# 1. EXECUTIVE SUMMARY

The Town operates a 0.250 mgd aerated lagoon wastewater treatment facility that operates under Discharge Permit No. 3-1172. In 2009, this facility was upgraded to address age related needs. During the upgrade, new equipment installed for the sewage pumps, lagoon aeration system and blowers was sized for a future capacity increase to 0.308 mgd.

The current permit limits phosphorus to an annual limit of 608 lbs or monthly average concentration of 0.8 mg/l. A new Lake Champlain Phosphorus TMDL is pending and is expected to lower Hinesburg's phosphorus limit to 152.2 lbs based on a concentration of 0.2 mg/l at the permitted flow of 0.250 mgd. The Town Discharge Permit is tentatively scheduled to be renewed in 2016 pending issue of the TMDL.

Historical operating data for this facility was reviewed for the prior 3 years (January 2013 through December 2015) to document the current operating conditions.

- Effluent flows were 0.140 mgd or 56% of the permitted capacity.
- Other than the spring of 2014, the effluent total suspended solids are consistently less than 10 mg/l.
- The effluent phosphorus concentration was 0.43 mg/l, and for 2015 the total annual lbs were 108 lbs.
- Effluent ammonia concentrations were consistently less than 12 mg/l, but monitoring was only required from June through September.

Information provided by the Town (dated May 26, 2015) on the uncommitted reserve capacity is summarized as follows:

- Total of committed reserve capacity is 17,130 gpd
- Per the allocation ordinance, 20,000 gpd is reserved
- 72,453 gpd is uncommitted

Once the flows approach 80% of the permitted capacity or 200,000 gpd, planning for expansion is recommended. The Town should have another 3 to 5 years of capacity available before planning for expansion is required, but this timeline will be impacted by how quickly the new approved residential and commercial customers are connected.

The Town wants to explore the option of increasing the permitted capacity of the existing aerated lagoon facility from 250,000 to 308,000 gpd. This change will require an amendment of the existing Discharge Permit and will be subject to the lower phosphorus limit of 152.2 lbs once the new P TMDL is issued by EPA. The State has also raised concerns about the impacts of the ammonia discharged to the La Platte River. Currently, there is no permit limit for ammonia but for the next permit renewal, it is likely that an annual ammonia limit will be added.

Alternatives were evaluated for expansion of the aerated lagoon to a capacity of 0.308 mgd. The Lemna LemTec biological treatment process would convert a portion of the existing lagoons to a covered two lagoon system followed by a polishing reactor. The EDI IDEAL system would convert a portion of the lagoons to a constant inflow, batch process, similar to a sequential batch reactor system. Upgrade of the lagoons would also require replacement of the original bentonite liner with a new HDPE lagoon liner. At an estimated cost of $3.5 M to upgrade the existing aerated lagoons, both of these systems can achieve lower ammonia limits but not the lower phosphorus limits. Addition of effluent pumping and a phosphorus removal technology will be required to comply with the lower phosphorus limit, and based on similar type and size aerated lagoon facilities this cost will range from $3.0 to $5.0 M.

Expansion of a treatment facility option to a capacity of 0.450 mgd that can comply with an ammonia limit and lower phosphorus limit was also evaluated. A sequential batch reactor (SBR) process was identified as a similar process that would be suitable for comparison purposes. For ease of construction and to maintain operation of the aerated lagoon, this new facility could be located on Town owned property to the east of the existing lagoons. This new facility would include the following elements; headworks, 2 SBR tanks, flow equalization/effluent pumping, filtration, disinfection, aerated sludge holding and control building. An estimated cost for this new larger facility is $9.0 to $10.0 M.

# 2. INTRODUCTION AND BACKGROUND

## 2.1 Purpose

In 2009, the 0.250 mgd aerated lagoon wastewater treatment facility was upgraded to address the age related needs. During the upgrade, new equipment installed for the sewage pumps, lagoon aeration system and blowers was sized for a future capacity increase to 0.308 mgd.

