

# NUTRIENT ASSESSMENT REDUCTION PLAN

## WORKPLAN FOR THE NORTH BRANCH CHICAGO RIVER, ILLINOIS

*Submitted to*

**North Branch Chicago River Watershed Workgroup**

*Submitted by*

**Geosyntec** 

consultants

engineers | scientists | innovators

December 2021

## TABLE OF CONTENTS

SECTION 1 Introduction.....	1-1
1.1 Purpose.....	1-1
1.2 NARP Development Process.....	1-4
1.3 NARP Objectives.....	1-6
1.3.1 NARP Objective 1 .....	1-6
1.3.2 NARP Objective 2 .....	1-6
1.3.3 NARP Objective 3 .....	1-7
1.4 Workplan Organization.....	1-7
SECTION 2 Existing Data Review.....	2-1
2.1 Summary of Data Reviewed .....	2-2
2.1.1 MBI 2018 & 2019 Bioassessment Reports.....	2-2
2.1.2 MBI SNAP vs Illinois EPA Risk of Eutrophication.....	2-2
2.1.3 Northeastern IL Sediment Oxygen Demand ISWS Report .....	2-5
2.1.4 NBCR Draft Watershed Plan.....	2-5
2.1.5 Flow Data .....	2-5
2.1.6 Precipitation and Climate Data.....	2-5
2.1.7 Water Quality Data.....	2-5
2.2 Phosphorus-Related Impairments in the NBCR .....	2-5
2.3 Summary .....	2-8
SECTION 3 Targeted Monitoring for NARP Development .....	3-1
SECTION 4 Recommended NARP Approach .....	4-4
4.1 Scope of Work for NARP Development .....	4-4
4.1.1 Phase I: Conduct Targeted Data Collection and Data Analysis ..	4-4
4.1.2 Phase II: Develop Modeling Tools.....	4-6
4.1.3 Phase III: Simulate Watershed Management Scenarios .....	4-6
4.1.4 Phase IV: Prepare Implementation Plan and Schedule .....	4-6
4.2 Cost for NARP Development .....	4-7
4.1 Schedule for NARP Development.....	4-8
SECTION 5 References .....	5-1

**LIST OF TABLES**

Table 1: Summary of Water Quality Data for NBWW Stations ..... 2-8  
Table 2: Summary of Recommended Stations for Targeted Sampling ..... 2-8  
Table 3A: Estimated Budget for NBWW NARP Development: Outcome A ..... 4-7  
Table 3B: Estimated Budget for NBWW NARP Development: Outcome B..... 4-7

**LIST OF FIGURES**

Figure 1: Major POTWs in the North Branch Chicago River Watershed ..... 1-3  
Figure 2: Suggested NARP Development Process ..... 1-4  
Figure 3: Meteorological and Flow Data Sources ..... 2-1  
Figure 4: IEPA RoE Determination Workflow ..... 2-3  
Figure 5: MBI Stations & Illinois Risk of Eutrophication..... 2-4  
Figure 6: Recommended Sites for Targeted Data Collection ..... 3-3  
Figure 7: Recommended Approach for Development of NBWW NARP ..... 4-5

**LIST OF APPENDICES**

Appendix A NBWW Committees and Geosyntec Project Team  
Appendix B Summary of Existing Data Review  
Appendix C Illinois EPA Meeting Presentation

## SECTION 1

### INTRODUCTION

#### 1.1 Purpose

The requirement to develop a Nutrient Assessment Reduction Plan (NARP) is being incorporated in many Illinois National Pollutant Discharge Elimination System (NPDES) permits for major publicly owned treatment works (POTWs) that discharge into a receiving water body which is impaired or at risk of eutrophication (RoE). In addition, there are conditions in the Municipal Separate Storm Sewer System (MS4) general permit that require permittees to provide a schedule for meeting waste load allocations in total maximum daily loads (TMDLs) or watershed management plans.

The purpose of the NARP is to identify phosphorus input reductions and other measures needed to help ensure that dissolved oxygen (DO) and offensive aquatic algae and aquatic plant criteria are met throughout a watershed. The NARP will therefore substitute for a TMDL to meet these numeric and narrative criteria. The NARP differs from a TMDL by allowing watershed groups to evaluate the appropriate water quality targets, adjust them if they are appropriate and necessary, and implement the NARP through adaptive management. Illinois EPA's expectations for the NARP, however, have not been articulated.

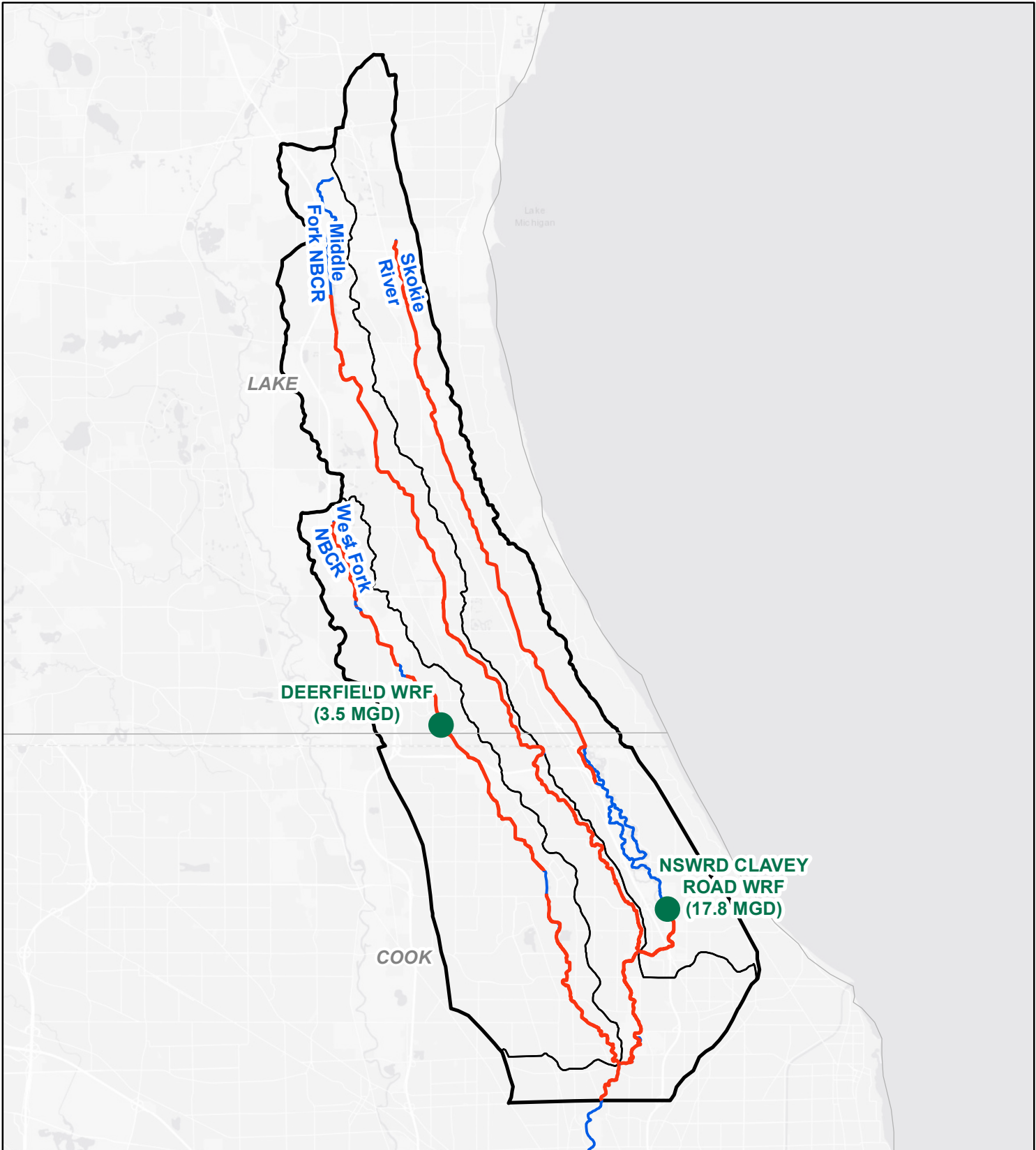
The North Branch Chicago River Watershed Workgroup (NBWW or Workgroup) is a voluntary, dues paying organization with a mission to bring together a diverse coalition of stakeholders to work together to improve water quality in the North Branch of the Chicago River (NBCR) watershed, cost-effectively to meet Illinois EPA NPDES permit requirements. The NBWW is committed to an approach for attaining water quality standards that focuses on stakeholder involvement, monitoring, and locally led decision-making based on sound science.

Membership consists of municipalities and agencies with MS4s, POTWs, and other interested parties. Dues include a fixed component, a variable amount based on the design average flows for POTWs and a drainage area within the watershed for MS4s. Dues are weighted so that POTWs will be responsible for one-third of the annual NBWW budget, and MS4s and other NPDES permit entities will be responsible for two-thirds of the annual budget.

The NBWW intends to develop a NARP by December 31, 2024. This is a significant effort and will require that the NBWW evaluate the management objectives for the NARP, assess data gaps that need to be filled, collect data to fill the gaps, develop tools (such as models) to assist with evaluating targets and management scenarios, and apply the tools to reach consensus on specific projects to be included in the NARP. The NBWW hired Geosyntec Consultants (Geosyntec) to develop a preliminary workplan to identify the scope, schedule, and budget for subsequent work required to produce the NARP over the next three years.

NBWW has also hired Midwest Biodiversity Institute (MBI) to develop an Integrated Prioritization System (IPS) tool to identify the most limiting stressors in receiving streams based on comprehensive monitoring and assessment. The NBWW intends to utilize the findings of the NARP and IPS tool concurrently to achieve water quality goals in the watershed. The results of the NARP will likely be used in the IPS tool.

This report documents the work done by Geosyntec to develop a preliminary workplan for the development of a NARP for the NBCR on behalf of the NBWW.



**Legend**

- North Branch Chicago River Watershed
- Subwatersheds
- Counties
- Major POTWs Discharge
- Major Tributaries
- 2018 IEPA 303(d) Impaired Streams
- DO & TP



**NBWW Location Map**  
(Illinois)



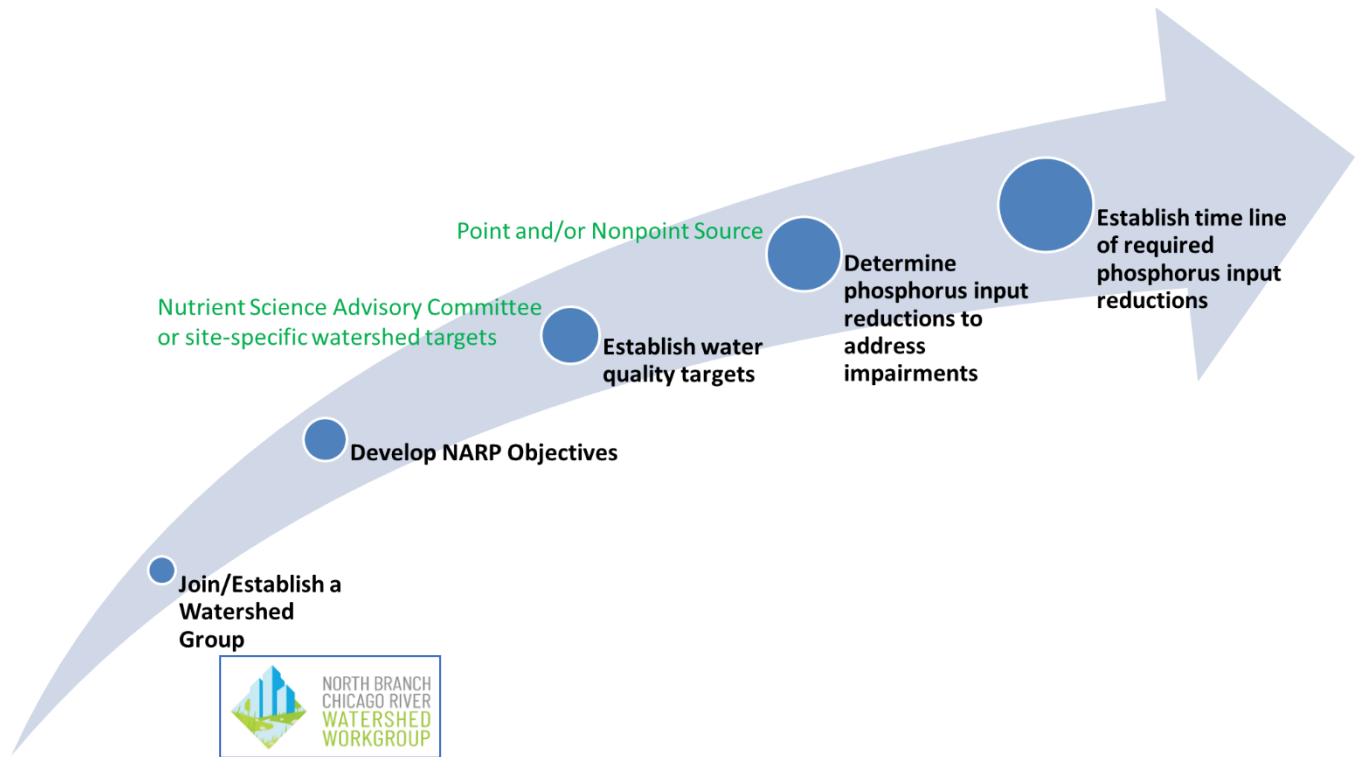
**Figure**  
**1**

(Oak Brook)

November 2021

## 1.2 NARP Development Process

A suggested NARP development process is shown in **Figure 2**. This figure is based on the language provided by Illinois EPA in the NPDES permits of NBWW members.



