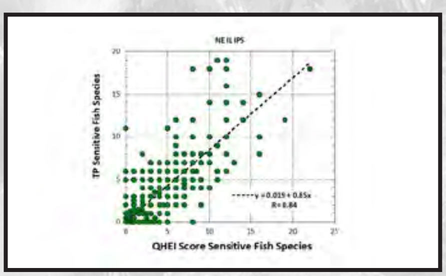
NUTRIENT IMPLEMENTATION PLAN

DECEMBER 31, 2023

DuPage River Salt Creek Workgroup

LOWER DUPAGE RIVER WATERSHED COALITION



Nutrient Implementation Plan for East Branch DuPage River, West Branch DuPage River, Lower DuPage River, and Salt Creek (Illinois)

December 31, 2023

PRESENTED TO

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EXECUTIVE SUMMARY

Aquatic life and dissolved oxygen (DO) are interacting products of complex water chemistry, physical stream characteristics, and weather conditions. Both are influenced by phosphorus, but the attempts in Illinois to establish State or ecoregion-protective phosphorus criteria have been unsuccessful. This failure is due to an incomplete understanding of how total phosphorus (TP) impacts DO and aquatic life, the complexity of the other factors and their interactions, and the difficulty of establishing robust statistical relationships between them. These issues compounded as the geographical scale increases, maximizing variation in and between the factors. Hence, the value of developing specific watershed targets for TP can better account for regional variation, as recommended under the development of Nutrient Implementation Plans (NIPs) and Nutrient Assessment and Reduction Plans (NARPs). These plans were mandated in National Pollutant Discharge Elimination System permits for wastewater treatment plants (WWTPs) upstream of river segments that had an aquatic life use impairment related to phosphorus (low DO, nuisance algae or plant growth and nutrients, primarily TP) or at risk of eutrophication as judged by pH, sestonic algae, and DO saturation. The DuPage River Salt Creek Workgroup and Lower DuPage River Watershed Coalition have been working to improve aquatic life scores in the basins of the DuPage River and Salt Creek and have developed this NIP to meet the permit condition and remove TP as a barrier to meeting the aquatic life goal as set out by Illinois Environmental Protection Agency.

A crucial step in developing this NIP was establishing a watershed threshold concentration for TP that is protective of aquatic life in the NIP area. A relationship between TP concentrations and fish species and macroinvertebrate taxa and their indices of biotic integrity was established by a multivariate analysis published in 2023 by the watershed groups. The analysis, which drew on paired biological, chemical, and physical data from 640 sites in Northeast Illinois, found fish species and the Fish Index of Biotic Integrity (fIBI) were more sensitive to TP concentration variation than the macroinvertebrate taxa and the Macroinvertebrate Index of Biotic Integrity. The 75th percentile of sites in the fIBI range of 41 and 49 (meeting and exceeding the General Use standard for aquatic life) was found to correspond to a TP concentration of 0.277 milligrams per liter (mg/L).

Analysis of the mean TP concentrations at sites monitored by the watershed groups' rolling bioassessments under various flow regimes show a clear differentiation between sites. Annual mean concentrations at sites downstream of WWTPs, a product of both wastewater and nonwastewater (stormwater and background sources, summarized as urban), ranged from 0.70 mg/L to 2.12 mg/L; concentrations at urban-only sites (upstream of any WWTP influence) had TP concentrations ranging nearly an order of magnitude lower, 0.03–0.53 mg/L. The flow was an important factor, with concentrations falling at both wastewater-influenced and urban sites as flow increased. Mean annual concentrations at all urban sites were beneath the watershed threshold (0.277 mg/L) in all years sampled when flows were above the 25th percentile. Sites downstream of WWTPs outfalls had a TP concentration significantly above the watershed threshold in all years. Aggregation of the flows and water quality data to allow for reduction scenarios modeling showed that while WWTPs contributed 13%–28% of annual flow, they contributed more than 80% of annual ambient instream TP.

Modeling was conducted using the QUAL2Kw platform to identify potential management scenarios that would decrease ambient instream TP concentrations below the identified TP watershed threshold. Receiving water models were developed for each basin and included the connectivity of the East and West Branches of the DuPage River model outputs to inform the headwater conditions of the Lower DuPage River. Following model calibration efforts, channel geometry and hydraulics were modified for the Lower DuPage River and Salt Creek to reflect the imminent removals of dams on these waterways (both dams have since been removed). The removal of the dam on Salt Creek was predicted to improve upstream DO conditions on average. Ultimately, the suite of scenarios modeled demonstrated that an effluent TP permit limit of 0.35 mg/L (for an effective effluent concentration of 0.28 mg/L) for WWTPs along Salt Creek and the West and East Branches of the DuPage River and an effluent TP permit limit of 0.5 mg/L (for an effective effluent concentration of 0.4 mg/L) for WWTPs along the Lower DuPage River would be sufficient to achieve the local threshold value satisfactorily.

The modeled reductions of effluent TP concentrations did not show meaningful improvements in predicted minimum and mean DO concentrations due in part to localized persistence of low gradients or flow restrictions which also factor into existing DO impairments.

The NIP recommends that targeted physical projects focused on eliminating DO sags and improving instream habitat be implemented. Recommendations include that (1) WWTPs discharging to Salt Creek and the East and West Branches of the DuPage River adopt an effluent limit of 0.35 mg/L TP (leading to an effective mean effluent concentration of 0.28 mg/L, assuming a 20% margin of safety) seasonal geometric mean for warm weather months (May–October) as part of an annual 0.50 mg/L TP geometric mean; (2) WWTPs discharging to the mainstem of the Lower DuPage River adopt an effluent limit of 0.50 mg/L TP (leading to an effective mean effluent concentration of 0.4 mg/L, assuming a 20% margin of safety) for warm weather months as an annual geometric mean, rolling 12-month basis; and (3) the Crest Hill STP, which discharges to a tributary on the Lower DuPage River, adopt the 0.35 mg/L TP limit.

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PURPOSE OF DOCUMENT

This Nutrient Implementation Plan (NIP) is submitted on behalf of the agencies managing wastewater treatment plants (WWTPs) who are members of the DuPage River and Salt Creek Workgroup (DRSCW) or the Lower DuPage River Watershed Coalition (LDRWC) to fulfill the following National Pollutant Discharge Elimination System (NPDES) permit Special Condition:

> *"The Permittee shall submit electronically to EPA.PrmtSpecCondtns@illinois.gov with "IL0028380 Special Condition 17.H" as the subject of the email and post to the DRSCWs website by December 31, 2023 a Nutrient Implementation Plan (NIP) for the DRSCW watersheds that identifies phosphorus input reductions by point source discharges, non-point source discharges and other measures necessary to remove DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 35 Ill. Adm. Code 302.206 and the narrative offensive aquatic algae criteria in 35 Ill. Adm. Code 302.203. The NIP shall also include a schedule for implementation of the phosphorus input reductions and other measures. The Permittee may work cooperatively with the DRSCW to prepare a single NIP that is common among DRSCW permittees. Progress reports shall be submitted every year until completion and submission of the NIP. The DRSCW may prepare a single progress report for all DRSCW permittees and may be submitted as part of a combined annual report with paragraph D above. The Agency will renew or modify the NPDES permit as necessary to incorporate NIP requirements."* **(DRSCW Permits)**
>
> *"The Permittee shall submit a Nutrient Implementation Plan (NIP) for the DRSCW/LDRWC watersheds that identifies phosphorus input reductions by point source discharges, non-point source discharges and other measures necessary to remove DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 35 IL Adm. Code 302.206 and the narrative aquatic algae criteria in 35 IL Adm. Code 302.203. The NIP shall also include a schedule for implementation of the phosphorus input reductions and other measures. The Permittee may work cooperatively with the DRSCW/LDRWC to prepare a single NIP that is common among DRSCW/LDRWC permittees. The NIP shall be submitted to the Agency by December 31, 2023."* **(LDRWC Permits)**

These agencies and their facilities are listed in Table 1.

The NIP is focused on developing a plan to target an ambient instream phosphorous concentration that is protective of aquatic life. However, it is a continuation of the DRSCW's and LDRWC's existing adaptive management plans to meet aquatic life use goals in the DuPage River and Salt Creek watersheds via comprehensive monitoring, data analysis, and redirecting water quality investments to address priority stressors. The NIP identifies essential physical projects to eliminate dissolved oxygen sags and improve aquatic habitat in parallel to total phosphorus (TP) reduction.

The TP watershed thresholds described in this document are not, nor are they intended to become, water quality standards. Therefore, they should not be used to set specific regulatory requirements. All schedules and project assessments are proposed for planning purposes only, and the agencies are only obligated to strictly adhere to them if and when they are formalized in an NPDES permit condition.

Table 1. Agencies and WWTPs contributing and participating in the NIP

Agency Name	Facility Name	NPDES Permit
Addison, Village of	A. J. LaRocca WTF	IL0027367
Addison, Village of	Addison - North STP	IL0033812
Bartlett, Village of	Bartlett WWTP	IL0027618
Bensenville, Village of	South STP	IL0021849
Bloomingdale, Village of	Reeves WRF	IL0021130
Bolingbrook, Village of	Bolingbrook #1	IL0032689
Bolingbrook, Village of	Bolingbrook #2	IL0032735
Bolingbrook, Village of	Bolingbrook #3	IL0069744
Carol Stream, Village of	Carol Stream WRC	IL0026352
Crest Hill, City of	Crest Hill STP	IL0021121
Downers Grove Sanitary District	Downers Grove S.D. – Wastewater Treatment Center	IL0028380
DuPage County	Green Valley	IL0031844
Elmhurst, City of	Elmhurst WRF	IL0028746
Glenbard Wastewater Authority	Glenbard WWTP	IL0021547
Glendale Heights, Village of	Glendale Heights WWTP	IL0028967
Hanover Park, Village of	Hanover Park STP	IL0034479
Itasca, Village of	Itasca STP	IL0079073
Joliet, City of	Aux Sable WWTP	IL0076414
Minooka, Village of	Minooka STP	IL0055913
Metropolitan Water Reclamation District of Greater Chicago	Egan WRP	IL0036340
Metropolitan Water Reclamation District of Greater Chicago	Hanover WRP	IL0036137
Naperville, City of	Springbrook WRP	IL0034061
Plainfield, Village of	Plainfield STP	IL0074373
Roselle, Village of	J. Botterman WWTP	IL0048721
Roselle, Village of	J. L. Devlin WWTP	IL0030813
Salt Creek Sanitary District	Salt Creek Sanitary District STP	IL0030953
West Chicago, City of and Winfield, Village of	West Chicago/Winfield Wastewater Authority Regional WWTP	IL0023469
Wheaton Sanitary District	Wheaton Sanitary District WWTF	IL0031739
Wood Dale, City of	City of Wood Dale - North STP	IL0020061
Wood Dale, City of	Wood Dale - South STP	IL0034274
Plainfield, Village of	Plainfield STP	IL0074373

Key:

DRSCW Member
LDRWC Member

ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
µg/L	micrograms per liter
BMP	best management practice
BNR	biological nutrient removal
BOD	biochemical oxygen demand
BOD5	5-day biochemical oxygen demand
BPR	biological phosphorous removal
CADDIS	Causal Analysis/Diagnosis Decision Information System
CAFO	concentrated animal feeding operation
CART	classification and regression trees
CBOD	carbonaceous biochemical oxygen demand
CFR	Code of Federal Regulations
cfs	cubic feet per second
CSO	combined sewer overflow
CUP	Capital Upgrade Period
DAF	design average flow
D.C.	direct current
DC SWM	DuPage County Stormwater Management Department
DDT	dichlorodiphenyltrichloroethane
DMR	discharge monitoring report
DO	dissolved oxygen
DRSCW	DuPage River Salt Creek Workgroup
EB	East Branch DuPage River
fIBI	Fish Index of Biotic Integrity
FIT	goodness-of-fit statistical factor
FPCC	Forest Preserves of Cook County
FPDDC	Forest Preserve District of DuPage County
GIS	geographic information system
HRT	hydraulic retention time
HUC	hydrologic unit code
HUC12	12-digit hydrologic unit code
IBI	Index of Biotic Integrity
ICI	Invertebrate Community Index
IEPA	Illinois Environmental Protection Agency

Acronym/Abbreviation	Definition
IPCB	Illinois Pollution Control Board
IPS	Identification and Prioritization System
kg	kilogram
lbs	pounds
LD	Lower DuPage River
LDRWC	Lower DuPage River Watershed Coalition
LTCP	long-term control plan
macros	macroinvertebrates
MBI	Midwest Biodiversity Institute
mg/L	milligrams per liter
MGD	million gallons per day
mIBI	Macroinvertebrate Index of Biotic Integrity
MS4	municipal separate storm sewer system
MSE	mean square error
MWRDGC	Metropolitan Water Reclamation District of Greater Chicago
NARP	Nutrient Assessment and Reduction Plan
NE	northeast
NIP	Nutrient Implementation Plan
NLCD	National Land Cover Database
NLDAS-2	National Land Cover Database-Phase 2
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NRCS	Natural Resources Conservation Service
NSAC	Nutrient Science Advisory Committee
O&M	operations and maintenance
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
QHEI	Qualitative Habitat Evaluation Index
RF	random forest
RM	river mile
ROW	right of way
SC	Salt Creek
SOD	sediment oxygen demand
SRT	solid retention time

Acronym/Abbreviation	Definition
SSI	Sensitive Species Index
SSURGO	Soil Survey Geographic
STP	sewage treatment plant
TARP	Tunnel and Reservoir Plan
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load
TN	total nitrogen
TP	total phosphorus
TSOP	Treatment System Optimization Period
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WB	West Branch DuPage River
WQS	water quality standards
WRC	water reclamation center
WRP	water reclamation plant
WWTP	wastewater treatment plant

1 BACKGROUND

This section details background information on the DuPage River and Salt Creek watersheds. This is a summary of the key elements that have gone into executing this Nutrient Implementation Plan (NIP), including an overall summary of the established watershed groups, workgroup studies, management planning, statistical tool evaluations of robust datasets, and implementation planning efforts.

1.1 ESTABLISHED WATERSHED GROUPS

Two watershed groups cover the project area of these watersheds: the DuPage River Salt Creek Workgroup (DRSCW), which covers the East and West Branches of the DuPage River and Salt Creek, and the Lower DuPage River Watershed Coalition (LDRWC), which covers the Lower DuPage River.

1.1.1 DuPage River Salt Creek Workgroup

The DRSCW is a consortium of wastewater treatment plants (WWTPs); municipalities; governmental agencies, such as park districts, forest preserves, and transportation agencies; engineering companies; and environmental advocacy groups in the East Branch DuPage River, West Branch DuPage River, and Salt Creek watersheds. A complete list of DRSCW members can be found on the DRSCW website[1] and is included in Table 2. The DRSCW was formed in 2005 in response to concerns about total maximum daily loads (TMDLs) being set for the East and West Branches of the DuPage River and Salt Creek. The DRSCW organized to implement rigorous analysis and targeted projects and programs that cost-effectively worked towards the goals of the Clean Water Act (CWA), particularly the designated use for aquatic life.

In 2015, the DRSCW submitted its Implementation Plan to the Illinois Environmental Protection Agency (IEPA). The adaptive management approach focuses on high-resolution, comprehensive monitoring of chemical, biological, and physical characteristics of the watersheds. This monitoring provides the data needed to execute the “Plan-Do-Check-Act” methodology inherent to adaptive management (Figure 1). Monitoring and analysis provide insight into the highest-priority stressors that affect stream health to identify projects or initiatives with the greatest potential to attain stream use goals. Monitoring also provides the feedback needed to properly assess the impacts of cutting-edge stream restoration projects and water quality initiatives to better formulate future activities.

[1] www.drscw.org

Figure 1. Infographic illustrating the Plan-Do-Check-Act adaptive management methodology.

The 2015 Implementation Plan was used to negotiate a Special Condition in the National Pollutant Discharge Elimination System (NPDES) permit for the watershed's major municipal WWTPs (see Section 3.8). The Special Condition covered two five-year permit cycles (10 years total); it set an effluent total phosphorus (TP) limit for WWTPs at 1.0 milligrams per liter (mg/L) required 10 years after the effective date of the initial permit for WWTPs using chemical treatment and 11 years after the effective date of the initial permit for WWTPs using biological treatment. Additionally, the Special Condition includes projects and activities as set out in the 2015 DRSCW Implementation Plan (Table 3).

Table 2. DuPage River Salt Creek Workgroup members by type

Member Type	Member Organizations		
Agency Members	Village of Addison	Village of Glenn Ellyn	Village of Roselle
	City of Aurora	Village of Glendale Heights	Salt Creek Sanitary District
	Village of Arlington Heights	Village of Hanover Park	Village of Schaumburg
	Village of Bartlett	Village of Hinsdale	Village of Streamwood
	Village of Bensenville	Village of Hoffman Estates	Village of Villa Park
	Village of Bloomingdale	Village of Itasca	City of Warrenville
	Village of Bolingbrook	Village of Lisle	City of West Chicago
	Village of Carol Stream	Village of Lombard	Village of Westchester
	Village of Clarendon Hills	Metropolitan Water Reclamation District of Greater Chicago	Village of Western Springs
	Village of Downers Grove	City of Naperville	Village of Westmont
	Downers Grove Sanitary District	City of Northlake	City of Wheaton
	DuPage County	Village of Oakbrook	Wheaton Sanitary District
	City of Elmhurst	City of Oakbrook Terrace	Village of Winfield
	Glenbard Wastewater Authority	Village of Palatine	City of Wood Dale
			Village of Woodridge
Associate Members	AECOM	Engineering Resource Association	Naperville Park District
	Baxter & Woodman, Black & Veatch	Forest Preserve District of DuPage County	Prairie Rivers Network
	The Conservation Foundation	Hey & Associates	Robinson Engineering
	Christopher B. Burke Engineering	Huff & Huff	Salt Creek Watershed Network, Sierra Club River Prairie Group
	Clark-Dietz, Deuchler Engineering	Illinois Department of Transportation	Stantec
	Donohue & Associates	Illinois State Toll Highway Authority	Strand Associates
	Elmhurst-Chicago Stone Company	Village of LaGrange Park	Trotter & Associates
		Lisle Township Highway Department	V3 Companies
		The Morton Arboretum	York Township Highway Department

Table 3. DRSCW Special Condition projects and activities per Implementation Planning from 2015 and 2020

Project Name	Completion Date	Short-Term Objectives	Long-Term Objectives
Oak Meadows Golf Course Dam Removal	December 31, 2016 (Completed)	Improve dissolved oxygen (DO)	Improve fish passage
Oak Meadows Golf Course Stream Restoration	December 31, 2017 (Completed)	Improve aquatic habitat (Qualitative Habitat Evaluation Index (QHEI)), reduce inputs of nutrients and sediment	Raise macroinvertebrate Index of Biotic Integrity (mIBI)
Fawell Dam Modification	December 31, 2022	Modify dam to allow fish passage	Raise fish Index of Biotic Integrity (fIBI) upstream of structure
Spring Brook Restoration and Dam Removal	December 31, 2020 (Completed)	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise mIBI and fIBI
Fullersburg Woods Dam Modification Concept Plan Development	December 31, 2016 (Completed)	Identify conceptual plan for dam modification and stream restoration	Build consensus among plan stakeholders
Fullersburg Woods Dam Modification	December 31, 2023	Improve DO, improve aquatic habitat (QHEI)	Raise mIBI and fIBI
Fullersburg Woods Dam Modification Area Stream Restoration	December 31, 2023	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise mIBI and fIBI
West Branch Physical Enhancement	December 31, 2023	Improve aquatic habitat (QHEI)	Raise mIBI and fIBI
Southern East Branch Stream Enhancement	December 31, 2024	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise mIBI and fIBI
QUAL2Kw Modeling for West Branch, East Branch, and Salt Creek	December 31, 2023	Collect new baseline data and update model	Quantify improvements in watershed. Prioritize DO improvement projects for years beyond 2024
Nonpoint Source (NPS) Phosphorus Feasibility Analysis	December 31, 2021	Assess NPS performance from reductions leaf litter and street sweeping	Reduce NPS contributions to lowest practical levels
East Branch Phase II [a]	December 31, 2028	Improve aquatic habitat (QHEI), reduce Inputs of nutrients and sediment	Raise mIBI and fIBI
Lower Salt Creek Phase 2 [a]	December 31, 2028	Improve aquatic habitat (QHEI), Remove fish barrier, reduce inputs of nutrients and sediment	Raise mIBI and fIBI
West Branch Restoration Project [a]	December 31, 2028	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise mIBI and fIBI

Note:
[a] Project was included in the 2020 DRSCW Implementation Plan and added to the Special Conditions in 2022.

Another requirement of the Special Conditions is that the included WWTPs participate in a watershed Chloride Reduction Program with the objective of optimizing public agency winter chloride compound application rates to decrease watershedwide chloride loading.

In 2022, the Special Conditions were extended for an additional five-year permit cycle and provided additional funding from participating members for projects identified in the 2020 Implementation Plan (Section 1.4.2). The

2022 Special Condition also extended the effective date of the effluent TP limit for WWTPs at 1.0 mg/L for an additional three years. Four DRSCW members chose to retain the original NPDES permit language and will be implementing a TP limit of 1.0 mg/L monthly average starting between 10/01/2025 and 08/02/2026 (see Section 9.1). Twelve agencies running 16 WWTPs have opted to adopt the new conditions. An additional two WWTPs are already treating to 1.0 mg/L TP due to earlier plant expansions.

The Special Conditions also require the DRSCW to prepare this NIP, as follows:

> *"The Permittee shall submit electronically to EPA.PrmtSpecCondtns@illinois.gov with "IL0021130 Special Condition 16.H" as the subject of the email and post to the DRSCWs website by December 31, 2023 a Nutrient Implementation Plan (NIP} for the DRSCW watersheds that identifies phosphorus input reductions by point source discharges, nonpoint source discharges and other measures necessary to remove DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 35 Ill. Adm. Code 302.206 and the narrative offensive aquatic algae criteria In 35 Ill. Adm. Code 302.203. The NIP shall also include a schedule for implementation of the phosphorus input reductions and other measures. The Permittee may work cooperatively with the DRSCW to prepare a single NIP that is common among DRSCW permittees. Progress reports shall be submitted every year until competition and submission of the NIP. The DRSCW may prepare a single progress report for all DRSCW permittees and may be submitted as part of a combined annual report with paragraph D above The Agency will renew or modify the NPDES permit as necessary to incorporate NIP requirements."*

The DRSCW has partnered with the adjacent LDRWC (see Section 1.1.2) on a multi-pronged and multi-year approach to develop this robust NIP. For DRSCW, this NIP serves as an update to the 2015 and 2020 implementation plans and will be used to direct future DRSCW work. The recommendations of the NIP are expected to be used to draft future NPDES permits for DRSCW member WWTPs.

1.1.2 Lower DuPage River Watershed Coalition

Communities in the Lower DuPage River Watershed came together to form the LDRWC after completion of a watershed plan in 2011. The LDRWC is also a consortium of WWTPs; municipalities; governmental agencies such as park districts, forest preserves, and transportation agencies; engineering companies; and environmental advocacy groups. A complete list of LDRWC members can be found on the group's website[2] and in Table 4. Following a similar adaptive management approach, the LDRWC implements a bioassessment monitoring program modeled after the DRSCW program, which allows for seamless data analyses across the entire DuPage River watershed. The LDRWC also plays an active role in providing education and outreach materials to members about water quality, stormwater, and aquatic ecosystems. The LDRWC works very closely with the DRSCW on monitoring and modeling efforts, analyzing data, reducing chloride, and developing this NIP for the entire DuPage River Watershed.

Similarly to the DRSCW, the LDRWC has negotiated a Special Condition with the IEPA that includes projects and activities that are the sole responsibility of the LDRWC (Table 5) as well as those that are the joint responsibility of the LDRWC and DRSCW (Table 6).

[2] www.ldpwatersheds.org

Table 4. Lower DuPage River Watershed Coalition members by type

Member Type	Member Organizations		
Agency Members	Village of Bolingbrook Village of Channahon City of Crest Hill City of Joliet	Village of Minooka City of Naperville Village of Plainfield	Village of Romeoville Village of Shorewood Will County Stormwater Management
Associate Members	Baxter & Woodman Channahon Park District	Forest Preserve District of Will County Naperville Park District Robinson Engineering	Strand Associates The Conservation Foundation Wheatland Township

Table 5. LDRWC Special Condition projects per Implementation Planning from 2016

Project Name	Completion Date	Short-Term Objectives	Long-Term Objectives
Hammel Woods Dam Removal	December 31, 2022	Improve DO, reduce nuisance algae	Improve fish passage
DuPage River Stream enhancement South of 119th Street in Plainfield	December 31, 2024	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise mIBI and fIBI

Table 6. LDRWC/DRSCW joint activities

Project Name	Completion Date	Short-Term Objectives	Long-Term Objectives
NPS Phosphorus Feasibility Analysis	December 31, 2021	Assess NPS performance from reductions leaf litter and street sweeping	Reduce NPS contributions to lowest practical levels

The LDRWC Special Condition NIP language is similar to that of the DRSCW:

> *"The Permittee shall submit a Nutrient Implementation Plan (NIP) for the DRSCW/LDRWC watershed that identified phosphorus input reductions by point source discharges, nonpoint source discharges and other measures necessary to remove DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 3 IL Adm. Code 302.203. The NIP shall also include a schedule for implementation of the phosphorus input reductions and other measures. The Permittee may work cooperatively with the DRSCW/LDRWC to prepare a single NIP that is common among DRSCW/LDRWC permittees. The NIP shall be submitted electronically to EPA.PrmtSpecCondtns@illinois.gov with "NPDES Permit Number Special Condition 16.H: as the subject of the email and posted to the permittees website to the Agency by to the Agency by December 31, 2023."*

As stated above, the LDRWC has been working directly with the DRSCW to prepare a single comprehensive NIP for the DuPage River watershed including the Lower DuPage River, East Branch DuPage River, and West Branch DuPage River, along with the Salt Creek watershed.

1.2 WORKGROUP STUDIES AND MANAGEMENT PLANS

The DRSCW and LDRWC have conducted extensive water quality monitoring and commissioned various studies for the DuPage River and Salt Creek watersheds to understand how best to preserve and protect instream conditions for aquatic life. Summaries of relevant monitoring efforts and studies used in the development of this NIP are included in this section.

1.2.1 Monitoring Programs

Relevant monitoring programs conducted throughout the DuPage River and Salt Creek watersheds include a bioassessment sampling program, continuous and expanded dissolved oxygen (DO) monitoring efforts, and a continuous winter chloride monitoring program.

1.2.1.1 Bioassessments

The DRSCW bioassessment program began in 2006 with sampling in the West Branch DuPage River; the East Branch DuPage River and Salt Creek watersheds were sampled in 2007. From 2006 to 2016, each watershed was sampled on a three-year rotation. Beginning in 2017, the watersheds were sampled in a four-year rotation to allow time for the report writing and program assessment. As of 2023, the DRSCW watersheds will be sampled on a six-year rotation. The LDRWC began its bioassessment program around 2014 and sampled the watershed every three years between 2012 and 2021. Beginning in 2021, the LDRWC watersheds will be sampled every five years. Table 7 details the bioassessment sampling dates for each DRSCW and LDRWC watershed.

Table 7. Bioassessment sampling dates for the DRSCW/LDRWC watersheds

Watershed	Years with Completed Sampling	Next Upcoming Sampling Year
East Branch DuPage River	2007, 2011, 2014, 2019, 2023	2029
West Branch DuPage River	2006, 2009, 2012, 2015, 2020	2025
Salt Creek	2007, 2010, 2013, 2016, 2021	2027
Lower DuPage River	2012, 2015, 2018, 2021	2026

The combined DRSCW and LDRWC bioassessment program uses standardized biological, chemical, and physical monitoring and assessment techniques employed to meet three major objectives:

1. Determine the extent to which biological assemblages are impaired (using IEPA guidelines).
2. Determine the categorical stressors and sources that are associated with those impairments.
3. Add to the broader databases for the DuPage River and Salt Creek watersheds to track and understand changes through time in response to abatement actions or other influences.

The data collected as part of the bioassessment is processed, evaluated, and synthesized as a biological and water quality assessment of aquatic life use status. The assessments are directly comparable to previously conducted bioassessments such that trends in status can be examined, and causes and sources of impairment can be confirmed, amended, or removed. A final report is prepared following each bioassessment. It contains a summary of major findings and recommendations for future monitoring, follow-up investigations, and any immediate actions needed to resolve readily diagnosed impairments. The bioassessment reports are posted on the DRSCW[3] and LDRWC[4] websites. All Special Conditions projects were identified using data and analyses from the bioassessment monitoring (see Table 3).

Sampling sites for the bioassessment program are determined systematically using a geometric design supplemented by the bracketing of features likely to influence stream resource quality (such as combined sewer overflows [CSOs], dams, major stormwater sources, and WWTP outfalls). The number of sampling sites by method/protocol and watershed are listed in Table 8.

[3] https://drscw.org/activities/bioassessment/
[4] https://ldpwatersheds.org/about-us/lower-dupage-river-watershed-coalition/our-work/reports-resources/

IEPA maintains a statewide network of reference sites to support the derivation and calibration of their fish and macroinvertebrate IBIs. However, and according to the most recent State program evaluation conducted in 2013, these sites are limited to wadeable streams and small rivers. The wadeable stratum includes very few if any headwater reference sites and none less that third-order streams. In addition, only two IEPA reference sites exist in calibration region 3 for the Illinois fIBI. DRSCW developed a network of reference sites to fill this gap and provide evidence that the IEPA fish and macroinvertebrate indices could attain the General Use standard beginning in 2006 and eventually consisting of 16 sites ranging in drainage area from by 2013. Additional reference sites will be added for the Lower Des Plaines River watershed sampled in 2020 and 2021. The purpose of the reference sites was expanded in 2019 to include water chemistry, sediment, continuous DO, and chlorophyll-*a* to establish reference values for these non-biological parameters.

Table 8. Number of sampling sites in the DRSCW/LDRWC watersheds

Method/Protocol	West Branch DuPage River (2020)	East Branch DuPage River (2023)	Salt Creek (2021)	Lower DuPage River (2021)	Reference Sites (2006–2023)	Total Sites
Biological Sampling						
Fish	42	44[a]	65[b]	42	13	206
Macroinvertebrates	42	43[a]	65[b]	42	13	205
Qualitative Habitat Evaluation Index (QHEI)	42	44[a]	65[b]	42	13	206
Water Column Chemical/Physical Sampling						
Nutrients/Demand	42	39	57	40	6	184
Water Quality Metals	30	22	34	0	6	92
Water Quality Organics	18	11	17	0	6	52
Sediment Sampling	23	15	27	8	6	79

Notes:
[a] Includes seven sites that were being monitored for fish and macroinvertebrates and one site that was being monitored for fish only as part of pre-project monitoring at the Lower East Branch Stream Enhancement Project.
[b] Includes eight sites that were being monitored as part of pre-project monitoring at Fullersburg Woods and post-project monitoring at the Preserve at Oak Meadows.

The bioassessment sampling includes four sampling methods/protocols: biological sampling, Qualitative Habitat Evaluation Index (QHEI), water column chemical/physical parameter sampling and sediment chemistry. The biological sampling includes two assemblages: fish and macroinvertebrates.

Biological sampling includes fish and macroinvertebrates, and results are presented as Index of Biotic Integrity (IBI) scores, an environmental evaluation concept formulated by Dr. James Karr in 1981. IBI is an evaluation of a waterbody's biological community that allows the identification, classification, and ranking of water pollution and other stressors. IBI scores allow for the statistical association of various anthropogenic influences on a waterbody with the observed biological activity in said water body and, in turn, the identification and evaluation of management interventions in the process of adaptive management. Chemical testing of water samples produces only a snapshot of chemical concentrations, while an IBI score allows an evaluation of the net impact of chemical, physical, and flow variables on a biological community structure.

Methods for collecting fish at wadeable sites include using a tow-barge or longline pulsed direct current (D.C.) electrofishing apparatus (MBI 2012. A Wisconsin Department of Natural Resources battery-powered backpack electrofishing unit is used as an alternative to the longline in the smallest streams (Ohio EPA 1989). A three-person crew carries out the sampling protocol for each type of wading equipment sampling in an upstream direction. The sampling effort is indexed to linear distance and ranges from 150 to 200 meters in length. Non-wadeable sites are sampled with a raft-mounted pulsed D.C. electrofishing device in a downstream direction (MBI 2012). Sampling efforts are indexed to linear distance over 0.5 kilometers. Sampling is conducted during a June 15 to October 15 seasonal index period.

Samples from each site are processed by enumerating and recording weights by species and by life stage (year-over-year, juvenile, and adult). All captured fish are immediately placed in a live well, bucket, or live net for processing. Water is replaced and/or aerated regularly to maintain adequate DO levels and to minimize mortality. Fish not retained for voucher or other purposes were released back into the water after being identified to the species level, examined for external anomalies, and weighed individually or in batches. While the majority of captured fish are identified to species level in the field, any uncertainty about the field identification requires their preservation for later laboratory identification. Identification is made to the species level at a minimum and to the sub-species level if necessary. Vouchers are deposited and verified at The Ohio State University Museum of Biodiversity in Columbus, Ohio.

The macroinvertebrate assemblage is sampled using the IEPA multi-habitat method (IEPA 2005). Laboratory procedures followed the IEPA (2005) methodology for processing multi-habitat samples by producing a 300-organism subsample with a scan and pre-pick of large and/or rare taxa from a gridded tray. Taxonomic resolution is performed to the lowest practicable resolution for the common macroinvertebrate assemblage groups, such as mayflies, stoneflies, caddisflies, midges, and crustaceans, which goes beyond the genus level requirement of IEPA (2005). However, calculating the macroinvertebrate Index of Biotic Integrity (mIBI) followed IEPA's methods in using genera as the lowest taxonomy level for mIBI calculation and scoring.

