Nutrient Assessment Reduction Plan (NARP)

City of Vandalia, IL

Submitted by:

Milano & Grunloh Engineers, LLC
114 W. WASHINGTON AVE. │ P.O. BOX 897
EFFINGHAM, IL 62401
Telephone: (217) 347-7262

Milano & Grunloh Engineers, LLC
engineering | surveying

Table of Contents

INTRODUCTION

Purpose

In an effort to reduce nutrient discharge from point sources, the State of Illinois has, as a part of their National Pollutant Discharge Elimination System (NPDES) permitting program, begun requiring all publicly owned treatment works (POTWs) classified as major contributors to develop a Nutrient Assessment Reduction Plan (NARP). This requirement is limited to POTWs permitted to discharge ≥1 MGD to a receiving body of water which is listed as impaired or at "Risk of Eutrophication" (RoE) in accordance with section 303(d) of 40 CFR 130.7 commonly referred to as the Clean Water Act (CWA). In lieu of a NARP, POTWs may join a Watershed Action Group whose stated objective is the reduction of nutrient discharge within the basin.

The intent of the NARP is to identify methods to reduce nutrients, specifically phosphorus and nitrogen, that increase algal growth in waterways, in turn reducing the amount of Dissolved Oxygen (DO) available in the body of water, be it a lake, stream, or river. Increased algae is detrimental to intended uses such as fishing, boating and swimming, while low DO impacts aquatic life. As all of Illinois eventually drains to the Mississippi River, nutrient loading is also a major contributor to the Gulf of Mexico Hypoxic Zone; an area of decreased DO in the northern gulf known as the "dead zone". The Gulf Hypoxia Task Force has developed an action plan to reduce the dead zone to 1,900 square miles by 2035 from its current 5-year average of 4,347 square miles. This requires partnership with individual states in the Mississippi River Basin and is a driving factor behind the development of the NARP.

As the Middle Kaskaskia Creek Watershed does not contain a Watershed Action Group, the City of Vandalia has hired Milano and Grunloh Engineers to develop a NARP to meet the requirements stated in the NPDES for their Sewage Treatment Plant (STP).

NARP Development

The Middle Kaskaskia Watershed is a drainage basin identified by Hydrological Unit Code 8 (HUC8) HUC07140202 and is contained primarily in the Illinois counties of Fayette, Clinton, Marion and Washington. The City of Vandalia is located in the central portion of this watershed in the Suck Creek-Kaskaskia River sub-basin (HUC071402020604) with the STP discharging to the basin's namesake receiving stream.

The Suck Creek - Kaskaskia River was not listed as impaired for the 2020/2022 303(d) listing. The City of Vandalia STP is located across the interstate from the outfall into Suck Creek, which is a tributary to the Kaskaskia River. The Kaskakskia river is documented as impaired at this location for Aldrin, Dieldrin Endrin, Heptachlor, Mercury, Mirex, Toxaphene, (all pesticides), and Fecal Coliform but not for any nutrient based impairments. Lake Carlyle to the south of the reach identified as IL_ROA is listed on the 2020/2022 303(d) listing as impaired for Total Phosphorus (TP) though fully supports aquatic life. The reach to the south of Lake Carlyle labeled IL_O-08 is listed as impaired aquatic life due to both Dissolved Oxygen (DO) and Total Phosphorous (TP) levels. Figure 1 displays the Middle Kaskaskia Watershed (HUC8) and major waterways, while Figure 2 shows the Suck Creek-Kaskaskia River (HUC12) and all tributaries.

Figure 1: Middle Kaskaskia River

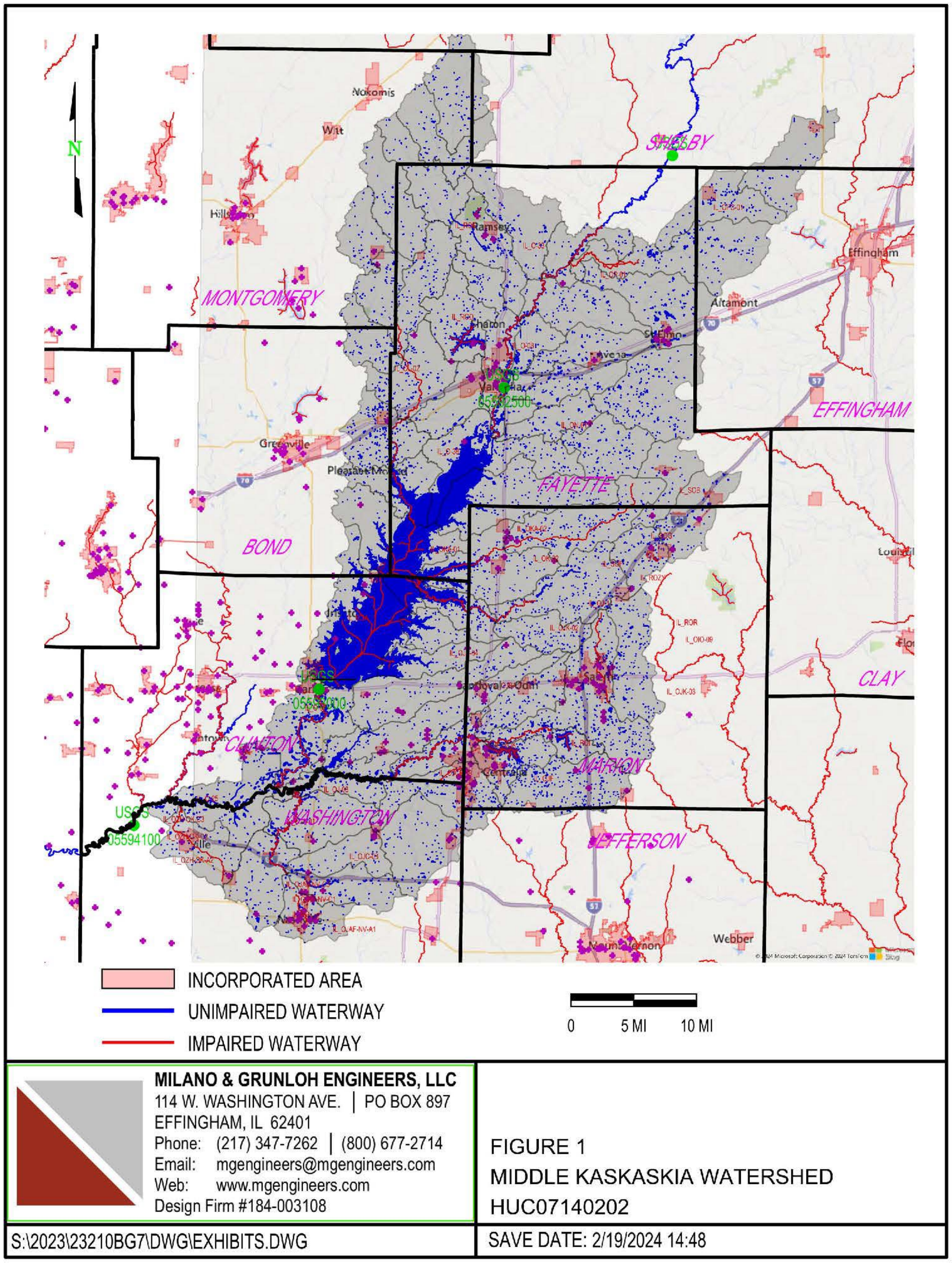
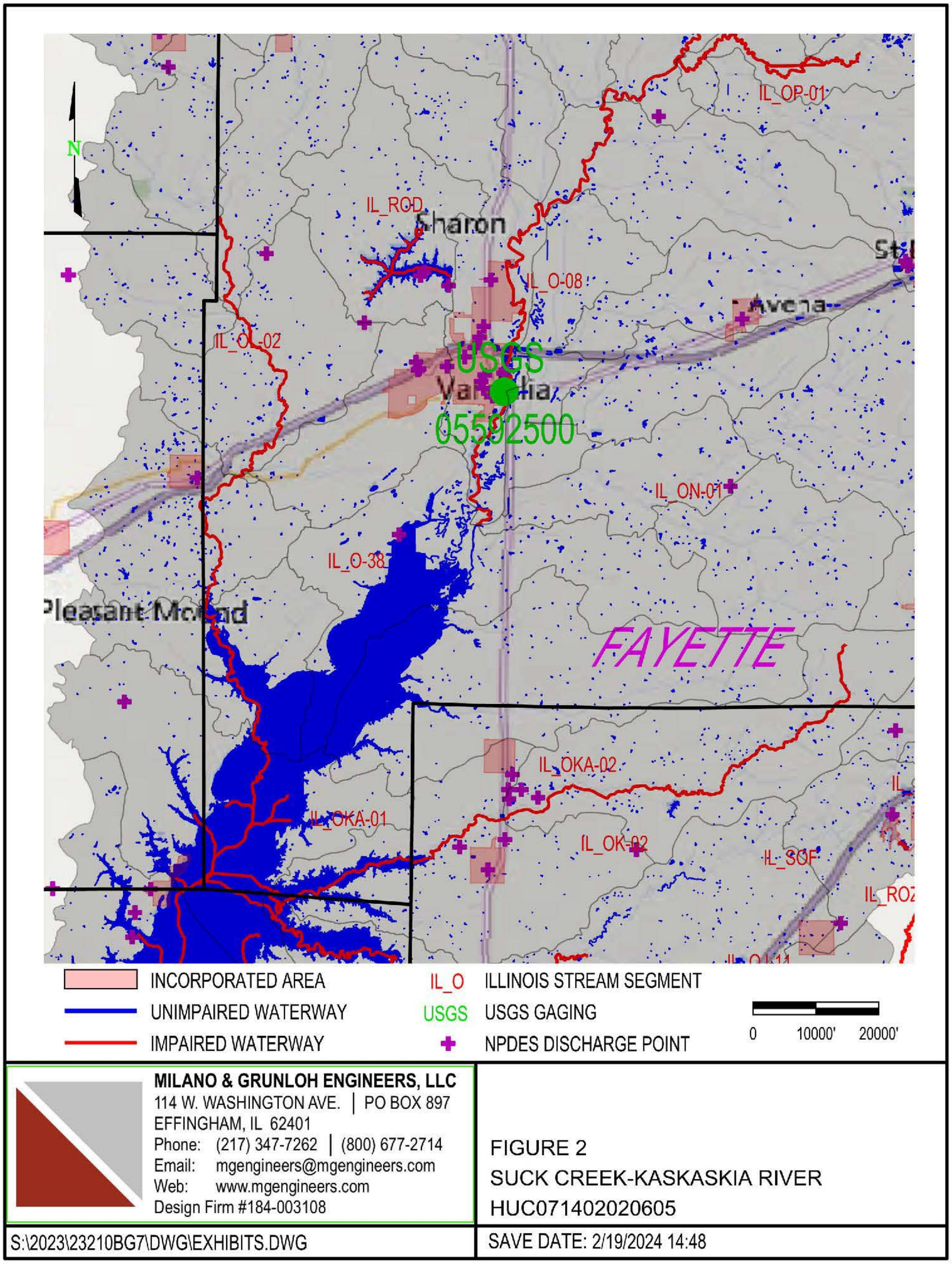


Figure 2: Suck Creek Kaskaskia River



The NARP was developed along the following procedures as indicated by the IEPA language in the NPDES permit. The development process is linear, with each step requiring completion prior to moving to the next step. The process is demonstrated below in Figure 3.

Figure 3: Nutrient Assessment Reduction Plan Development Strategy

Milano and Grunloh worked with the city to develop an achievable strategy to develop and implement the NARP by identifying current flows and concentrations, discussing potential outcomes and obstacles, determining objectives of the plan, setting realistic targets for objectives, and reviewing the completed plan.

A. NARP Objectives

The objectives required for the NARP directly support the development strategy. The objectives developed are as follows:

Objective 1:

Determine the extent and source of impairment in the receiving stream. Establish realistic nutrient discharge targets to improve stream quality and protect non-impaired portions of the water body.

