
Replace wiring		✓	
Replace automatic control valves	✓		
Headworks			
Replace grit pumps, valves, piping		✓	
Enclose grit cyclone and conveyor		✓	
Heating upgrades		✓	
Primary Clarifiers			
Concrete tank repairs		✓	
Replace effluent weirs		✓	
Primary sludge building repairs		✓	
Aeration Tanks			
Replace gates		✓	
Replace two aeration blowers		✓	
Upgrade blower/DO controls		✓	
Replace motor control center		✓	
Flocculation Tanks			
Replace mixers		✓	
Secondary Clarifiers			
Replace gates		✓	
Refurbish interior superstructure		✓	
Replace RAS pumps and upgrade controls		✓	
Replace WAS pumps		✓	

Table 4.15
Summary of Major Deficiencies
Solids Processing

Item Description	**Projected Date of Required Upgrade**		
	< 2 Years	**2 to 5 Years**	**6 to 10 Years**
Sludge Thickening/Dewatering			
Replace gravity belt thickener			✓
Replace dewatering feed pumps			✓
Replace belt filter presses			✓
Replace motor control center			✓
Anaerobic Digestion			
Replace gas mixing systems		✓	
Repair gas piping		✓	
Upgrade gas collection system		✓	
Replace sludge recirculation pumps		✓	
Replace sludge transfer pumps		✓	
Replace heat boiler/heat exchangers		✓	
Replace/refurbish covers		✓	
Replace waste gas burner		✓	
Heating/ventilation upgrades		✓	
Control system upgrades		✓	
Electrical upgrades		✓	

4.14. Short-Term Refurbishment Priorities

From the short and long-term needs documented from the assessment of the treatment facility in Section 4.0, the age related needs will be identified. These improvements are intended to address a variety of needs to extend the useful life of the existing facilities and include items to address the following deficiencies and/or future needs:

- Maintenance and repairs
- Safety improvements
- Code compliance needs
- Refurbishment of existing equipment
- Improved operating efficiencies
- Replacement of aged equipment

The City continues to work on addressing short-term deficiencies using funds from the Wastewater Treatment budget. Some of these items include:

- Anaerobic Digester System; Replacement of gas piping, valves, gas appurtenances, etc.
- Administration Building renovations; painting of walls, heating/ventilation upgrades, etc.

- Control system upgrades

A few other process related items were identified with the potential to improve operations. These items are listed below and should be further evaluated. Cost estimates were not prepared for these items as more detail needs to be developed.

- Headworks: Enclosing the grit dewatering equipment
- Aeration Tanks: Add DO monitoring and automatic blower controls to reduce energy usage and optimize process control
- Chemical Feed System: Add flow pacing for the sodium aluminate feed systems

Those items requiring upgrade in the next 2 to 5 years are listed below for the liquid stream and sludge processing.

Liquid Stream

The liquid stream items identified as deficient in Section 4.0 and listed in Table 4.14 for refurbishment are listed below by structure.

Influent Valve Pit

- Replace wiring

Headworks

- Replace grit pumps, valves, and piping
- Heating/ventilation upgrades

Primary Clarifiers

- Concrete tank repairs
- Replace effluent weirs
- Primary sludge building repairs

Aeration Tanks

- Replace gates
- Replace two aeration blowers
- Replace motor control center

Flocculation Tanks

- Replace two mixers

Secondary Clarifiers

- Replace gates

- Refurbish interior superstructure and equipment
- Replace three (3) RAS pumps and upgrade controls
- Replace two (2) WAS pumps

Sludge Processing

The sludge processing items identified as deficient in Section 4.0 and listed in Table 4.15 for refurbishment are listed below by structure. The thickening/dewatering components are not included in this 2 to 5 year timeframe for replacement and prior to upgrade of the dewatering equipment, evaluation of alternative technologies and pilot testing should be performed. The majority of the short needs are for the Anaerobic Digestion as most of this equipment is original at about 30 years old.

Anaerobic Digestion

- Replace gas mixing systems in two (2) tanks
- Replace gas piping and gas safety equipment
- Upgrade gas collection systems
- Replace two (2) sludge recirculation pumps
- Replace two (2) sludge transfer pumps
- Replace two (2) boilers/heat exchangers
- Replace/refurbish two (2) digester covers #1 and #2
- Replace waste gas burner
- Heating/ventilation upgrades
- Control system upgrades
- Electrical upgrades

Estimated Costs

A summary of the estimated construction costs to address the age related needs required for each process element over the next 2 to 5 years is summarized in Table 4.16. The estimated construction cost is $7,000,000 based on an ENR 9800 = August 2014. Appendix B contains detailed cost estimates for the refurbishment items. A budget estimate is shown for the Anaerobic Digestion system upgrade based on the limited investigation and evaluation performed for this study. It is recommended that a more comprehensive evaluation of the Digester Building and tanks be performed to verify normal operating conditions of all equipment, upgrades performed on gas piping by City staff, and other code compliance requirements. Building upgrades and/or expansion may be required for sequencing during construction and to comply with NFPA 820 requirements and will increase the cost of the upgrades.

Table 4.16
WWTF Refurbishment
Estimated Construction Costs

Item Description	Estimated Cost (ENR 9800)
Influent Valve Pit	$25,000
Headworks	$190,000
CSO Headworks	$0
Septage Receiving	$0
Primary Clarifiers	$150,000
Aeration Tanks/Blower Building	$900,000
Flocculation Tanks	$110,000
Secondary Clarifiers	$1,370,000
Chemical Feed	$0
Disinfection	$0
Sludge Thickening/Dewatering	$0
Anaerobic Digestion	$3,300,000
Subtotal	$6,045,000
15% Contingency	$907,000
Total	$6,950,000
Use	$7,000,000

Notes:
1. ENR 9800 = August 2014

5. POTENTIAL NEW DISCHARGE LIMITS ASSESSMENT

5.1. Introduction and Potential WWTF Permit Limit Changes

The purpose of this section of the report is to outline available options to meet a future anticipated effluent phosphorus limits at the Rutland WWTF. At this point in time, the future effluent limit has not been confirmed although the anticipated limit is expected to be either 0.1 mg/L or 0.2 mg/L. This new effluent phosphorus limit will likely be instituted once the updated TMDL is issued for Lake Champlain. It is fully expected that the new limit will be mandated with no funding assistance from either the State or EPA. For this reason, it was decided to investigate the potential best case performance at the Rutland WWTF assuming it may be necessary to proceed with an interim effluent phosphorus limit on the road to ultimate compliance, due to financial constraints at the local level.

The project team has considered three effluent compliance scenarios for the Rutland WWTF including:

- Effluent total phosphorus (TP) concentration of <0.1 mg/L which is considered to be the most stringent possible limit;
- Effluent TP concentration of <0.2 mg/L; and,
- Effluent TP concentration of 0.2 to 0.3 mg/L.

Meeting these limits at the current facility flow and at the ultimate design flow has also been considered.

5.2. WWTF Computer Modeling and Process Assessment

Sodium aluminate is currently added to the liquid stream upfront of the secondary clarifiers to precipitate phosphorus.

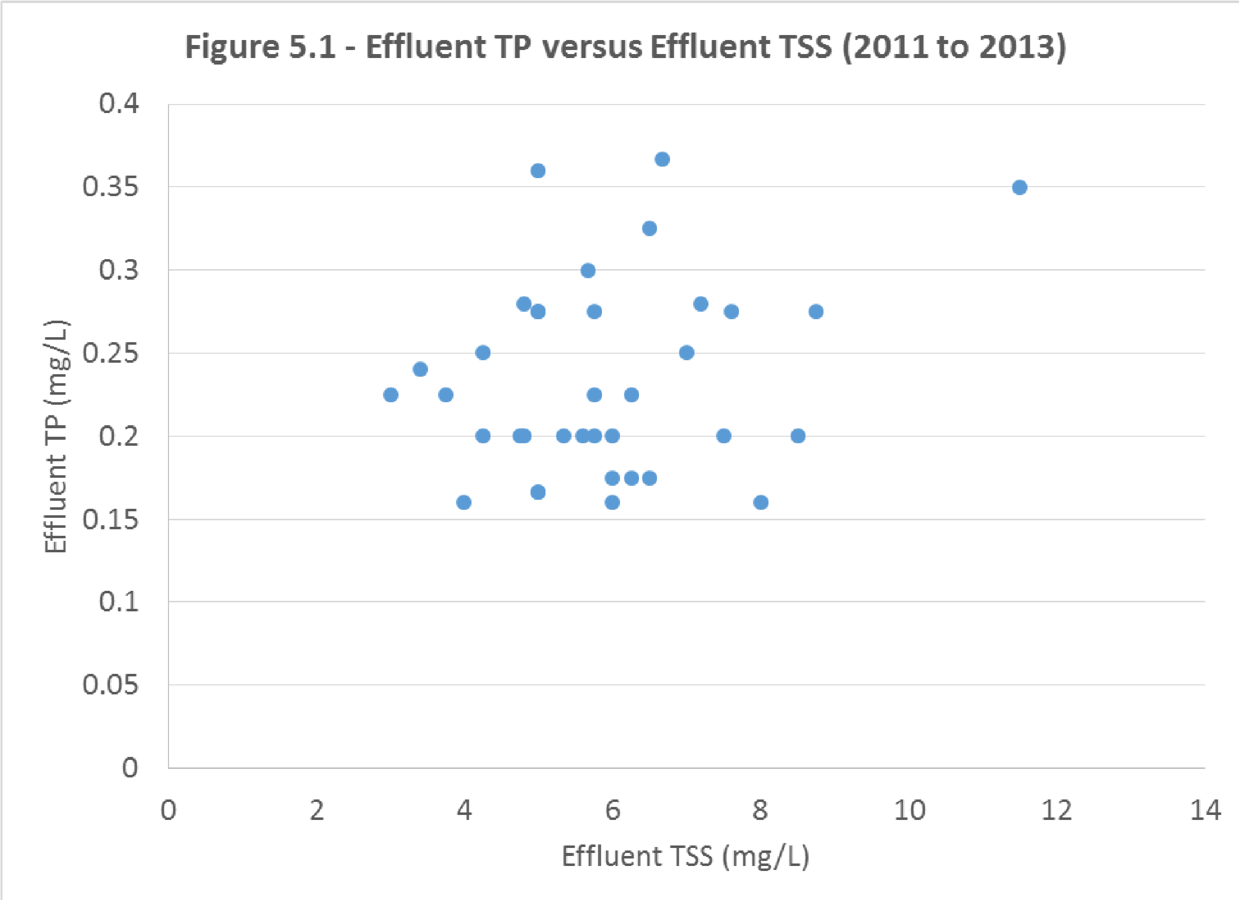
The active ingredient in sodium aluminate for chemical precipitation of phosphorus is aluminum. Aluminum is available in five forms for phosphorus precipitation; aluminum sulfate, aluminum chloride, poly-aluminum chloride (PAC), aluminum chlorohydrate, and sodium aluminate. Theoretically, 0.87 pounds of aluminum removes one pound of phosphorus (as P). But, as with iron, much more will be required to meet lower phosphorus limits.

The different aluminum forms consume differing amounts of alkalinity. Alum uses approximately 0.5 mg/L of alkalinity for each mg/L of aluminum added. Aluminum chloride uses 1 mg/L. PAC and sodium aluminate use almost no alkalinity which makes them especially attractive for use at the Rutland WWTF.

The existing Rutland WWTF is a conventional activated sludge process that uses sodium aluminate for phosphorus precipitation as indicated previously. A good starting point to determine the infrastructure required to meet a future phosphorus limit is confirmation of the reasonable limits of the existing system. Typically some form of effluent filtration is required to consistently meet an effluent TP of <0.3 mg/L if operating at design conditions. Effluent filtration is not installed at the Rutland facility.

Facility operations staff has done a good job optimizing the existing facility operations to drive effluent phosphorus concentrations as low as possible. Industry experience has shown that with continuous chemical addition and low secondary clarifier overflow rates of approximately 300 to 500 gallons/ft2-day, an effluent TP of between 0.2 and 0.5 mg/L is achievable. The average daily secondary clarifier surface overflow rate at the Rutland facility for 2013 varied between 180 gallons/ft2-day and 420 gallons/ft2-day with an average of 263 gallons/ft2-day. The facility design surface overflow rate is approximately 1,100 gallons/ft2-day. The combination of a low clarifier overflow rate and continuous chemical addition (approximately 100 gallons of sodium aluminate per day) resulted in an average annual effluent TP of 0.24 mg/L in 2013. Approximately seventy percent (70%) of the reported effluent TP values were 0.2 mg/L or less. Facility staff has admittedly not attempted to optimize effluent TP concentration below the current levels although our experience suggests it would likely be difficult to consistently achieve an effluent TP level of <0.2 mg/L without effluent filtration.

Good effluent TP control is highly dependent upon effluent solids control which is why effluent filtration is typically an integral part of the treatment process when it becomes necessary to consistently meet a low effluent TP limit, especially when approaching design conditions. A scatter plot of effluent total suspended solids (TSS) versus effluent TP based upon available 2011 to 2013 data is presented here as Figure 5.1. The plotted data presented in the figure suggests even if the effluent TSS concentration was below 5 mg/L, which is excellent for a secondary clarifier, there is no guarantee an effluent TP of less than 0.2 mg/L could be achieved on a consistent basis. Our review of the available historical data is consistent with our experience that effluent filtration would likely be required to meet an effluent TP limit of 0.2 mg/L or lower on a consistent basis. At this point in time we are of the opinion that the facility is currently performing at or near its limit for TP removal and that the absolute best performance, without filtration, is in the 0.2 to 0.3 mg/L range given present day flows.

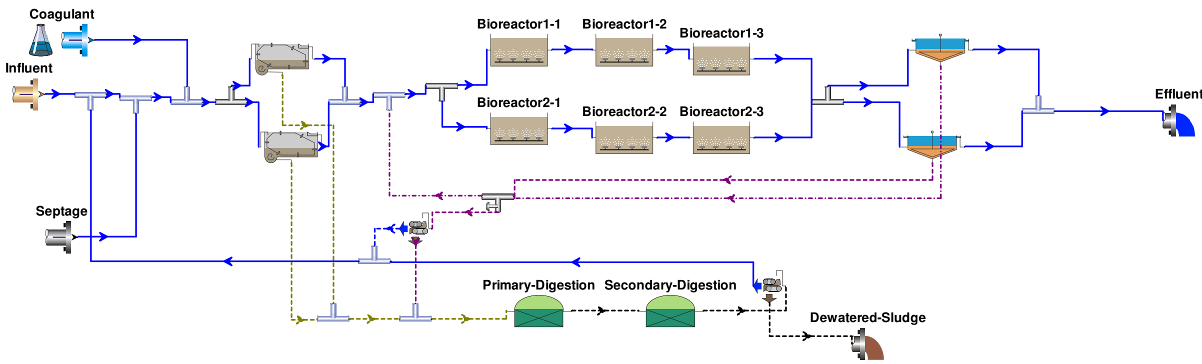


Model Verification and Initial Process Evaluation

Computer based process modeling was conducted using BioWin™ software to confirm the capacity of the existing treatment process as well as alternatives to meet future effluent TP limits of <0.2 mg/L and <0.1 mg/L. The first step in the process modeling was model verification. Verification is a preliminary evaluation of the model outputs against available facility data. It is different from model calibration which involves extensive study and associated cost to develop critical model parameters.

We developed an initial process model of the liquid stream to work out the 'bugs' in the modeling process. The liquid stream model was then expanded to include the solids stream process including the gravity belt thickener, anaerobic digesters, and belt filter presses. The model also included the addition of septage. The addition of the solids stream processes to the overall process model is critical for estimating the impact of side stream and recycle streams on facility loadings. The graphic representation of the existing facility process in BioWin™ is presented here as Figure 5.2.