Physical habitat is evaluated using the QHEI developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995; Ohio EPA 2006 and as modified by the Midwest Biodiversity Institute (MBI) for specific attributes. Attributes of habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates; amount and quality of instream cover; channel morphology; extent and quality of riparian vegetation; pool, run, and riffle development and quality; and gradient are used to determine the QHEI score, which generally ranges from 20 to less than 100. QHEI scores and physical habitat attributes were recorded in conjunction with fish collections.

Water column and sediment samples are also collected as part of the bioassessment programs. The number of samples collected at each site is largely a function of the site's drainage area, with the sampling frequency increasing as the drainage size increases. Organics sampling is a single sample collected at a subset of sites. Sediment sampling is performed at a subset of sites using the same procedures as IEPA.

The parameters sampled are included in Table 9 and can be grouped into oxygen-demanding parameters, nutrients, demand, metals, and organics.

Table 10 includes the number of samples by analyte group for each watershed, and it shows the total number of collected samples by watershed (typical for a full watershed-specific assessment) All water sampling occurs between May and October, and sediment sampling occurs October to December. Standard Operating Procedures[5] were practiced for all water quality sampling.

[5] http://drscw.org/wp/bioassessment/

Table 9. Water quality and sediment parameters sampled as part of the Bioassessment Program

Water Quality Parameters Sampled by Group/Type	
Nutrients	Ammonia
	Nitrogen/nitrate
	Nitrogen – total Kjeldahl
	Phosphorus, total
	Chlorophyll-*a*
Oxygen Demand-Related Parameters	Total suspended solids
	Total dissolved solids
	DO
	pH
	Temperature
	Conductivity
	5-day biochemical oxygen demand
	Chloride
Metals	Cadmium
	Calcium
	Copper
	Iron
	Lead
	Magnesium
	Zinc
Organics	Polychlorinated biphenyls
	Volatile organic compounds
	Pesticides
	Semi volatile organics
Municipal Separate Storm Sewer System (MS4)	Sulfate
	Oil and grease

Sediment Parameters Sampled by Group/Type	
Sediment Nutrients	Phosphorus
Sediment Metals	Arsenic
	Barium
	Cadmium
	Chromium
	Copper
	Iron
	Lead
	Manganese
	Nickel
	Potassium
	Silver
	Zinc
Sediment Organics	Organochlorine pesticides
	Polychlorinated biphenyls
	Percent moisture
	Semi volatile organics
	Volatile organic compounds

Table 10. Number of samples in each watershed by analyte group in the Bioassessment Program

Watershed	# of Sites	Water Chemistry (# of Samples)				Sediment Chemistry (# of Samples)	
		Demand & Nutrients	MS4 Parameters	Metals	Organics	Metals	Organics
East Branch DuPage River	41	212	6	100	11	15	15
West Branch DuPage River	41	225	7	116	18	23	23
Salt Creek	57	319	7	167	17	27	27
Lower DuPage River	44	237	-	237	-	8	8

1.2.1.2 Continuous Dissolved Oxygen Monitoring

The DRSCW launched its continuous DO monitoring network in 2006. Before that, DO was monitored continuously at only one site in the Upper DuPage, on the West Branch, at the City of Wheaton under the authority of the Wheaton Sanitary District and at four sites on Salt Creek under the authority of the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC). In 2022, DRSCW, in collaboration with DuPage County Stormwater Management (DC SWM), gathered continuous DO data via water quality sondes at four sites on Salt Creek, five sites on the East Branch DuPage River, and five sites on the West Branch DuPage River.

The LDRWC began collecting continuous DO data in 2015; most recently, in 2022, the LDRWC collected data at five locations on the Lower DuPage River. All sondes are deployed from May to October and collect DO, temperature, conductivity, and pH on an hourly basis. Details on the site locations are included in Table 11, and additional details on the program are available online.[6]

Table 11. Continuous DO monitoring locations in the DRSCW and LDRWC watersheds in 2022

Site ID	Stream Name	River Mile	Latitude	Longitude	Location
DuPage River Salt Creek Workgroup					
EBAR	East Branch (EB) DuPage River	23.0	41.935171	-88.05843	Army Trail Road
EBCB	EB DuPage River	18.8	41.88510	-88.04110	Crescent Boulevard
EBHL	EB DuPage River	14.0	41.82570	-88.05316	Hidden Lake Preserve
EBHR	EB DuPage River	8.5	41.76800	-88.07160	Hobson Road
EBWL	EB DuPage River	3.8	41.712315	-88.094842	Whalon Lake
WBAD	West Branch (WB) DuPage River	29.9	41.9750	-88.1386	Arlington Drive
WBBR	WB DuPage River	11.7	41.825268	-88.179456	Butterfield Road
WBWD	WB DuPage River	11.1	41.82027	-88.17212	Downstream of former Warrenville Grove Dam
WBMG	WB DuPage River	8.6	41.795928	-88.187263	Upstream of former McDowell Grove Dam
WBNPV	WB DuPage River	3.0	41.74029	-88.126879	Downstream Bailey Road
SCBW	Salt Creek	29.4	42.01630	-88.00061	Downstream of Busse Woods Dam (MWRDGC)

[6] http://drscw.org/wp/dissolved-oxygen/

Site ID	Stream Name	River Mile	Latitude	Longitude	Location
SCOM	Salt Creek	23.0	41.941279	-87.983363	Upstream of former Oak Meadows Dam
SCBR	Salt Creek	16.1	41.864686	-87.95073	Butterfield Road
SCFW	Salt Creek	11.1	41.825493	-87.93158	Fullersburg Woods impoundment
SCWR	Salt Creek	8.1	41.82576	-87.90045	Wolf Road (MWRDGC)
Lower DuPage River Watershed Coalition					
Channahon	DuPage River	0.88	41.4258836	-88.2327367	US Route 6
Shorewood	DuPage River	8.28	41.497661	-88.216733	River Crossing Drive
Minooka	DuPage River	3.36	41.4484391	-88.2405691	McEvilly Road
NPVLDOWN	DuPage River	26.53	41.695334	-88.162136	1090 feet downstream of Springbrook Water Reclamation Center Discharge
NPVLUP	DuPage River	26.68	41.697024	-88.160490	Upstream of Springbrook Water Reclamation Center Discharge

1.2.1.3 Expanded Dissolved Oxygen Monitoring

In 2019, the DRSCW began an Expanded DO Monitoring Program to collect additional DO-related data on parameters such as nutrients and benthic algae in the watersheds. This program is coordinated with the Bioassessment Program and is conducted during the same years as the watershed bioassessment sampling cycles (see Table 7). The sampling period for the Expanded DO Monitoring Program is late June to the end of August in dry and low-flow conditions (no rain for a minimum of 72 hours prior to any sampling). Sondes are deployed in the channel thalweg for a minimum of 72 hours, where they collect data on DO, temperature, pH, conductivity, turbidity, and chlorophyll-*a* at 15-minute intervals.

Composite water quality samples and sestonic algae sampling are collected once during the sonde deployment using the sampling technique described in the IEPA Standard Operating Procedure for Stream Water Quality Sample Monitoring (DCN184). Samples are analyzed for the water chemistry constituents listed below, including the one benthic algae sample collected at each site:

- 5-day biochemical oxygen demand (BOD5)
- 5-day carbonaceous biochemical oxygen demand (CBOD5)
- Total suspended solids (TSS)
- Volatile suspended solids (VSS)
- Total dissolved solids (TDS)
- Chloride
- Conductivity
- Total organic carbon
- Total dissolved carbon
- Ammonia
- Nitrite
- Nitrate
- Total Kjeldahl nitrogen (TKN)
- TP
- Orthophosphate
- Total dissolved phosphorus
- Sestonic chlorophyll-*a*
- Benthic chlorophyll-*a*

1.2.1.4 Winter Continuous Chloride Monitoring

As part of its Chloride Reduction Strategy Program, the DRSCW and its partners began collecting winter ambient continuous conductivity data in 2007. Currently, the DRSCW monitors winter stream conductivity at six locations (Table 12). The sites are positioned in the upper and lower sections of each subwatershed. For the sites located within the DRSCW watersheds, conductivity concentrations are used to calculate chloride concentrations based on a linear relationship established by the DRSCW.

The LDRWC began its continuous conductivity monitoring program in 2021 and currently monitors at two locations annually (Table 12). The LDRWC is still collecting grab sample chloride data to generate a linear relationship between conductivity and chloride for these sites.

Table 12. Winter continuous chloride monitoring locations in the DRSCW/LDRWC watersheds

Site ID	Stream Name	River Mile	Latitude	Longitude	Location
DuPage River Salt Creek Workgroup					
EBAR	East Branch DuPage River	23	41.935171	-88.05843	Army Trail Road
EBHR	East Branch DuPage River	8.5	41.768	-88.0716	Hobson Road
WBAD	West Branch DuPage River	29.9	41.975	-88.1386	Arlington Drive
WBNPV	West Branch. DuPage River	3	41.74029	-88.126879	Downstream Bailey Road
SCBW	Salt Creek	29.4	42.0163	-88.00061	Downstream of Busse Woods Dam (MWRDGC)
SCWR	Salt Creek	8.1	41.82576	-87.90045	Wolf Road (MWRDGC)
Lower DuPage River Watershed Coalition					
Channahon	DuPage River	0.88	41.4258836	-88.2327367	US Route 6
Shorewood	DuPage River	8.28	41.497661	-88.216733	River Crossing Drive

1.2.2 East Branch/Salt Creek Dissolved Oxygen Improvement Project

Between 1992 and 1998, Salt Creek and the East Branch DuPage River were listed as impaired for DO on the Section 303(d) List of Impaired Waters by the State of Illinois (see Section 2.2 for more information on the 303(d) List). In 2004, TMDLs for each of these streams were prepared by the IEPA and approved by the United States Environmental Protection Agency (USEPA). These reports focused on changes to WWTP effluent permit limits on nutrients to meet DO standards, but they also recommended that dam removal be investigated. The DRSCW designed the East Branch/Salt Creek Dissolved Oxygen Improvement Project to explore the feasibility and benefits of WWTP effluent nutrient load reductions, the removal or modification of existing dams, and the construction and operation of instream aeration projects. Modeling conducted for the study used publicly available WWTP discharge monitoring report (DMR) data, instead of the effluent limits used in the TMDL, and it incorporated continuous ambient data for calibration.

Additional field data collected included stream characteristics, such as stream depth, canopy cover, sediment accumulation, stream bank erosion, riparian zone composition, wetland presence, stream slope, bank heights, point source inputs, flow data, continuous DO data, and sediment oxygen demand (SOD) data. The updated field data were used to convert the existing TMDL models from the legacy software QUAL2E to the more-updated receiving water model platform QUAL2K, as it provided a more robust representation of instream processes and a more user-friendly interface. The updated calibrated and corroborated QUAL2K models were used to test various potential management scenarios that included the WWTP nutrient load reductions, dam removals, and aeration alternatives. DRSCW prioritized project evaluations that would benefit the ecosystem and surrounding community and improve DO concentrations. The feasibility studies found that, due to their use of effluent permit limits to allocate flow and concentration values, the TMDLs overestimated the influence of WWTP effluent on DO concentrations under typical conditions.

The East Branch DuPage River Final Report and Implementation Plan included a concept plan for removing the Churchill Wood Dam. DRSCW and the Forest Preserve District of DuPage County (FPDDC) developed construction plans to remove Churchill Woods Dam; in 2011, DC SWM removed the dam. The project was funded by DC SWM and a Section 319 grant provided by the IEPA and matched by the DRSCW.

Priority projects identified in the *Salt Creek Dissolved Oxygen Improvement Plan Final Report* included the removal of the Oak Meadows and Fullersburg Woods (Graue Mill) dams. These dam removals were incorporated into the

2015 Implementation Plan and are included in the NPDES permit's Special Condition language. The Oak Meadows Dam was removed in 2016, and the Fullersburg Woods (Graue Mill) Dam is scheduled for removal in 2023–2024.

More information on the East Branch/Salt Creek Dissolved Oxygen Improvement Project is available online at the DRSCW website.[7]

1.3 IDENTIFICATION AND PRIORITIZATION SYSTEMS TOOL

1.3.1 Identification and Prioritization System Tool Development (2010)

In the mid-2010s, the DRSCW partnered with the MBI to develop the Identification and Prioritization System (IPS) tool. The IPS was a key tool in selecting projects for inclusion in the DRSCW's 2015 Implementation Plan. DRSCW used the IPS Tool to perform robust relational analyses of stressors responsible for aquatic life (low DO) impairments based on biological resources, and the results were used to help select implementation projects that:

- Address the most limiting stressors at a reach level
- Prioritize reaches for intervention
- Establish restoration endpoints
- Provide a level of confidence in the likelihood of success
- Have measurable outcomes

The IPS Tool employs statistical techniques to examine correlations between observed aquatic communities (as measured by IBI) relative to 42 potential stressor parameters. Possible stressors include landscape-scale stressors (such as land use, road density, and basin size), ambient water chemistry (such as chloride and phosphorous concentrations) and physical conditions (using subcomponents of the QHEI such as measures of riparian buffer width and stream sinuosity). The stressors evaluated in the IPS Tool analysis do not directly include physical barriers to fish movement (such as dams or other control structures); however, other metrics affected by such structures (such as poor habitat or sediment conditions that exist due to the presence of impounded water upstream of a dam) are included. Sampling sites directly affected by dams were weighted high (prioritized) during the final restorability ranking. The IPS examined relationships between the independent variables (stressors) and IBIs, and it also considered stressor relationships with specific species and taxa from which IBIs are constructed. The methods used in the IPS Tool are based on the USEPA Causal Analysis/Diagnosis Decision Information System (CADDIS) methodology, incorporating cluster analysis and Non-metric Multidimensional Scaling and Classification and Regression Trees (CART).

The IPS Tool statistical analyses identified the following nine priority or "proximate" stressors as having the most significant correlation with the 2007–2013 IBI values used in the analysis:

1. Riparian habitat
2. Riffles
3. Channel condition
4. Substrate
5. Pools
6. Chloride
7. TKN
8. Biochemical oxygen demand (BOD)
9. Ammonia

[7] https://drscw.org/activities/dissolved-oxygen/

Quantile regression was used to examine the relationships between individual stressors and the Fish Index of Biotic Integrity (fIBI) and mIBI scores. This analysis supplied thresholds for the stressor response in aquatic communities and information for project planners to design potential restoration projects. Two additional stressors, physical fragmentation (dams) and polycyclic aromatic hydrocarbons (PAHs), were also added to the list of priority stressors identified by the IPS Tool. Although neither stressor was used in the statistical evaluation for methodological reasons, both have explanatory power in IBI variation, the former (dams) in longitudinal IBI plots and the latter (PAHs) in sediment samples.

Stream segments were then graded according to their estimated "restorability" using a composite score based on three factors:

- The site score was positively weighted if the site had proximity to open space (based on geospatial analysis of aerial images and land use coverage). This criterion was selected to ensure that sufficient physical space existed in the riparian corridor for physical enhancement projects.
- The site score was negatively weighted relative to the number of proximate stressors (based on the analysis outlined above) identified at the site. A low number of proximate stressors was assumed to mean that restoring the biotic integrity to the site would be less complex than at a site with many proximate stressors.
- The site score was increasingly negatively weighted as an inverse to observed deviation from the IEPA biotic threshold for IBI rankings. This criterion assumes that segments nearest to compliance would be easier to bring into full compliance than sites with poorer assemblages (exhibited by large deviations from thresholds).

The grading exercise allowed potential restoration projects to be ranked on a nominal scale of 1–6 in descending order of restorability, and it also generated a list of actions to undertake at the priority sites, such as creating riparian buffers, addressing chloride, or restoring channel meanders. The IPS tool was validated by evaluating priority sites with field visits by stream restoration and water quality specialists.

Once a site was chosen to move forward, restoration projects were identified based on IPS Tool results. Restoration projects were designed based on remediation actions identified by the IPS Tool to reduce proximate stressors. Target thresholds for proximate stressors were determined by quantile regressions using site-specific field data (QHEI subset scores and species data).

1.3.2 IPS Tool Update (2023)

In 2019, the DRSCW, LDRWC, and two other partner watershed organizations elected to update and refine the IPS Tool. The updated tool draws on a larger regional dataset of paired biological, chemical, and physical data across seven northeastern Illinois Level IV subregions (53a, 53b, 54a, 54b, 54d, 54e, and 54f). The IPS Tool was used to statistically derive tiered thresholds for a more robust 87 different potential stressors paired with biological data at the site level across a total of 640 sites in the Northeast (NE) Illinois IPS study area. The 87 stressors were identified from a total dataset that included 139 water column parameters, 144 sediment parameters, 16 habitat variables, and 39 land use variables. Observed thresholds (or targets for potentially improving aquatic life conditions) were derived and tiered to five narrative categories of the fIBI and mIBI. Thresholds were derived for 31 water column parameters, 31 sediment parameters, and 25 habitat and land use variables. Each individual threshold includes a parameter-specific numeric evaluation of a goodness-of-fit (FIT) factor, which allows each parameter to be ranked in order from the strongest to the weakest stressor response.

The refined IPS Tool includes several improvements from the original application across the DRSCW watersheds (2010 IPS, described in Section 1.3.1), including:

- More sampling sites—expanded from 120 to 640—by including additional sites from sampling efforts conducted by the IEPA basin monitoring program, Lake and Will counties (collected with a methodology consistent with DRSCW methods), and DRSCW, which had collected data from additional reference sites outside the DRSCW area to supplement the dataset.
- An increased temporal dataset at the original sampling sites (three years of assessment rather than one).
- An improved spatial dataset built by incorporating a more heterogeneous geographical area. The DRSCW watersheds, as the only dataset used in the original iteration of the IPS Tool, have experienced a high level of physical and chemical anthropomorphic modification; therefore, these watersheds support only a truncated list of fish species and macroinvertebrate taxa. Including additional sites from a larger range of healthy aquatic conditions allows for a more fully developed statistical evaluation of “good” and “excellent” aquatic community stressor response relationships.
- An updated methodology for deriving stressor-response relationships. The modified approach included identifying stressor-sensitive species and taxa first and then linking the species or taxa to Illinois fIBI or mIBI General Aquatic Life Use benchmarks and the five narrative classes of condition.

In addition to these improvements, the IPS methodology was updated and refined to take advantage of new applications and methods. Paired data collected from participating agencies and the IEPA was used to calculate weighted means for fish species and macro taxa sensitive in relation to each stressor and stream drainage area (wadeable and headwater). This allowed the most sensitive species and taxa to be identified at the upper and lower 20% of species or taxa, depending on stressor “direction.” Stressor direction is due to the nature of the stressor’s relationship with the biological communities. Typically, this is an inverse relationship, with community health declining as a stressor increases (seen with chemical stressors such as chloride and ammonia, but also landscape variables such as imperviousness). However, some stressors, such as QHEI, have positive relationships with biological communities.

Once the taxa and species had been identified, the numbers of stressor-sensitive species/taxa at each site in the IPS study area were then observed and weighted (using the numbers of individuals present at each site). The sensitive species index (SSI) thus generated were then plotted against the sites Illinois IBI scores to allow agreement to be observed. This allows the user to map out the relationship between the two to see if SSI represents Illinois IBI across the sites but also gauge if the Illinois IBI is sensitive to the stressor under consideration. The sites and their SSI and IBI rankings are plotted against the stressor values in scatter plots; then, quantile regression is used to characterize the “goodness of fit” (i.e., strong versus weak).

Sites were then sorted into IBI score categories of very poor (IBI 0–15), poor (16–29), fair (30–40), good (41–49), and excellent (>50), with “good” being equivalent to the Illinois General Use standard for fish and macroinvertebrates. The 25th percentile (for positive stressors such as QHEI) or 75th percentile (for negative stressors such as chloride) stressor value of sites for both fIBI or mIBI values for each category was identified as the threshold corresponding to the Illinois biotic threshold for fish and macroinvertebrates. The more sensitive of the two communities (fish or macroinvertebrates) was adopted as the basis for the threshold. The steps used for threshold derivation are shown in Figure 2.

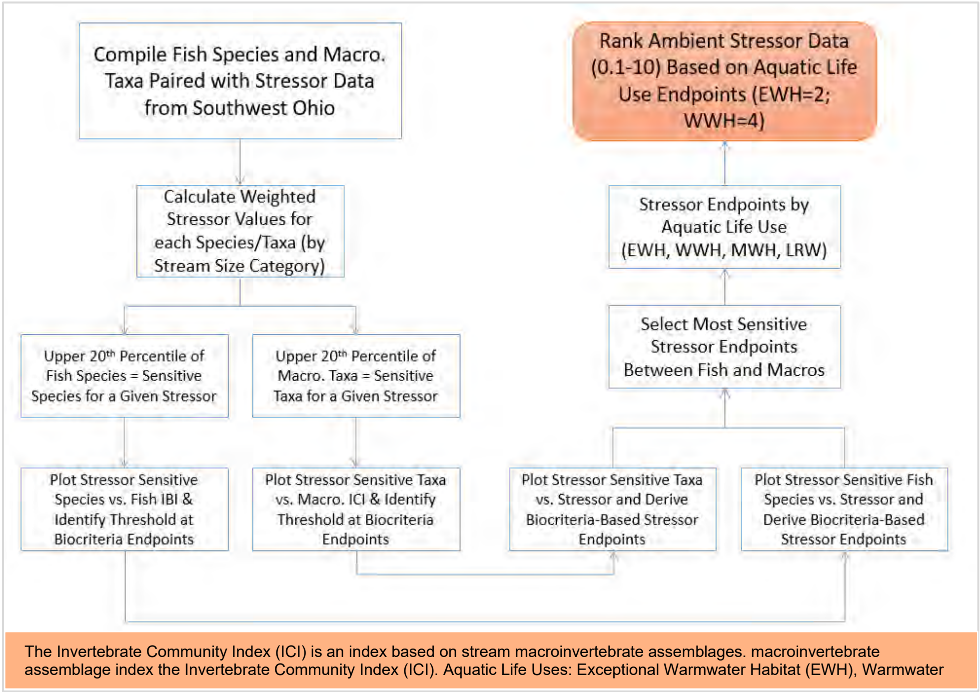

Figure 2. Steps in threshold development in the updated IPS Tool.

Aquatic assemblages are not equally impacted by each category of stressor, or even by stressors within the same category. Stressors were weighted (scaled from 0.1 to 10) based on the strength of the relationship between the stressor and its most stringent biological assemblage. The number of stressor-specific sensitive fish species or macroinvertebrate taxa at a site can also be used to predict a stressor rank; comparing this to the actual stressor rank using a FIT analysis allows the user to rank order stressors. Stressors that are strongly limiting along such a threshold have a relatively "tight" relationship, with few outliers that exceed the predicted threshold.

The FIT coefficient compared existing stressor ranks to backcasted (or reverse-engineered) predicted stressor ranks determined by stressor-specific fish species or macro-invertebrate taxa richness. A FIT value was calculated based on the sum of the divergences from the expected stressor ranks and was extrapolated from the sensitive species or taxa collected at a site. The larger the deviation from the expected stressor rank (e.g., more sensitive species at higher stressor levels), the larger the FIT score, and thus, a worse FIT. Sites with lower FIT scores indicates that higher stressor levels were associated with fewer sensitive species, indicating that the stressor was more likely limiting these species (i.e., better FIT). In a perfect FIT test, all stressor values would be at or below the categories along the slope represented by the threshold line. The results of this analysis showed that habitat stressors dominated (seven of the top 12 stressors were QHEI variables), but landscape variables such as impervious surfaces were also prominent. QHEI and its component pieces had scores in the 0.04–0.31 range, while parameters such as PAH compounds and metals (except zinc) had the weakest FIT scores. Nutrients also came to the forefront as important stressors based on their FIT scores, with TP having the strongest score (0.04) in this category. Table 13 shows the FIT results for the top 20 stressors alongside two random forest (RF) rankings (another method for ranking stressors relative to each other).

The RF ranking scores were then used to cross-check the FIT scoring. Here again, habitat-based, 12-digit hydrologic unit code (HUC12) QHEI variables were at or near the top of each RF analysis, illustrating the overarching importance of reach-level and small watershed-level cumulative habitat conditions. After HUC12 QHEI, the urban-related developed and impervious land use variables at both the watershed and 500-meter spatial buffer scales were important for both the fIBI and mIBI. This was followed by the site QHEI score and QHEI embeddedness score.

While the exact rank order of the importance measures between the FIT scores and the RF regression scores is not identical, the pattern suggests that multiple stressors nearly always contribute to observed variation in fIBI and mIBI, particularly habitat features (e.g., substrate and embeddedness), chlorides, DO, and nutrients. The IPS analysis indicated that habitat conditions dominate the explanation for variation in aquatic life. Sites that suffer from multiple stressors are key explanatory variables for aquatic life conditions, unlike results from the predecessor IPS Tool application, which indicated that TP may have explanatory power on aquatic life conditions (Section 1.3.1).

The updated IPS Tool can be used to generate site restorability scores for creating a prioritized project list. The database used as inputs and the threshold analysis have been placed in a Power BI platform to ease use for program management.

Table 13. Measures of FIT (values <0.32) and RF importance ranks (1–20)[3] for key NE Illinois IPS stressors.

Stressor	FIT Score	Regression and Classification Tree		RF Regression Tree Importance Rank (MSE[1]/Impurity[2])		RF Classification Tree Importance Rank (MSE[1]/Impurity[2])		
		Fish	Macros	fIBI	mIBI	Fish by Narrative	Macros by Narrative	General Use Standard Attainment
HUC12 Mean QHEI	-	-	-	1/1	2/2	1/1	3/3	1/1
Impervious Land Use (500 meter [m] scale)	0.01	✓	✓	12/20	6/9	11/17	6/7	8/9
QHEI Embeddedness Score	0.03	✓	✓	17/5	16/7	-	16/ -	11/16
Urban Land Uses (Watershed Scale)	0.03	-	-	6/6	5/5	5/5	3/3	2/2
QHEI Overall Score	0.04	✓	✓	10/12	4/8	9/6	5/5	17/ -
QHEI Substrate Score	0.04	✓	✓	17/14	19/20	12/10	14/12	-
QHEI Good Attributes	0.04	✓	✓	-	-	-	-	-
TP	0.04	✓	✓	-	17/15	15/ -	9/16	18/ -
Impervious Land Use (30m scale)	0.04	-	-	-	20/ -	10/15	18/ -	7/11
Impervious Land Use (30m scale Clipped)	0.04	-	-	8/13	17/ -	7/8	-	9/10
Conductivity	0.05	✓	✓	-	-	- /18	- /13	- /20
QHEI Channel Score	0.07	✓	✓	-	-	-	-	-
QHEI Silt Cover Score	0.07	-	-	-	-	- /16	-	-
Developed Land Use (Watershed Scale)	0.07	✓	✓	3/4	3/4	2/2	2/1	5/3
Minimum DO	0.10	-	-	9/11	9/10	-	-	- /12
TDS	0.10	-	-	-	-	-	-	-
Impervious Land Use (Watershed Scale)	0.10	-	-	7/9	8/11	4/7	8/10	4/4
Hydro-QHEI Depth Score	0.11	-	-	-	-	14/ -	15/ -	19/ -
QHEI Poor Habitat Attributes	0.12	✓	✓	5/3	7/3	16/9	10/9	10/12
Hydro-QHEI Overall Score	0.13	-	-	- /10	-	17/11	11/14	14/15
Zinc (in water column)	0.13	✓	✓	-	-	-	-	-
Hydro-QHEI Current Score	0.14	-	-	- /15	-	20/ -	-	-
TKN	0.14	✓	✓	-	12/15	-	19/20	-

Stressor	FIT Score	Regression and Classification Tree		RF Regression Tree Importance Rank (MSE[1]/Impurity[2])		RF Classification Tree Importance Rank (MSE[1]/Impurity[2])		
		Fish	Macros	fIBI	mIBI	Fish by Narrative	Macros by Narrative	General Use Standard Attainment
QHEI Pool Score	0.15	-	-	-	-	18/19	17/15	-
Heavy Urban Land Use (Watershed Scale)	0.17	-	-	4/6	10/6	3/4	7/6	6/5
Chloride	0.17	✓	✓	11/16	14/13	13/12	-	15/7
QHEI Cover Score	0.17	-	-	-	-	- /16	-	20/ -
BOD5	0.21	-	-	-	-	-	-	-
QHEI Riffle Score	0.27	-	-	- /18	-	- /13	-	-
Total Ammonia	0.28	✓	✓	-	-	-	-	-
Nitrate	0.29	✓	✓	14/ -	13/ -	8/20	13/19	12/14
Sodium	0.29	-	-	- /17	- /18	-	-	13/8
QHEI Gradient Score	0.31	-	-	13/7	11/12	6/3	1/2	16/ -
Total Suspended Solids	0.32	-	-	16/ -	- /19	19/ -	-	- /19

Notes:
[1] MSE definition: Mean square error which is average of the summation of the squared difference between the actual output value and the predicted output value.
[2] Impurity definition: In random forest analyses, impurity is a measure of the variance in a node; conversely you want nodes where purity is high (low variance of the data in a node).
[3] The top five ranked forest variables in each analysis are in blue boldface type

1.3.3 Summary of Relationships and Thresholds for Continuous Dissolved Oxygen Variables, Nutrient Effects, and Biological Attributes in Northeast Illinois Rivers and Streams

An Illinois Nutrient Science Advisory Committee (NSAC) 2018 report identified several data issues that hindered the development of strong associations between biological responses and stressor levels, one of which was too few samples with continuous DO data. The NE Illinois IPS document (MBI 2023) identified data gaps, like insufficient continuous DO data, which prevented an accurate assessment of nutrients' influence on fish and macroinvertebrate assemblages. As a result, watershed surveys in NE Illinois implemented the collection of continuous DO over the past 10–15 years, which was supplemented by continuous DO data collected across Illinois by IEPA.

Statistics generated from recently collected continuous DO data were integrated with NE Illinois biological, habitat, and nutrient data (e.g., TP, nitrate, ammonia, TKN, etc.) and algal response data (sestonic and benthic chlorophyll-*a*) from sites with a sufficient range of quality from very poor to excellent. The goal of this data analysis was to examine how continuous DO could better quantify the effects of nutrients on biological assemblage conditions in NE Illinois.

The analyses in this document identified the minimum DO statistics (as measured by the 5th percentile value)[8] as the most explanatory of the studied DO statistics compared to the maximum value or the maximum diurnal swing

[8] The 5th percentile of DO was used rather than the 25th percentile used for other parameters in the IPS because of the controlling nature of DO; also, the continuous data provides hundreds of values of DO compared to the 6–8 or fewer grab samples used to present exposure to parameters such as nutrients, dissolved constituents, etc. We used the 5th percentile rather than the absolute minimum to reduce the influence of extreme outliers.

of DO. Because of the lack of association between the maximum DO or maximum diurnal swing and the fIBI or mIBI, these statistics are, not by themselves, predictive of aquatic life impairment unless associated with low DO.

Similarly, little correlation existed between chlorophyll-*a* measures and the fIBI and mIBI. For benthic chlorophyll-*a*, the lack of correlation may be related to generally low benthic chlorophyll-*a* values compared to literature values that are considered excessive. This is consistent with other Illinois studies that found similar lower benthic chlorophyll-*a* measures than might be expected based on enriched nutrient concentrations. We generated minimum DO thresholds focused on the 5th percentile DO statistic for fish and macroinvertebrates that can be used for stressor identification. Identifying nutrients as major causes of aquatic life impairment is complex, particularly in urban settings. Stream geomorphology and physical habitat quality can influence nutrient and DO dynamics. In this study, QHEI and several of its metrics showed threshold relationships with minimum DO such that sites with physically degraded habitat are more likely to have low minimum DO values.

1.4 DRSCW IMPLEMENTATION PLANNING

1.4.1 DRSCW Implementation Plan (2015)

The DRSCW 2015 Implementation Plan set forth the DRSCW's adaptative management approach to achieve the attainment of water quality standards (WQS) and designated uses for Salt Creek, East Branch DuPage River, and West Branch DuPage River. The DRSCW adaptive management approach focuses on high-resolution, comprehensive monitoring of the watersheds' chemical, biological, and physical characteristics. These monitoring efforts (detailed in Section 1.2.1) provide the data needed to execute the "Plan-Do-Check-Act" methodology inherent to adaptive management and complex problem-solving. Monitoring and analysis provide insight into the highest-priority stressors affecting stream health to identify projects or initiatives with the greatest potential to attain stream use goals. Monitoring also provides the context for pre- and post-project conditions needed to properly assess the impacts of stream restoration projects and water quality initiatives. Adaptive management requires reviewing and assessing activities to better formulate future activities based on lessons learned.

Holistic monitoring and analysis of stream characteristics from 2013 in the DRSCW program area have revealed that point source nutrient loading alone is insufficient to explain the inability of local streams to support aquatic life. Based on empirical evidence, the physical anthropomorphic modifications to stream corridors and changing streamflows associated with increased watershed imperviousness provide more compelling and statistically correlated explanations for poor aquatic life conditions. Successful management actions need to be:

1. Implemented on a watershed scale.
2. Systematically applied over an extended period of time.
3. Guided by a system that prioritizes actions both by nature (physical restoration, pollutant reduction) and space (stream reaches) to ensure measurable progress.

The DRSCW has developed the IPS Tool (see Section 1.3), which uses monitoring data to identify priority stressors at a small spatial scale and rank the assessed stream reaches for restoration activities. This prioritization system was used to identify potential projects for further development and design, including preliminary scopes and costs. Post-project monitoring is conducted to evaluate the impacts and identify the next set of activities, which may include modifying future project design based on an improved understanding of the relationships between stressors and biological communities.

DRSCW data and analyses currently indicate that major investments in channel form and instream and riparian habitat at a watershed scale are essential to making efficient and measurable progress toward attaining designated uses for aquatic life. The 2015 Implementation Plan included activities and projects that would be performed by DRSCW as part of an adaptive management program focused on working towards the aquatic life use goals in affected watersheds. The identified projects and activities were included in the Special Conditions of the NPDES permit for the major municipal WWTPs in the watershed (See Table 3 for a list of the projects and Section 3.8 for a list of the major WWTPs). The Special Condition covers two five-year NPDES permit cycles ending in approximately 2025.