The NARP is intended to be used as a tool to assist in evaluation of the receiving stream. While neither Suck Creek-Kaskaskia River nor the Middle Kaskaskia River is considered impaired due to nutrient loading, monitoring is limited within this waterbody and additional monitoring is expected to further the understanding of the cause of Dissolved Oxygen and Phosphorous impairments in the lower reaches, and whether the upper reach is in danger of developing impairments of this nature.

Objective 2:

Examine current discharge concentrations, evaluate their impact, and determine appropriate steps to reduce the amount of nutrients released.

A baseline discharge quantity for nutrients will be developed using the STP historical data to include a rolling 12-month average to determine possible reduction amounts. This data will be examined with the current stream data to gain a better understanding of the impact of the nutrients on the receiving stream, and determine if the discharge is impacting the downstream low DO levels and high phosphates indicated in the 303(d) listing.

Objective 3:

Develop a plan to implement the steps identified in an acceptable timeframe.

After identifying the appropriate steps to reduce the nutrient loading, a timeline will be developed to implement the proposed measures. The timeline will consider factors such as immediate need, IEPA requirements, and funding.

B. NARP Organization

This document is the result of a collaboration between the City of Vandalia and Milano and Grunloh Engineers to develop a Nutrient Assessment Reduction Plan for the Vandalia Sanitary Treatment Plant. Section 2 will review existing data from plant discharge records, as well as information gathered from other sources such as USGS, IEPA, and NLRS. Section 3 will examine means and methods of monitoring and assessing the gathered information to make informed decisions regarding plant improvements. Section 4 will include recommendations and options for reduction in nutrient loadings.

WATERSHED CHARACTERIZATION

Objective 1 - Assessment

The Suck Creek-Kaskaskia River watershed (HUC#0714020206) contains approximately 60 square miles in Southern Illinois in Fayette County and is a portion of the larger Middle Kaskaskia watershed (HUC 07140202). The Suck Creek-Kaskaskia River headwaters begin near the Village of St Elmo, IL and flow approximately 38.5 miles east to its confluence with Kaskaskia River north of Vandalia, IL. which in turn Joins the Mississippi River south of St Louis, Missouri.

1. Land Use and Cover

The watershed is primarily agricultural, however also contains the City of Vandalia.

2. Point Discharges

a. *Per CWA §502(14) a point source is described as:*

"Any discernible, confined and discrete conveyance, including any ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation [CAFO], or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agriculture storm water discharges and return flow from irrigated agriculture."

Under the CWA, all point sources are regulated under the National Pollutant Discharge Elimination System (NPDES) program. A municipality, industry, or operation must apply for an NPDES permit if an activity at that facility discharges wastewater to surface water. Point sources can include facilities such as municipal wastewater treatment plants (STPs), industrial facilities, concentrated animal feeding operations (CAFOs), or regulated storm water including municipal separate storm sewer systems (MS4s).

b. The IEPA ECHO website

Lists 11 NPDES permit holders discharging to Suck Creek. One of those permit holders is a municipal wastewater treatment plant in Vandalia.

3. Monitoring

There is no active monitoring of this segment of Suck Creek. However, a monitoring station is located on the Middle Kaskaskia River just south of the city's water treatment plant.

Objective 2 - Existing Data Examination

1. Sources

a. Information Collection

Milano and Grunloh gathered information from several sources for review in the preparation of this report. Existing discharge data was provided from the city, as well as being available on the EPA ECHO website. Geographical data, including stream flowlines, was obtained from the USGS National Map and StreamStats websites. Impairment data was drawn from the Illinois Nutrient Loss Reduction Strategy Biennial Report for 2021. Nitrogen and Phosphorus annual yields were sourced from the Great Lakes to Gulf Dashboard and the USGS National Water Dashboard. The Illinois Integrated Water Quality Report and Section 303(d) List were referred to for impairments.

2. Plant Effluent

a. Initial Step

Effluent data was collected for the previous three years to determine the plant nutrient contributions to the stream. This information was gathered both from operator records and the ECHO website. Data was compiled for flow, nitrogen, phosphorus, and dissolved oxygen. Data compilation dates for all parameters are from 10/31/2020 through 11/30/2023.

b. Flow

The Vandalia STP has a design average flow of 1.30 MGD, with a maximum design flow of 8.25 MGD. For the dates examined, an average monthly flow of 0.812 MGD was determined, with a one-time daily maximum of 6.42 MGD in March of 2021. This indicates that the plant is running an average of approximately 62.5% capacity. Figure 4 below provides a graphical representation of the flow during the three-year period.

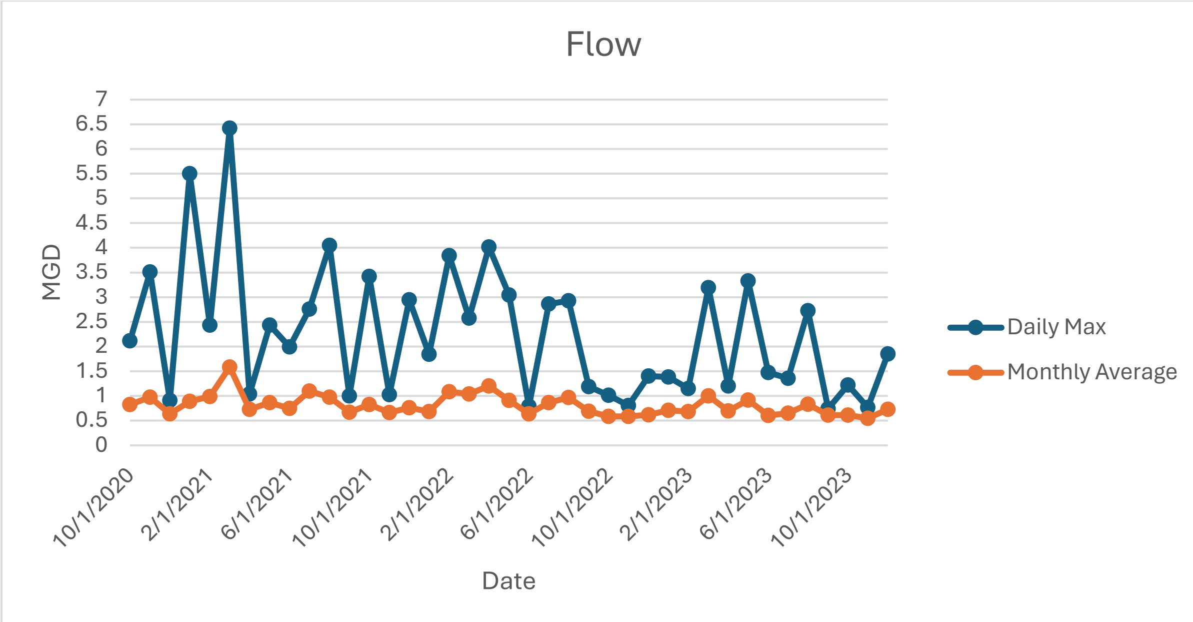


Figure 4: Vandalia STP 3-Year Flow

c. Nitrogen

Nitrogen was assessed both as Ammonium (as N), and Total (as N). Nitrogen as ammonium indicated a three-year average of 3.54 mg/L, with a maximum daily concentration of 5.0 mg/L. Plant effluent permit parameters are set at a weekly average limit of 5.70 mg/L. The total nitrogen 3-year average was 9.21 mg/L with a one-time daily maximum of 16.0. There are no discharge limits for total nitrogen and is a monitored parameter only. These values can be seen in Figure 5 for Ammonium and Figure 6 for Total Nitrogen.

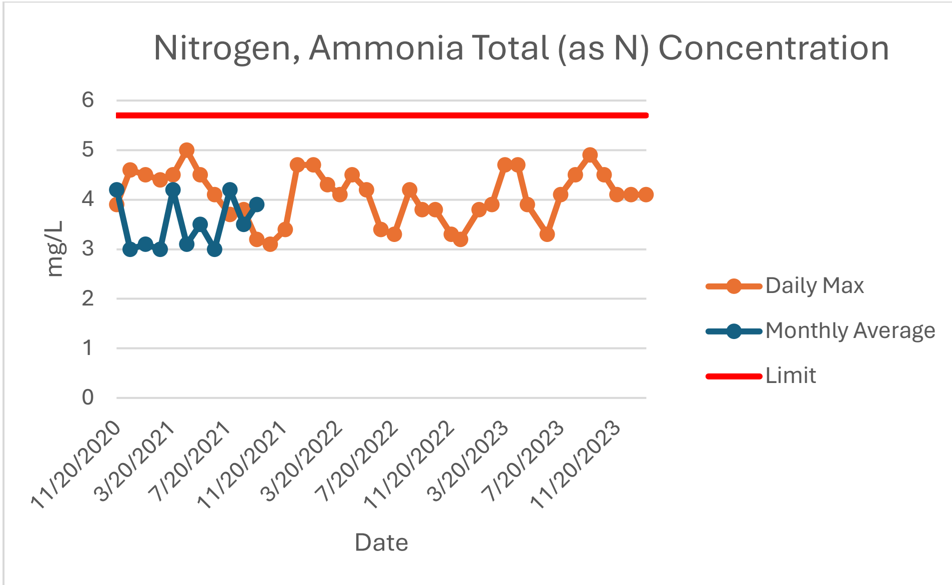


Figure 5: Vandalia STP 3-Year Ammonium

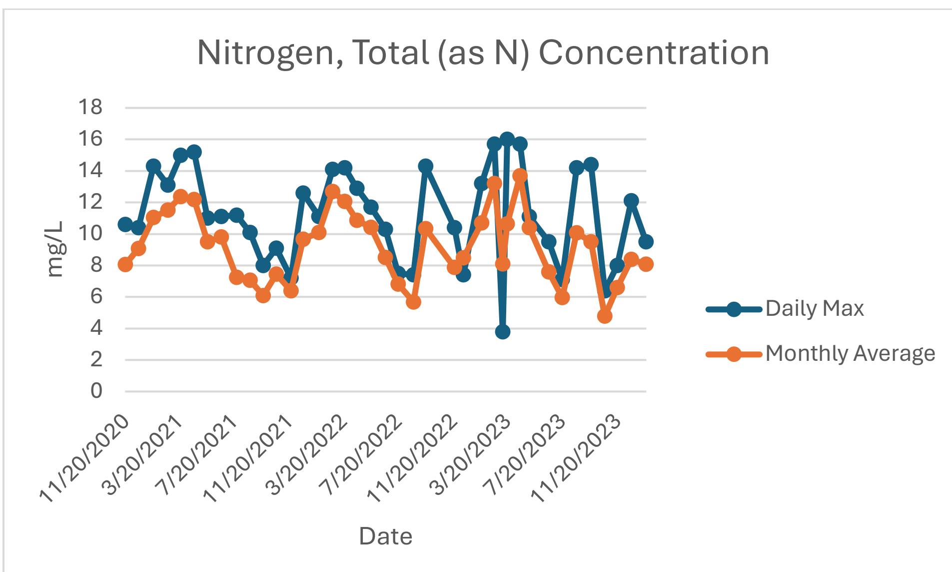


Figure 6: Vandalia STP 3-Year Total Nitrogen

As demonstrated in the graphs, Vandalia did not have high nitrogen discharge levels, and has maintained constant effluent levels in recent years.

d. Phosphorus

Influent monitoring has been conducted for the prior year for both the Vandalia Sanitary Treatment Plant and the Vandalia Correctional Center. The WTP plant's influent values averaged to 1.76 mg/L with a maximum concentration of 4.1 mg/L on October 13 of 2023. VCC concentrations averaged 2.41 mg/L with a maximum concentration of 4.7 mg/L on the same date. The mathematically combined concentration of the influent is 1.89 mg/L. The VCC contributes approximately 0.163 MGD or 20.1% of the daily flow but 25.6% of the Phosphorous going into the STP. See Figure 7 for influent and effluent data over the previous year.