**Figure 2: Suggested NARP Development Process**

Geosyntec worked closely with Executive Board President Brandon Janes, Monitoring & Water Quality Impairment Abatement Committee Chair Rob Flood, and NBWW Coordinator Ashley Strelcheck on all final decisions regarding the development of the workplan and approach for the NARP (**Attachment A** – Geosyntec team and NBWW Coordinating members). Geosyntec conducted eight (8) presentations with the NBWW which consisted of the Executive Board, Monitoring Committee, and open membership meetings. In addition, due to time constraints and the need to obtain additional feedback, Geosyntec worked with the NBWW to facilitate meetings with outside stakeholder groups. Key meetings are briefly summarized below.

- Kickoff meeting (3/10/21 – Executive Board Meeting):
  - Identify overview and components of a NARP Process
  - Discuss potential NARP Outcomes for the NBWW
  - Discuss data review process
  - Discussion of preliminary objectives of a NARP
  - Review of Geosyntec’s proposed scope of work and schedule
- Impairments discussion meeting (4/14/21 – Executive Board Meeting):

- Status update on preliminary data review
- Introduction to the concept that the NBCR and tributaries did not appear to demonstrate the traditional linkage between phosphorus, algal growth, and DO impairments
- Data review ongoing
- Not-for-Profit / Non-Governmental Organization (NFP/NGO) stakeholder meeting (5/04/21 – Special Executive Board Meeting):
  - Introduce and integrate NFPs/NGOs into the NBWW NARP process
  - Educate the NFPs/NGOs on the purpose of the NARP in Illinois and, more specifically, in the NBCR
  - Discuss the regulatory framework of the NARP within the NBWW
  - Update and inform stakeholders that initial data review suggests that DO problems in the waterways may not be due to nutrients
  - Discuss potential contradictions of data and MBI interim modified Stream Nutrient Assessment Procedure (SNAP)
  - Discuss the need for a follow up meeting
- Low DO discussion (6/30/21 – Internal Discussion Meeting):
  - Review total temporal coverage of data monitoring stations
  - Discuss differences between MBI SNAP and EPA RoE criteria
  - Highlight and discuss potential non-nutrient factors driving DO impairments
    - Topography
    - Flow regime
    - Sediment oxygen demand
  - Discuss preliminary hypothesis and how that may shape the NARP process moving forward
- Data review meeting (7/14/21 – Executive Board Meeting):
  - Discussion of work completed, and data reviewed to date
  - Presentation of MBI nutrient enrichment criteria cross-compared to Illinois EPA RoE criteria and discussion of possible discrepancies
  - Walkthrough of the potential targeted data collection program
  - Discussion of potential for DO being driven by non-nutrient factors
  - Discussion of how targeted collection program can be used as a mechanism to confirm non-nutrient driven impairment and drive NARP development for NBWW
- Check-in meeting with Illinois EPA (7/29/21):
  - Presented findings to Illinois EPA based on available data and work performed to date
  - Presented recommendations, including the need for a targeted data collection program to ground truth MBI SNAP and test Geosyntec hypotheses
  - Present and discuss suggested non-nutrient factors causing DO impairment in several monitoring sites within the NBCR and tributaries



- Illinois EPA, in concurrence with the approach, suggested the addition of station on mainstem NBCR at Dempster St. (Station MF-19).
- NFP/NGO stakeholder follow up meeting (8/4/21):
  - Review presentation and discussion materials presented to NBWW and Illinois EPA regarding monitoring locations within the watershed that deviate from more traditional nutrient impairment
  - Discuss the proposed approach to monitor specific sample locations further to verify (or discount) non-nutrient factors
  - Discuss Illinois EPA support for the approach
  - Request feedback

### 1.3 NARP Objectives

Geosyntec recommended three potential objectives for the development of the NARP. These included:

- 1) Determine underlying causes of water quality impairments. If impairments are not phosphorus driven, document the potential sources of those impairments.
- 2) Determine phosphorus reductions/other measures needed to address phosphorus-related impairments in the watershed.
- 3) Develop a plan to track the success of proposed measures.

#### 1.3.1 NARP Objective 1

**Determine underlying causes of water quality impairments. If impairments are not phosphorus driven, document the potential sources of those impairments.**

The NBWW NARP process will help assess the impairment sources within the watershed. While certain water bodies, such as portions of the Skokie River, demonstrate a more traditional DO response due to the presence of chlorophyll-a, there are several other monitoring locations throughout the watershed that do not. For this reason, in conjunction with the NBWW Monitoring and Water Quality Impairment Abatement Committee, we have developed a targeted monitoring approach that will help identify additional considerations that may be tied to underlying instream sediment and other constituents.

#### 1.3.2 NARP Objective 2

**Determine phosphorus reductions/other measures needed to address phosphorus-related impairments in the watershed.**

The NBWW NARP will determine phosphorus reductions needed to achieve site-specific water quality targets where applicable. These phosphorus reductions may include reductions from point sources such as municipal and industrial dischargers and non-point sources such as MS4s or streambank erosion. The NARP will also document areas where DO impairment is not phosphorus driven.

### **1.3.3 NARP Objective 3**

#### **Develop a plan to track the success of proposed measures.**

The NBWW NARP will identify a schedule for the workgroup to structure and chart improvements from implementation measures. Various measures will be evaluated during the development of the NARP and coordinated with the workgroup for the final agreement of the framework. These measures could include:

- Assess the feasibility of best management practices, prioritization, and costs
- Point-to-point trading program
- Point-to-non-point trading program
- Funding plan

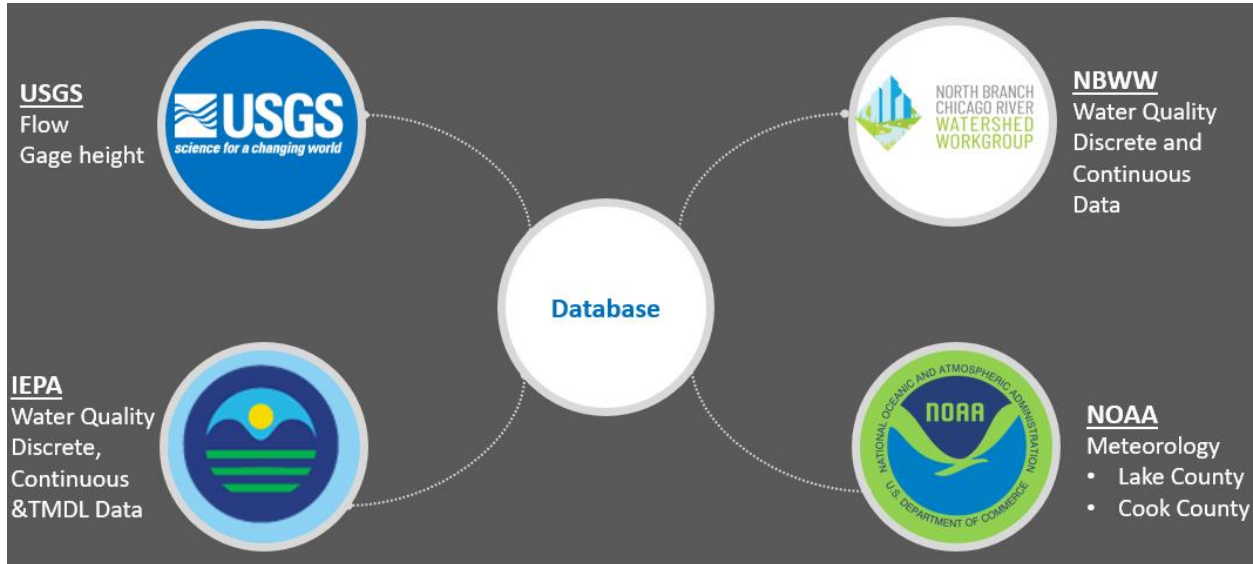
### **1.4 Workplan Organization**

This report documents the work done by Geosyntec in coordination with the NBWW for developing a preliminary workplan for the NBWW NARP. **Section 2** assesses existing data collected by NBWW and other agencies. The tools needed for the development of NARP are discussed in **Section 3**. **Section 4** provides the recommended approach for the development of a NARP for the NBCR watershed.

## SECTION 2

### EXISTING DATA REVIEW

Geosyntec acquired and reviewed existing data for the development of the NARP. This was used to identify potential data gaps and guide future monitoring efforts. A summary of existing data and their sources is shown in **Figure 3** and detailed in Appendix B.



**Figure 3: Meteorological, Flow, and Other Data Sources**

Geosyntec completed the review of the following data as part of the development of the NARP Workplan:

- Reviewed MBI 2018 & 2019 bioassessment report
- Evaluated MBI’s interim modified SNAP and applied Illinois EPA RoE methodology
- Reviewed historical report on sediment oxygen demand ([Butts and Evans, 1978](#))
- Reviewed draft watershed plan sections
- Developed recommendations for future investigations
- USGS flow data
- Precipitation and climate data
- Illinois EPA continuous flow gage data

## **2.1 Summary of Data Reviewed**

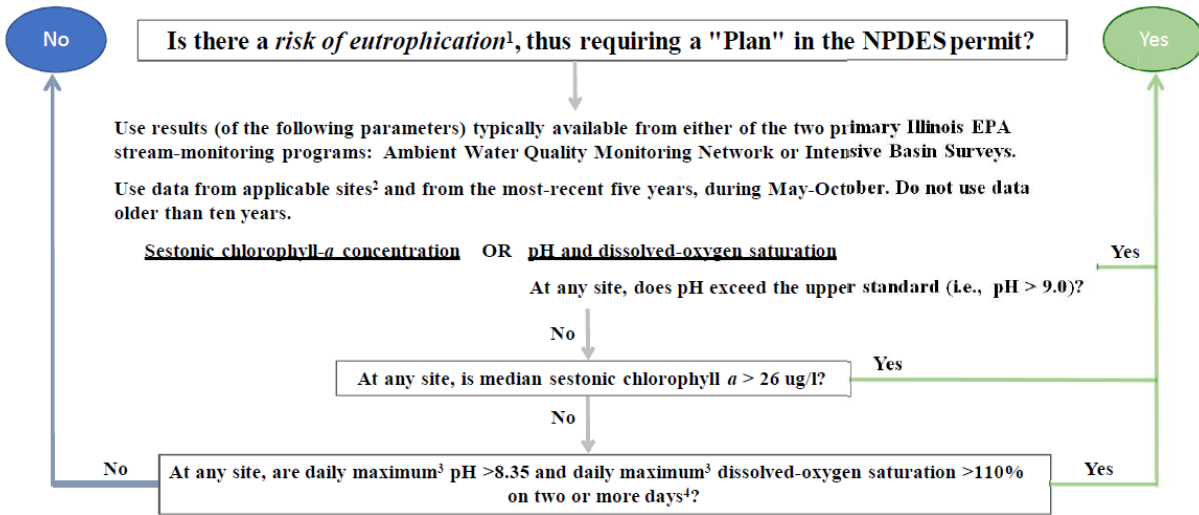
### **2.1.1 MBI 2018 & 2019 Bioassessment Report**

NBWW partnered with MBI to develop baseline waterway criteria and help assess the condition of the NBCR and tributaries. MBI completed a single bioassessment report for 2018 and 2019. During the development of this workplan, the 2020 data was collected but was still in draft form and was unavailable and therefore not used in the evaluation process.