To fund these watershed plan projects, the 2015 Implementation Plan established a funding structure—paid by WWTPs participating in the Special Condition—that would generate approximately $7.5 million over the initial five-year NPDES permit cycle and approximately $15 million over the eight-year period of the assessment.

To date, three prioritized projects have been completed: Oak Meadows Golf Course Dam Removal and Stream Restoration, Spring Brook Restoration and Dam Removal, and Klein Creek Streambank Stabilization Project. Post-project monitoring was completed for the Oak Meadows and Spring Brook projects. Details on these projects and post-project monitoring results can be found in the DRSCW and LDRWC Annual Reports.[9]

The 2015 Implementation Plan was designed to be amended for future planning periods coinciding with future NPDES permit cycles. The 2015 Implementation Plan (DRSCW 2015) was updated in 2020 (see Section 1.4.2), and this NIP will serve as an update to the 2015 and 2020 DRSCW implementation plans.

1.4.2 DRSCW Implementation Plan (2020)

In 2020, the DRSCW Implementation Plan was updated with the inclusion of three additional projects (one per watershed) and/or expansions of projects that were included in the 2015 Implementation Plan (see Section 1.1 and Table 3). The projects will be implemented over an additional five-year NPDES permit cycle (through approximately 2028) and are funded by an additional $6 million.

1.5 LDRWC IMPLEMENTATION PLANNING

1.5.1 LDRWC Implementation Plan (2016)

The LDRWC 2016 Implementation Plan set forth the LDRWC's adaptative management approach to achieve the attainment of WQS and designated uses for Lower DuPage River. The adaptative management strategy in the LDRWC Implementation Plan is similar to that of the 2015 and 2020 DRSCW implementation plans.

The identified projects and activities in the Implementation Plan were included in the Special Conditions of the NPDES permit for the major municipal WWTPs in the watershed (See Section 1.1 for a list of the projects and Section 0 for a list of the major WWTPs). To fund these watershed projects, this plan established a funding structure that would generate approximately $3.3 million in project funding from the two WWTPs participating in the Special Condition, Naperville and Bolingbrook #3.

To date, the LDRWC has completed one project: the Hammel Woods Dam Removal. Details on this project and related post-project monitoring can be found in the DRSCW and LDRWC Annual Reports.[10]

The 2016 Implementation Plan was designed to be amended for future planning periods coinciding with NPDES permit cycles. This NIP will serve as an update to the 2016 LDRWC Implementation Plan.

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9 https://drscw.org/activities/stressors-analysis/

10 https://drscw.org/activities/project-identification-and-prioritization-system/

2 WATER QUALITY ASSESSMENT

This section details the designated uses, impairments, TMDLs, and WQS as relevant to the DRSCW and LDRWC NIP.

2.1 DESIGNATED USES

The waters of Illinois are classified by site-specific designated uses (Table 14). Designated uses applicable to the DuPage River and Salt Creek watersheds include aquatic life, aesthetic quality, fish consumption, and primary contact recreation. The corresponding water quality standard classification for these designated uses is the General Use standard. The General Use classification is defined by Illinois Pollution Control Board (IPCB) as being developed to protect the state's waters for aquatic life, wildlife, agricultural use, secondary contact use, and most industrial uses and ensure the aesthetic quality of the state's aquatic environment. Primary contact uses are protected for all General Use waters whose physical configuration permits such use.

Table 14. Illinois designated uses and applicable WQS for the DuPage River and Salt Creek watersheds

Illinois EPA Designated Uses	Illinois Waters where Designated Use and Standards Apply	Applicable Illinois WQS
Aquatic Life	Streams, Inland Lakes	General Use Standards
	Lake Michigan Basin waters	Lake Michigan Basin Standards
Aesthetic Quality	Inland Lakes	General Use Standards
	Lake Michigan Basin Waters	Lake Michigan Basin Standards
Primary Contact	Streams, Inland Lakes	General Use Standards
	Lake Michigan Basin Waters	Lake Michigan Basin Standards
Fish Consumption	Streams, Inland Lakes	General Use Standards
	Lake Michigan Basin Waters	Lake Michigan Basin Standards
	Specific Chicago Area Waters	Secondary Contact and Indigenous Aquatic Life Standards

2.2 IMPAIRED WATERS

Each waterbody has one or more designated uses that may include aquatic life, aesthetic quality, indigenous aquatic life (for specific Chicago-area waterbodies), primary contact (swimming), public and food processing water supply, and fish consumption. Water quality assessments are based on biological, physicochemical, physical habitat, and toxicity data. The degree of support (attainment) of a designated use in a waterbody (or segment) is assessed as "fully supporting" or "not supporting." Waters in which at least one applicable use is not fully supported is designated as "impaired." Potential causes and sources of impairment are also identified for these waters. The 303(d) List (i.e., the state's list of impaired and threatened waters) is organized by watershed based on the requirements of 40 Code of Federal Regulations (CFR) Part 130.7(b)(4).

Several streams, lakes, and impoundments within the DuPage River and Salt Creek watersheds have been placed on the State of Illinois Section 303(d) list of impaired waters. The list includes 17 mainstem river segments, 11 tributary segments, and 11 lakes/impoundments identified as impaired in the DuPage River and Salt Creek Watersheds on the 2020–2022 Section 303(d) lists (Table 15 for streams; Table 16 for lakes). The geographical coverage of the various designated use support classifications are included for aquatic life (Figure 3 for streams; Figure 4 for lakes), aesthetic quality (Figure 5 for streams; Figure 6 for lakes), fish consumption (Figure 7 for streams; Figure 8 for lakes), and primary contact recreation (Figure 9 for streams; Figure 10 for lakes).

Total phosphorus is listed as a cause of aquatic life impairment for 13 mainstem segments, four tributary segments, and one lake in the DuPage River and Salt Creek watersheds. TP is also listed as an impairment to aesthetic quality in one tributary segment and nine lakes. Low DO concentrations are listed as a cause of aquatic life impairment on one mainstem segment and three tributary segments. Excessive algae growth has been noted on one mainstem segment, two tributary segments, and five lakes. Excessive aquatic plant growth has been noted on one mainstem segment and three lakes.

Segments are placed in Category 4c rather than on the Section 303(d) list when the State determines that the failure to meet an applicable water quality standard is not caused by a pollutant, but rather is caused by other types of pollution (i.e., only nonpollutant causes of impairment). Waterbodies placed in the 4c category are usually those where the aquatic life use is impaired by habitat-related conditions (Table 17 and Figure 11).

2.3 TMDL DEVELOPMENT IN THE WATERSHEDS

Section 303(d) of the CWA and the USEPA Water Quality Planning Regulations (40 CFR Part 130) require states to develop TMDLs for impaired waterbodies that are not meeting designated uses or WQS. A TMDL is a calculation of the maximum quantity of specific pollutants that a waterbody can receive and still meet applicable WQS and the targets that are necessary to protect the designated beneficial use (or uses) for that waterbody.

Previous TMDL reports have been developed and approved in the DuPage River and Salt Creek watersheds. The development of the West Branch DuPage River, East Branch DuPage River, and Salt Creek TMDLs began in 2000. Table 18 summarizes the TMDLs developed for each of these watersheds.

Table 15. DuPage River and Salt Creek stream impairments and pollutants, 2020–2022 Illinois 303(d) List

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Designated Use	Pollutant(s)	Observed Effects
IL_GB-01	DuPage River	8.14	Fish Consumption	Mercury, polychlorinated biphenyls (PCBs)	Mercury, PCBs
IL_GB-11	DuPage River	10.07	Aquatic Life	Arsenic, Cause Unknown, Methoxychlor, TP, PCBs	Aquatic Plants, Arsenic, Cause Unknown, Cover Loss, Flow Modification, Methoxychlor, Nitrogen, PCBs, TP
			Fish Consumption	Mercury; PCBs	Mercury, PCBs
IL_GB-16	DuPage River	11.31	Aquatic Life	TP	Cover Loss, DO, Flow Modification, Nitrogen, TP
			Fish Consumption	Mercury; PCBs	Mercury, PCBs
IL_GBLG	Armitage Ditch	1.2	Aquatic Life	Cause Unknown	Cause Unknown, Loss of Instream Cover, Alterations in Streamside or Littoral Vegetative Covers
IL_GBA	Illinois & Michigan Canal	9.85	Fish Consumption	Mercury	Mercury
IL_GBE-02	Lily Cache Creek	10.05	Aquatic Life	Cause Unknown	Cause Unknown
IL_GBAA-01	Rock Run	9.64	Aquatic Life	Cause Unknown	Cause Unknown
IL_GBK-02	West Branch DuPage River	9.43	Fish Consumption	Mercury	Mercury
IL_GBK-05	West Branch DuPage River	10.51	Aquatic Life	Cause Unknown, TP, TSS	Cause Unknown, Flow Regime, Modification, Nitrogen, TP, TSS
IL_GBK-09	West Branch DuPage River	11.86	Aquatic Life	Cause Unknown, TP, Sedimentation/Siltation	Cause Unknown, TP, Sedimentation/Siltation
IL_GBK-14	West Branch DuPage River	3.82	Aquatic Life	Chloride	DO, Flow Alteration-Changes in Depth and Flow Velocity, Alterations in Streamside or Littoral Vegetative Covers
IL_GBKB-01	Kress Creek	7.91	Aquatic Life	DO	Alterations in Streamside or Littoral Vegetative Covers, DO, Loss of Instream Cover
IL_GBKA	Spring Brook	1.74	Aquatic Life	Chloride, TP	Chloride, DO, Alterations in Streamside or Littoral Vegetative Covers
IL_GBKA-01	Spring Brook	3.18	Aquatic Life	TP	Alterations in Streamside or Littoral Vegetative Covers, Loss of Instream Cover, TP
IL_GBKF-01	Winfield Creek	6.89	Aquatic Life	DO	DO, Alterations in Streamside or Littoral Vegetative Covers
IL_GBL-02	East Branch DuPage River	8.01	Aquatic Life	Arsenic, Cause Unknown, Methoxychlor, TP, Sedimentation/ Siltation	Arsenic, Cause Unknown, Flow Regime, Modification, Methoxychlor, TP, Sedimentation/Siltation

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Designated Use	Pollutant(s)	Observed Effects
			Fish Consumption	Mercury	Mercury
IL_GBL-05	East Branch DuPage River	3.18	Aquatic Life	TP, TSS	Chloride, DO Alterations in Streamside or Littoral Vegetative Covers, TP, TSS
			Fish Consumption	PCBs	PCBs
IL_GBL-08	East Branch DuPage River	4.71	Aquatic Life	Arsenic, Dieldrin, Hexachlorobenzene, Methoxychlor, TP, TSS, Sedimentation/Siltation,	Arsenic, Dieldrin, Flow Regime Modification Hexachlorobenzene, Methoxychlor, Nitrogen, TP, Sedimentation/Siltation, Alterations in Streamside or Littoral Vegetative Covers, TSS
			Fish Consumption	PCBs	PCBs
IL_GBL-10	East Branch DuPage River	4.64	Aquatic Life	Arsenic, Cause Unknown, Dieldrin, Hexachlorobenzene, Methoxychlor, TP	Arsenic, Cause Unknown, Dieldrin, Hexachlorobenzene, Methoxychlor, Nitrogen, TP
			Fish Consumption	PCBs	PCBs
IL_GBL-11	East Branch DuPage River	3.45	Aquatic Life	DO, pH, TP, Sedimentation/Siltation	DO, Flow Regime Modification, Nitrogen, pH, Sedimentation/Siltation, Alterations in Streamside or Littoral Vegetative Covers, TP
			Fish Consumption	PCBs	PCBs
IL_GBLC	Lacey Creek	3.69	Aquatic Life	Bottom Deposits, Chloride, Sedimentation/ Siltation	Bottom Deposits, Chloride, Loss of Instream Cover, Sedimentation/Siltation
IL_GBLB-01	St Joseph Creek	4.29	Aquatic Life	Oil and Grease, TSS	Algae, Loss of Instream Cover, Flow Regime Modification, Oil/Grease, Alterations in Streamside or Littoral Vegetative Covers, TSS
IL_GL	Salt Creek	11.34	Aquatic Life	Chloride, Dissolved Oxygen, TP	Algae, Chloride, DO, Flow Regime Modification, TP
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Primary Contact Recreation	Fecal Coliform	Fecal Coliform
IL_GL-03	Salt Creek	10.52	Aquatic Life	Dichlorodiphenyltrichlor-oethane (DDT), Heptachlor, TP, PCBs, Sedimentation/ Siltation	DDT, DO, Flow Alteration–Changes in Depth and Flow Velocity, Heptachlor, Nitrogen, PCBs, Sedimentation/Siltation, Alterations in Streamside or Littoral Vegetative Covers, TP, TSS
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
IL_GL-09	Salt Creek	12.21	Aquatic Life	Aldrin, Cause Unknown, Methoxychlor, TP, TSS	Aldrin, Cause Unknown, Fish Barrier, Flow Regime Modification, Methoxychlor, Nitrogen, TP, TSS
			Fish Consumption	Mercury, PCBs	Mercury, PCBs

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Designated Use	Pollutant(s)	Observed Effects
IL_GL-10	Salt Creek	3.71	Aquatic Life	Arsenic, Hexachlorobenzene, Methoxychlor	Arsenic, Flow Regime Modification, Hexachlorobenzene, Methoxychlor, Nitrogen, Alterations in Streamside or Littoral Vegetative Covers
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
IL_GL-19	Salt Creek	3.15	Aquatic Life	Cadmium, TP	Cadmium, Flow Regime Modification, Alterations in Streamside or Littoral Vegetative Covers, Nitrogen, TP, TSS
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
IL_GLA-02	Addison Creek	6.71	Aquatic Life	Cause Unknown, Aldrin, Chromium (total), DDT, Hexachlorobenzene, TP	Aldrin, Cause Unknown, Chromium, DDT, Flow Alteration–Changes in Depth and Flow Velocity, Flow Regime Modification, Hexachlorobenzene, Alterations in Streamside or Littoral Vegetative Covers, TP
IL_GLA-04	Addison Creek	3.44	Aquatic Life	*a*-benzenehexachloride (Alpha-BHC), Copper, Hexachlorobenzene, PCBs, Sedimentation/ Siltation, TSS	Alpha-BHC, Copper, DO, Flow Regime Modification, Hexachlorobenzene, Nitrogen, PCBs, Sedimentation/Siltation, Alterations in Streamside or Littoral Vegetative Covers, TP
			Aesthetic Quality	Bottom Deposits, Oil, TP	Algae, Bottom Deposits, Oil, TP
IL_GLB-01	Spring Brook	3.14	Aquatic Life	DDT, Endrin, Hexachlorobenzene, TP, Sedimentation/Siltation	Algae, DDT, DO, Endrin, Flow Regime Modification, Hexachlorobenzene, Sedimentation/Siltation, Alterations in Streamside or Littoral Vegetative Covers, TP, TSS
IL_GLB-07	Spring Brook	4.19	Aquatic Life	Cause Unknown	Cause Unknown

Table 16. DuPage River and Salt Creek watershed lake impairments and pollutants, 2020–2022 Illinois 303(d) List

Waterbody ID	Waterbody Name	Size (acres)	Designated Use	Pollutant(s)	Potential Source(s)
IL_RGG	Churchill Lagoon	21.0	Aquatic Life	Aldrin, Silver, TP, TSS	Aldrin, Silver, Algae, TP, TSS
			Aesthetic Quality	TP, TSS	TP, TSS
IL_WGZE	Hidden Lake	10.0	Aesthetic Quality	TP, TSS	Aquatic Plants, TP, TSS
IL_WGB	Marmo	3.7	Aesthetic Quality	Cause Unknown	Algae, Aquatic Plants, Cause Unknown
IL_WGA	Meadow	4.9	Aesthetic Quality	TP	Algae, TP
IL_WGC	Sterling Pond	2.1	Aesthetic Quality	TP, TSS	Algae, Aquatic Plants, TP, TSS
IL_WGZW	Rice Lake (DuPage)	38.0	Aesthetic Quality	Cause Unknown	Algae, Cause Unknown
IL_WGN	Herrick Lake	20.5	Aesthetic Quality	TP	TP
IL_VGZ	Whalon Lake	249.0	Aesthetic Quality	TP	TP
IL_RGD	Silver	56.9	Aesthetic Quality	TP	TP
IL_RGZX	Busse Woods	21.0	Aesthetic Quality	TP, TSS	TP, TSS
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Primary Contact Recreation	Fecal Coliform	Fecal Coliform
IL_WGZY	Swan (Indiana Lake)	4.0	Aesthetic Quality	TP	Algae, TP

Table 17. DuPage River and Salt Creek 4c waters

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Cause
IL_GBLF-01	Glencrest Creek	1.48	Alteration in Streamside or Littoral Vegetative Cover, Loss of Instream Cover
IL_GBKC-01	Klein Creek	3.38	Alteration in Streamside or Littoral Vegetative Cover, Loss of Instream Cover, Flow Alteration–Changes in Depth and Flow Velocity, Flow Regime Modification
IL_GBLA	Prentiss Creek	3.50	Alteration in Streamside or Littoral Vegetative Cover, Flow Alteration–Changes in Depth and Flow Velocity

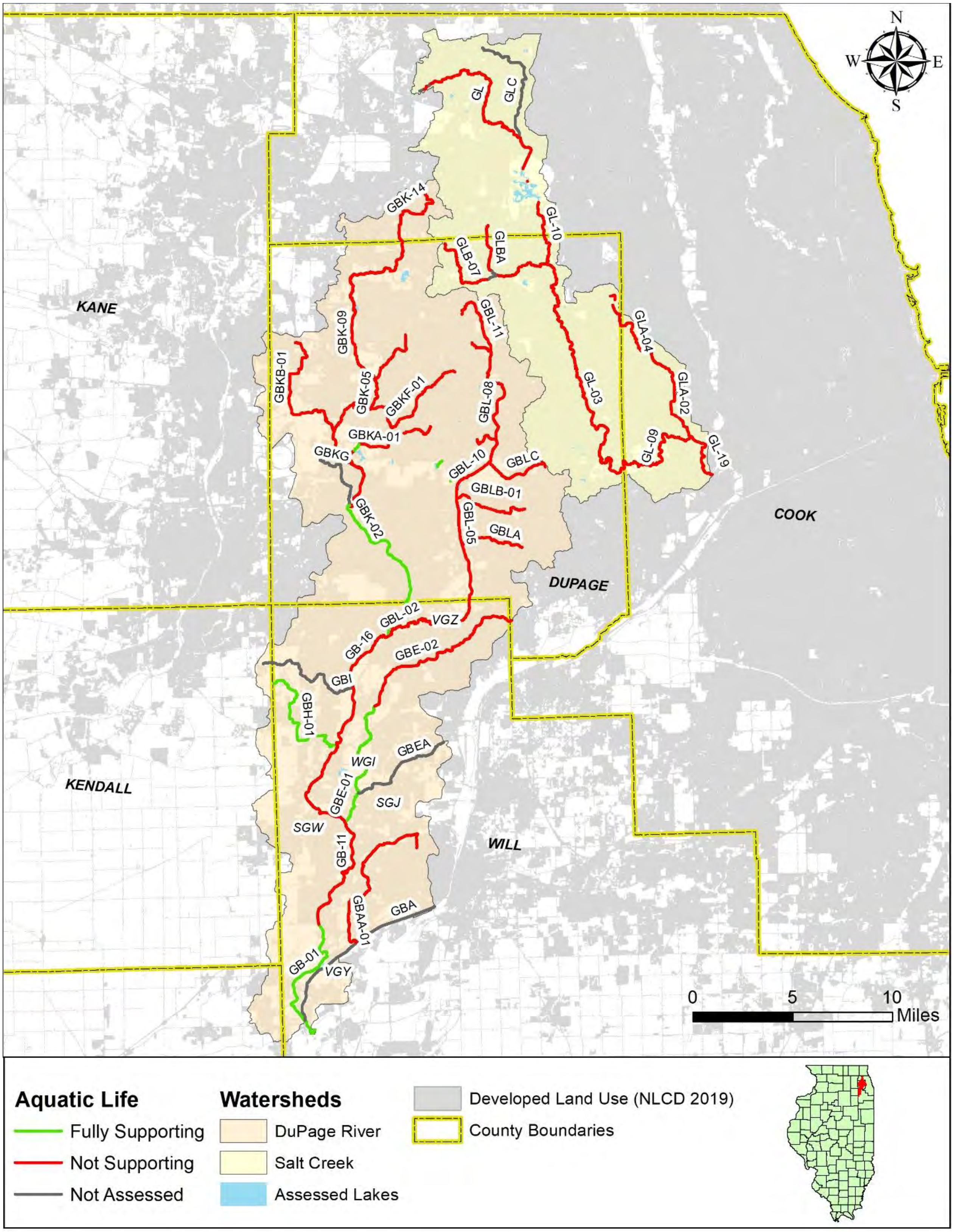


Figure 3. Aquatic life use support in the streams and rivers in the DuPage River and Salt Creek watersheds.

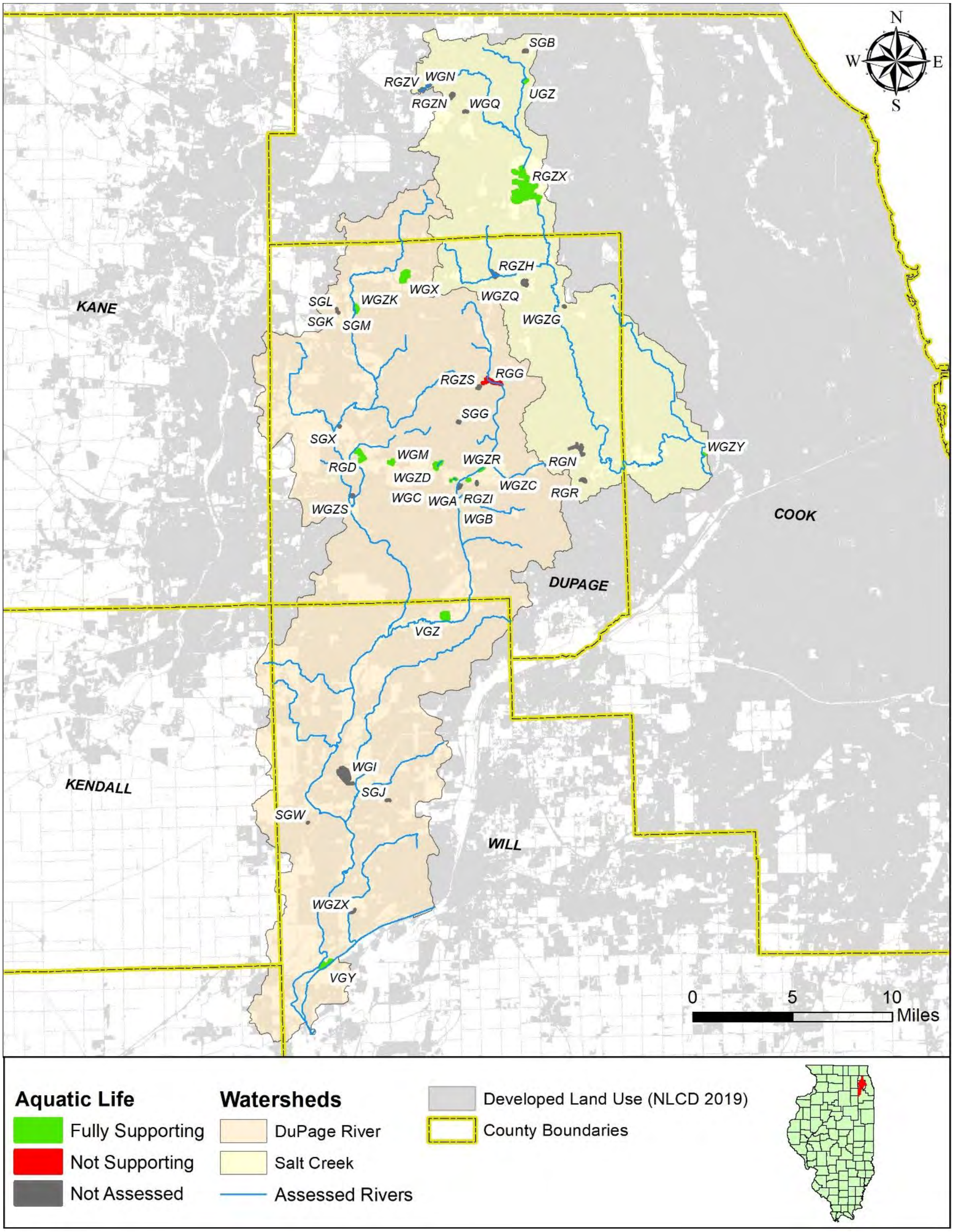


Figure 4. Aquatic life use support in lakes in the DuPage River and Salt Creek watersheds.

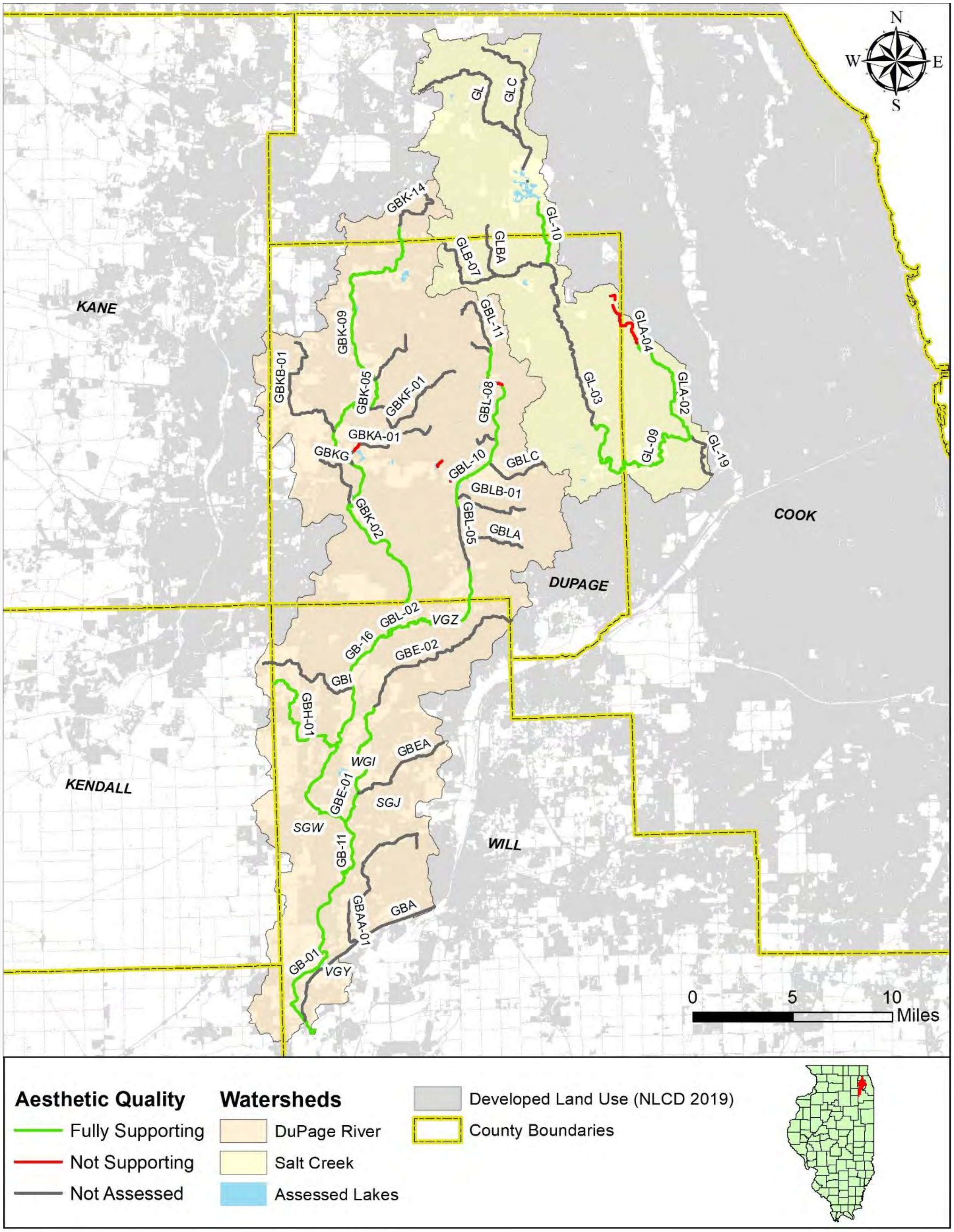


Figure 5. Aesthetic quality use support in the streams and rivers in the in the DuPage River and Salt Creek watersheds.

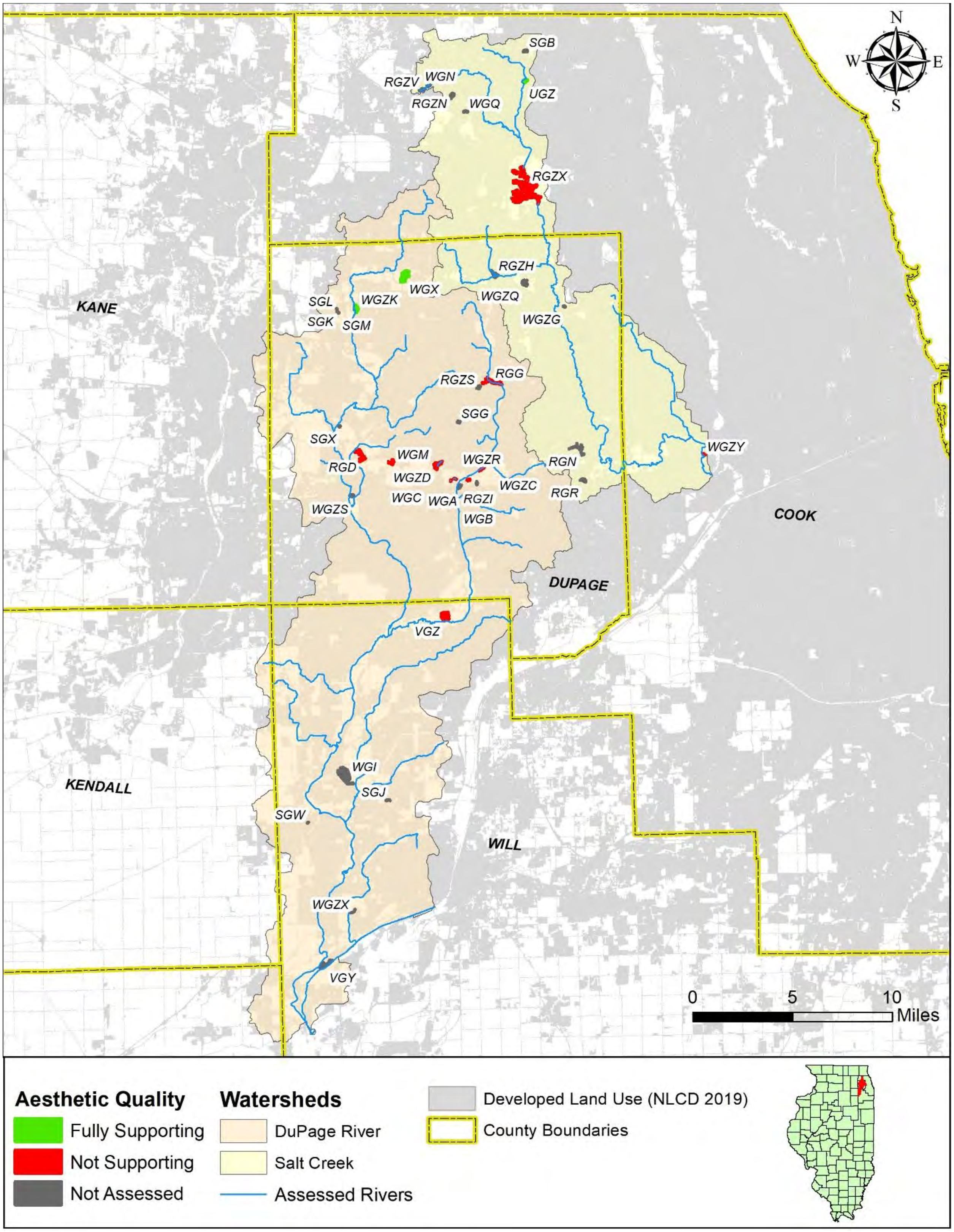


Figure 6. Aesthetic quality use support in lakes in the DuPage River and Salt Creek watersheds.