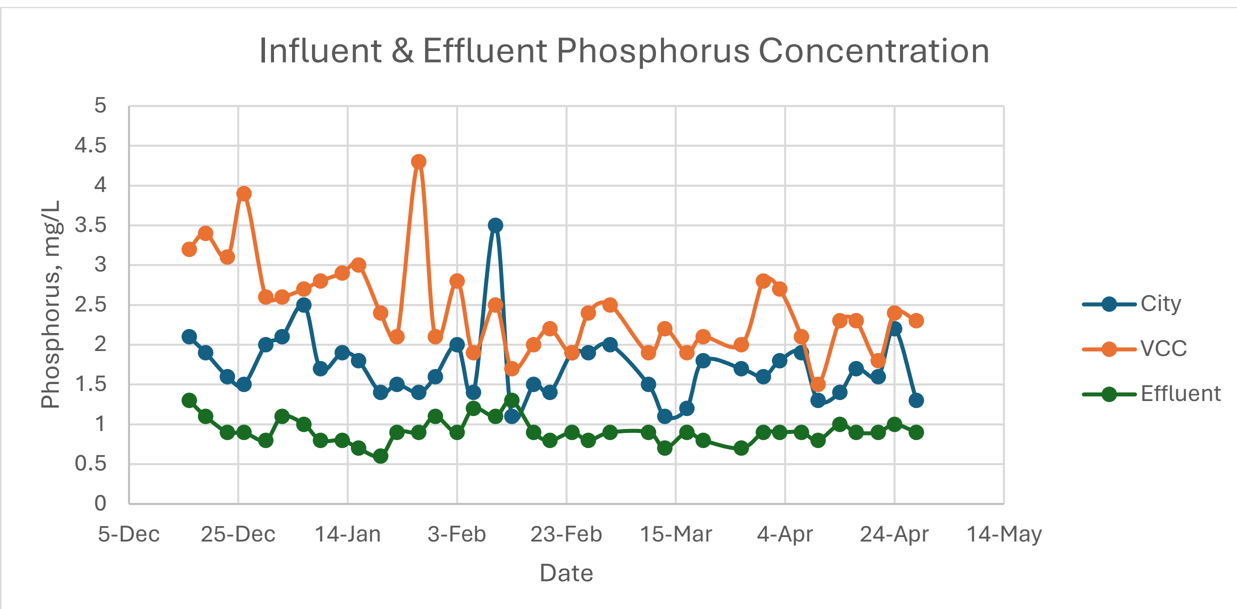


Figure 7: Influent – Effluent Phosphorous Concentration

Phosphorus was examined as monthly average, 12-month rolling average, and daily maximum in mg/L over the same three-year period. Vandalia currently does not have a discharge limit on phosphorus and is required only to monitor. The daily maximum value reported a high of 1.5 mg/L, while the three-year monthly average calculated at 0.85 mg/L. With the calculated concentration from influent this equates to 55.0%

removal rate of Phosphorus. The collected data was used to develop Figures 7 and Figure 8.

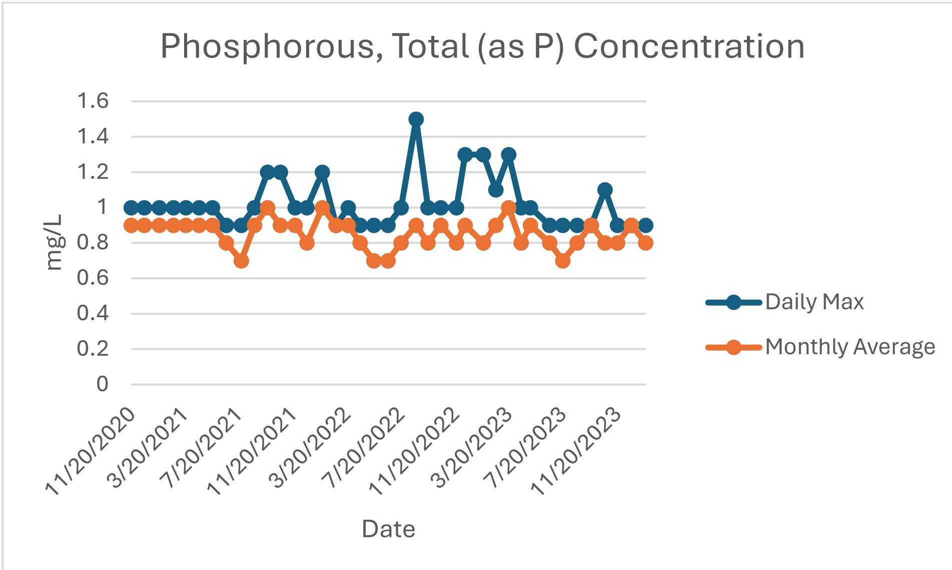


Figure 8: Vandalia STP 3-Year Total Phosphorus

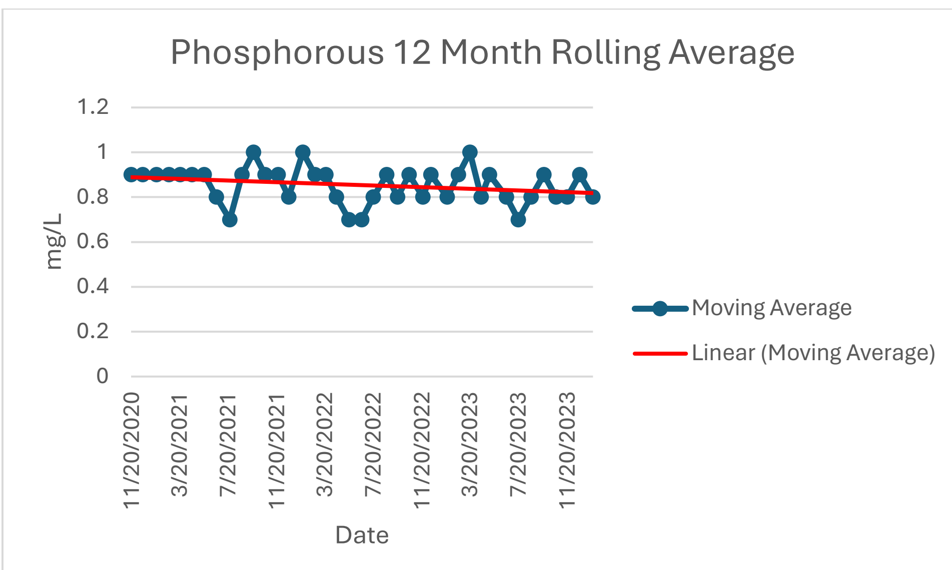


Figure 9: Vandalia STP 12-Month Total Phosphorus Rolling Average

Graphing the data helped identify a consistent monthly average below 1 mg/L, with occasional slight fluctuations. These variances are likely the result of external events creating issues, and the city is expected to reach out to large industrial users and the state penitentiary, as well as any other possible sources to attempt to determine the cause of the spike. The 12-month rolling average indicates a gradual decrease in phosphorus concentrations leaving the plant. With the pattern emerging in Figure 7, it is expected to see a gradual decline in the average.

e. Dissolved Oxygen

Dissolved Oxygen (DO) was examined as both a daily minimum and a weekly minimum average. Vandalia has maintained their minimums for both above the established minimum limits. Graphical representation of DO levels in the discharge can be seen below in Figures 9 & 10.

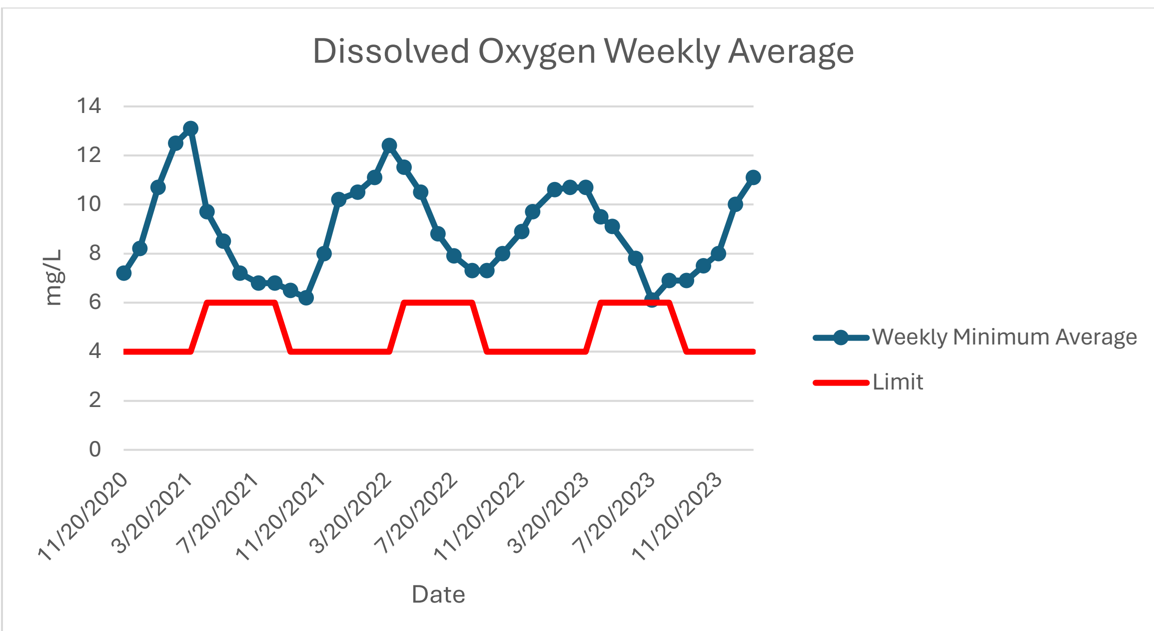


Figure 10: Vandalia STP Dissolved Oxygen, Weekly Minimum Average

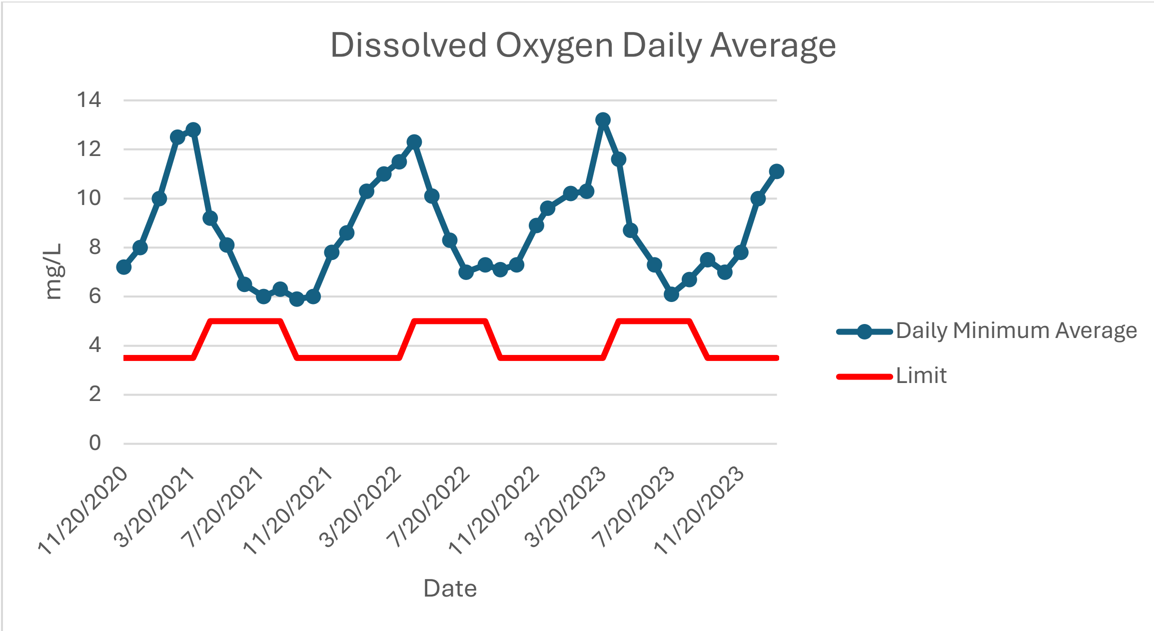


Figure 11: Vandalia STP Dissolved Oxygen, Daily Minimum

3. Illinois Environmental Protection Agency

Suck Creek-Kaskaskia River in its entirety was assessed as non-impaired. This assessment states that the reach fully supports both aquatic life and aesthetic quality. As Suck Creek-Kaskaskia River traverses all agricultural land with no riparian borders, Phosphorous and Nitrogen loading is somewhat expected in contribution to the lower reaches of the Kaskaskia River which is designated as impaired for Aquatic Life It also lends credence to the theory that the depressed DO levels in the lower reaches of Kaskaskia River are due to phosphorus loadings creating excessive algal blooms, however this is likely occurring in Kaskaskia River itself as there is no evidence of high concentrations of algae in Suck Creek-Kaskaskia River. It is probable that increased algae growth in Kaskaskia River is producing a decline in DO, which is then combined with the other southern tributaries to the Kaskaskia River thereby reducing its DO levels. Suck Creek-Kaskaskia River is a low flow channel and therefore contributes little in the addition of oxygen depleted waters that would exacerbate the impairment.