### **2.1.2 MBI SNAP vs. Illinois EPA Risk of Eutrophication**

MBI has developed an interim modified SNAP that utilizes the baseline survey data collected to evaluate stream condition metrics and biological taxa richness. It was developed as a tool to assist the NBWW in understanding some of the nutrient-related factors and how they may be cumulatively and independently impacting the biological structure of the waterways. This procedure establishes an “enrichment” status which is utilized by MBI as an indication of nutrient presence.

The information was evaluated against the Illinois EPA’s criteria for Risk of Eutrophication (RoE). Illinois EPA has developed specific water quality parameter attribute thresholds to assist in the determination of RoE (See Figure 4) in the development of the NARP Special Conditions. The data from the MBI Bioassessment Reports was reviewed against these thresholds to understand whether or not assessed stream reaches met the criteria for RoE and to what extent throughout the watershed compared to other relevant water quality data sets discussed further below. Figure 5 presents MBI enrichment status at the sampled stations and stations meeting Illinois EPA conditions for RoE.



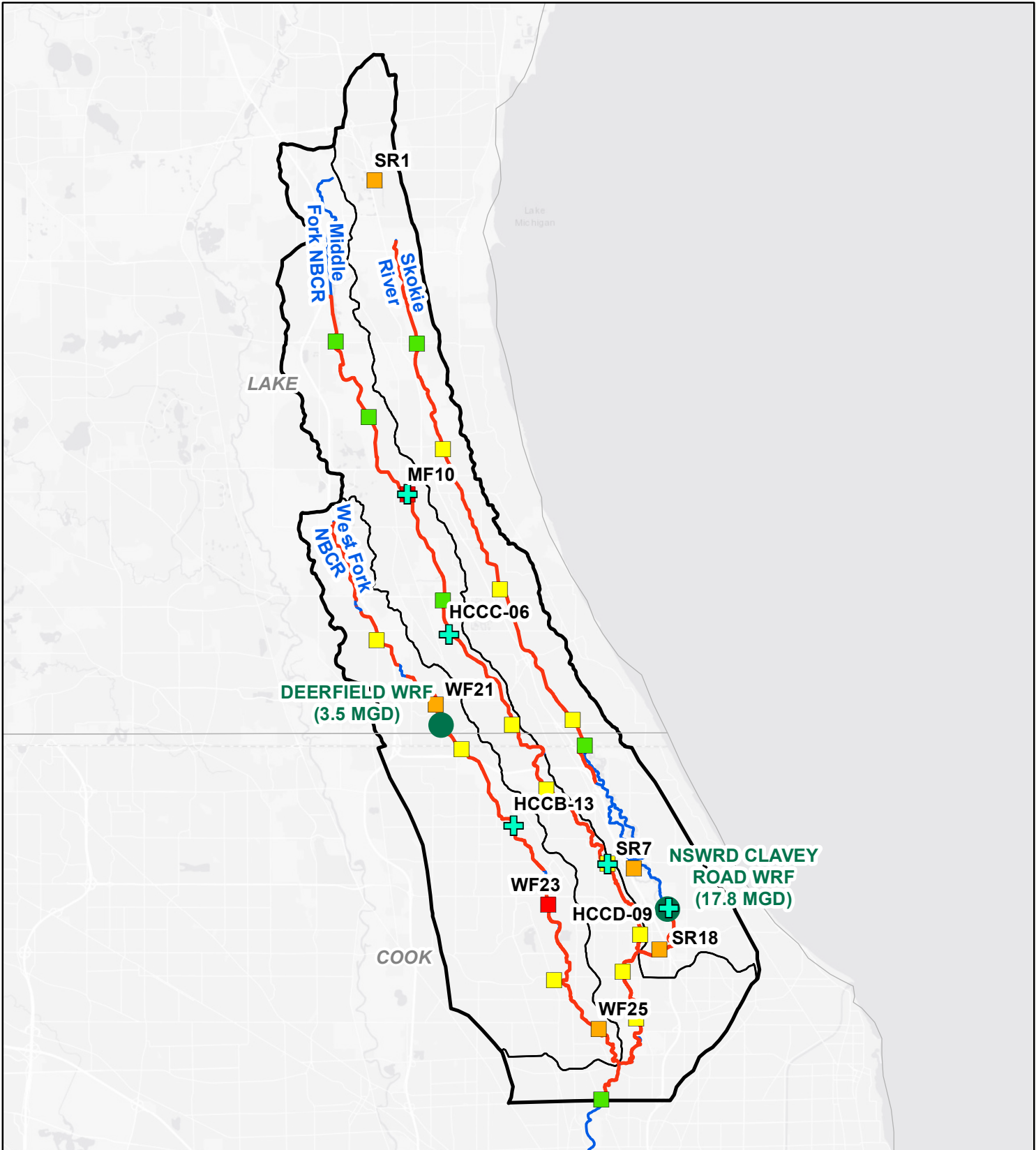
**Figure 4: Illinois EPA RoE Determination Workflow**

<sup>1</sup> Risk of eutrophication means reasonable suspicion that plant, algal, or cyanobacterial growth is causing or will cause violation of a water-quality standard.

<sup>2</sup> To be determined, case by case.

<sup>3</sup> 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.

<sup>4</sup> For many-per-day (i.e., continuously monitored) results, a "day" means a discrete 24-hour period.



**Legend**

- North Branch Chicago River Watershed
  - Subwatersheds
  - Counties
  - Major POTWs Discharge
  - Tributaries
  - 2018 IEPA 303(d) Impaired Streams
  - DO & TP
  - + IEPA Risk of Eutrophication
- Enrichment Status**
- Highly Enriched
  - Enriched
  - Possible Nutrients
  - Not Nutrients



**MBI Stations & Illinois Risk of Eutrophication**  
(NBWW, Illinois)



**Figure**

**5**

(Oak Brook)

November 2021

### **2.1.3 Northeastern IL Sediment Oxygen Demand ISWS Report**

During the data review process, it became apparent that indicators suggested in the SNAP procedure were not consistent with other water quality data acquired from Illinois EPA when applied against the RoE criteria. As the information was cross-referenced, the literature review suggested that DO depletion patterns in the absence of chlorophyll indicated a potential for impairment due to non-phosphorus-based impacts. Geosyntec's literature review uncovered a geographically relevant 1978 report completed through the Illinois State Water Survey (Butts & Evans, 1978) which provided further insight into the potential linkage of sediment to the DO depletion patterns. Using the available data and this report as a guide, Geosyntec believes some sites have a sediment oxygen demand (SOD) issue rather than a phosphorus-related issue.

### **2.1.4 NBCR Draft Watershed Plan**

Available sections of the NBCR Draft Watershed Plan (Lake County SMC, 2021) were evaluated for potential background information relevant to the waterway's history and evolution. Documented inventory of floodplain impoundments, dams, and streambank condition can further assist in evaluating localized conditions and may be further utilized during NARP implementation.

### **2.1.5 Flow Data**

Flow data available for the mainstem of the NBCR and its tributaries was assessed as part of the existing review. The magnitude of flow in the NBCR and its tributaries impacts the instream water quality.

### **2.1.6 Precipitation and Climate Data**

Meteorological data includes precipitation, solar radiation, dry bulb temperature, dew point temperature, wind speed and direction, cloud cover, atmospheric pressure, and relative humidity data. This information was reviewed for its potential to influence flow and water quality data.

### **2.1.7 Water Quality Data**

Available instream water quality data in the mainstem of the NBCR and its tributaries was assessed as part of the existing review. Instream water quality data of interest includes DO, DO saturation, ammonia, nitrogen, total phosphorus, organic carbon, total suspended solids (TSS), pH, conductivity, and chloride.

## **2.2 Phosphorus-Related Impairments in the NBCR**

The NARP Special Conditions are meant to address DO and/or offensive condition (algae and/or aquatic plant growth) impairments that are related to excessive phosphorus levels. Excessive phosphorus levels in streams result in unnatural growth of algae. The algae produce DO during the day via photosynthesis and consume DO during the night via respiration. This results in high

diurnal swings in DO levels associated with the high chlorophyll-a levels in the stream, which is a sign of phosphorus-related impairment.

MBI used the modified SNAP methodology to determine the NBWW streams sites impacted by nutrients. Geosyntec focused on the review of the water quality data for sites where MBI assigned an enrichment status of “highly enriched” (two stations), “enriched” (five stations), or “possibly nutrients” (twelve stations). The location of stations is shown in Table 1, which shows the minimum DO, maximum DO swings, and sestonic and benthic chlorophyll-a for the stations. Specific inferences for the NBCR tributaries and mainstem are discussed below.

### **West Fork**

The West Fork receives an effluent discharge from the Village of Deerfield WRF. NBWW conducted continuous water quality monitoring, including DO, for a limited time period at three stations (WF1, WF23, and WF25) along the West Fork in August 2018. Geosyntec reviewed this data and concurrent discrete water quality data at stations WF20 and WF24 for nutrient and chlorophyll-a to assess the phosphorus-related impairment.

Station WF23,<sup>1</sup> designated as “highly-enriched”, had a wide DO swing and low DO levels but was associated with low levels of sestonic chlorophyll-a (<5 micrograms per liter or ug/L) and benthic chlorophyll-a levels (<60 milligrams per cubic meter or mg/m<sup>3</sup>). Stations WF21<sup>2</sup> and WF25<sup>1</sup>, designated as “enriched” based on SNAP methodology, do not have high DO swings or high chlorophyll-a levels. Stations WF20<sup>2</sup>, WF22<sup>1</sup> and WF24<sup>1</sup> also have low levels of measured sestonic chlorophyll-a. The Illinois EPA RoE criteria application to the NBWW continuous water quality monitoring stations (WF21, WF23, WF25) showed that none of the stations are at RoE. The low levels of chlorophyll-a along with no stations at RoE in West Fork indicate that DO impairment in West Fork may not be phosphorus related. Hence, Geosyntec recommends further ground truthing of the modified SNAP methodology before it is applied to assess phosphorus-related impairments.

### **Middle Fork**

The impairments in the Middle Fork do not need to be addressed by the NARP Special Conditions since it is not impacted by POTW discharges. NBWW conducted continuous water quality monitoring, including DO for a limited time period at two stations (MF17 and MF19) in August 2018 and three stations (MF10, MF12, MF14) in August 2019. Using the Illinois EPA RoE criteria application showed that none of the stations, except MF10 and MF14, are at RoE. Similar to the West Fork, relatively low levels of sestonic and benthic algae were observed in Middle Fork. This indicates that the DO impairment in the Middle Fork may not be phosphorus-related.

---

<sup>1</sup> Station located downstream of Deerfield WRF.

<sup>2</sup> Station located upstream of Deerfield WRF.



## Skokie River

The Skokie River is impacted by the discharge from the NSWRD Clavey Road facility downstream of the Skokie Lagoon. NBWW conducted continuous water quality monitoring, including DO, for a limited time period at five stations (SR1, SR3, SR5, SR7, and SR18) in August 2018 along the Skokie River. Station SR1 is located upstream of the Skokie Lagoon and was designated as “enriched” and “possibly enriched” based on the modified SNAP methodology. However, this station was not flagged by Illinois EPA RoE criteria and had relatively low benthic and sestonic chlorophyll-a. Similarly, Stations SR3 and SR5 located upstream of the Skokie Lagoon were not determined to be at RoE with low levels of sestonic and benthic chlorophyll-a associated with a narrow range of DO swings. This indicates that the Skokie River reach upstream does not have phosphorus related impairments. Downstream of the Skokie lagoon, relatively high levels of sestonic chlorophyll-a were measured at Stations SR7 and SR18 along with wider DO diurnal swings. This indicates that the Skokie River reach downstream of the lagoons may have phosphorus-related impairments. The water quality data collected by Illinois EPA at station HCCD-09 also indicates that the Skokie River reach downstream of the Skokie Lagoon is at RoE.