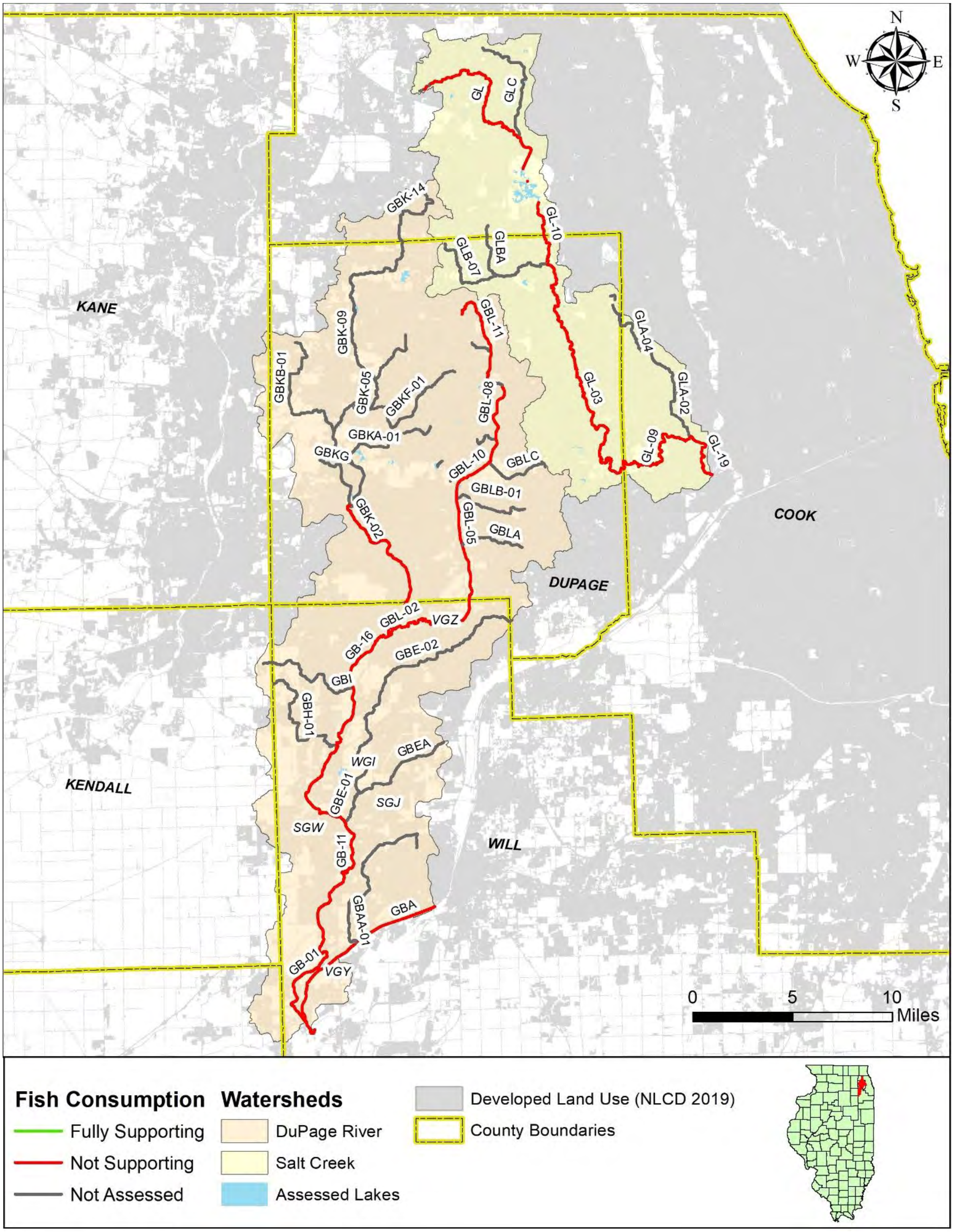


Figure 7. Fish consumption use support in the streams and rivers in the DuPage River and Salt Creek watersheds.

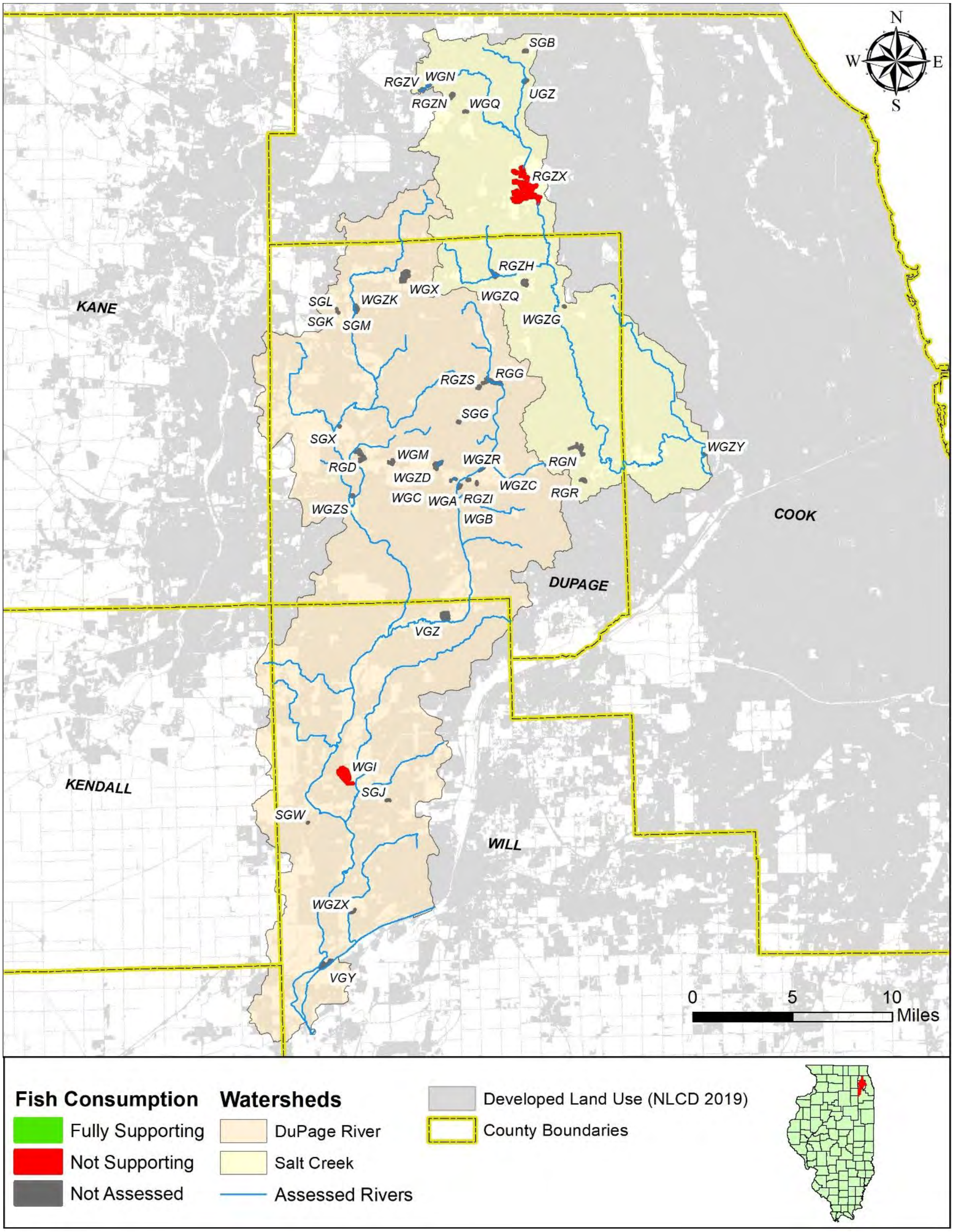


Figure 8. Fish consumption use support in lakes in the DuPage River and Salt Creek watersheds.

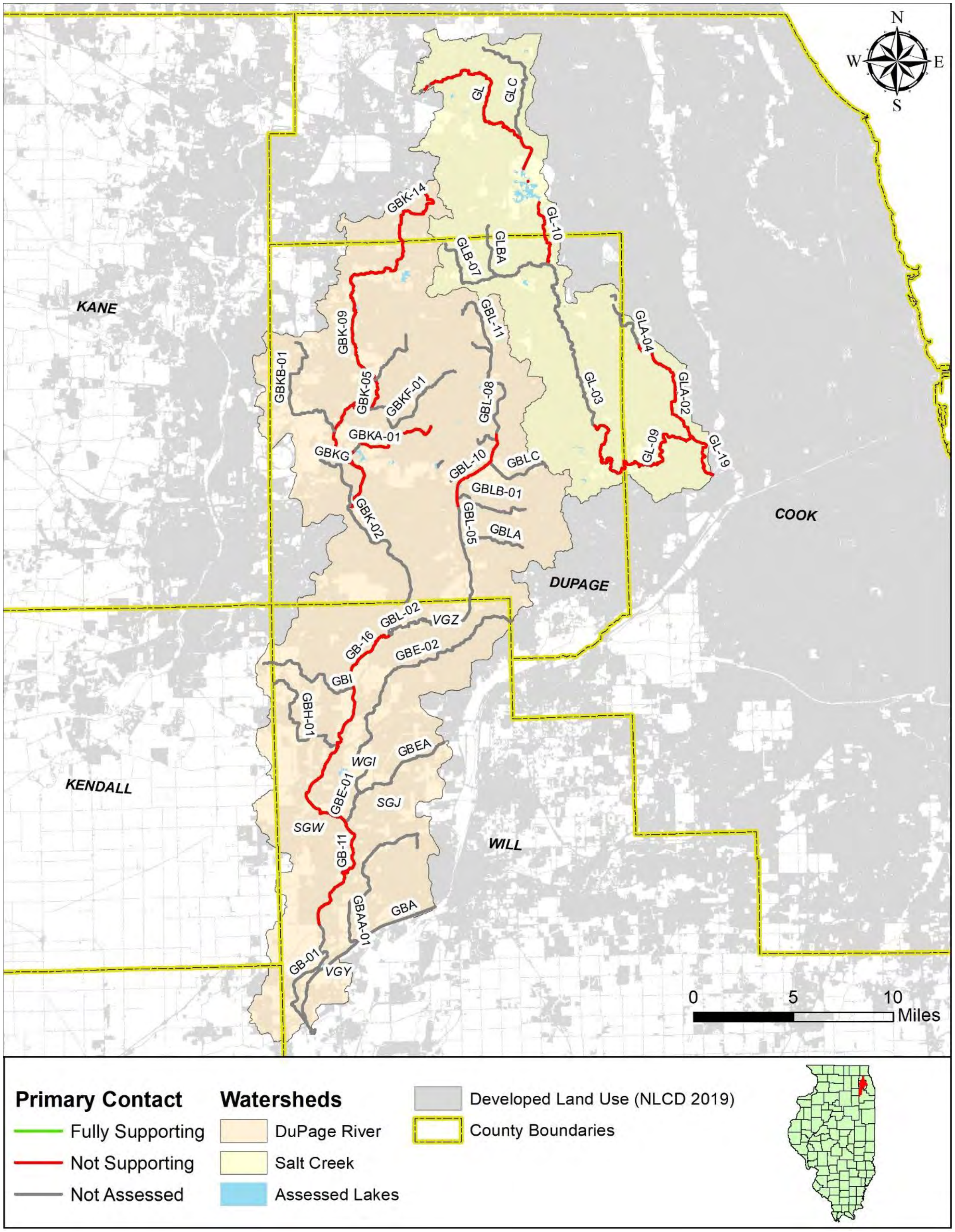


Figure 9. Primary contact recreation use support in the streams and rivers in the DuPage River and Salt Creek watersheds.

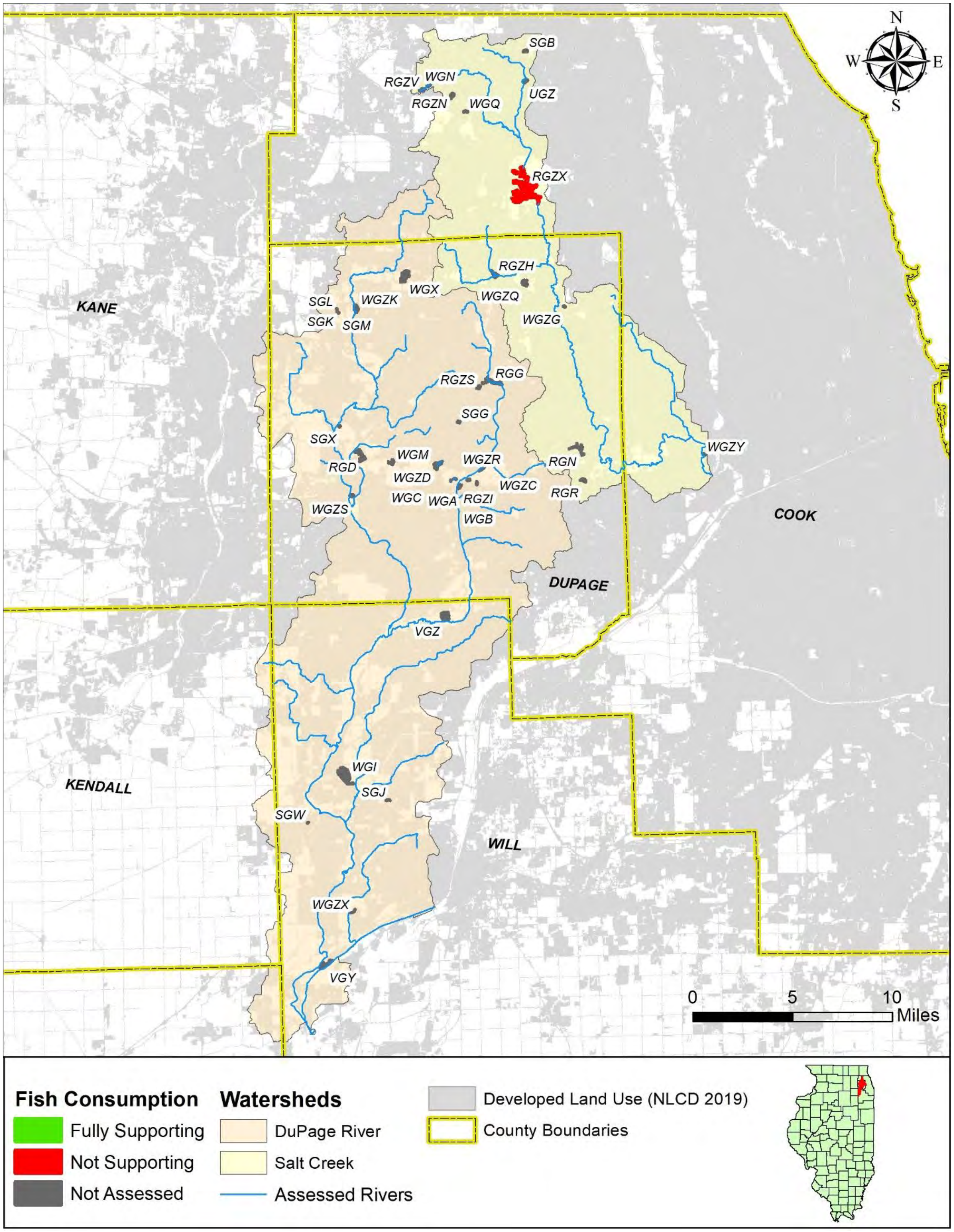


Figure 10. Primary contact recreation use support in lakes in the DuPage River and Salt Creek watersheds.

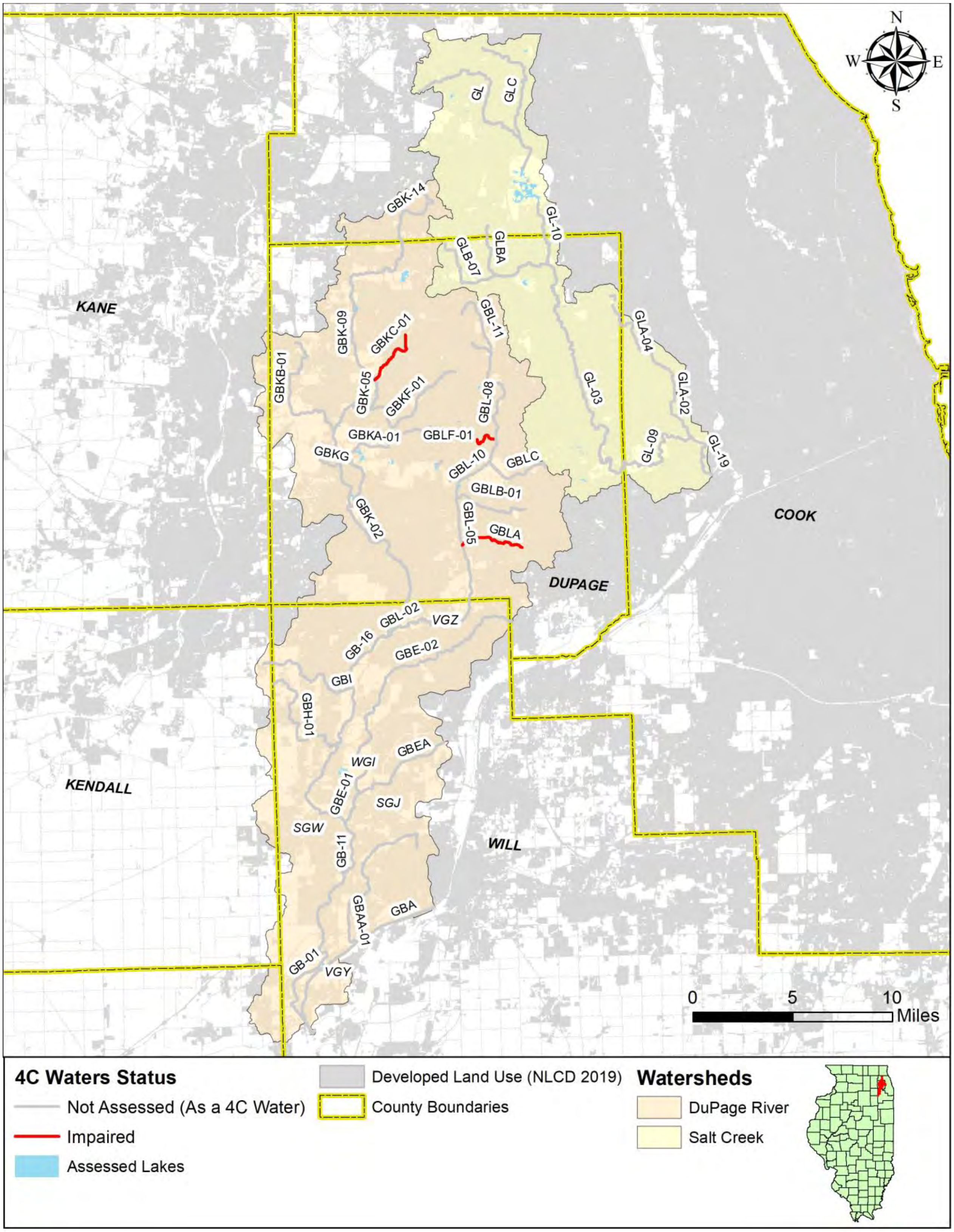


Figure 11. Map of Category 4c waters in the DuPage River and Salt Creek watersheds.

Table 18. Summary of existing TMDLs in the DuPage and Salt Creek watersheds

TMDL Project	TMDL Approval	Waterbody Name	Impaired Segments Addressed by TMDL	Pollutant(s) Addressed by TMDL
DuPage River/Salt Creek Watershed TMDL Report	2019	DuPage River	IL_GB-11	Chloride, Fecal Coliform
			IL_GB-16	DO (TP, CBOD5, and Ammonia), Fecal Coliform
		West Branch DuPage River	IL_GBK-06	Fecal Coliform
			IL_GBK-09	Fecal Coliform
			IL_GBK-14	DO (DO Deficit)
		Spring Brook	IL_GBKA	DO (DO Deficit), Fecal Coliform
			IL_GBKA-01	Fecal Coliform
		East Branch DuPage River	IL_GBL-10	Fecal Coliform
		Salt Creek	IL_GL-09	Fecal Coliform
			IL_GL-10	Fecal Coliform
			IL_GL-19	Fecal Coliform
		Addison Creek	IL_GLA-02	Fecal Coliform
TMDLS for the West Branch of the DuPage River, IL	2004	West Branch DuPage River	GBK-07	Chloride
			GBK-09	Chloride
			GBK-05	Chloride
			GBK-12	Chloride
TMDLs for the East Branch of the DuPage River, IL	2004	East Branch DuPage River	IL_GBL-05	Chloride, DO (Ammonia, CBOD5)[a]
			IL_GBL-10	Chloride, DO (Ammonia, CBOD5)[a]
			IL_GBL-09	DO (Ammonia, CBOD5)
TMDLs for Salt Creek, IL	2004	Salt Creek	GL-03	Chloride, DO (Ammonia, CBOD5, VSS)[a,b]
			GL-09	Chloride[a]
			GL-10	Chloride[a]
			GL-19	DO (Ammonia, CBOD5, VSS)[b]
		Addison Creek	GLA-02	Chloride
			GLA-04	DO (Ammonia, CBOD5, VSS)[b]
		Spring Brook	GLB-01	DO (Ammonia, CBOD5, VSS)[b]
		Prentiss Creek	GBLA	DO (Ammonia, CBOD5, VSS)[b]
		Busse Woods	RGZX	DO (Ammonia, CBOD5, VSS)[b]

Notes:
[a] One chloride TMDL was set at the mouth of the river to address all chloride impairments.
[b] One TMDL was developed to address all DO-impaired segments in the Salt Creek watershed.

2.4 NIP-APPLICABLE WATER QUALITY STANDARDS AND CRITERIA

Environmental regulations for the State of Illinois are contained within the Illinois Administrative Code, Title 35. Specifically, Title 35, Part 302, contains WQS promulgated by the IPCB. Relevant WQS associated with the DuPage River and Salt Creek watersheds NIP are provided in Table 19.

Table 19. Summary of relevant Illinois water quality standards

Standard Type	Parameter	General Use Water Quality Standard
Numerical WQS	Chloride (mg/L)	>500
	DO (mg/L)[a]	**For most waters:** • March–July > 5.0 minimum, and > 6.0 seven-day mean • August–February > 3.5 minimum, and > 4.0 seven-day mean, and > 5.5 30-day mean **For waters with enhanced protection (i.e., GB-16):** • March–July > 5.0 minimum, and > 6.25 seven-day mean • August–February > 4.0 minimum, and > 4.5 seven-day mean, and > 6.0 30-day mean **Lakes:** Seasonally and waterbody dependent
	TP (mg/L)	**Lakes ≥ 20 acres**[b] Acute: 0.05
Narrative WQS	Offensive Conditions	Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin.

Notes:
[a] Applies to the DO concentration in the main body of all streams, in the water above the thermocline of thermally stratified lakes and reservoirs, and in the entire water column of unstratified lakes and reservoirs. Additional DO criteria are found in 35 Ill Adm. Code 302.206, including the list of waters with enhanced DO protection and methods for assessing attainment of DO minimum and mean values.
[b] The TP standard at 35 Ill. Adm. Code 302.205 applies to lakes of 20 acres or larger.

DuPage River segment GB-16 is designated for DO “enhanced protection” according to Title 35 Ill Adm. Code 302.206. Waters with enhanced protection have a more stringent DO standard than all other waters of the state. These waters were chosen based on the potential biota (fish early life stages present) and the DO concentrations needed for these biota to thrive. The “most waters” DO standard applies to all other riverine waterways in the DuPage River and Salt Creek watersheds.

Illinois does not have an IPCB-approved standard for TP, total nitrogen (TN), sestonic chlorophyll-*a*, or benthic chlorophyll-*a* for streams and rivers. The TP standard for lakes greater than 20 acres in size is 0.05 mg/L for acute toxicity. Illinois does not have an IPCB-approved standard for TN, sestonic chlorophyll-*a*, or benthic chlorophyll-*a* for lakes.

2.4.1 Total Phosphorus Impairments on the Section 303(d) List

TP is listed as a cause of aquatic life impairment on 13 mainstem segments, four tributary segments, and one lake in the DuPage River and Salt Creek watersheds. These listings were based on violations of a nonstandards-based numeric criteria for TP (0.61 mg/L derived from 85th-percentile values) determined from a statewide set of TP observations from the Ambient Water Quality Monitoring Network for water years 1978–1996.

2.4.2 Illinois Nutrient Science Advisory Committee Recommendations

NSAC consisted of scientific experts nominated by stakeholder sectors represented in the Illinois Nutrient Loss Reduction Strategy Policy Working Group to assist IEPA with developing numeric nutrient criteria. Between 2015 and 2018, NSAC worked to develop potential numeric criteria most appropriate for Illinois streams and rivers based on the best available science. NSAC published their final report, *Recommendations for numeric criteria and eutrophication standards for Illinois streams and rivers*, on December 10, 2018 (NSAC 2018); the relevant recommendations are included below (Table 20).

To date, IEPA has not adopted the NSAC-recommended nutrient criteria as WQS. Through the development of this NIP, IEPA has asked DRSCW and LDRWC to evaluate the implementation of the NSAC TP recommendations for potential to remove the DO and offensive condition impairments or develop their own watershed-specific TP target.

Table 20. Summary of relevant water quality criteria recommended by NSAC

Parameter	Total Nitrogen	Total Phosphorus
North Ecoregion	3979 micrograms per liter (µg/L) (based on seasonal [May–October] geometric means)	Not applicable (N/A)
South Ecoregion	901 µg/L (based on seasonal [May–October] geometric means)	N/A
Non-wadeable Rivers and Streams (≥ 5th order)	N/A	TP must exceed 100 µg/L and chlorophyll-a must exceed 25 µg/L to exceed the eutrophication standard (based on seasonal [May–October] geometric means)
Wadable Streams (≤ 4th order)	N/A	TP must exceed 110 µg/L and either chlorophyll-*a* criteria (5 µg/L sestonic, 79 mg per square meter benthic) to exceed the eutrophication standard. **OR** If TP <110 µg/L and either of the chlorophyll-*a* criteria are exceeded, eutrophication standard is violated.

3 WATERSHED CHARACTERIZATION

This section describes the general characteristics of the DuPage River and Salt Creek watersheds, including location, topography, land cover, soils, population, climate, hydrology, and both point and nonpoint pollutant sources. The DuPage River and Salt Creek watersheds are in northeastern Illinois and together cover approximately 520 square miles (332,600 acres). The watersheds include the DuPage River (U.S. Geological Survey [USGS] HUC 0712000408) and Salt Creek (USGS HUC 0712000404), which are located within Cook, Kendall, Will, Grundy, and DuPage counties.

The DuPage River originates from two branches, the East Branch DuPage River and the West Branch DuPage River. The two rivers meet near Bolingbrook to create the main branch of the DuPage River. The mainstem of the DuPage River flows approximately 30 miles before its confluence with the Des Plaines River near the town of Channahon, Illinois.

Salt Creek is approximately 40 miles long and drains to the Des Plaines River. The Des Plaines River flows southwest and, after its confluence with the DuPage River, joins the Illinois River, a major tributary of the Mississippi River flowing south to the Gulf of Mexico.

3.1 TOPOGRAPHY

Topography can influence prevalent soil types, precipitation patterns, and, subsequently, watershed hydrology and pollutant loading. For the DuPage and Salt Creek watersheds, a USGS 30-meter resolution digital elevation model was obtained from the Illinois Natural Resources Geospatial Data Clearinghouse to characterize topography (Figure 12). Generally, the watersheds are at a higher elevation in the north and west, grading down to lower elevations in the south and east. This topography results in an overall surface water flow from northwest to southeast toward the Des Plaines River. A ridge separates the Salt Creek and DuPage River watersheds. Elevations across the DuPage River and Salt Creek watersheds range from 475–974 feet.

The elevation at the Salt Creek headwaters is 895 feet, and the stream flows approximately 43 miles before entering the Des Plaines River (elevation of 607 feet), resulting in a stream gradient of 6.72 feet per mile (0.0013 slope). The elevation at the DuPage River headwaters is 974 feet, and the river flows into the Des Plaines River 63 miles downstream (elevation of 475 feet). The resulting stream gradient is 7.92 feet per mile (0.0015 slope).

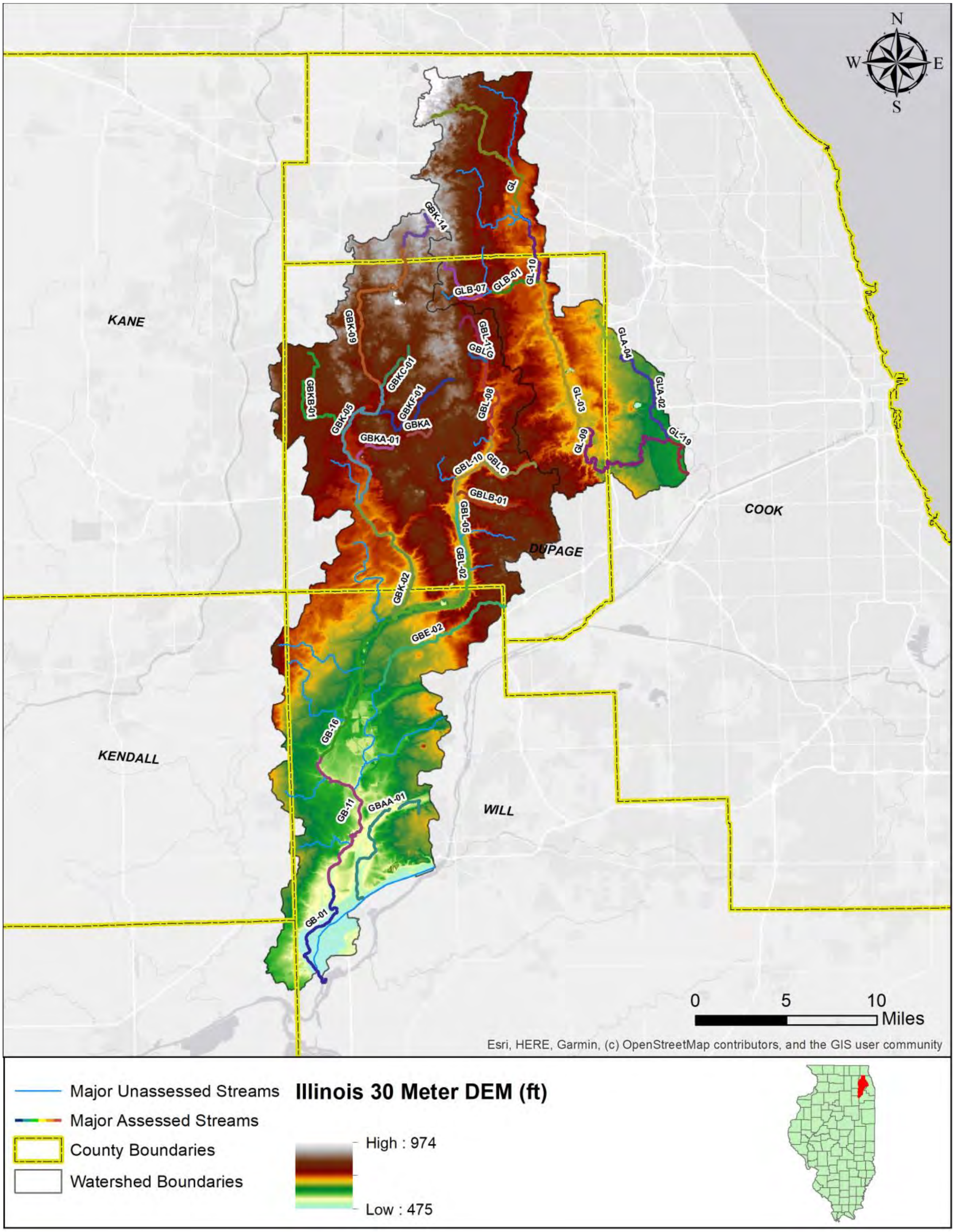


Figure 12. DuPage River and Salt Creek watersheds' topography.

3.2 SOILS

Soils data and Geographic Information Systems (GIS) files from the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) were used to characterize soils in the DuPage River and Salt Creek watersheds. General soils data and map unit delineations for the country are provided as part of the Soil Survey Geographic (SSURGO) database. Field mapping methods using national standards are used to construct the soil maps in the SSURGO database. Mapping scales generally range from 1:12,000 to 1:63,360; SSURGO is the most detailed level of soil mapping prepared by the NRCS. A map unit is composed of several soil series having similar properties. Identification fields in the GIS coverage can be linked to a database that provides information on chemical and physical soil characteristics. The SSURGO database contains many soil characteristics associated with each map unit.

The SSURGO data were analyzed based on hydrologic group (Figure 13) and soil erodibility, or "K-factor" (Figure 14). The hydrologic soil group classification identifies soil groups with similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, clay soils that are poorly drained have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates. The U.S. Department of Agriculture has defined four hydrologic soil groups (A, B, C, or D) for soils. Group A soils have high infiltration potential, while D soils have very low infiltration rates. Table 21 summarizes the group characteristics and shows the distribution of hydrologic soil groups in the DuPage River and Salt Creek watersheds.

The K-factor is a dimensionless measure of a soil's natural susceptibility to erosion. Factor values may range from 0 for water surfaces to 1.00 (although in practice, the maximum K-factor values do not generally exceed 0.67). Large K-factor values reflect a greater potential for soil erodibility. The compilation of K-factors from SSURGO data was completed in several steps. Soils are classified in the SSURGO database by map unit symbol. Each map unit symbol is made up of "components," and each component is further broken down into horizons or layers. The K-factor was determined by selecting the dominant components in the most surficial horizons per each map unit. The distribution of K-factor values in the DuPage River and Salt Creek watersheds is shown in Figure 14. K-factors range from 0.02 to 0.43 in this watershed. Areas with the highest K-factor are dispersed throughout the watershed with the greatest concentration within DuPage County.