4. Illinois Integrated Water Quality Report

This report was utilized as a reference to determine impaired waters, as well as the level and cause of impairment. USEPA's latest Integrated Report guidance (USEPA 2005) calls for all waters of the state to be reported in a five-category system as below. Although the guidance allows waters to be placed into more than one category, Illinois EPA treats all categories as mutually exclusive.

Category 1:

Segments are placed into Category 1 if all designated uses are supported, and no use is threatened. (Note: Illinois does not assess any waters as threatened)

Category 2:

Segments are placed in Category 2 if all designated uses that were assessed are supported. (All other uses are reported as Not Assessed or Insufficient Information).

Category 3:

Segments are placed in Category 3 when there is insufficient available data and/or information to make a use support determination for any use.

Category 4:

Contains segments that have at least one impaired use but a TMDL is not required. Category 4 is further subdivided as follows based on the reason a TMDL is not required.

Category 4a:

Segments are placed in Category 4a when a TMDL to address a specific segment/pollutant combination has been approved or established by USEPA. Illinois EPA places water bodies in category 4a only if TMDLs have been approved for all pollutant causes of impairment.

Category 4b:

Segments are placed in Category 4b if technology-based effluent limitations required by the Act, more stringent effluent limitations required by state, local, or federal authority, or other pollution control requirements (e.g., best management practices) required by local, state or federal authority are stringent enough to implement applicable water quality standards (40 CFR 130.7(b)(1)) within a reasonable period of time.

Category 4c:

Segments are placed in Category 4c when the state demonstrates that the failure to meet an applicable water quality standard is not caused by a pollutant, but instead is caused by other types of pollution (i.e., only nonpollutant causes of impairment). Water bodies placed in this category are usually those where Aquatic Life use is impaired by habitat related conditions. (See discussion in Section C-2 Assessment Methodology, Aquatic Life-Streams.)

Category 5:

Segments are placed in Category 5 if available data and/or information indicate that at least one designated use is not being supported and a TMDL is needed. Water bodies in Category 5 (and their pollutant causes of impairment) constitute the 303(d) List that USEPA will review and approve or disapprove pursuant to 40 CFR 130.7.

Category 5-alt:

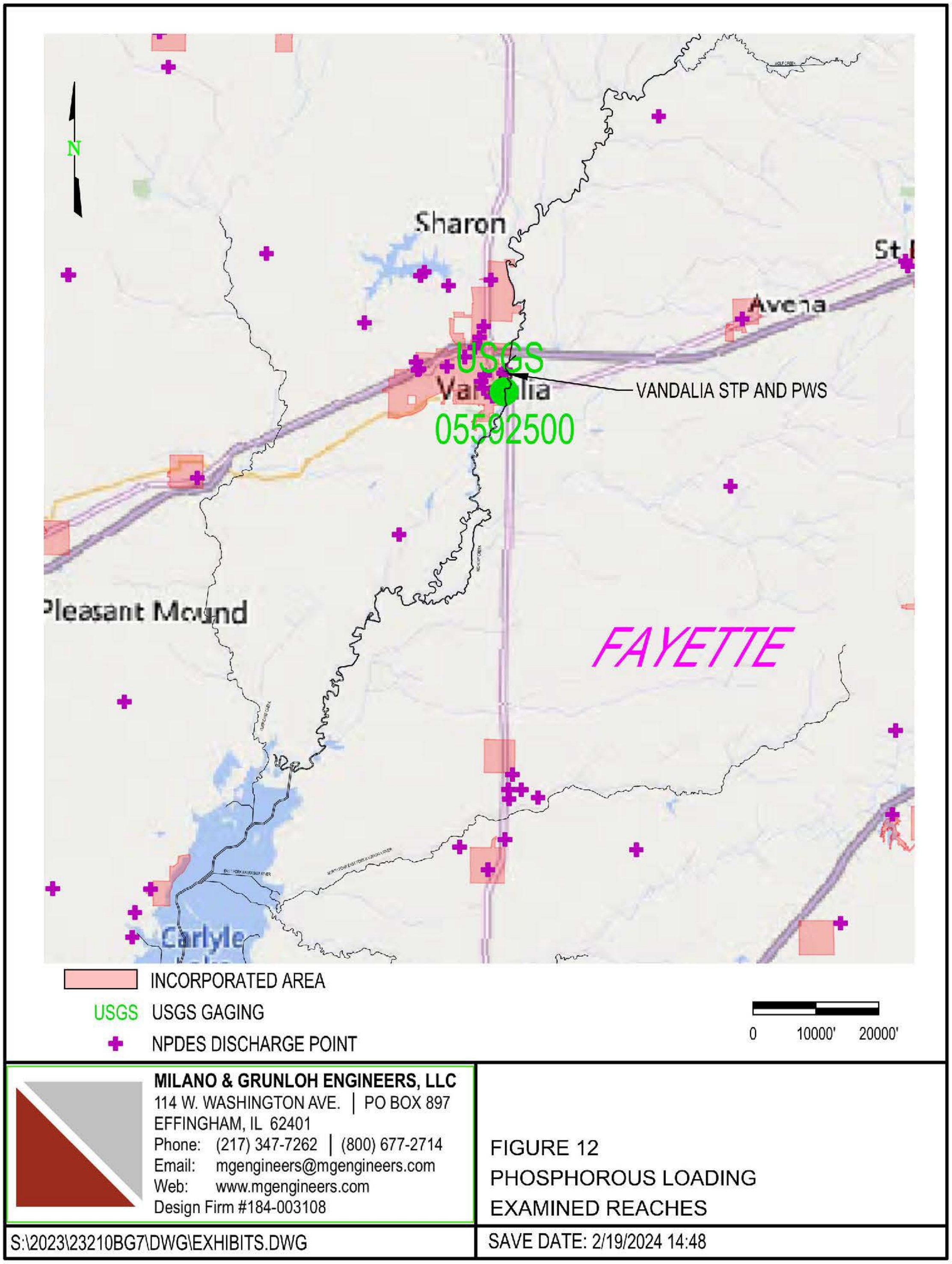
Waters are placed in category 5-alt when alternative restoration approaches are used to address impairments instead of traditional TMDLs. An alternative restoration approach is a plan, or a set of actions pursued in the near-term designed to attain water quality standards. Waters in category 5-alt remain on the 303(d) list until water quality standards are achieved or a TMDL is developed. When a State decides to pursue an alternative restoration approach for waters on its 303(d) list, USEPA expects the State to provide documentation that such an (TMDL) is required. The approach is designed to meet water quality standards and is a more immediately beneficial or practicable way to achieve water quality standards than the development of a TMDL in the near future. USEPA considers the adequacy of the State's documentation for pursuing an alternative restoration approach in determining whether to give credit to such an approach. For this cycle, Illinois has no waters in category 5-alt.

Evaluation of the current 2020-2022 listing in Appendix A-1: Specific Assessment Information for Streams the Suck Creek-Kaskaskia River to which Vandalia STP discharges is listed as a Category 3 stream therefor there is insufficient sata to make a determination.

5. USGS Data

Suck Creek-Kaskaskia River has no USGS monitoring station, therefore any data used from these sources are speculative. As the Vandalia STP has established effluent limits for ammonium as nitrogen, and as a point source, phosphorus contribution is more prevalent than in the agricultural sector, it was decided to concentrate the research efforts on phosphorus. Data sourced from the USGS Water Dashboard used in conjunction with data from the Illinois Ambient Water Quality Monitoring Network enabled the development of an approximation of phosphorus loading on the Kaskaskia River in the portion of the reach in question. Data was drawn for three monitoring stations. Station 5592500 near Cowden Station represents the first monitoring station downstream from Suck Creek. From this, the loading reported at the next upstream station, Station 5592100 at Cowden was deducted to provide the amount of loading added to the Kaskaskia between the two stations. From this, the loading data was compiled from Station 5593000 on Kaskaskia River near Carlyle, IL to negate the loadings from further up the watershed. This left the loadings contributed to the areas shown in Figure 11. It should be noted that Big Creek IL_OP-01 is impaired due to DO and contributes to the loading between the sampling points and is not monitored, the total recorded loading was charted for the Cowden Station monitoring, and also for the Vandalia and Carlyle monitoring stations combined. The results are shown in Figure 12.

Figure 12: Phosphorous Loading



The area unaccounted for is located to the northeast of Vandalia, and includes large rural farming areas in Fayette, Shelby, and Effingham Counties.

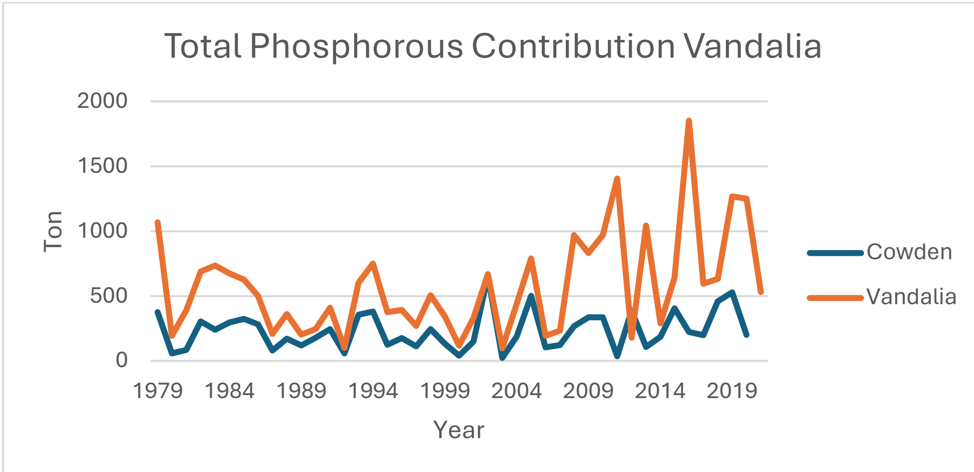


Figure 13: Loadings Reported at Cowden, Vandalia, and Carlyle

This allowed a comparison to determine the delta value between the two, estimating a contribution from the area displayed in Figure 11. This value is graphed in Figure 13.