Station	Minimum DO (mg/L)	Maximum DO swing (mg/L)	Sestonic Chlorophyll-a (ug/L)	Benthic Chlorophyll-a (ug/L)	Enrichment Status	Risk of Eutrophication
<b>West Fork</b>						
WF20			5.0		Possible Nutrients	No
WF21	1.4	5.8	4.4	41.3	Enriched	No
WF22			8.8		Possible Nutrients	No
WF23	1.6	6.7	4.4	58	Highly Enriched	No
WF24			0.9		Possible Nutrients	No
WF25	2.77	5.2	1.1	30.3	Enriched	No
<b>Middle Fork</b>						
MF10	1.12	15.3	4.5	20.6	Highly Enriched	Yes
MF12	3.72	3.6	1.1	31.1	Possible Nutrients	No
MF13			1.2		Possible Nutrients	No
MF14	5.02	5.2	1.4	27.9	Possible Nutrients	Yes

Station	Minimum DO (mg/L)	Maximum DO swing (mg/L)	Sestonic Chlorophyll-a (ug/L)	Benthic Chlorophyll-a (ug/L)	Enrichment Status	Risk of Eutrophication
MF16			8.5		Possible Nutrients	No
MF17	4.5	2.6	3.2	28.6	Possible Nutrients	No
<b>Skokie River</b>						
SR1	2.4	5.1	4.2	23.3	Enriched	No
SR18	5.6	4.0	14	47.4	Enriched	No
SR3	3.9	5.1	3	31.7	Possible Nutrients	No
SR4			2.2		Possible Nutrients	No
SR5	3.3	5.8	3.4	44.3	Possible Nutrients	No
SR7	1.3	6.5	25	43.3	Enriched	No

**Table 1: Summary of Water Quality Data for NBWW Stations**

### 2.3 Summary

Geosyntec’s assessment of water quality data collected in NBCR revealed that DO impairment in some reaches of NBCR might not be phosphorus related. Hence, Geosyntec recommends a targeted monitoring approach described in Section 3 to assess the causes of DO impairments in NBCR reaches. The monitoring will verify one of two potential outcomes for the NBWW NARP described in more detail in Section 4.

## SECTION 3

### TARGETED MONITORING FOR NARP DEVELOPMENT

Several reaches of the NBCR exhibit water quality issues that are not indicative of phosphorus-related impairments. Geosyntec hypothesized that there are non-nutrient factors that might be causing low DO issues. This is consistent with the findings of Illinois EPA TMDL Report (Illinois EPA, 2020). The non-nutrient factors which may cause low DO in NBCR streams are described below.

- 1) **Low Aeration:** The aeration of a stream is dependent on velocity and, consequently, the gradient of water. Slow moving streams with lower gradients typically have low DO input from the atmosphere. The NBCR streams have very low gradients of approximately 3.3 feet per mile (Slope of 0.001). This low gradient results in reduced turbulence and aeration of the streams.
- 2) **Sediment Oxygen Demand:** SOD is the DO demand exerted by organic material in the stream bed sediment, which results in depleted DO concentrations in the water column. The SOD study conducted by the Illinois State Water Survey in the 1970s suggests that SOD may be an important factor in depleting the DO in the NBCR streams.
- 3) **Macroinvertebrates Respiration:** Macroinvertebrate respiration may also result in depleted DO concentration.

Geosyntec recommends a targeted monitoring program to test the hypothesis that non-nutrient factors (described above) are responsible for low DO observed in NBCR streams. Geosyntec recommends targeted monitoring to assess the causes of DO impairment in the NBCR reaches. Eight (8) sites were selected for additional targeted monitoring based on the current data review. The stations include two stations on West Fork (WF23 and WF21), two stations on Middle Fork (MF10 and MF14), and two stations on Skokie River (SR-8 and SR-18). The Skokie River sites will help determine the potential influence of the lagoons on phosphorus-based impairment near the NSWRD outfall. Station SR8 will also require the development of a rating curve which is included in the proposed budget. Illinois EPA recommended the addition of station WF19 on the mainstem NBCR. Station MF17 serves as a necessary sample site prior to the confluence with the West Fork. These locations include collecting data at two stations located upstream of POTW discharges (WF21 on West Fork and SR8<sup>3</sup> on Skokie River) The location of these eight (8) sites for targeted monitoring is shown in Figure 6 below. It is anticipated that the targeted monitoring will be conducted in 2022 over two months (recommended mid-June through mid-September timeframe). The targeted monitoring will include the following elements:

---

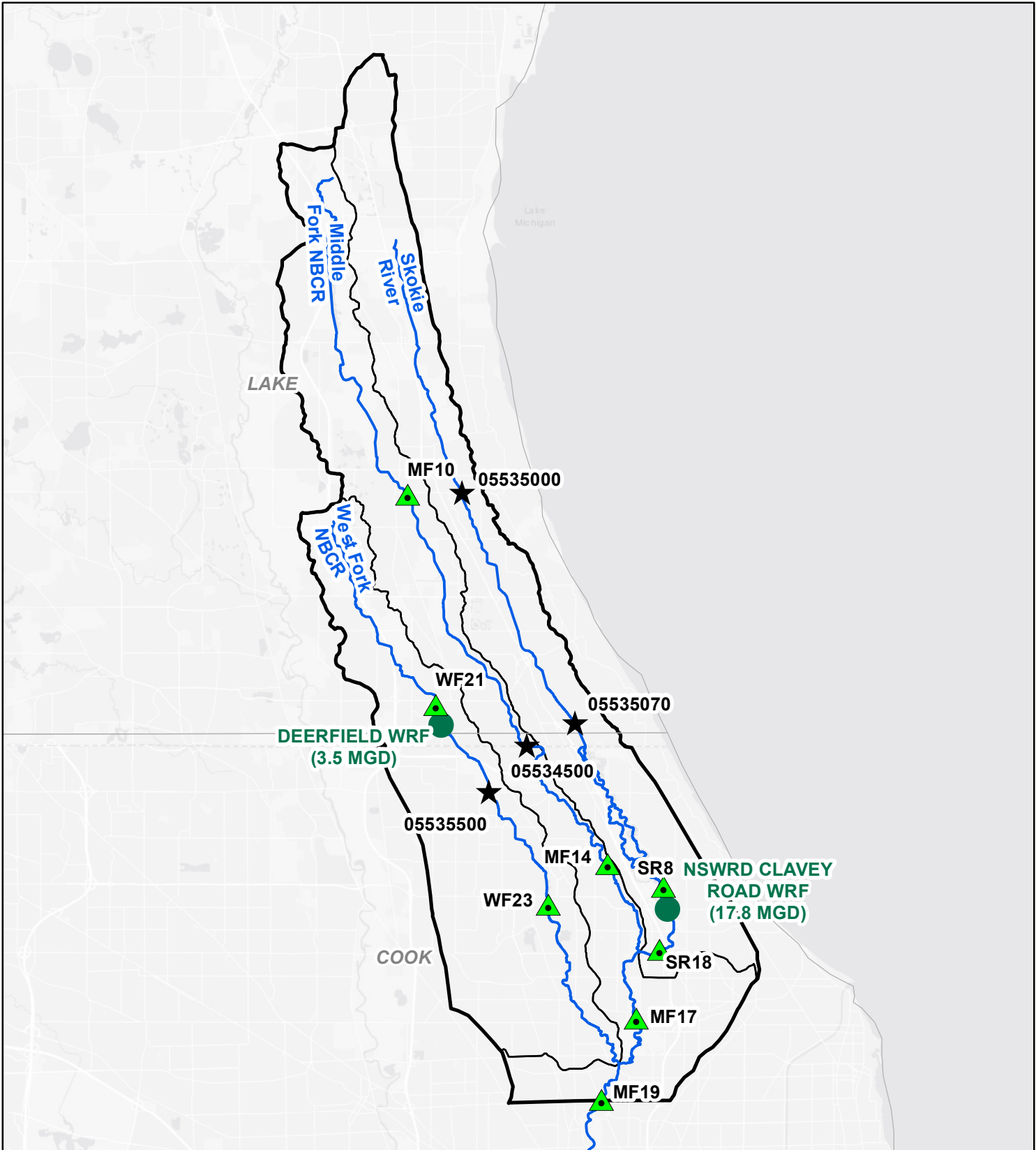
<sup>3</sup> SR8 is a new proposed monitoring located downstream of Skokie lagoon

- 1) **Continuous Water Quality Monitoring:** This would involve the installation of water quality sondes to measure DO, pH, temperature, and conductivity continuously. The continuous sampling will help capture the seasonal range and the diurnal DO swings, which is critical to understanding algal respiration patterns and range throughout the monitoring period.
- 2) **Discrete Water Quality Monitoring:** This would involve the collection of grab samples at a frequency of every two weeks and analyzing the samples for the following parameters:
  - Nutrients - Ammonia, nitrate-nitrite, total kjeldahl nitrogen, total phosphorus, and dissolved reactive phosphorus;
  - Chlorophyll-a - Sestonic and benthic;
  - DO and 5-day Biochemical Oxygen Demand (BOD);
  - Total Suspended Solids; and
  - pH, temperature, and conductivity.
- 3) **SOD and Sediment Characterization Sampling:** This will entail using specialized chambers (similar to one shown on the side) that will be placed on the stream bed. SOD will be measured at each targeted monitoring site indicated in Table 2 below during a singular event. The results of the targeted monitoring will be used to evaluate the hypothesis of the impact of non-nutrient factors in the NBCR streams.



Waterbody	Station ID	Purpose	Discrete WQ	Continuous WQ	S O D	Flow	Description	Lat	Long
West Fork	WF21	Provide upstream boundary for NARP model	✓	✓			D.S. Deerfield Rd.	42.165	-87.856
West Fork	WF23	Testing hypothesis for NARP; instream calibration station	✓	✓	✓		D.S. Willow Rd.	42.102	-87.809
Middle Fork	MF10	Testing hypothesis for NARP	✓	✓	✓		D.S. Westleigh St.	42.231	-87.868
Middle Fork	MF14	Testing hypothesis for NARP	✓	✓	✓		D.S. Sunset Dr.	42.115	-87.784
Skokie River	SR8	Provide upstream boundary for NARP model	✓	✓	✓	✓	TBD		
Skokie River	SR18	Testing hypothesis for NARP; instream calibration station	✓	✓	✓		D.S. I-94	42.088	-87.762
NBCR	MF17	Instream Calibration Station	✓	✓			D.S. Glenview Rd.	42.066	-87.773
NBCR	MF19	Instream Calibration Station; Recommended by Illinois EPA	✓	✓			U.S. Dempster St.	42.041	-87.787

**Table 2: Summary of Recommended Stations for Targeted Sampling**



**Legend**

- North Branch Chicago River Watershed
- Subwatersheds
- Counties
- Major POTWs Discharge
- Tributaries
- USGS Gages
- Targeted Monitoring Sites



**Targeted Monitoring Sites**

(NBWW, Illinois)

**Geosyntec**  
consultants

**Figure**

**6**

(Oak Brook)

December 2021

## SECTION 4

### RECOMMENDED NARP APPROACH

The NARP Special Conditions in the NPDES permits for the Village of Deerfield WRF and the NSWRD Clavey Road WRF requires them to address phosphorus-related impairments in the downstream reaches. As explained in Section 2 above, phosphorus-related impairments are apparent in the Skokie River tributary of the NBCR where the NSWRD Clavey Road WRF discharges; however that linkage is not directly apparent on the West Fork of the Chicago River where the Village of Deerfield WRF discharges. Geosyntec recommends the approach shown in Figure 7 to develop the NARP for the NBWW watershed. The recommended approach will enable the NBWW to be more suitably informed of conditions driving the DO impairments so that the necessary resources for the NARP are directed at the reaches exhibiting phosphorus-driven impairments. This approach will allow for collaboration between the different stakeholders involved in the NARP and Illinois EPA. It will also help both the POTWs meet the NARP Special Conditions. The NARP scope for the NBCR is described below. The results of Phase 1 will be used to determine the geographical extent of the NARP study.