Table 21. Relative characteristics of hydrologic soil groups

Hydrologic Soil Group	Runoff Potential	Infiltration Rate	Percent of Watersheds
A	Low	High	0.25%
A/D	High[1]	Very Low[1]	0.21%
B	Moderate	Moderate	6.59%
B/D	High[1]	Very Low[1]	13.65%
C	High	Low	28.84%
C/D	High[1]	Very Low[1]	29.05%
D	High	Very Low[1]	16.42%
No Data (Water, Gravel Pits, Landfill, Urban Land)	--	--	5.00%

Notes:
[1] Undrained soils in their natural condition

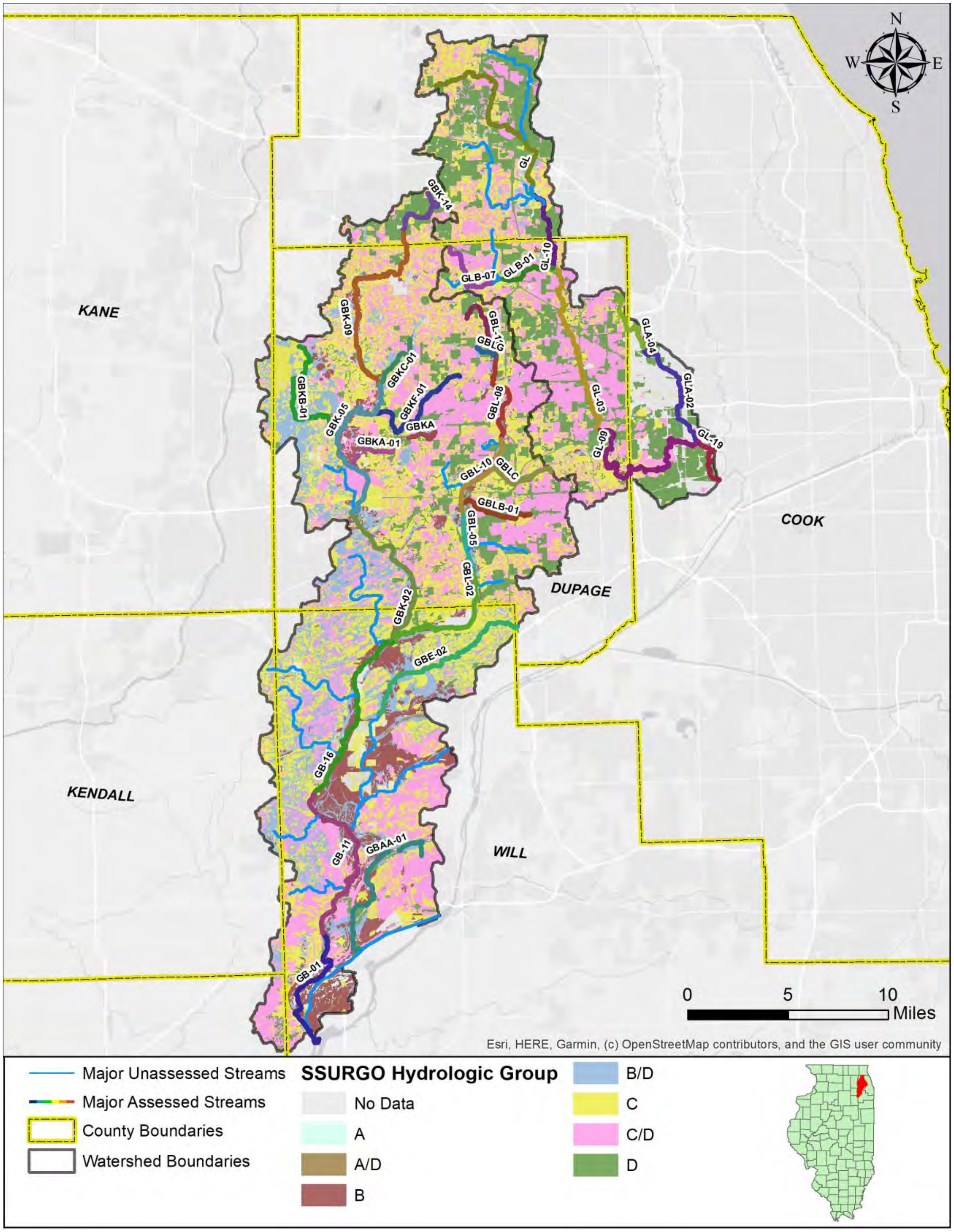


Figure 13. DuPage River and Salt Creek watersheds' hydrologic soil groups.

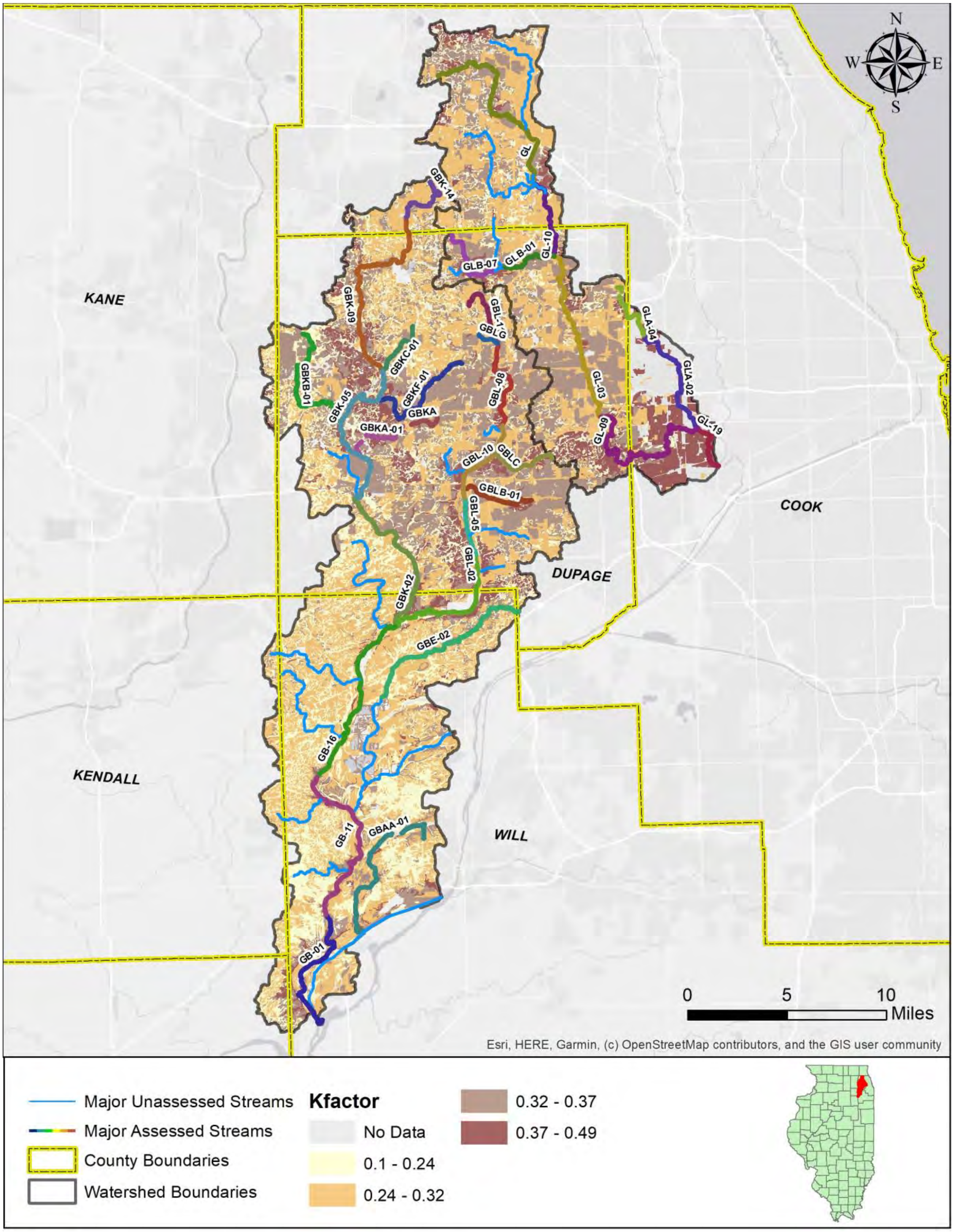


Figure 14. DuPage River and Salt Creek watersheds' SSURGO K-Factor.

3.3 LAND COVER

Land cover data for the watershed were extracted from the 2019 NLCD. Table 22 and Table 23 summarize the land cover for the DuPage River and Salt Creek watersheds, respectively.

Figure 15 shows the land cover in the DuPage River/Salt Creek watersheds and indicates that developed land cover is dominant in both subwatersheds, accounting for 75% of the total area in the DuPage River watershed and 91% in the Salt Creek watershed. In the DuPage River and Salt Creek watersheds, low intensity development is the predominant land cover (33% and 37% of the total land cover, respectively). Agricultural land accounts for 13% of land cover in the DuPage River watershed and less than 1% in the Salt Creek watershed.

Table 22. Summary of land cover data (NLCD 2019) for the DuPage River watershed

Land Cover Classification	Acreage	Percent	Aggregated Acreage	Aggregated Percent
Open Water	3,820	1.6%	3,820	1.6%
Developed, Open Space	26,090	10.8%	181,899	75.6%
Developed, Low Intensity	79,198	32.9%		
Developed, Medium Intensity	54,719	22.7%		
Developed, High Intensity	20,522	8.5%		
Barren Land	1,370	0.6%		
Deciduous Forest	9,496	3.9%	10,207	4.2%
Evergreen Forest	62	< 0.1%		
Mixed Forest	648	0.3%		
Shrub/Scrub	443	0.2%	5,916	2.5%
Herbaceous	5,473	2.3%		
Hay/Pasture	4,581	1.9%	32,132	13.4%
Cultivated Crops	27,551	11.5%		
Woody Wetlands	5,007	2.1%	6,570	2.7%
Emergent Herbaceous Wetlands	1,563	0.6%		

Table 23. Summary of land cover data (NLCD 2019) for the Salt Creek watershed

Land Cover Classification	Acreage	Percent	Aggregated Acreage	Aggregated Percent
Open Water	1,229	1.3%	1,229	1.3%
Developed, Open Space	11,288	11.9%	86,942	91.4%
Developed, Low Intensity	34,703	36.5%		
Developed, Medium Intensity	27,142	28.5%		
Developed, High Intensity	13,705	14.4%		
Barren Land	105	0.1%		
Deciduous Forest	2,778	2.9%	3,082	3.2%
Evergreen Forest	9	< 0.1%		
Mixed Forest	295	0.3%		
Shrub/Scrub	108	0.1%	465	0.5%
Herbaceous	357	0.4%		
Hay/Pasture	321	0.3%	620	0.7%
Cultivated Crops	300	0.3%		
Woody Wetlands	2,398	2.5%	2,805	2.9%
Emergent Herbaceous Wetlands	407	0.4%		

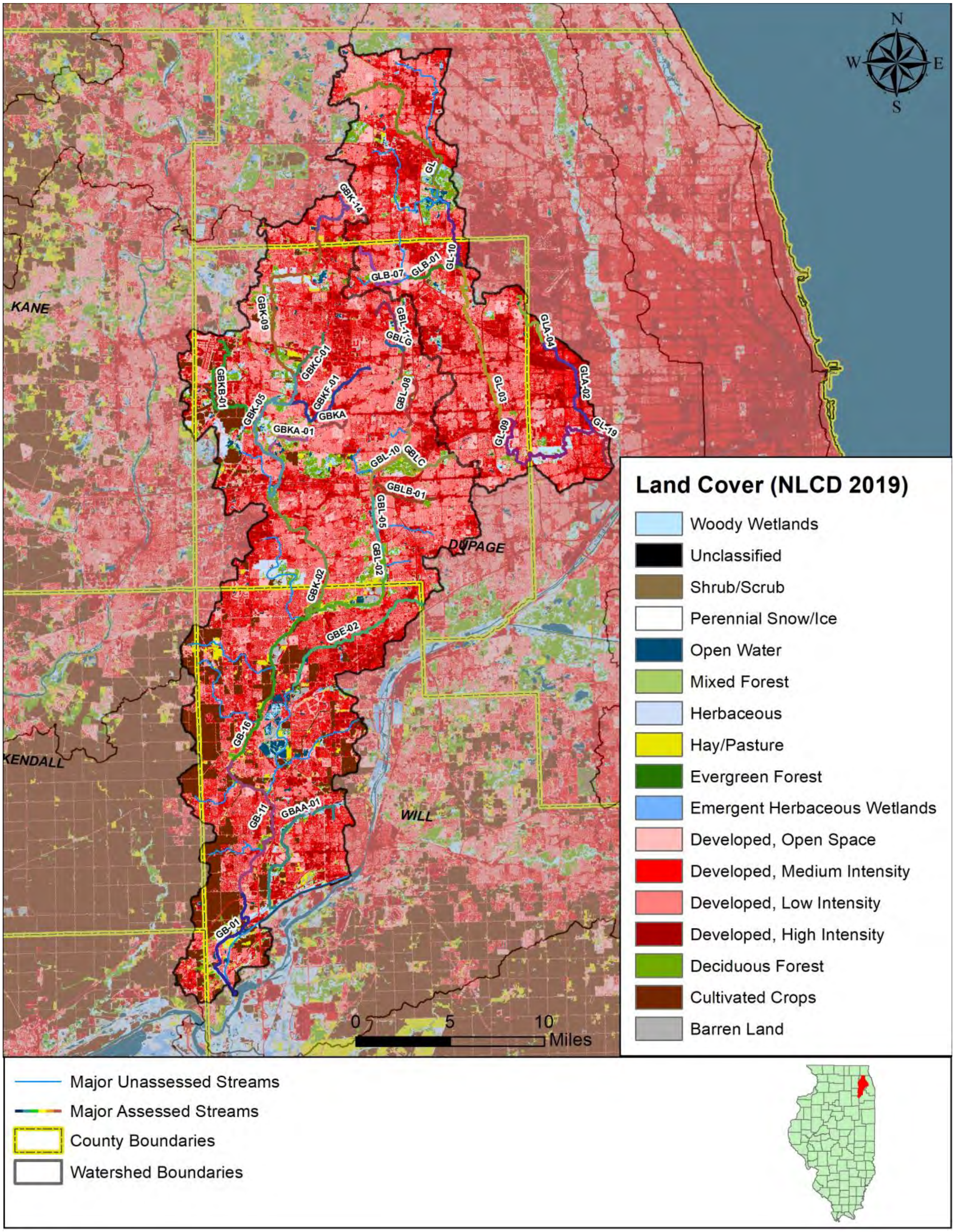


Figure 15. DuPage River and Salt Creek watersheds land use. IEPA stream reach codes are supplied for state-assessed reaches.

3.4 POPULATION

Today's conditions in the DuPage River and Salt Creek watersheds are not only the product of the geologic and natural processes that have occurred in the watershed, but also a reflection of human impacts and population growth. Development has changed the watershed's natural drainage system, as channelization and dredging have replaced slow-moving shallow streams and wetlands. This alteration has affected water runoff patterns and pathways across the landscape, increasing the volume and velocity and resulting in potential increases in pollutant transport.

In 2020, approximately 1.66 million people resided in the DuPage River and Salt Creek watersheds, roughly 3,173 persons per square mile. Census blocks with the greatest populations occur in the central and southern areas of the DuPage River watershed in Aurora, Naperville, and Joliet. The Chicago Metropolitan Agency for Planning provides population projections by municipality on their website ("Population Forecast"; updated in 2014).

Figure 16 depicts the projected percent population change in the watershed from 2020 to 2050. In general, the southern portion of the DuPage watershed is expected to have the most growth, with 100%–200% combined growth across smaller municipalities within Kendall and Will counties. Based on these data, the entire watershed is expected to continue to increase in population over the upcoming years, but development will grow dramatically in the southern portion of the watershed.

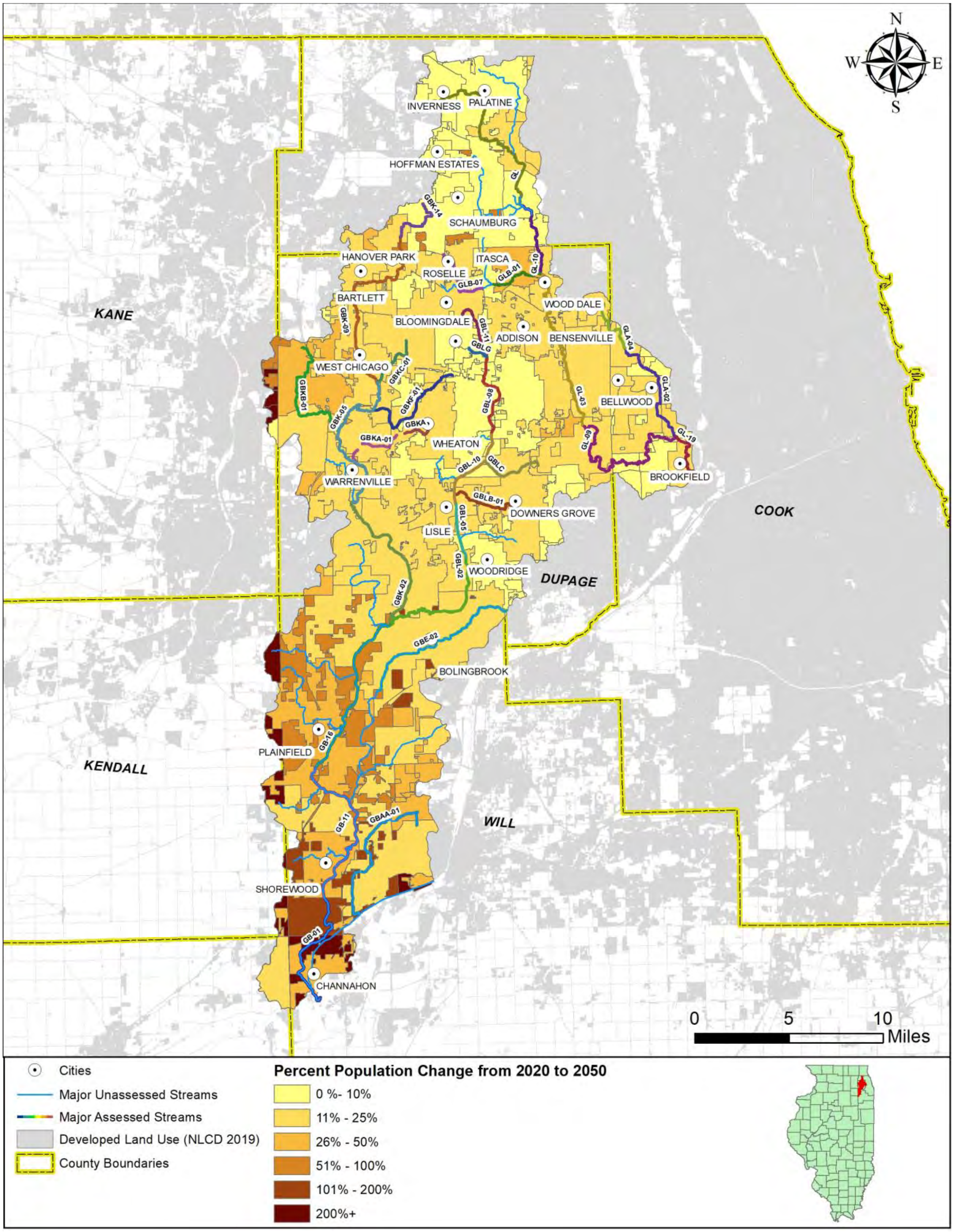


Figure 16. DuPage River and Salt Creek watersheds population projection (2020–2050).

3.5 CLIMATE

NE Illinois has a continental climate with highly variable weather. The temperatures of continental climates are not buffered by the influence of a large waterbody (like an ocean, inland sea, or Great Lake). Areas with continental climates often experience wide temperature fluctuations throughout the year. Temperature and precipitation data were obtained from the Illinois State Climatologist Office website. The nearest monitoring station to the DuPage River and Salt Creek watersheds is the Village of Lisle (IL5097), which is located in the central area of the watershed. For the DuPage River and Salt Creek watersheds, the highest temperatures in the summer can range from the high 80s to over 100 degrees Fahrenheit (°F), and the lowest winter temperatures might range between sub-zero and the teens. Precipitation in the form of rainfall is greatest in the growing season (April through September) (Figure 17).

Climate data were analyzed for the Village of Lisle at the Morton Arboretum (IL5097) for 1950–2021. The mean high summer air temperature was 72.1 °F, and the mean low air temperature in winter was 26.1 °F. Mean annual high air temperatures were approximately 60.8 °F, while mean annual air low temperatures were approximately 39.3 °F (Table 24). Mean monthly precipitation data in Lisle are displayed in Figure 17. Lisle receives most of its precipitation in the spring and summer months, with maximum precipitation occurring in June (4.2 inches). The least amount of average rainfall precipitation occurs in February (1.7 inches). Annual total precipitation average was approximately 37 inches.

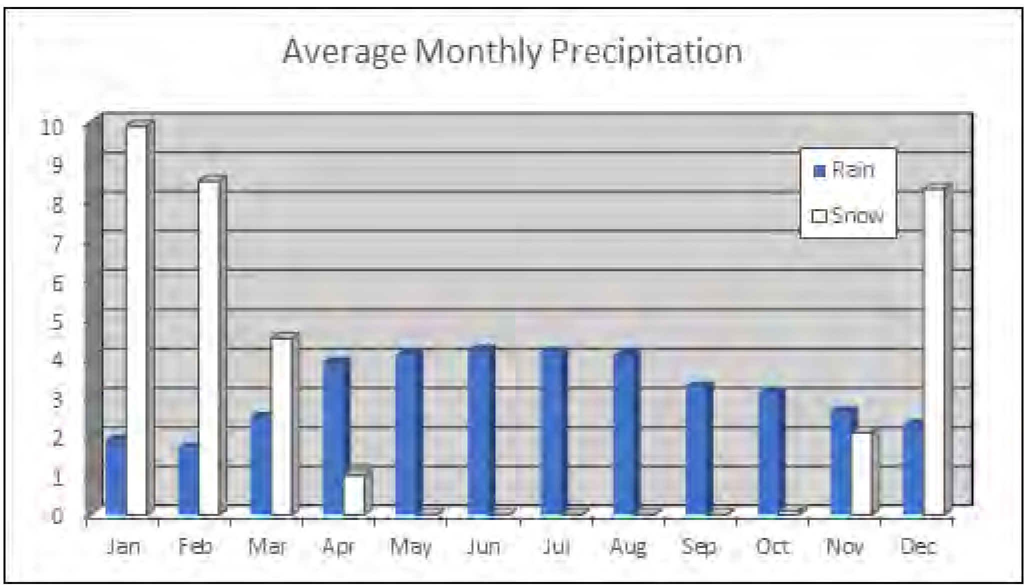


Figure 17. Mean monthly precipitation in Lisle, IL, the Morton Arboretum (1950–2021).

Table 24. Temperature characterization, the Morton Arboretum, Lisle, IL (1950–2021)

Averaging Period	Average High (°F)	Average Low (°F)	Average Number of Days with High >90 (°F)	Average Number of Days with Low <32 (°F)	Mean (°F)
January	31.26	14.50	0.00	28.36	22.91
February	36.13	17.86	0.00	25.11	26.99
March	47.78	27.30	0.00	21.99	37.55
April	61.47	37.60	0.10	9.00	49.53
May	73.03	47.76	1.16	1.30	60.40
June	82.48	57.56	6.03	0.01	70.01
July	85.64	62.30	8.31	0.00	73.97
August	83.81	60.81	5.50	0.00	72.29
September	77.42	53.04	2.10	0.20	65.25
October	65.01	42.06	0.03	5.68	53.54
November	49.19	30.96	0.00	17.21	40.12
December	36.25	20.32	0.00	26.38	28.29
Annual	60.79	39.34	1.94	11.27	50.07
Spring	60.76	37.55	0.42	10.76	49.16
Summer	83.98	60.22	6.61	0.00	72.09
Fall	63.87	42.02	0.71	7.69	52.97
Winter	34.55	17.56	0.00	26.62	26.06

3.6 HYDROLOGY

Understanding hydrologic pathways is an important component of characterizing watershed conditions. All the parameters listed in the previous sections (i.e., topography, land cover, soils, population dynamics, and climate) affect a watershed's hydrology. Hydrological data are available from the USGS website. The USGS maintains stream gages throughout the United States, and it monitors conditions such as gage height and stream flow and, at some locations, precipitation and water quality (Figure 18).

Four USGS gage stations within the DuPage River and Salt Creek watersheds were chosen to evaluate stream flow: East Branch of DuPage River at Downers Grove, IL (05540160), West Branch of DuPage River at Naperville, IL (05540130), DuPage River at Shorewood, IL (05540500), and Salt Creek at Western Springs, IL (05531500). The Salt Creek gage is located just upstream from the Addison Creek confluence near its confluence with the Des Plaines River. The East Branch is located upstream of the confluence with the West Branch. The West Branch of the DuPage River gage station is located immediately upstream of the confluence with the East Branch. Finally, the DuPage River at Shorewood is located immediately upstream of the confluence of the DuPage River mainstem and the Des Plains River.

Figure 18 shows the location of these four and other USGS gages throughout the watershed. Figure 19 depicts the streamflow measured at Salt Creek for 1945–2021. The drainage area upstream of this gage was 115 square miles. The highest average monthly streamflows at Salt Creek were measured in April (243.1 cubic feet per second [cfs]), while the lowest monthly streamflows were measured in September (112.4 cfs). Overall, the highest stream flow for this gage occurs during the late winter and spring months, while low flows occur during the fall. The annual streamflow for the Salt Creek gage was measured at about 153.9 cfs.

The East Branch DuPage gage drains an area of 26.6 square miles; data from this gage exist for 1989–2021. Over this period, the average stream flow of the East Branch was 53.1 cfs (Figure 20). Similar to the Salt Creek gage, streamflows were highest in the late winter and spring months, with lower flows in the fall. The maximum average monthly flows occurred in May (79.2 cfs), while the lowest average monthly flows occurred in September (39.6 cfs).

Figure 21 displays the streamflow measured at the West Branch DuPage River for 1988–2021. The drainage area upstream of this gage was 123 square miles, and the highest average monthly streamflows at the West Branch were measured in May (278.4 cfs). The minimum average monthly streamflows of 177.9 cfs were measured in September. The annual streamflow for the West Branch gage was approximately 171.5 cfs.

Data from the mainstem DuPage River gage are available for 1940–2021. This gage has a drainage area of 324 square miles; over the duration of its monitoring, the average streamflow of the DuPage River at this point was 349.7 cfs (Figure 22). Peak streamflows typically occur here in the late winter and spring months, with lowest flows occurring in the fall. The maximum monthly flow volumes occurred in April (558 cfs), while the lowest monthly flows occurred in September (230 cfs).

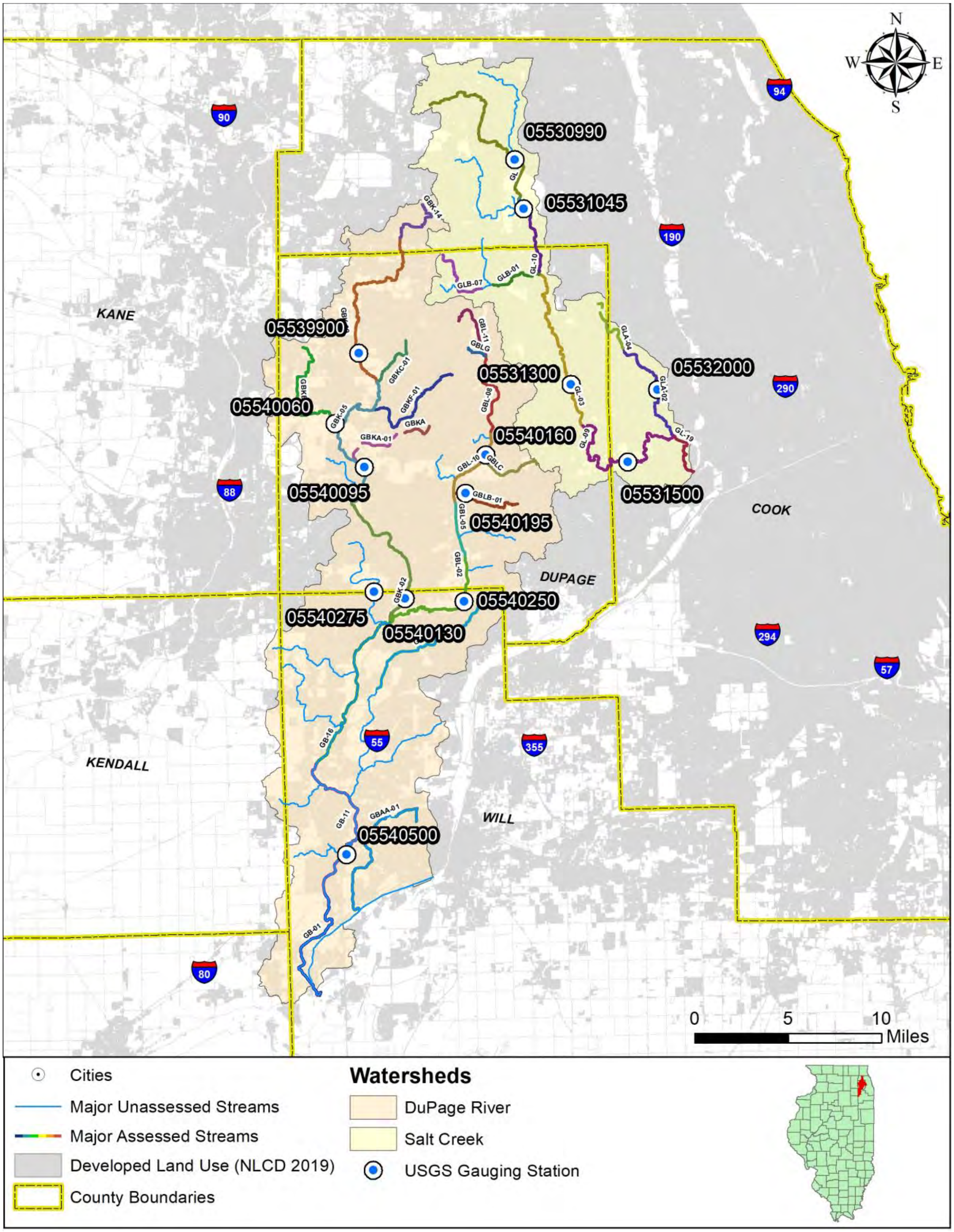


Figure 18. DuPage River and Salt Creek watersheds' USGS gaging stations.

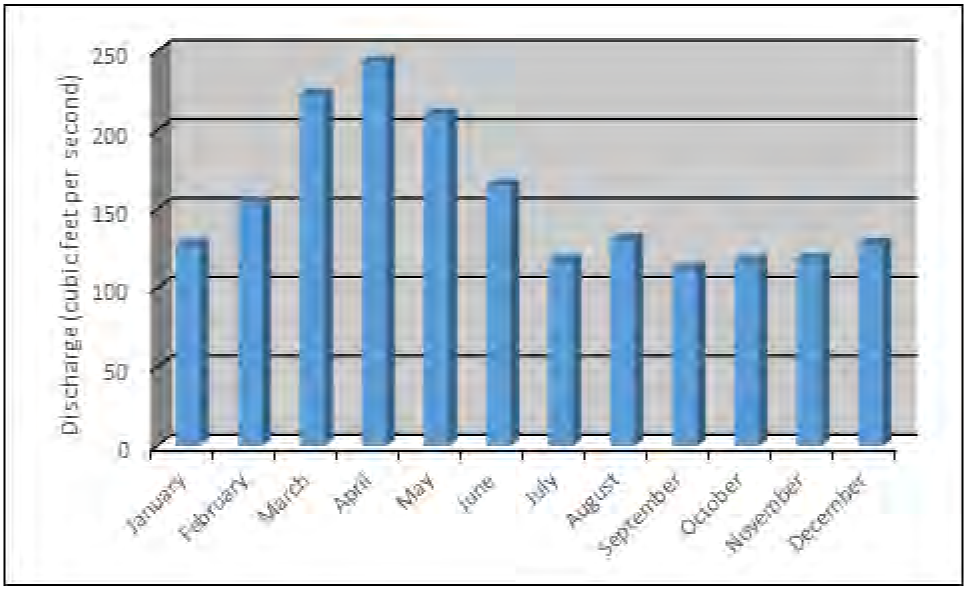


Figure 19. Mean monthly flow in Salt Creek at Western Springs, IL USGS station 05531500 (1945–2021).

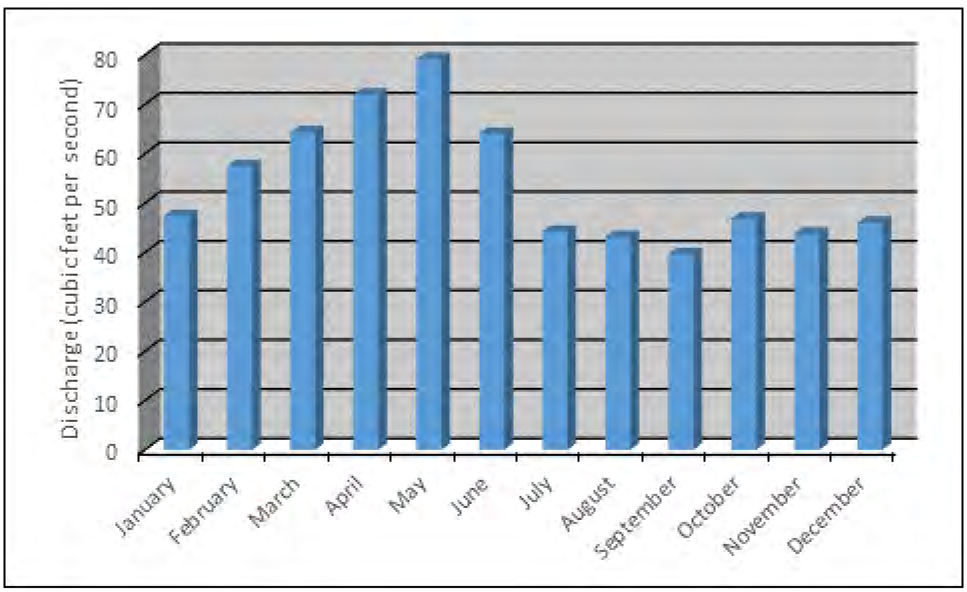


Figure 20. Mean monthly flow for the East Branch DuPage River at Downers Grove, IL USGS 005540160 (1989–2021).