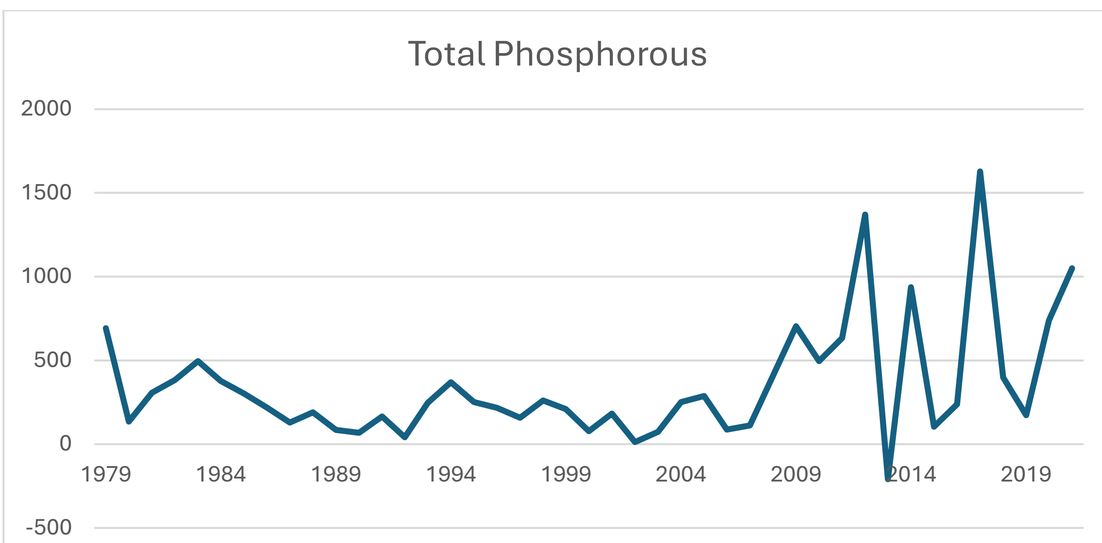


Figure 14: Phosphorus Contribution of Figure 12, Tons/Year

The most recent data available computed a ΔP of 348.76 tons per year being added to the loading. Examining the data from Vandalia indicates an average contribution of 0.63 ton during this same time period, accounting for 0.18% of the loading. Average phosphorus discharge has remained relatively constant for the plant since the examined date of 2021.

6. Data Summary

Upon evaluation of the data, it appears that phosphorus discharge from the Vandalia STP is not a significant contributor. Collected data indicates the TP discharge from Vandalia is quite consistent, ranging from 0.7 mg/L – 1 mg/L, regardless of seasonal temperature changes. 1 mg/L in the autumn months before dropping back to approximately 0.7 mg/L in the spring. DO has also been consistently above that required by their discharge permit, and nitrogen discharge as ammonium has been negligible for the last three years.

7. Water Quality Targets

Examination of previous phosphorus discharges from the Vandalia STP indicates the plant is capable of achieving phosphorus concentrations of less than 1 mg/L utilizing the current treatment train and process, however portions of the plant may need updating to regain lost efficiency due to aging equipment. Short term goals include returning to these previous effluent quantities and a concentration on maintaining these levels. Longer term goals are to reduce the phosphorus concentration of the discharge to 0.5 mg/L through a combination of organic, chemical, and mechanical means.

Objective 3: Planned Nutrient Reduction Steps

1. Existing facility

The Vandalia STP is an aging facility but remains functional. The plant receives wastewater discharge from the municipality, as well as a state prison and several industrial discharges. Treatment consists of aerated flow equalization, aerated stabilization lagoon, lime, alum and ferric chloride feed, dual floc clarification for phosphorous control, recarbonation, filtration and chlorination. Vacuum assisted drying beds dewater sludge from floc clarification. Sludge is applied to farmland.

2. Monitoring

Localized testing and monitoring in the collection system would help identify primary sources of phosphorus in the city's wastewater. Multiple manufacturers produce monitors capable of being deployed in manholes to record phosphorus concentrations in the wastewater. In addition, these monitors are easily transferred from one location to another, allowing the city to strategize placement, then move monitors upstream to follow nutrients to their source. As there is no current means for testing influent concentrations, there is no means of determining the effectiveness of treatment and the implementation of a monitoring system would be a great benefit. A special emphasis should be placed on monitoring of the prison, as this is likely a major contributor of phosphorus.

3. Community Outreach

Prevention of phosphorus reaching the plant should always be considered as the primary method of reduction. In concert with the proposed monitoring, Vandalia should begin community outreach to all business users; Industrial, commercial and institutional, to include 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 to provide tips for reducing the phosphorus load. Suggested methodology should include:

- 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 the manufacturer.
- Do not accept sample cleaners from vendors.

Municipal sources should also be examined for practices that may impact the amount of phosphorus reaching the facility. Examples of municipal action include:

- Institute environmentally preferred purchasing with policies to limit phosphorus containing products for 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 stormwater management policies, such as minimizing run-off from parking lots and other surfaces.

4. Phosphorus Removal

Although the Vandalia STP is capable of reaching phosphorus concentrations of less than 1 mg/L, it will likely need additional, dedicated removal methods to reduce beyond this level. A number of methods are being considered for use, both organic and mechanical/chemical. These options are discussed below and have already been incorporated into the daily operation of the facility.

PHOSPHOROUS REDUCTION PLAN

The City of Vandalia, Illinois owns and operates a wastewater treatment facility consisting of a lagoon system with a secondary mechanical treatment plant that is monitored in accordance with National Pollutant Discharge Elimination System Permit No. IL0023574 and regulated by the Illinois Environmental Protection Agency (IEPA). As required by this agency, the city must prepare and submit a Phosphorus Management Plan (PMP) to the IEPA for review and implementation. In fulfillment of this obligation, the City of Vandalia has hired Milano & Grunloh Engineers, LLC to prepare this document.

The purpose of this PMP is to improve phosphorus management within Vandalia's wastewater system. This is accomplished by identifying sources of phosphorus and developing strategies to eliminate phosphorus from wastewater either through source control measures or removal at the City's treatment facility. This report uses a seven-step guideline to evaluate phosphorus management for the City of Vandalia's wastewater system:

- Description of existing facilities and flow schematic.
- Evaluation of current influent and effluent phosphorus concentrations.
- Evaluation of phosphorus reduction potential.
- Determination of phosphorus reduction goals.
- Optimizing the treatment facility.
- Phosphorus reduction potential of users.
- Create an implementation plan to meet phosphorus reduction and removal goals.

STEP 1 – FACILITY DESCRIPTION & FLOW SCHEMATIC

1. Facility Description

The City of Vandalia STP was constructed in 1986, is located on the northeast corner of the city limits, and is bound by US 51 to the west, I-70 to the south, the Kaskaskia River to the east, and farmland to the north. The design average flow (DAF) for the facility is 1.3 million gallons per day (MGD) and the design maximum flow (DMF) for the facility is 8.25 MGD. Treatment consists of a bar rack, aerated flow equalization, aerated stabilization lagoon, dual floc clarification for TSS removal and phosphorous control, and chlorination. Plant effluent discharges to the Kaskaskia River and clarifier sludge is applied to farmland.

a. Collection – Vandalia's collection system consists of multiple lift stations, both private and public, with gravity sewer piping ranging from 2 to 42 inches in diameter. This system was constructed at various times throughout the city's history, and as such consists of a variety of materials. It is believed that sump pumps and storm discharge contribute to the flow. Vandalia Correctional Center (VCC) connected to the municipal STP at the time of construction and is not included in DMR totals for influent flow.

b. Screening – A bar rack is located at the influent of Lagoon 1 and was installed at the time of plant construction. VCC flow is not directed to the bar rack, and discharges to the north side of Lagoon 1.

c. Lagoons – An aerated, two lagoon system provides primary treatment of the raw sewage.

d. Mixing Chamber/Chemical Addition – Lagoon effluent is directed to a mixing chamber building to begin mechanical secondary treatment. Dual flocculants (Cedarclear 1757 and Brennfloc AP9891) are added in a mixing chamber to assist in TSS and phosphorus removal.

e. Clarification – Two 35' diameter center feed clarifiers are operated in unison during normal operation. Clarified water is able to be directed to a filter bank, or filter bypass.

f. Filters – Water from the clarifier is passed through a bank of three gravity sand filters. These filters proved problematic due to algae, requiring excessive backwashing, and have been bypassed.

g. Chlorination Chamber – Effluent is passed through a chlorination chamber where it is treated by gaseous chlorine stored in 150# cylinders prior to discharge.

h. Lift station – Final effluent is transferred from the WWTF by means of a lift station to outfall 001 located on the Kaskaskia River.

i. Sludge Storage – Clarifier sludge is pumped to two sludge holding beds where supernatant is drawn off and pumped back to Lagoon 1. Solids are stored until removal is required, at which point it is removed for land application.

2. Flow Schematic

Figure 14 provides a topographic site map of the City of Vandalia, highlighting the wastewater treatment facility and outfall locations. Figure 15 provides a process flow schematic of the wastewater treatment facility.