The Town of Hinesburg wants to conduct a planning study to address the following issues related to the lower permit limits for phosphorus and the need for increased treatment capacity:

- The Lake Champlain Total Daily Maximum Load (TMDL) for phosphorus is currently being finalized by EPA and will require future upgrades at the WWTF. EPA has developed waste load allocations (WLA) for all WWTFs that discharge to the Lake Champlain Basin.
    - For Hinesburg, it has been identified that the facility will be required to meet an effluent total phosphorus limit based on an annual lbs loading and calculated for 0.2 mg/l at the permitted flow. The discharge permit for Hinesburg is scheduled to be renewed in 2016, so the Town wants to assess the impacts at current and permitted flow conditions.
    - Analyze the impacts for a lower phosphorus limit of 0.1 mg/l.
- Determine whether an increase in capacity from the permitted flow of 250,000 to 308,000 gpd is possible. If this is possible, determine what the range of costs are, permits required, and timeline.
- Develop and assess an option for expanding the treatment capacity to 450,000 to 500,000 gpd to support the full Village build-out scenario.

## 2.2 SCOPE

The scope of this study includes the following tasks:

- Review existing information
- Assess operating data
- WWTF assessment
- Evaluation of expansion and phosphorus removal alternatives
- Report
- Review meetings

# 3. HISTORICAL OPERATIONS

## 3.1 Permit Limitations

The current facility operates under Discharge Permit No. 3-1172 with an expiration date of September 30, 2010, and defines the effluent limitations based on the permitted flow of 0.250 mgd. Under Section I.A. of the Discharge Permit, the Town is allowed to discharge from the treatment facility outfall (S/N 001) to the LaPlatte River an effluent whose characteristics do not exceed the values presented in the Permit. A summary of the permitted effluent limitations are provided in Table 3.1.

**Table 3.1**
**Permitted Effluent Limitations**

| Effluent Characteristics | Annual Limits | Monthly Average | Weekly Average | Maximum Day | Instantaneous Maximum |
|---|---|---|---|---|---|
| Flow (Annual Average) | 0.250 mgd | --- | --- | --- | --- |
| Ultimate Oxygen Demand[1] | --- | --- | --- | 400 lbs/day | |
| Biochemical Oxygen Demand ($BOD_5$) | --- | 30 mg/l<br>63 lbs/day | 45 mg/l<br>94 lbs/day | 50 mg/l | --- |
| Total Suspended Solids (TSS) | --- | 45 mg/l<br>94 lbs/day | 45 mg/l<br>94 lbs/day | 50 mg/l | --- |
| Total Phosphorus (TP) | 608 | 0.8 mg/l | | | |
| Total Residual Chlorine | --- | --- | --- | --- | 0.1 mg/l |
| Total Kjeldahl Nitrogen (TKN) | | | | Monitor only | |
| Ammonia | | | | Monitor only | |
| Settleable Solids | --- | --- | --- | --- | 1.0 ml/l |
| E. Coli | --- | --- | --- | --- | 77/100 ml |
| pH | --- | Between 6.5 and 8.5 Standard Units | | | |

Notes:
1. Ultimate oxygen demand limitation shall apply from June 1 through September 30.

## 3.2 Flows

The Discharge Permit limits the average monthly effluent flow to 0.250 mgd. As shown in Figure 3.1, from January 2013 through December 2015, the average monthly effluent flow was 0.14 mgd which is approximately 56% of the permitted average monthly effluent flow. The WWTF saw a maximum effluent flow of .27 mgd in June 2013.

