Geosyntec consultants

engineers | scientists | innovators

Litchfield ILLINOIS

NUTRIENT ASSESSMENT REDUCTION PLAN FOR WEST SHOAL CREEK WATERSHED

Prepared for

City of Litchfield
120 E. Ryder Street
Litchfield, Illinois 62650

Prepared by

Geosyntec Consultants, Inc.
1420 Kensington Road, Suite 103
Oak Brook, Illinois 60523

Project Number: MOW5673

December 2023

Geosyntec consultants

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

%	percent
mg/L	milligrams per liter
µg/L	micrograms per liter
BMP	best management practice
CAP	Continuing Authorities Program
CIP	Capital Improvement Plan
CSO	combined sewer overflow
DO	dissolved oxygen
EPA	Environmental Protection Agency
IDOA	Illinois Department of Agriculture
NARP	Nutrient Assessment Reduction Plan
NLCD	National Land Cover Database
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
O&M	operations & maintenance
POTW	publicly owned treatment works
PPP	pollution prevention plan
TMDL	Total Maximum Daily Load
TP	total phosphorus
TSS	total suspended solids
USACE	United States Army Corps of Engineers
US EPA	United States Environmental Protection Agency
WWTF	wastewater treatment facility

1. INTRODUCTION

1.1 Purpose of the NARP

The Illinois Environmental Protection Agency (Illinois EPA) has incorporated special condition requirements to develop a Nutrient Assessment Reduction Plan (NARP) in many Illinois National Pollutant Discharge Elimination System (NPDES) permits. These special conditions can affect major wastewater water treatment facilities (WWTFs) with a design flow of one or more million gallons per day. The NARP requirements apply to WWTFs that discharge upstream of water bodies that have a phosphorus-related impairment[1] or are at risk of eutrophication.[2] The purpose of the NARP is to identify phosphorus input reductions and other measures necessary to address phosphorus-related impairments. Illinois EPA recognizes that other measures (such as dam removal, stream restoration, riparian buffers, or constructed wetlands) may be needed to eliminate impairments in addition to point source and nonpoint source (NPS) nutrient reductions.

The current NPDES permit for the City of Litchfield (City) WWTF includes Special Condition 24 to develop a NARP (IL0020621, issued on December 9, 2020). The City received the NARP special condition since the WWTF was located upstream of a stream segment listed in the Illinois Section 303(d) list due to phosphorus-related impairment. Per the NPDES permit public notice dated October 30, 2020, the West Shoal Creek segment OIM-02, which receives discharge from the City's WWTF, was listed for aquatic life impairment due to dissolved oxygen (DO) and temperature. Illinois EPA removed this aquatic life impairment designation in the 2020/2022 303(d) list.

The City contracted with Geosyntec Consultants, Inc. (Geosyntec) in August 2023 to develop the NARP. Geosyntec's data review determined that stream segment OIM-02 is at risk of eutrophication, which would require that the City still develop the NARP to address the risk of eutrophication. Geosyntec developed the NARP based on available data and best professional judgment to address the risk of eutrophication in the West Shoal Creek segment OIM-02.

This report documents the work conducted by Geosyntec in close collaboration with the City to develop the NARP. Following this introductory chapter, Chapter 2 provides an overview of the risk of eutrophication, nutrient sources, and other factors impacting water quality and details previous water quality studies. The NARP development process, which included acquiring and analyzing data, is described in Chapter 3. Chapter 4 recommends an implementation plan and schedule to address the risk of eutrophication in West Shoal Creek.

[1] A water body with a phosphorus-related impairment is listed by Illinois EPA on the state's 303(d) list as impaired because of the presence of dissolved oxygen or "offensive conditions" (e.g., algae or aquatic plant growth).
[2] A water body is determined to be at risk at eutrophication if the levels of sestonic chlorophyll-a, pH, and dissolved oxygen are above the thresholds set by the Illinois Risk of Eutrophication Committee.

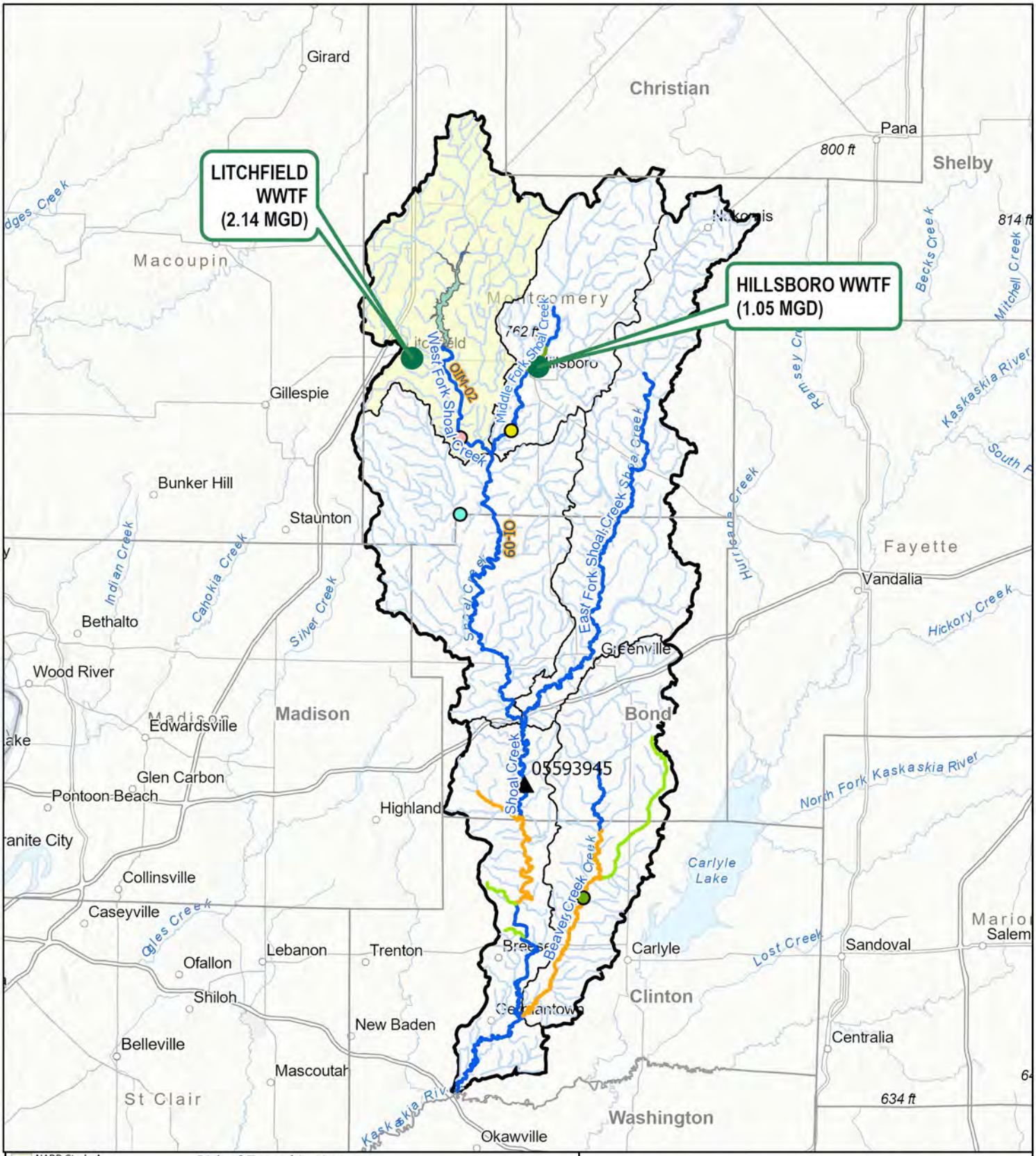
1.2 Study Area

The Study Area for the NARP is the West Shoal Creek watershed, which is the shaded area in **Figure 1**. The West Shoal Creek drains an area of 160 square miles through Montgomery, Macoupin, and Christian Counties in Southeast Illinois. The Creek flows through Lake Lou Yaeger, which serves as a primary drinking water source for Litchfield and surrounding communities.