Figure 14: Topographic Map for City of Vandalia

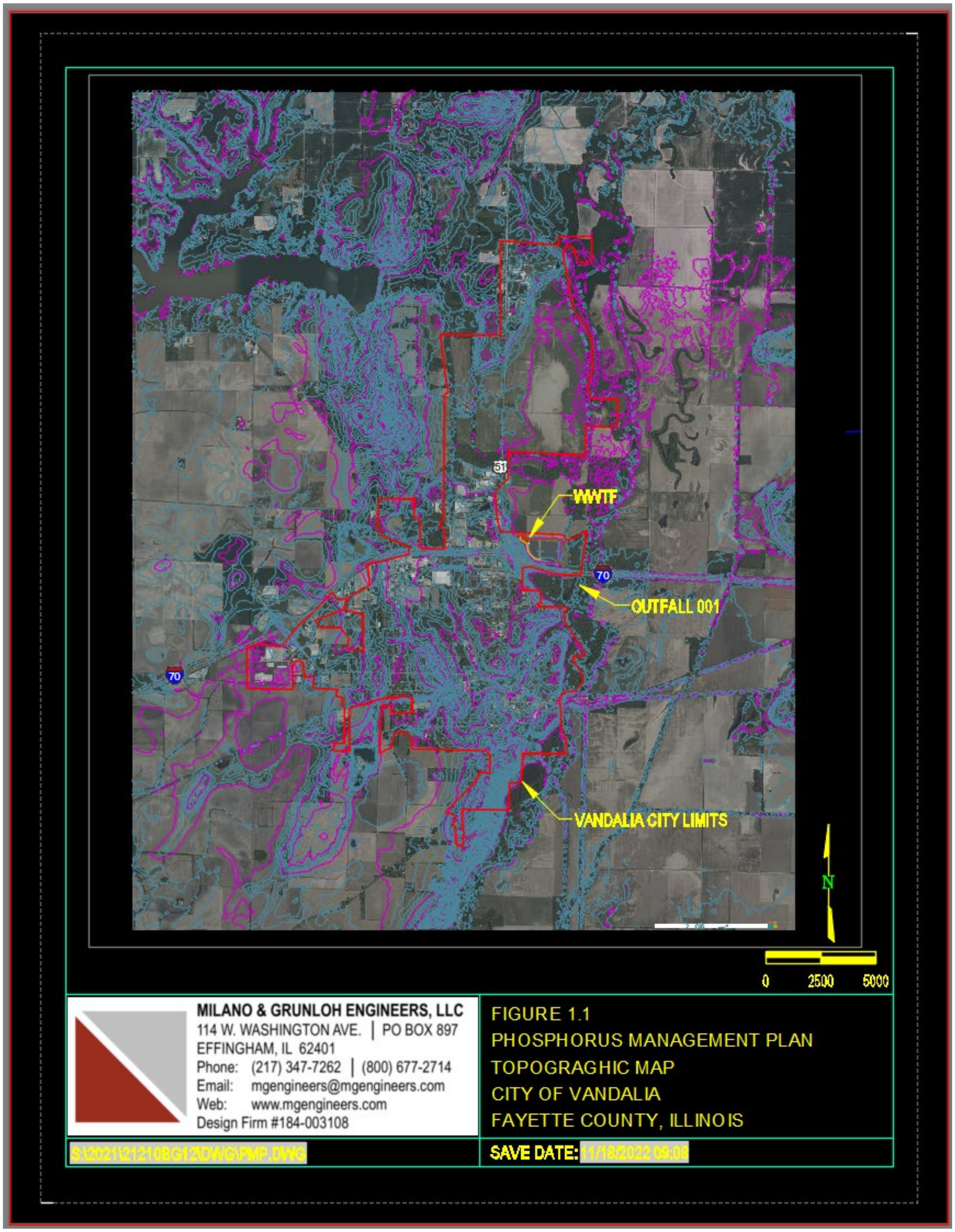
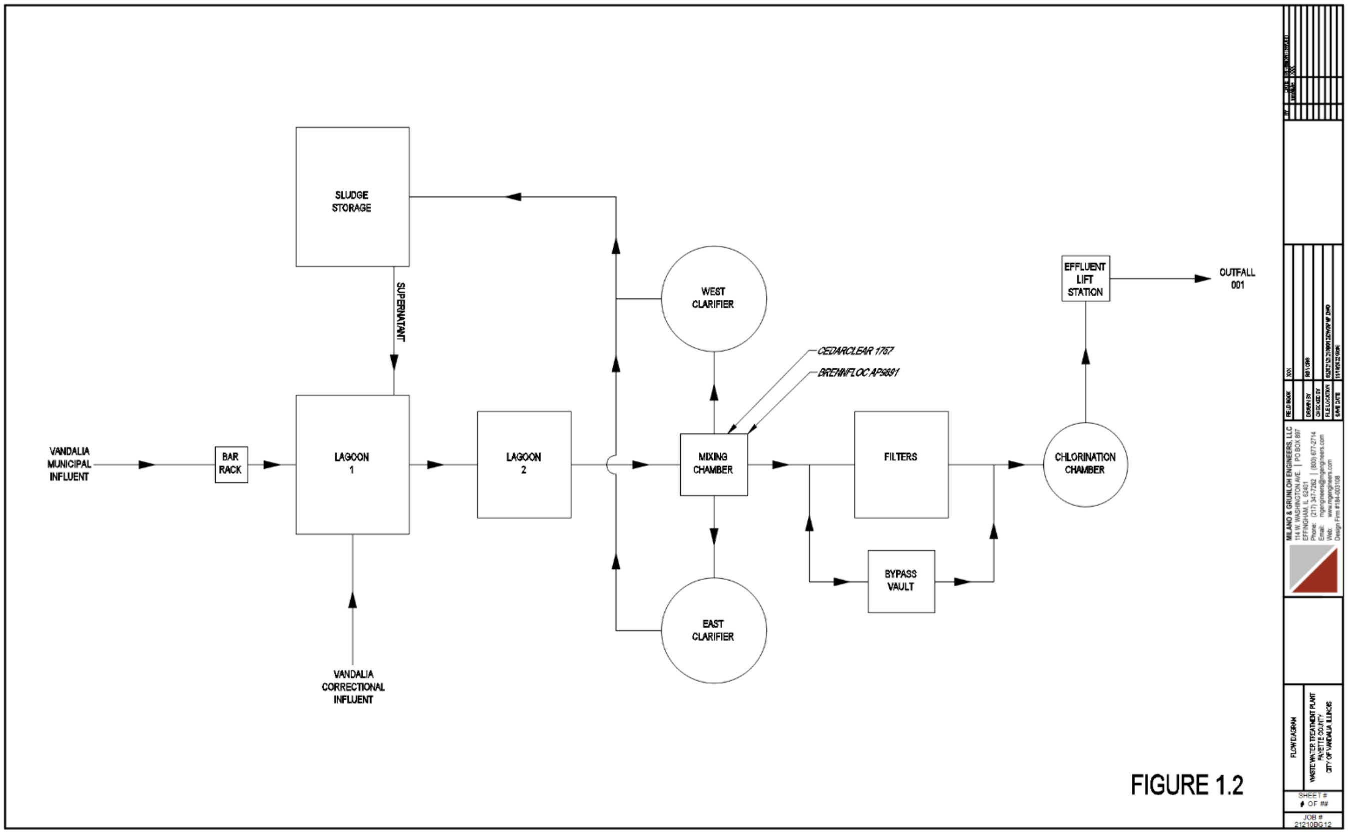


Figure 15: Flow Diagram for Vandalia STP



3. Wastewater Facility Design Data

Table 1.1 summarizes design data for the existing wastewater treatment facility. The City of Vandalia's treatment facility is required to meet performance standards in accordance with NPDES Permit No. IL0023574.

Table 1.1: Wastewater Treatment Design Data

TABLE 1.1 - WASTEWATER TREATMENT DESIGN DATA		
Parameter	Value	Unit
Design Flows		
Design Average Flow (DAF)	1.3	MGD
Design Max Flow (DMF)	8.25	MGD
Average Removal Rates		
Biochemical Oxygen Demand	99.9	%
Total Suspended Solids	92.12	%

STEP 2 – INFLUENT & EFFLUENT PHOSPHORUS CONCENTRATIONS

1. Phosphorus Monitoring Data

Table 2.1 below summarizes influent and effluent phosphorus monitoring data for the past five years (2018-2022). This data was obtained from the United States Environmental Protection Agency's (USEPA) Enforcement and Compliance History Online (ECHO) website.

Table 2.1: Flow and Phosphorous Monitoring Data

TABLE 2.1 - FLOW AND PHOSPHORUS MONITORING DATA, DAILY MAX									
Date	Flow ,Influent (MGD)		Flow, Effluent (MGD)		Phosphorus, Effluent				
	Location	Value	Location	Value	Location	Conc	Unit	Load	Unit
1/31/2018	Influent Structure	1.069	External Outfall	1.099	External Outfall	0.9	mg/L	8	lb/d
2/28/2018	Influent Structure	3.416	External Outfall	1.133	External Outfall	0.9	mg/L	8	lb/d
3/31/2018	Influent Structure	3.515	External Outfall	1.696	External Outfall	0.8	mg/L	7.8	lb/d
4/30/2018	Influent Structure	1.956	External Outfall	1.522	External Outfall	0.9	mg/L	11	lb/d
5/31/2018	Influent Structure	1.446	External Outfall	1.516	External Outfall	0.9	mg/L	11	lb/d
6/30/2018	Influent Structure	7.12	External Outfall	1.402	External Outfall	1	mg/L	11	lb/d
7/31/2018	Influent Structure	1.734	External Outfall	1.763	External Outfall	0.09	mg/L	12	lb/d
8/31/2018	Influent Structure	3.202	External Outfall	1.584	External Outfall	0.9	mg/L	11	lb/d
9/30/2018	Influent Structure	3.092	External Outfall	1.662	External Outfall	0.9	mg/L	12	lb/d
10/31/2018	Influent Structure	0.903	External Outfall	1.55	External Outfall	0.9	mg/L	10	lb/d
11/30/2018	Influent Structure	1.825	External Outfall	1.456	External Outfall	0.9	mg/L	11	lb/d
12/31/2018	Influent Structure	1.768	External Outfall	1.501	External Outfall	0.9	mg/L	11	lb/d
2018	Average=	2.587	Average=	1.490	Average=	0.833	mg/L	10.32	lb/d
1/31/2019	Influent Structure	3.453	External Outfall	1.569	External Outfall	0.9	mg/L	11	lb/d
2/28/2019	Influent Structure	3.4	External Outfall	1.474	External Outfall	0.9	mg/L	10	lb/d
3/31/2019	Influent Structure	4.206	External Outfall	1.881	External Outfall	0.9	mg/L	12	lb/d
4/30/2019	Influent Structure	2.443	External Outfall	1.73	External Outfall	0.9	mg/L	13	lb/d
5/31/2019	Influent Structure	3.811	External Outfall	1.592	External Outfall	0.8	mg/L	11	lb/d
6/30/2019	Influent Structure	2.369	External Outfall	1.739	External Outfall	0.9	mg/L	11	lb/d
7/31/2019	Influent Structure	1.574	External Outfall	1.401	External Outfall	0.9	mg/L	10	lb/d
8/31/2019	Influent Structure	2.225	External Outfall	1.369	External Outfall	0.9	mg/L	9	lb/d
9/30/2019	Influent Structure	1.152	External Outfall	1.6	External Outfall	1	mg/L	11	lb/d
10/31/2019	Influent Structure	3.776	External Outfall	1.549	External Outfall	1	mg/L	12	lb/d
11/30/2019	Influent Structure	3.261	External Outfall	1.642	External Outfall	1	mg/L	13	lb/d
12/31/2019	Influent Structure	3.901	External Outfall	1.72	External Outfall	0.9	mg/L	13	lb/d
2019	Average=	2.964	Average=	1.606	Average=	0.917	mg/L	11.33	lb/d
1/31/2020	Influent Structure	5.715	External Outfall	1.761	External Outfall	0.9	mg/L	13	lb/d
2/29/2020	Influent Structure	2.523	External Outfall	1.987	External Outfall	0.9	mg/L	12	lb/d
3/31/2020	Influent Structure	3.292	External Outfall	1.891	External Outfall	0.9	mg/L	13	lb/d
4/30/2020	Influent Structure	3.782	External Outfall	1.851	External Outfall	0.9	mg/L	13	lb/d
5/31/2020	Influent Structure	2.261	External Outfall	1.89	External Outfall	1	mg/L	16	lb/d
6/30/2020	Influent Structure	1.201	External Outfall	1.803	External Outfall	1	mg/L	14	lb/d
7/31/2020	Influent Structure	3.356	External Outfall	1.796	External Outfall	1	mg/L	14	lb/d
8/31/2020	Influent Structure	3.356	External Outfall	1.767	External Outfall	1	mg/L	15	lb/d
9/30/2020	Influent Structure	0.914	External Outfall	1.642	External Outfall	1	mg/L	14	lb/d
10/31/2020	Influent Structure	2.116	External Outfall	1.648	External Outfall	1	mg/L	14	lb/d
11/30/2020	Influent Structure	3.508	External Outfall	1.696	External Outfall	1	mg/L	13	lb/d
12/31/2020	Influent Structure	0.911	External Outfall	1.599	External Outfall	1	mg/L	11	lb/d
2020	Average=	2.745	Average=	1.778	Average=	0.967	mg/L	13.50	lb/d
1/31/2021	Influent Structure	5.5	External Outfall	1.606	External Outfall	1	mg/L	11	lb/d
2/28/2021	Influent Structure	2.431	External Outfall	1.831	External Outfall	1	mg/L	13	lb/d
3/31/2021	Influent Structure	6.42	External Outfall	1.823	External Outfall	1	mg/L	14	lb/d
4/30/2021	Influent Structure	1.041	External Outfall	1.841	External Outfall	1	mg/L	15	lb/d
5/31/2021	Influent Structure	2.432	External Outfall	1.74	External Outfall	0.9	mg/L	13	lb/d
6/30/2021	Influent Structure	1.99	External Outfall	1.595	External Outfall	0.9	mg/L	12	lb/d
7/31/2021	Influent Structure	2.756	External Outfall	1.726	External Outfall	1	mg/L	14	lb/d
8/31/2021	Influent Structure	4.047	External Outfall	1.714	External Outfall	1.2	mg/L	17	lb/d
9/30/2021	Influent Structure	0.998	External Outfall	1.542	External Outfall	1.2	mg/L	13	lb/d
10/31/2021	Influent Structure	3.421	External Outfall	1.515	External Outfall	1	mg/L	12	lb/d
11/30/2021	Influent Structure	1.026	External Outfall	1.533	External Outfall	1	mg/L	12	lb/d
12/31/2021	Influent Structure	2.947	External Outfall	1.552	External Outfall	1.2	mg/L	15	lb/d
2021	Average=	2.917	Average=	1.668	Average=	1.033	mg/L	13.42	lb/d
1/31/2022	Influent Structure	1.844	External Outfall	1.57	External Outfall	0.9	mg/L	11	lb/d
2/28/2022	Influent Structure	3.842	External Outfall	1.643	External Outfall	1	mg/L	12	lb/d
3/31/2022	Influent Structure	2.576	External Outfall	1.719	External Outfall	0.9	mg/L	13	lb/d
4/30/2022	Influent Structure	4.018	External Outfall	1.78	External Outfall	0.9	mg/L	13	lb/d
5/31/2022	Influent Structure	3.046	External Outfall	1.685	External Outfall	0.9	mg/L	11	lb/d
6/30/2022	Influent Structure	0.79	External Outfall	1.446	External Outfall	1	mg/L	9	lb/d
7/31/2022	Influent Structure	2.861	External Outfall	1.329	External Outfall	1.5	mg/L	8	lb/d
8/31/2022	Influent Structure	2.924	External Outfall	1.54	External Outfall	1	mg/L	9	lb/d
9/30/2022	Influent Structure	1.19	External Outfall	1.552	External Outfall	1	mg/L	13	lb/d
2022	Average=	2.566	Average=	1.585	Average=	1.011	mg/L	11.00	lb/d