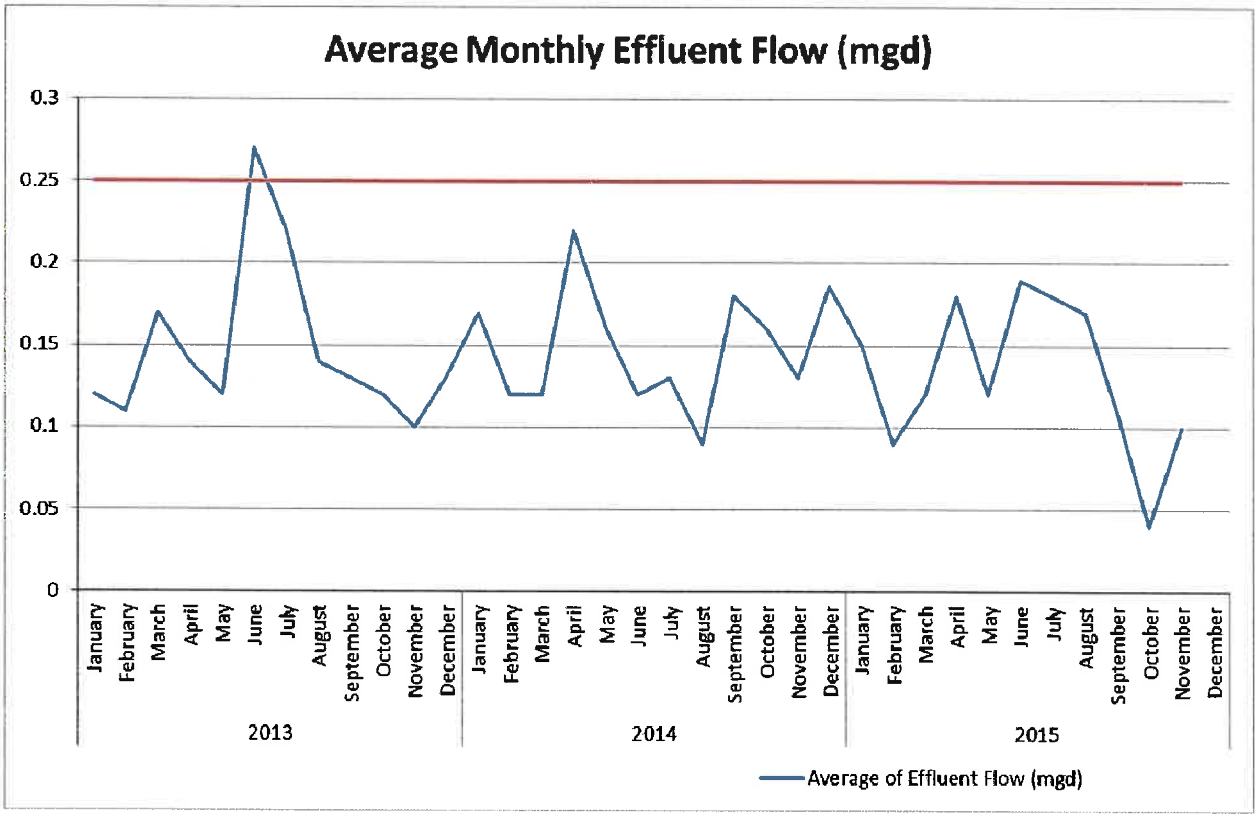



**Figure 3.1: Average Monthly Effluent Flow (mgd)**

There was an exceedance of the Hinesburg WWTF for their permitted average monthly effluent flow. This occurred in June 2013 with a average monthly flow of .27 mgd.

Information was provided by the Town on the committed reserve capacity and a copy of this May 26, 2015 Memo is provided in Appendix .

## 3.3 Influent BOD and TSS Concentration

The average monthly influent BOD concentration from January 2013 through December 2015 was 311 mg/l BOD. The WWTF saw a maximum BOD concentration of 920 mg/l in July 2013. BOD concentrations are shown on Figure 3.2. The average monthly influent TSS concentration from January 2013 through December 2015 was 286 mg/l BOD. The WWTF saw a maximum

## 3.7 Effluent Phosphorous Concentration

The average monthly effluent phosphorous concentration from January 2013 through December 2015 was 0.43 mg/l. The WWTF saw a maximum phosphorous concentration of 3.2 mg/l in March 2014. Phosphorous concentrations are shown on Figure 3.9. In 2015, effluent phosphorus averaged less than 0.3 mg/l.

In the spring of 2014, the phosphorus concentrations increased significantly due to the high sludge depths in the last lagoon cell. Once the accumulated sludge was removed, the phosphorus concentrations decreased significantly and were in compliance with the permit limits.