Based on the 2021 National Land Cover Database (NLCD), land use in the Study Area is predominantly agriculture (68 percent [%]), with some urban development in and around Litchfield (**Figure 2**). Forest and hay/pasture exist along much of the riparian areas around the Creek. Most of the soil in the Study Area consists of silt loam to silty clay loam, which is classified as Hydrologic Soil Group C/D. This type of soil is poorly drained and has a high runoff potential.

The climate in the Study Area is humid continental, with an average of four distinct seasons. Summers are hot and humid, with temperatures typically ranging from the mid-70s to the low 90s (degrees Fahrenheit), while winters can be quite cold and windy, with temperatures usually hovering around freezing. Precipitation is somewhat evenly distributed throughout the year but tends to be heaviest in spring and fall. Snowfall is common during winter months. Litchfield receives an annual average of 39 inches of rain per year.

According to the 2020 United States Census, the total population of Montgomery County is 28,020 (United States Census Bureau, 2020).



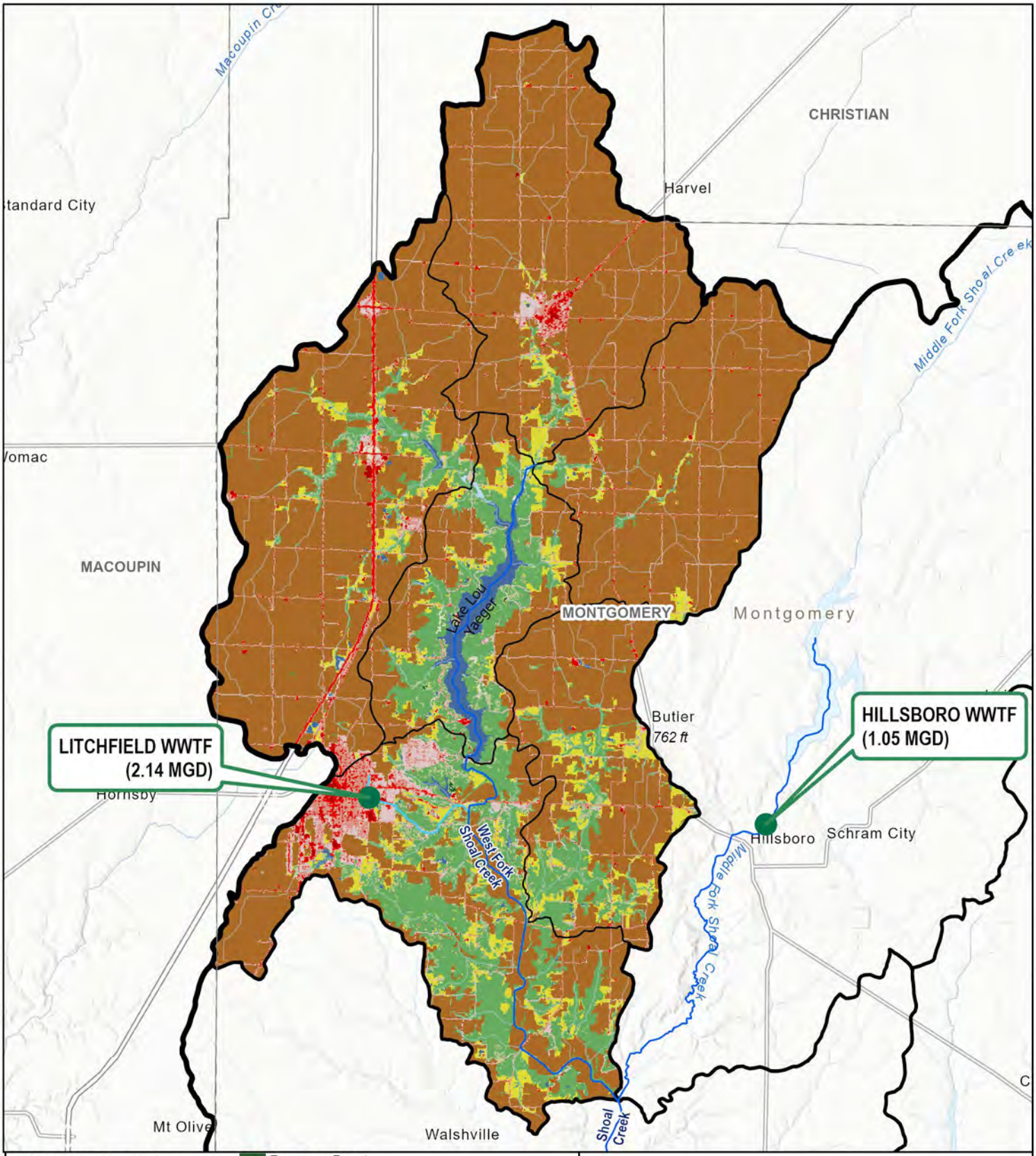
Nutrient Assessment Reduction Plan (NARP) Study Area

State of Illinois

Geosyntec consultants

Oak Brook | December 2023

Figure 1



Nutrient Assessment Reduction Plan
Study Area Land Use

State of Illinois

Geosyntec consultants

Oak Brook | December 2023

Figure 2

2. WATER QUALITY STATUS

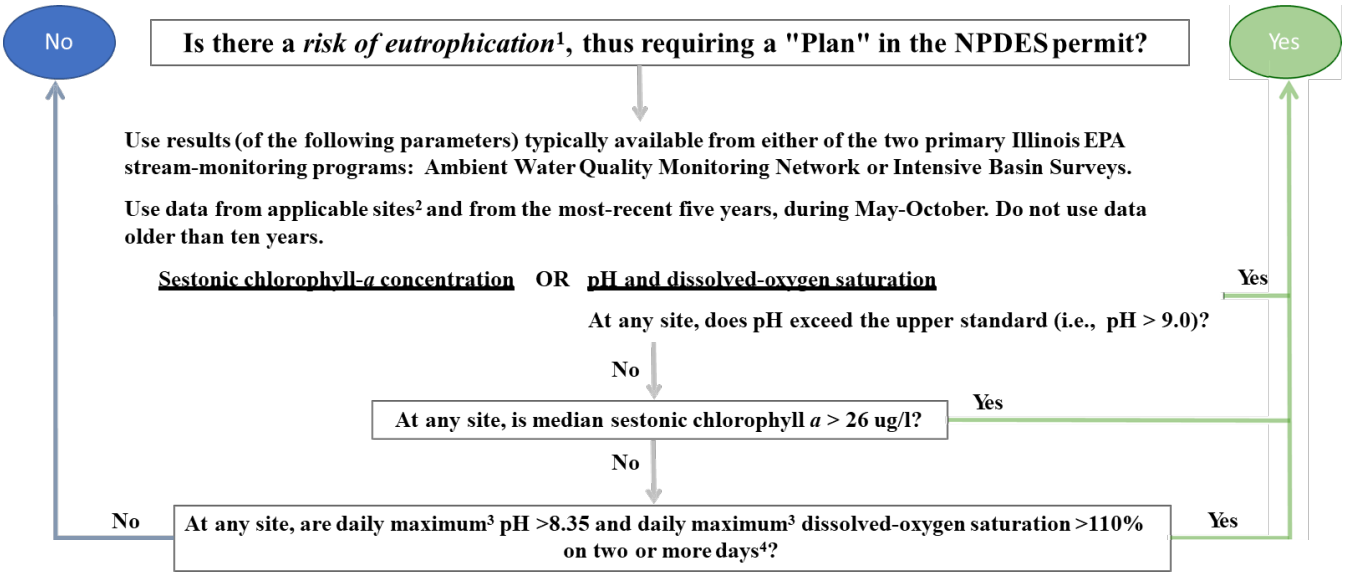
2.1 Impairment Status

The Litchfield WWTF discharges to an unnamed tributary of West Shoal Creek, which then further discharges into West Shoal Creek segment OIM-02. Segment OIM-02 discharges to Shoal Creek approximately 8.5 miles downstream of the unnamed tributary confluence. Illinois EPA had listed the West Fork Shoal Creek segment OIM-02 as impaired for aquatic life due to DO in the 2018 Integrated Water Quality Report (Illinois EPA, 2021). Consequently, the Litchfield WWTF received the NARP special condition in the NPDES permit dated December 9. 2020. However, Illinois EPA delisted the impairment for segment OIM-02 in the 2020/2022 Integrated Water Quality Report (Illinois EPA, 2022). Further, Shoal Creek (segment OIM-09) is listed as fully supporting designated uses in the 2020/2022 Integrated Water Quality Report (**Figure 1**).