Figure 5-2 – BioWin™ Representation of Existing Rutland WWTF



The process model was also used to verify reported historical data as well as confirm the model's ability to predict effluent quality. Process models such as the one used for this evaluation evaluate the outcome of the biochemical reactions taking place in the treatment facility while completing a mass balance across the entire treatment process. The model computed mass balance can be used to verify the accuracy of the reported O&M data.

The staff conducted special sampling of the septage and sidestream data to assist with the model development and assessment. The septage data provided by the City is summarized here in Table 5.1. These data were used as an input to the model verification runs.

Table 5.1 – Septage Characteristics

Parameter	US EPA Data			Rutland Data
	Avg.	Range	Design Values	
TSS (mg/L)	12,862	310-93,378	***15,000***	***9,700***
VSS (mg/L)	9,027	95-51,500	***10,000***	***69***
BOD_5 (mg/L)	6,480	440-78,600	***7,000***	***3,900***
COD (mg/L)	31,000	1,500-703,000	***15,000***	***9,100***
TKN (mg/L)	588	66-1,060	***700***	***440***
Total P	210	20-760	***250***	***40***
Grease (mg/L)	5,600	208-23,360	***8,000***	***Not measured***
pH	1.5	12.6	***6***	***Not measured***

The data collected by Rutland staff suggests the septage entering the facility is relatively weak compared to the typical range of values reported by EPA and others.

Facility staff also collected primary effluent samples for volatile fatty acid (VFA) analyses. VFA's are required to support biological phosphorus removal (referred to here as bio-P). Bio-P would involve the conversion of some of the existing bioreactor volume to an anaerobic zone and operation in an anaerobic/aerobic configuration. The advantage of this configuration is that it allows operators to achieve a high degree of phosphorus removal with little or no chemical addition. It should be noted biological phosphorus removal requires an adequate supply of VFA to be present in the anaerobic zone. Four to six milligrams of VFA is typically required for each milligram of phosphorus to be removed. VFA is either present in the primary effluent or must be generated through primary sludge fermentation. The Rutland facility would require an influent VFA concentration of 10 to 15 mg/L to support bio-P without constructing costly primary sludge fermentation. The data collected by O&M staff indicates there is insufficient VFA in the influent to the facility to support bio-P.

The annual average data for 2013 were input into the model to calculate effluent quality which was compared to reported average values to confirm the models predictive value and validity. The BioWin model supports alum and ferric addition, whereas the city currently adds sodium aluminate for phosphorus control. Project team members added the equivalent aluminum concentration based upon historical sodium aluminate usage data. Full blown model calibration would require extensive sampling and flow monitoring which was not conducted for this study, nor is it necessary for a preliminary evaluation to identify potential alternatives.

A summary of the results from the initial validation runs is presented here in Table 5.2.

Table 5.2 – Summary of Modeling Results from Initial Verification Runs

Condition	Effluent Concentrations (mg/L)				
	BOD	**TSS**	**TP**	**TKN**	**pH**
Annual Average (2013)	3.1	6.3	0.24	2.1	7.2
BioWin Output	2.6	9.9	0.23	1.85	6.7

The model predictions for BOD, TP, and TKN were relatively close to the annual average values reported by staff. Effluent pH projections were slightly lower than actually reported; however, this is as expected given alum equivalents were added in lieu of sodium aluminate. A number of utilities use sodium aluminate for phosphorus removal given it has a lesser impact upon effluent pH than other common metal precipitates such as ferric chloride and alum.

The one parameter that was slightly higher than the average annual was TSS although the estimated value is well within the anticipated error of the suspended solids test for TSS levels below 10 mg/L. The model predicted mixed liquor suspended solids (MLSS) concentration was approximately 2,400 mg/L compared to the reported annual average value of 2,600 mg/L a variation of approximately 10% which is well within the error of the test. The fact that the solids balance computed by the model is within the anticipated error of the solids tests confirms the validity of the reported effluent data.

The ability of the model to predict annual average effluent quality supports its utility and general applicability.

Model Conditions

The developed model was used to evaluate the following conditions:

- **Existing Flow and Loads**
  - Annual average flow and loading - all trains in service
  - Annual average flow and loading – all trains in service with biological phosphorus removal configuration to reduce chemical addition requirements
  - Annual average flow and loading – one train out of service
  - Maximum month flow and loading – all trains in service
- **Future Flow and Loads (to existing facility capacity of 8.1 MGD)**
  - **Conventional treatment with effluent filtration to meet 0.2 mg/L TP**
    - Annual average flow and load – all trains in service
    - Annual average flow and load – one train out of service
    - Maximum month flow and loading – all trains in service
  - **Conventional Treatment with membrane filtration to meet 0.1 mg/L TP**
    - Annual average flow and load – all trains in service
    - Annual average flow and load – one train out of service
    - Maximum month flow and loading – all trains in service

Model Results

A treatment facility must be able to treat annual average loadings with one train out of service to accommodate unscheduled breakdowns and scheduled maintenance requirements. The model of the existing flow and loading conditions indicates mixed liquor suspended solids concentrations and oxygenation rates are at practical limits at current loadings with one train out of service for maintenance.

The modeling results indicate little if any benefit to converting to biological phosphorus removal unless the city was to construct primary sludge fermenter facilities. The cost of these facilities would likely be in excess of $4M and would not eliminate the need for effluent filtration. Effluent filtration will be required regardless of whether the City continues with chemical phosphorus removal or converts to biological phosphorus removal.

Effluent filtration is required to meet an effluent total phosphorus limit of either 0.1 or 0.2 mg/L on a consistent basis. The project team models assumed a 10-micron disk filter would be used to meet the 0.2 mg/L effluent limit and that a deep bed filter or effluent microfiltration would be employed to meet the 0.1 mg/L limit. Aqua Aerobics, a supplier of disk filters, has suggested they could meet the 0.1 mg/L total phosphorus limit with the 5 micron filter. However, they do not currently have any operating facilities with long term operating experience. For this reason, we would recommend a pilot be conducted should Rutland wish to pursue the disk filter technology to achieve the 0.1 mg/L limit. A 10-micron disk filter is expected to provide suspended solids removal of between 50 and 75%. We would anticipate effluent solids removal of over 90% or more for both the deep bed and microfiltration alternatives.

Summary and Conclusions

The following conclusions can be drawn from the evaluation of the existing process, historical data, and preliminary modeling:

- At this point in time we are of the opinion that the facility is currently performing at or near its limit for TP removal and that the absolute best performance, without filtration, is in the 0.2 to 0.3 mg/L range given present day flows;
- The modeling verification confirms the ability of the model to predict annual average effluent quality supports its utility and general applicability.
- Process modeling indicates there is insufficient VFA in the primary effluent to support biological phosphorus removal at the Rutland WWTF.
- The existing facility has significant reserve capacity and should be able to easily meet treatment requirements with one bioreactor out of service at both existing and design flows.
- Effluent filtration is required to meet an effluent total phosphorus limit of either 0.2 mg/L or 0.1 mg/L.
- A TSS removal efficiency of between 50 and 75% (typical of a 10 micron disk filter) is required to consistently meet an effluent TP limit of <0.2 mg/L. A TSS removal efficiency of over 90% is required to consistently meet an effluent TP limit of <0.1 mg/L.
- The City will need to construct filtration facilities with a capacity of at least two times the average dry weather flow. The final filtration capacity determination should be confirmed during preliminary design based upon sampling conducted during wet weather events.

5.3. Review of Phosphorus Removal Technologies for the Rutland WWTF

As mentioned prior, if the future phosphorous limit is ≤0.2 mg/L, an advanced tertiary treatment process will be required at the Rutland WWTF. The likely tertiary treatment processes that would be considered can be grouped into two (2) categories as follows:

Filtration

- Disk Filters (Aqua-Aerobics AquaDisk and others)
- Deep Bed Sand Filters (Blue Water Technologies)
- Membrane Filtration (GE/Zenon)

Ballasted Floc

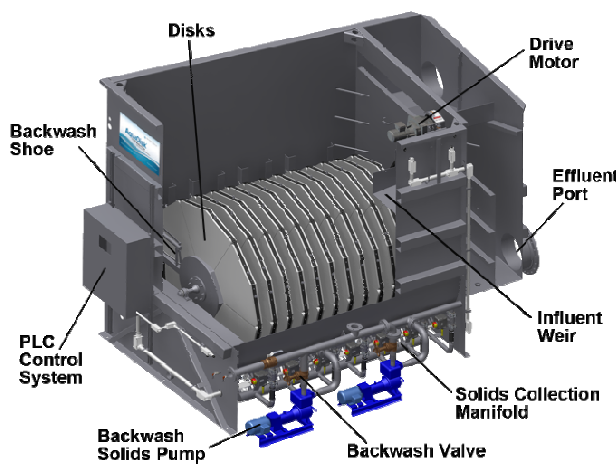
- CoMag Process by Siemens
- ActiFlo process by Kruger

One additional process is dissolved air floatation offered by IDI Aqua DAF. Each process is described briefly below.

Filtration

Filtration is simply the mechanical or physical separation of solids from liquids by interposing a medium through which only the fluid can pass. In wastewater treatment, unwanted constituents (i.e. phosphorus) are removed by absorption into a biological film grown on or in the filter medium. There are several filter technologies that could be utilized to remove phosphorus at the Rutland WWTF as described below.

Disk Filters



Cloth disk filters consist of a fabric stretched around the drum of a filter support. As wastewater flows through the cloth, the filtrate (or phosphorous precipitate) collects on the filter while the flow continues through a center area where it discharges by gravity. Heavier solids may settle out before the filter. As flow continuously passes through the filter, a build-up of solids occurs on the outside cloth media. This build-up forms a mat that causes the filtering resistance through the cloth to increase, and results in a rise in water level on the upstream side of the filter. The differential between the upstream level and the effluent level is monitored electronically. At a predetermined level the cloth filter will engage to backwash filters, ridding them of solid build up.

Considerations related to the use of cloth filters are the disposal of settleables and backwash water. They take up less space than granular filters and are generally less expensive. The efficiency of these filters will be enhanced by the addition of polymer to coagulate the precipitate which is necessary for phosphorous removal. Also, recent pilot testing has shown that with proper chemical addition, low levels of phosphorous can be achieved.

Deep Bed Sand Filters

Conventional granular media filters consist of a bed of fine grain media (typically sand) which wastewater flows through, capturing suspended solids in the voids between the grains. The wastewater flows downward via gravity into an underdrain system or upward under pressure. Accumulation of solids will decrease the voids, thus increasing flow velocity. As the filtration cycle progresses, head loss increases. When head loss reaches its maximum level and voids are full, the filter must be backwashed until clean. These filters require chemical additives (such as alum, sodium aluminate or ferric chloride) to precipitate soluble phosphorous.

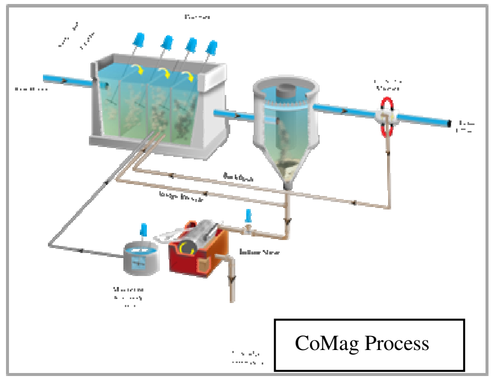
Advanced filters such as the Blue-Pro filter by Blue Water Technologies use chemical precipitation of secondary effluent and a continuously backwashed moving bed sand filter process to remove phosphorus to at least 0.1 mg/L. In some applications, a two-step filtration process is used. The first filter has a deep bed sand media to remove most of the phosphorus. The effluent is then polished in the second filter using a medium bed sand media. A small portion of the sand media is continuously removed for backwash to remove trapped solids and then returned into the filters for reuse. This eliminates the rapid backwash return rates typically found in fixed bed filters. The Blue Pro process utilizes a hydrous ferric oxide (HFO) coated filter media for improved phosphorous removal. Single pass Blue Pro systems may reduce phosphorous down to 0.1 mg/L depending on the influent concentration. Lower limits can be achieved with a two pass system.

Membrane Filtration

This process uses chemical precipitation and micro-filtration driven by a vacuum pump to remove phosphorus precipitate and other solids from the wastewater. Membrane filtration typically requires less area at a treatment facility, and can be installed either as a stand-alone system, or within existing aeration or clarifier basins. Membrane filtration can be a good choice if combined with a biological process upgrade or in an area limited WWTF site such as Rutland.

Ballasted Flocculation

Ballasted flocculation is a physical-chemical treatment process that uses a continuously recycled media additive (magnetite, silica sand, etc.) coupled with chemical addition to improve the settling properties of solids in wastewater.


CoMag Process

CoMag Magnetic Separation

CoMag is a ballasted flocculation process that uses chemical precipitation of secondary effluent and recoverable magnetite to first enmesh the precipitated phosphorus floc with the magnetite and then settle the solids in a small clarifier. The magnetite is recovered on a magnetic drum and reused. Removals to 0.1 mg/L are routine and by adding a polishing magnet the removals to 0.04 mg/L can be achieved. Numerous pilot testing and full scale facilities have shown success in removing phosphorous with flexibility using either alum, iron salts (ferric) or PAC (poly-aluminum chloride).

ActiFlow

ActiFlow is a ballasted flocculation process that uses chemical precipitation of secondary effluent and recoverable silica sand to first enmesh the precipitated phosphorus floc to the sand and then settle the solids in a lamella clarifier. The sand is recovered using hydrocyclones to separate the sand and recycle it to the process. Removals to 0.1 mg/L are routine and by adding a polishing filter, even greater removals can be achieved. Numerous pilot testing and full scale facilities have shown success in removing phosphorous with flexibility using either alum, iron salts (ferric) or PAC (poly-aluminum chloride).

Summary

For the Rutland WWTF, we would anticipate that if additional tertiary processes are required for phosphorus removal, either disk filters or membrane filtration would be utilized based on the level of phosphorus removal required.

5.4. Impact of a Phosphorus Limit at 0.2-0.3 mg/L

As stated prior, if a new phosphorus limit at 0.2 to 0.3 mg/L or greater is implemented, it is likely that the Rutland WWTF could meet this limit with the existing chemical addition scheme used at the facility using sodium aluminate. No modifications to that process would be required.

5.5. Impact of a Phosphorus Limit of 0.2 mg/L

If a new phosphorus limit of 0.2 mg/L is implemented, a tertiary treatment process will be required for the Rutland WWTF. Single point chemical addition will not produce consistent results down to this low permit limit.

As described earlier in this report, there are a number of tertiary treatment processes available for low level phosphorus removal. For purposes of this report, we have focused on disk filters which are believed to be the lowest cost option to consistently achieve ≤0.2 mg/l phosphorus limit.

The disk filters could be installed adjacent to the existing chlorine contact tanks to allow for gravity flow. A new rapid mix chemical addition and flocculation tank would be required upstream of the filters to agglomerate solids for removal. A small backwash return pump station would also be required to return filter backwash water to the head of the facility. Flow diversion structure(s) would be needed to divert the flow to the new filter complex and back to the chlorine contact tanks, and can be located/sized during final design. Civil/Site work to the north of the tanks would be required to account for the slope to the roadway above. We estimate that the present day cost of a disk filter system at approximately $6M. Detailed cost estimates are provided in Appendix B. These costs include contractor overhead and profit, and assume a contingency of 30% which is appropriate for this stage of design. A preliminary layout is provided as Figure 2 in Appendix A. Manufacturer equipment cutsheets are located in Appendix C.

Annual operating costs for current day flows based on similar facility experience have been estimated to increase ranging from $120,000- $250,000 per year for chemicals, power, labor and miscellaneous consumables. An allowance for major maintenance items is not included.

5.6. Impact of a Phosphorus Limit of 0.1 mg/L

If a new phosphorus limit at ≤0.1 mg/L is implemented, a tertiary treatment process for low-level phosphorus removal will be required for the Rutland WWTF. Single point chemical addition will not consistently achieve this low limit.