TABLE 2.1 - FLOW AND PHOSPHORUS MONITORING DATA, MONTHLY AVERAGE									
Date	Flow ,Influent (MGD)		Flow, Effluent (MGD)		Phosphorus, Effluent				
	Location	Value	Location	Value	Location	Conc	Unit	Load	Unit
1/31/2018	Influent Structure	0.65	External Outfall	1.028	External Outfall	0.8	mg/L	7	lb/d
2/28/2018	Influent Structure	0.978	External Outfall	0.924	External Outfall	0.07	mg/L	7	lb/d
3/31/2018	Influent Structure	1.05	External Outfall	1.128	External Outfall	0.8	mg/L	7.5	lb/d
4/30/2018	Influent Structure	0.939	External Outfall	1.255	External Outfall	0.8	mg/L	9	lb/d
5/31/2018	Influent Structure	0.716	External Outfall	1.389	External Outfall	0.8	mg/L	9	lb/d
6/30/2018	Influent Structure	1.207	External Outfall	1.301	External Outfall	0.9	mg/L	9	lb/d
7/31/2018	Influent Structure	0.889	External Outfall	1.385	External Outfall	0.08	mg/L	10	lb/d
8/31/2018	Influent Structure	1.013	External Outfall	1.236	External Outfall	0.8	mg/L	9	lb/d
9/30/2018	Influent Structure	0.914	External Outfall	1.395	External Outfall	0.8	mg/L	10	lb/d
10/31/2018	Influent Structure	0.715	External Outfall	1.175	External Outfall	0.8	mg/L	8	lb/d
11/30/2018	Influent Structure	0.895	External Outfall	1.342	External Outfall	0.8	mg/L	9	lb/d
12/31/2018	Influent Structure	0.932	External Outfall	1.302	External Outfall	0.8	mg/L	9	lb/d
2018	Average=	0.908	Average=	1.238	Average=	0.688	mg/L	8.63	lb/d
1/31/2019	Influent Structure	1.188	External Outfall	1.39	External Outfall	0.9	mg/L	11	lb/d
2/28/2019	Influent Structure	1.151	External Outfall	1.229	External Outfall	0.9	mg/L	9	lb/d
3/31/2019	Influent Structure	1.217	External Outfall	1.451	External Outfall	0.9	mg/L	10	lb/d
4/30/2019	Influent Structure	1.264	External Outfall	1.395	External Outfall	0.9	mg/L	10	lb/d
5/31/2019	Influent Structure	1.392	External Outfall	1.359	External Outfall	0.8	mg/L	9	lb/d
6/30/2019	Influent Structure	1.116	External Outfall	1.408	External Outfall	0.8	mg/L	9	lb/d
7/31/2019	Influent Structure	0.947	External Outfall	1.32	External Outfall	0.8	mg/L	9	lb/d
8/31/2019	Influent Structure	1.082	External Outfall	1.225	External Outfall	0.7	mg/L	7	lb/d
9/30/2019	Influent Structure	0.843	External Outfall	1.354	External Outfall	0.8	mg/L	9	lb/d
10/31/2019	Influent Structure	0.935	External Outfall	1.138	External Outfall	0.8	mg/L	9	lb/d
11/30/2019	Influent Structure	0.93	External Outfall	1.586	External Outfall	0.9	mg/L	12	lb/d
12/31/2019	Influent Structure	1.026	External Outfall	1.516	External Outfall	0.8	mg/L	10	lb/d
2019	Average=	1.091	Average=	1.364	Average=	0.833	mg/L	9.50	lb/d
1/31/2020	Influent Structure	1.496	External Outfall	1.639	External Outfall	0.8	mg/L	11	lb/d
2/29/2020	Influent Structure	1.125	External Outfall	1.687	External Outfall	0.8	mg/L	10	lb/d
3/31/2020	Influent Structure	1.277	External Outfall	1.658	External Outfall	0.8	mg/L	12	lb/d
4/30/2020	Influent Structure	1.041	External Outfall	1.633	External Outfall	0.8	mg/L	11	lb/d
5/31/2020	Influent Structure	1.08	External Outfall	1.639	External Outfall	0.9	mg/L	12	lb/d
6/30/2020	Influent Structure	0.778	External Outfall	1.612	External Outfall	0.9	mg/L	12	lb/d
7/31/2020	Influent Structure	1.193	External Outfall	1.675	External Outfall	0.9	mg/L	12	lb/d
8/31/2020	Influent Structure	1.106	External Outfall	1.661	External Outfall	0.9	mg/L	13	lb/d
9/30/2020	Influent Structure	0.729	External Outfall	1.47	External Outfall	0.9	mg/L	11	lb/d
10/31/2020	Influent Structure	0.825	External Outfall	1.15	External Outfall	0.9	mg/L	9	lb/d
11/30/2020	Influent Structure	0.975	External Outfall	1.305	External Outfall	0.9	mg/L	10	lb/d
12/31/2020	Influent Structure	0.638	External Outfall	1.007	External Outfall	0.9	mg/L	7	lb/d
2020	Average=	1.022	Average=	1.511	Average=	0.867	mg/L	10.83	lb/d
1/31/2021	Influent Structure	0.892	External Outfall	1.045	External Outfall	0.9	mg/L	7	lb/d
2/28/2021	Influent Structure	0.989	External Outfall	1.585	External Outfall	0.9	mg/L	11	lb/d
3/31/2021	Influent Structure	1.586	External Outfall	1.604	External Outfall	0.9	mg/L	11	lb/d
4/30/2021	Influent Structure	0.731	External Outfall	1.48	External Outfall	0.9	mg/L	12	lb/d
5/31/2021	Influent Structure	0.863	External Outfall	1.37	External Outfall	0.8	mg/L	9	lb/d
6/30/2021	Influent Structure	0.747	External Outfall	0.875	External Outfall	0.7	mg/L	5	lb/d
7/31/2021	Influent Structure	1.1	External Outfall	1.294	External Outfall	0.9	mg/L	10	lb/d
8/31/2021	Influent Structure	0.972	External Outfall	1.562	External Outfall	1	mg/L	12	lb/d
9/30/2021	Influent Structure	0.671	External Outfall	1.111	External Outfall	0.9	mg/L	8	lb/d
10/31/2021	Influent Structure	0.823	External Outfall	1.089	External Outfall	0.9	mg/L	8	lb/d
11/30/2021	Influent Structure	0.666	External Outfall	1.374	External Outfall	0.8	mg/L	10	lb/d
2021	Average=	0.913	Average=	1.308	Average=	0.873	mg/L	9.36	lb/d
12/31/2021	Influent Structure	0.759	External Outfall	0.999	External Outfall	1	mg/L	8	lb/d
1/31/2022	Influent Structure	0.681	External Outfall	1.325	External Outfall	0.9	mg/L	9	lb/d
2/28/2022	Influent Structure	1.087	External Outfall	1.437	External Outfall	0.9	mg/L	10	lb/d
3/31/2022	Influent Structure	1.042	External Outfall	1.536	External Outfall	0.8	mg/L	10	lb/d
4/30/2022	Influent Structure	1.202	External Outfall	1.59	External Outfall	0.7	mg/L	10	lb/d
5/31/2022	Influent Structure	0.912	External Outfall	1.393	External Outfall	0.7	mg/L	8	lb/d
6/30/2022	Influent Structure	0.634	External Outfall	0.757	External Outfall	0.8	mg/L	5	lb/d
7/31/2022	Influent Structure	0.866	External Outfall	0.803	External Outfall	0.9	mg/L	6	lb/d
8/31/2022	Influent Structure	0.97	External Outfall	1.047	External Outfall	0.8	mg/L	8	lb/d
9/30/2022	Influent Structure	0.69	External Outfall	0.834	External Outfall	0.9	mg/L	7	lb/d
2022	Average=	0.884	Average=	1.172	Average=	0.840	mg/L	8.10	lb/d

2. Phosphorus Removal Calculations

The city has not yet implemented regular influent phosphorus testing, however the operator has recently begun testing the influent from the municipality and Vandalia Correctional Center simultaneously with the effluent testing required by the NPDES with recent results indicating 3.2 mg/L from VCC and 2.1 mg/L from the municipality. This testing will establish a baseline from which calculations may be made to determine the effectiveness of the treatment processes.

STEP 3 – PHOSPHORUS REDUCTION POTENTIAL

1. Pattern and Trends

Recent testing shows influent total phosphorus (TP) combined concentration at approximately 2.18 mg/L, which is lower than typical domestic wastewater concentrations that generally ranges from 4 to 8 mg/L. Over the past five years, average effluent phosphorus concentration has been 0.82 mg/L, with an average daily maximum concentration of 0.95 mg/L. Due to a lack of data, the removal rate is currently unknown, but is estimated to be greater than 50%.

The City's current NPDES discharge permit does not have a limit for total phosphorus discharge, although phosphorus must be sampled twice per month. The treatment facility is designed to remove excess phosphorus and was originally equipped with chemical feeds for metal salts (ferric chloride or aluminum sulfate) for chemical precipitation, however these systems have been converted to feed the flocculants currently in use. These flocculants consist of polyaluminum chloride, which performs much in the same manner as ferric chloride and aluminum sulfate, helping to reduce the phosphorus concentrations. The facility also gains some removal from the small amount of phosphorus needed to sustain bacterial metabolism and algal growth in the aerated lagoons.

2. Recommended Actions

It is recommended that the City of Vandalia undertake efforts to reduce influent TP concentrations, such as continuing to monitor influent concentrations, working with local institutions and industries to reduce phosphorus usage, and a reexamination with its agreement to provide municipal sewage disposal to the correctional center to specify a daily phosphorus loading limit and restricting the access to suction truck offloading to optimal timeframes.

It is also recommended to pilot a Dissolved Air Flotation (DAF) system in the secondary treatment operations to examine the effectiveness of this technology, as well as introducing a strainer between the lagoons and the mechanical plant to prevent excessive algae from entering the clarifiers. This would possibly allow the currently bypassed filters to be brought back into service with a courser grain media without the headloss issues previously experienced. These pilots are expected to begin testing during the summer of 2023, when influent phosphorus concentrations are expected to increase.

STEP 4 – PHOSPHORUS REDUCTION GOALS

1. Effluent TP

Table 4.1 provides phosphorus reduction goals for the City of Vandalia's wastewater treatment facility over the next five years. Reduction goals are stated in the city's NPDES permit requirements for phosphorus discharge. Currently, the city is only required to monitor effluent phosphorus, however Special Condition 22 requires reaching an effluent limit of 0.5 mg/L by January 1, 2030, unless meeting otherwise stated conditions. Influent TP concentrations are currently unknown, as testing has not been a requirement under the NPDES. Due to this, the removal rate cannot be calculated. The city has begun a program of testing influent TP concentrations to allow for a comparison of any changes made to the treatment process. It is intended to develop a baseline of influent TP concentrations from both the municipality and Vandalia Correctional Center. Source mitigation will be examined to determine the feasibility of reducing the influent phosphorus, thus lowering the amount required for removal. It is expected that the correctional center is a major contributor to phosphorus levels, however the ability to lower levels from this source is uncertain.