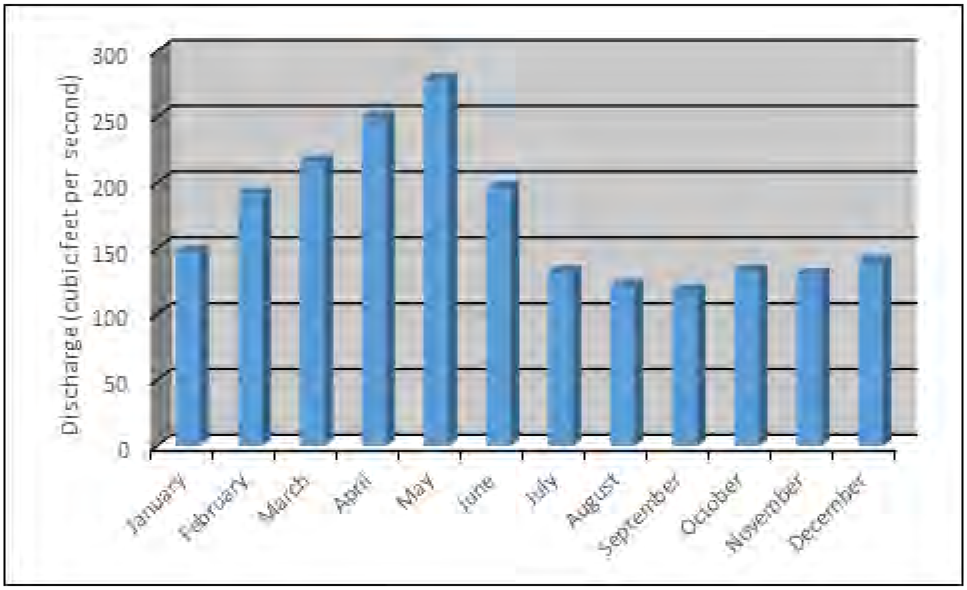


Figure 21. Mean monthly flow in the West Branch DuPage River at Naperville, IL USGS 05540130 (1988–2021).

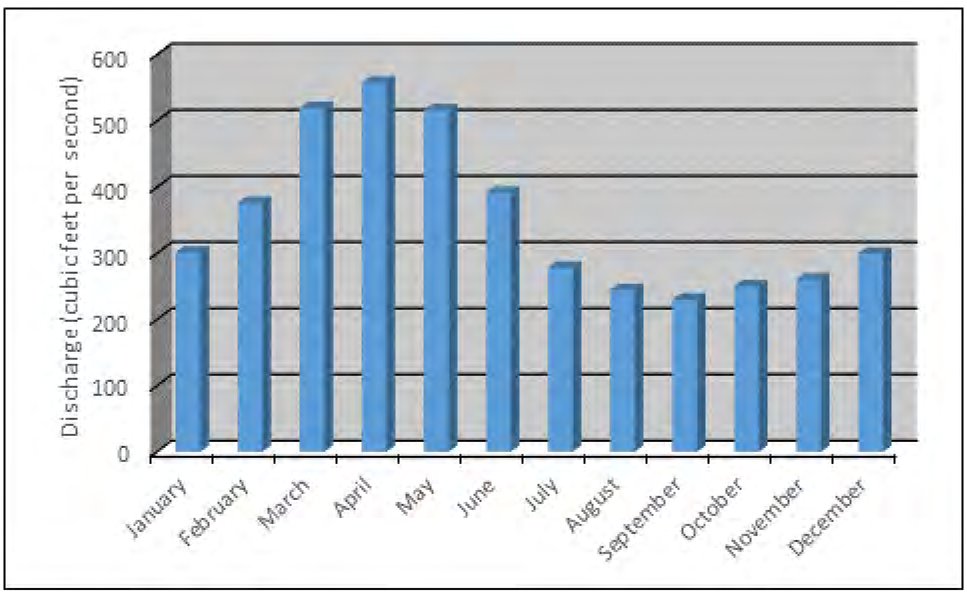


Figure 22. Mean monthly flow in the Lower DuPage River at Shorewood, IL USGS 05540500 (1940–2021).

3.6.1 Dams

Dams also influence a watershed's hydrologic and water quality conditions. Dams regulate the depth of water in the river and affect flows. They can also prevent fish migration and contribute to low DO conditions due to slow-moving or stagnant waters in upstream pools. This section details all major dams in the DuPage River and Salt Creek watersheds (Figure 23). Four dams within the watersheds have been removed or modified to address these issues. Design plans are underway for the removal or modification of two additional two dams. Details on the dams in the DuPage River and Salt Creek watersheds are included below.

3.6.1.1 Lower DuPage River

Hammel Woods Dam: The Hammel Woods Dam is owned by the Forest Preserve District of Will County and is located within their Hammel Woods Forest Preserve in Shorewood, IL. The Hammel Woods dam was removed in 2021. The dam was formerly located at River Mile 10.6, about 300 feet upstream from the Illinois Route 52 Bridge over the river. The dam was a run-of-the-river structure constructed of quarried limestone with a concrete foundation. The original construction plans for the dam are not available. The dam was a straight, broad-crest weir 110 feet across, with a total height of about 4 feet and a hydraulic height of 2.3 feet (from spillway crest to tailwater elevation under average flow conditions).

Channahon Dam: The Channahon Dam is the first dam on the DuPage River, located 1.1 miles from the DuPage confluence with the Des Plaines River in the I&M Canal State Park in Channahon. The 9-foot-high dam has effectively disconnected the DuPage River from the Des Plaines River from a biological standpoint. The impoundment behind the dam extends upstream 4.1 miles and covers an area of 75 acres. The environment within the impoundment is characterized as a deep channel with little or no diversity of flows and silty deposits over a rocky substrate.

In 1996, the dam was breached under extremely high flow conditions, but the damaged structure was fully rebuilt, and the impoundment was restored in 1998.

The Channahon Dam is a key piece of infrastructure preventing invasive nonnative carp (*Asian carp or Copi*) from entering the DuPage River watershed. As such, there is no potential for the modification or removal of this dam to allow for fish passage through this structure at this time.

3.6.1.2 West Branch DuPage River

Warrenville Grove Dam: The Warrenville Grove Dam was fully removed in September 2011 under a cooperative project administered by the DC SWM and the FPDDC. It was located on the West Branch of the DuPage River within the Warrenville Grove Forest Preserve in the City of Warrenville. The dam was one-third mile upstream from Warrenville Road and 0.4 miles downstream from Butterfield Road (Illinois Route 56). The site is owned by the FPDDC, and the dam was approximately 75 years old. Access to the site is best gained via the Forest Preserve parking lot on the east side of Batavia Road.

The dam was constructed of limestone facing placed in a stair step configuration, with a concrete foundation and headwall on the upstream face of the spillway. The dam was 107 feet across, with a curving spillway face that has a total crest length of about 125 feet. The dam height was 8.5 feet above the downstream river channel bottom, with a total hydraulic height of 5.7 feet (from spillway crest to tailwater elevation under average flow conditions).

The site maintains the original millrace that was partially retrofitted in 1995 to function as a fish ladder and canoe chute. The original dam impoundment was approximately 1.2 miles long and covered 16.9 acres.

The dam was designed by the National Park Service and constructed by the Civilian Conservation Corps between 1936 and 1938 as part of a dam-building program introduced to mitigate bank erosion. The dam site was chosen due to the presence of an older, abandoned mill dam that existed at the same location between 1847 and 1897.

McDowell Grove Dam: The McDowell Grove Dam was removed in mid-2008 under a cooperative project administered by DC SWM and the FPDDC. The dam was located on the West Branch of the DuPage River within the McDowell Grove Forest Preserve in unincorporated DuPage County and was approximately 75 years old.

Fawell Dam: The Fawell Dam is located on the West Branch of the DuPage River at river mile 8.1. It is a flood control structure operated by DC SWM. The dam consists of a set of three gate structures that can control flow through a three-barrel concrete box culvert to impound water, as necessary, upstream within the McDowell Grove Forest Preserve. The existing three-barrel concrete box culverts consist of a center barrel (11.83 feet wide by 10 feet high) and two square side barrels (10 feet by 10 feet). The culvert barrels are 80 feet long, and the bottom slopes down at 5% from the upstream end to the downstream end. There are concrete wing walls on the upstream side of the culvert structure and a 50-foot-long concrete stilling basin structure on the downstream side. Atop the culvert, the grade slopes up from the ends to a 25-foot-wide path running perpendicular to the structure, which is approximately 10 feet above the top elevation of the barrels. During low water events, when the structure is not operating, the upstream end of the culvert features a concrete sill set above the natural bed elevation of the river. The earth embankment is approximately 1,000 feet long.

To comply with the NDPES Special Conditions (Table 3 in Section 1), the DRSCW is currently working with DC SWM and the FPDDC to install a fish ladder system in one of the culverts of the Fawell Dam to allow for fish passage through the structure. The project is expected to be completed in 2024.

Arrow Road/Spring Brook Marsh #1 Dam: The dam was located at river mile 0.85 on Spring Brook # 1 in the Blackwell Forest Preserve. The structure consisted of a 4.5-foot weir (approximately 35 inches wide), which spilled into a reinforced concrete pipe that passed under Arrow Road. When the weir was fully closed, the impoundment was approximately 15 acres, most of which was less than one foot deep. The FPDDC owned the dam site and the impoundment. The dam was removed in a cooperative project administered by the FPDDC, the Illinois State Toll Highway Authority, and DRSCW during the 2020 field season; stream restoration efforts concluded soon thereafter.

3.6.1.3 East Branch DuPage River

West Lake Dam: The West Lake Dam is in West Lake Park in Bloomingdale, approximately one-half mile north of Army Trail Road and 500 feet west of Glen Ellyn Road. The existing concrete inlet and outlet channels and the existing lake outfall structure were constructed in the early 1970s in conjunction with the development of the Westlake Subdivision. The primary purpose of the lake is to retain excess stormwater runoff from the upstream Westlake development. The secondary benefit of the lake is that it provides aesthetic benefits and recreational uses as a public park area on land owned and operated by the Bloomingdale Park District. Maintenance to sustain the lake function as a stormwater retention facility is handled by the Village.

Churchill Woods Dam: The Churchill Woods Dam was located on the East Branch (river mile 18.7) within the Churchill Woods Forest Preserve in Glen Ellyn. Originally built in the 1930s as part of the Works Progress Administration, the 50-foot-long and 3.5-foot-high concrete gravity dam was removed in February 2011. The former impoundment created by the dam was approximately 31 acres in size and extended from Crescent Boulevard to approximately St. Charles Road (river miles 18.7–20.0). The river is still somewhat impounded at the site, with the new elevation being set by three box culvers under Crescent Boulevard immediately downstream of the former dam wall. The remaining impoundment area is approximately 12 acres.

Maryknoll Gabion Weir Dam: The Maryknoll Gabion Weir Dam is located on the East Branch, adjacent to the Maryknoll residential subdivision in Glen Ellyn. The dam is located east of Maryknoll Circle, approximately one-quarter mile south of Route 38 and 200 feet west of I-355. The dam was constructed in the early 1980s as part of Maryknoll Development to provide stormwater detention for the development. Flow at normal water level is not impeded. The dam consists of gabions with no concrete caps. The impoundment does not extend further upstream than Route 38.

Seven Bridges and Prentiss Creek dams (flow-through): The Seven Bridges and Prentiss Creek dams are located within the Seven Bridges Golf Club in Woodridge. The Seven Bridges Dam is located on the

East Branch DuPage River, and the Prentiss Creek Dam is located at the mouth of Prentiss Creek, and both are located immediately upstream from Hobson Road. The Village of Woodridge owns the structures, which are 19 years old. The dams were constructed in 1989 to provide in-line stormwater detention for the adjacent development. The dams are gravity structures consisting of rock-filled gabions that impound water at a greater rate as the flow increases. The East Branch structure is 20 feet wide, and the Prentiss Creek structure is 10 feet wide.

3.6.1.4 Salt Creek

Busse Woods Reservoir South Dam: The Busse Woods Reservoir South Dam is located on Salt Creek within the Busse Woods Forest Preserve in Elk Grove Village. The dam is owned and maintained by the Illinois Department of Natural Resources Office of Water Resources, while the forest preserve is owned by The Forest Preserve District of Cook County. The dam was built for flood control and recreational purposes in 1977. The dam is of earthen construction and is 23 feet high and 1381 feet long. The reservoir has a surface area of 415 acres.

Itasca Country Club Dam: Situated on Spring Brook 50 feet upstream of Prospect Avenue, this dam is privately owned and maintained. No other information was available.

Lake Kadijah Dam: This dam is located one-half mile upstream of Rohlwing Road/Illinois Route 53. This dam is maintained by the Medinah County Club and serves as part of the DC SWM Spring Creek Reservoir operation system.

Eaglewood Dam: The Eaglewood Dam is located on Spring Brook upstream of Route 53 on the Eaglewood Golf Course. This dam was constructed to support irrigation purposes.

Oak Meadows Golf Course Dam: The Oak Meadows Golf Course Dam was located on Salt Creek within the Oak Meadows Golf Course. The dam was removed in 2016 by the FPDDC, the DRSCW, and the DC SWM. The golf course is maintained by the FPDDC and is east of Addison Road and north of I-290. The date of original construction is unknown. The dam was originally built by Elmhurst Country Club to provide a source of irrigation water for the golf course; it impounded 6 acres over 4,500 linear feet of the mainstem. The spillway was approximately 3 feet high and 75 feet wide.

Westwood Creek Dam (Salt Creek Tributary WWTP dam): The Westwood Creek Dam is located on Westwood Creek, a tributary to Salt Creek in Addison. The dam is approximately 500 feet east of Addison Road and 200 feet southwest of I-290 and is maintained by the Village of Addison. The dam was brought online in 1994 as part of an effort by the DC SWM to reduce flooding in the area. Residential areas to the west along Westwood Creek are protected during flood events by closing the gates of the dam and pumping Westwood Creek to Louis' Reservoir, a two-stage, 210-foot retention and detention area at the southwest corner of Lake Street and Villa Avenue.

Redmond Reservoir Dam (George Street Reservoir): Located on Addison Creek in Bensenville and operated by the Village of Bensenville, this dam was originally constructed in 1999. The headwaters originate in Wood Dale and Bensenville.

Mount Emblem Cemetery Pond Dam: Located in Elmhurst at the southwest corner of Grand Avenue and County Line Road on Addison Creek, this low-head dam was originally constructed in the 1930s to create an online pond that is a landscape feature of the Mount Emblem Cemetery.

Graham Center Dam (Elmhurst County Forest Preserve Dam): The dam is located on Salt Creek near Elmhurst. The dam is one-quarter mile east of Route 83 and one-quarter mile south of Monroe Street. The dam was constructed in the early 1990s as a result of dredging on Salt Creek from Oak Brook north to this point. The structure was installed to allow for a step down between the dredged and not-dredged portions of the river and to prevent sedimentation of the dredged portions. The structure was not intended to be a dam, but it functions like one in low-flow conditions. The dam originally consisted of a single line of sheet metal piling. However, the creek began to erode the banks at the point of contact with the sheet metal piling. This was repaired by cutting a notch in the original sheet metal piling and installing another line of sheet metal piling further downstream.

Old Oak Brook Dam: The Old Oak Brook Dam is located on Salt Creek, downstream of 31st Street in Oak Brook. The dam is maintained by the Village of Oak Brook and is approximately 90 years old. The dam was originally built by Paul Butler in the 1920s to maintain an aesthetic pool on his property during low-flow periods.

Oak Brook Dam has undergone major rehabilitation over the last 20 years. There are two main spillway components: the fixed elevation spillway and an old, inoperable, gated emergency spillway. The gated spillway section consists of two steel vertical slide gates. The dam was rehabilitated in 1992. The primary spillway is 65 feet wide with about 3 feet of head at normal flow conditions, and it consists of grouted stone with a concrete cap. The left and right training walls consist of grouted stone and reinforced concrete, overlain to a larger extent by concrete-filled Fabriform® mats.

Fullersburg Woods Dam: The Fullersburg Woods Dam (also known as the Graue Mill Dam) is located on Salt Creek. It is associated with Graue Mill and is within the Fullersburg Woods Forest Preserve. The dam is 300 feet upstream of York Road near the Village of Oak Brook. The dam is owned by FPDDC and is 74 years old. The adjacent historic mill was originally constructed in 1852. The mill and dam were rebuilt by the Civilian Conservation Corps in 1934. The dam is 123 feet across and 6.3 feet high. The impoundment created by the dam covers 16 acres and 3,900 linear feet. The Fullersburg Woods dam was removed in November/December 2023 to comply with the NDPES Special Conditions (see Table 3 in Section 1).

Fox Lane Impoundment: An approximately 5-acre impoundment located at river mile 10.0 was created by what appears to be the remnant foundation of a former dam. The remnants currently function as a large riffle under low- to average-flow conditions.

Possum Hollow Woods Dam: Located in Westchester, three-fourth mile east of Wolf Road and one-quarter mile north of 31st Street on FPCC property, Possum Hollow Woods Dam does not result in a notable impoundment. No additional data are available at this time.

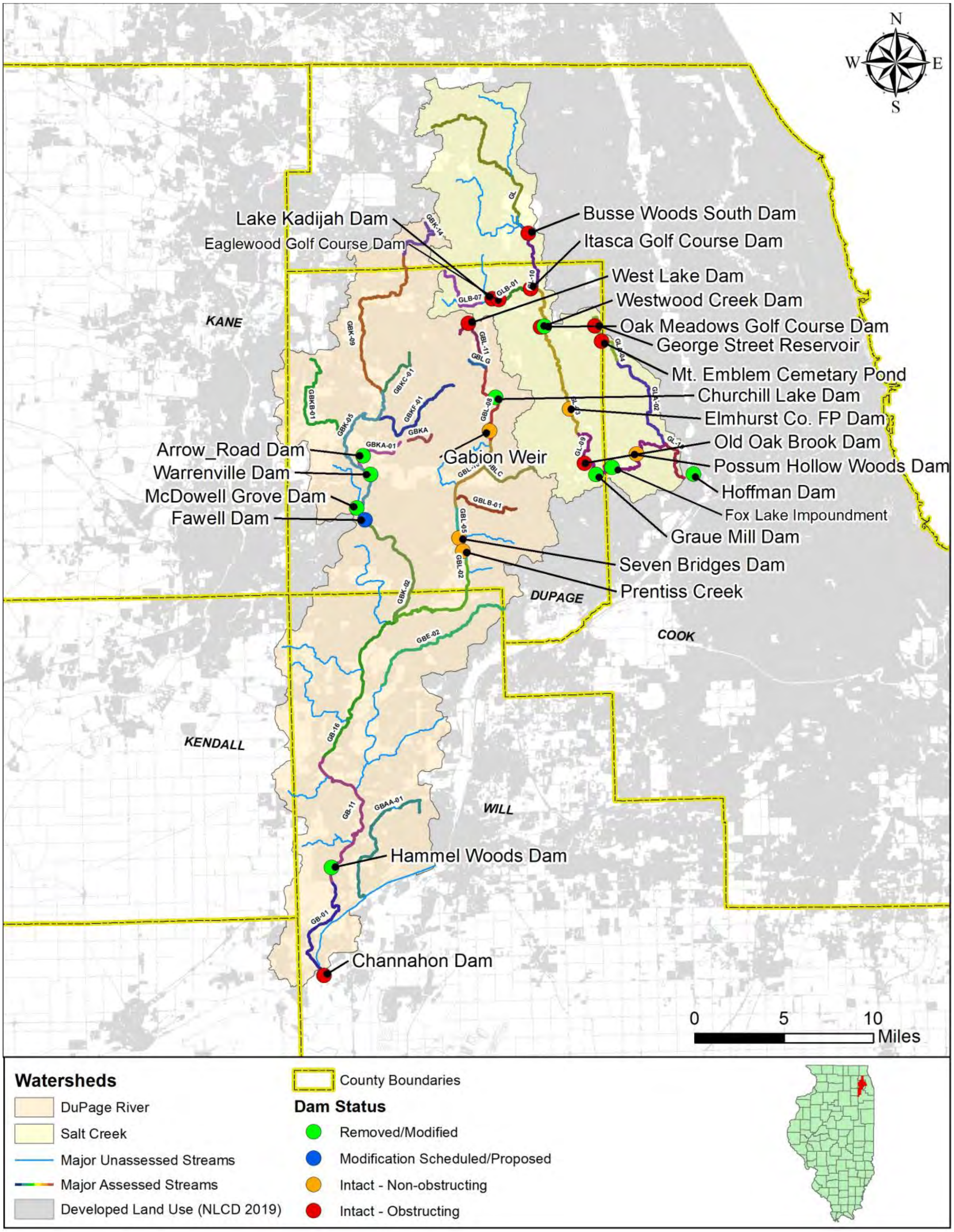


Figure 23. Dams in the DuPage River and Salt Creek watersheds.

3.7 NONPOINT SOURCES

The term nonpoint source pollution is defined as any source of pollution that does not meet the legal definition of point sources. Nonpoint source pollution typically results from overland stormwater runoff that is diffuse in origin, as well as background conditions. It should be noted that stormwater collected and conveyed through a regulated municipal separate storm sewer system (MS4) is considered a controllable point source. Runoff from nonregulated areas, which in this case is limited to agricultural areas, is the main nonpoint source of pollutants to impaired streams. In addition, SOD in streams also contributes to low DO conditions. Septic systems can also be a source of nonpoint pollution if they are not maintained properly.

Agricultural areas can significantly affect water quality if proper best management practices are not in place, specifically contributing to high BOD and nutrients that can affect the DO conditions in streams. Like MS4-permitted stormwater, nonpoint stormwater runoff acts as a delivery mechanism for several sources of pollutants. During wet-weather events (snowmelt and rainfall), pollutants, including fecal coliform, chloride and nutrients from fertilizer application, and oxygen-demanding substances (e.g., decaying vegetation), are incorporated into stormwater runoff and can be delivered to downstream waterbodies. Fertilizers used for cropland are typically considered a potential source of nutrient enrichment in waterbodies, which results in increased BOD and is linked to lower DO conditions. SOD is a result of the biological consumption of organic material at the sediment-water interface and is a component of BOD; however, because it is a result of biochemical processes in the stream itself, it is considered a nonpoint source pollutant.

3.8 POINT SOURCES

Point source is defined by the federal CWA Section 502(14) 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 stormwater discharges and return flow from irrigated agriculture."*

Under the CWA, all point sources are regulated under the 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 major WWTPs, minor municipal WWTPs, industrial facilities, CAFOs, or regulated stormwater including MS4s. There are no permitted CAFOs in the DuPage River and Salt Creek watersheds.

3.8.1 NPDES-Permitted Facilities

NPDES-permitted facilities within the watershed include municipal and industrial WWTPs of various sizes. Permitted major municipal WWTPs in the DuPage River and Salt Creek watersheds are summarized in Table 25 and included in Figure 24. Minor municipal WWTPs are summarized in Table 26 and also included in Figure 24. Industrial discharges in the watersheds are summarized in Table 27 and included in Figure 25.

Eight NPDES-permitted facilities also have permitted CSOs in the DuPage River and Salt Creek watersheds (Table 28 and Figure 26). CSOs occur as the result of wet weather, which is not of specific concern for this NIP because the critical condition for DO is during warm, dry, low-flow periods—not the wet weather season. When CSO events occur, untreated wastewater enters rivers and streams, potentially discharging pollutants such as fecal coliform, solids, chloride, and nutrients (e.g., phosphorus). An ongoing Long-Term Control Plan (LTCP) was established to eliminate CSO events across these watersheds. One facility (Glenbard Wastewater Authority-Lombard, IL002247) is exempt from developing a LTCP because, due to CSO control measures, the permittee has achieved no more than four overflows per year as required under the Presumption Approach and as allowed in its NPDES permit. Four CSO facilities are part of the MWRDGC Tunnel and Reservoir Plan (TARP) system, which diverts and conveys would-be CSO flows to storage reservoirs through underground tunnels. After wet weather events end, the water in the reservoirs is pumped to a water reclamation plant for treatment and discharge to surface waters. The facilities that are part of the TARP program are not required to submit separate LTCPs.

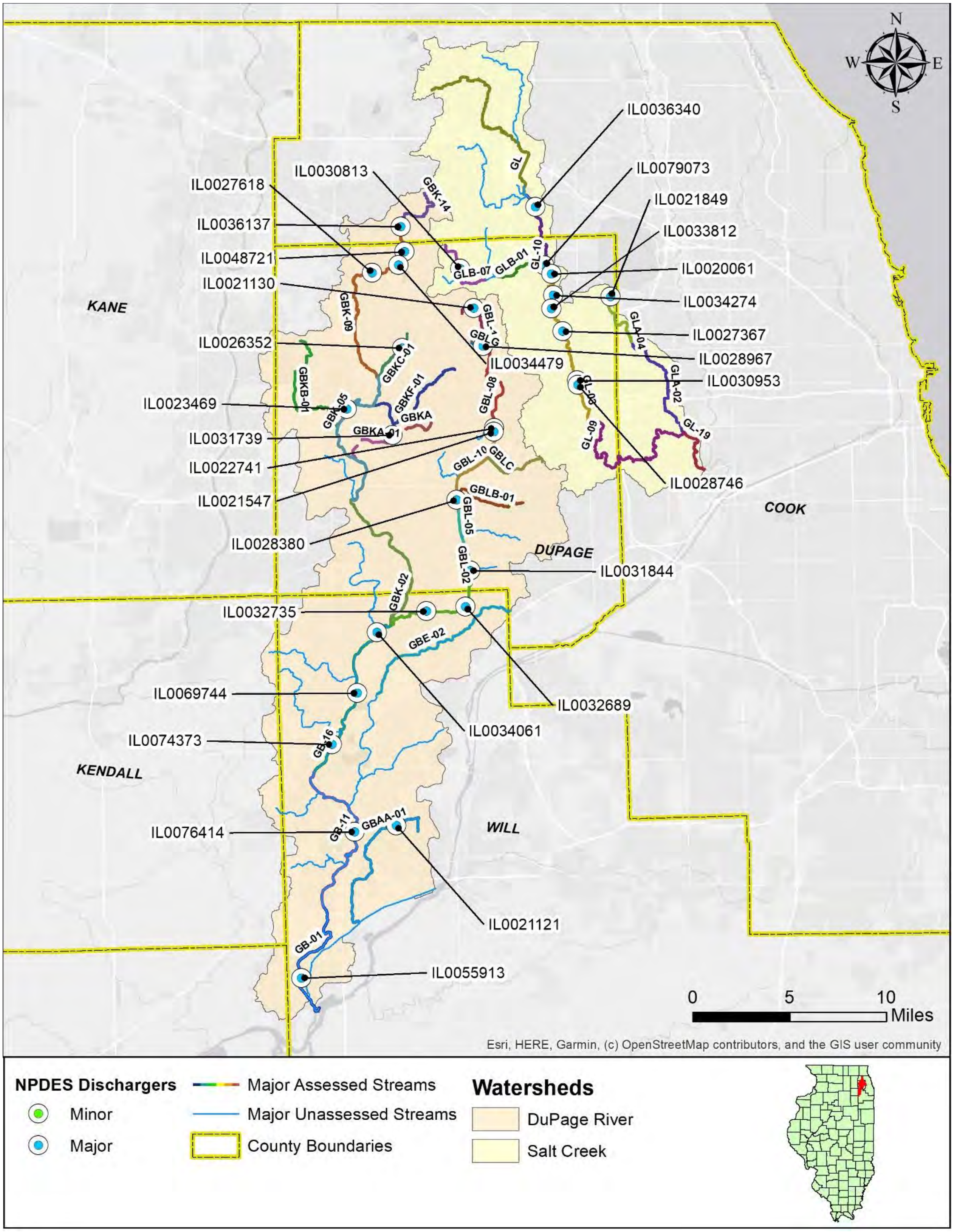


Figure 24. Major and minor municipal WWTPs in the DuPage River and Salt Creek watersheds.

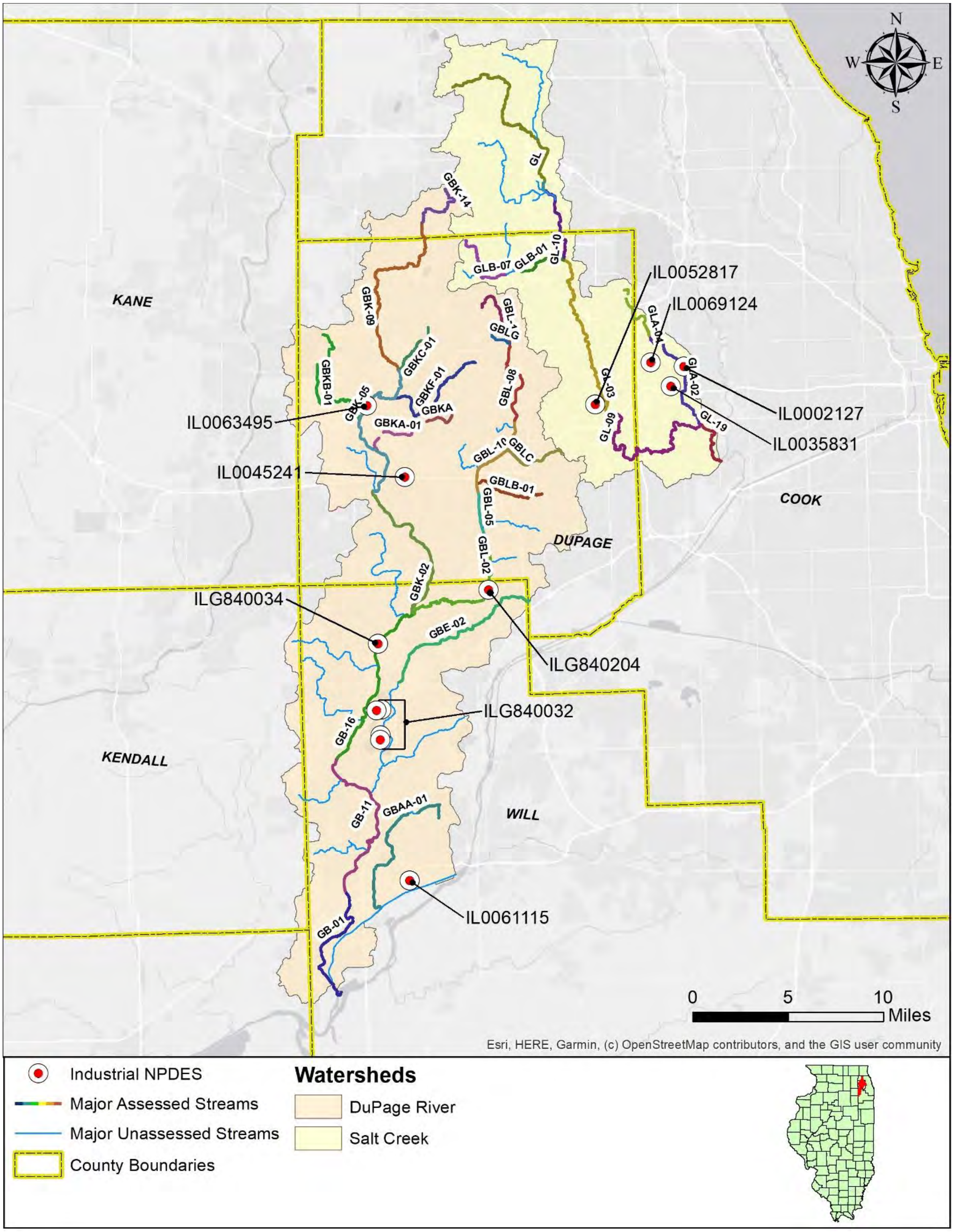


Figure 25. Industrial discharges in the DuPage River and Salt Creek watersheds.

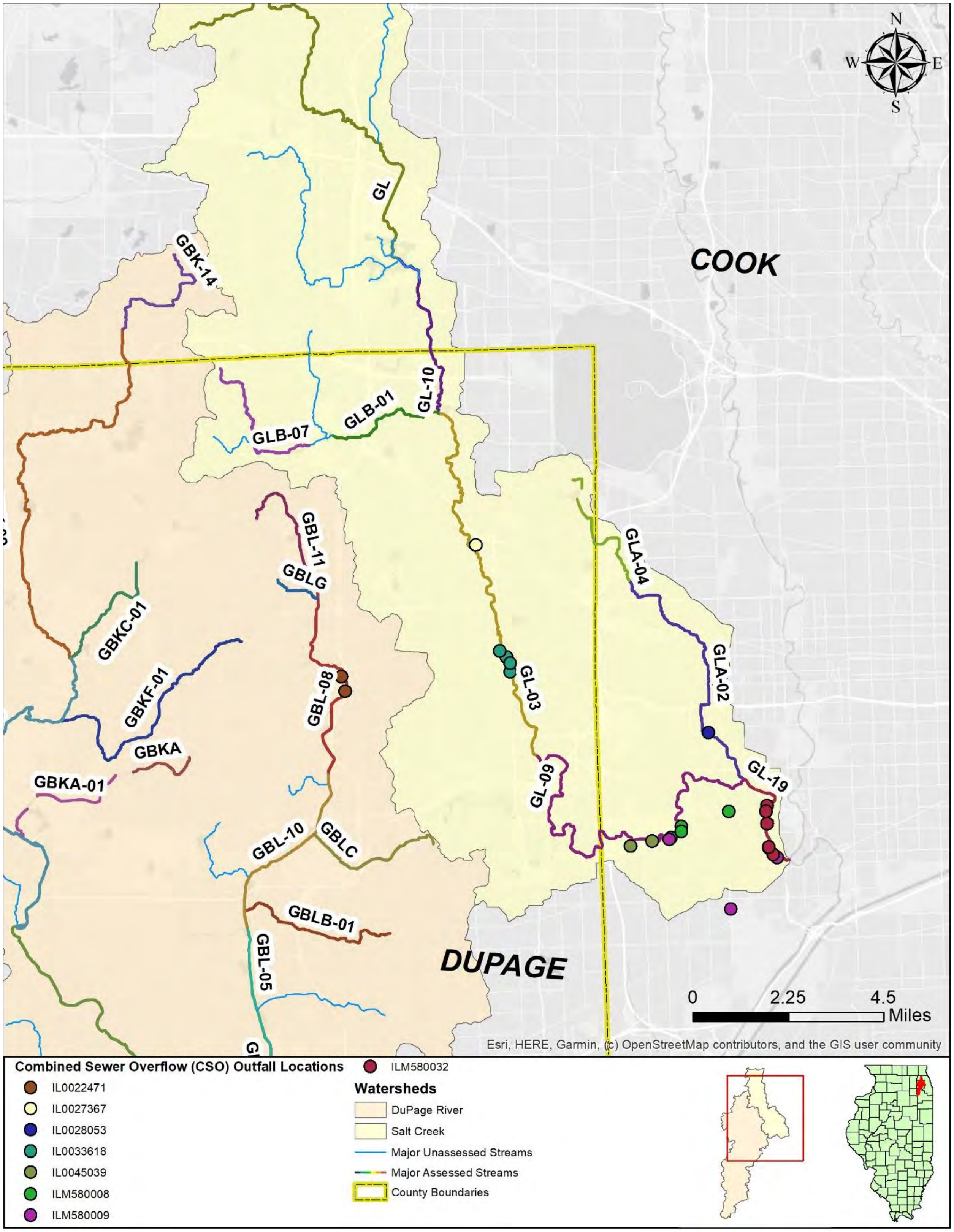


Figure 26. CSOs in the DuPage River and Salt Creek watersheds.