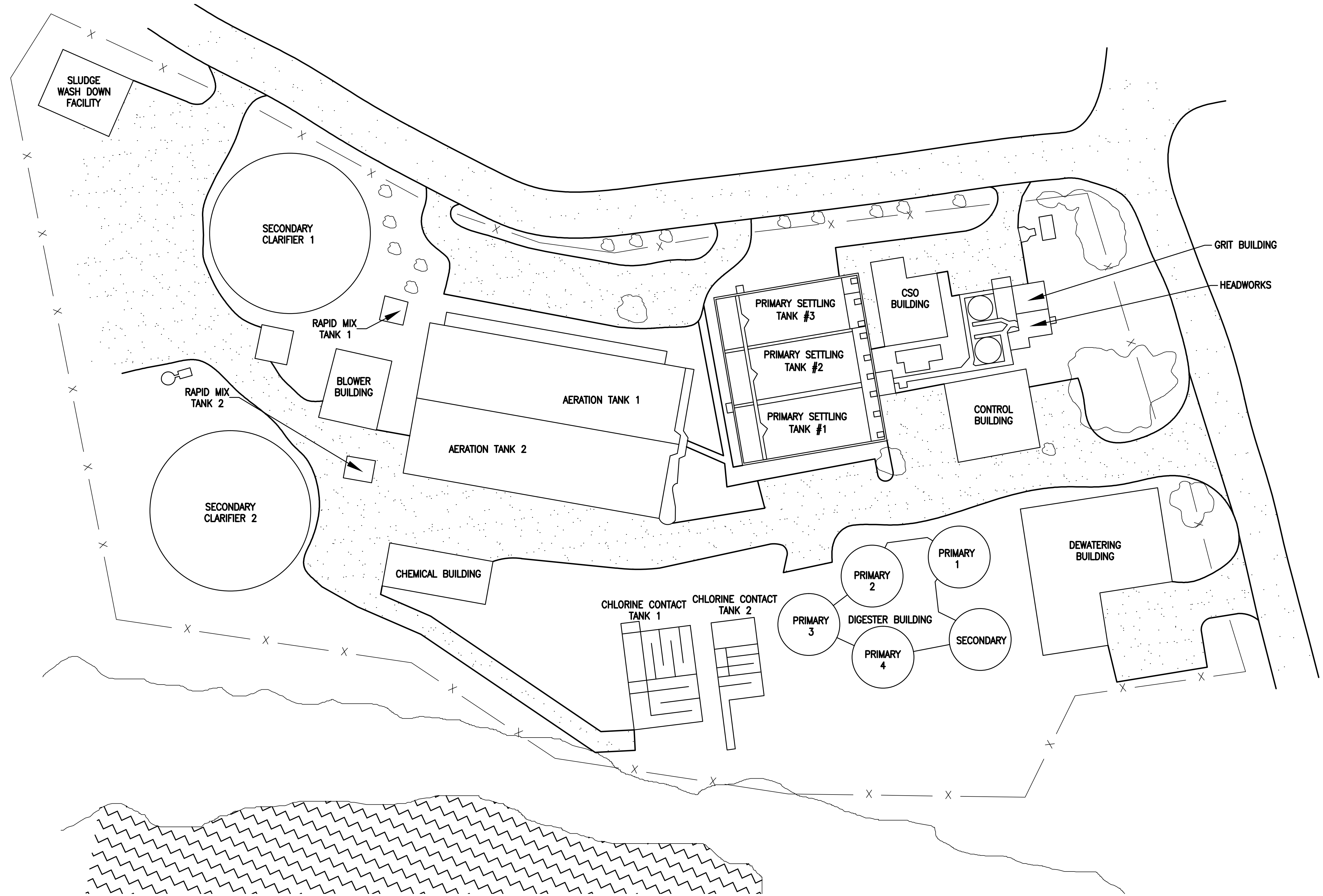
While there are a number of tertiary treatment processes available for low level phosphorus removal, to consistently achieve a limit of 0.1 mg/l, membrane filtration would likely be required. However, it is worth recalling that Aqua Aerobics has suggested that a 0.1 mg/L limit is possible using 5 micron disk filters. Our experience with disk filters indicates that a 0.1 mg/L limit may be difficult for disk filters to consistently achieve, and may require significant chemical and polymer use. However, it may be worthwhile to pilot test this equipment for proof

of concept. Should a 5 micron disk filter be able to consistently achieve the 0.1 mg/L limit, this may be a more cost effective option than the installation of a membrane filtration system.
For the purposes of this report, however, and in order to frame the cost requirements for a 0.1 mg/L limit, we have assumed the need for a membrane filtration system. The membranes and appurtenant equipment could be installed adjacent to the existing chlorine contact tanks to allow for gravity flow, taking advantage of the available head between the secondary clarifiers and the contact tanks. A new 2mm fine screen upstream of the membranes would be required to protect them from large solids. It is likely, too, that some civil/site work would be required on the north side of the membrane tanks to account for the slope to the roadway above. Further site work would be required to re-align the roadway to the existing contact tanks. We estimate that the present day cost of a membrane filtration system to be approximately $18M. Detailed cost estimates are provided in Appendix B. These costs include contractor overhead and profit, and assume a contingency of 30% which is appropriate for this stage of design. A preliminary layout of this arrangement is provided as Figure 3 in Appendix A. Manufacturer equipment cutsheets are located in Appendix C.

Annual operating costs for current day flows based on similar facility experience have been estimated to increase ranging from $200,000 - $250,000 per year for chemicals, power, labor and miscellaneous consumables. An allowance for major maintenance items is not included.

APPENDIX A

Figures



N
SITE PLAN
SCALE: NONE

Aldrich + Elliott
WATER RESOURCE ENGINEERS
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AEengineers.com

EXISTING SITE PLAN

PHOSPHORUS REMOVAL PLANNING STUDY

CITY OF RUTLAND

RUTLAND VERMONT

DESIGNED	JA
DRAWN	JEB
CHECKED (PM)	WAE
CHECKED (PE)	WAE
SCALE	NONE
DATE	9/2014
PROJECT NO.	13122
FIGURE NO.	1

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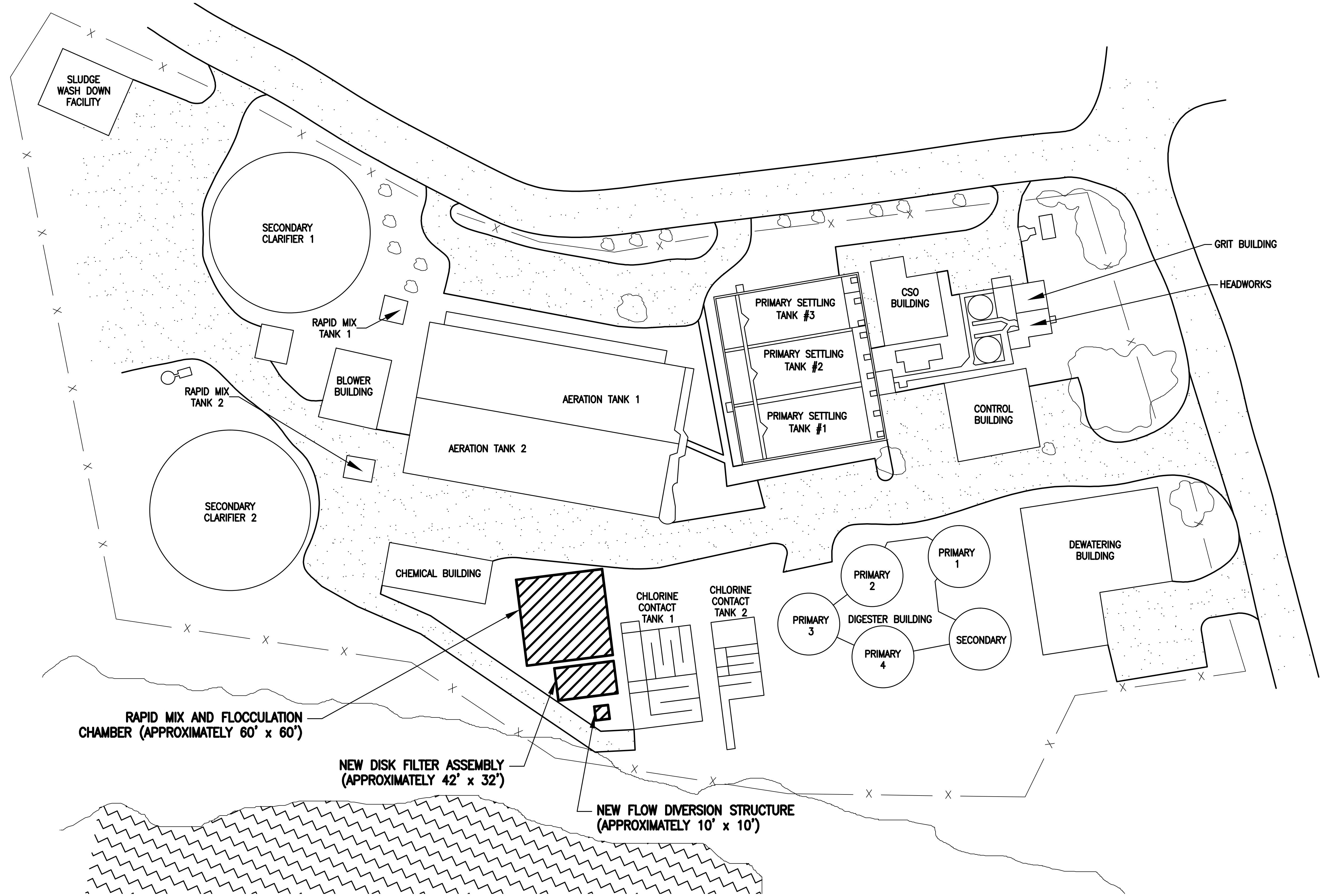

SITE PLAN
SCALE: NONE

Aldrich + Elliott
WATER RESOURCE ENGINEERS
6 Market Place, Suite 2
Essex Jct., VT 05452
P: 802.879.7733
AEengineers.com

DISK FILTER ALTERNATIVE PRELIMINARY SITE PLAN

PHOSPHORUS REMOVAL PLANNING STUDY

CITY OF RUTLAND
RUTLAND VERMONT

DESIGNED	JA
DRAWN	JEB
CHECKED (PM)	WAE
CHECKED (PE)	WAE
SCALE	NONE
DATE	9/2014
PROJECT NO.	13122
FIGURE NO.	2

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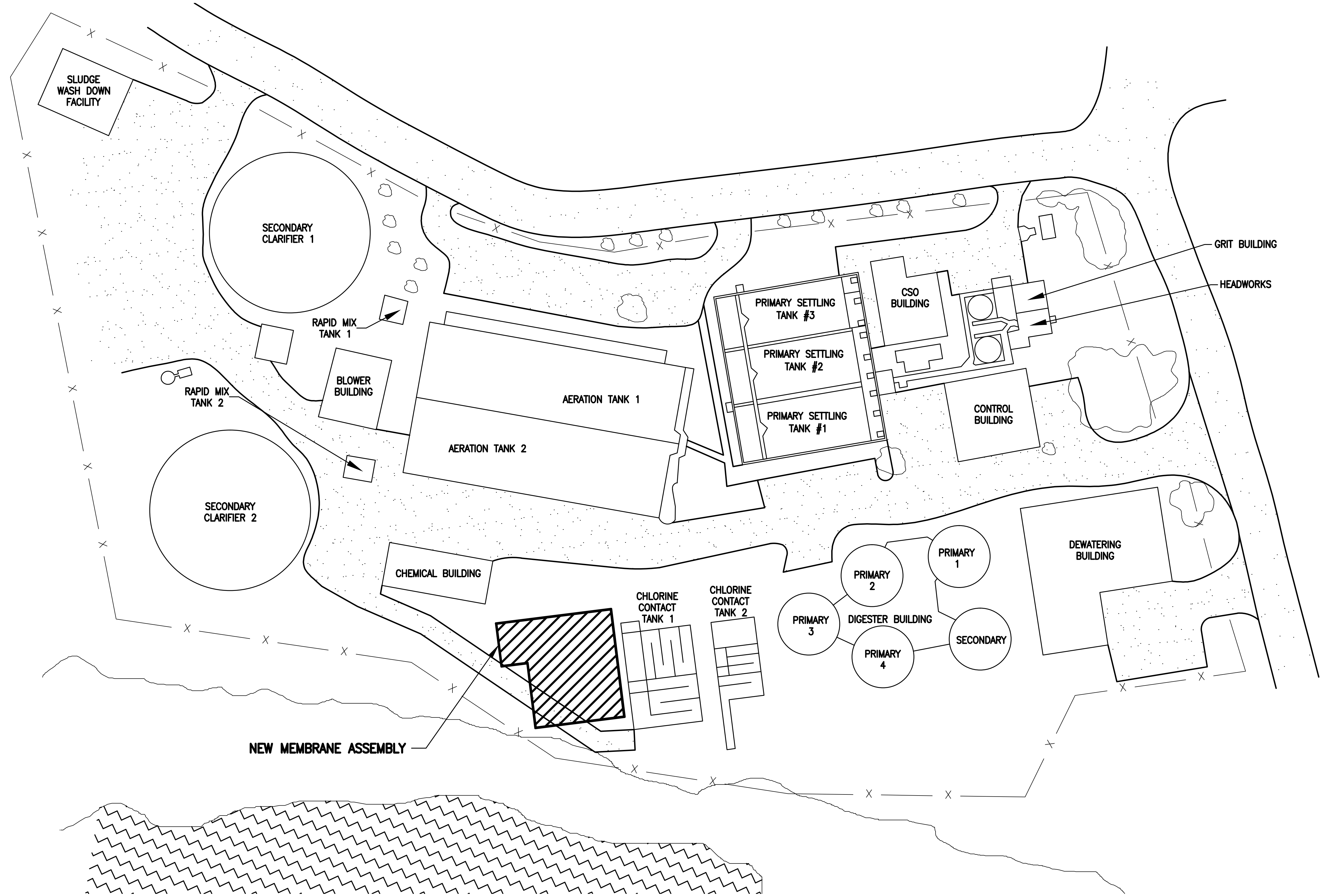

SITE PLAN

SCALE: NONE

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AEengineers.com

MEMBRANE SYSTEM ALTERNATIVE PRELIMINARY SITE PLAN

PHOSPHORUS REMOVAL PLANNING STUDY

CITY OF RUTLAND

RUTLAND VERMONT

DESIGNED	JA
DRAWN	JEB
CHECKED (PM)	WAE
CHECKED (PE)	WAE
SCALE	NONE
DATE	9/2014
PROJECT NO.	13122
FIGURE NO.	3

Y:\13122-RUTLAND\13122-1.dwg, 10/2/2014 9:52:54 AM, Patrick Hanley

APPENDIX B

Cost Estimates

ESTIMATED BUDGET WORKSHEET

PROJECT: Rutland WWTF
ITEM: Headworks
DATE: Aug-14

CATEGORY	ITEM	QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements						$16,500
Demolition						
	Demo equipment	1	$10,000	Allowance	$10,000	
	Subtotal				$10,000	$10,000
Sitework/Yard Piping						
	Erosion Control	0	$2,500	Lump sum	$0	
	Excavation	0	$35	c.y.	$0	
	Structural Bedding	0	$50	c.y.	$0	
	Structural Backfill	0	$40	c.y.	$0	
	Bit. Walks	0	$45	s.y.	$0	
	Bit. Pavement	0	$40	s.y.	$0	
	Loam, Seed & Mulch	0	$5.00	s.y.	$0	
	Subtotal				$0	$0
Concrete						
	Footings	0	$500	c.y.	$0	
	Walls	0	$750	c.y.	$0	
	Suspended Slab	0	$1,000	c.y.	$0	
	Floor Slab	0	$750	c.y.	$0	
	Misc. Repairs	1	$5,000	Allowance	$5,000	
	Subtotal				$5,000	$5,000
Misc. Metals						
	Al Handrail	0	$100	l.f.	$0	
	Stairs	0	$500	Riser	$0	
	Al Grating	0	$75	s.f.	$0	
	Supports	0	$5,000	Allowance	$0	
	Subtotal				$0	$0
Building						
	Building Repairs	0	$15,000	Allowance	$0	
	Subtotal				$0	$0
Equipment						
	Grit Pumps					
	Equipment	2	$17,500	Each	$35,000	
	Installation	2	$5,000	Each	$10,000	
	Subtotal				$45,000	$45,000
Process Piping/Valves						
	Interior	1	$30,000	Allowance	$30,000	$30,000
Heating/Ventilation						
		1	$50,000	Allowance	$50,000	$50,000
Electrical/Controls						
		1	$25,000	Allowance	$25,000	$25,000
TOTAL						$181,500
USE						**$190,000**

