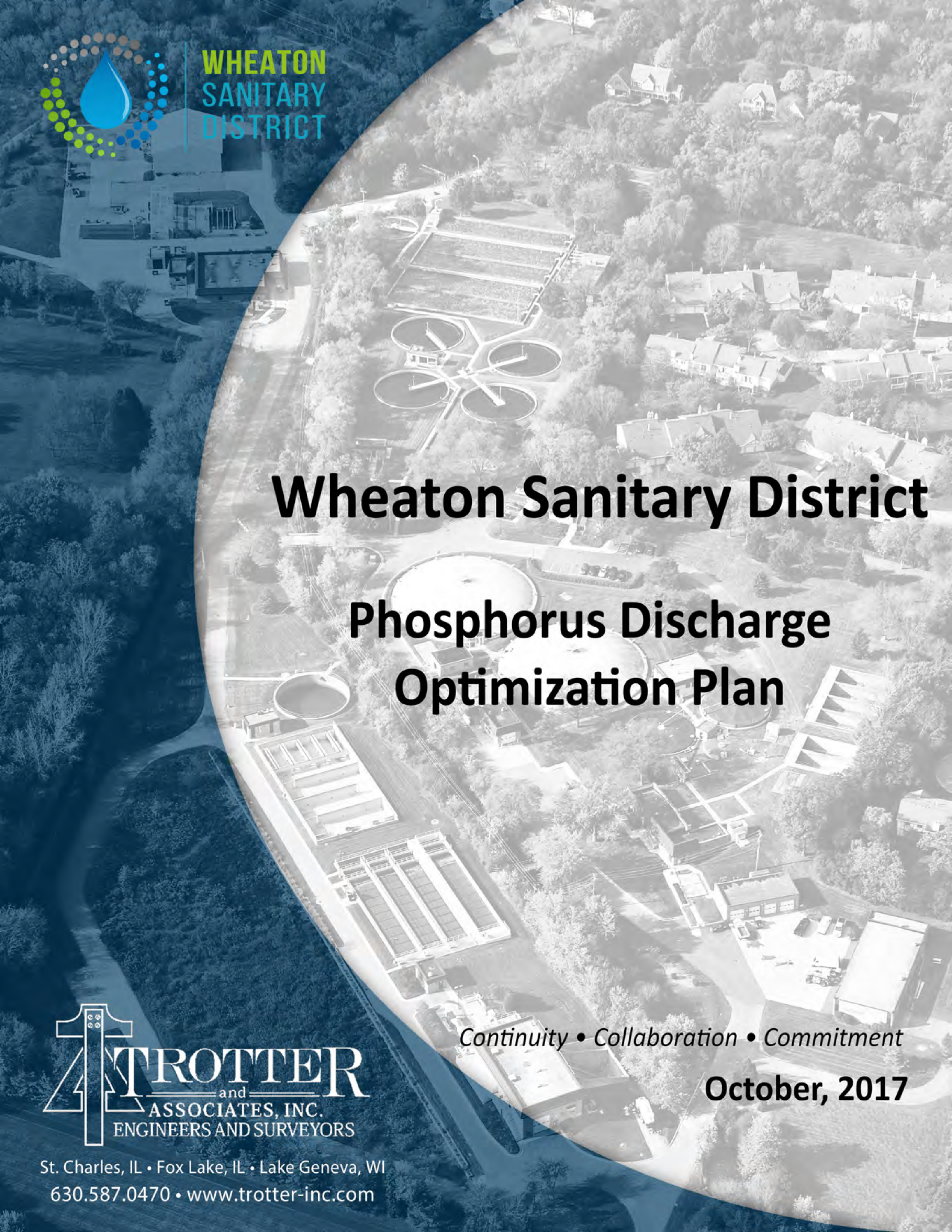

WHEATON SANITARY DISTRICT

Wheaton Sanitary District

Phosphorus Discharge Optimization Plan

Continuity • Collaboration • Commitment

October, 2017

TROTTER and ASSOCIATES, INC.
ENGINEERS AND SURVEYORS

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WHEATON SANITARY DISTRICT

PHOSPHORUS DISCHARGE OPTIMIZATION PLAN

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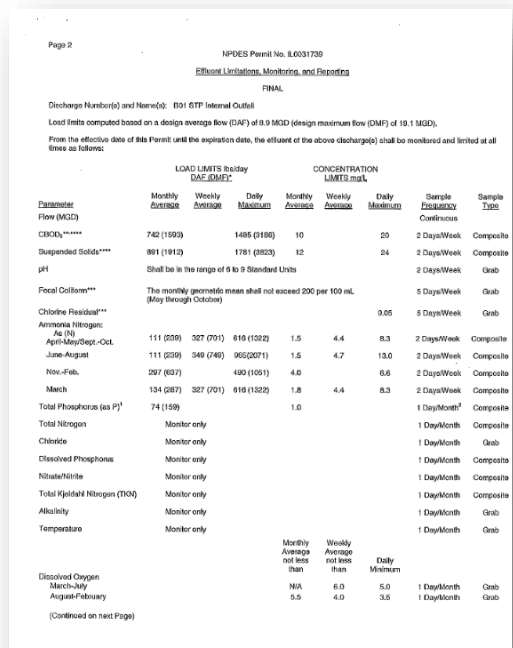
1. Overview and Summary

1.1 Project Background

According to the Illinois EPA Clean Water Act Section 303(d) List, the DuPage River does not meet water quality standards for its intended use in the majority of the segments, including the segments immediately downstream of the Wheaton Sanitary WWTF. According to the Illinois EPA Clean Water Act Section 303(d) List, the DuPage River does not meet water quality standards for its intended use in the majority of the segments. The DuPage River is impaired for aquatic life based on a low dissolved oxygen concentration, and phosphorous.

Spring Brook Creek directly upstream of the Wheaton Sanitary District (Segment GBKA) is impaired for aquatic life based on dissolved oxygen, chlorides, and phosphorous. Additionally, the upstream stretch of Spring Brook Creek is also impaired for primary contact based on fecal coliform. Spring Brook Creek downstream from the District (GBKA 01), however, is only impaired for aquatic life based on phosphorous and primary contact based on fecal coliform.

In order to address this issue, the DuPage River Salt Creek Workgroup (DRSCW) was formed, which includes members from communities along the DuPage River including the Wheaton Sanitary District. The goal of this group is to restore the water quality in both the DuPage River and the Salt Creek, which passes through DuPage County, Illinois. The goal of this group is not only to improve the water quality in the DuPage River, but also cause a positive impact on downstream water such as the Illinois River and Mississippi River. The group has identified phosphorus reduction from point sources, such as wastewater treatment facilities, as a means to improve the water quality. Therefore, in partnership with the Illinois Environmental Protection agency, the creation of a Phosphorus Discharge Optimization Study has been added to the National Pollutant Discharge Elimination System permits for all WWTF's that are part of the DRSCW.


Page 2

NPDES Permit No. IL0031739

Effluent Limitations, Monitoring, and Reporting

FINAL

Discharge Number(s) and Name(s): B01 STP Internal Outfall

Load limits computed based on a design average flow (DAF) of 8.9 MGD (design maximum flow (DMF) of 19.1 MGD).