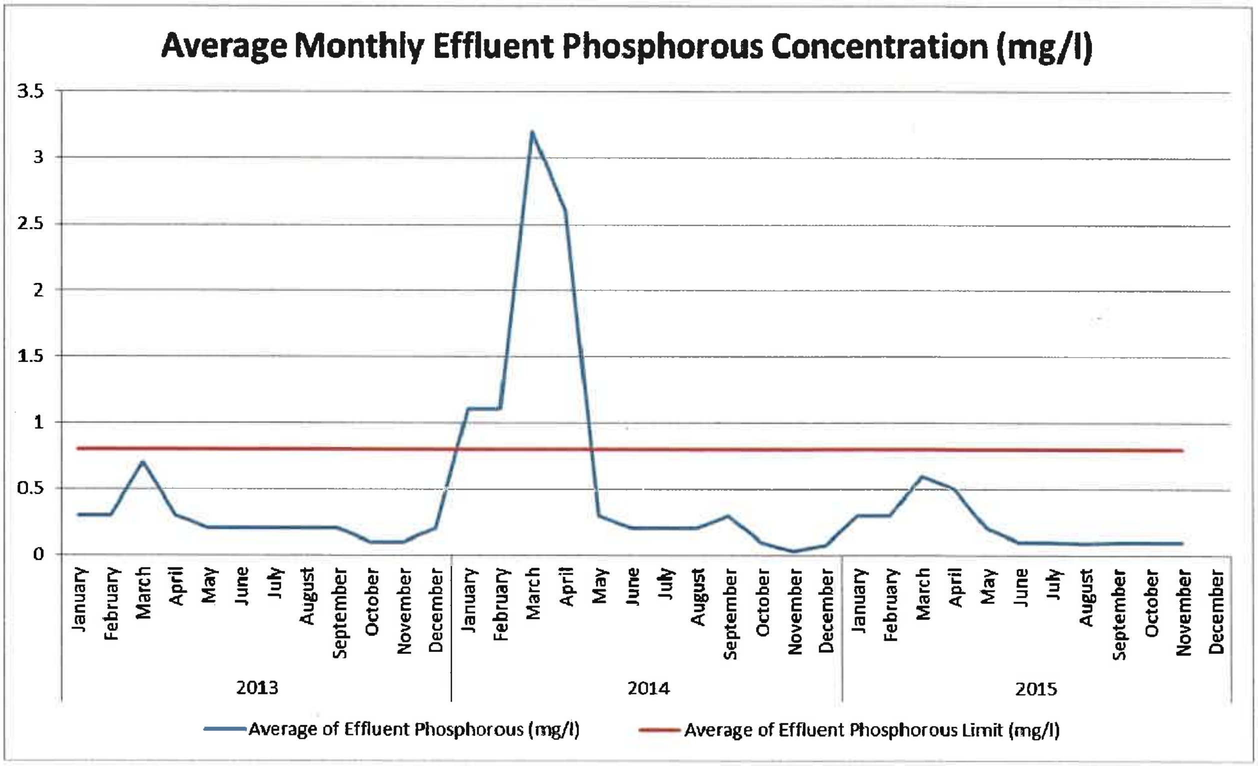



**Figure 3.9: Average Monthly Effluent Phosphorous Concentration (mg/l)**

## 3.9 Effluent Ammonia Concentration and Loading

The average monthly effluent ammonia concentration from January 2013 through December 2015 was 5.67 mg/l. The WWTF saw a maximum ammonia concentration of 11.5 mg/l in September 2015. Ammonia concentrations are shown on Figure 3.11 and sampling is only required from June through September.