Notes:
1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

ESTIMATED BUDGET WORKSHEET

PROJECT: **Rutland WWTF**
ITEM: **Primary Clarifiers**
DATE: Aug-14

CATEGORY	ITEM	QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements						$10,600
Demolition						
	Existing Clarifier Equipment	3	$2,500	Each	$7,500	
					$0	
	Subtotal				$7,500	$7,500
Sitework						
	Erosion Control	0	$2,500	Lump sum	$0	
	Excavation	0	$35	c.y.	$0	
	Structural Backfill	0	$50	c.y.	$0	
	Concrete Walks	0	$45	s.y.	$0	
	Bit. Pavement	0	$25	s.y.	$0	
	Loam, Seed & Mulch	0	$5.00	s.y.	$0	
	Subtotal				$0	$0
Yard Piping						
	Misc.	0	$7,500	Allowance	$0	
	Subtotal				$0	$0
Concrete						
	Slab	0	$750	c.y.	$0	
	Wall	0	$750	c.y.	$0	
	Tank Concrete Repairs	2	$30,000	Each	$60,000	
	Subtotal				$60,000	$60,000
Misc. Metals						
	Al Handrail	0	$65	l.f.	$0	
	Stairs	0	$500	Riser	$0	
	Al Grating	0	$50	s.f.	$0	
	Gates	0	$10,000	Each	$0	
	Subtotal				$0	$0
Building						
	Repairs	1	$25,000	Each	$25,000	$25,000
Equipment						
	Clarifiers					
	Equipment:	2	$10,000	Each	$20,000	
	Installation	2	$10,000	Each	$20,000	
	Subtotal				$40,000	$40,000
Process Piping						
	Interior	1	$0	Allowance	$0	$0
Heating/Ventilation						
		1	$0	Allowance	$0	$0
Electrical						
		1	$0	Allowance	$0	$0
TOTAL						$143,100
USE						**$150,000**

Notes:
1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

ESTIMATED BUDGET WORKSHEET

PROJECT: **Rutland WWTF**
ITEM: **Aeration Tanks/Blower Building**
DATE: Aug-14

CATEGORY	ITEM	QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements						$81,500
Demolition						
	Existing Blower Equipment	2	$5,000	Allowance	$10,000	
					$0	
	Subtotal				$10,000	$10,000
Sitework						
	Erosion Control	0	$8,000	Lump sum	$0	
	Excavation	0	$15	c.y.	$0	
	Structural Backfill	0	$25	c.y.	$0	
	Concrete Walks	0	$45	s.y.	$0	
	Bit. Pavement	0	$25	s.y.	$0	
	Loam, Seed & Mulch	0	$5.00	s.y.	$0	
	Subtotal				$0	$0
Yard Piping						
	Misc.	1	$0	Allowance	$0	
	Subtotal				$0	$0
Concrete						
	Slab	0	$750	c.y.	$0	
	Wall	0	$750	c.y.	$0	
	Misc. Repairs	0	$15,000	Each	$0	
	Subtotal				$0	$0
Misc. Metals						
	Al Handrail	0	$65	l.f.	$0	
	Stairs	0	$500	Riser	$0	
	Al Grating	0	$50	s.f.	$0	
	Gates	10	$10,000	Each	$100,000	
	Subtotal				$100,000	$100,000
Painting						
	Equipment	1	$0	Allowance	$0	$0
Equipment						
	Blowers					
	Equipment:	2	$125,000	Each	$250,000	
	Installation	2	$15,000	Each	$30,000	
	Subtotal				$280,000	$280,000
Process Piping						
	Interior	1	$150,000	Allowance	$150,000	$150,000
Heating/Ventilation						
		1	$75,000	Allowance	$75,000	$75,000
Electrical/Controls						
		1	$200,000	Allowance	$200,000	$200,000
TOTAL						$896,500
USE						**$900,000**

Notes:
1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

ESTIMATED BUDGET WORKSHEET

PROJECT: **Rutland WWTF**
ITEM: **Flocculation Tanks**
DATE: Aug-14

CATEGORY	ITEM		QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements							$8,000
Demolition							
	Equipment removal		2	$2,500	Allowance	$5,000	
	Bypass Pumping		0	$35,000	Allowance	$0	
		Subtotal				$5,000	$5,000
Sitework/Yard Piping							
	Erosion Control		0	$500	Lump sum	$0	
	Bit. Walks		0	$45	s.y.	$0	
	Loam, Seed & Mulch		0	$5.00	s.y.	$0	
		Subtotal				$0	$0
Concrete							
	Footings		0	$500	c.y.	$0	
	Walls		0	$500	c.y.	$0	
	Suspended Slab		0	$1,000	c.y.	$0	
	Floor Slab		0	$750	c.y.	$0	
	Misc. Repairs		0	$5,000	Allowance	$0	
		Subtotal				$0	$0
Misc. Metals							
	Al Handrail		0	$100	l.f.	$0	
	Stairs		0	$500	Riser	$0	
	Al Grating		0	$75	s.f.	$0	
	Al Supports		2	$5,000	Each	$10,000	
		Subtotal				$10,000	$10,000
Building							
	Renovations		0	$50	s.f.	$0	$0
Equipment							
	Mixers						
		Equipment	2	$20,000	Each	$40,000	
		Installation	2	$10,000	Each	$20,000	
		Subtotal				$60,000	$60,000
Process Piping							
	Interior		1	$0	Allowance	$0	$0
Heating/Ventilation							
			0	$0	Allowance	$0	$0
Electrical/Controls							
			1	$25,000	Allowance	$25,000	$25,000
TOTAL							$108,000
USE							**$110,000**

Notes:

1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

ESTIMATED BUDGET WORKSHEET

PROJECT: **Rutland WWTF**
ITEM: **Secondary Clarifiers**
DATE: Aug-14

CATEGORY	ITEM	QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements						$101,200
Demolition						
	Existing clarifier equipment	2	$7,500	Each	$15,000	
	Existing pumps and piping	5	$10,000	Each	$50,000	
	Subtotal				$15,000	$15,000
Misc. Metals						
	Al Handrail	0	$65	l.f.	$0	
	Stairs	0	$500	Riser	$0	
	Al Grating	0	$50	s.f.	$0	
	Gates	4	$7,500	Each	$30,000	
	Subtotal				$30,000	$30,000
Painting						
	Clarifier Equipment	2	$60,000	Each	$120,000	
	Subtotal				$120,000	$120,000
Equipment						
	Clarifier equipment					
	Equipment:	2	$150,000	Each	$300,000	
	Installation:	2	$50,000	Each	$100,000	
	RAS Pumps					
	Equipment:	3	$25,000	Each	$75,000	
	Installation:	3	$15,000	Each	$45,000	
	WAS Pumps					
	Equipment:	2	$25,000	Each	$50,000	
	Installation:	2	$15,000	Each	$30,000	
	Subtotal				$600,000	$600,000
Process Piping/Valves						
	Interior	1	$200,000	Allowance	$200,000	$200,000
Heating/Ventilation						
		1	$100,000	Allowance	$100,000	$100,000
Electrical/Controls						
		1	$200,000	Allowance	$200,000	$200,000
TOTAL						$1,366,200
USE						**$1,370,000**

Notes:
1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

ESTIMATED BUDGET WORKSHEET

PROJECT: **Rutland WWTF**
ITEM: **Anaerobic Digestion System**
DATE: Aug-14

CATEGORY	ITEM	QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements						$245,000
Demolition						
	Piping/Valves	1	$150,000	Allowance	$150,000	
	Drain/clean digester tanks				$100,000	
	Subtotal				$250,000	$250,000
Sitework/Yard Piping						
	Misc.	0	$25,000	Allowance	$0	$0
Concrete						
	Misc.	1	$50,000	Allowance	$50,000	$50,000
Misc. Metals						
	Al Handrail	400	$65	l.f.	$26,000	
	Stairs	0	$500	Riser	$0	
	Al Grating	150	$50	s.f.	$7,500	
	Subtotal				$33,500	$33,500
Building						
	Renovations	1	$200,000	Allowance	$200,000	
	Roof	5000	$12	s.f.	$60,000	
	Subtotal				$260,000	$260,000
Painting						
	Digester Covers	2	$40,000	Each	$80,000	
	Interior Piping	1	$50,000	Allowance	$50,000	
	Subtotal				$130,000	$130,000
Equipment						
	Digestion Equipment					
	Equipment:	1	$750,000	Each	$750,000	
	Installation:	1	$200,000	Each	$200,000	
	Gas Safety Equipment					
	Equipment:	1	$300,000		$300,000	
	Installation:	1	$50,000		$50,000	
	Sludge Recycle Pumps:					
	Equipment:	2	$20,000	Each	$40,000	
	Installation:	2	$7,500	Each	$15,000	
	Sludge Transfer Pumps:					
	Equipment:	2	$20,000	Each	$40,000	
	Installation:	2	$7,500	Each	$15,000	
	Gas Detection System					
	Equipment:	1	$100,000	Each	$100,000	
	Installation:	1	$25,000	Each	$25,000	
	Subtotal				$1,535,000	$1,535,000
Process Piping						
	Interior Piping/Valves	1	$350,000	Allowance	$350,000	$350,000
Heating/Ventilation						
		1	$200,000	Allowance	$200,000	$200,000
Electrical/Controls						
		1	$250,000	Allowance	$250,000	$250,000
TOTAL						$3,303,500
USE						**$3,000,000**

Notes:
1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

ESTIMATED BUDGET WORKSHEET

PROJECT: **Rutland WWTF**
ITEM: **Disk Filters**
DATE: Sep-14

CATEGORY	ITEM	QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements (Mob/DeMob, Bonds, Insurance)						$359,200
Demolition						
				Allowance	$0	
					$0	
	Subtotal				$0	$0
Sitework						
	Erosion Control	0	$10,000	Lump sum	$0	
	Retaining Wall / Sitework	1	$250,000	Allowance	$250,000	
	Excavation	1500	$15	c.y.	$22,500	
	Structural Backfill	100	$25	c.y.	$2,500	
	Concrete Walks	100	$45	s.y.	$4,500	
	Bit. Pavement	100	$25	s.y.	$2,500	
	Loam, Seed & Mulch	200	$5.00	s.y.	$1,000	
	Subtotal				$283,000	$283,000
Yard Piping						
	Misc.	1	$75,000	Allowance	$75,000	
	Subtotal				$75,000	$75,000
Concrete						
	Slab	55	$750	c.y.	$41,250	
	Wall	200	$750	c.y.	$150,000	
	Misc. Repairs	0	$15,000	Each	$0	
	Subtotal				$191,250	$191,000
Misc. Metals						
	Al Handrail	125	$65	l.f.	$8,125	
	Stairs	0	$500	Riser	$0	
	Al Grating	0	$50	s.f.	$0	
	Gates	4	$10,000	Each	$40,000	
	Subtotal				$48,125	$48,000
Building						
	Equipment Building	1	$150,000	Allowance	$150,000	$150,000
Equipment						
	Filters/Appurtenar	1	$1,071,450	Each	$1,071,450	
	Rapid Mix Tank M	1	$75,000	Each	$75,000	
	Backwash PS anc	1	$300,000	Each	$300,000	
	Chemical Feed	1	$150,000	Each	$150,000	
	Installation	1	$798,225	Each	$798,225	
	Subtotal				$2,394,675	$2,395,000
Process Piping						
		1	$150,000	Allowance	$150,000	$150,000
Heating/Ventilation						
		1	$50,000	Allowance	$50,000	$50,000
Electrical/Controls						
		1	$250,000	Allowance	$250,000	$250,000
SUBTOTAL						$3,951,200
Contractor OH&P (18%)						$711,216
Contingency (30%)						$1,185,360
USE						**$5,847,776**

Notes:

1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

ESTIMATED BUDGET WORKSHEET

PROJECT: **Rutland WWTF**
ITEM: **Membranes (Within Final Clarifiers)**
DATE: Sep-14

CATEGORY	ITEM	QUANTITY	UNIT COST	UNIT	SUBTOTAL	USE (ENR 9800)
General Requirements (Mob/DeMob, Bonds, Insurance)						$1,109,000
Demolition						
				Allowance	$0	
					$0	
	Subtotal				$0	$0
Sitework						
	Erosion Control	0	$10,000	Lump sum	$0	
	Retaining Wall / Site Work	1	$250,000	Allowance	$250,000	
	Excavation	350	$15	c.y.	$5,250	
	Structural Backfill	150	$25	c.y.	$3,750	
	Concrete Walks	75	$45	s.y.	$3,375	
	Bit. Pavement	150	$25	s.y.	$3,750	
	Loam, Seed & Mulch	250	$5.00	s.y.	$1,250	
	Subtotal				$267,375	$267,000
Yard Piping						
	Misc.	1	$100,000	Allowance	$100,000	
	Subtotal				$100,000	$100,000
Concrete						
	Slab	350	$750	c.y.	$262,500	
	Wall	300	$750	c.y.	$225,000	
	Misc. Repairs	0	$15,000	Each	$0	
	Subtotal				$487,500	$488,000
Misc. Metals						
	Al Handrail	0	$65	l.f.	$0	
	Stairs	0	$500	Riser	$0	
	Al Grating	0	$50	s.f.	$0	
	Gates	6	$10,000	Each	$60,000	
	Subtotal				$60,000	$60,000
Building						
	Equipment Building	1	$500,000	Allowance	$500,000	$500,000
Equipment						
	Screen/Building	1	$1,000,000	Each	$1,000,000	
	Membranes	1	$4,600,000	Each	$4,600,000	
	Chemical Feed	1	$100,000	Each	$100,000	
	Bridge Crane	1	$200,000	Each	$200,000	
	Installation	1	$3,000,000	Each	$3,000,000	
	Subtotal				$8,900,000	$8,900,000
Process Piping						
		1	$300,000	Allowance	$300,000	$300,000
Heating/Ventilation						
		1	$75,000	Allowance	$75,000	$75,000
Electrical/Controls						
		1	$250,000	Allowance	$400,000	$400,000
SUBTOTAL						$12,199,000
ntractor OH&P (18%)						$2,195,820
Contingency (30%)						$3,659,700
USE						**$18,054,520**

Notes:
1. ENR 9800 = August 2014
2. The general requirements are based on 10% of the total.

APPENDIX C

Equipment Vendor Data

PROCESS DESIGN REPORT

AQUA-AEROBIC SYSTEMS, INC.

RUTLAND VT

Design#: 138255

Option: Preliminary Filter Design (MDF of 16 MGD)

Designed By: Dawn Brady on Friday, September 5, 2014

Design Notes

Process/Site

- NOTE: This system has been designed to be expandable from a Phase I maximum design flow of 16 MGD to an ultimate, Phase II flow of 22.5 MGD.

- To achieve an effluent monthly average total phosphorus limit, the biological process, chemical feed systems, and Cloth Media Filters need to be designed to facilitate optimum performance.

- A minimum of twelve (12) daily composite samples per month (both influent and effluent) shall be obtained for total phosphorus analysis.

- Meeting the required total phosphorus final effluent limit is contingent on a secondary effluent total phosphorus concentration of less than or equal to 0.8 mg/l on a daily average basis, a daily average TSS of less than or equal to 10 mg/l, and a maximum TSS concentration of less than or equal to 15 mg/l.