From the effective date of this Permit until the expiration date, the effluent of the above discharge(s) shall be monitored and limited at all times as follows:

	LOAD LIMITS lbs/day DAF (DMF)*			CONCENTRATION LIMITS mg/L				
Parameter	Monthly Average	Weekly Average	Daily Maximum	Monthly Average	Weekly Average	Daily Maximum	Sample Frequency	Sample Type
Flow (MGD)							Continuous	
CBOD₅**,*****	742 (1593)		1485 (3186)	10		20	2 Days/Week	Composite
Suspended Solids****	891 (1912)		1781 (3823)	12		24	2 Days/Week	Composite
pH	Shall be in the range of 6 to 9 Standard Units						2 Days/Week	Grab
Fecal Coliform***	The monthly geometric mean shall not exceed 200 per 100 mL (May through October)						5 Days/Week	Grab
Chlorine Residual***						0.05	5 Days/Week	Grab
Ammonia Nitrogen: As (N) April-May/Sept.-Oct.	111 (239)	327 (701)	616 (1322)	1.5	4.4	8.3	2 Days/Week	Composite
June-August	111 (239)	349 (749)	965(2071)	1.5	4.7	13.0	2 Days/Week	Composite
Nov.-Feb.	297 (637)		490 (1051)	4.0		6.6	2 Days/Week	Composite
March	134 (287)	327 (701)	616 (1322)	1.8	4.4	8.3	2 Days/Week	Composite
Total Phosphorus (as P)[1]	74 (159)			1.0			1 Day/Month[2]	Composite
Total Nitrogen	Monitor only						1 Day/Month	Composite
Chloride	Monitor only						1 Day/Month	Grab
Dissolved Phosphorus	Monitor only						1 Day/Month	Composite
Nitrate/Nitrite	Monitor only						1 Day/Month	Composite
Total Kjeldahl Nitrogen (TKN)	Monitor only						1 Day/Month	Composite
Alkalinity	Monitor only						1 Day/Month	Grab
Temperature	Monitor only						1 Day/Month	Grab
				Monthly Average not less than	Weekly Average not less than	Daily Minimum		
Dissolved Oxygen March-July				N/A	6.0	5.0	1 Day/Month	Grab
August-February				5.5	4.0	3.5	1 Day/Month	Grab

(Continued on next Page)

1.2 NPDES Permit

The Wheaton Sanitary District received updated NPDES Permit No. IL0031739, effective August 1st, 2016. Effluent limits are regulated by this permit which is outlined in Table 1 on the following page.

Table 1: NPDES effluent limits

Parameter	Effluent Limit			
	Monthly Average Loading (lbs/day)	Daily Maximum Loading (lbs/day)	Monthly Average Concentration (mg/L)	Daily Maximum Concentration (mg/L)
CBOD5	742	1485	10	20
Suspended Solids	891	1781	12	24
Ammonia Nitrogen				
April-May/Sept-Oct	111	616	1.5	8.3
June-August	111	965	1.5	13.0
Nov-Feb	297	490	4.0	6.6
March	134	616	1.8	8.3
Total Phosphorus*	74	-	1.0	-

**This phosphorus limit is not applicable for this permit cycle, but is included as part of a schedule for future compliance and is the driving factor in this study.*

This permit includes Special Condition 16, which requires the preparation of the Phosphorus Removal Feasibility Study and Phosphorus Discharge Optimization Plan. The relevant special conditions are outlined below:

SPECIAL CONDITION 16.

"The Permittee shall develop a written Phosphorus Discharge Optimization Plan. In developing the plan, the Permittee shall evaluate a range of measures for reducing phosphorus discharges from the treatment plant, including possible source reduction measures, operational improvements, and minor low cost facility modifications that will optimize reductions in phosphorus discharges from the wastewater treatment facility. The Permittee's evaluation shall include, but not necessarily be limited to, an evaluation of the following optimization measures:

a. WWTF Influent Reduction Measures.

a. Evaluate the phosphorus reduction potential of users.

b. Determine which sources have the greatest opportunity for reducing phosphorus (e.g. industrial, commercial, institutional, municipal, and others).

c. Determine whether known sources (e.g. restaurant and food preparation) can adopt phosphorus minimization and water conservation plans.

d. Evaluate implementation of local limits on influent sources of excessive phosphorus.

b. WWTF Effluent Reduction Measures.

a. Reduce phosphorus discharges by optimizing existing treatment processes without causing non-compliance with permit effluent limitations or adversely impacting stream health.

b. Adjust the solids retention time for biological phosphorus removal.

c. Adjust aeration rates to reduce DO and promote biological phosphorus removal.

d. Change aeration setting in plug flow basins by turning off air or mixers at the inlet side of the basin system.

e. Minimize impact on recycle streams by improving aeration within holding tanks.

f. Adjust flow through existing basins to enhance biological nutrient removal.

g. Increase volatile fatty acids for biological phosphorus removal.

Within 24 months of the effective date of this permit (August 1, 2018), the Permittee shall finalize the written Phosphorus Discharge Optimization Evaluation Plan and submit it to IEPA. The plan shall include a schedule for implementing all of the evaluated optimization measures that can practically be implemented and include a report that explains the basis for rejecting any measure that was deemed impractical. The schedule for implementing all practical measures shall be no longer than 36 months (August 1, 2019) after the effective date of this permit.

The Permittee shall implement the measures set forth in the Phosphorus Discharge Optimization Plan in accordance with the schedule set forth in that Plan. The Permittee shall modify the Plan to address any comments that it receives from IEPA and shall implement the modified plan in accordance with the schedule therein. Annual progress reports on the optimization of the existing treatment facilities shall be submitted to the Agency by March 31 of each year beginning 24 months from the effective date of the permit."

1.3 Purpose and Scope

As stated previously, the Wheaton Sanitary District WWTF must complete a Phosphorus Discharge Optimization Plan to remain in compliance with their NPDES permit. This scope of this plan is to assess the current plant operations and determine process changes requiring minimal capital investment that will help reduce the total phosphorus in the plant's effluent.

The permit also requires the completion of a Phosphorus Removal Feasibility study. In this study, it was required to determine the costs and feasibility associated with reducing phosphorus in the effluent to 1.0 mg/L, 0.5 mg/L and 0.1 mg/L. This plan includes assessing the implementation of capital improvement projects which could include construction of new basins, purchase of new technology, etc. In contrast, the Phosphorus Discharge Optimization Plan was developed to determine the maximum phosphorus reduction possible that the plant can achieve by simply adjusting the daily operations.

For purposes of this report, an optimization project was defined as a change in operation that would not cost the District more than 5% of the annual operation and maintenance budget in to implement. Based on the Fiscal Year 2016 Annual Audit, the District spent a total of $2,337,690 on plant operations and maintenance. Therefore, the maximum increase in operations costs that was considered for optimization of phosphorus removal was $116,885. This is less than 2% of the total operating budget for the Wheaton Sanitary District. The permit also states that all recommendations stated in this plan must be implemented within 12 months of the submission to the IEPA.

1.4 Community Overview

The Wheaton Sanitary District's Wastewater Treatment Facility (WWTF) discharges to the Spring Brook Creek and ultimately discharges to West Branch of the DuPage River. The District's facility planning area consists of parts of the City of Wheaton, the Village of Carol Stream, the Village of Winfield, the Village of Glen Ellyn, and unincorporated DuPage County. The District serves approximately 66,513 population equivalents (P.E.), with primarily residential users.