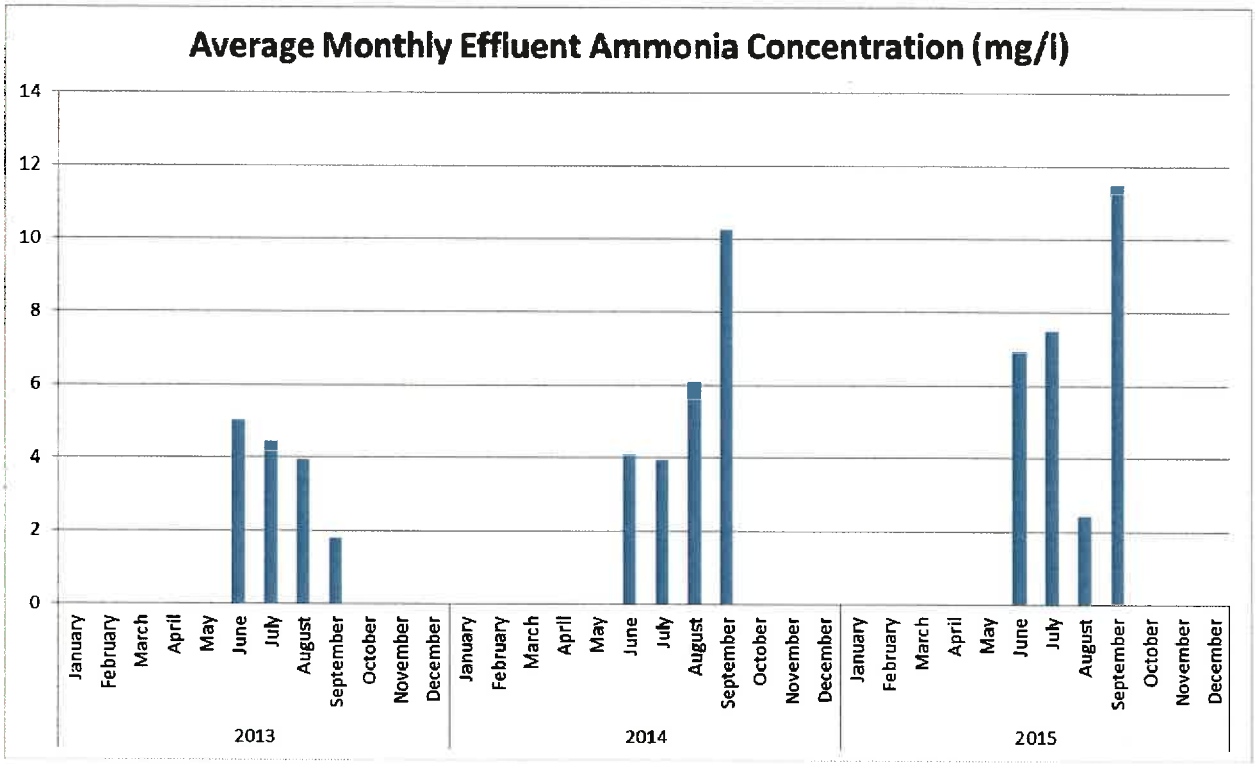



**Figure 3.11: Average Monthly Effluent Ammonia Concentration (mg/l)**

The average monthly effluent ammonia loading from January 2013 through December 2015 was 6.4 lbs/d. The WWTF saw a maximum phosphorous loading of 14.18 lbs/d in June 2013. Ammonia loadings are shown on Figure 3.12.