2.2 Risk of Eutrophication

Illinois EPA defines the risk of eutrophication as reasonable suspicion that plant, algal, or cyanobacterial growth is causing or will cause a violation of a water quality standard in a stream segment. The Illinois EPA Risk of Eutrophication Committee developed a simple decision process to assess the risk of eutrophication by using numeric thresholds of chlorophyll-*a*, pH, and DO saturation **(Figure 3**). The numeric thresholds for pH, chlorophyll-*a*, and DO saturation levels were determined by analyzing the relationships between these parameters for data at Illinois EPA sites located throughout the state.

Using the above method for determining the risk of eutrophication, Geosyntec analyzed discrete monitoring and continuous monitoring samples collected from West Shoal Creek and Shoal Creek in 2011 and 2016. The results of the analysis indicated that Illinois EPA Station OIM-02 is at risk of eutrophication. The pH at this station exceeds the threshold of nine for two days. There were 14 days when pH and DO saturation were above their thresholds. Station OIM-02 is located approximately 8.5 miles downstream of the Litchfield WWTF. Station RON-01, located at the outlet of Lake Lou Yeager and upstream of Litchfield WWTF discharge, also exhibits risk of eutrophication.



[1] Risk of eutrophication means that there is reasonable suspicion that plant, algal, or cyanobacterial growth is causing or will cause violation of a water-quality standard.
[2] To be determined, case by case.
[3] For one-per-day results, daily maximum is represented by the single result. For many-per-day (i.e., continuously monitored) results, daily maximum is the maximum result in a discrete 24-hour period.

Figure 3: Illinois EPA Procedure for Determining Risk of Eutrophication

2.3 Previous Water Quality Studies

The previous water quality studies in the NARP Study Area are described below.

2.3.1 Lake Lou Yaeger Total Maximum Daily Load Study

Section 303(d) of the Clean Water Act and US EPA's Water Quality Planning and Management regulations require states to develop total maximum daily loads (TMDLs) for water bodies that do not meet designated uses. In 2021, the Illinois EPA commissioned the *Lake Lou Yaeger Watershed TMDL* report (CDM Smith, 2021). Within the watershed, Lake Lou Yaeger has been listed by the Illinois EPA as impaired for aesthetic quality due to total phosphorus or TP (Illinois EPA 2022). Potential sources of phosphorus to the lake include agriculture, internal nutrient recycling, and runoff from forest/grassland/parkland.

A water quality model of Lake Lou Yaeger was developed using the Simplified Lake Analysis Model framework for the TMDL. The model results indicated that phosphorus load into the lake is from external (66%) and internal (34%) sources. The TP target for the lake is 0.05 milligrams per liter (mg/L), the Illinois General Use Water Quality Standard for lakes (Illinois Administrative Code Title 35, Section 302.205). The modeling results indicated that this criterion could be met with a reduction of 75% and 89% in external and internal TP loads, respectively.

2.3.2 Lake Lou Yaeger Aquatic Ecosystem Restoration Project

The Lake Lou Yaeger Aquatic Ecosystem Restoration Project is being undertaken under the Continuing Authorities Program (CAP) of the US Army Corps of Engineers (USACE, 2016). The project is cost-shared between the federal government and non-federal sponsors. The non-federal sponsor for the project is the City of Litchfield. The project aims to restore the aquatic ecosystem of the lake by improving water quality and enhancing aquatic habitats. The project is divided into two phases: (1) Feasibility and (2) Design & Implementation. The feasibility study was completed in September 2016 and identified the existing features, hydraulic and hydrologic conditions, historic and cultural resources, natural resources, and environmental quality of the area. The study also identified the sources of pollutants such as phosphorus and total suspended solids (TSS) that impair the water quality of the lake. The project is currently in the design and implementation phase, which includes the development of an implementation plan and the execution of the recommended actions.

2.4 Nutrient Sources

The nutrient sources in the NARP Study Area include point-source loading from the WWTF and NPS loading from surface runoff. The NPS loading can be grouped into three major categories:

- Agricultural
- Urban (developed and open space in urban areas)
- Other (forest, rural grassland, surface water, and wetlands)

The annual average phosphorus loading from the WWTF was estimated using the effluent flows and TP concentrations from 2019 to 2023. The estimated annual TP loads from the WWTF for 2019 to 2023 are shown graphically in **Figure 4.**

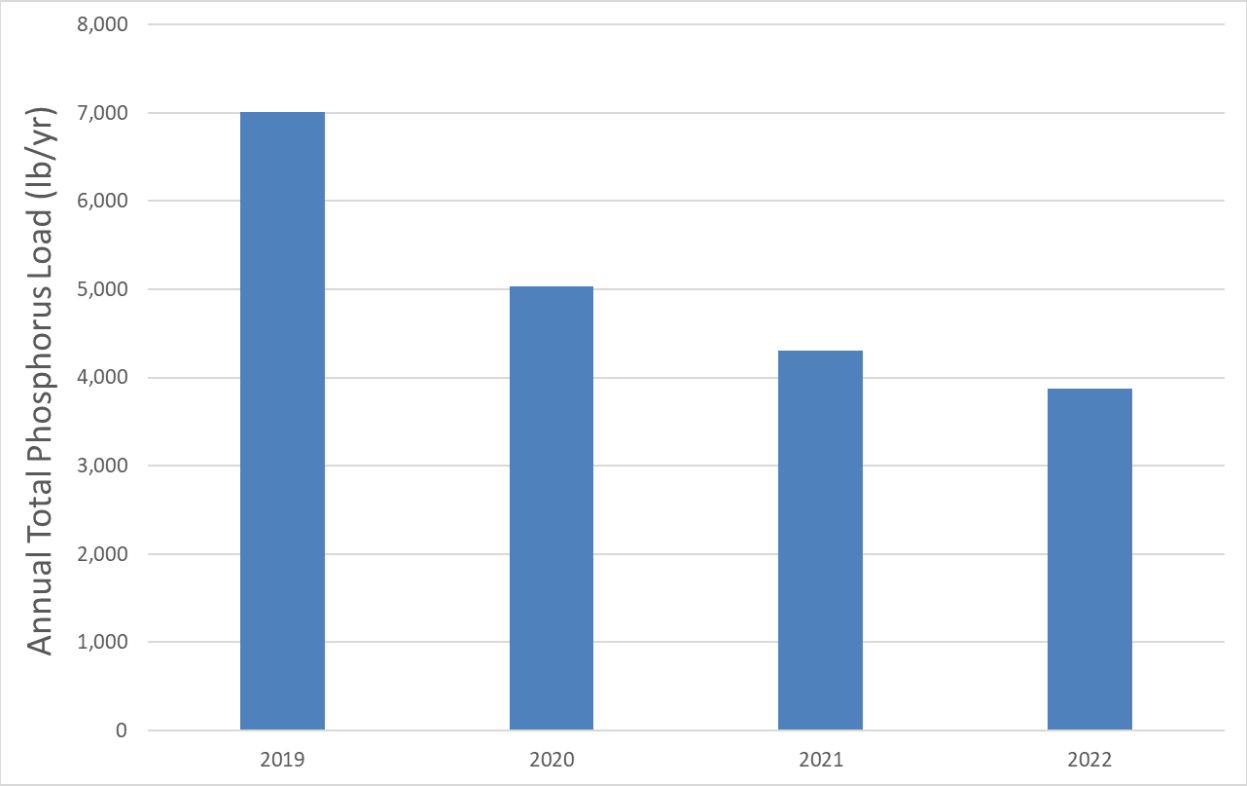


Figure 4: Estimated Annual Total Phosphorus Loading from the Litchfield Wastewater Treatment Facility

The average annual loading from NPS was estimated using the United States Environmental Protection Agency (US EPA) Pollutant Load Estimation Tool (Tetra Tech, 2022) based on the 2011 land cover data from the National Land Cover Database (Homer et al., 2015). The estimated annual average TP load (in pounds per year) and the distribution (by percentage) among the different sources within the Study Area are shown in **Figure 5**. The annual phosphorus load is dominated by agricultural sources (68%), followed by other (19%), urban (9%), and WWTF effluent discharge (4%) sources. A comparable breakdown is shown in **Figure 6** for the case where the TP discharge from the WWTF is capped at 0.5 mg/L. This analysis shows that WWTF load is the smallest source of TP loading to the West Shoal Creek, and the reduction of WWTF will not significantly impact the TP loading into the West Shoal Creek.