- Secondary effluent phosphorus shall be in a reactive phosphate form and/or a filterable particulate form.

- Chemical feed lines (i.e. metal salts) shall be furnished to each reactor, aerobic digester and dewatering supernatant streams as necessary.

- Chemical addition (i.e. metal salts, polymer) shall be furnished prior to the filter. Adequate rapid mixing must be provided as part of the chemical feed system. The chemical dosage should be flow-paced and controlled to avoid overdosing. Jar testing with various metal salts and polymers is recommended to determine the most effective metal salt and polymer as well as the optimum dosages of each, and to estimate the degree of phosphorus removal that can be achieved. In addition, a pilot study may be required to verify the actual performance capability.

- A flocculation tank with a minimum of 5-minute HRT at the maximum daily flow shall be furnished after chemical addition and prior to the filter.

- pH monitoring and control in a range of 6.8-7.2 of the upstream biological reactor is required when adding metal salts.

- The cloth media filter will only remove TP that is associated with the TSS removed by the filter. Solids include both biological and chemical solids. Since only insoluble, particle-associated phosphorous is capable of being removed by filtration with tertiary filtration technology, phosphorous speciation shall be provided by the owner to substantiate the concentrations of soluble and insoluble phosphorous in the filter influent. If the proportions of soluble (unfilterable) and insoluble phosphorous are such that removal to achieve the desired effluent limit is not practical, the owner will provide for proper conditioning of the wastewater, upstream of the filter system, to allow for the required removal.

Filtration

- The cloth media filter recommendation is based upon the following conditions (as shown on the design sheet): 10 mg/l average daily influent TSS, 15 mg/l peak influent TSS, and an acceptable upstream process such as an activated sludge plant with a minimum SRT of 5 days.

- The anticipated filtered effluent quality is based on the filter influent conditions as shown under "Design Parameters" of this Process Design Report. In addition, the filter influent should be free of algae and other solids that are not filterable through a nominal pore size media. Provisions to treat algae and condition the solids to be filterable are the responsibility of others.

- For this application, pile filter cloth is recommended.

- The cloth media filter has been designed to handle the maximum design flow while maintaining one unit out of service.

Equipment

- Aqua-Aerobic Systems, Inc. (AASI) is familiar with the Buy American provision of the American Recovery and Reinvestment Act of 2009 as well as other Buy American provisions (i.e. FAR 52.225, EXIM Bank, USAid, etc.). AASI can provide a system that is in full compliance with Buy American provisions. As the project develops AASI can work with you to ensure full compliance with a Buy American provision, if required. Please contact the factory should compliance with a Buy American provision be required.

AquaDISK Tertiary Filtration - Design Summary

DESIGN INFLUENT CONDITIONS

Pre-Filter Treatment:	Secondary		
Avg. Design Flow	= 6.8 MGD	= 4722.22 gpm	= 25741 m³/day
Max Design Flow	= 16 MGD	= 11111.1 gpm	= 60567 m³/day

DESIGN PARAMETERS

			Effluent			
	Influent	**mg/l**	**Required**	**<= mg/l**	**Anticipated**	**<= mg/l**
Avg. Total Suspended Solids:	TSSa	10	TSSa	5	TSSa	5
Max. Total Suspended Solids:	TSSm	15	--	--	--	--
Phosphorus:	Total P	0.50	Total P	0.20	Total P	0.20

AquaDISK FILTER RECOMMENDATION

Qty Of Filter Units Recommended	= 2
Number Of Disks Per Unit	= 16
Total Number Of Disks Recommended	= 32
Total Filter Area Provided	= 3443.2 ft² = (319.88 m²)
Filter Model Recommended	= AquaDisk Concrete: Model ADFSC-108 x 16E-PC
Filter Media Cloth Type	= OptiFiber PES-14

AquaDISK FILTER CALCULATIONS

Filter Type:

Vertically Mounted Cloth Media Disks featuring automatically operated vacuum backwash.

Average Flow Conditions:

Average Hydraulic Loading
= Avg. Design Flow (gpm) / Recommended Filter Area (ft²)
= 4722.2 / 3443.2 ft²
= 1.37 gpm/ft² (0.93 l/s/m²) at Avg. Flow

Maximum Flow Conditions:

Maximum Hydraulic Loading
= Max. Design Flow (gpm) / Recommended Filter Area (ft²)
= 11111.1 / 3443.2 ft²
= 3.23 gpm/ft² (2.19 l/s/m²) at Max. Flow

Solids Loading:

Solids Loading Rate
= (lbs TSS/day at max flow and max TSS loading) / Recommended Filter Area (ft²)
= 2001.6 lbs/day / 3443.2 ft²
= 0.58 lbs. TSS /day/ft² (2.83 kg. TSS/day/m²)

The above recommendation is based upon the provision to maintain a satisfactory hydraulic surface loading with (1) unit out of service. The resultant hydraulic loading rate at the Maximum Design Flow is: 6.5 gpm / ft² = (4.4 L/s / m²)

Cloth Media Filters

AquaDisk Tanks/Basins

2 AquaDisk Model # ADFSC-108x24/16E-PC Concrete Filter Basin Accessories consisting of:

- Concrete basin(s) (by others).
- 304 stainless steel support brackets.
- Dual wheel support weldment(s).
- Effluent seal plate weldment.
- Effluent seal plate gasket(s).
- 304 stainless steel anchors.

AquaDisk Centertube Assemblies

2 Cloth will have the following feature:

- Cloth will be OptiFiber PES-14.

1 Centertube(s) consisting of:

- 304 stainless steel centertube weldment(s).
- Centertube driven sprocket(s).
- Dual wheel assembly(ies).
- Rider wheel bracket assembly(ies).
- Centertube bearing kit(s).
- Centertube support weldment(s).
- Centertube wall support(s).
- Bearing spacer plate(s
- Effluent centertube lip seal(s).
- Pile cloth media and non-corrosive support frame assemblies.
- Disk segment 304 stainless steel support rods.
- Centertube port covers.
- Centertube port gaskets.

AquaDisk Drive Assemblies

2 Drive System(s) consisting of:

- Gearbox with motor.
- Drive sprocket assemby(ies).
- Drive chain(s) with pins.
- Stationary drive bracket weldment(s).
- Adjustable drive bracket weldment(s).
- Chain guard weldment(s).
- Warning label(s).

AquaDisk Backwash/Sludge Assemblies

2 Backwash System(s) consisting of:

- Backwash shoe assemblies.
- Backwash shoe support weldment(s).
- 3" flexible hose.
- 304 stainless steel backwash collection manifold(s).
- PVC solids manifold installation(s).

2 Backwash/Solids Waste Pump(s) consisting of:

- Backwash/waste pump(s).
- Pressure gauge(s).
- 0 to 30 inches mercury vacuum gauge(s).
- 6" Manual plug valve(s).

- 6" magnetic flow-meter and converter(s).

AquaDisk Instrumentation

2 Pressure Transducer Assembly(ies) each consisting of:

- Mounting bracket weldment(s).
- Transducer pipe weldment(s).
- Pressure transducer(s).
- Aneroid bellows.
- Stainless steel anchor kit(s).
- Nylon electrical cable tie wrap(s).

2 Vacuum Gauge with Transmitter(s) consisting of:

- 0 to 30 inches mercury vacuum gauge(s).
- Vacuum transmitter(s).
- 1/4" Threaded bronze ball valve.

2 Float Switch(es) consisting of:

- Float switch mounting bracket(s).
- Float switch(es).
- Stainless steel anchor kit(s).

AquaDisk Valves

2 Set(s) of Backwash Valves consisting of:

- 6 inch diameter Milliken 601-N0 electrically operated eccentric plug valve(s) with 125# flanged end connection, ASTM A-126 Class B cast iron body with welded in nickel seat, EPDM coated ductile iron plug, assembled and tested with a Auma SG07, 115 VAC, 60 hertz, single phase open/close service electric actuator. Valve actuator includes local controls and compartment heater.

2 Solids Waste Valve(s) consisting of:

- 3 inch electrically operated plug valve(s).

AquaDisk Controls w/Starters

2 Control Panel(s) consisting of:

- NEMA 4X fiberglass enclosure(s).
- Circuit breaker with handle.
- Transformer(s) with fuses.
- 4 inch NEMA 4X fan(s).
- GFI receptacle.
- Fuses and fuse blocks.
- Line filter(s).
- GFI convenience outlet(s).
- Control relay(s).
- Selector switch(es).
- Indicating pilot light(s).
- MicroLogix 1400 PLC(s).
- Operator interface(s).
- Ethernet switch(es).
- 15 HP VFD(s).
- 5 HP VFD(s).
- Power supply(ies).
- Terminal blocks.
- UL label(s).

1. DRAWING FOR REFERENCE ONLY.
   ALL WALLS ARE SHOWN AT 1'.
   ALL DIMENSIONS TO BE VERIFIED BY CUSTOMER.

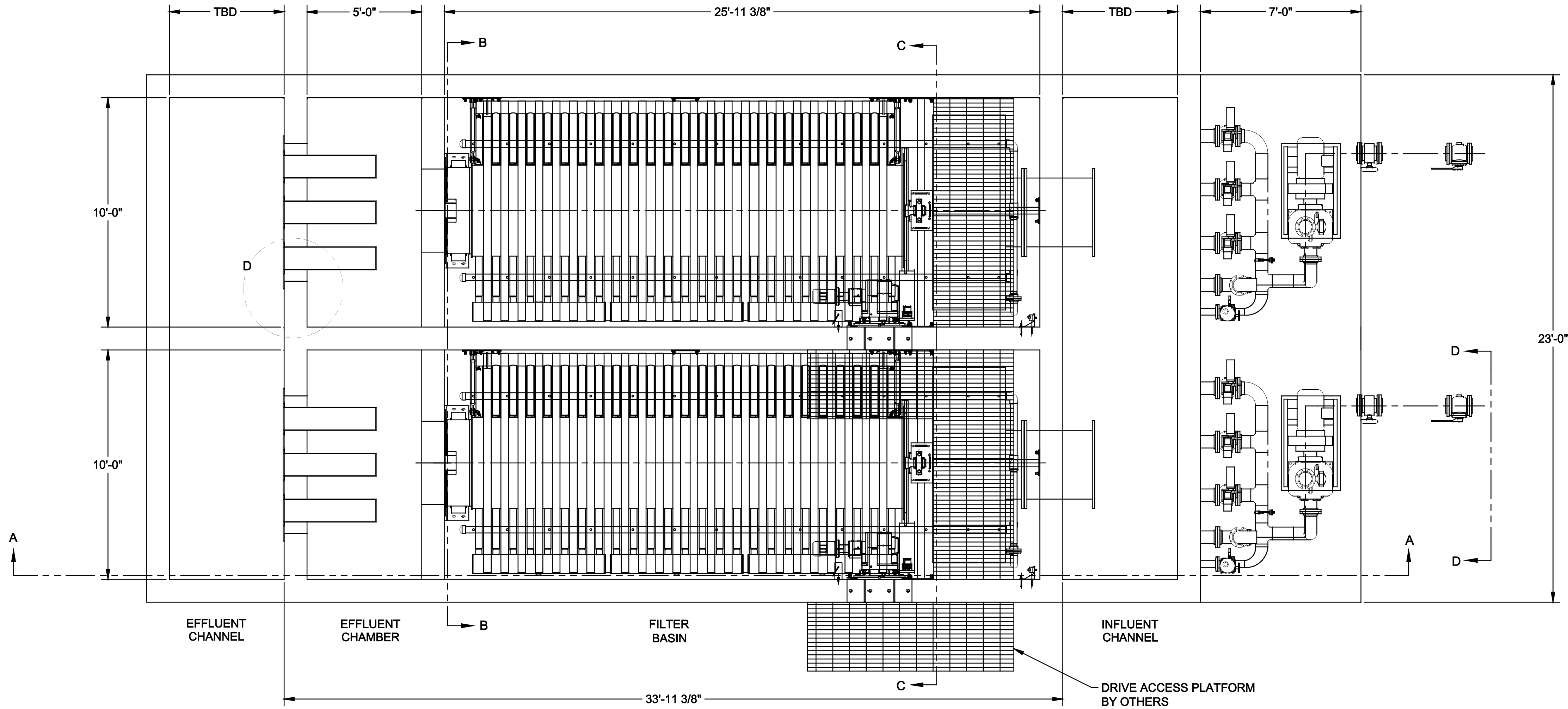
2. AQUA-AEROBIC SYSTEMS PROVIDES PUMPS AND VALVES LOOSE FOR INSTALLATION BY THE INSTALLING CONTRACTOR. ALL INTERCONNECTING PIPING, WIRING, AND WALL SPOOL PIPES ARE PROVIDED BY THE INSTALLING CONTRACTOR.

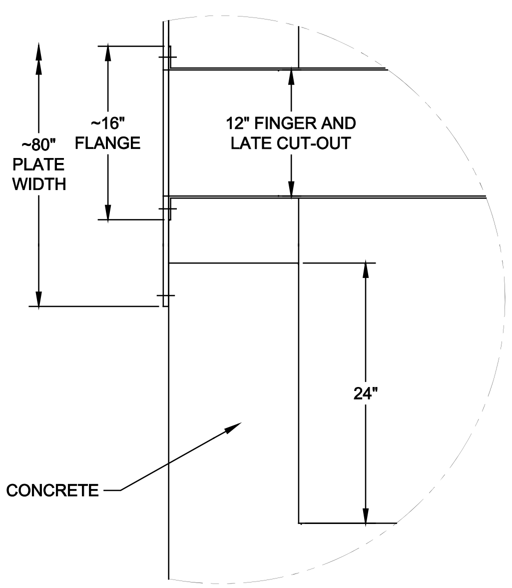
3. IF FREEZING IS A CONCERN, AQUA-AEROBIC SYSTEMS RECOMMENDS THE FILTERS BE PLACED IN A HEATED BUILDING. IF A BUILDING IS NOT PROVIDED, ANY NECESSARY PROTECTION, INCLUDING BUT NOT LIMITED TO, HEAT TRACING AND INSULATION OF PUMPS AND PIPING, AS WELL AS PROTECTION AGAINST INTERNAL TANK FREEZING, SHALL BE PROVIDED BY THE INSTALLING CONTRACTOR.

4. ALL PIPING AND FITTINGS SHALL BE PROVIDED BY OTHERS, ACTUAL PIPING LAYOUT AND PUMP LOCATION TO BE DETERMINED BY OTHERS. WHEN THREADED OR WELDED PIPE IS USED IN LIEU OF FLANGED PIPE, UNIONS SHALL BE USED AT EACH PUMP CONNECTION TO FACILITATE SERVICE.

5. THE INFLUENT AND EFFLUENT CHANNELS TO BE SIZED BY THE CONSULTING ENGINEER BASED ON THE PLANT FLOW.

6. AN INFLUENT VALVE IS REQUIRED FOR ISOLATION / MAINTENCE OF EACH FILTER UNIT. INFLUENT ISOLATION SHALL BE PROVIDED BY OTHERS AND INSTALLED BY OTHERS.