#### **4.1 Scope of Work for NARP Development**

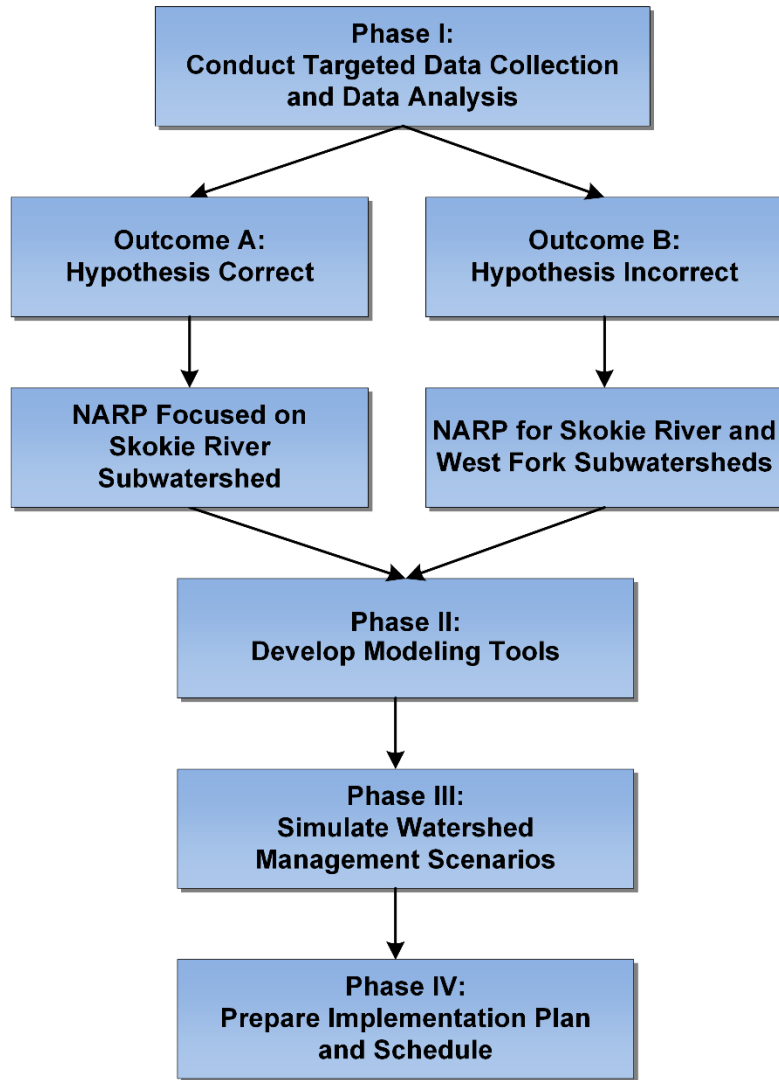
As mentioned above, the NBCR exhibits some stream conditions under the NARP Special Conditions as drafted in the Deerfield and NSWRD NPDES permits. Impairments due to phosphorus are apparent in the Skokie River Branch of the NBCR where the North Shore WRD discharges however, that linkage is not directly apparent on the West Fork of the Chicago River where the Deerfield WRF discharges. For this reason, we have provided scope for two potential outcomes of the targeted monitoring. The scope is described below in phases that can better highlight the potential alternatives.

##### **4.1.1 Phase I: Conduct Targeted Data Collection and Data Analysis**

This phase involves collecting data per the recommendations provided in Section 3. It is recommended that the data collection occur for two months in the summer of 2022. The data collected in this phase will help determine the underlying causes of impairment (NARP Objective 1). The data will be analyzed to test the hypothesis that DO impairments in several reaches of NBCR are driven by non-nutrient factors. Based on the validity of the hypothesis, there are two possible outcomes for each monitored reach in the NBCR watershed. Furthermore, by obtaining additional supporting water quality data below Willow Road and upstream of the NSWRD outfall, it can be better determined if conditions within the lagoon contribute to the phosphorus-related impairments.

**Outcome A - Hypothesis Correct:** The data analysis verifies that DO impairments in the West Fork and Middle Fork are not related to phosphorus but rather caused by non-nutrient factors described in Section 3. The data analysis also confirms that the Skokie River's DO impairments are phosphorus-related. Under Outcome A, the NBCR NARP would focus on eliminating the identified phosphorus-driven impairments in the Skokie River.

**Outcome B - Hypothesis Incorrect:** The data analysis is inconclusive regarding the impact of non-nutrient factors on the DO impairment in the NBCR tributaries. Under Outcome B, the NBWW develops a NARP for the Skokie River and the West Fork and below the confluence of the three tributaries (if appropriate).



**Figure 7: Recommended Approach for Development of NBCR NARP**

#### **4.1.2 Phase II: Develop Modeling Tools**

Under this phase, modeling tools will be developed for the NARP. Depending on the outcomes defined in the Phase 1 data analysis, the NBWW will determine the extent of the scope of the NARP. If Outcome A is validated, the NARP only needs to be developed for the portion of the Skokie River downstream of the lagoons. If Outcome B is validated, resources must be allocated throughout the entire watershed.

This phase of the work includes developing watershed and instream models for the NBCR watershed. The instream model will focus on specific reaches identified from the results of Outcome A, or the Skokie River and West Fork (and downstream of the confluence of the three tributaries if appropriate) for Outcome B. The modeling tools will be used to determine phosphorus reductions where necessary to achieve site-specific water quality targets (NARP Objective 2).

Geosyntec conducted a detailed comparison of a different watershed and instream models for the DRWW NARP development (Geosyntec, 2020). Based on that review the following models are recommended to develop the NBCR NARP.

**Watershed Model** – The NBCR watershed is predominantly urban. Hence, Geosyntec recommends using the EPA’s Storm Water Management Model (SWMM) for simulating flow and loads from non-point sources in the NBCR watershed. SWMM is the watershed model of choice for highly urbanized watersheds like the NBCR.

**Water Quality Model** – Geosyntec recommends using QUAL2Kw or WASP7 to develop instream models for the NBCR watershed. Both the models have been applied throughout the country to simulate the impact of nutrient loads on instream water quality, such as DO and algae.

#### **4.1.3 Phase III: Simulate Watershed Management Scenarios**

This phase involves simulation of watershed management scenarios using the specific modeling tools developed under Phase 2 to determine the phosphorus reductions needed to achieve site-specific water quality targets. These simulations will include baseline conditions, point source load reductions, non-point source reductions, upstream load reductions, and various combinations of management strategies. The simulations will provide the NBWW with alternatives to remove impairments related to phosphorus loadings in the NBCR. If appropriate, upon completion of the North Branch Watershed Plan Update, plan scenarios could be included within specific scope language if desired. The scope of this phase will be scaled accordingly based on the verification of Outcome A versus Outcome B.

#### **4.1.4 Phase IV: Prepare Implementation Plan and Schedule**

This phase includes planning for facilitating a cost-effective implementation of measures to reduce phosphorus loadings and ultimately developing a plan to track the success of those proposed measures (NARP Objective 3). Inputs from various stakeholders such as NBWW members,



Illinois EPA, environmental groups, and other stakeholders will be solicited to gain input on the proposed measures and the feasibility and schedule for individual projects. An implementation plan and schedule for proposed phosphorus reduction measures will be developed under this phase.

#### 4.2 Cost for NARP Development

Costs for developing the NARP depend on Outcome A versus Outcome B. Table 3A and Table 3B below provides the cost for developing Outcome A and Outcome B, respectively. To assess which outcome will be applied, the NBWW will conduct a targeted data collection and data analysis task (Phase 1) in 2022. The recommended budget for Phase 1 is \$154,305, which is included below in Table 3A. All field data would need to be collected and tabulated in 2022 to ensure the NARP stays on schedule, as provided in the table below.

The estimated cost for developing the NARP given Outcome A is \$360,605, to be executed from 2022-2024. The estimated cost for developing the NARP given Outcome B is \$590,205, to be executed over that same time period. The cost for each phase of the NARP development broken down for each year is provided in Table 3A and Table 3B, respectively.

**Table 3A: Estimated Budget for NBWW NARP Development: Outcome A**

Phase	Description	2022	2023	2024	Total
1	Conduct Targeted Data Collection and Data Analysis	\$154,305			\$154,305
2	Develop Modeling Tools		\$116,000		\$116,000
3	Watershed Management Scenarios			\$50,800	\$50,800
4	Implementation Plan and Schedule			\$39,500	\$39,500
<b>Total Budget Estimate</b>		\$154,305	\$116,000	\$90,300	\$360,605

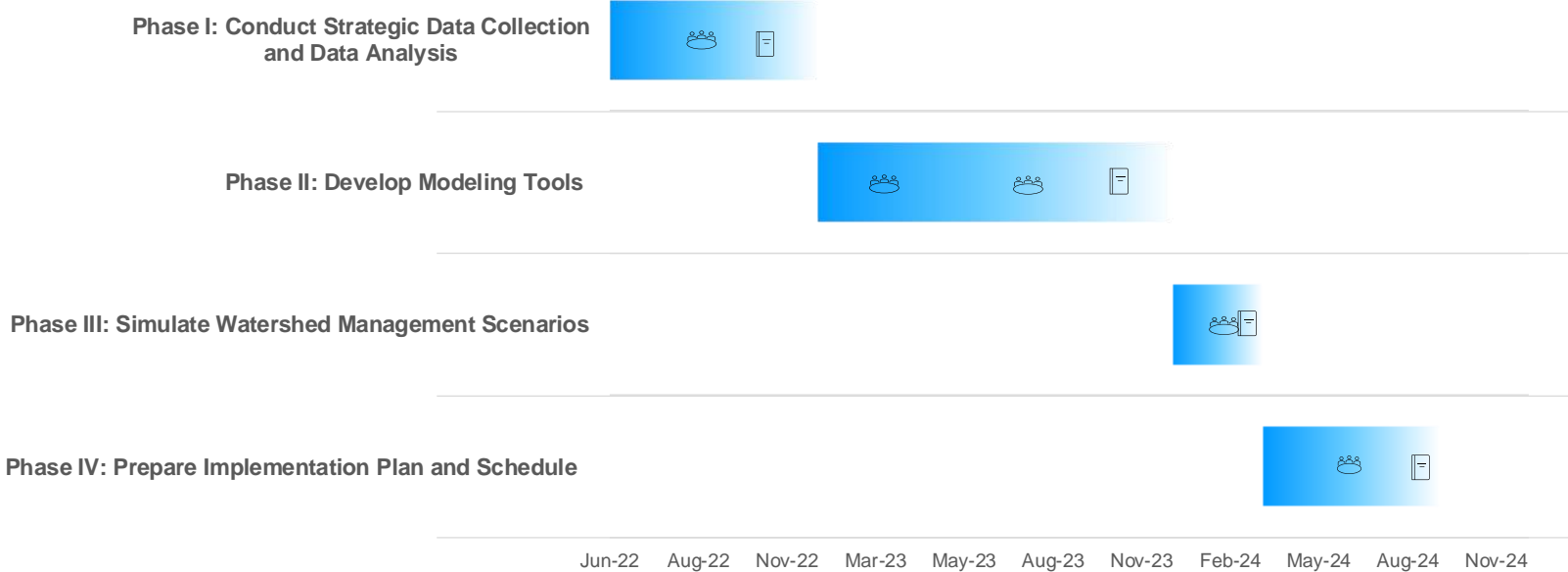
**Table 3B: Estimated Budget for NBWW NARP Development: Outcome B**

Phase	Description	2022	2023	2024	Total
1	Conduct Targeted Data Collection and Data Analysis	\$154,305			\$154,305
2	Develop Modeling Tools		\$261,300	\$0	\$261,300
3	Watershed Management Scenarios			\$114,600	\$114,600
4	Implementation Plan and Schedule			\$60,000	\$60,000
<b>Total Budget Estimate</b>		\$154,305	\$261,300	\$174,600	\$590,205

#### **4.1 Schedule for NARP Development**

A proposed schedule for NARP development for both NARP Outcomes A and B is provided below. It is recommended that monitoring work start no later than July 2022 to collect the necessary data for NARP development. Each phase of NARP development includes meeting time with the NBWW to discuss findings and results as needed.