Table 25. Major municipal WWTPs in the DuPage River and Salt Creek watersheds

Watershed	NPDES Number	Facility and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Design Average Flow (million gallons per day [MGD])	Design Maximum Flow (MGD)
East Branch DuPage River	IL0021130	Bloomingdale-Reeves Water Reclamation Facility (WRF) – B01	East Branch DuPage River	GBL-10, GB-16, GB-11	3.45	8.625
	IL0028967	Glendale Heights Sewage Treatment Plant (STP) – 001	Armitage Ditch	GBL-10, GB-16, GB-11	5.26	10.52
	IL0021547	Glenbard Wastewater Authority – Main WWTP – 001	East Branch DuPage River	GBL-10, GB-16, GB-11	16.02	47
	IL0028380	Downers Grove Sanitary District WTC – B01	East Branch DuPage River & St. Joseph Creek	GBL-10, GB-16, GB-11	11	22.0
	IL0031844	DuPage County- Woodridge-Green Valley STP – 001	East Branch DuPage River	GB-16, GB-11	12	28.6
	IL0032735	Bolingbrook WRF #2 – 001	East Branch DuPage River	GB-16, GB-11	3	7.5
	IL032689	Bolingbrook STP #1 – B01	East Branch DuPage River to Des Plaines River	GB-16, GB-11	2.04	4.51
West Branch DuPage River	IL0036137	MWRDGC Hanover Park Water Reclamation Plant (WRP) – 007	West Branch DuPage River	GBK-09, GBK-05, GB-16 GB-11	12	22
	IL0048721	Roselle-Botterman WWTP – 001	West Branch DuPage River	GBK-09, GBK-05, GB-16, GB-11	1.22	4.60
	IL0034479	Hanover Park STP #1 – B01	West Branch DuPage River	GBK-09, GBK-05, GB-16, GB-11	2.42	8.68
	IL0027618	Bartlett WWTP – B01	West Branch DuPage River	GBK-09, GBK-05, GB-16 GB-11	3.679	5.151
	IL0026352	Carol Stream STP – B01	Klein Creek	GBK-05, GB-16, GB-11	6.5	13.0
	IL0023469	West Chicago/Winfield Wastewater Authority RWTP – B01	West Branch DuPage River	GBK-05, GB-16, GB-11	7.64	20.3
	IL0031739	Wheaton Sanitary District – 001	Spring Brook Creek	GBKA-01, GBK-05, GB-16, GB-11	8.9	19.1
Salt Creek	IL0036340	MWRDGC Egan WRP – 001	Salt Creek	GL-10, GL-09, GL-19	30	50
	IL0030813	Roselle STP – B01	Salt Creek	GL-09, GL-19	2	4
	IL0079073	Itasca STP – 001	Salt Creek	GL-09, GL-19	3.2	8.2
	IL0020061	Wood Dale North STP – 001	Salt Creek	GL-09, GL-19	1.97	3.93
	IL0034274	Wood Dale South STP – 001	Salt Creek	GL-09, GL-19	1.13	2.33
	IL0033812	Addison North STP – B01	Salt Creek	GL-09, GL-19	5.3	7.6
	IL0027367	Addison South – A.J. LaRocca STP – B01	Salt Creek	GL-09, GL-19	3.2	8.0
	IL0028746	Elmhurst WRF – 001	Salt Creek to Des Plaines River	GL-09, GL-19	8	20.0

Watershed	NPDES Number	Facility and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Design Average Flow (million gallons per day [MGD])	Design Maximum Flow (MGD)
	IL0030953	Salt Creek Sanitary District – 001, 002	Salt Creek	GL-09, GL-19	3.3	8.0
	IL0021849	Bensenville STP – 001	Addison Creek	GLA-02, GL-19	4.7	10.0
Lower DuPage River	IL0034061	Naperville Springbrook Water Reclamation Center (WRC) – 001	DuPage River	GB-16, GB-11	26.25 current, 30 future	55.13 current, 63 future
	IL0069744	Bolingbrook WRF #3 – 001	DuPage River	GB-16, GB-11	2.8 current, 4.2 future	7.0 current, 10.5 future
	IL0074373	Plainfield North STP – 001	DuPage River to Des Plaines River	GB-16, GB-11	7.5	15.0
	IL0076414	Joliet Aux Sable WWTP – 001	DuPage River	GB-11	7.7	17.3
	IL0021121	Crest Hill West STP – 001	Rock Run Creek	None	1.3	3.0 (also an excess flow facility)
	IL0055913	Minooka STP – 001	DuPage River to Des Plaines River	None	2.2	5.8

Table 26. Minor municipal WWTPs in the DuPage River and Salt Creek watersheds

Watershed	NPDES Number	Facility and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Design Average Flow (MGD)	Design Maximum Flow (MGD)
West Branch DuPage River	IL0028428	DuPage County – Cascade STP – 001	West Branch DuPage River	GBK-09, GBK-05, GB-16, GB-11	0.00585	0.0234
Salt Creek	IL0028398	DuPage County – Nordic Park STP – 001	Spring Brook Creek	GL-09, GL-19	0.5	1.0
Lower DuPage River	IL0045381	Camelot Utilities STP – 001	DuPage River	None (GB-01)	0.1	0.25

Table 27. Industrial dischargers in the DuPage River and Salt Creek watersheds

Watershed	NPDES Number	Facility	Receiving Water	Downstream Aquatic Life Impairments	Design Flow
East Branch DuPage River	ILG840204	Vulcan Construction Materials – Barbers Corner Quarry	East Branch DuPage River	GB-16, GB-11	No design flows, average flow of 2.62 MGD reported in 2023 Discharge Monitoring Reports (DMRs); discharge is pit pumpage and stormwater runoff
West Branch DuPage River	IL0063495	Kerr-McGee Chemical Corp.	West Branch DuPage River	GBK-05, GB-16, GB-11	No design flows, average flow of 0.0 MGD reported on 2023 DMRs; discharge is stormwater, wash water, and excavation pit water
	IL0045241	INEOS USA	West Branch DuPage River	GBK-05, GB-16, GB-11	No design flows, average flow of 0.0011 MGD reported on 2023 DMRs; discharge is stormwater and noncontact cooling water
Salt Creek	IL0035831	Congress Development	Des Plaines River	GLA-02, GL-19	No design flows, average flow of 0.097 MGD reported on 2023 DMRs; discharge is stormwater
	IL0002127	Union Pacific Railroad	Mud Creek Tributary to Addison Creek	GLA-02, GL-19	No design flows, average flow of 2.45 MGD reported on 2023 DMRs; discharge is stormwater
	IL0069124	Vanee Foods Company	Unnamed Tributary to Addison Creek	GLA-02, GL-19	No design flows, average flow of 0.043 MGD reported on 2023 DMRs; discharge is stormwater and noncontact cooling water
	IL0052817	Stonewall Utility Company – STP	Unnamed Ditch Tributary to Salt Creek	GL-09, GL-19	Design average and max flows: 0.01 and 0.07 MGD, respectively
Lower DuPage River	ILG840034	Vulcan Construction Materials – Bolingbrook Quarry	DuPage River	GB-16, GB-11	No design flows, average flow of 0.29 MGD reported in DMRs; discharge is stormwater
	ILG840032	Vulcan Materials	Lily Cache Creek	GBE-01	No design flows, average flow of 0.14 MGD reported in DMRs; discharge is stormwater
	IL0061115	LaFarge Aggregates – Joliet Quarry	Unnamed Tributary to Illinois and Michigan Canal	N/A	No design flows, average flow of 1.09 MGD reported in DMRs; discharge is stormwater

Table 28. Combined sewer overflows in the DuPage River and Salt Creek watersheds

Watershed	NPDES Number	Facility and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Status of Long-Term Control Plan
East Branch DuPage River	IL0022471	Glenbard WW Authority – Lombard – 002/003 Overflows	East Branch DuPage River	GBL-08, GBL-10, GB-16, GB-11	Exempt
Salt Creek	IL0027367	Addison South – A.J. LaRocca STP – 004 Overflows	Salt Creek	GL-09, GL-19	Submitted 2009, update due 2024
	IL0028053	MWRDGC Stickney WRP CSOs – 150 (Westchester Pump Station) Overflows	Addison Creek	GLA-02, GL-19	TARP (no LTCP required)
	IL0033618	Villa Park Wet Weather STP CSOs – 001/002/003/004 Overflows	Salt Creek	GL-09, GL-19	Submitted 2016, approved 2020
	IL0045039	Village of Western Springs CSOs – 001/002 Overflows	Salt Creek	GL-09, GL-19	Submitted 2015, updated 2019
	ILM580008	LaGrange Park CSOs – 001/002/003/ 004/005/006 Overflows	Salt Creek	GL-09, GL-19	TARP (no LTCP required)
	ILM580009	Village of LaGrange CSOs – 001/002/003 Overflows	Salt Creek	GL-09, GL-19	TARP (no LTCP required)
	ILM580032	Brookfield CSOs – 001/002, 003/005/006/007 Overflows	Salt Creek	GL-19	TARP (no LTCP required)

3.8.2 Municipal Separate Storm Sewer Systems

Stormwater alone is not a pollutant or pollutant source, but it acts as an important delivery mechanism of pollutants from various sources. Pollutant sources in urban stormwater runoff can be associated with decaying vegetation (e.g., leaves and grass clippings), pet and wildlife waste, sediment and soil, deposited atmospheric particulate matter, road de-icing salts, and oil and grease from vehicles. The most significant stormwater pollutants and their sources include chloride from de-icing agents used for winter road maintenance (road salt) and fecal coliform conveyed in runoff from pet and wildlife waste. In urban areas, nonpermitted cross-connections between sanitary sewers and storm sewers can also occur either due to unintentional negligence or intentional malfeasance occurring during construction activities. These illicit connections, although unknown and undocumented, cause discharges that may also be considered point sources.

Under the NPDES program, municipalities serving populations over 100,000 people are considered Phase I MS4 communities. Municipalities serving populations under 100,000 people are considered Phase II communities. Within Illinois, Phase II communities are allowed to operate under the statewide General Stormwater Permit (ILR40) for protection of waterways from urban stormwater runoff pollution, which first requires dischargers to file a Notice of Intent, acknowledging that municipal stormwater runoff discharges shall not cause or contribute to a WQS violation. To assure pollution is controlled to the maximum extent practical, regulated entities operating under the State General Permit (ILR40) are required to implement all six of the following control measures:

- Public education and outreach on stormwater impacts
- Public involvement and participation
- Illicit discharge detection and elimination
- Construction site stormwater runoff control

- Post construction stormwater management in new development and redevelopment
- Pollution prevention and good housekeeping for municipal operations

The entire project area included within this NIP is regulated under the State General Permit (ILR40). Aside from cities, major roadways are regulated by the Illinois Department of Transportation and Illinois State Toll Highway Authority, and counties are regulated MS4s responsible for permitting within unincorporated portions of the county. A list of all MS4s present within the DuPage/Salt NIP coverage area is provided in Table 29.

Table 29. MS4 communities in the DuPage River and Salt Creek watersheds

Permit ID	MS4 Name	Permit ID	MS4 Name	Permit ID	MS4 Name
ILR400001	Addison Township	ILR400199	Glen Ellyn Village	ILR400415	Oswego Village
ILR400277	Addison Village	ILR400342	Glendale Heights Village	ILR400107	Palatine Township
ILR400282	Arlington Heights Village	ILR400347	Hanover Park Village	ILR400416	Palatine Village
ILR400283	Aurora	ILR400063	Hanover Township	ILR400111	Plainfield Township
ILR400526	Aux Sable Township	ILR400354	Hillside Village	ILR400426	Plainfield Village
ILR400285	Barrington Village	ILR400355	Hinsdale Village	ILR400112	Proviso Township
ILR400008	Barrington Township	ILR400210	Hoffman Estates Village	ILR400433	Rockdale Village
ILR400286	Bartlett Village	ILR400494	IL State Toll Highway Authority	ILR400435	Rolling Meadows
ILR400288	Batavia	ILR400493	Illinois Dept of Transportation	ILR400436	Romeoville Village
ILR400009	Batavia Township	ILR400359	Inverness Village	ILR400437	Roselle Village
ILR400291	Bellwood Village	ILR400360	Itasca Village	ILR400122	Schaumburg Township
ILR400292	Bensenville Village	ILR400361	Joliet	ILR400443	Schaumburg Village
ILR400166	Berkeley Village	ILR400071	Joliet Township	ILR400445	Shorewood Village
ILR400013	Bloomingdale Township	ILR400259	Kane County	ILR400648	South Barrington Village
ILR400295	Bloomingdale Village	ILR400261	Kendall County	ILR400454	St Charles
ILR400298	Bolingbrook Village	ILR400365	LaGrange Park Village	ILR400131	St Charles Township
ILR400167	Broadview Village	ILR400364	LaGrange Village	ILR400248	Stone Park Village
ILR400302	Brookfield Village	ILR400076	Leyden Township	ILR400456	Streamwood Village
ILR400308	Carol Stream Village MS4	ILR400079	Lisle Township	ILR400141	Troy Township
ILR400027	Channahon Township	ILR400376	Lisle Village	ILR400463	Villa Park Village
ILR400623	Channahon Village	ILR400080	Lockport Township	ILR400274	Warrenville
ILR400175	Clarendon Hills Village	ILR400378	Lombard Village	ILR400149	Wayne Township
ILR400485	Cook County Highway Dept	ILR400082	Lyons Township	ILR400500	Wayne Village
ILR400319	Crest Hill, City	ILR400220	Lyons Village	ILR400466	West Chicago
ILR400561	Crystal Lawn Subdivision	ILR400384	Maywood Village	ILR400468	Westchester Village
ILR400180	Darien City	ILR400386	Melrose Park Village	ILR400469	Western Springs Village
ILR400040	Downers Grove Township	ILR400086	Milton Township	ILR400254	Westmont Village
ILR400183	Downers Grove Village	ILR400638	Minooka Village	ILR400152	Wheatland Township
ILR400502	DuPage County	ILR400594	NA-AU-SAY Township	ILR400470	Wheaton
ILR400042	DuPage Township	ILR400396	Naperville	ILR400153	Wheeling Township
ILR400048	Elk Grove Township	ILR400092	Naperville Township	ILR400272	Will County
ILR400334	Elk Grove Village	ILR400229	North Riverside Village	ILR400155	Winfield Township
ILR400187	Elmhurst	ILR400406	Northlake	ILR400474	Winfield Village
ILR400195	Franklin Park Village	ILR400407	Oak Brook Village	ILR400478	Wood Dale
ILR400341	Geneva	ILR400232	Oakbrook Terrace City	ILR400480	Woodridge Village
ILR400056	Geneva Township	ILR400104	Oswego Township	ILR400159	York Township

4 WHY IS BIOLOGY THE FOCUS OF THE NIP?

It is the objective of the CWA to protect and restore the chemical, biological, and physical integrity of the Nation's waters (CWA Section 101[a]). To achieve this objective, national goals were established by the 1972 Federal Water Pollution Control Act amendments or what is better known as the CWA. Perhaps most well-known is the CWA goal, "wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water (Section 101[a][2])," which is commonly referred to as the "fishable/swimmable" goal. It provides the legislative foundation for the WQS that are used to measure and manage water quality via monitoring and assessment and water quality-based regulation of pollution sources. A WQS consists of the designated use and the chemical, physical, and biological criteria designed to protect that use. Designated uses broadly include the protection of aquatic life, recreation in and on the water, aesthetics, providing safe water supplies, and consumption uses for protecting humans and wildlife. Both the attainability and attainment of WQS is determined via adequate monitoring and assessment, a commitment made by DRSCW when it was formed in 2004 (USEPA 2007). The systematic watershed monitoring, carried out by the DRSCW since 2006 and the LDRWC since 2012, has focused primarily on determining the status of the Illinois aquatic life designated use and determining the causes (agents) and sources (origins) of impairments. This is emblematic of the CWA's broad focus on the restoration and protection of aquatic life uses by considering all causes and sources of impairment.

DRSCW and LDRWC have supported using the IEPA biological indices as direct measures of attainment and nonattainment of the General Use standard for aquatic life. In Illinois, WWTP permit conditions are drawn from the state's CWA Section 303(d) list (Section 2.2). The 2020–2022 Illinois Integrated Water Quality Report and Section 303(d) list includes 29 segments out of 34 assessed stream segments in the DuPage River and Salt Creek watersheds as impaired for aquatic life, making it the most common designated use impairment—more than the other designated use impairments combined. This makes the understanding of aquatic life, and the effective monitoring of it, a priority for entities seeking compliance with state and federal law. Under the CWA, the states, including Illinois, use IBI for fish and macroinvertebrates to measure aquatic diversity and compliance. The direct measurement of IBIs allows for the direct measurement of current conditions, trends, and impacts of any remediate actions, deleterious interventions, or background changes. Such direct observation of the end goal's current and future condition is critical for success. A resource that is not adequately monitored and measured cannot be understood, managed, or protected.

A closer examination of the Integrated Water Quality Report and Section 303(d) List further reveals that many of the observed effects linked to aquatic life impairments are not subject to direct regulatory action, as they do not have an adopted numerical standard (Table 15 for streams and Table 16 for lakes in Section 2.2). With the exception of the few narrative standards (e.g., prevention of toxic or nuisance conditions), WQS are currently only developed for a limited set of chemical parameters, as these have been given priority by regulators and are easy to implement. While important, reliance on water chemistry without the context provided by direct measurement of the health of the aquatic communities can lead to over-prioritization of those selected parameters. The almost exclusive focus on individual parameters, especially when used in regulatory actions such as the implementation of TMDLs (Section 2.3) as recommendations for lower effluent limits in WWTP permits, can result in unnecessary expenditures by public utilities and a lack of measurable improvement because not all WQS excursions lead to aquatic life impairment.

Empirical observations demonstrate that it is possible to have aquatic life use attainment even in the presence of WQS exceedances. The ambient condition impacts of WQS exceedances on aquatic life are a function not only of the exceedance itself but also of the nature of the pollutant (toxicity) and the duration, magnitude, and frequency of the exceedance. The absence of data on the biological response makes it impossible to gauge the actual impact of such exceedances. Therefore, this precludes the design of an appropriate targeted response or the ability to weigh the impact's importance relative to other priorities. While a violation of a WQS is a violation of the law, efficient watershed management demands that choices be made on how to invest scarce resources to maximize progress towards meeting the end goal (in this case, aquatic life attainment). A second kind of error exists where a waterbody with no detected chemical exceedances is granted full attainment status even though biology indicates a significant impairment.

This still leaves those stressors with no WQS. To that end, the concept of "pollution" needs to take on a broader context (Karr and Chu 1999). Regulators generally understand and treat pollution as being purely chemical in nature. However, the 1972 CWA and its 1987 CWA reauthorization deliver a much broader and holistic definition (from CWA Section 502: General Definitions), defining it as "any man made or man-induced alteration of the physical, chemical or biological or radiological integrity of water." However, measuring such alterations piecemeal would mean sampling all such components—a practical impossibility. Living organisms, by their nature, are the product of the integration of these alterations and their cumulative effect. Indeed, IBIs, a multimetric index, are designed to measure such impacts and their accumulated effects. This makes aquatic life not just the objective of remediate actions but also the single most complete measure of existing stream resource quality, including identifying and weighing stressors that do not have a WQS. The nature of aquatic life, as a composite result of all stressors, allows interventions to be more precisely tailored and ranked based on the observed and predicted response of the aquatic organisms.

The condition of the biota of the receiving streams and rivers is the ultimate arbiter of the success or failure in meeting the terms and conditions of the NIP and any other restoration plans or projects. This is an essential aspect of the aforementioned adaptive management approach that is supported by robust and detailed analyses of the multiples of chemical, physical, habitat, and landscape stressors that affect the attainment of the General Use standard for aquatic life in the DuPage River and Salt Creek watersheds. At the same time, the DRSCW and LDRWC recognize the need to establish causal linkages between the objectives of the NIP to address DO- and nutrient-related stressors as they affect the attainment of the biological endpoints. This need was addressed by the development of the IPS framework and model (MBI 2010, 2023), as detailed in Section 1.3.

4.1.1 Measuring Biological Response

The fIBI and mIBI are multimetric indices that IEPA uses to measure attainment and nonattainment of the General Use standard for aquatic life (IEPA 2022); they are the established methods for determining aquatic life use status for Illinois. These types of indices are designed to integrate the effects of all stressors, partly by having an array of metrics comprised of species and taxa attributes that respond in a predictable manner along different parts of the stressor gradient and specifically to different categories of stress (habitat, toxics, nutrients, dissolved solids, etc.). Two assemblage groups are used in Illinois: fish and macroinvertebrates. These groups may respond differentially to the same stressors (e.g., Marzin et al. 2012), such that one index might be attaining its biocriteria while the other reveals an impairment. This is consistent with the USEPA (2013) bioassessment program evaluation methodology that calls for using two assemblages. The approach of using a fully calibrated and regionally relevant IBI fulfills one of the originally intended purposes of Karr et al. (1986) to assess ". . . large numbers of sample areas and to determine trends, thus enabling us to assess the effects of management programs for water resources...". It also reflects the unique role of the IBI for which no suitable surrogate exists.

Because the fIBI and mIBI are designed to integrate the effects of all stressors that are present, the aggregate index value alone has limited value in stressor identification (Vadas et al. 2022). Identical IBI scores can result from entirely different stressors, which some have erroneously cited as an inherent liability. In acknowledgment of the limitation of an IBI score alone to reveal specific stressors, the NE Illinois

IPS (MBI 2023) used fish species and macroinvertebrate taxa-based responses to individual stressors to develop stressor-specific Species Sensitivity Distributions. This was used to develop a compendium of biological response-based stressor thresholds for use in the NE Illinois watershed bioassessments. The Species Sensitivity Distributions were then linked back to the fIBI or mIBI narrative tier to act as a causal threshold for supporting stressor analyses and developing the Restorability, Susceptibility, and Threat factors with the IPS framework (Section 1.3).

4.1.2 Reliability of the Illinois IBIs

The IEPA bioassessment program underwent a series of such evaluations between 2002 and 2012 using the Critical Elements Evaluation (CEE) process (Yoder and Barbour 2009). Soon thereafter, the Critical Elements Evaluation was documented in a USEPA methodological document entitled *Biological Assessment Program Review: Assessing Level of Technical Rigor to Support Water Quality Management* (USEPA 2013). While several opportunities for improving the level of rigor of the IEPA program were identified (MBI 2010, 2013), the fIBI and mIBI were found to be capable of assessing Illinois rivers and streams beyond a pass/fail basis. In terms of their respective critical technical elements scoring, both Illinois and Ohio scored 3.5 and 4.0, respectively, for the ecological attributes and discriminatory capacity elements, which is at or near the maximum score of 4.0 (MBI 2010).

The statistical properties of the Illinois fIBI were examined by Gerritsen et al. (2011), who found the coefficient of variation at the least-disturbed sites was 9.5% but was higher at impaired sites, which is not unexpected. Holtrop and Dolan (2003) analyzed the precision of the fIBI as the mean difference in resampled sites, which was 17% or 10 fIBI units on a 60-point scale. The Illinois IBI has similar structural properties to the Ohio IBI (Ohio EPA 1987), which Fore et al. (1993) concluded reliably scales to six condition categories and, with sufficient numbers (>200) of fish in a sample, produces a variance of only +2 IBI units. Thus, using the five narrative condition categories defined by Smogor (2005) for the fIBI to provide a framework for deriving tiered stressor thresholds is appropriate.

4.1.3 The Central Role of Biological Response

Taken together, the structure of the indicators and parameters used in the systematic monitoring and assessment employed by DRSCW and LDRWC reflects the five factors that comprise the integrity of an aquatic resource: flow regime, chemical variables, biotic factors, energy source, and habitat structures (Karr et al. 1986; Figure 27). The aquatic biota, as measured via an IBI, integrate these five factors and serves as a composite of their combined effects in a river or stream. Hence, the biota contains multiple types of information in response to each of these factors and their subcomponents, including hundreds of chemical pollutants. This reinforces the primacy of using biological indicators to assess not only aquatic life use status, but also the causes and sources of impairments and the threats to attainment.

When stressors influence or impact one or more of these factors or their interactions, the aquatic biota responds predictably, as depicted in Figure 28, which also serves as an explicit model of causation (Karr and Yoder 2004). It establishes linkages between stressors (or drivers of ecosystem change) through the five major factors of water resource integrity (as each is altered by stressors) to the biological response produced by those interactions. The biological response is the endpoint of primary interest and is the focus of water quality management through protecting and restoring an aquatic life designated use. This model illustrates the multiple causes of water resource changes associated with human activities. The severity and extent of the biological response to these impacts are ultimately what is important, not the mere presence of an impact itself. The understanding of these interactions guides the selection of indicators and parameters for comprehensive monitoring programs that use biological endpoints for determining attainment and nonattainment status (Karr 1991).

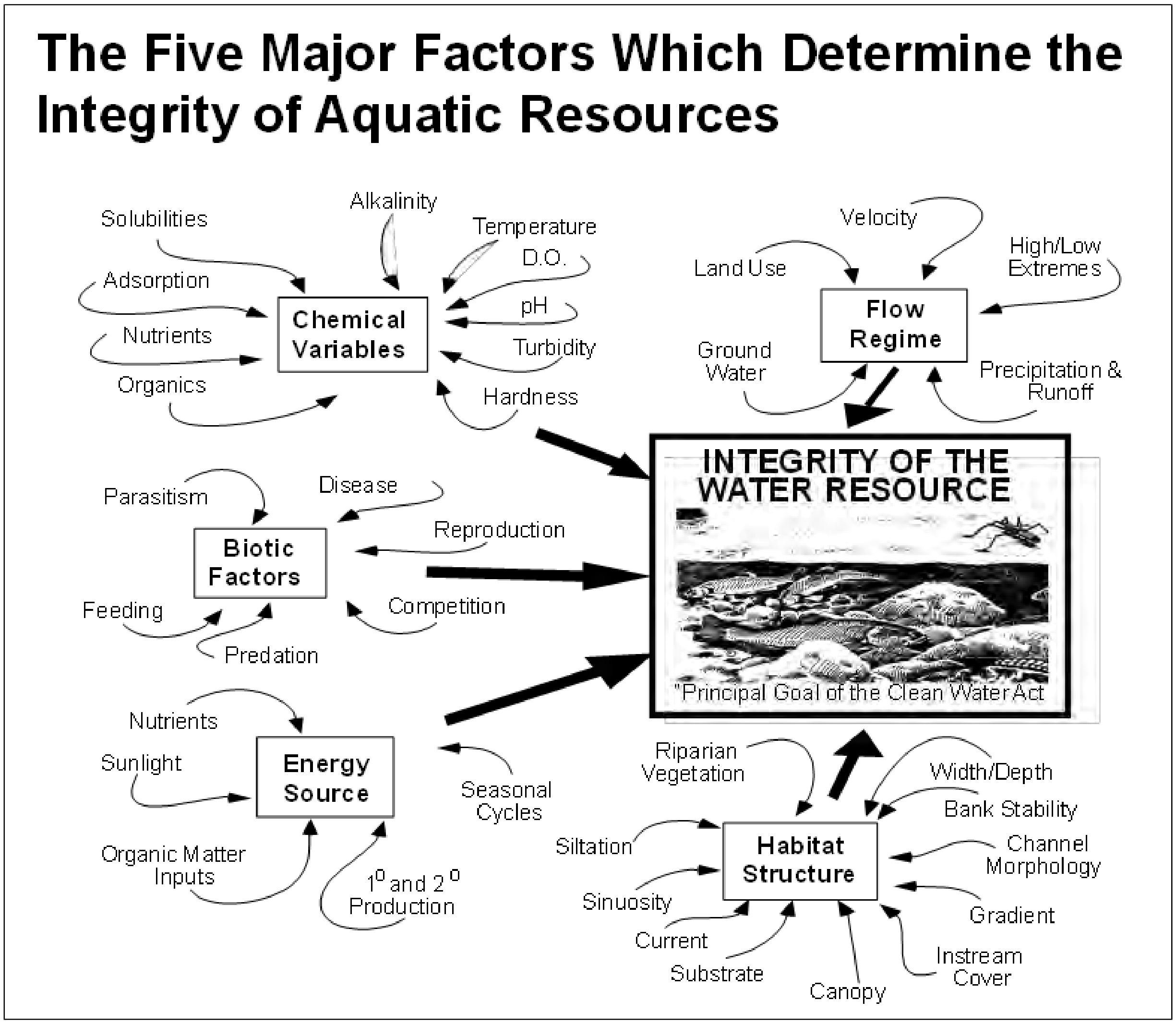


Figure 27. The five factors that comprise and determine the integrity of an aquatic resource (after Karr et al. 1986). Bioassessment serves as an integration of the five factors and a composite of their integration in an aquatic ecosystem.

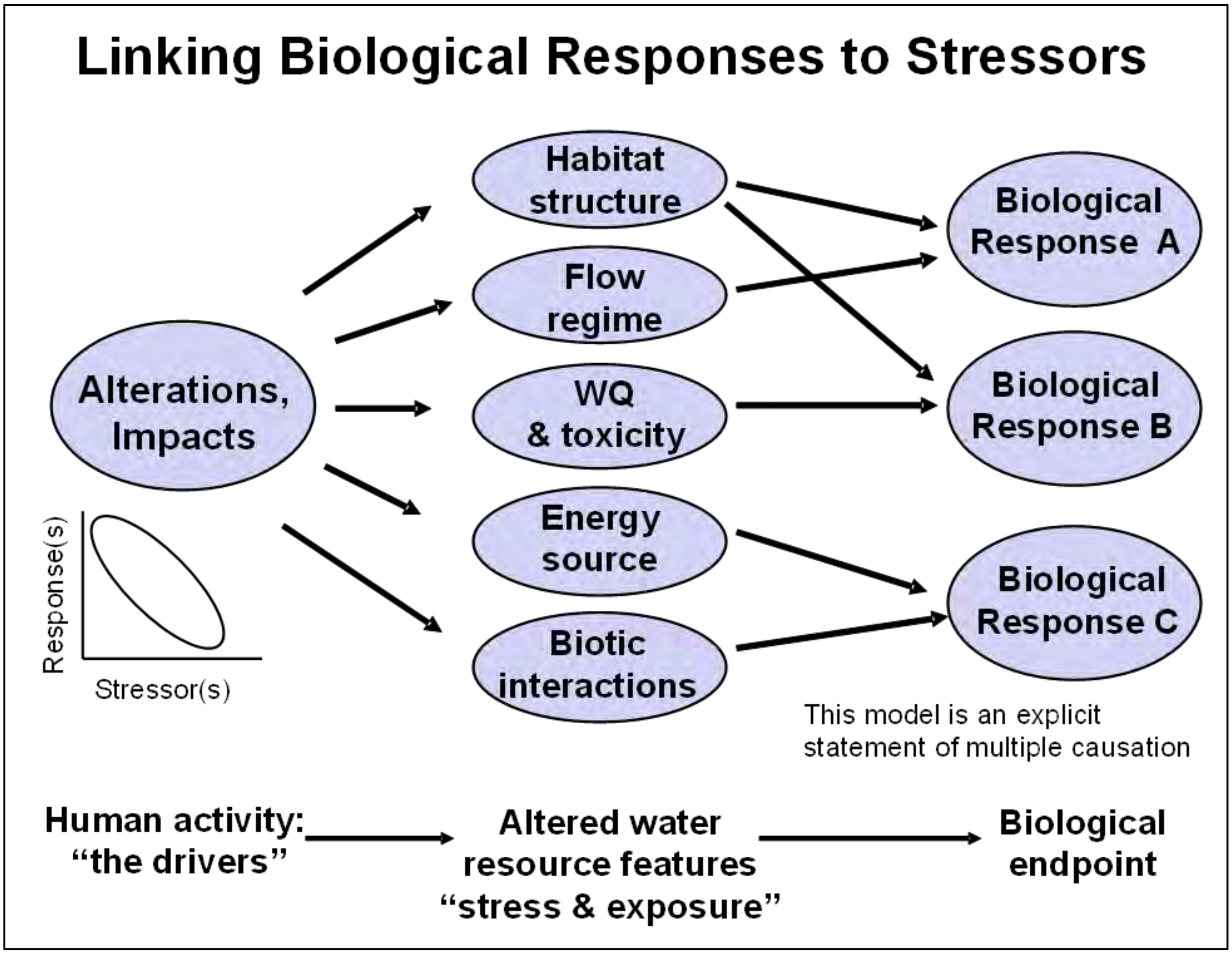


Figure 28. Linkages between stressors (or drivers of ecosystem change) through the five major factors of water resource integrity (as altered by stressors) to the biological responses produced by the interactions. The biological response is the endpoint of primary interest and is the focus of water quality management. The insert illustrates the relationship between stressor dose and the gradient of biological response that signals a good biological metric (modified from Karr and Yoder 2004).