Table 4.1: Phosphorous Reduction Goals

TABLE 4.1 - PHOSPHORUS REDUCTION GOALS			
Parameter	Current Concentration (mg/L)	5-Year Goal (mg/L)	Explanation
Influent TP Concentration (mg/L)	Unknown	TBD	The City of Vandalia should aim to lower influent TP concentrations as general procedure. Steps have been taken to begin developing an influent concentration baseline to determine the potential gains of this strategy. Influent phosphorus concentration is solely a function of the type of users discharging to the wastewater system. Source reduction measures are most effective when targeting the highest dischargers of phosphorus. Steps 6 and 7 of this plan discuss phosphorus sources and an implementation plan for source control.
Effluent TP Concentration (mg/L)	0.85	0.5	Over the next five years, the City of Vandalia should aim to lower effluent TP conentrations to 0.5 mg/L as stated under Special Condition 22 of the NPDES. Upgrades to the secondary treatment are planned to undergo pilot program trials in 2023. These pilot programs, if implemented, are expected to both increase the removal rate of TP, as well as allowing the currently bypassed filters to be placed back into service due to a reduction in TSS.

2. Effluent TP

Concentrations based on a 12-month rolling geometric mean were calculated with values ranging from 0.5 mg/L to 1 mg/L as shown in Table 4.2.

Table 4.2: Geometric Mean

TABLE 4.2 -12 MONTH ROLLING GEOMETRIC MEAN																										
	1/31/2018	2/28/2018	3/31/2018	4/30/2018	5/31/2018	6/30/2018	7/31/2018	8/31/2018	9/30/2018	10/31/2018	11/30/2018	12/31/2018	1/31/2019	2/28/2019	3/31/2019	4/30/2019	5/31/2019	6/30/2019	7/31/2019	8/31/2019	9/30/2019	10/31/2019	11/30/2019	12/31/2019	1/31/2020	2/29/2020
Daily Max	0.9	0.9	0.8	0.9	0.9	1	0.09	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	0.9	0.9	0.9	1	1	1	0.9	0.9	0.9
Geo Mean												0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.9	0.9	1	1	1	0.9	0.9	0.9
Mo Ave.	0.8	0.1	0.8	0.8	0.8	1	0.08	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	0.9	0.8	0.8	0.8	0.7	1	1	1	0.8	0.8	0.8
Geo Mean												0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.8	0.8	1	1	1	0.8	0.8	0.8

TABLE 4.2 -12 MONTH ROLLING GEOMETRIC MEAN																														
3/31/2020	4/30/2020	5/31/2020	6/30/2020	7/31/2020	8/31/2020	9/30/2020	10/31/2020	11/30/2020	12/31/2020	1/31/2021	2/28/2021	3/31/2021	4/30/2021	5/31/2021	6/30/2021	7/31/2021	8/31/2021	9/30/2021	10/31/2021	11/30/2021	12/31/2021	1/31/2022	2/28/2022	3/31/2022	4/30/2022	5/31/2022	6/30/2022	7/31/2022	8/31/2022	9/30/2022
0.9	0.9	1	1	1	1	1	1	1	1	1	1	1	1	0.9	0.9	1	1.2	1.2	1	1	1.2	0.9	1	0.9	0.9	0.9	1	1.5	1	1
0.9	0.9	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
0.8	0.8	1	1	1	1	1	1	1	1	1	1	1	1	0.8	0.7	1	1	0.9	1	1	1	0.9	1	0.8	0.7	0.7	1	0.9	1	1
0.8	0.8	1	1	1	1	1	1	1	1	1	1	1	1	0.9	0.9	1	0.9	0.9	1	1	0.9	0.9	1	0.9	0.9	0.8	1	0.9	1	1

STEP 5 – OPTIMIZING THE FACILITY

1. Percent Removal Goal

With no known removal rate, the ultimate goal can only be to improve the percentage of phosphorus removed. Until a baseline of influent concentration values can be established, the effects of reducing TP concentrations in the influent is purely hypothetical. Despite this, the city should continue improving the collection system by identifying sources of major phosphorus contribution.

2. Chemical Feeds

The current chemical feeds may need to be adjusted to find an optimal feed rate for phosphorus removal. It is expected that the current feed rate is near optimal, and any further addition of the existing feeds will have diminishing returns and not be economically feasible. This strategy should still be examined as it requires no additional infrastructure and could possibly be the most economical solution.

3. Increasing Infrastructure

The previously mentioned pilot programs consisting of a strainer prior to the secondary treatment and a DAF system should be applied to determine their ability to enhance treatment and represent the next most economical solution. The DAF system is estimated to be approximately $600,00 for parts, plus labor costs, therefore implementing a pilot system allows examination of the process before investing in a permanent solution. The installation cost for this system is estimated at $1.5 million.

STEP 6 – SUMMARY OF PHOSPHORUS SOURCES

1. Phosphorous Sources

Table 6.1 summarizes phosphorus sources in the City of Vandalia. Phosphorus reduction tips are provided in Appendix A.

Table 6.1: Phosphorous Sources

TABLE 6.1 - SOURCES OF PHOSPHORUS IN VANDALIA		
Location	Phosphorus Sources	Assessment (Reduction Potential)
Commercial:		
Aldi		
Walmart	Food Processing Waste	
County Market IGA	Cleaning/Sanitizing chemicals	Low
Multiple Hospice Residence	Human Waste	
Multiple Hotels	Cleaning/Sanitizing chemicals	Low
Multiple Food Services	Food Processing Waste	
Pilot Travel Center	Cleaning/Sanitizing chemicals	Low
Institutional:		
Vandalia Community Schools		
Kaskaskia Community College	Human Waste	
Vandalia Correctional Center	Cleaning/Sanitizing chemicals	Medium/High
Fayette County Hospital		
IDOT Garage		
Municipal:		
City Hall	Human Waste	
Public Works	Cleaning/Sanitizing chemicals	Low
Domestic:		
City of Vandalia	Human Waste	
	Cleaning/Sanitizing chemicals	Low
	Garbage Disposal Waste	

2. Effluent Goals for Users

Phosphorus contributions to the City of Vandalia's wastewater system are largely generated from residential and small commercial users. The city does not have any businesses or industries that are considered Significant Industrial Users (SIUs) to the wastewater system although the correctional center, multiple hotels, and truck stop likely contribute the bulk of the concentration. Sources of phosphorus from residential and commercial users are primarily from human waste, garbage disposal waste, and cleaning and sanitizing products. Ultimately, effluent goals for these users are difficult to define as the phosphorus contributions are largely unavoidable (i.e. natural) and difficult to monitor on a large scale. Individual monitoring is generally not worthwhile unless there is strong suspicion of a significant contribution. Ongoing influent phosphorus testing may indicate locations with improvement potential; however, the gains are likely to be small.

PLAN TO MEET PHOSPHORUS REDUCTION AND REMOVAL GOALS

Phosphorus removal strategies are detailed below and summarized in Table 7.1.

1. Phosphorus Source Reduction Strategies

a. Businesses – Industrial, Commercial, and Institutional Users:

- Visit businesses and institutions thought to be significant contributors of phosphorus (see Table 6.1) and re-evaluate ways to minimize or eliminate phosphorus sources such as phosphorus-based cleaning/sanitation products and excess food and disposal waste.
- Send a general mailer to all local businesses and institutions as an educational tool on the importance of phosphorus management.
- If necessary, monitor and inspect businesses and institutions that may be significant contributors of phosphorus.

b. Municipal Sources:

- Evaluate potential phosphorus sources generated from municipal facilities such as cleaning and sanitizing products. Evaluate ways to eliminate phosphorus sources.

c. Domestic Sources:

- Provide avenues for public education of phosphorus management through local media outlets and the City website. Consider including educational materials with utility bills once or twice per year in order to increase exposure and awareness of phosphorus management.

2. Phosphorus Removal Strategies

a. Monitoring

- Continue monitoring TP concentrations as required by the NPDES.
- Monitor and record influent TP concentrations from the municipality and the correctional center and calculate a composite concentration for use in removal calculations. These samples should be tested concurrently with the effluent monitoring.

b. Chemical Feed Adjustment

- Adjustment of chemical feeds should only be conducted once a baseline for removal has been established. Any mechanical methods implemented will have uncertain effects without a means of comparison.

c. Pilot Studies

- Move forward with plans to conduct pilot studies with the physical strainer and Dissolved Air Flotation systems. Should these methods prove effective, a preliminary engineering report can be submitted outlining the advantages and disadvantages of each system for consideration of permanent implementation.

d. Filters

- Should the strainer prove effective at preventing algae from entering the clarifiers, the existing filters should be examined for retrofitting and placing back in service.

Table 7.1: Phosphorous Maintenance Schedule

Table 7.1 - Phosphorus Maintenance Plan Schedule				
Parameter	Step	Estimated implementation	Cost Estimate	Schedule
Influent	Evaluate the phosphorus reduction potential of users	City has begun phosphorus testing of influent. Expansion of testing could draw from multiple lift stations further isolating sources.	Labor costs	2022-2025
	Determine which sources have the greatest opportunity for reducing phosphorus.	See Table 6.1 for initial determination.	Labor costs	2022-2025
	Determine wether known sources (i.e. , restaurant and food preperation) can adopt phosphorus minimization and water conservation plans	After influent concentrations and removal rates are established, investigation can proceed on minimization. Six months to one years data are required to analyze.	Labor costs	2023-2025
	Evaluate and implement local limits on influent sources of excessive phosphorus.	If it is determined that gains may be made, phosphorus minimization and water conservation plans will be examined for implementation. (approximately 1 year)	Labor costs	2024-2025
Effluent	Adjust the solids retention time for nitrification, denitrification, or biological phosphorus removal.	Existing lagoons are fixed, with an extended detention time currently in place. A small addition could be achieved by returning the filters to service.	Not feasible	NA
	Adjust aeration rates to reduce dissolved oxygen and promote simultaneous nitrification-denitrification.	Existing surface aeration units can be examined to determine efficiency.	Labor costs	2023-2025
	Add baffles to existing units to improve microorganism conditions by creating divided anarerobic, anoxic, and aerobic zones.	Adding baffles to the lagoons would be cost prohibitive. These cells, by their nature, already possess all three trophic zones.	Not feasible	NA
	Change aeration settings in plug flow basins by turning off air or mixers at the inlet side of the basin system.	Vandalia does not operate a plug flow basin. Lagoons are aerated causing a mixing reaction, as well as the return of supernatant to Lagoon 2.	NA	NA
	Minimize impact on recycle streams by improving aeration within holding tanks.	Existing surface aeration units can be examined to determine efficiency.	Labor costs	2023-2025
	Reconfigure flow through existing basins to enhance biological nutrient removal	Flow through basins could only take place in lagoons, requiring cost prohibitive excavation, while reducing retention time.	Not feasible	NA
	Increase volatile fatty acids for biological phosphorus removal.	No sequential batch reactors make this option unlikely.	Not feasible	NA
	Improvements to existing systems.	Addition of a strainer, disolved air flotation (DAF) unit, or both may improve quality entering secondary treatment, allowing for existing filters to be returned to operation.	$500,000 - $3 million	2023-2025
	Chemical feed adjustments	Optimize the addition of flocculants to precipitate and settle phosphorus.	Cost to be determined by increased chemical usage.	2023-2025

APPENDIX A

Phosphorus Reduction Tips at a Glance

Prevention First Here are some quick tips for selecting phosphorus reduction strategies for business users—commercial, industrial, and institutional operations; your wastewater treatment facility (WWTF); residential or domestic sources and the drinking water treatment plant that prevent or minimize phosphorus releases.

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 the 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 stormwater management policies, such as minimizing run-off from parking lots and other surfaces
Domestic	• Institute environmentally preferable purchasing in your household. Find sources for low- or non-phosphorus dishwashing liquids 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
Your WWTF	• Optimize the WWTF operations for phosphorus removal • Improve phosphorus removal using biological or chemical treatment methods • Feed supernatant back to the plant

Water Conservation Reducing effluent flows from businesses may reveal hidden phosphorus concentrations.