**NBWW NARP SCHEDULE**



Tentative Meeting with NBWW  
 Memorandums and Final Report

## SECTION 5

### REFERENCES

Chicago Metropolitan Agency for Planning (CMAP) Data Hub. 20 May 2019.

<https://datahub.cmap.illinois.gov/>

Illinois Geospatial Data Clearing House. 20 May 2019.

<https://clearinghouse.isgs.illinois.edu/data>

Lake County, IL Open Data & Records Hub. 20 May 2019.

<http://datalakecountyil.opendata.arcgis.com/>

Lake County SMC. Unpublished. North Branch River Watershed-Based Plan. Lake County Stormwater Management Commission. Draft 2021.

Butts, T.A., and Evans, R.L., 1978. Sediment Oxygen Demand Studies of Selected Northeastern Illinois Streams. Illinois State Water Survey. Urbana, Illinois.

LimnoTech. 2013. User Manual: Model Selection Decision Tool. Prepared for Water Environment Research Federation.

MBI. 2017. Development of an Integrated Prioritization System (IPS) and Supporting Tools for the Upper Des Plaines River Watershed. Prepared by Midwest Biodiversity Institute for Des Plaines River Watershed Workgroup and Lake County Stormwater Management. December 27, 2017.

Michael Baker Jr., Inc., Aqua Terra, Consultants, Dynamic Solutions, LLC., 2015. Setup, Calibration, and Validation for Illinois River Watershed Nutrient Model and Tenkiller Ferry Lake EFDC Water Quality Model, and Appendices. Submitted to EPA Region 6, Dallas TX. August 7, 2015.

WERF. 2005. Technical Approaches for Setting Site-Specific Nutrient Criteria. Water Environment Federation. Water Environment Research Federation. EPA/100/K-09/003. March 2009.

US EPA. 2000. Nutrient Criteria Technical Guidance Manual. Office of Water. Office of Science and Technology. EPA-822-B-00-002. July 2000.

US EPA. 2009. Guidance on the Development, Evaluation, and Application of Environmental Models. Council for Regulatory Environmental Modeling, Office of the Science Advisor. EPA/100/K-09/003. March 2009.

US EPA. 2018. Nutrient and Sediment Estimation Tools for Watershed Protection. United States Environmental Protection Agency. March 3, 2018

USGS National Hydrographic Dataset. 20 May 2019. <https://www.usgs.gov/core-science-systems/ngp/national-hydrography>

United States Department of Agriculture Web Soil Survey State Soil. 20 May 2019. <https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

**APPENDIX A – NBWW Executive Committee,  
Coordinating Team Members and Geosyntec  
Project Team**

## **NBWW EXECUTIVE COMMITTEE MEMBERS**

President: Brandon Janes, Village of Deerfield

Vice President: Matt Farmer, Village of Northbrook

Members at-Large:

- Matt Ueltzen, Lake County Forest Preserve District
- Robyn Flakne, Village of Glenview
- Al Gertych, Lake County Division of Transportation
- James Bernahl, Village of Winnetka
- Rob Flood, North Shore Water Reclamation District

## **NBWW NARP COORDINATING TEAM**

Brandon Janes, Village of Deerfield

Rob Flood, North Shore Water Reclamation District

Ashley Strelcheck, Lake County Stormwater Management Commission

## **GEOSYNTEC PROJECT TEAM**

Project Director: Adrienne Nemura

Project Manager: Brian Valleskey

Technical Lead: Rishab Mahajan

Senior Technical Advisor: Rob Annear

Data Analyst: Karoline Qasem

**APPENDIX B - Summary of Existing Data Review  
(Excel Spreadsheet)**

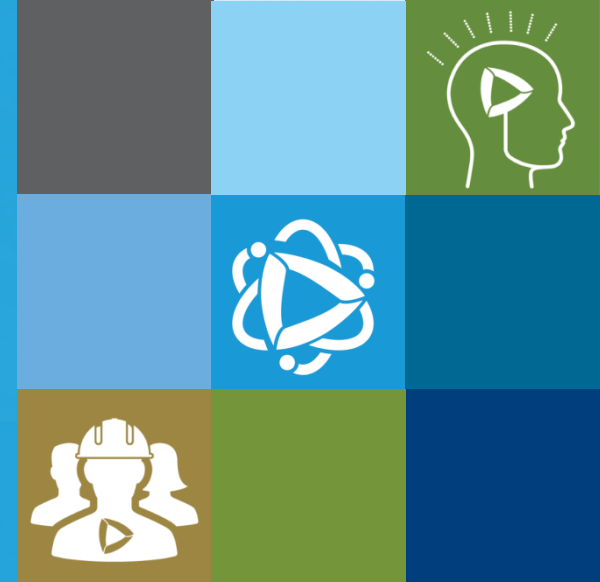


**APPENDIX C - Illinois EPA Meeting  
Presentation**



## NBWW Station & Data-Review - Executive Summary

July 29, 2021



## Work Conducted to Date

- Reviewed the MBI 2018-2019 bioassessment report
- Evaluated MBI's interim modified Stream Nutrient Assessment Procedure (SNAP) and applied Illinois EPA risk of eutrophication methodology
- Reviewed historic report on sediment oxygen demand
- Reviewed draft watershed plan
- Developed recommendations for future investigations

# Recommendations

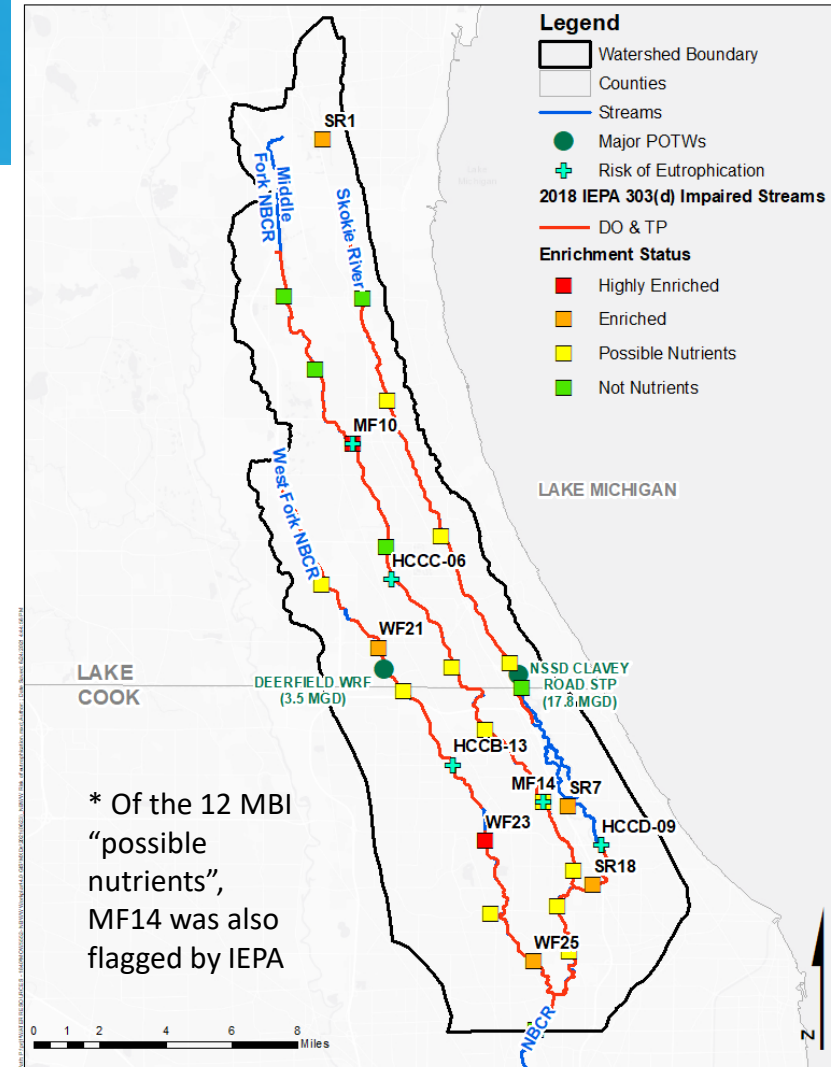
- The interim modified SNAP should be tested for the NBW using data collected from targeted areas
- A targeted data collection program is needed
  - Long-term (2+ months) deployments of sondes (DO/pH)
  - Weekly benthic/sestonic chlorophyll-a
- Hypotheses about the role of non-nutrient factors should be explored
  - Lack of reaeration
  - Sediment oxygen demand
  - Macroinvertebrates

# Interim Modified SNAP

# Intersection of MBI & Illinois EPA Risk of Eutrophication

- MBI nutrient enrichment
  - Two “highly enriched”
  - Five “enriched”
  - Twelve “possible nutrients”
- Applying risk of eutrophication
  - Five at risk of eutrophication

Station	Years	Enrichment Status	Risk of Eutrophication
MF10	2019	Highly enriched	Yes
WF23	2019	Highly enriched	No
SR1	2018	Enriched	No
SR7	2018, 2020	Enriched	No
SR18	2018, 2020	Enriched	No
WF21	2019	Enriched	No
WF25	2019	Enriched	No
MF14*	2019	Possible Nutrients	Yes
HCCD-09	2011, 2016	-	Yes
HCCC-06	2011, 2016	-	Yes
HCCB-13	2011, 2016	-	Yes



# MBI Assessment

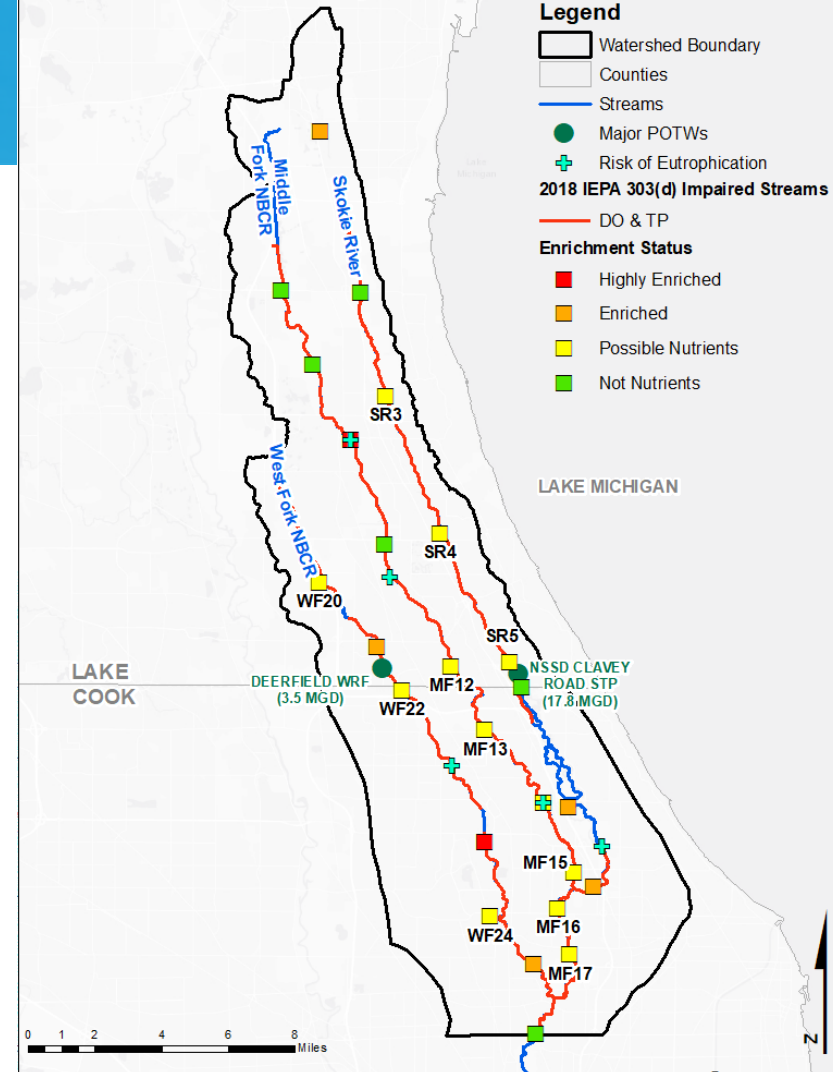
- All of the benthic chlorophyll-a scored as “Very Low” (<35) to “Low” (35-79) (i.e. “not nutrients”)