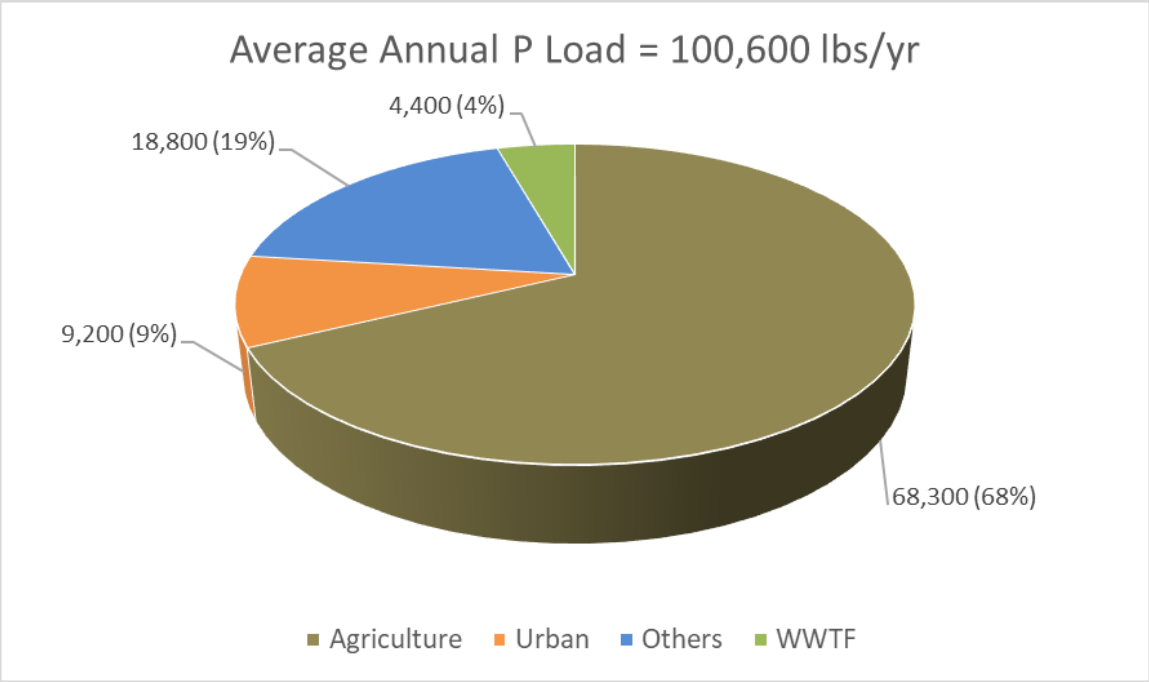


Figure 5: Estimated Average Annual Total Phosphorus Load to Study Area

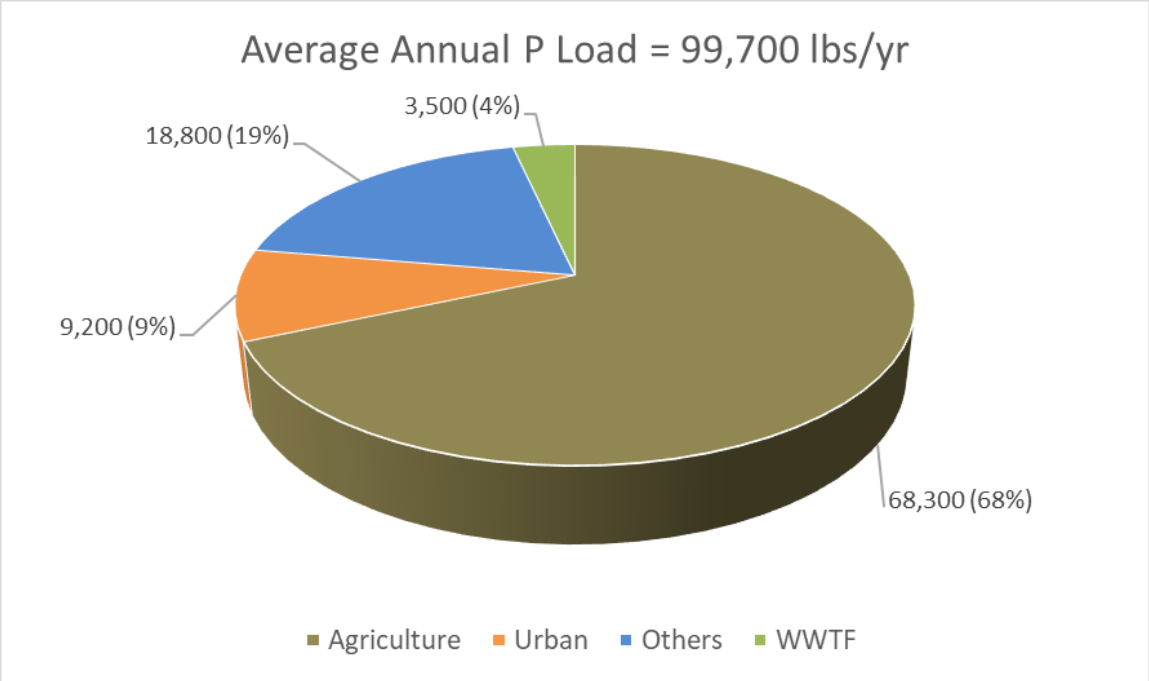
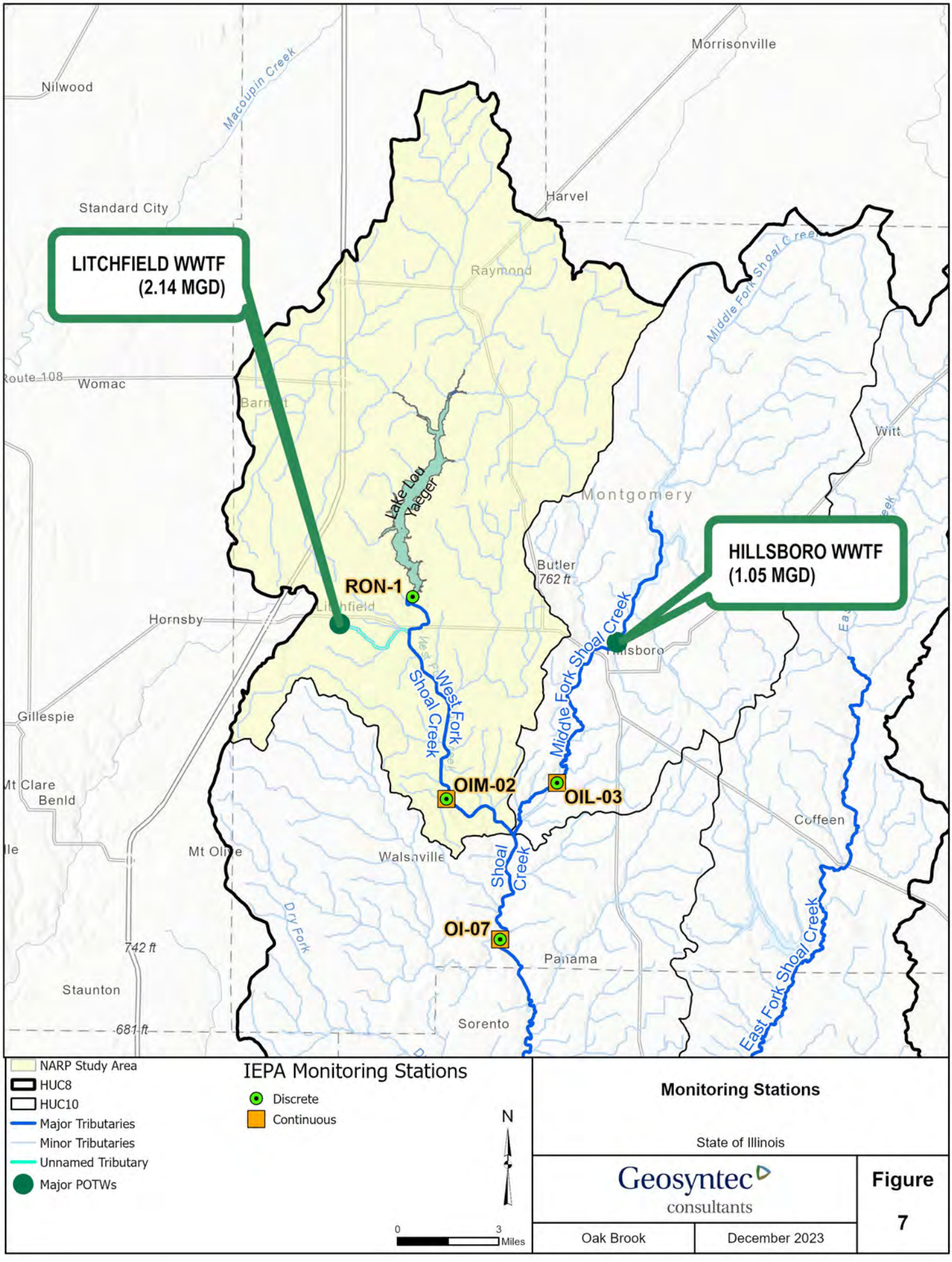