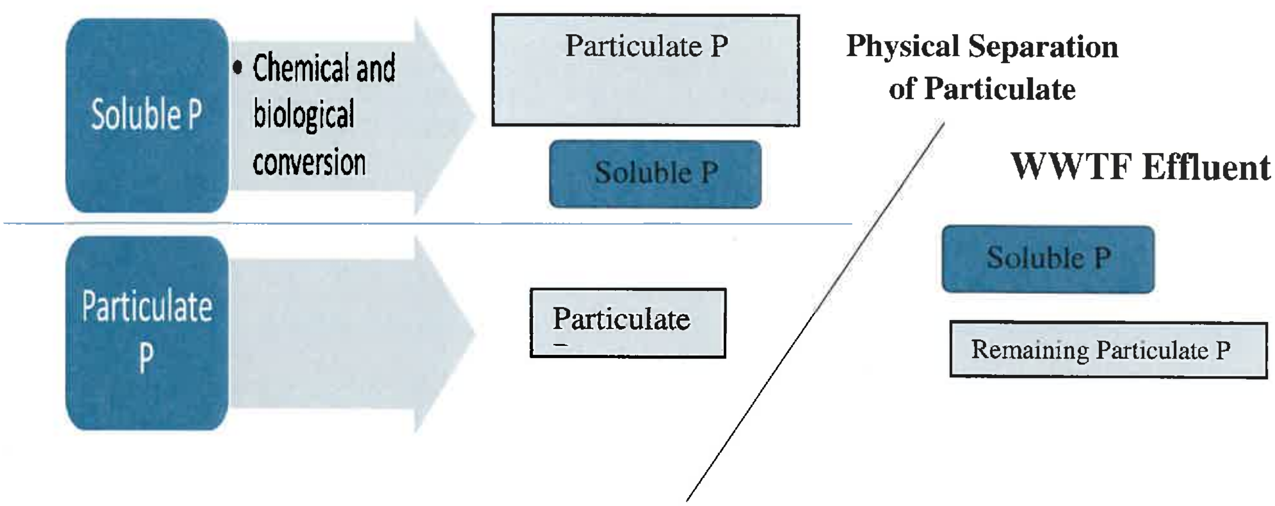
# 4. PHOSPHRUS REMOVAL ALTERNATIVES

## 4.1 Description

Tertiary phosphorus removal is a polishing step that typically treats secondary effluent. Meeting an effluent TP concentration of 0.11 mg/l is dependent on establishing effective chemistry to allow for soluble reactive phosphorus (orthophosphate) to be converted to particulate using a metal salt coagulant and removed from the effluent. In processes such as filtration or ballasted flocculation that depend on particle formation, tankage for coagulation and flocculation must be designed with hydraulic retention times that allow for particle formation.

There are four types of phosphorus present in wastewater:

1. Insoluble Non-Reactive: Removed by solids separation
2. Insoluble Reactive: Removed by Solids Separation
3. Soluble Non-Reactive: Very difficult to remove
4. Soluble Reactive (Orthophosphate):
    a. Precipitated with coagulant with polymer added and removed by solids separation
    b. Uptake in the biomass with biological phosphorus removal then wasted in sludge