1.5 Treatment Process Overview

1.5.1 Collection System

The Wheaton Sanitary District owns approximately 64 miles of sanitary sewer, including two major interceptor sewers and two lift stations. Another 120 miles of sanitary sewer that carries waste to the Wheaton Sanitary District is owned by the municipalities in the facility planning area. As previously discussed, these include the City of Wheaton, the Village of Carol Stream, the Village of Glen Ellyn, and the Village of Winfield. The majority of the sewer owned by the District is located in unincorporated DuPage County.

1.5.2 Wastewater Treatment Process

The Wheaton Sanitary District employs preliminary, primary, secondary, and tertiary treatment, as well as disinfection, to wastewater before it is discharged to Spring Brook Creek, which is tributary to the West Branch of the DuPage River. The facility has a Design Average Flow (DAF) of 8.9 MGD with capacity to treat up to 44.1 MGD utilizing excess flow facilities. The average daily flow over the past three years is 7.3 MGD with influent concentrations of approximately 185 mg/L BOD and 231 mg/L TSS.

Flow enters an influent pumping station where it is pumped to preliminary treatment, including mechanical screening, and grit removal. Wastewater then flows to the primary clarifiers where heavy solids are settled out as primary sludge. The solids are transferred to the anaerobic digesters for stabilization.

Primary effluent flows by gravity to the Intermediate Pumping Station which is used to pump flow to the biological process. The District employs an activated sludge (single-stage nitrification) process where flow is split evenly through five aeration basins. From the biological process, mixed liquor flows to the final clarifiers. The final clarifiers allow for more solids to settle out, and secondary effluent flows over the weirs to tertiary treatment. Solids settled in the final clarifiers are split to a waste stream (waste activated sludge) and a recycle stream (return activated sludge) the recycle stream is returned to the aeration basins to maintain the active microbial population needed for the biological treatment to occur. The waste stream is sent to a gravity thickener which is used to concentrate the WAS before it is sent to the anaerobic digesters for stabilization.

The secondary effluent flows via gravity to tertiary treatment. Through 2016 this consisted of a system of sand filters, however, the District is currently in the process of upgrading this process to disc filtration. These filters will remove suspended particles and impurities. Filtered effluent is then disinfected with chlorine prior to being discharged to Spring Brook.

2. Influent Reduction Strategies

2.1 Potential Phosphorus Reduction of Individual Users

It was determined that a practical influent reduction strategy would be designed to lower the influent loading by 10% or more, if possible. In order to achieve this reduction TAI evaluated all industrial and commercial users and designated users as "significant" based on their respective potential phosphorus loads. For the purposes of this report, a significant user has been defined as one capable of contributing 1% or more of the WWTP's average influent phosphorus load. Based on an average influent phosphorus load of 222 lbs/day (3.65mg/L at 7.3 MGD), each significant user must be capable of discharging 2.2 lbs/day of phosphorus. In order to narrow down potential significant contributors, a high-level phosphorus limit of 30 mg/L was utilized, and therefore any users with a flow less than 9,000 gallons/day were not considered. If there were a commercial user contributing greater than 30 mg/L, it is possible that they are contributing greater than 1% at a lower flow, however it is unlikely.

Table 2: Influent Assessment Criteria

Average Flow	7.30	MGD
Average Influent P Concentration	3.65	mg/l
Average P Loading	222	lbs/day
1% P Loading	2.2	lbs/day
Flow to contribute 1% P at 30 mg/L P	0.00888	MGD
Min. GPD for Significant Use	8882	GPD
Users Assessed >	9,000	GPD Rounded

Once all users discharging in excess of 9,000 gpd were identified, they were categorized according to potential of phosphorus reduction. This is based on assumptions of what type of pollutants may be found in the wastewater from users depending on what type of establishment is at each identified location. This narrowed the list to users which require further evaluation, such as a walk-through or detailed survey regarding what products are typically used that would end up in the waste stream.

Table 3 on the following page shows each user that has a flow greater than 9,000 GPD and determines if there is a low, medium or high potential for phosphorus reduction. Many of the users that met the flow requirement of 9,000 gpd or more would not be considered a high phosphorus contributor and therefore reduction would be minimal. For example, users like Wheaton College and the DuPage Power Plant met the flow criteria but are typically not facilities that would be expected to contribute much, if any, phosphorus based on the use of water at these locations. Each of these facilities may have some phosphorus present in their wastewater, but it is probably less than or equivalent to domestic strength levels. At the power plant, the majority of the wastewater flow is non-contact cooling water, which is typically more dilute than domestic strength waste. Any phosphorus that is present in the cooling water would be present from the potable water source, therefore the user would not have an obligation to reduce the pollutant before discharge into the collection system.

Additionally, a four medium phosphorus contributors were identified. These may be suitable candidates for best management practices and educational materials to help make them aware of the types of products that contain phosphorus and those that are phosphate free. Some of the businesses identified and placed within this tier are a correctional facility, a health care facility, and a supermarket. The public education outreach that is included in Section 2.4 will be provided to these users. This will aid in helping the users to make better decisions with what types of products they are using at their facilities and the impact it has on water quality.

Three users were identified as phosphorus contributors with high potential to contribute 1% or more influent loading. One of which is the metal finishing facility Circuitronics, a categorical user that is already regulated under federal pretreatment regulations. If needed, reduction of phosphorus for this facility would be relatively straightforward to enforce. It is recommended that this facility is surveyed and a walk through is performed in order to assess the phosphorus contribution further. The two remaining “high potential” users are a car wash and a County facility which has high flows.

The District has a septage and leachate receiving station where waste is hauled and dumped on a regular basis. This waste stream is intermittent and is typically is high concentration. The District has been testing both the septage and leachate to determine the additional phosphorus load that this system adds to the overall process. Several samples, both grab and composite, were taken over the course of December 2016 through April 2017. The average phosphorus concentration of the leachate was relatively low at 3.36 mg/L, however the average septage concentration exceeded 100 mg/L.

Based on the results of laboratory testing, the leachate does not appear to largely contribute to phosphorus loading. The septage, however, has very high concentrations of phosphorus. In 2015, the District received about 7,000,000 gallons of septage. At an average concentration of 107.21 mg/L, this equates to about 6,500 lbs. At an average daily flow of 7.3 MG and an average influent phosphorus concentration of 3.65 mg/L, the annual loading of phosphorus to the plant equates to about 81,000 lbs. This means that septage contributes about 8% of the phosphorus loading. It is recommended that the District reviews the costs charged to septic haulers if chemical phosphorus removal is implemented.