Nutrient Enrichment Status	Site ID	Benthic Chla (mg/m3)	Sestonic Chla (ug/L)	Rationale for Nutrient Enrichment Status
Highly Enriched	MF10	21	4.5	Max. DO, Min. DO, DO swing
Highly Enriched	WF23	58	4.4	Min. DO, DO swing
Enriched	SR1	23	4.2	Min. DO, DO swing, TKN
Enriched	SR7	43	25.0	Min. DO, DO swing, TKN, Ses. Chla
Enriched	SR18	47	14.0	TP, TKN, Ses. Chla
Enriched	WF21	41	4.4	Min. DO, DO swing, TKN
Enriched	WF25	30	1.1	Min. DO, DO swing, TKN
Possible Nutrients	MF14	28	1.4	DO swing, TKN

Category	Sestonic Chla
Very Low	<2.5
Low	>2.5-5.1
Moderate	>5.1-13.8
High	>13.8-28.9
Very High	>28.9

# MBI Assessment – Other “Possible Nutrients”

Site ID	Benthic Chla (mg/m3)	Sestonic Chla (ug/L)	Rationale for Nutrient Enrichment Status
SR3	32	3.0	Min. DO; DO swing
SR4		2.2	TKN
SR5	44	3.4	Min. DO, DO swing
MF12	31	1.1	Min. DO, TKN
MF13		1.2	TKN
MF15	31	2.8	DO swing
MF16		8.5	TKN, Ses. Chla
MF17	29	3.2	Min. DO, TKN
WF20		5.0	TKN, Ses. Chla(?)
WF22		8.8	TP, TKN, Ses. Chla
WF24		0.9	TKN





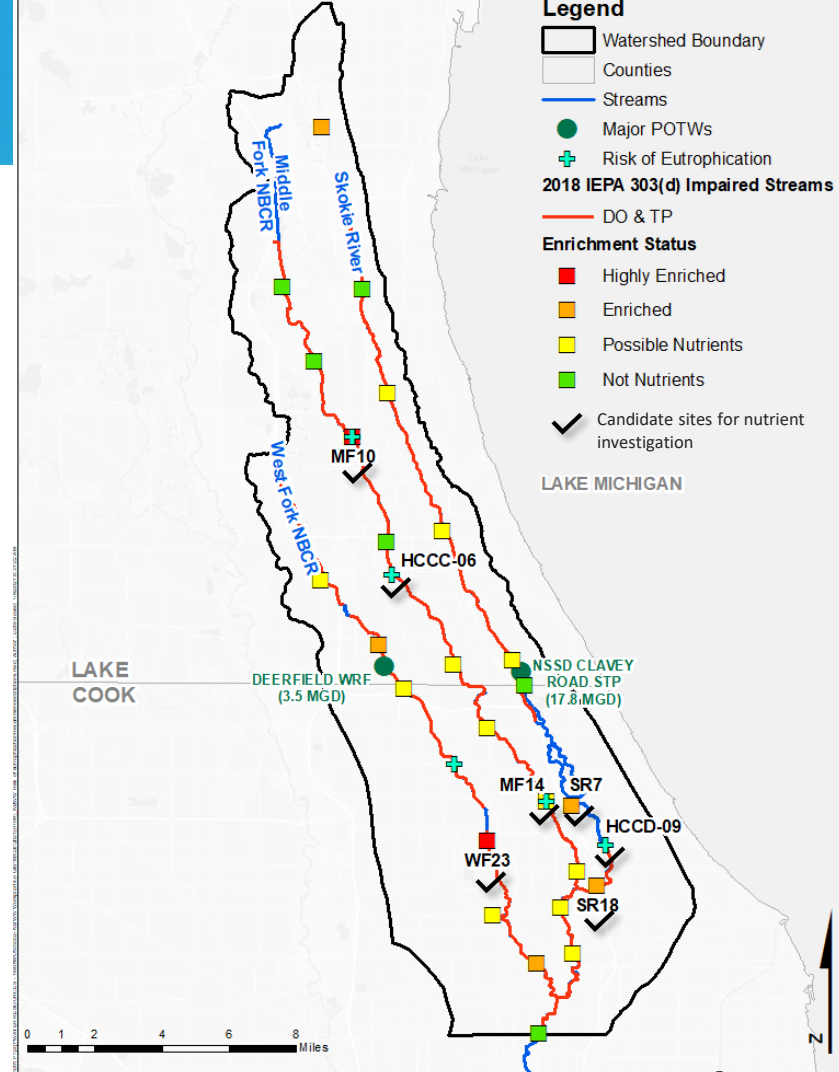
# Station Assessment Summary

- **MBI**
  - Chlorophyll-a (benthic and sestonic) low/very low for both “highly enriched” stations
  - Also for 3 of the 5 “enriched” stations
  - Also for 9 of the 11 “possible nutrients” stations
  - Suggests
    - Additional instream investigation needed
    - Additional ground-truthing of interim modified SNAP may be needed

# A Targeted Data Collection Program

# Candidate sites for detailed nutrient investigations

- Understand physical features at each site
  - MF23 (highly enriched & risk of eutrophication)
  - MF14 (possible nutrient & risk of eutrophication)
  - SR7/HCCD-09/SR18 flagged by both – downstream of Skokie Lagoons
  - HCCC-06 (flagged by IEPA, upstream location “not nutrients” by MBI)
  - WF23 (highly enriched)

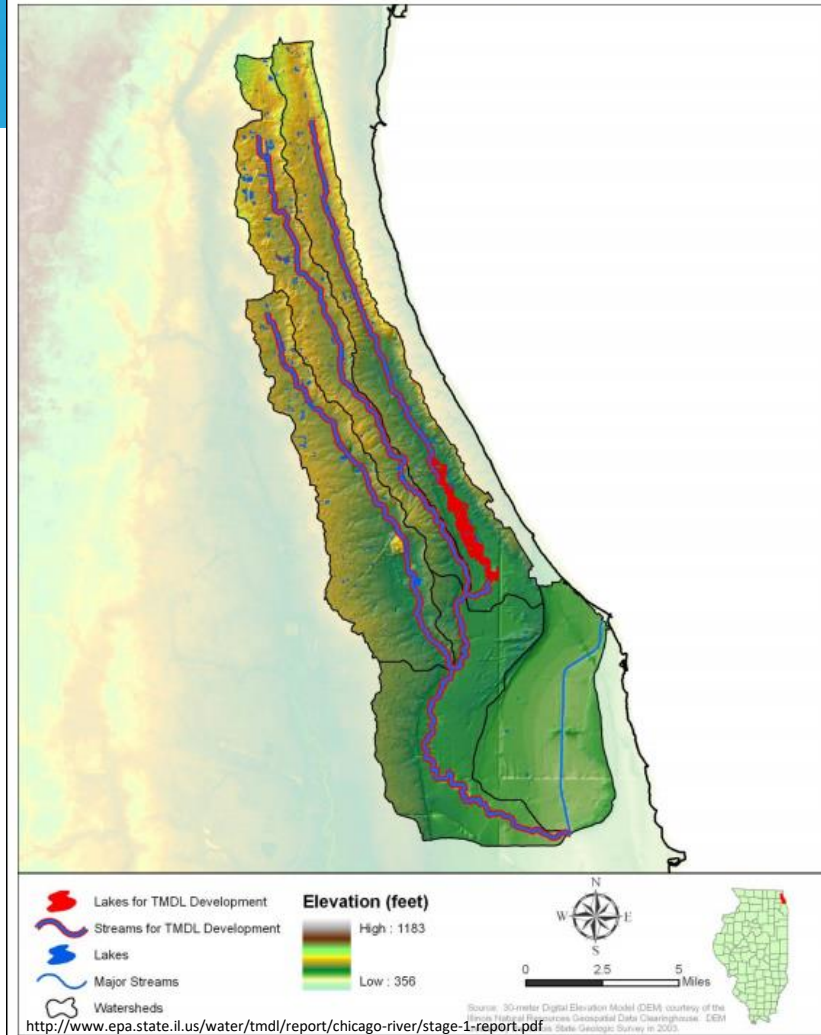


# Non-nutrient factors

# Topography

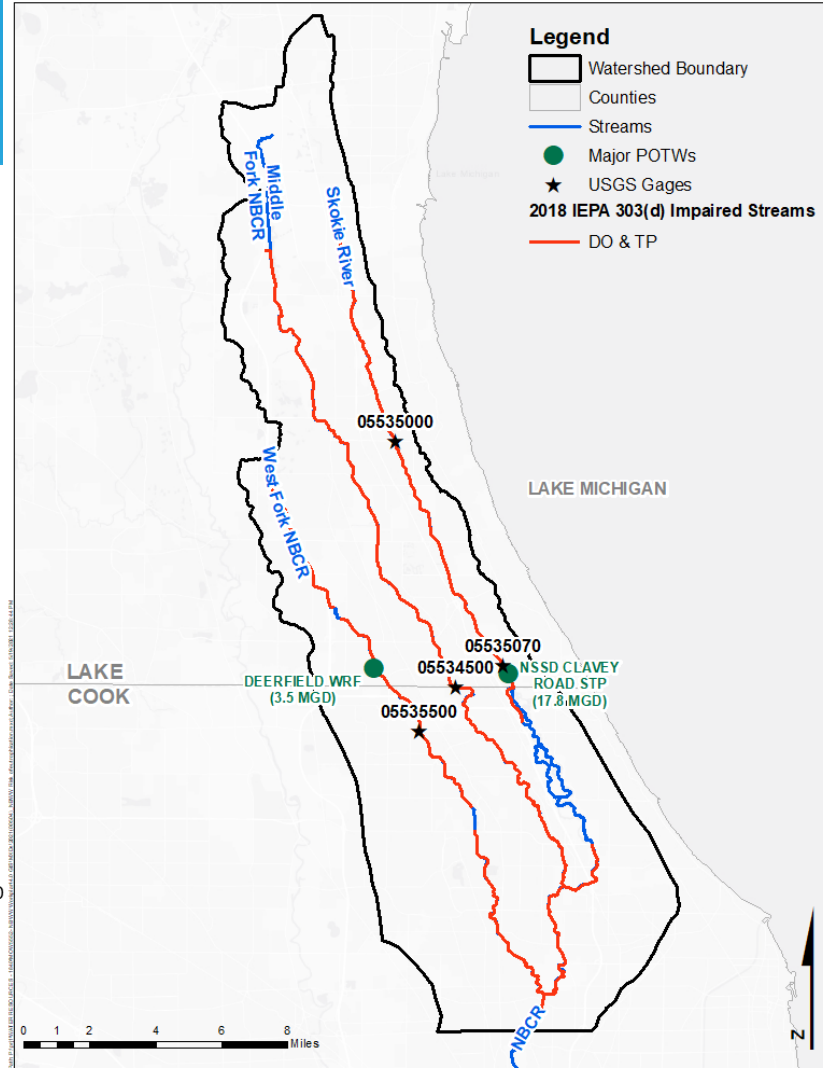
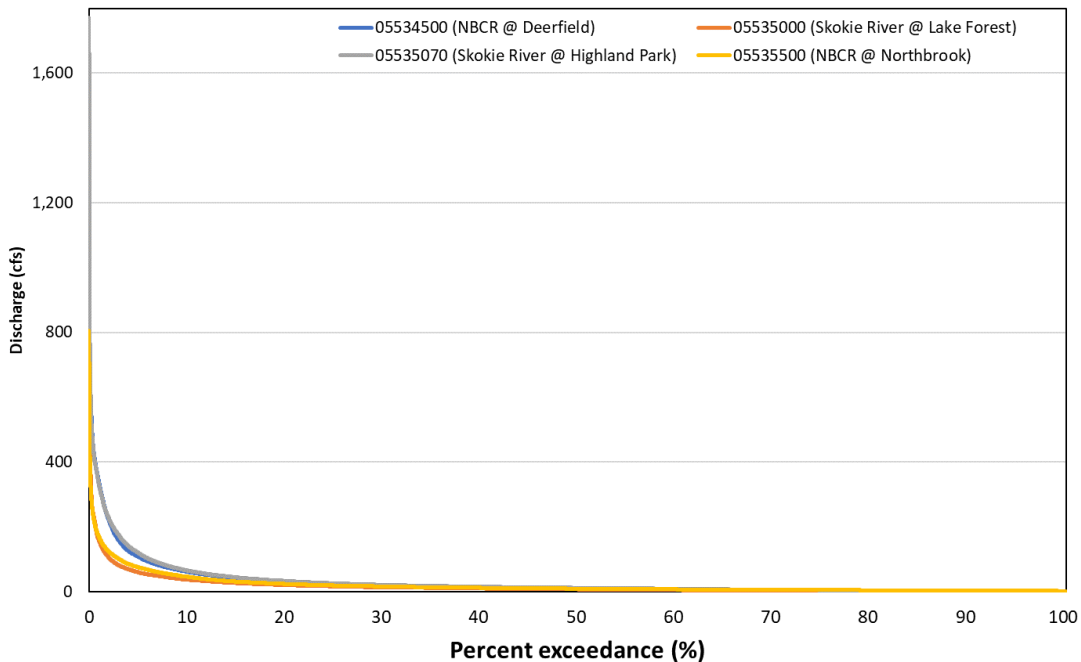
- FEMA longitudinal profiles
  - Elevation ranges from 700 ft to 585 ft
  - Gradient of 3.3 ft per mile (Slope of 0.001)
- Gradient is relatively low for a natural stream
  - Lack of high turbulence and reaeration
- IEPA TMDL report indicates agency will revisit phosphorus impairment assessment