Figure 6: Estimated Annual Average Total Phosphorus Load to Study Area Assuming Total Phosphorus Concentration from the Wastewater Treatment Facility is Capped at 0.5 milligrams per liter

3. NARP DEVELOPMENT PROCESS

3.1 Data Acquisition

Geosyntec obtained data for the Shoal Creek watershed from Illinois EPA through a Freedom of Information Act (FOIA) request. The locations of Illinois EPA monitoring stations are shown in **Figure 7**. Illinois EPA collected discrete data in the NARP Study Area and surrounding watersheds from 2010 to 2023 as part of the Ambient Water Quality Monitoring Network Program, Intensive River Basin Survey, and Special Studies. The discrete samples were collected on a six-week sampling frequency and analyzed for several parameters, including field pH, temperature, specific conductance, sestonic chlorophyll-*a*, DO, suspended solids, nutrients, fecal coliform bacteria, and total and dissolved heavy metals. Illinois EPA also measured continuous DO, pH, temperature, and specific conductivity in 2012 and 2017 over a period of one to two weeks at stations OIM-02 (West Shoal Creek) and OI-07 (Shoal Creek).



Monitoring Stations

State of Illinois

Geosyntec consultants

Oak Brook | December 2023

Figure 7

3.2 Data Analysis

Geosyntec analyzed the data obtained from Illinois EPA to assess the linkage of instream TP with sestonic algae and DO. The results of the data analysis were presented to Illinois EPA on a conference call on November 14, 2023. The results of the data analysis are described below.

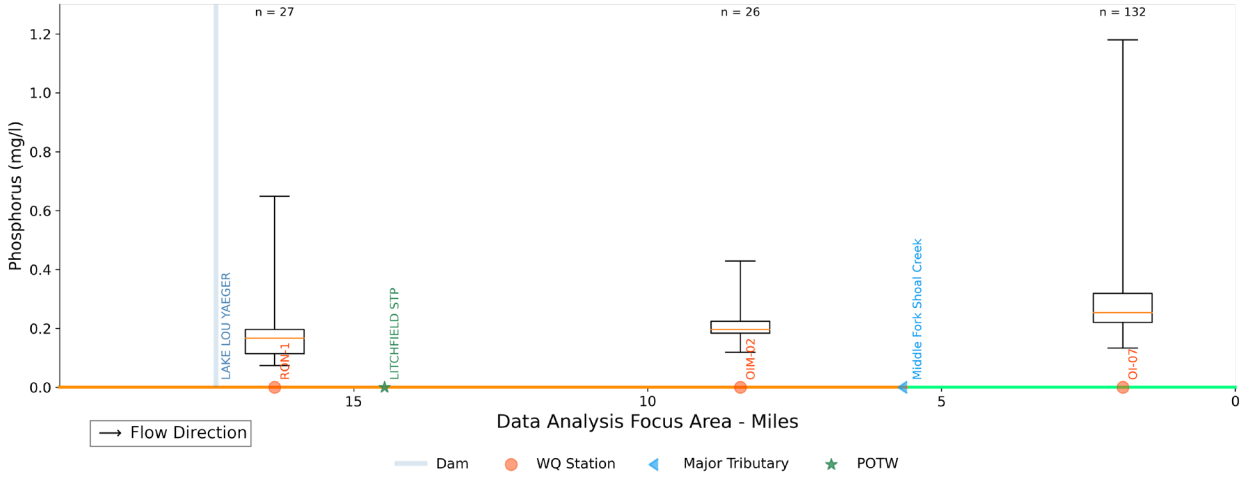
The range of available measured data TP, sestonic chlorophyll-*a*, pH DO, and DO saturation are presented in **Table 1. Figure 8** shows the longitudinal box plots[3] for measured TP, sestonic chlorophyll-*a* pH, DO, and DO saturation along West Shoal Creek and Shoal Creek from 2012 to 2022. TP values increase slightly from upstream (station RON-01) to station OIM-02, located downstream of the Litchfield WWTF discharge. However, the sestonic chlorophyll-*a* values decrease significantly along the same stretch. The measured pH exceeds the threshold of 9 more frequently at station RON-01 than at downstream station OIM-02. The measured DO in West Shoal Creek station RON-01, located upstream of Litchfield WWTF, is very low and improves downstream. Based on this data, it can be inferred that the risk of eutrophication at station OIM-02 is primarily driven by upstream flow from the lake.

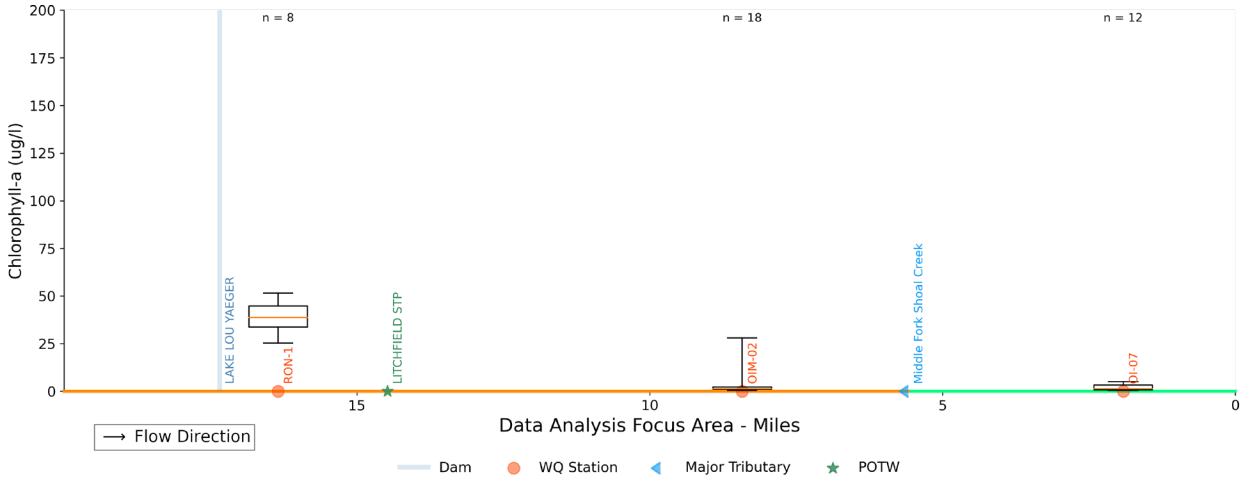
Table 1: Summary of Monitoring Results from 2010 to 2023