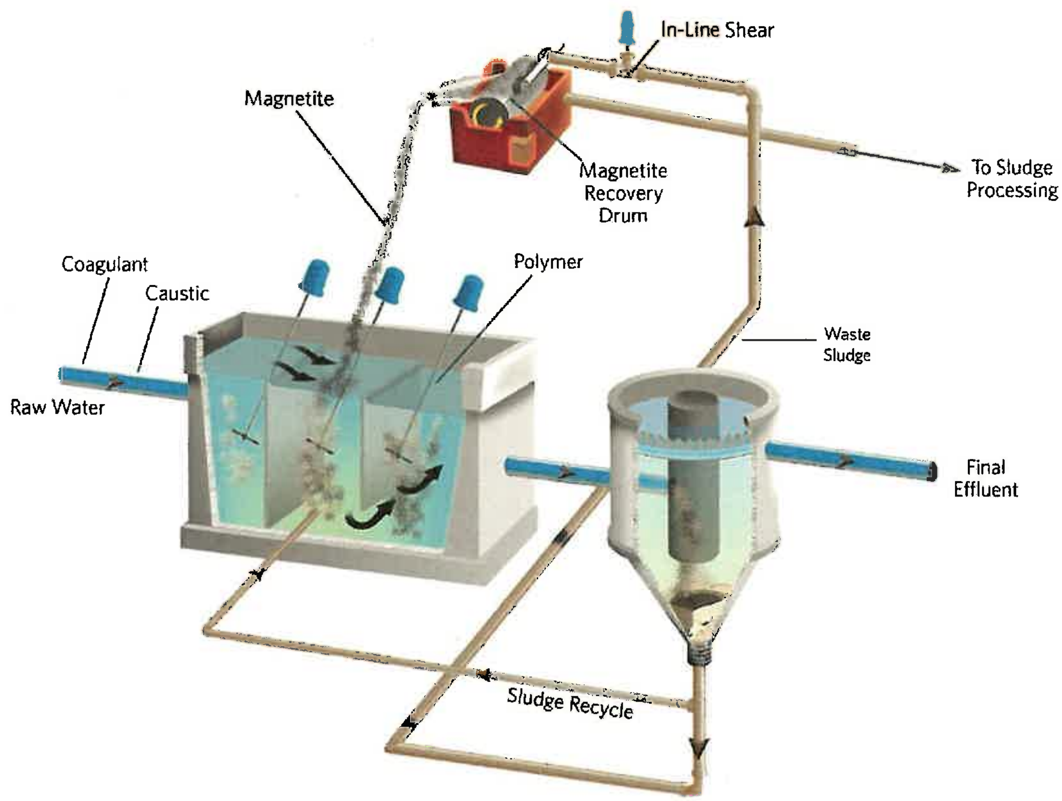

The following tertiary phosphorus removal technologies that could potentially meet an effluent TP limitation of 0.11 mg/l:

- Ballasted Flocculation:
    - Evoqua – CoMag
    - Veolia - Kruger Actiflo
- Continuous Upflow Filter with Reactive Media Adsorption: Blue Water Technologies - Centra-flo Filters with Blue PRO Process
- Filtration: Aqua-Aerobic Systems - Cloth Media Filter

An overview of these technologies is provided below.

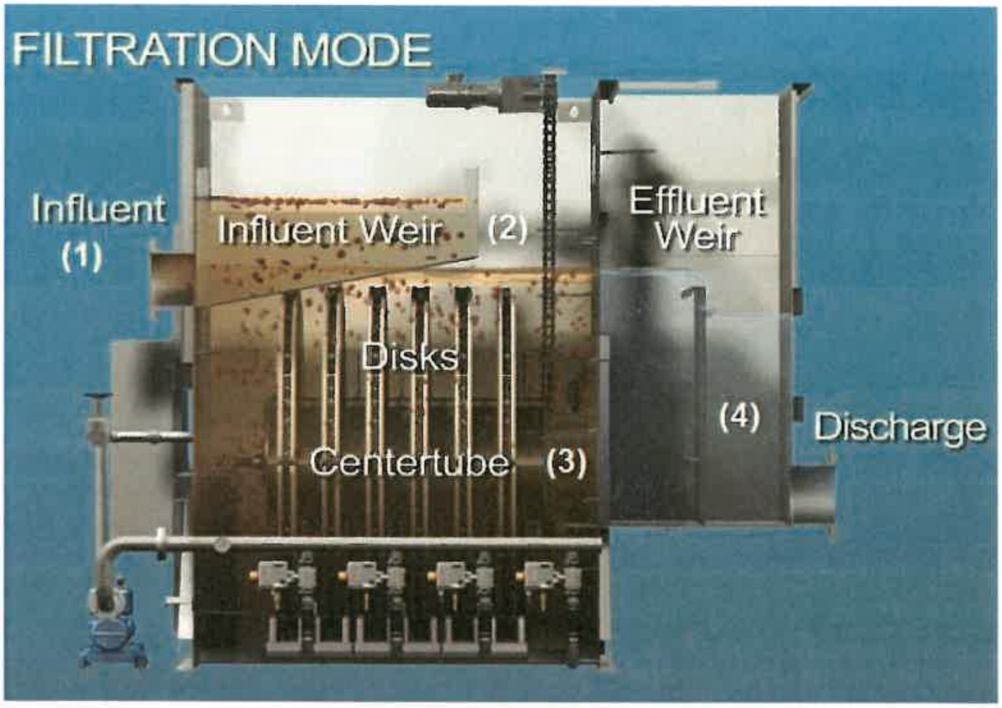
## 4.2 Ballasted Flocculation: Evoqua - CoMag

The CoMag process is based on conventional coagulation and flocculation, and a ballast material. The ballast material is magnetite (Fe3O4), which is a fully inert, high specific gravity (5.2), finely ground, non-abrasive, iron ore.