DETAIL D

JOB NAME: XX				
JOB LOCATION: XX				
REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

AQUA-AEROBIC SYSTEMS, INC.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES

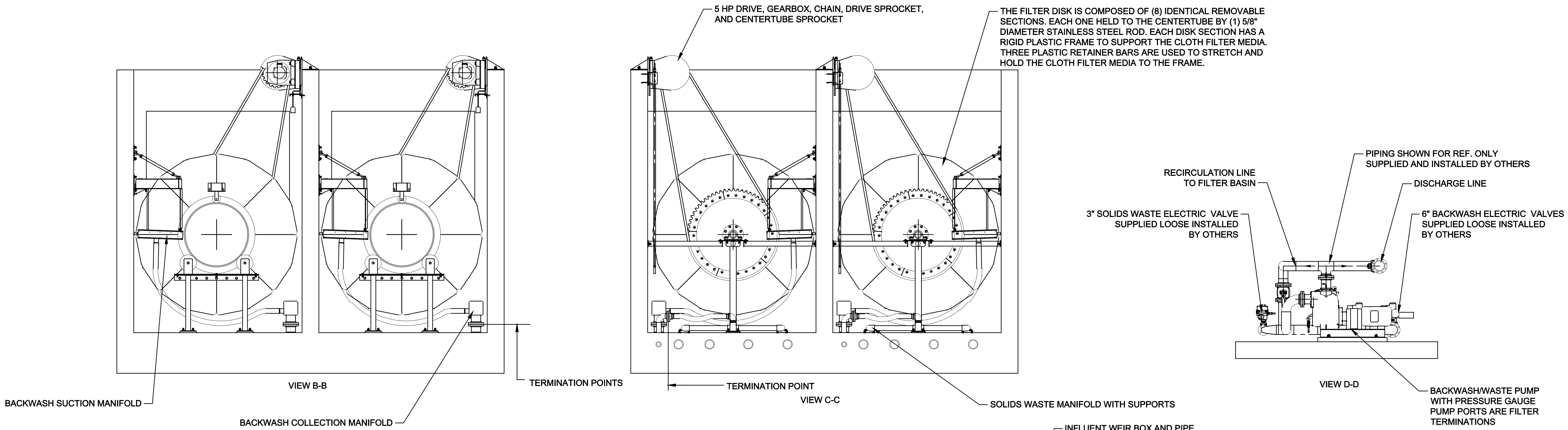
FRACTIONAL DIMENSIONS	+/- 1/16
ALL TWO PLACE DECIMALS	+/- 0.010
ALL THREE PLACE DECIMALS	+/- 0.005
ALL ANGLES	+/- 1/2°

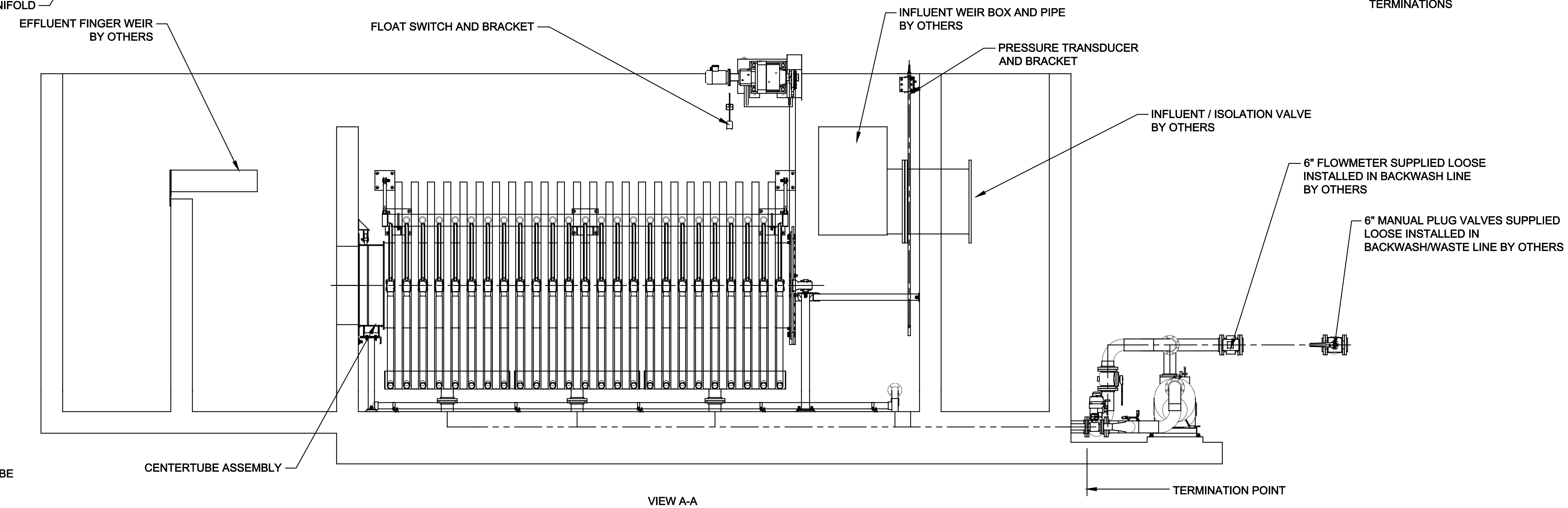
ANSI

MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: XXX — DATE: XX
WEIGHT: — SHEET: 1 OF

DRAWING NAME: AQUADISK FILTER MODEL ADFSC-108X24E

DRAWING NUMBER: 2802061 — SCALE: — SIZE: D





1. ALL PIPING AND FITTINGS SHALL BE PROVIDED BY OTHERS ACTUAL PIPING LAYOUT AND PUMP LOCATION TO BE DETERMINED BY OTHERS WHEN THREADED OR WELDED PIPE IS USED IN LIEU OF FLANGED PIPE, UNIONS SHALL BE USED AT EACH PUMP AND VALVE CONNECTION TO FACILITATE SERVICE.

2. 15 H.P. BACKWASH / WASTE PUMP CONNECTIONS ARE 6" BACKWASH PIPING IS 6" DIAMETER. WASTE PIPING IS 3", 6" TO 3" REDUCER FITTINGS SHALL BE PROVIDED AND INSTALLED BY OTHERS AT EACH WASTE VALVE.

3. THE STANDARD BACKWASH / WASTE PUMP PROVIDES 23.2 FEET OF TOTAL HEAD AT A FLOW RATE OF 1040 GPM. THE SUCTION SIDE PIPING REQUIRES APPROXIMATELY 9 FEET OF THIS HEAD. THIS LEAVES APPROXIMATELY 14 FEET FOR THE DISCHARGE SIDE. THE DISCHARGE DIAMETER, EQUIVALENT LENGTH, AND VERTICAL LIFT MUST RESULT IN A HEAD LOSS LESS THAN 14 FEET. INSTALLATIONS WITH MORE THAN ONE BACKWASH / WASTE PUMP MUST ACCOMMODATE ALL BACKWASH / WASTE PUMPS RUNNING SIMULTANEOUSLY WITHOUT EXCEEDING 14 FEET OF DISCHARGE HEAD.

FOR INSTALLATIONS THAT REQUIRE MORE DISCHARGE HEAD, ALTERNATIVE PUMPS ARE AVAILABLE. PLEASE CONSULT AASI ENGINEERING TO VERIFY THE SUITABILITY OF THE DISCHARGE PIPING OR FOR SPECIAL PUMP REQUIREMENTS.

JOB NAME: XX
JOB LOCATION: XX

REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

AQUA-AEROBIC SYSTEMS, INC.

DO NOT SCALE DRAWING

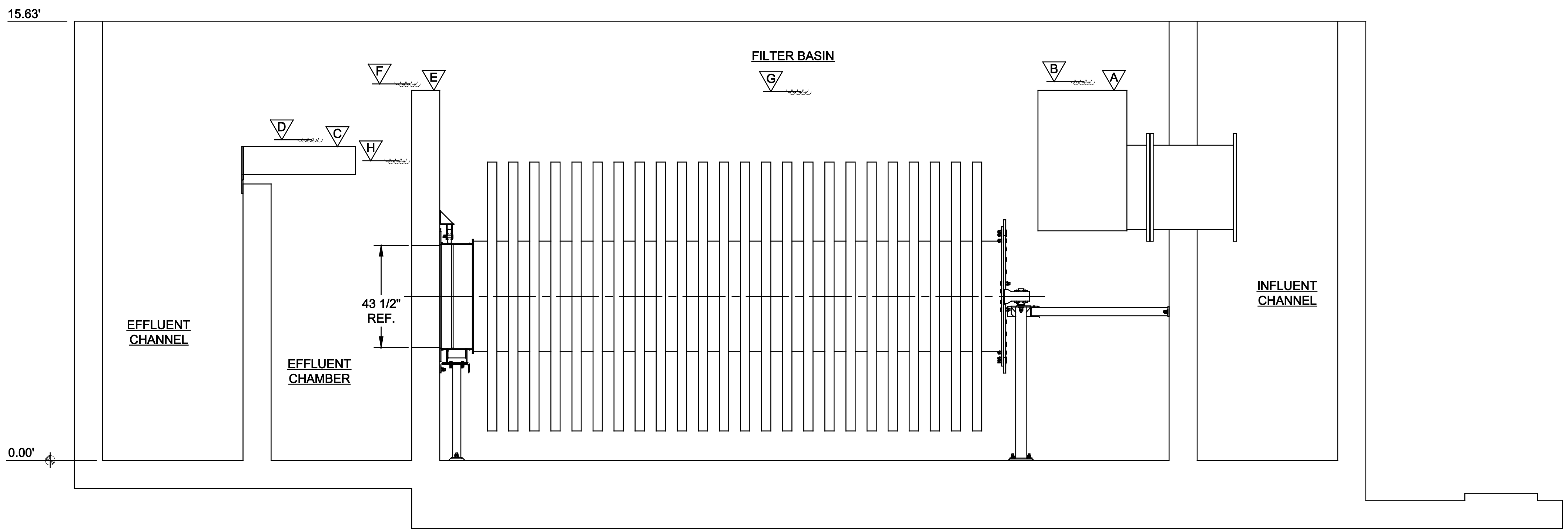
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES

FRACTIONAL DIMENSIONS	+/- 1/16
ALL TWO PLACE DECIMALS	+/- 0.010
ALL THREE PLACE DECIMALS	+/- 0.005
ALL ANGLES	+/- 1/2°

ANSI

MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: XXX DATE: XX
WEIGHT: SHEET: 2 OF

DRAWING NAME: AQUADISK FILTER MODEL ADSFC-108X24E
DRAWING NUMBER: 2802061 SCALE: SIZE: D



ELEVATION

A	13.17'	INFLUENT WEIR ELEVATION
B	13.55'	NAPPE OVER INFLUENT WEIR AVERAGE FLOW
	13.78'	NAPPE OVER INFLUENT WEIR MAXIMUM FLOW
C	11.17'	EFFLUENT WEIR ELEVATION
D	11.47'	NAPPE OVER EFFLUENT WEIR AVERAGE FLOW
	11.69'	NAPPE OVER EFFLUENT WEIR MAXIMUM FLOW
E	13.17'	OVERFLOW WEIR ELEVATION
F	13.84'	NAPPE OVER OVERFLOW WEIR AVERAGE FLOW
	14.24'	NAPPE OVER OVERFLOW WEIR MAXIMUM FLOW
G	12.98'	BACKWASH START LEVEL
H	10.67'	MAXIMUM AVAILABLE LIQUID LEVEL FOR EFFLUENT CONVEYANCE

HYDRAULIC PROFILE
BASED UPON AVERAGE FLOW RATE OF 3.25 GPM PER SQUARE FOOT (12.09 MGD)
BASED UPON MAXIMUM FLOW RATE OF 6.5 GPM PER SQUARE FOOT (24.17 MGD)

WEIR LENGTHS
INFLUENT = 23.3'
EFFLUENT = 30.0'
OVERFLOW = 10.0'

JOB NAME: XX				
JOB LOCATION: XX				
REV	ERN / ECO	DATE	BY	REVISION DESCRIPTION

DRAWING NAME: AQUADISK FILTER MODEL ADFSC-108X24E

AQUA-AEROBIC SYSTEMS, INC.

DO NOT SCALE DRAWING

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES

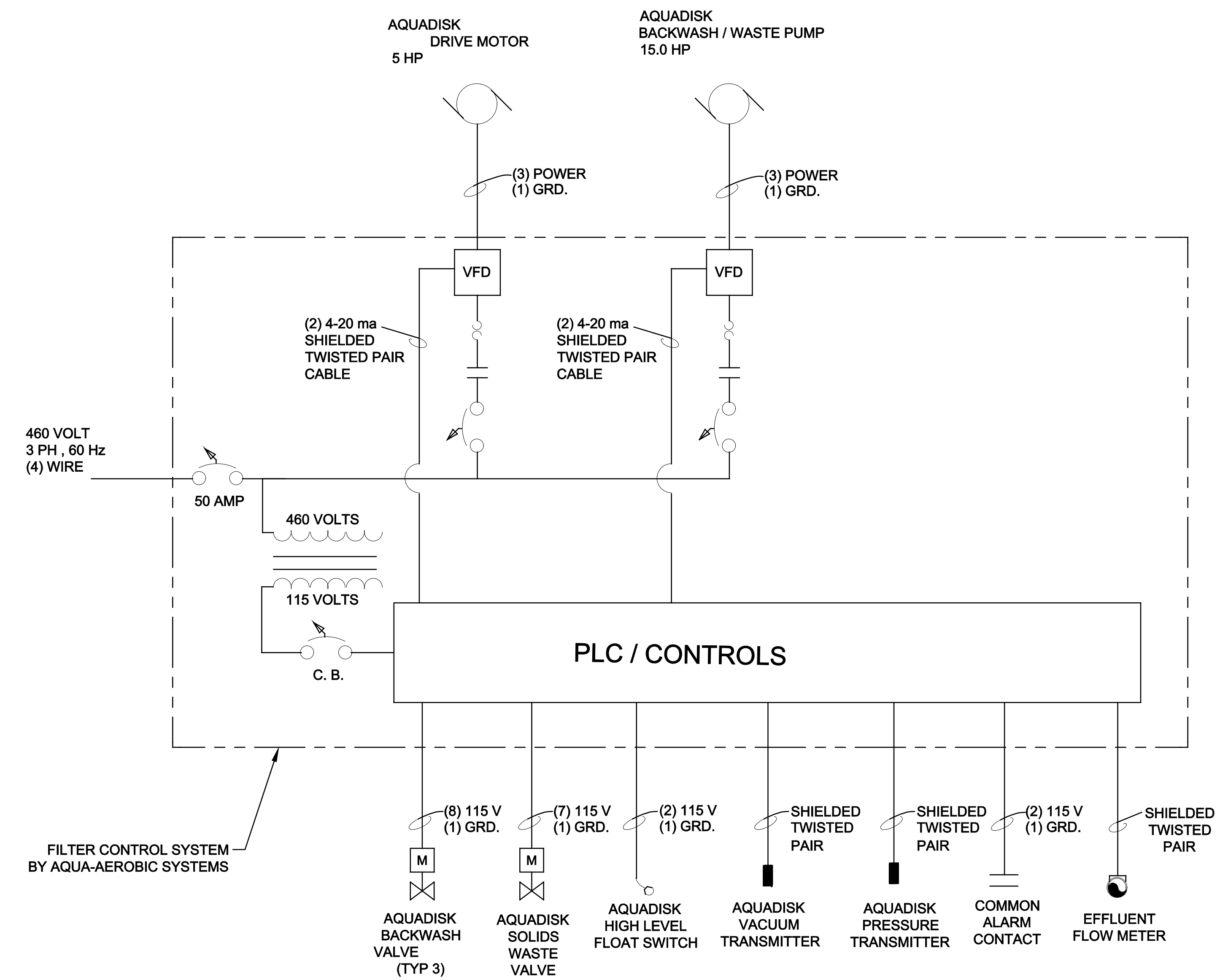
FRACTIONAL DIMENSIONS	+/- 1/16
ALL TWO PLACE DECIMALS	+/- 0.010
ALL THREE PLACE DECIMALS	+/- 0.005
ALL ANGLES	+/- 1/2°