Table 3: Potential Significant Phosphorus Contributors

	Name	gpd	mg/l req.	User Type	P Sources	P Reduction
1	DuPage Judicial Building	8,904	29.92	Court House	Cleaning products	Low
2	Wheaton College Ave LLC	11,753	22.67	Apartments	Household detergents/soaps	Low
3	Board Of Education	11,918	22.36	High School	Cleaning products	Low
4	Septage Receiving	20,000	13.32	Domestic	Household detergents/soaps	Low
5	GC Real Estate LLC	25,268	10.54	Retail	???? Vacant	Low
6	George Koufos	25,951	10.27	Strip Mall	Cleaning products	Low
7	Wheaton 121 Owner, LLC	26,093	10.21	Apartments	Household detergents/soaps	Low
8	Wheaton College Ave LLC	32,932	8.09	Apartments	Household detergents/soaps	Low
9	DuPage Power Plant	49,241	5.41	Power Plant	Cooling towers	Low
10	DuPage Power Plant	50,718	5.25	Power Plant	Cooling towers	Low
12	Roundy's Supermarket	13,334	19.98	Supermarket	Cleaning products	Medium
13	Wheaton Care Center	14,178	18.79	Nursing Home	Cleaning products	Medium
14	Marionjoy / Franciscan	14,967	17.80	Hospital	Cleaning products	Medium
15	Wheaton Sports Center	23,471	11.35	Gym	Cleaning products	Medium
16	Dung & Doan	9,170	29.06	Strip Mall	Car Wash	High
17	Circuitronics, LLC	18,019	14.79	circuit board mfr.	Metal finishing products	High
18	DuPage County Facilities Management	81,518	3.27	Jail	Cleaning products	High

2.2 Cost-Effectiveness of Implementing Local Limits on Influent Sources w/ Excessive P

Currently Wheaton does not have a phosphorus limit to use for enforcement purposes. This means that if a user is identified to have a high phosphorus loading to the WWTP, the District does not have the ability to enforce or implement any pretreatment. It is recommended that an Local Limits evaluation be completed, allowing the WWTP to adopt an appropriate enforceable phosphorus limit.

A Local Limits Evaluation with collection system sampling and analysis in line with state and federal standards can range from $25,000 - $35,000 on average. While this study may not results in an appreciable decrease in influent phosphorus loading, it provides the mechanisms for enforcement and a baseline understanding of the collection system and loading sources.

2.3 Permitting and Sampling for Significant Contributors Recommendations

The Wheaton Sanitary District sampled effluent from the seven potential significant contributors identified in Table 3 of Page 8. Users which had been identified as having a medium or high potential to be a significant contributor were sampled and average phosphorus concentrations recorded.

Through this sampling, only two were found to contribute over the 1% threshold as a significant contributor – Dung & Doan car wash and the DuPage County jail and facilities. The concentration required to meet the threshold for the car wash was 29.04 mg/L phosphorus, and the sample result was 41.6 mg/L. The concentration required to meet the threshold for the County facility was only 3.27 mg/L due to very high flows, and the actual recorded effluent concentration was 5.2 mg/L.

The County facility effluent phosphorus level of 5.2 mg/L is indicative of typical domestic strength waste, and would be difficult to reduce from a best management practices or treatment standpoint. Sewer Use Ordinance levels for phosphorus are typically found to be 10 mg/L or higher to avoid targeting typical domestic strength waste. Therefore, it is recommended that a review of products used in the County facilities be performed, and any cleaning products can be substituted with zero or low phosphorus comparable products.

The results of the car wash sampling are significantly higher than all others analyzed. The effluent concentration of 41.6 mg/L presents an opportunity to engage with the user and determine whether a reduction can be made. It is likely that cleaning products in the car wash process contribute to this level. These products can either be substituted with low phosphorus products. Alternatively, if the District performs a Local Limits Evaluation, a level/surcharge system may be implemented. This may allow, for example, effluent phosphorus up to 10 mg/L, over which a surcharge is incurred per pound discharged. A limit would also be instituted setting the point in which a user is in violation of the Sewer Use Ordinance.

2.4 Community Education and Outreach Recommendations

Table 4: Recommendations for Phosphorus Reduction

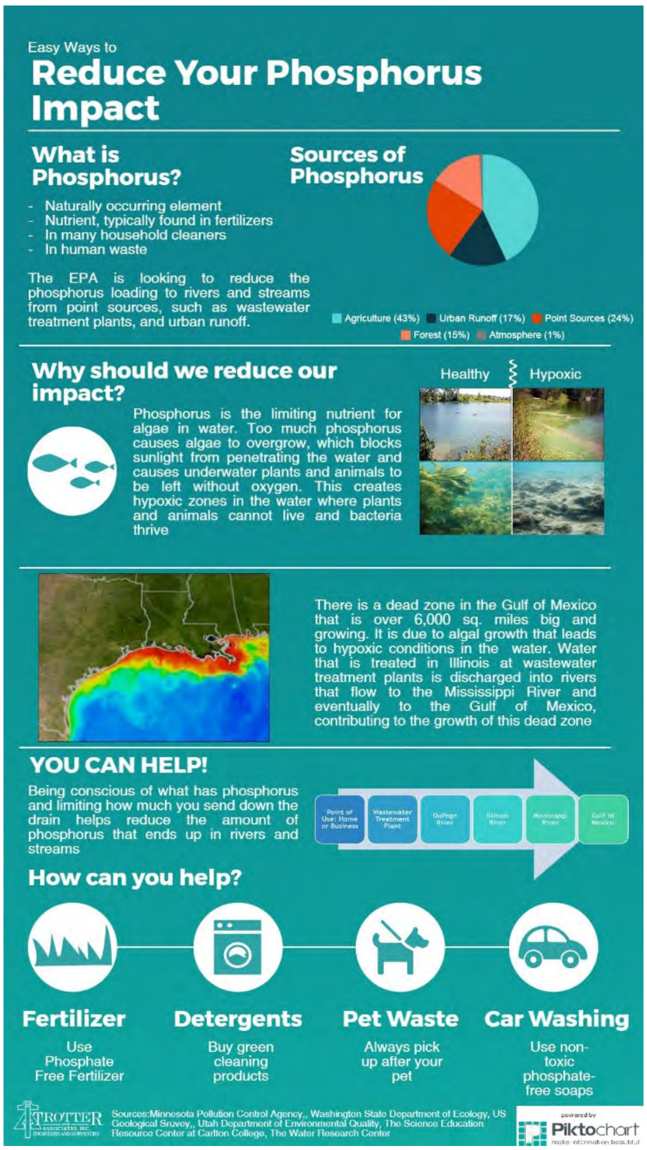
Phosphorus Contributors	Tips to Reduce Phosphorus
All Business Users— **Industrial, Commercial and Institutional** Including agricultural co-ops, car/truck washing facilities, dairies, food processing plants, meat packing and locker plants, metal finishing facilities, municipal water treatment plants that add phosphorus to drinking water, nursing homes, restaurants, schools and other businesses or institutions with phosphorus sources.	**Cleaning & Sanitizing** • Establish purchasing criteria for cleaning products • Use low or non-phosphorus cleaners and detergents • Use proper concentrations of cleaners and detergents • Use cleaners and detergents as directed by manufacturer • Do not accept sample cleaners from vendors
Industrial / Metal Finishers	**Metal Preparation, Finishing & Painting** • Evaluate low- and non-phosphorus systems • Reuse water where it will enhance cleaning • Maintain proper levels of phosphate in the bath • Keep process solutions in their tanks by reducing carryover • Use deionized reverse osmosis water for process baths and rinses • Ensure all process controls are properly set, calibrated and maintained • Keep spray nozzles cleaned and maintained
Industrial / Food Processors Including dairies, meat packing and locker plants.	**Food Processing** • Keep food by-products off the floor and out of drains • Use dry cleanup practices prior to wet cleaning • Reduce spills, leaks and tank overflows • Use an automatic clean-in-place (CIP) system • Reuse food by-products for animal feed, composting or land spreading