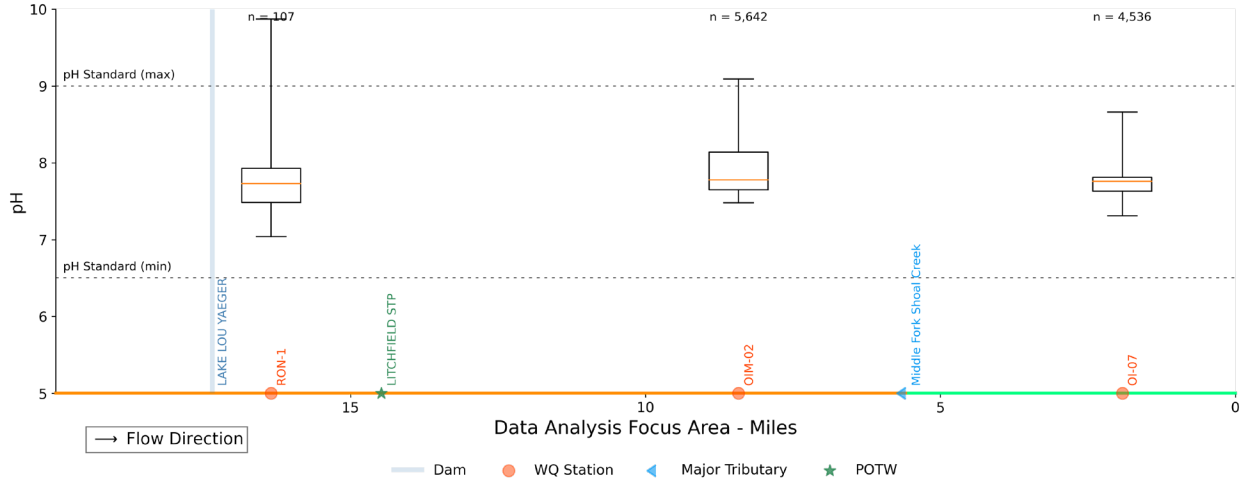
Stream	Site	TP Min – Max (Count) mg/L	Sestonic Chlorophyll-*a* Min – Max (Count) µg/L	pH Min – Max (Average, Count) SU	DO Min – Max (Count) mg/L	DOsat Min – Max (Count) percent
West Shoal Creek	RON-01[1]	0.01-0.65 (58)	25.40-87.20 (9)	7.04-9.87 (119)	0.02-21.12 (119)	0.30-263.10 (119)
	OIM-02[2]	0.08-0.43 (22)	0.53-28.00 (9)	7.48-9.09 (2,813)	3.65-15.26 (2,813)	45.60-201.00 (2,813)
Shoal Creek	OI-07[3]	0.03-1.18 (226)	0.53-5.06 (6)	7.31-8.17 (2,207)	5.82-9.52 (2,207)	67.7-118.9 (2,207)

[1] For RON-01, discrete data for all parameters (May 2012 to October 2022)
[2] For OIM-02, discrete data for TP and Sestonic Chlorophyll-a (May 2012 to October 2022); continuous data for pH, DO and DOsat (7/5-7/12/12, 9/4-9/11/12, 6/19-6/26/17, and 8/15-8/23/17).
[3] For OI-07, discrete data for TP and Sestonic Chlorophyll-a (May 2010 to June 2023); continuous data for pH, DO and DOsat (7/3-7/12/12, 9/6-9/13/12, 6/28-7/6/17, and 8/15-8/23/17).
µg/L: micrograms per liter
TP: Total Phosphorus
DO: Dissolved Oxygen
DOsat: Dissolved Oxygen saturation
mg/L: milligrams per liter

[3] Whiskers represent the minimum and maximum values, the edges of the box represent the 25th and 75th percentile values, and the central lines represents the median values. Text on top of each box shows the numbers of samples available.


n = 27
n = 26
n = 132
Phosphorus (mg/l)
1.2
1.0
0.8
0.6
0.4
0.2
0.0
LAKE LOU YAEGER
RON-1
LITCHFIELD STP
OIM-02
Middle Fork Shoal Creek
OI-07
15
10
5
0
Data Analysis Focus Area - Miles
Flow Direction
Dam
WQ Station
Major Tributary
POTW


n = 8
n = 18
n = 12
Chlorophyll-a (ug/l)
200
175
150
125
100
75
50
25
0
LAKE LOU YAEGER
RON-1
LITCHFIELD STP
OIM-02
Middle Fork Shoal Creek
OI-07
15
10
5
0
Data Analysis Focus Area - Miles
Flow Direction
Dam
WQ Station
Major Tributary
POTW


n = 107
n = 5,642
n = 4,536
pH
10
9
8
7
6
5
pH Standard (max)
pH Standard (min)
LAKE LOU YAEGER
RON-1
LITCHFIELD STP
OIM-02
Middle Fork Shoal Creek
OI-07
15
10
5
0
Data Analysis Focus Area - Miles
Flow Direction
Dam
WQ Station
Major Tributary
POTW

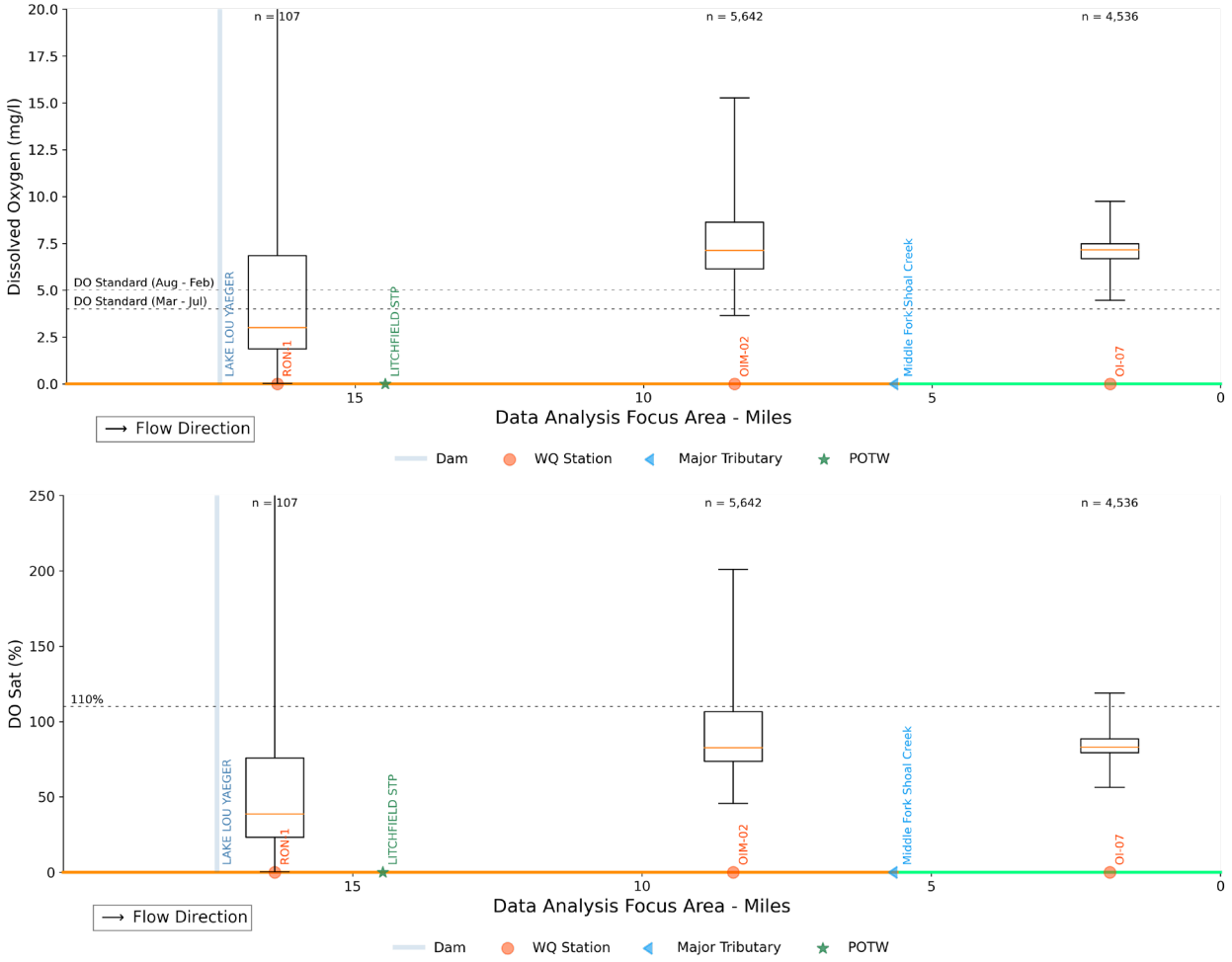


Figure 8: Longitudinal Plots of Total Phosphorus, Sestonic Chlorophyll-a, pH, Dissolved Oxygen, and Dissolved Oxygen Saturation along West Shoal Creek and Shoal Creek from 2012 to 2022

3.3 Mass Balance Analysis

Geosyntec conducted a mass balance analysis to assess the impact of reducing the WWTF TP concentrations on the instream TP levels in the West Shoal Creek downstream of the WWTF. The mass balance was conducted for the four survey dates in 2022 when instream data at station RON-01.