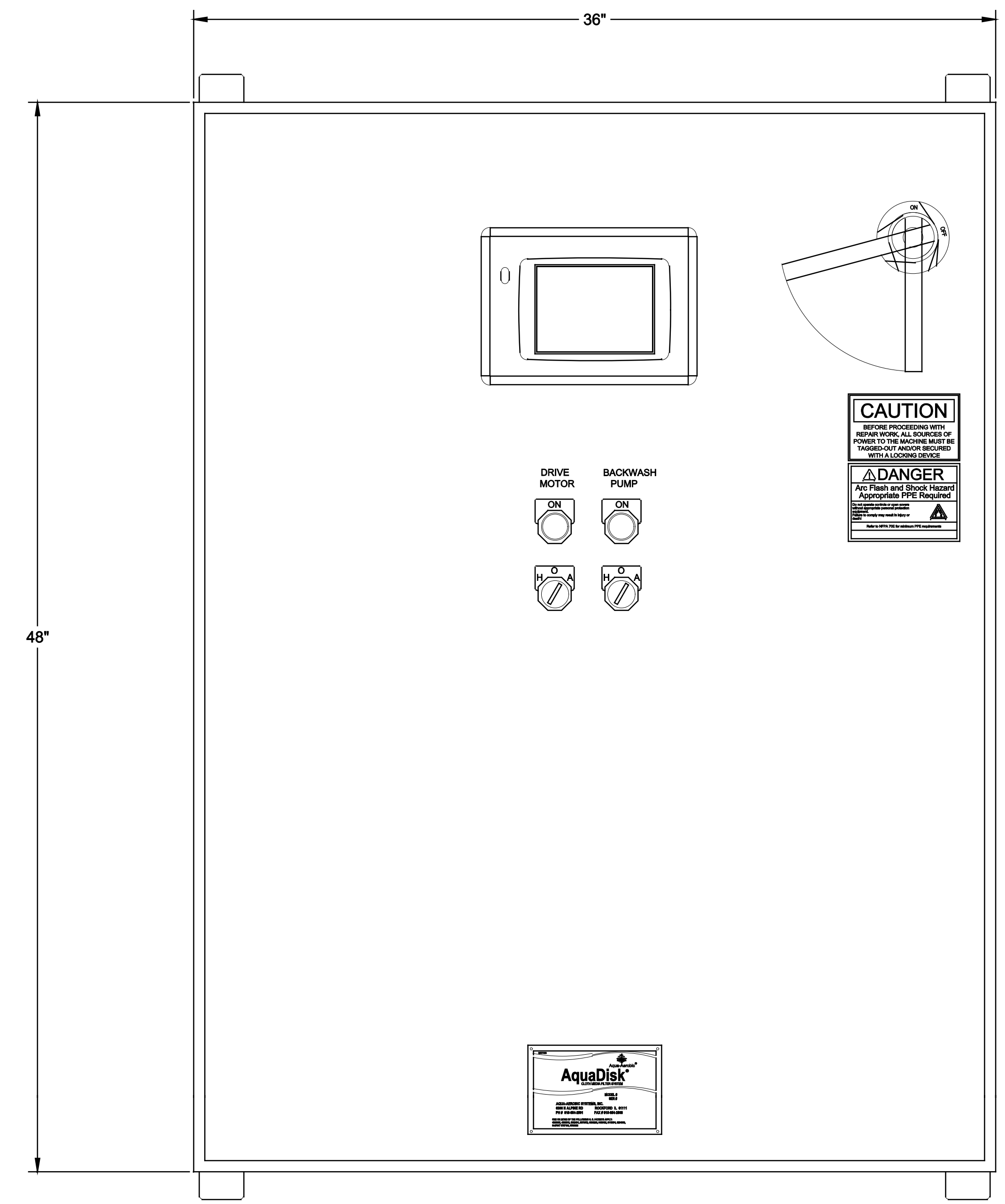
ANSI

MATERIAL:
SIMILAR TO:
TYPE:
DRAWN BY: XXX | DATE: XX
WEIGHT: | SHEET: 3 OF
DRAWING NUMBER: 2802061 | SCALE: | SIZE: D

SYMBOL KEY											
	MOTOR		CIRCUIT BREAKER		ELECTRICAL DISCONNECT	VFD	VARIABLE FREQUENCY DRIVE		TRANSDUCER		STARTER CONTACTOR
M	MOTOR OPERATED VALVE		TRANSFORMER		MOTOR OVERLOAD	P	PNEUMATIC OPERATED VALVE		FUSE		FLOAT SWITCH

NOTE: SOME SYMBOLS MAY NOT BE APPLICABLE





1. CONTROL PANEL
   ENCLOSURE NEMA 4X WALL MOUNTED TYPE FIBERGLASS
   FACTORY ASSEMBLED AND SHIPPED LOOSE. INSTALLED BY OTHERS.
   MUST BE LOCATED WITHIN 50 FEET OF THE PRESSURE TRANSMITTER.
   FACING NORTH TO LIMIT THE H.M.I. EXPOSURE TO DIRECT SUNLIGHT.
   FLOOR MOUNTING IS AVAILABLE WITH STEEL OR STAINLESS STEEL ENCLOSURES.

2. STANDARD CONTROL PANEL SIZE
   48" HEIGHT X 36" WIDE X 16" DEEP

3. (1) CONTROL PANEL PER FILTER

JOB NAME: XXX	AQUA-AEROBIC SYSTEMS, INC.
JOB LOCATION: XX	
REV / ERN / ECO / DATE / BY / REVISION DESCRIPTION	DO NOT SCALE DRAWING
	UNLESS OTHERWISE SPECIFIED: FRACTIONAL DIMENSIONS +/- 1/16; ALL TWO PLACE DECIMALS +/- 0.010; ALL THREE PLACE DECIMALS +/- 0.005; ALL ANGLES +/- 1/2°; ANSI
	MATERIAL:
	SIMILAR TO:
	TYPE:
	DRAWN BY: XX — DATE: XX
	CHECKED BY: — DATE:
	WEIGHT: — SHEET: 4 OF
DRAWING NAME: AQUADISK FILTER MODEL ADFSC-108X24E	DRAWING NUMBER: 2802061 — SCALE: — SIZE: D

GE
Water & Process Technologies

Budget Proposal for

Rutland WWTP

ZeeWeed® Membrane Filtration System

Submitted to:

Stantec
100 Pearl Street 11th Floor
Hartford CT 06103-4506

Attention: Michael Headd, PE
Associate

September 18th, 2014

Local Representation By:
Technology Sales Associates Inc.
Michael Caso
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GE Water & Process Technologies
Confidential and Proprietary Information

GE Water and Process Technologies ("Seller") submits the information contained in this document for evaluation by Stantec ("Engineer") only. Buyer agrees not to reveal its contents except to those in Engineer's organization necessary for evaluation. Copies of this document may not be made without the prior written consent of Seller's Management. If the preceding is not acceptable to Engineer, this document shall be returned to Seller.

This proposal is for budgetary purposes only and does not constitute an offer of sale.

Table of Contents

1 Basis of Design

The proposed ZeeWeed® Membrane Filtration System for the Rutland WWTP is offered based on the design parameters summarized in the following sections.

1.1 Influent Flow Data

The influent design flows are summarized in the table below.

	Phase 1	Phase 2	Units
Average Day Flow	6.0	8.4	mgd
Maximum Month Flow	7.5	10.5	mgd
Maximum Day Flow	10.0	15	mgd
Peak Hour Flow	16.0	22.5	mgd
Maximum Flow with one train offline for up to 30 days	6	8.4	mgd

Note 1: Any flow conditions that exceed the above-noted flow limits must be equalized prior to treatment in the membrane bioreactor unit.

- Average Day Flow (ADF) – The average flow rate occurring over a 24-hour period based on annual flow rate data.
- Maximum Month Flow (MMF) – The average flow rate occurring over a 24-hour period during the 30-day period with the highest flow based on annual flow rate data.
- Maximum Day Flow (MDF) – The maximum flow rate averaged over a 24-hour period occurring within annual flow rate data.
- Peak Hour Flow (PHF) – The maximum flow rate sustained over a 1-hour period based on annual flow rate data.

1.2 Influent Quality

The design solution proposed is based on the wastewater characteristics detailed below.

Minimum Influent Temperature	10	°C
Incoming MLSS concentration from bioreactor	≤8000	mg/L
Soluble TP	0.2	mg/L
pH [1]	6-8	
Material greater than 2 mm in size in mixed liquor in membrane tanks	0	mg/L

1.3 Effluent Quality

The following performance parameters are expected upon equipment startup and once the biological system has stabilized based on the data listed in Sections 1.1 and 1.2.

TSS	< 5	mg/L
Turbidity	< 1	NTU

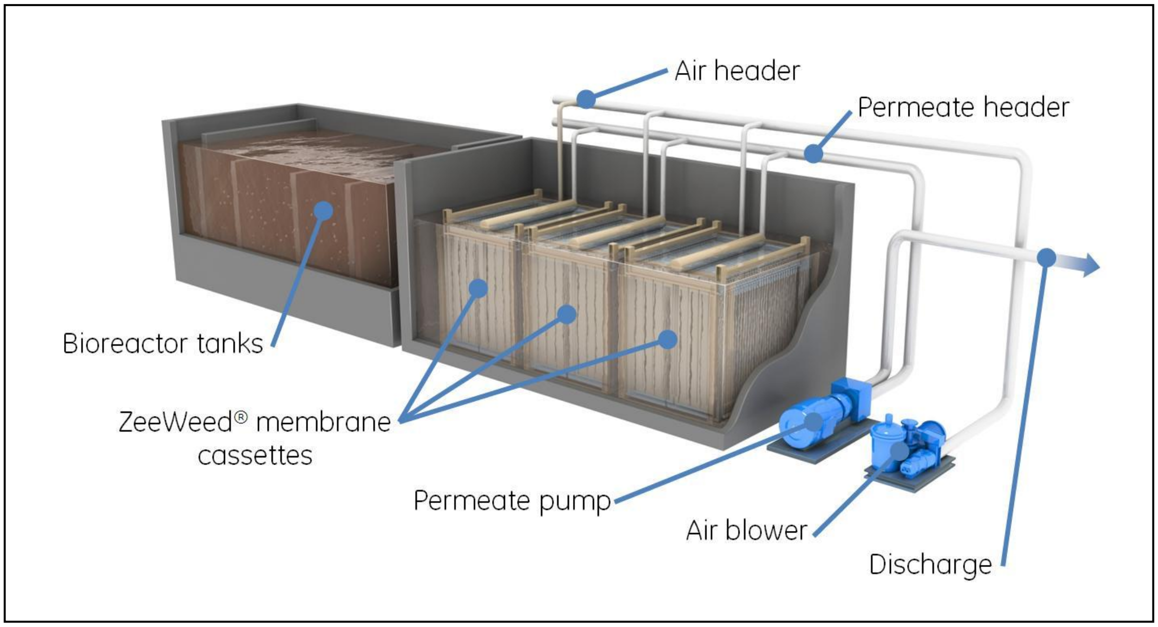
1.4 Influent Variability

Flows or loads in excess of the design criteria defined above must be equalized prior to the MBR system. In the event that the influent exceeds the specifications used in engineering this proposal, or the source of influent changes, the ability of the treatment system to produce the designed treated water quality and/or quantity may be impaired. Buyer may continue to operate the system, but assumes the risk of damage to the system and/or additional costs due to increased membrane cleanings, potential for biological upset and/or increased consumable usage.

2 System Design and Scope

The ZeeWeed® Membrane Bioreactor (MBR) process consists of a suspended growth biological reactor integrated with a membrane filtration system, using the ZeeWeed® hollow fiber ultrafiltration membrane. The membrane filtration system essentially replaces the solids separation function of secondary clarifiers and sand filters used in a conventional activated sludge process.

ZeeWeed® ultrafiltration membranes are immersed, in direct contact with mixed liquor. Through the use of a permeate pump, a vacuum is applied to a header connected to the membranes. The vacuum draws the treated water through the hollow fiber membranes. Permeate is then directed to downstream disinfection or discharge facilities. Air, in the form of large bubbles, is introduced below the bottom of the membrane modules, producing turbulence that scours the outer surface of the hollow fibers to keep them clean.



The proposed MBR design includes LEAPmbr, GE's latest technology advancement for wastewater treatment, which offers the lowest cost of ownership in the industry. LEAPmbr incorporates several innovations, including the latest ZeeWeed® 500 module with increased membrane surface area, increased productivity through proven MBR design flux improvements, an optimized membrane tank design, along with a more efficient membrane aeration system (known as LEAPmbr Aeration Technology) that simplifies the aeration system and reduces aeration requirements. These innovations combine to offer:

- 15% productivity improvement
- 20% footprint reduction
- 50% reduction in membrane aeration equipment
- 30% energy savings

The LEAPmbr advancement highlights some of the most important benefits of ZeeWeed® MBR systems – simplicity, reliability, and lowest life-cycle cost.

Simplicity

Over the years, GE has continually improved the design of ZeeWeed® MBR systems, making them the simplest MBR systems in the industry to operate and maintain. The system is fully automated, with operators having the ability to review operation, adjust set points, or schedule operating tasks through the easy-to-understand HMI graphical display.

Membrane cleaning procedures are automated and do not require any manual handling or removal of the membranes from the tanks.

The LEAPmbr system uses no moving parts within the membrane aeration system. A single air pipe and a single permeate pipe (per membrane train) provide the connection between the immersed membranes and the ancillary pumps and blowers that comprise the rest of the ZeeWeed® system.

Reliability

GE's reinforced ZeeWeed® hollow fiber membrane incorporates a patented internal support to which the membrane is bonded, creating the most robust membrane in the industry. In addition, GE's automated manufacturing processes ensure a consistent membrane product meeting the highest standards of workmanship and quality. This exceptionally strong and reliable membrane forms the backbone of ZeeWeed® MBR systems, which consistently meet and exceed the toughest regulatory standards around the world.

GE is the world leader in MBR technology, with the majority of the industry's largest and longest-operating MBR plants. GE now has over two decades of experience with the well-proven ZeeWeed® membrane. The earliest MBR plants using the ZeeWeed®-500D membrane, GE's current standard for MBR applications, have now been in operation for almost 10 years. GE's long-term and wide-ranging MBR experience ensure that plant operators can count on many years of successful ZeeWeed® MBR plant operation.

Lowest Lifecycle Cost

LEAPmbr Aeration Technology is a significant innovation for ZeeWeed® MBR technology that offers a 30% reduction in air flow versus GE's previous air cycling technology. When combined with LEAPmbr's other features, membrane aeration energy savings are almost 50% compared with the previous generation of ZeeWeed® MBR. In addition to the substantial energy savings, LEAPmbr requires fewer membrane modules and cassettes, smaller membrane tanks, fewer valves and pipes, and lower connected horsepower. In many cases, using LEAPmbr technology, a ZeeWeed® MBR system has an equivalent lifecycle cost to conventional treatment options.

2.1 Ultrafiltration System Design

The ultrafiltration design of this system is described in the table below where membrane modules are assembled into cassettes and cassettes are installed in concrete tanks supplied by Buyer.

	Phase 1	Phase 2
Type of Membrane	ZeeWeed® 500d	
Number of Trains	6	8
Number of Cassettes Installed per Train	7	7
Number of Modules Installed per Train	326	336
Total Number of Cassettes	36	56
Total Number of Modules	1,956	2,688

2.2 Scope of Supply by GE

ZeeWeed® Membranes and Associated Equipment

- ZeeWeed® 500 membrane cassettes and modules
- Membrane tank cassette mounting assemblies
- Permeate collection & air distribution header pipes
- Membrane tank level transmitters
- Membrane tank level switches

Permeate Pumping System

- Permeate pumps supplied loose, complete with required isolation valves, pressure gauges, and flow meters (VFD's required – by others)
- Vacuum ejectors and associated air release valves
- Trans-membrane pressure transmitters
- Turbidimeters

Membrane Air Scour Blowers

- Membrane air scour blowers supplied loose, complete with required isolation valves, pressure gauges and flow switches

Backpulse System

- Backpulse pumps (VFD's required – by others)
- Backpulse water storage tank, with isolation valves and level transmitter

Mixed Liquor Recirculation

- Mixed liquor recirculation pumps used to transfer mixed liquor from bioreactor to membrane tanks

Membrane Cleaning Systems

- Sodium hypochlorite chemical feed system
- Citric acid chemical feed system

Electrical and Control Equipment

- Master PLC control panel complete with touch screen HMI and remote I-O panels (3 panels - 1 per 2 trains)

Miscellaneous

- Air compressors and refrigerated air dryers for ejectors and pneumatic valve operation

General

- Equipment general arrangement and layout drawings
- Operating & Maintenance manuals
- Field service and start-up assistance[2] - 42 days support over 4 site visits from GE Water field-service personnel for installation assistance, commissioning, plant start-up and operator training
- Membrane warranty – 5 year prorated (includes 2 year initial full warranty)
- Equipment mechanical warranty – 1 year or 18 months from shipment of equipment
- Remote Monitoring & Diagnostics and 24/7 Emergency Technical Support – 1 year

Notes:

1 Additional man-hours will be billed separately from the proposed system capital cost at a rate of $1,300 per day plus living and traveling expenses. Detailed GE Water service rates are available upon request.