Phosphorus Contributors	Tips to Reduce Phosphorus
Municipal Sources	• Institute environmentally preferred purchasing with policies to limit phosphorus containing products for your municipal operations • Institute a public education campaign to raise awareness about phosphorus issues and sources • Optimize the addition of phosphorus to the drinking water supply to prevent pipe corrosion. • Evaluate the use of water treatment plant filter backwash residuals as a possible mechanism for phosphorus removal at the WWTF • Optimize storm water management policies, such as minimizing run-off from parking lots and other surfaces
Domestic	• Purchase only non-phosphorus dishwashing liquids, laundry detergents and soaps **Prevent phosphorus from entering storm sewers** • Wash the car on the lawn to prevent phosphorus-laden rinse water from running into stormwater sewers • Collect organic material (leaves, grass clippings, etc.) from street drains and gutters. Check fall leaf pick-up dates to take advantage of composting services • Use phosphorus-free lawn fertilizer • Restore natural shoreland or streambank habitat to prevent phosphorus-laden runoff from entering surface water • Use lawn mowers that chop up grass clippings and leave them on the lawn. These mulching mowers reduce the need for fertilizers

2.5 Summary of Influent Reduction Strategies

Through a comprehensive sampling and evaluation program it was determined that only two dischargers within the District's collection system may be contributing greater than a 1% daily phosphorus load to the wastewater treatment facility. In light of there only being two potentially significant discharge within the collection system, it would not be cost effective to permit the users independently on the basis of phosphorus. It is recommended that a Local Limits Evaluation be performed to evaluate the loading capacity of various constituents into the treatment facility, including phosphorus.

Figure 1: Influent Reduction Measures for Community Education



Following this evaluation, a level/limit surcharge system could be implemented. For example, the level limit surcharge system would charge dischargers a per-pound fee for high strength waste over 10.0 mg/L phosphorus. This surcharge would be incurred for discharge concentrations up to 30 mg/L phosphorus, for example, at which point a limit is reached and a violation would be issued. This allows dischargers to avoid cost-prohibitive pretreatment systems while still funding the costs incurred at the WWTF in treating the phosphorus.

It is also recommended that the District continue its community education program with regards to the influent phosphorus reduction initiatives. The District has published means and methods for reducing citizen's phosphorus footprint on the District's website. This education component is low-cost and should be continued.

3. Effluent Reduction Strategies (Plant Optimization)

3.1 Existing System Data and Design Overview

The Wheaton Sanitary District's WWTF was designed to treat influent with characteristics identified in Table 5 below. The comparison of the current loadings to the design loadings is included in Table 6. The plant is currently running at about 82% of its design capacity on a flow basis. The effluent reduction strategies outlined in this plan are based on means and methods to reduce phosphorus discharge at current loading, not design. This is because these methods are intended to be implemented within one year of the submittal date of this report. The Phosphorus Removal Feasibility Study, completed in parallel with this optimization plan, utilize design data for the plant in determining the best methods for meeting future phosphorus discharge limits.

Table 5: WSD Design Loading Conditions

Parameter	Basis of Design
Design Average Flow (MGD)	8.9
Design Maximum Flow (MGD)	19.1
BOD_5 Loading (lbs/day)	15,142
TSS Loading (lbs/day)	17,814

Table 6: Current Influent Loadings

Parameter	Unit	Current Condition	Design Condition	Percent of Design
Flow	MGD	7.3	8.9	82%
BOD5	lbs/day	11,263	15,142	74%
TSS	lbs/day	14,064	17,814	79%
NH3-N	lbs/day	1,157	1,633*	71%
Phosphorus	lbs/day	214	297*	72%

**Based on TKN of 33 mg/L and TP of 4 mg/L due to 11% increase in BOD concentration between current and design values*

3.2 Summary of On-Site Analysis

The plant is running as designed. It has been well maintained and kept up to date. The District has not had any issues meeting permit limits in the recent past. The District employs preliminary, primary, secondary, tertiary treatment, and disinfection. In order to utilize the current processes for phosphorus removal, changes can be made to the current primary or secondary treatment processes. Table 7 on the following page illustrates the methods required for evaluation by the IEPA, and the means in which this reduction method could be implemented by the District.

Table 7: NPDES Required Effluent Reduction Measures to Evaluate

	Effluent Reduction Measure from NPDES Permit	Implementation Method
A.	Adjust the solids retention time for biological phosphorus removal.	Reduce SRT to promote BPR in aeration basins while maintaining nitrification
B.	Adjust aeration rates to reduce DO and promote biological phosphorus removal.	Reduced DO to promote BPR in aeration basins while maintaining nitrification
C.	Change aeration setting in plug flow basins by turning off air or mixers at the inlet side of the basin system.	Creation of an anaerobic zone in the front end of the aeration basins by adding a valve and baffle wall to the system while maintaining nitrification
D.	Minimize impact on recycle streams by improving aeration within holding tanks.	There are no holding tanks for recycle streams at the WWTP therefore this is not a viable option
E.	Adjust flow through existing basins to enhance biological nutrient removal.	This is not hydraulically feasible
F.	Increase volatile fatty acids for biological phosphorus removal.	Return WAS to the primary clarifiers to increase VFAs earlier in the process

Of the six methods suggested for evaluation in the NPDES permit, four of them are feasible for implementation at the Wheaton Sanitary District. The two that are not feasible are method D, adjusting aeration in recycle stream holding tanks, and E, changing the flow pattern in the aeration basins.

Method D is not feasible because the District does not have any holding tanks for their recycle flow. The construction of new tanks for side stream treatment is considered a capital improvement as was evaluated as part of the phosphorus removal feasibility study. In order to evaluate the impact of side stream phosphorus reduction on the overall plant performance, a small chemical feed was considered.

Method E also is not feasible. A hydraulic capacity analysis of the plant was completed by TAI in 2015. Based on the results of this study, there is no room for an increase in friction that would lead to a loss of freeboard at design maximum flows. Changing the flow pattern within the current basins, such as creating a serpentine pattern throughout the basins, would increase the head loss due to friction, as well as increase the velocity of flow through the basins. This would lead to a reduction in freeboard which creates potential for flat watering over the weirs or flooding the basins at high flows.

Results of the evaluation of methods A-C, as well as F, can be found on the following pages.

3.3 Unit Process Phosphorus Removal Capabilities

Typically, phosphorus can be removed in one of two ways in a wastewater treatment plant. The first and most common way is settling out of any non-soluble phosphorus in the solids removal process. The second, and less common, is for soluble reactive phosphorus to be converted to its insoluble form throughout the biological process and removed in secondary settling and tertiary treatment. In order for this to occur, the biological process can be optimized to promote the conversion of soluble phosphorus. The existing biological process was evaluated in order to determine if there were any low-cost practical methods to modify the current operating parameters in order to promote this conversion.

3.4 Process Modeling and Simulation of Existing System

The primary tool used in the analysis of the facility was the wastewater treatment modeling software BioWin™, from developer EnviroSim™. BioWin™ is the leading wastewater treatment modeling software in the industry today. It incorporates widely accepted physical, biological, and chemical principles to predict flows and loadings throughout a treatment system given influent and assumed parameters.