Through mixing, the magnetite is infused into the metal hydroxide floc, thereby significantly increasing the specific gravity of the floc. When the magnetite infused flocs are introduced to the CoMag clarifier, the flocs settle 20 to 60 times faster than conventional flocs or those infused with micro-sand. Rapid settling reduces required clarifier size. CoMag recycles settled solids from the clarifier back to the reaction tanks to increase nucleation sites, enhance precipitation kinetics and promote sweep floc. The magnetite ballast is recovered from the waste sludge magnetically and returned to the treatment system with very little magnetite loss.

media via an outside-in flow path, some particulates are removed and stored within the pile cloth media while others are deposited on the pile cloth media surface. Filtered water, or filtrate, is collected in a centertube (3) and flows, via gravity, over the effluent weir and into the effluent chamber (4) prior to discharge. The disks do not rotate during filtration.




***Normal Operation***

As more particulates are deposited on and within the pile cloth media, the pressure required to drive water through the pile cloth media (headloss) increases. This results in a rise in the water level within the filter basin and increased differential pressure on the pile cloth media. Upon reaching a specific basin water level set point, the PLC automatically initiates the backwash mode to clean the pile cloth media.

Solids are backwashed from the pile cloth media surface by liquid suction through backwash shoes positioned on both sides of each disk. These spring loaded backwash shoes contact the pile cloth media to provide the necessary suction for cleaning. During backwash, disks are cleaned in multiples of two, unless the filter has only one disk. The disks rotate slowly while a backwash/waste pump draws filtered water from the centertube through the pile cloth media on an inside-to-outside, or reversed, flow path. This provides cleaning of the pile cloth media over the entire disk. By the end of the backwash cycle, the basin water level returns to its normal operating level. Backwash water is typically directed to the headworks. Filtration continues while the filter is in backwash mode. This allows for continuous filtration.

**Table 5.1**
**Permitted Effluent Limitations**

| Effluent Characteristics | Annual Limits | Monthly Average | Weekly Average | Maximum Day | Instantaneous Maximum |
|---|---|---|---|---|---|
| Flow (Annual Average) | 0.308 mgd | --- | --- | --- | --- |
| Ultimate Oxygen Demand[1] | --- | --- | --- | 400 lbs/day | |
| Biochemical Oxygen Demand ($BOD_5$) | --- | 30 mg/l<br>63 lbs/day | 45 mg/l<br>94 lbs/day | 50 mg/l | --- |
| Total Suspended Solids (TSS) | --- | 45 mg/l<br>94 lbs/day | 45 mg/l<br>94 lbs/day | 50 mg/l | --- |
| Total Phosphorus (TP) | 152.2 | --- | | | |
| Total Residual Chlorine | --- | --- | --- | --- | 0.1 mg/l |
| Total Kjeldahl Nitrogen (TKN) | | | | Monitor only | |
| Ammonia | | < 10 mg/l | | | |
| Settleable Solids | --- | --- | --- | --- | 1.0 ml/l |
| E. Coli | --- | --- | --- | --- | 77/100 ml |
| pH | --- | Between 6.5 and 8.5 Standard Units | | | |

Notes:

1. Ultimate oxygen demand limitation shall apply from June 1 through September 30.

## 5.3 Ammonia Removal Alternatives

To provide consistent year round compliance with a lower ammonia limit, retrofit treatment technologies for the aerated lagoon were evaluated. Compared to other treatment technologies, consistent ammonia removal with an aerated lagoon is very challenging. Ammonia removal to levels less than 5.0 mg/l via nitrification is very achievable with other treatment processes, but for an aerated lagoon, these factors must be considered:

- Adequacy of air supply to maintain sufficient dissolved oxygen levels
- Providing the majority of the BOD removal prior to meeting the air supply needs for nitrification
- Maintaining a suitable pH between 7.5 – 8.0 SU
- Suitable water temperatures in colder weather conditions
- Reduction of accumulated sludge volumes
- Maintaining adequate mixing

To meet these objectives, extensive work is required to modify the aerated lagoons and may require the following upgrades;

- Larger aeration blowers, air distribution line, and aeration diffusers
- Creating a complete mix zone at the influent to optimize the biochemical oxygen demand (BOD) removal