2 All GE supplied equipment is designed for installation in an unclassified area.

3 A further customized package of post-commissioning Field Service support can be provided upon request. The package may include additional years of GE's Remote Monitoring & Diagnostics or 24/7 services or site visits by GE Field Service personnel.

3 Buyer Scope of Supply

The following items are for supply by Buyer and will include but are not limited to:

- ❑ Overall plant design responsibility
- ❑ Review and approval of design parameters related to the membrane separation system
- ❑ Review and approval of GE supplied equipment drawings and specifications
- ❑ Detail drawings of all termination points where GE equipment or materials tie into equipment or materials supplied by Buyer
- ❑ Design, supply and installation of lifting devices including overhead traveling beam crane and monorail beam able to lift 5 ton for membrane removal, lifting davit crane and guide rails for submersible mixers and pumps, hoists, etc…
- ❑ Civil works, provision of main plant tank structures, buildings, equipment foundation pads etc. including but not limited to:
  - Common channels, Housekeeping pads, Equipment access platforms, walkways, stairs etc.
  - Equalization tankage
  - Bioreactor tankage
  - Membrane tanks c/w tank coating to be suitable for appropriate chemical contact, covers, grating, and their support over membrane tanks. Note: cassette beams provided by GE are designed to provide structural support for tank grating/covers.
  - Treated water storage tank, as required
- ❑ HVAC equipment design, specifications and installation (where applicable)
- ❑ UPS, power conditioner, emergency power supply and specification (where applicable)
- ❑ 2 mm Pretreatment fine screen
- ❑ Biological process equipment – including process blowers, diffusers and mixers
- ❑ Acoustical enclosures for membrane and process blowers
- ❑ VFDs and MCC for all GE supplied equipment
- ❑ Plant SCADA system
- ❑ Process and utilities piping, pipe supports, hangers, valves, etc. including but not limited to:
  - Piping, pipe supports and valves between GE-supplied equipment and other plant process equipment
  - Piping between any loose-supplied GE equipment
  - Process tank aeration system air piping, equalization tank system piping, etc.

- Electrical wiring, conduit and other appurtenances required to provide power connections as required from the electrical power source to the GE control panel and from the control panel to any electrical equipment, pump motors and instruments external to the GE-supplied enclosure
- Design, supply and installation of equipment anchor bolts, brackets, and fasteners for GE supplied equipment. Seismic structural analysis and anchor bolt sizing.
- Receiving (confirmation versus Packing List), unloading and safe storage of GE supplied equipment at site until ready for installation
- Installation on site of all GE supplied equipment
- Alignment of rotating equipment
- Raw materials, chemicals, and utilities during equipment start-up and operation
- Disposal of initial start-up wastewater and associated chemicals
- Supply of seed sludge for process start-up purposes
- Laboratory services, operating and maintenance personnel during equipment checkout, start-up and operation
- Touch up primer and finish paint surfaces on equipment as required at the completion of the project
- Weather protection as required for all GE supplied equipment. Skids and electrical panels are designed for indoor operation and will need shelter from the elements.

4 Commercial

4.1 Pricing Table

Pricing for the proposed equipment and services, as outlined in Section 2, is summarized in the table below. All pricing is based on the operating conditions and influent analysis detailed in Section 1. The pricing herein is for budgetary purposes only and does not constitute an offer of sale. No sales, consumer use or other similar taxes or duties are included in the pricing below.

Price: All Equipment & Service	
ZeeWeed® Membrane Filtration System, **Phase 1**	$ 5,744,000 USD
ZeeWeed® Membrane Filtration System, **Phase 2**	$ TBD

4.2 Equipment Shipment and Delivery

All pricing is quoted Ex Works (Inco Terms) Oakville, Ontario, Canada. Equipment Shipment is estimated at 26 to 35 weeks after order acceptance. The Buyer and Seller will arrange a kick off meeting after contract acceptance to develop a firm shipment.

4.3 Schedule.

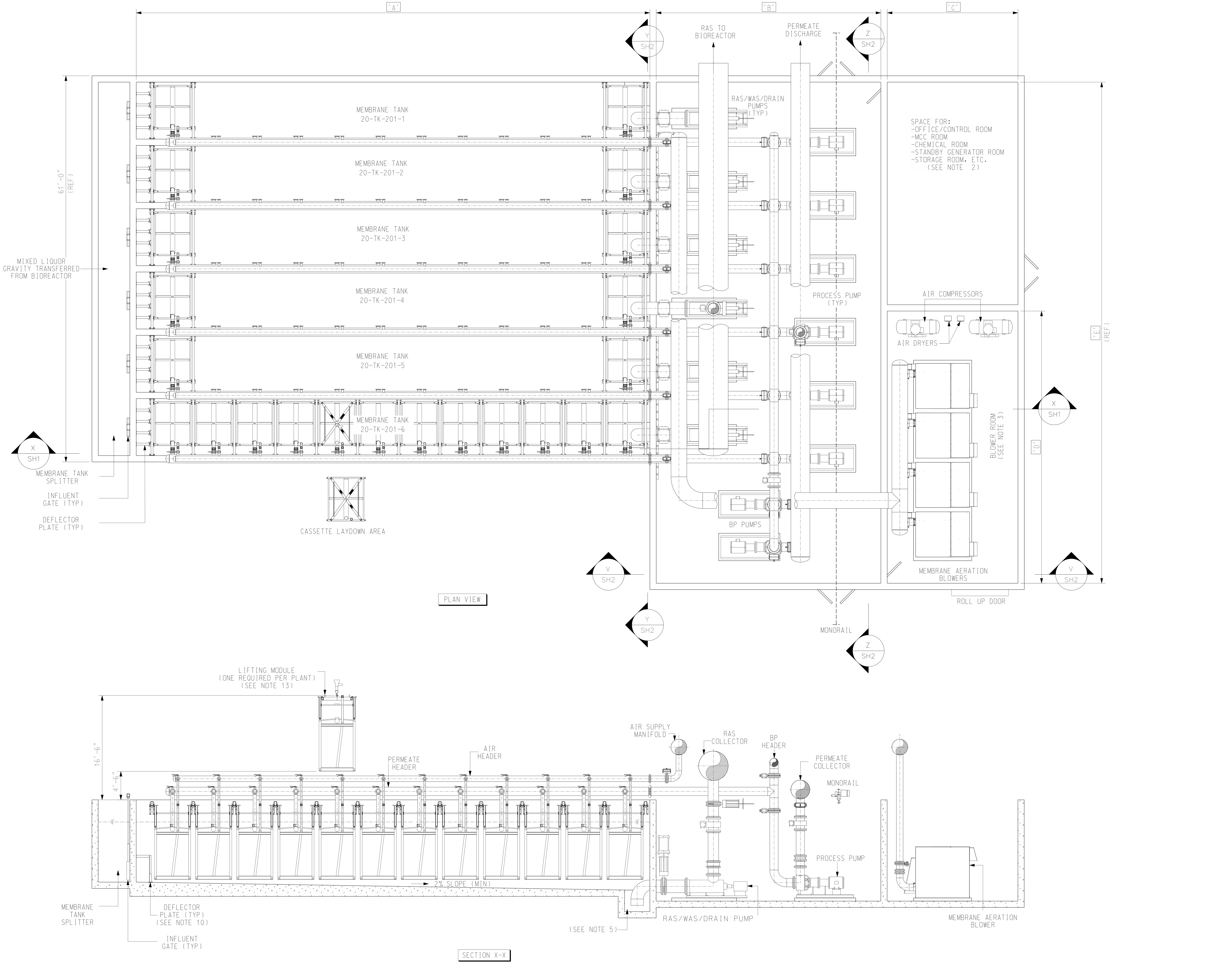
Typical Drawing Submission and Equipment Shipment Schedule

		8-12 weeks	2-3 weeks	16-20 weeks		2 weeks
Acceptance of PO						
Submission of Drawings						
Drawings Approval						
Equipment Manufacturing						
Equipment Shipment						
Plant Operations Manuals						

The delivery schedule is presented based on current workload backlogs and production capacity. This estimated delivery schedule assumes no more than 2 weeks for Buyer review of submittal drawings. Any delays in Buyer approvals or requested changes may result in additional charges and/or a delay to the schedule.

4.4 Terms and Conditions of Sale

This proposal has been prepared and is submitted based on Seller's Standard Terms and Conditions of Sale.



MAJOR TANK & BUILDING DIMENSIONS

CASSETTES 'N' PER TRAIN	'A'	'B'	'C'	'D'	'E'
7	48'-4"	25'-6"	18'-8"	33'-6"	68'-6"
8	55'-0"	30'-6"	18'-8"	33'-6"	68'-6"
9	61'-8"	30'-6"	20'-8"	43'-0"	78'-0"
10	68'-4"	30'-6"	20'-8"	43'-0"	78'-0"
11	75'-0"	35'-6"	20'-8"	44'-6"	79'-6"
12	81'-8"	35'-6"	20'-8"	44'-6"	79'-6"

ALL EQUIPMENT AND PIPING SIZE SHOWN ON THIS DRAWING IS FOR THE LARGEST TRAIN SIZE (12 CASSETTES). EQUIPMENT LAYOUT CAN CHANGE WITH SMALLER TRAIN SIZES.

NOTES

1. FOR SCOPE OF GE-SUPPLIED EQUIPMENT AND TECHNICAL DATA REFER TO THE PROPOSAL AND P&IDs.
2. SIZE AND LOCATION OF LISTED ROOMS ARE PRESENTED FOR REFERENCE ONLY. SYSTEM INTEGRATOR TO DETERMINE SIZE AND LOCATION OF ALL AMENITIES.
3. BIOLOGICAL PROCESS AERATION BLOWERS ARE NOT INCLUDED IN THE BLOWER ROOM. BOTH GROUPS OF BLOWERS CAN BE PLACED IN THE SAME ROOM.
4. SYSTEM INTEGRATOR IS RESPONSIBLE FOR DESIGN OF CONCRETE TANKS,GRAVITY CHANNELS INFLUENT GATES, EMERGENCY OVERFLOW, WALKWAYS/HANDRAILS ON TOP OF WALLS (IF REQUIRED). THESE ARE NOT SHOWN IN THIS DRAWING FOR CLARITY.
5. TANK BOTTOM AND DRAIN SUMP DESIGNS ARE NOT BY GE. HOWEVER IT IS RECOMMENDED THAT MEMBRANE TANK BOTTOM IS TO BE CONFIGURED AS A ONE WAY SLOPE TOWARDS DRAIN TRENCH CROSSING THE ENTIRE TANK WIDTH. DRAIN SUMP CAN BE LOCATED ANYWHERE INSIDE THE TRENCH, WITH A TRENCH SLOPE TAPERING INTO THE SUMP ON ONE OR BOTH SIDES OF IT, DEPENDING ON THE LOCATION OF THE DRAIN SUCTION NOZZLE.
6. DRAIN SUCTION NOZZLE OPENING HAS TO BE AT LEAST 6" BELOW ELEVATION OF A TANK BOTTOM AT ITS SHALLOW END.
7. TANKS TO BE COVERED FOR ACCESS TO CASSETTES AND EQUIPMENT. DESIGN, SUPPLY AND INSTALLATION OF MEMBRANE TANK COVERS ARE BY OTHERS (TANKS MUST BE VENTED). GE-SUPPLIED CASSETTE SUPPORT BEAMS INCLUDE A 3" ALLOWANCE FOR TANK COVERS THAT HAVE TO BE FLUSH WITH TOP OF TANKS. SPECIFIC DESIGN HAVE TO BE COORDINATED WITH GE. FOR ADDITIONAL INFORMATION REFER TO THE GE DESIGN GUIDELINE LISTED BELOW (NOTE 14a).
8. MEMBRANE TANK INTERNALS WILL BE IN CONTACT WITH MEMBRANE CLEANING CHEMICALS - TYPICALLY SODIUM HYPOCHLORITE OR CITRIC ACID SOLUTIONS. FOR ADDITIONAL INFORMATION REFER TO THE GE DOCUMENT LISTED BELOW (NOTE 14b).
9. ALL INTERNAL DIMENSIONS ARE GIVEN TO THE FINISHED CONCRETE AND COATING SURFACE; CONTRACTOR TO CALCULATE THE THICKNESS OF THE COATING BEFORE POURING THE CONCRETE (NOTE 14c).
10. DEFLECTOR PLATE DESIGN AND SUPPLY ARE BY OTHERS. FOR ADDITIONAL INFORMATION REFER TO THE GE DESIGN GUIDELINE LISTED BELOW (NOTE 14d).
11. DESIGN AND SUPPLY OF SUPPORTS FOR PERMEATE AND AIR HEADERS ARE BY OTHERS. SYSTEM INTEGRATOR TO DETERMINE DESIGN, NUMBER AND LOCATION OF SUPPORTS. GE TIE POINTS MUST NOT BE USED TO SUPPORT INTERCONNECTING PIPING.
12. SYSTEM INTEGRATOR TO CONSIDER PROVISION FOR FOAM/SLUDGE SURFACE WASTING AT THE DETAILED ENGINEERING STAGE.
13. ESTIMATED CASSETTE SHIPPING WEIGHT 4,500 LBS [2,040 KG]. ESTIMATED CASSETTE MAX WEIGHT(SLUDGED) 10,000 LBS [4,535 KG]. MEMBRANE LIFTING DEVICE (TRAVELING BRIDGE-CRANE) TO BE SIZED FOR 5,000 KG (NOTE 14e).
14. THE FOLLOWING DESIGN GUIDELINES ARE AVAILABLE FROM GE UPON REQUEST:
    a. TANK COVER GUIDELINES FOR ZEEWEED 500 SYSTEMS.
    b. MG-09012-C CONCRETE TANK COATING GUIDELINES FOR ZEEWEED SYSTEMS.
    c. MG-09011-A MEMBRANE TANK TOLERANCES.
    d. BEP #2007-04 BAFFLE DESIGN.
    e. ZEEWEED 500 SERIES MEMBRANE LIFTING EQUIPMENT GUIDELINE.

GE Water & Process Technologies
ZENON Membrane Solutions

REFERENCE ONLY
DO NOT USE FOR CONSTRUCTION

REV	DESCRIPTION	ECO	DWN	APVD	DATE	CHKD
A	INITIAL RELEASE		JPG	JM	10SEP12	TA

TOLERANCES UNLESS NOTED: DECIMALS .X ± .XX ± 0.50 .XXX ± ; ANGLES ±0.5 ; FRAC ±1/2"
DIMENSIONS IN INCHES DO NOT SCALE — THIRD ANGLE

		DATE
DRAWN BY	JPG	10SEP12
CHECKED BY	TA	10SEP12
APPROVED BY	JM	10SEP12
APPROVED BY		

GE Water & Process Technologies
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CLIENT/JOB: PRE ENGINEERED LEAPMBR 6 TRAINS PUMP FROM

FILE: MICROSTATION

TITLE: PLOT PLAN CENTRIFUGAL PROCESS PUMP

MATERIAL:

SIZE: D — DRAWING NO.: 4200000A-AG-02 — REV: A

PROJECT: 4200000

SCALE: 1:96 — SHEET: 1OF2

P/N 1161662-RHP01