Several models were developed for the District to analyze various loadings to the plant with the existing infrastructure in place at current conditions. These models were calibrated and compared to current flows and loadings and then modified to predict the capabilities of the alternatives being considered.

Calibration

In order to provide a basis of comparison for process alternatives, the existing process was modeled to reflect the current flows and loadings to the plant in order to ensure that it was reasonably accurate. Recycle flows from the sludge stabilization processes were determined from historical plant operating data. Figure 1 on the following page displays the BioWin™ model of the Wheaton Sanitary District with current infrastructure. BioWin is used as a representative biological process model, and therefore does not include tertiary filtration or disinfection.

Table 8 on the following page illustrates the final effluent values that the model generated, compared to the known values from lab data. Based on this information, it was determined that the model was properly calibrated and is running similarly to the actual WSD plant. The model was then manipulated in various ways based on the methods recommended by the IEPA to optimize phosphorus discharge to determine if the plant would benefit from these process changes.

Figure 2: BioWin™ Model for Current Plant Operations

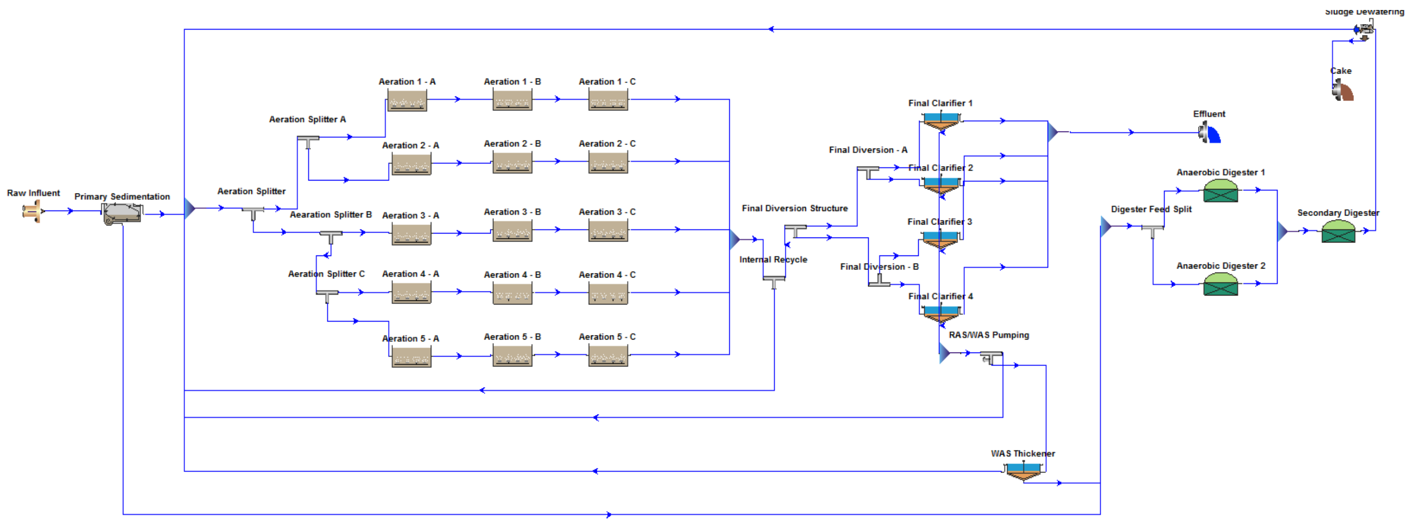


Table 8: BioWin™ Calibration Results

	BioWin™ Model	Average Effluent Values
BOD (mg/L)	1.14	0.44
TSS (mg/L)	2.01	2.76
NH_3 (mg/L)	0.08	0.49
TP (mg/L)	2.27	2.04
TN (mg/L)	20.66	21.22

The model was calibrated such that the predicted effluent water quality closely reflected actual plant lab data. For modeling purposes, each of the aeration basins was split into three subsections in order to simulate differences in reactions in the upstream end, middle, and downstream end of each tank. This allows for more accurate results, as well as helps retain consistency in the model when it is manipulated to simulate various biological phosphorus removal processes. Table 9 below lists the values utilized during the BioWin™ evaluation.

Table 9: Average Values Used for Modeling

	BioWin™ Model
Flow (MGD)	7.3
Temperature (°C)	16
SRT (days)	22
MLSS	2500
TSS (mg/L)	231
BOD (mg/L)	185
TKN (mg/L)	30
TP (mg/L)	3.65

3.5 Existing Process Evaluation for Phosphorus Reduction

Biological treatment varies greatly based on the temperature. Additionally, the ammonia limits set by the IEPA for the Wheaton Sanitary District vary seasonally. The current biological process is used for nitrification of ammonia to nitrates. When discharged directly to a stream, ammonia can be harmful for aquatic plant and animal life. For this reason, an ammonia limit has been enforced.

When determining the feasibility of process modifications for increased phosphorus removal, it is important to account for the consequences of these changes on other process parameters, specifically effluent ammonia levels. Nitrification occurs with high dissolved oxygen levels at longer solids retention times. Biological phosphorus removal occurs when areas with little to no dissolved oxygen are implemented. It also is more likely are shorter SRT's. Table 10 outlines the average monthly temperature over the past three years, as well as the ammonia limit that corresponds with that month. The effect of temperature was considered in the evaluation of various process modifications, as well as the change in ammonia levels.

Table 10: Average Influent Temp and Ammonia Limits by Month

	Avg. Temp	NH_3 Monthly Avg	
	°C	(mg/L)	(lbs/day)
Jan	13	4.0	297
Feb	11	4.0	297
Mar	10	1.8	134
Apr	11	1.5	111
May	13	1.5	111
Jun	15	1.5	111
Jul	17	1.5	111
Aug	18	1.5	111
Sept	20	1.5	111
Oct	19	1.5	111
Nov	17	4.0	297
Dec	15	4.0	297

3.5.1 Solids Retention Time

One way to increase the update of phosphorus in the aeration basins is to reduce the solids retention time (SRT), however, this also can affect the nitrification process. In order to assess the feasibility of reducing the phosphorus in the effluent through a shorter SRT the BioWin™ model was used. The process is temperature dependent, therefore the minimum SRT will vary at different temperatures. The effluent ammonia limits also varies throughout the year, so the process optimization recommendations will vary based on the typical temperature throughout the year.

Table 11: Impact of SRT Reduction on Effluent Phosphorus and Ammonia

Temp	SRT	WAS	MLSS	Effluent P		Effluent NH_3	
°C	Days	MGD	mg/L	mg/L	lbs	mg/L	lbs
Avg: 16	22	0.06	2480	2.27	138.33	0.08	4.84
9	5.5	0.25	917	2.13	129.67	4.01	244.31
	10	0.10	1495	2.14	130.51	0.25	15.03
20	2.5	0.56	466	2.08	126.41	1.36	83.07
	5.5	0.25	859	2.15	130.77	0.10	5.92

The BioWin™ model was used to evaluate the impact of an SRT reduction at various temperatures would have on both phosphorus and ammonia levels in the effluent. The minimum SRT was found that the District could run without surpassing their ammonia limits due to decreased nitrification at shorter SRTS. Additionally, the wasting rate and solids handling capacity of the plant was taken into consideration. Table 10 illustrates the results. From this, it was determined that there would be less than 10% reduction in phosphorus, even in the most extreme cases. In order to create this reduction, nitrification would be sacrificed and the solids handling process would be overloaded, reducing the volatile solids reduction. Based on the total digester volume of 760,985 gallons, and a design SRT of 12 days, the total flow to the digesters cannot exceed 63,000 gallons/day. Based on these results, a change in SRT alone is not a viable option for plant optimization for phosphorus removal.