A mean average flow of 63.4 cubic feet per second was assumed for the upstream boundary based on US EPA Region 5 Working Paper No 310 (US EPA, 1975). Instream monitoring data for station RON-1 was used for the upstream boundary concentration. The mass balance was performed using the WWTF monitoring data (daily flow and discrete TP samples) to estimate the downstream TP concentrations. The estimated TP concentrations were then used as the baseline for comparison to future scenarios. The mass balance was applied to simulate future scenarios where the WWTF TP concentration was set to 0.5 mg/L and 0.1 mg/L, keeping the upstream inputs and WWTF flow similar to the baseline.

Table 2: Comparison of Estimated Total Phosphorus Concentrations Downstream of the Wastewater Treatment Facility for the Baseline and Future Scenarios

Date[1]	Baseline	TP 0.5 mg/L Scenario	TP 0.1 mg/L Scenario
5/25/2022	0.10	0.10	0.10
6/16/2022	0.25	0.15	0.14
7/19/2022	0.40	0.40	0.37
9/28/2022	0.19	0.18	0.17

[1] Dates in 2022 when instream monitoring data at the upstream boundary was available

The results of the mass balance calculations show that reducing the WWTF effluent TP beyond 0.5 mg/L would not have a significant impact on downstream TP levels in West Shoal Creek (**Table 2**).

3.4 Key Takeaways from Analysis

The key takeaways from the data review and mass balance calculations are summarized below.

3.4.1 Key Takeaway #1: Reducing phosphorus beyond 0.5 mg/L at the wastewater treatment facility under the current conditions has minimal impact on water quality.

The mass balance analysis results (**Table 2**) show that reduction of TP effluent concentrations beyond 0.5 mg/L will not significantly impact the downstream instream TP levels under current conditions. The WWTF TP loading constitutes approximately 4% of the annual average TP loading to the West Shoal Creek under the existing condition. Reduction of the WWTF effluent TP concentration to 0.5 mg/L would result in a reduction of approximately 21% in the WWTF TP load but would not substantially impact the total loading to the Creek (**Figure 6**).

3.4.2 Key Takeaway #2: Reducing high algal loads from Lake Lou Yaeger is required to reduce the high algae levels in West Shoal Creek.

Lake Lou Yaeger shows elevated levels of sestonic chlorophyll-*a*, which are flushed into the West Shoal Creek. Therefore, a reduction in algae levels from the lake is required to address the high levels in the Creek.

3.4.3 Key Takeaway #3: Reducing agricultural phosphorus loads is required to significantly reduce the loading into West Shoal Creek.

Agriculture contributes more than 68% of the annual TP loading to the Creek in the watershed (**Figure 5**). Therefore, a reduction in agricultural loading is required to significantly reduce loading into the Creek.

4. IMPLEMENTATION PLAN AND SCHEDULE

The work completed for the NARP focused on identifying management actions to eliminate DO and nuisance algae impairments. This section presents the recommended management actions for addressing the risk of eutrophication in the Study Area. Recommended actions fall under the following categories:

- WWTF upgrades
- Actions to reduce NPS loading
- Actions to reduce loading from Lake Lou Yaeger
- Monitoring studies

The recommended actions include shorter-term actions that can be implemented prior to 2033 and longer-term priorities for implementation after 2033. An implementation schedule with realistic milestones has been developed to allow the City and other watershed stakeholders to pursue and utilize funds more effectively. The pre- and post-2033 recommended actions, along with key stakeholders and potential funding sources, are summarized in **Table 3** and described below.

4.1 Wastewater Treatment Facility Phosphorus Reduction

The Litchfield WWTF uses chemical addition (alum) for TP reduction and is currently meeting the required TP effluent limit of one mg/L monthly average. The NPDES permit Special Condition 23 requires the WWTF to meet a TP effluent limit of 0.5 mg/L by January 1, 2030. The City has already submitted to the Illinois EPA a Phosphorus Reduction Feasibility Study and Discharge Optimization Plan (CMT, 2021) required by Special Conditions 20 and 21 of the NPDES permit. The City has hired Crawford Murphy and Tilly to develop a Capital Improvement Plan (CIP) to upgrade the WWTF. Additional upgrades to the WWTF to meet the limit of 0.5 mg/L will be determined in the CIP process. Based on the data analysis, TP reduction beyond the limit of 0.5 mg/L is not recommended.

4.1.1 Stakeholder Engagement

The stakeholders for the WWTF upgrade include the City, its ratepayers, and Illinois EPA. It will be important to communicate information about needed upgrades with these stakeholders to help ensure that the required upgrades get funded.

4.1.2 Potential Funding Sources

The sources of funding for WWTF include the City budget and the State Revolving Fund Program.

4.2 Actions to Reduce Nonpoint Sources

The NPS loading to the Creek includes agriculture and urban sources. Agriculture contributes more than 68% of the TP load into the West Shoal Creek. Therefore, it is essential to reduce phosphorus loading from agriculture to the Creek. This would warrant a select group of best management

practices (BMPs) that are conducive to capturing and treating water in a rural field setting. Engaging agricultural communities in collaborative efforts to reduce NPS pollution is a strategy that has been widely adopted to aid instream water quality improvements. Although attribution and quantification remain challenging, field-level research documents the benefit of implementing in-field, edge-of-field, and structural practices to decrease field runoff.

Recommended practices to reduce agricultural loading include traditional practices such as improved nutrient management, cover crops, grassed waterways, riparian buffers, filter strips, and innovative practices such as iron sand filters and agricultural runoff treatment systems (ARTS).

The urban sources of loading into the West Shoal Creek include direct runoff and combined sewer overflows (CSOs). The City has developed a combined sewer pollution prevention plan (PPP) and operations and maintenance (O&M) plan, which has been approved by Illinois EPA. The O&M plan includes weekly street sweeping, ditch cleaning, cleaning of street and curb inlets, and cleaning of culverts. The City continues to implement the recommendations of these plans to control pollution from urban sources.

Additional programmatic recommendations for the reduction of phosphorus loading for the City's consideration include the following:

- Evaluate opportunities for implementation of BMPs that reduce phosphorus, such as pretreatment devices, retention basins, and filtration BMPs.
- Periodically review communal practices in relation to seasonal street sweeping and leaf litter pickup. The City's street sweeping program runs year-round, with higher volumes during the spring and fall. The City also performs leaf and brush pickup at a minimum of two months per year in the spring and fall and then runs short programs at different times in the summer.
- Continue to promote the construction and retrofitting of stormwater detention facilities.

4.2.1 Stakeholder Engagement

The City may explore opportunities for engaging the agricultural community in the application of these recommended practices. This could be done through the Illinois Farm Bureau, county farm bureaus, and the Montgomery County Soil and Water Conservation District. Innovative technologies (e.g., iron sand filters, ARTS) can be merged with traditional practices (e.g., cover crop, no-till). The City could work with the agricultural community to identify farm practitioners for pilot demonstration projects. After the initial projects, the City could further investigate opportunities for the adoption of BMPs and strategic alliances with the agricultural community to shore up marginal lands, switching them from limited agricultural returns to areas of beneficial nutrient capture while investigating the means to programmatically fund the design and construction of the needed facilities to reduce agricultural loading. The above strategy would tie in well with the goals of the Illinois Nutrient Loss Reduction Strategy (Illinois EPA et al., 2015).