Figure 2-3: Upper North Branch Chicago River Watershed Digital Elevation Model (DEM)



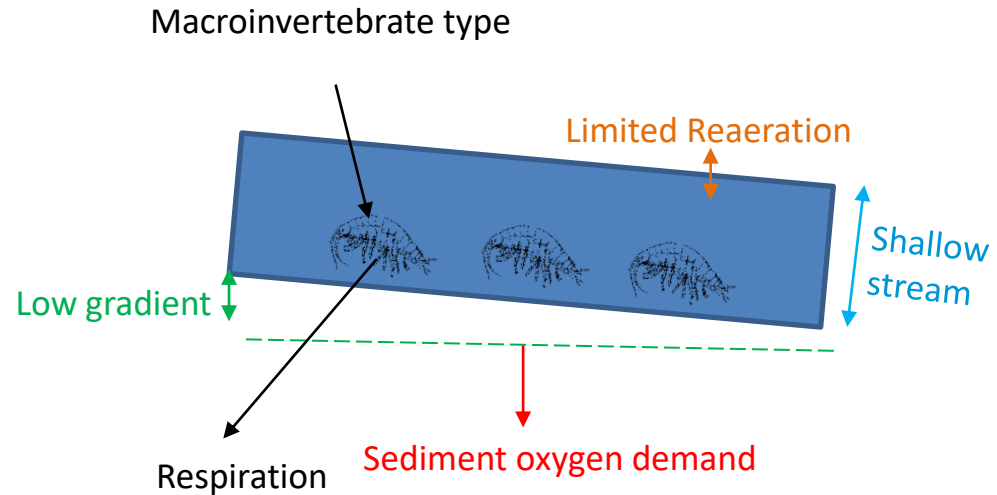
# Flow Regime - Low

### Flow duration curves



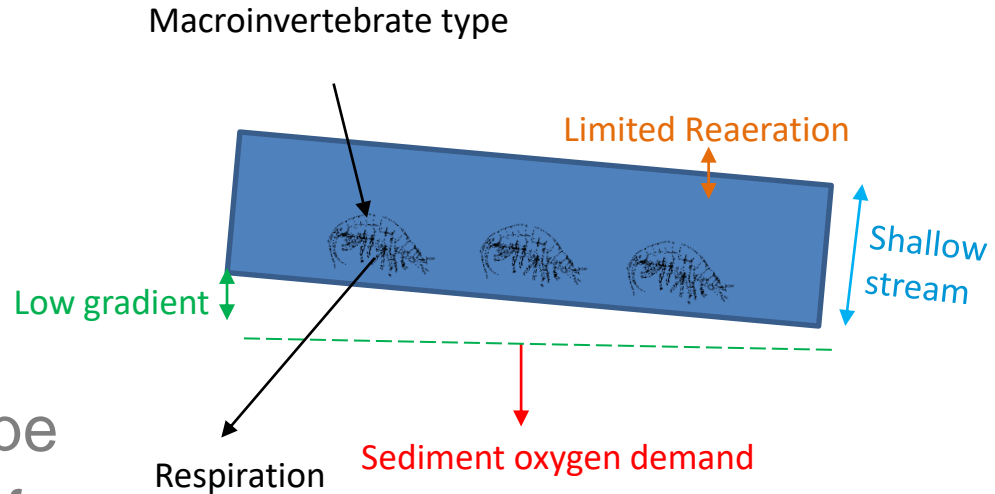
# Hypotheses

- Low dissolved oxygen due to algal growth appears unlikely in most stations
- Limited reaeration due to low flows and small slope
- High SOD suggests sediment is an important factor in depleting DO
- Macroinvertebrate respiration might deplete DO levels



# Recommendations to test the hypotheses

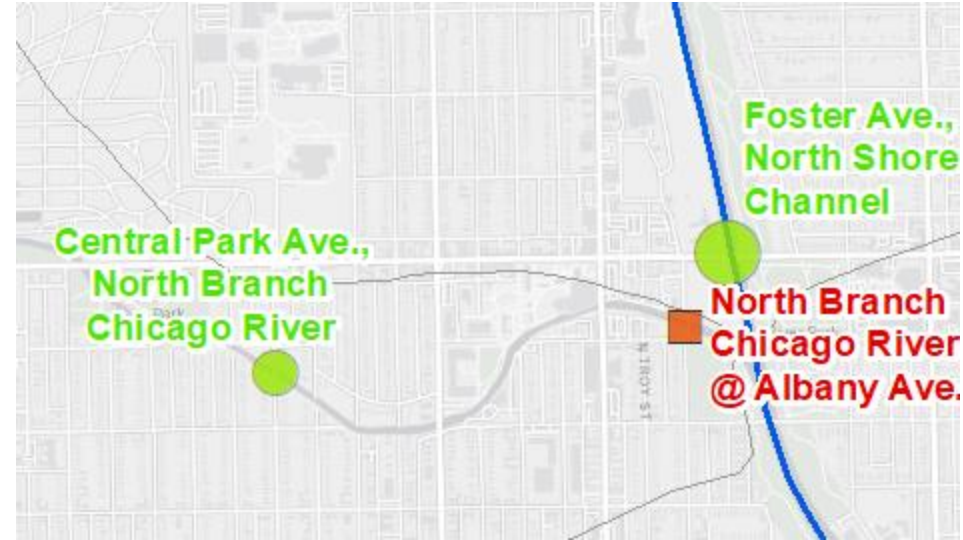
- Data monitoring
  - SOD rates
  - Sediment depth
  - Reaeration
    - water depth
    - slope
  - Macroinvertebrate type
  - Longer deployment of DO/pH sondes



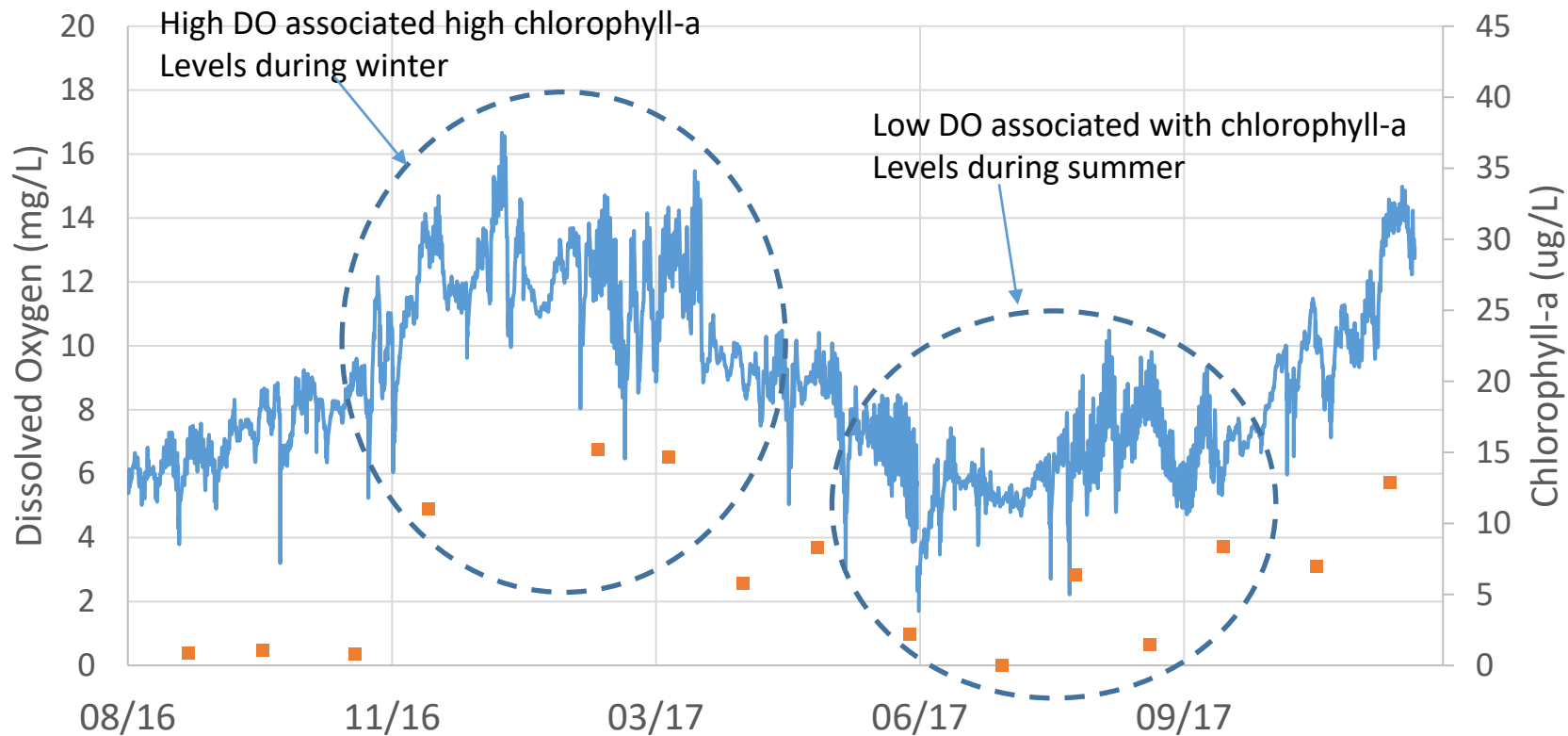


# MWRD Data Review

- Stations just upstream of junction of North Branch Chicago River with North Shore Channel
  - Central Park Ave. – Continuous DO measurements
  - Albany Ave. – Monthly discrete measurements



# DO and chlorophyll-a



## Inferences

- **High DO associated with higher chlorophyll-a level during winter**
  - Similar phenomenon observed in Upper North Shore Channel managed by MWRD
  - Algal activity does not correspond with low DO and DO swings
- **Low DO associated with lower chlorophyll-a levels during growing season**
  - Algal activity does not correspond with low DO and DO swings

## Recommendations

- Higher chlorophyll-a levels during winter may not be in the scope of NARP
- Investigate other causes of low DO in growing season
  - Sediment Oxygen Demand
  - Low reaeration

## What does this mean for the NARP?

- **Workplan will address two alternatives**
  - If hypotheses are correct, budget for NARP-lite (Skokie Lagoons and downstream)
  - If hypotheses are incorrect, budget for NARP throughout the watershed

- 
- Review with environmental groups
  - Questions?