3.5.2 Reduction of Dissolved Oxygen Concentration

Research has shown that a reduction in oxygen available for microorganisms in the secondary treatment processes has potential to lead to an increase in phosphorus uptake by the phosphorus accumulating organisms. Typically if this occurs, more phosphorus will leave with the solids in the WAS. However, there must still be available oxygen to completely nitrify in order to meet effluent ammonia limits. Additionally, to produce the most dramatic results in phosphorus reduction, an anaerobic zone must be implemented. Table 12 demonstrates the effect of reducing the dissolved oxygen available to microorganisms in the mixed liquor. The results of this were determined to be inconsequential due to the necessity of maintaining dissolved oxygen for nitrification.

Table 12: Results of Reduced Dissolved Oxygen in the Aeration Basins

Temp	D.O	Effluent P		Ammonia N	
°C	mg/L	mg/L	lbs	mg/L	lbs
9	1.0	2.24	136.71	0.27	16.63
	0.5	2.25	137.14	0.68	41.54
	0.2	2.27	138	14.36	874.32
16	1.0	2.23	136.1	0.12	7.56
	0.5	2.24	136.18	0.18	11.14
	0.2	2.23	136.06	1.25	76.23
20	1.0	2.25	136.61	0.09	5.64
	0.5	2.24	136.67	0.12	7.22
	0.2	2.24	136.52	0.45	27.22

3.5.3 Anaerobic/Anoxic Zone Implementation

A proven method of phosphorus reduction is the implementation of an anaerobic zone. In this zone, microorganisms are starved of oxygen, causing an increase in the phosphorus accumulating organism population. Once oxygen is reintroduced, luxury uptake will occur as organisms use phosphate as a food source and then settle out with the WAS. The results from modeling of this scenario are displayed in Table 13.

Table 13: Impact of Baffle Wall Construction for Anaerobic Zone Implementation

33% Volume: Anaerobic, 67% Volume: D.O 2 mg/L					
Temp	SRT	Effluent P		Ammonia N	
°C	days	mg/L	lbs	mg/L	lbs
16	22	2.03	123.83	0.12	7.44
16	16	1.97	120.2	0.16	9.56
9	14	1.89	114.84	0.79	48.33
9	12	1.71	104.23	1.08	65.87
20	14	1.92	116.63	0.13	7.98
20	12	1.75	106.52	0.14	8.81

This method was by far the most effective in reduction of phosphorus from the effluent when using solely biological methods, however, it is also the most complex and requires not only process changes, but construction of a baffle wall and installation of automatic valves on the aeration headers. With this method implemented, the District will see about a 15% drop in effluent phosphorus levels. In order to see the largest reduction in phosphorus, the SRT must also be reduced. The District currently typically runs with an SRT between 17 and 22 days. If the SRT is reduced to 12 days, a 25% reduction in effluent phosphorus is possible with this method, however there is an impact on the nitrification of ammonia at lower SRTs, especially at lower temperatures. During winter months the ammonia limit is higher, however, careful monitoring would need to occur in March when the ammonia limit is 1.8 mg/L and temperature is still typically less than 12°C. A longer SRT may be necessary to meet ammonia limits.

Table 14: Equipment Cost Estimate for Anaerobic Zone Implementation

Description	Quantity	Unit	Unit Price	Total
ANAEROBIC ZONE IMPLEMENTATION				
Equipment				
Anaerobic Mixers	5	Each	$32,400	$162,000
FRP Baffle Walls	5	Each	$30,706	$153,531
Diffuser Removal and Capping	5	Each	$7,500	$37,500
Installation				
Anaerobic Mixers Installation	5	Each	$10,000	$50,000
FRP Baffle Wall Installation	5	Each	$12,000	$60,000
General Conditions				$115,758
SUBTOTAL				**$578,789**
Contingency	20%			$57,879
TOTAL COST				**$636,668**

Further analysis of the potential to implement an anaerobic zone at the WSD WWTP led to the conclusion that the costs are beyond the scope of optimization, and therefore, it is not recommended. The potential costs are outlined in Table 14, above.

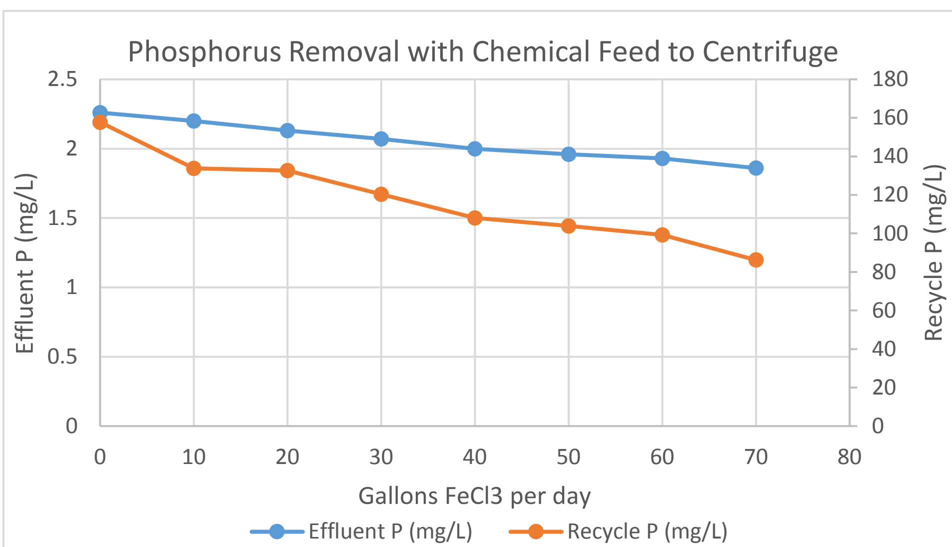
3.5.4 Iron Salts in Dewatering

An additional method that was considered is the potential to reduce phosphorus loading in the recycle streams coming from the centrate, where pollutant concentrations are typically high. If a holding tank for the recycle were utilized, there would be potential to change the tank process parameters, however this is not an option at this time because there is no tank available. In order to combat the high phosphorus loading that is recycled through the plant, chemical addition to the recycle stream could be used. The capital investment in the equipment for a small sidestream treatment feed is much lower than the costs for implementing a chemical feed for the entire process flow. There is typically a building available for storage. There is also no impact on the process flow when the chemical dose is prior to dewatering so the potential for complications due to increased solids is eliminated. The chemical addition also should be lower than that necessary to treat the entire process flow. Additionally, ferric chloride has similar properties to polymer that is used for dewatering. This could lead to a reduction in the polymer demand, leading to a long term savings in chemical costs. The results of a small chemical feed to the recycle stream are summarized in Table 15. It was found that the reduction had a linear relationship with the amount of chemical added, therefore was only modeled up at 70 gpd. Based on this, it would require 140 gallons of ferric daily in order to remove all of the phosphorus in the recycle stream and reduce the effluent phosphorus by about 36% to around 90 lbs or 1.45 mg/L.