Farmers make decisions to implement conservation practices based on multiple considerations, including bottom-line cost, land tenure, soil productivity, and peer norms, beliefs, and attitudes. Access to information can also affect how these decisions are made. Programs to increase conservation adoption should consider how all these factors come together to affect land management decisions and associated practices. Financial assistance has traditionally been offered to incentivize farmers to change their work practices or try something new. Recent research suggests that additional tactics that can successfully address NPS agricultural runoff include working in localized, smaller watersheds, aligning cost-share incentives to target the highest contributors, and promoting adoption of conservation systems (e.g., by adopting a graduated cost-share rate that supports multi-practice adoption). A targeted and tailored outreach and engagement strategy is equally important.

4.2.2 Potential Funding Sources

Potential funding sources for agriculture-related implementation practices include the Agricultural Conservation Easement Program, Conservation Reserve Program, Conservation Stewardship Program, Environmental Quality Incentives Program, Wetland Program Development Grants, and the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Regional Conservation Partnership Program (RCPP). The Conservation Fund (TCF) and its partners are offering financial assistance to farmers in Illinois to implement conservation practices that promote soil health, production diversity, and healthy waters and habits through the RCPP. The initiative is called the Illinois Working Lands, Water & Wildlife Conservation Partnership. Thirty-two of the 60 eligible practices under the program would reduce the phosphorus loading to the Creek.

4.3 Actions to Reduce Loading from Lake Lou Yaeger

The Lake Lou Yaeger Aquatic Ecosystem Restoration Project recommended the construction of an in-lake rock structure (berm) that would retain the sediment entering the northern part of the lake (USACE, 2016). The construction of the berm would result in the restoration of 32 acres of emergent wetland upstream of the berm and also restore the aquatic habitat downstream. This project is also anticipated to reduce the phosphorus loading into the lake since inorganic phosphorus is typically bound to sediments. The estimated cost of the project is $818,000, with the City anticipated to provide a 35 percent cost share as the non-federal partner. This City's cost share will include credit for the acquisition of easements. The City may evaluate other measures to address high algae levels in the lake.

4.3.1 Stakeholders

The stakeholders in the effort to reduce Lake Lou Yaeger loading include the City, USACE, and Illinois EPA.

4.3.2 Potential Funding Sources

The potential funding sources include Illinois EPA Section 319 grants, USACE Section 206 Funding, and the City budget.

4.4 Monitoring Studies

The City will undertake two monitoring programs to support the implementation of the NARP.

4.4.1 Monitoring to Support NPDES Permitting

The City will continue to undertake monitoring to meet the requirements of the WWTF's NPDES permit.

4.4.2 Post-2033 Monitoring Study

The City will consider conducting a monitoring study after 2033. The results of the study could be used to assess the impact of implemented management actions at the WWTF, Lake Lou Yeager, and NPS BMPs.

Table 3: Implementation Plan and Schedule for the Litchfield NARP

Category	Pre-2033	Post-2033	Key Stakeholders	Potential Funding Sources
Wastewater Treatment Facility (WWTF) Upgrades	Develop a Capital Improvement Plan to support the WWTF upgrades requires			City Capital Budget
	Meet a 0.5 milligram per liter (mg/L) total phosphorus (TP) effluent limit (12-month rolling geometric mean, calculated monthly) by December 31, 2030	Monitor the impact of 0.5 mg/L effluent on attainment of mainstem dissolved oxygen (DO) swings and algal growth	City; Illinois Environmental Protection Agency (Illinois EPA)	City Capital Budget State Revolving Fund
Actions to Address Nonpoint Source Loading	Collaborate with the Montgomery County Soil and Water Conservation District to support the implementation of best management practices (BMPs) if grant funding is available	Continue to support the implementation of identified projects if grant funding is available	City; Illinois Farm Bureau; Natural Resources Conservation Service (NRCS); The Conservation Fund; Montgomery County SWCD; Illinois Department of Agriculture (IDOA); NRCS	American Farmland Trust; Illinois EPA Section 319; NRCS
	Explore opportunities to engage in implementation programs like the Regional Conservation Partnership Program (RCPP)			
	Continue to implement recommendations of the Combined Sewer Overflow (CSO) Pollution Prevention Plan (PPP) and Operations and Maintenance (O&M) Plan	Continue to implement recommendations of CSO PPP and O&M Plan	City	City Capital Budget
	Continue communal practices in relation to seasonal street sweeping and leaf litter pickup	Encourage a targeted leaf collection program.		

Category	Pre-2033	Post-2033	Key Stakeholders	Potential Funding Sources
Actions to Address Nonpoint Source Loading	Evaluate opportunities for implementation of BMPs such as pretreatment devices, retention basins, and filtration BMPs		City	City Capital Budget; Illinois EPA Section 319 Grants
Action to Reduce Lake Lou Yaeger loading	Support design and implementation of in-lake rock structure to reduce sediment loading		US Army Corps of Engineers (USACE), City	USACE Section 206 Funding; City Capital Budget; Illinois EPA Section 319 Grants
	Evaluate additional options to reduce algae levels in the lake	Implement feasible options to reduce sediment loading to the lake		
Monitoring Studies		Implement monitoring program, assess the impact of WWTF upgrades	City; Illinois EPA	City Capital Budget; Illinois EPA Section 604(b)
	Monitoring to meet the National Pollutant Discharge Elimination System (NPDES) permit requirements for WWTF and CSO	Continue monitoring		City Capital Budget

5. REFERENCES

CDM Smith. 2021. *Lake Lou Yaeger Watershed Final TMDL Report.* Prepared for Illinois EPA. February 2021

Crawford, Murphy & Tilly, 2021. *Phosphorus Reduction Feasibility Study and Discharge Optimization Plan.* Prepared for the City of Litchfield, IL

Homer, C. G., Dewitz, J. A., Yang, L., Jin, S., Danielson, P., Xian, G., Coulston, J., Herold, N. D., Wickham, J. D., & Megown, K. 2015. *Completion of the 2011 National Land Cover Database for the conterminous United States - Representing a decade of land cover change information*. Photogrammetric Engineering and Remote Sensing 81(5), 345-354.

Illinois EPA, Illinois Department of Agriculture, and University of Illinois Extension 2015. *Illinois Nutrient Loss Reduction Strategy*. Illinois Environmental Protection Agency and Illinois Department of Agriculture; Springfield, Illinois. University of Illinois Extension; Urbana, Illinois.

Illinois EPA. 2022. *Illinois Integrated Water Quality Report and Section 303(d) List, 2020/2022. Clean Water Act Sections 303(d), 305(b), and 314. Water Resource Assessment Information and List of Impaired Waters*. Illinois Environmental Protection Agency. June 2022.

Illinois EPA. 2021. *Illinois Integrated Water Quality Report and Section 303(d) List, 2018. Clean Water Act Sections 303(d), 305(b), and 314. Water Resource Assessment Information and List of Impaired Waters. Illinois Environmental Protection Agency*. February 2021

Tetra Tech. 2022. *Users Guide Pollutant Load Estimation Tool (PLET). Version 1.0*. Developed for the United States Environmental Protection Agency by Tetra Tech, Inc.

US Army Corps of Engineers (USACE). 2016. *Lake Lou Yaeger Aquatic Ecosystem Restoration Project Continuing Authorities Program, Section 206*. Draft Feasibility Report. Prepared for the City of Litchfield, Montgomery County, Illinois, and USACE St. Louis District

United States Census Bureau. 2020. "Illinois: 2020 Census." *State Profiles: 2020 Census*. https://www.census.gov/library/stories/state-by-state/illinois-population-change-between-census-decade.html.

United States Environmental Protection Agency (EPA). 1975. *Report on Lake Lou Yaeger, Montgomery County, Illinois. Working Paper No. 310*. US EPA Region 5. June 1974