Table 15: Impact of Chemical Addition to Recycle Stream

FeCl3 Addition Prior to Digestion				
FeCl3	Effluent P		Recycle P	
gpd	mg/L	lbs	mg/L	lbs
0	2.26	134.95	157.50	55.12
10	2.20	132.43	133.73	48.33
20	2.13	129.79	132.63	43.30
30	2.07	125.77	120.28	39.32
40	2.00	121.77	107.97	35.27
50	1.96	199.56	103.95	32.52
60	1.93	117.36	99.29	30.89
70	1.86	113.29	86.21	27.56

Figure 3: Change in Phosphorus Concentration with Ferric Chloride Addition



The cost associated with implementation of a ferric chloride feed is high because ferric is highly corrosive. Therefore, it must be stored in a building on its own if it is not stored outside in heated tanks. The construction costs for the building and equipment are beyond the scope of plant optimization. An alternative option would be to use aluminum sulfate (alum) rather than ferric chloride. Alum is not corrosive and can be stored in the dewatering building if there is space. If alum is selected, twice the amount of chemical would need to be used. This equates to about 280 gallons/day. The District would need to provide at least two weeks storage so a 4,000 gallon tank would be required. Capital Improvements of this nature would be considered beyond the scope and scale of an Optimization Plan, and will be further reviewed in the Phosphorus Removal Feasibility Study.

3.5.5 Primary Clarifier Conversion to Activated Primary Clarifier for VFA Production

Another method of plant optimization would be to return the WAS to the primary clarifiers. This could be effective in increasing the concentration of volatile fatty acids (VFAs) to the biological process. VFAs are the preferred food of phosphorus accumulating organisms (PAOs). When exposed to VFAs, the PAOs break the phosphorus bonds within themselves to release energy which is used to convert VFAs for storage. When exposed to enough VFAs, the PAOs will become stressed because they will release their ortho-phosphate in an effort to use the energy from this release to transform the VFAs. When exposed to higher dissolved oxygen, the PAO's will over-react and go into "luxury phosphorus uptake", during which they will accumulate more phosphorus than they previously stored to restore their chemical energy storage.

In order to test the potential to increase the VFA production in the process at the WSD WWTF, the BioWin™ model was used to model the results of returning some or all of the thickened WAS to the head of the primary clarifiers. By adding activated sludge to the primary clarifiers, they are "activated" and therefore, should produce more VFAs in the primary process. However, this method did not appear to be effective in the model. No changes in the VFA concentration were indicated by the model, however, it may be effective in the field.

3.6 Summary of Plant Optimization Strategies

Seven methods for effluent reduction through plant optimization were reviewed within this study. These methods included:

i. Adjust the solids retention time for biological phosphorus removal.
ii. Adjust aeration rates to reduce dissolved oxygen (D.O.) and promote biological phosphorus removal.
iii. Change aeration setting in plug flow basins by turning off air or mixers at the inlet side of the basin system.
iv. Minimize impact on recycle streams by improving aeration within holding tanks.
v. Adjust flow through existing basins to enhance biological nutrient removal.
vi. Increase volatile fatty acids for biological phosphorus removal.
vii. Side stream treatment using small chemical feed

Of those, three were found to be ineffective in the removal of phosphorus; adjustment of the solids retention time in the biological process, reducing the dissolved oxygen within the aeration basins, and activating the primary clarifiers to produce additional volatile fatty acids. Further, two of the methods are not feasible due to the lack of specific infrastructure necessary to implement them at the District's facility; aerating side-stream holding tanks, and adjusting the flow patterns of the aeration basins.

Addition of iron salts to the recycle stream from the dewatering process was found to remove a small amount of phosphorus, however building space for locating chemical and equipment does not exist and would have to be constructed. This is outside the scope of an optimization measure and will be further evaluated in the Phosphorus Removal Feasibility Study.

The sole optimization strategy that did prove to be effective was creating an anaerobic zone upstream of the nitrification basins. This measure was found to reduce effluent phosphorus concentrations by as much as 40% with one-third of the basin being converted to anaerobic. The anaerobic basin would provide approximately five hours of hydraulic retention time, which may result in nuisance odors and generation of filamentous materials. A typical hydraulic retention time of two hours was reviewed for the anaerobic basin and found remove approximately 15% of the phosphorus from the effluent. The capital cost for implementation of the anaerobic zones, including baffle walls and mixers, was estimated at over $636,000. This is considered outside the scope of an optimization measure and would likely be removed as part of the District's long-term phosphorus removal strategy. Therefore, it is not recommended that the District implement any of the effluent reduction measures at this time.

4. Summary and Implementation Plan

Further reduction of effluent phosphorus concentration in the existing Wastewater Treatment Facility was reviewed at length. This included the methods recommended in the District's NPDES Special Condition, as well as other potential measures identified by the District and TAI. Of the seven optimization measures reviewed, two were infeasible and three were found to be ineffective. While chemical addition to the filtrate recycle stream provides a nominal benefit, there is no infrastructure in place to house chemical storage and metering equipment. Finally, implementation of an anaerobic zone in the existing nitrification basins was moderately effective, but had a capital cost over $600,000, which is outside the scope of an optimization measure and was further reviewed in the Phosphorus Removal Feasibility Study.

Following this evaluation, a Local Limits Evaluation and subsequent level/limit surcharge system could be implemented. For example, the level limit surcharge system would charge dischargers a per-pound fee for high strength waste over 10.0 mg/L phosphorus. This surcharge would be incurred for discharge concentrations up to 30 mg/L phosphorus, for example, at which point a limit is reached and a violation would be issued. This allows dischargers to avoid cost-prohibitive pretreatment systems while still funding the costs incurred at the WWTF in treating the phosphorus.

The District currently removes approximately 40% of the influent phosphorus through the treatment process. The plant has been optimized to remove as much phosphorus as possible, while not jeopardizing nitrification or other effluent limits. It is recommended that the District continue the education and community outreach programs to continue reducing influent loading, however the treatment facility is removing as much phosphorus as possible and practical at this time. Further reductions to 1.0 mg/L, 0.5 mg/L and 0.1 mg/L effluent phosphorus will be reviewed in the Phosphorus Removal Feasibility Study.

The Wheaton Sanitary District supports and is an active member of several organizations dedicated to studying and solving watershed nutrient issues. The Illinois Association of Wastewater Agencies (IAWA) represents more than 50 municipalities and Sanitary Districts throughout the state. IAWA's efforts include a legislative initiative which works with elected representatives to shape the future of nutrient removal strategies in order to provide sustainable, attainable goals for watershed improvements. The DuPage River Salt Creek Workgroup (DRSCW) is similarly comprised of 45 municipalities and Sanitary Districts, within the East and West Branch DuPage River and Salt Creek watersheds. The DRSCW formed in 2005 to compile comprehensive data sets within these watersheds and implement targeted activities that resolve waterway problems. Both organizations have been instrumental in shaping the direction of nutrient removal efforts. The Wheaton Sanitary District has been at the forefront of both organizations, including serving as the current Vice President of the DRSCW, as well as providing significant financial support. It is recommended that the District continue to support these organizations and their efforts in targeted, sustainable, nutrient reduction measures.

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