Figure 29 illustrates two examples of the five factors linkage model to two common stressors in the DuPage and Salt Creek watersheds, urbanization and nutrient enrichment, which were two of the most limiting factors to aquatic life in the IPS study area (MBI 2023) (Section 1.3.2). Urban stressors included impervious cover and urban land use in the 500-meter spatial buffer and the HUC12 watershed scale; they were second only to the mean HUC12 QHEI in the battery of multivariate analyses and first in the univariate Species Sensitivity Distributions FIT score. Nutrients, mainly TP, ranked fourth in terms of the FIT score and as they affected DO in the multivariate analyses. By using the biological assemblage attributes (e.g., stressor-sensitive species and taxa) and IBIs, the IPS analyses directly linked General Use standard attainment for aquatic life to the most limiting stressors at the site, watershed, and HUC12 watershed scales. The IPS analysis provided insights about how to determine which of the five factors each contribute to the biological response to a given stressor category (such as urbanization or nutrient enrichment). These are illustrated in Figure 30 by the width of the arrows extending from each of the five factors to the biological response for that stressor category. Without the integrative capacity of the biota to respond to multiple stressors, the alternative would be limited to presumed outcomes based on single-dimension chemical surrogates that may or may not be real. Quite simply, using biological indicators as the endpoint of concern provides a reality check on such assumptions.

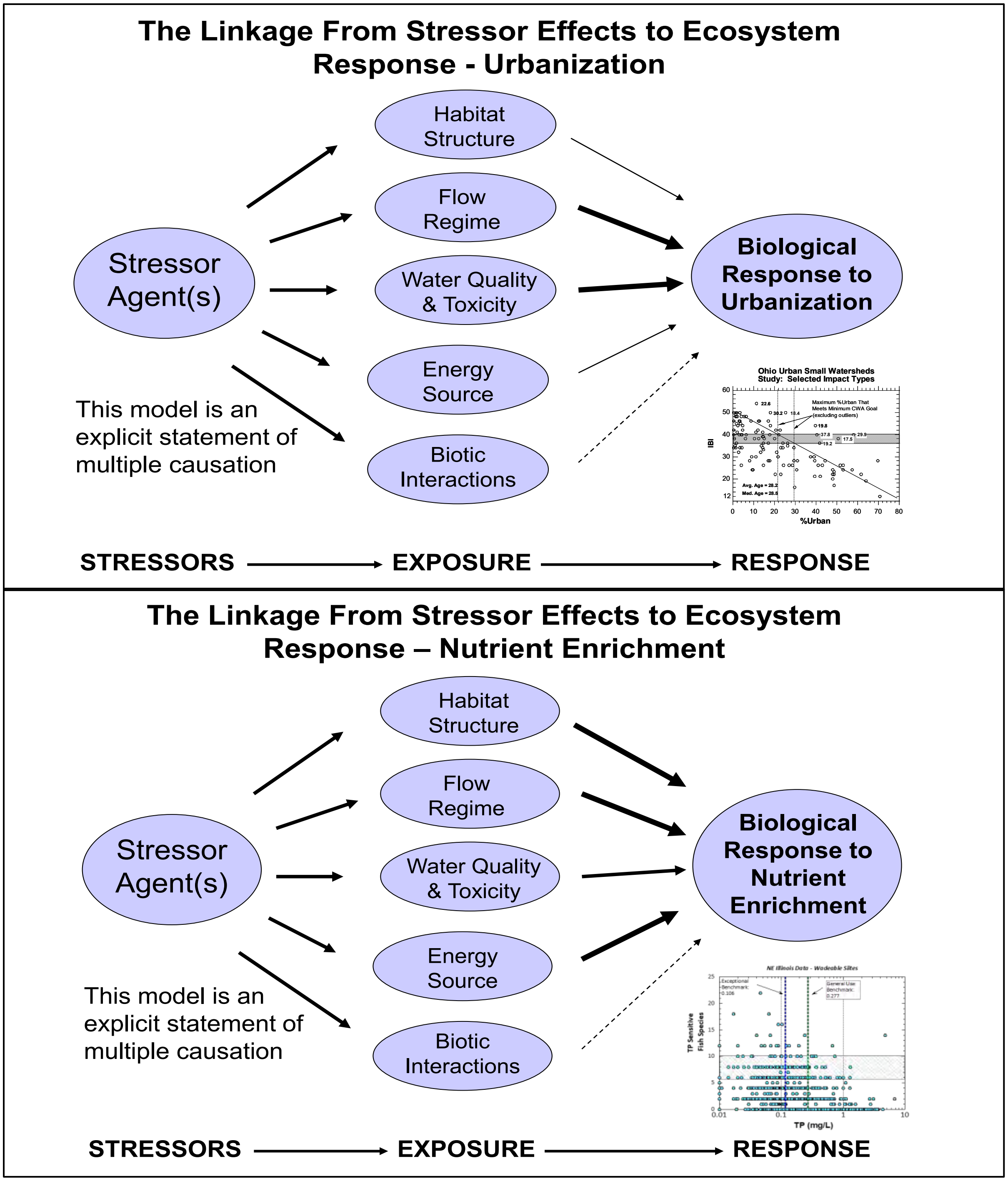


Figure 29. Two stressor linkage models show that the biological response will exhibit different stressor-specific characteristics. The response to watershed stressors common across NE Illinois, urbanization (upper) and nutrient enrichment (lower), are illustrated. The arrow thickness indicates the relative importance of that factor to the biological response.

5 NIP OBJECTIVES

An essential element of the NIP is the identification of a target threshold for TP which is protective of the desired objective. For the DRSCW and LDRWC, the principal objective is to create ambient conditions conducive to supporting aquatic biota that meet the Illinois General Use standard criteria for aquatic life (Section 2.1). Results from modeling the system (see Section 7.2) suggest that regional ambient DO concentrations are relatively unresponsive to instream TP changes at this magnitude, further supporting an approach that is centered around aquatic life.

The importance of identifying a protective instream TP concentration threshold is recognized by IEPA guidance after the DRSCW and LDRWC requirement for writing a NIP was included in their NPDES permits in 2015. IEPA guidance states that groups could either adopt the recommendations by the Nutrient Science Advisory Committee (NSAC 2018, see Section 2.4.2), or develop their own watershed-specific targets.

5.1 DERIVING A TP THRESHOLD PROTECTIVE OF AQUATIC LIFE

5.1.1 TP Threshold Derivation for Wadeable Streams

When the IPS Tool was most recently updated in 2023 (Section 1.3.2), the Tool's statistical analyses successfully derived a regionally specific instream TP concentration threshold for the adjacent DuPage River and Salt Creek watersheds. A central goal of the IPS Tool was the determination of numeric thresholds for stressors that can be protective of aquatic life, based on a robust suite of measured variables. In practice, the TP threshold identified herein for the DuPage/Salt wadeable streams is representative of quantifying attainment of the General Use standard waters criteria. The process of the TP threshold derivation process is illustrated in Figure 30 and detailed further below.

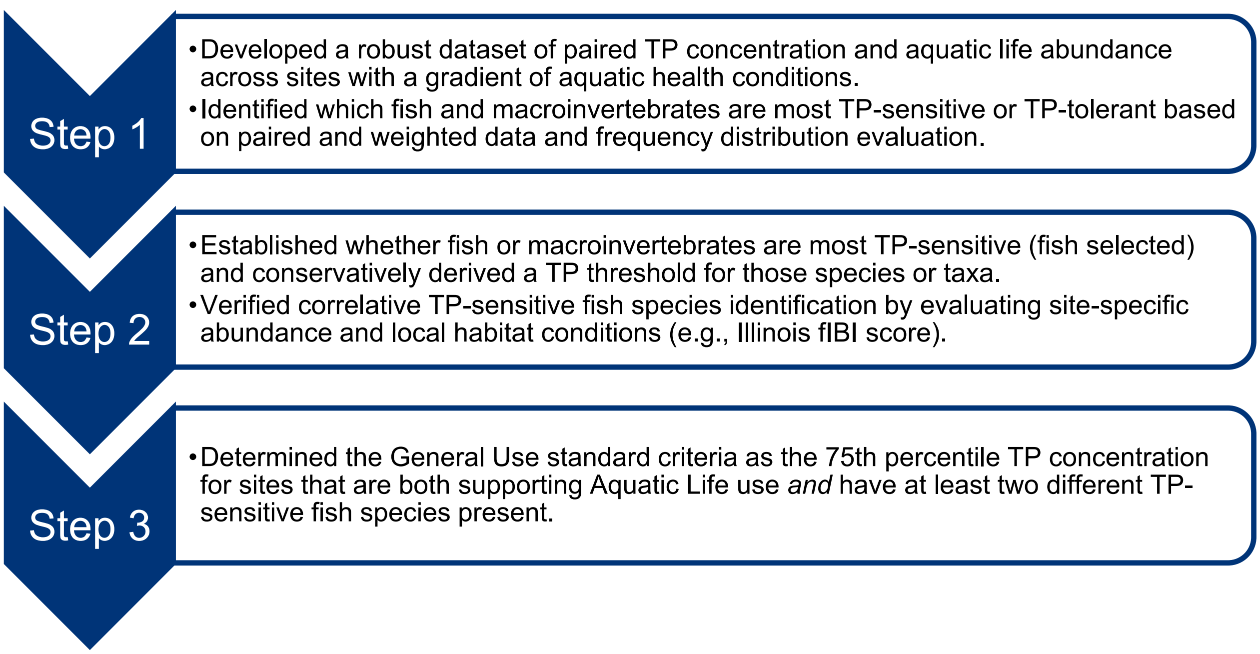


Figure 30. Simplified evaluation summary of the TP threshold derivation for DuPage/Salt wadeable streams.

The process of TP threshold derivation started with identifying the fish species and macroinvertebrate taxa that were most sensitive to TP concentrations. Each species or taxa was classified for its TP-sensitivity based on an evaluation of its occurrence and abundance relative to the paired ambient TP concentrations and assigned a weighted arithmetic mean TP concentration. Low weighted averages (low species/taxa abundance relative to TP concentrations) indicate that TP-sensitive aquatic life is frequently absent from high TP sites, with more frequent abundance at sites with low TP (relative to other species/taxa). The large dataset of paired aquatic life and TP concentrations was incorporated within the IPS Tool, allowing for a meaningful and robust correlative statistical analysis. Figure 31 illustrates the distribution of weighted mean TP concentrations for fish in wadeable streams based on IPS Tool data pairing, with the most and least TP-sensitive species emphasized. Various fish species and macroinvertebrates taxa were found to be sensitive to TP concentrations, with fish identified by the IPS Tool results having the most statistically significant TP-sensitivity of the two types of aquatic life. As a result, the TP threshold analysis was conducted conservatively along the TP concentration gradient for fish species to identify a threshold that is protective of both the fish species and the less-sensitive macroinvertebrates.

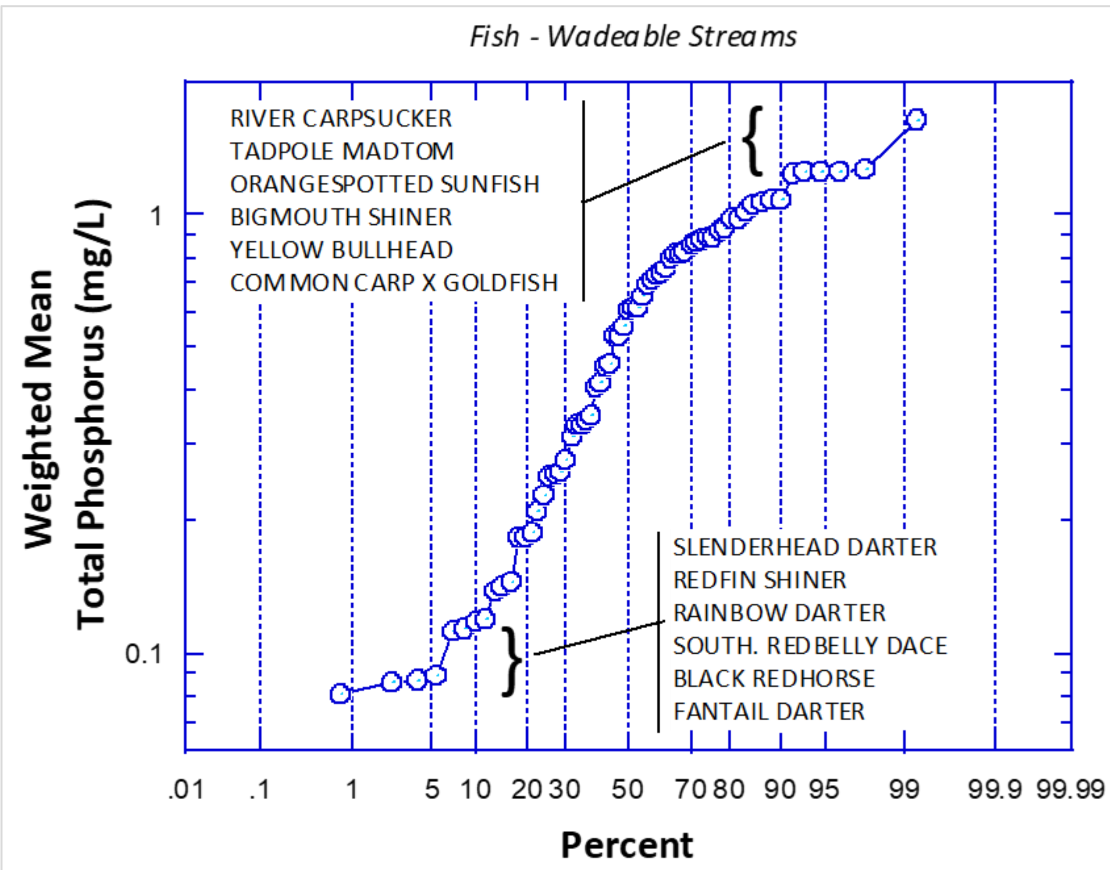


Figure 31. Field-data derived Species Sensitivity Distribution for fish species (most TP-sensitive and TP-tolerant species labeled), based on paired weighted mean TP concentrations as evaluated by the IPS Tool in northeastern Illinois.

After identifying the suite of TP-sensitive species, the occurrence of those species was linked back to the fIBI observation data for those same specific sampling locations to verify a strong positive correlation (Figure 32). As recommended in the *Nutrient Criteria Technical Guidance Manual: Rivers and Streams*, methods for examining potential relationships were conducted using frequency distribution approaches, focusing on the 25th and 75th percentiles of data (USEPA 2000). The 25th percentile of TP-sensitive fish species relative to fIBI was identified to be a count of at least two different species.

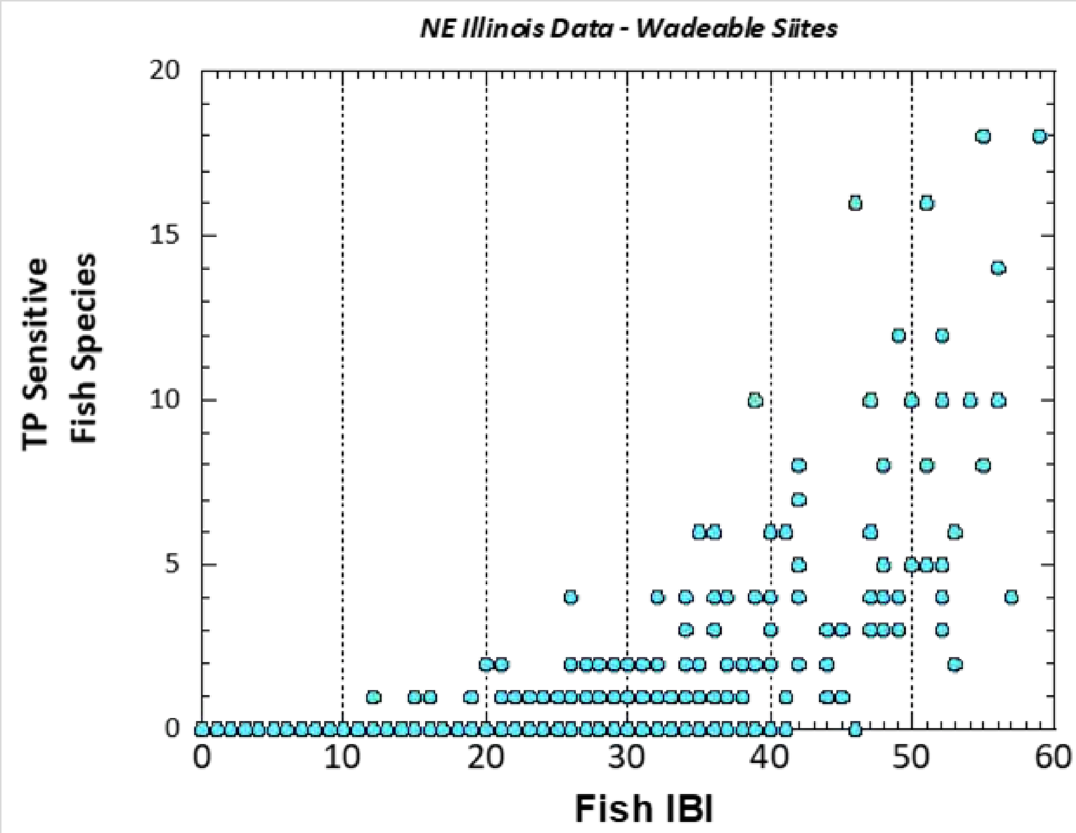


Figure 32. Scatterplot of observed TP-sensitive fish species abundance relative to fIBI scores in regional wadeable streams used as part of the derivation of the TP threshold support of the General Use standard.

Fully supporting sites (fIBI > 41) with at least two different TP-sensitive species found (25th percentile of species abundance per Figure 32) were placed in two groups (IBI 41–49 and 50–60) and were graphed on a probability plot (Figure 33). The TP threshold identified to reflect attainment of the General Use standard was then derived using the 75th percentile TP concentration at sampling sites, which support the Aquatic Life criteria (fIBI > 41) *and* have at least two different TP-sensitive fish species present (25th percentile of sensitive species abundance). This TP number for these sites was 0.277 mg/L; for exceptional sites, identified as those with IBIs scoring 50–60 and more than two sensitive species, the threshold was 0.1 mg/L.

For wadeable streams in NE Illinois, the General Use standard attainment threshold was identified to be 0.277 mg/L TP based on this evaluation.

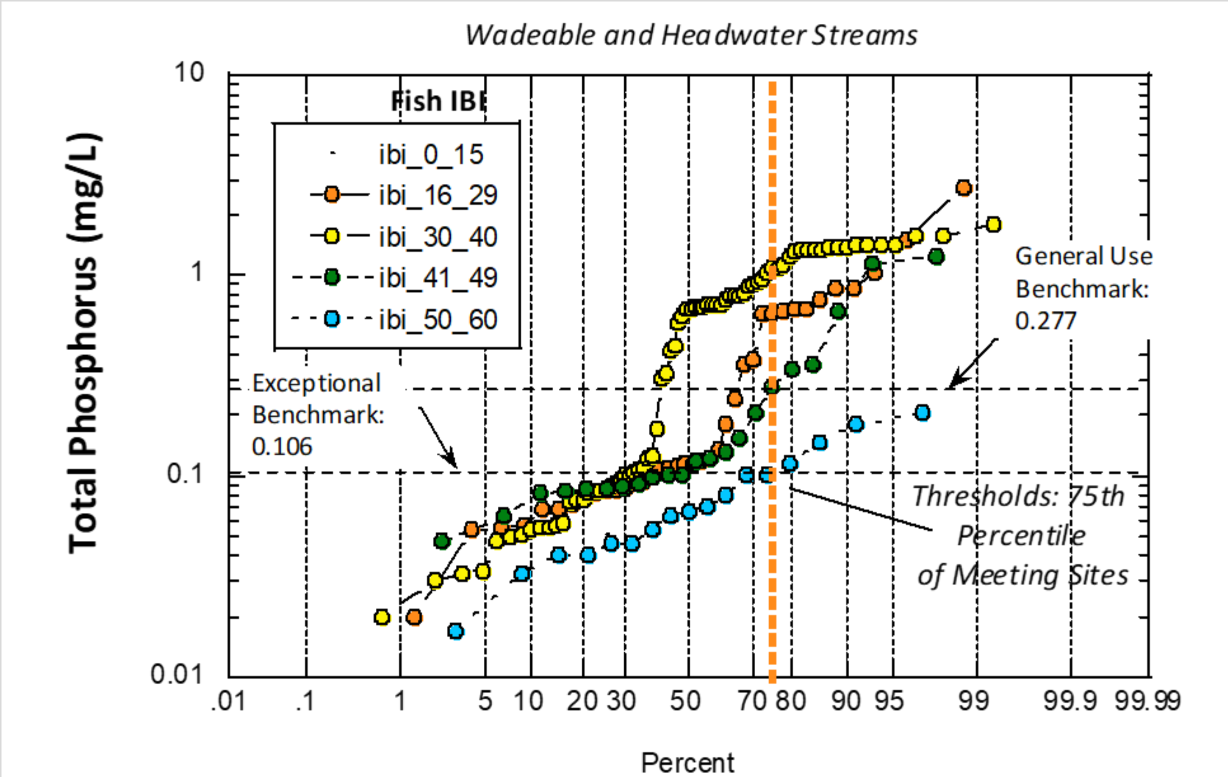


Figure 33. Probability plot of TP concentrations by narrative ranges of observed fIBI in regional wadeable streams used to identify the TP threshold supportive of General Use. The 75th percentile TP concentration associated with sites supporting good IBI (41–49) is clearly identifiable.

Using this same approach, an additionally informative subcategory (integrity class) of General Use standard attainment was derived to best characterize the observed relationship between TP and fIBI across a gradient of observed ranges. Figure 34 is a box-and-whisker plot showing the number of different TP-sensitive fish species observed relative to the range of observed fIBI values.

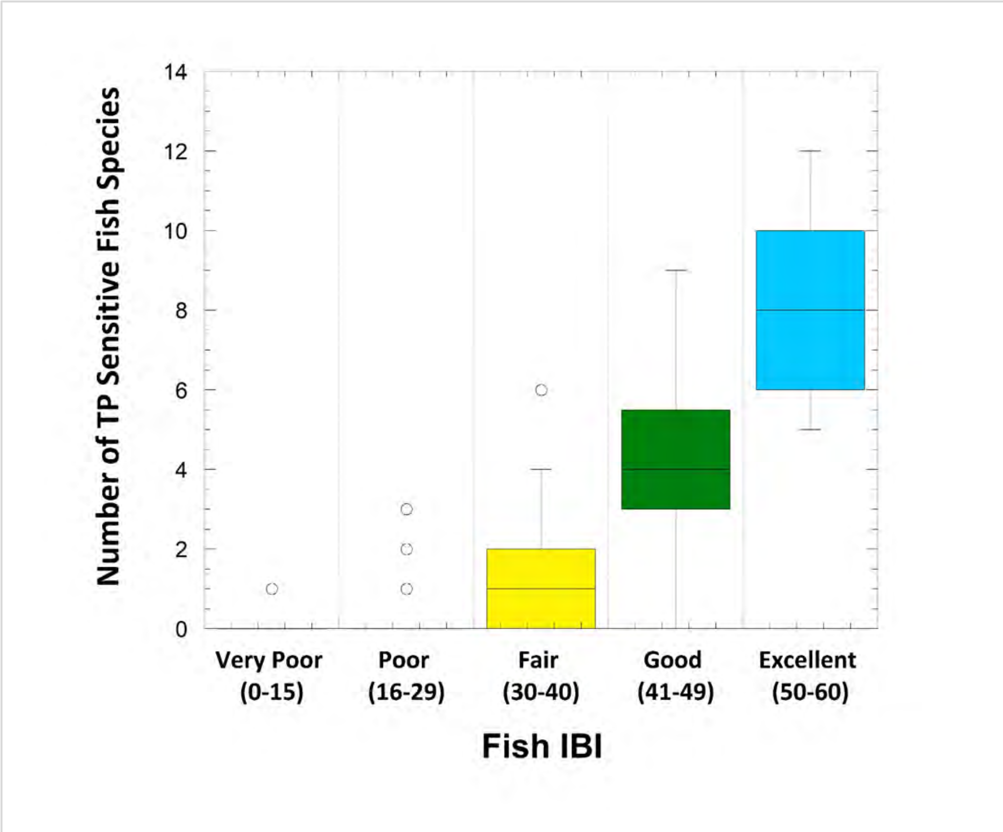


Figure 34. Box-and-whisker plot of TP-sensitive fish species abundance relative to site fIBI used in the northeast wadable streams Illinois IPS Tool.

This gradient includes General Use standard attainment integrity classes ranging (as IBI scores range) from Excellent, Good, Fair, Poor, to Very Poor, depending on the paired average of observed TP and fIBI:

- Excellent – Sites with more than two different TP-sensitive fish species present and fIBI score greater than 50. These sites provide “excellent” protective conditions for TP-sensitive fish species with a TP threshold of less than 0.11 mg/L TP (Figure 33 and Figure 34). These sites have the greatest number of different TP-sensitive species present and are fully supporting the General Use criteria.
- Good – Sites with at least two different TP-sensitive fish species present and an fIBI score of 41–49. These sites are the minimum protective conditions for TP-sensitive fish species, with a TP threshold less than 0.277 mg/L and are fully supporting the General Use standard.
- Fair – Sites with less than two different TP-sensitive fish species present and an fIBI score of 30–40. When fIBI scores fell below 30, no significant presence of TP-sensitive fish species was observed, so this classification does not support General Use standard attainment.
- Poor – Sites with less than two different TP-sensitive fish species present and an fIBI score of 16–29. This classification does not support General Use standard attainment.
- Very Poor – Sites with less than two different TP-sensitive fish species present and an fIBI score of less than 16. This classification does not support General Use standard attainment.

There is some natural variability and, therefore, uncertainty associated with these numeric thresholds, the magnitude of which can be evaluated by a calculation of FIT measuring the variability of relationships. For the relationship between TP and fIBI, the FIT score was relatively strong, indicating few sites have attaining fIBI scores paired with *high* TP concentrations, such that most sites with high TP concentrations show some level of aquatic life impairment.

5.1.2 Proposed Application of TP Threshold Results

The mean TP concentration range of 0.11–0.277 mg/L was determined to be conservatively protective of aquatic communities that meet the Illinois General Use standard. Because the threshold was derived to be protective based on fIBI (because fish species were observed to be more TP-sensitive than macroinvertebrates), the threshold will also be protective of the less TP-sensitive mIBI. The IPS Tool results also indicate that as TP concentrations fall even lower than 0.277 mg/L, aquatic life protections continue to improve, allowing for increases in both TP-sensitive species abundance and fIBI scores (see Table 30).

One critical finding of the IPS Tool evaluation was that no analyzed stream segments were identified as having TP concentrations as the exclusive limiting factor for aquatic life (see Section 1.3.2). The urban stream sites evaluated were found to be limited by multiple stressors (e.g., sediment metals, habitat, siltation, chloride); therefore, TP concentration reductions alone will not be sufficient to restore General Use standard attainment. The FIT scoring shown in Table 13 in Section 1.3.2 showed that habitat (general QHEI and its component pieces) plays the dominant role in limiting stream biology. To that end, this NIP recommends continued investments in improving QHEI in conjunction with instream TP reductions.

Additionally, this NIP recommends that subsequent monitoring data be used to refine and update thresholds to improve confidence in statistical relationships and reduce impacts from potentially confounding variables or covariance between metrics (e.g., habitat-related criteria).

Table 30. Paired thresholds for General Use standard attainment as derived by IPS Tool evaluation of TP concentrations and fIBI categories

IPS-Derived Threshold Parameters	General Use Standard Attainment Integrity Classes					Reference Median (IQR) N=35
	Very Poor	Poor	Fair	Good (General Use)	Excellent	
TP (mg/L)	> 1.74	1.01–1.74	0.277–1.01	**0.106–0.277**	≤ 0.106	0.088 (0.062–0.115)
fIBI (unitless)	< 16	16–29	30–39	**41–49**	> 50	N/A

Note: The green highlighted area represents Illinois General Use standard for aquatic life attainment and the target TP concentration range for ambient conditions applicable to this NIP.

5.1.3 Peer Review of Derivation of the TP Threshold

The DRSCW and LDRWC retained engineering consulting firm Kieser & Associates to conduct an independent peer review of the updated IPS Tool developed by MBI. The peer review was conducted to evaluate the scientific aspects of the tool in relation to its ability to develop nutrient thresholds, including TP, for wadeable streams in NE Illinois. Kieser & Associates determined that the IPS Tool is a useful, science-based approach for modeling stream ecosystem impacts to better inform management actions targeting restoration and protection of aquatic life in these surface waters. Strengths of the tool identified included the use of multiple years of field data on multiple biological and stressor variables in model development, as well as the systematic evaluation of relationships among those variables to assign potential causality. Additionally, the tool framework resembles other relative risk assessment approaches published in peer-reviewed literature to date. Stressor thresholds contribute to a weight-of-evidence approach for assessing the likely influence of each stressor of interest. The derived threshold for TP (0.11–0.277 mg/L), which was identified to be likely protective of aquatic communities that meet the Illinois General Use standard, was found to be reasonable.

Kieser & Associates identified areas of potential concern with respect to its ability to characterize nutrient-related stress during their peer review. These include the following:

- The lack of data on algal metrics and/or their surrogates (e.g., continuous DO data) limits the ability of the IPS Tool to assess impairments caused or threatened by nutrients.
- The use of the Species Sensitivity Distribution approach based on field data is relatively new.
- A more thorough description of the correlation between potential stressors is needed to maximize weight-of-evidence support.
- The dominance of habitat degradation in the IPS Tool evaluation as a macroinvertebrate and fish community stressor may limit the tool's sensitivity to nutrient impacts.

The peer review also identified several additional areas for potential future data collection or research that could improve the support for, and transparency of, the IPS Tool output for nutrient assessment and management decision-making:

- Including primary productivity metrics (e.g., algal abundance, chlorophyll-*a*) as a biological endpoint for impact evaluation.
- The weight-of-evidence approach would benefit from a more detailed description of the expected nutrient impact mechanisms that account for observed patterns of fish and macroinvertebrate taxa presence or absence.
- Additional model validation using existing data and/or data collected in the future could further quantify the predictive performance of the IPS Tool related to nutrient impacts and risks.

6 EXISTING PHOSPHORUS CONDITIONS AND SOURCES

To determine the best potential opportunities to decrease TP concentrations instream, it is critical to evaluate TP contributions by source. For each of the watersheds, TP source loading was evaluated for a specific calendar year related to the year of simulation for the QUAL2Kw modeling detailed further in Section 5.0.

The DuPage River and Salt Creek watersheds produce approximately 1,441,257 pounds (lbs) (653,743 kilograms [kg]) of TP annually with 482,053 lbs (218,656 kg) attributed to Salt Creek and 959,204 lbs (435,087 kg) attributed to the DuPage River basin (Section 6.1). Because the instream TP threshold concentration is the basis for the majority of analyses, the source contributions are generally expressed in that form (TP concentrations as opposed to TP loads). The primary data source used for analyzing existing instream TP conditions and sources was the basinwide biological monitoring studies (bioassessments) carried out by the DRSCW and LDRWC over the last 16 years. A detailed summary of the DRSCW and LDRWC bioassessment program is in Section 1.2.1.1.

Another important data source used for the source analysis was the individual WWTP effluent discharge data supplied by the WWTPs and their IEPA filings, called DMRs. WWTP permits issued after calendar year 2015 included the following phosphorus-specific condition in their permits:

> *"The Permittee shall monitor the wastewater effluent, consistent with the monitoring requirements on Page 2 and 4 of this permit, for total phosphorus, dissolved phosphorus, nitrate/nitrite, total Kjeldahl nitrogen (TKN), ammonia, total nitrogen (calculated), alkalinity and temperature at least once a month" (emphasis added).*

This section of the NIP presents the existing TP conditions instream, a tabulation of TP source attribution, and ongoing implementation efforts to reduce TP from various WWTPs.

6.1 INSTREAM PHOSPHOROUS CONDITIONS

The mean ambient mainstem TP concentrations summarized here were derived from bioassessment program data collected from 2006 to 2021 (Figure 35, Figure 36, and Figure 37). Existing ambient phosphorus conditions along the mainstems of the West and East Branches of the DuPage River and Salt Creek have observably similar longitudinal patterns, where TP concentrations are highest near the headwaters immediately downstream of the first-discharging (most-upstream) WWTP. Where flows are low in the headwater reaches, the potential dilution of waste flows from background instream flows is the lowest. Concentrations gradually decline with the distance downstream of the initial WWTP discharge as background flows increase. This pattern is most clearly visible along Salt Creek, where the upper quarter of the basin includes no WWTP discharges (Figure 37). Observed TP concentrations along Salt Creek upstream of the first WWTP (Egan Water Reclamation Plant [WRP]; IL0036340) range from 0.1 mg/L to 0.2 mg/L, followed by a downstream spike ranging from 1.5 to 2.0 mg/L. These observed TP concentration patterns suggest that instream dilution of concentrated TP in wastewater by stormwater and background sources like tributaries plays an important role in determining ambient TP conditions instream. This is further reinforced by the water balance for all three waterways, where point sources contribute approximately 25% of the total streamflow volume relative to urban (non-WWTP) sources, which contribute 75% of the total flow (Section 6.2).

A somewhat different geographical TP pattern is observed on the Lower DuPage River (Figure 38). This system receives headwater flow from the East and West Branches of the DuPage River, which include large contributions of both point sources and urban background sources. The effect of this condition from the upper waterways effectively smooths out the TP concentration spike of the most upstream WWTP input to the Lower DuPage River (Naperville-Springbrook Water Reclamation Center, the largest WWTP on the Lower DuPage) due to dilution. The general pattern of ambient TP concentrations declining towards the outlet due to increased dilution from urban (non-WWTP) sources is also observed for the Lower DuPage River.

During all years for all basin assessments, observed instream TP concentrations on all four mainstem waterways exceeded the watershed TP threshold of 0.277 mg/L (solid dark line in Figure 35 – Figure 38), as identified in Section 5.1.

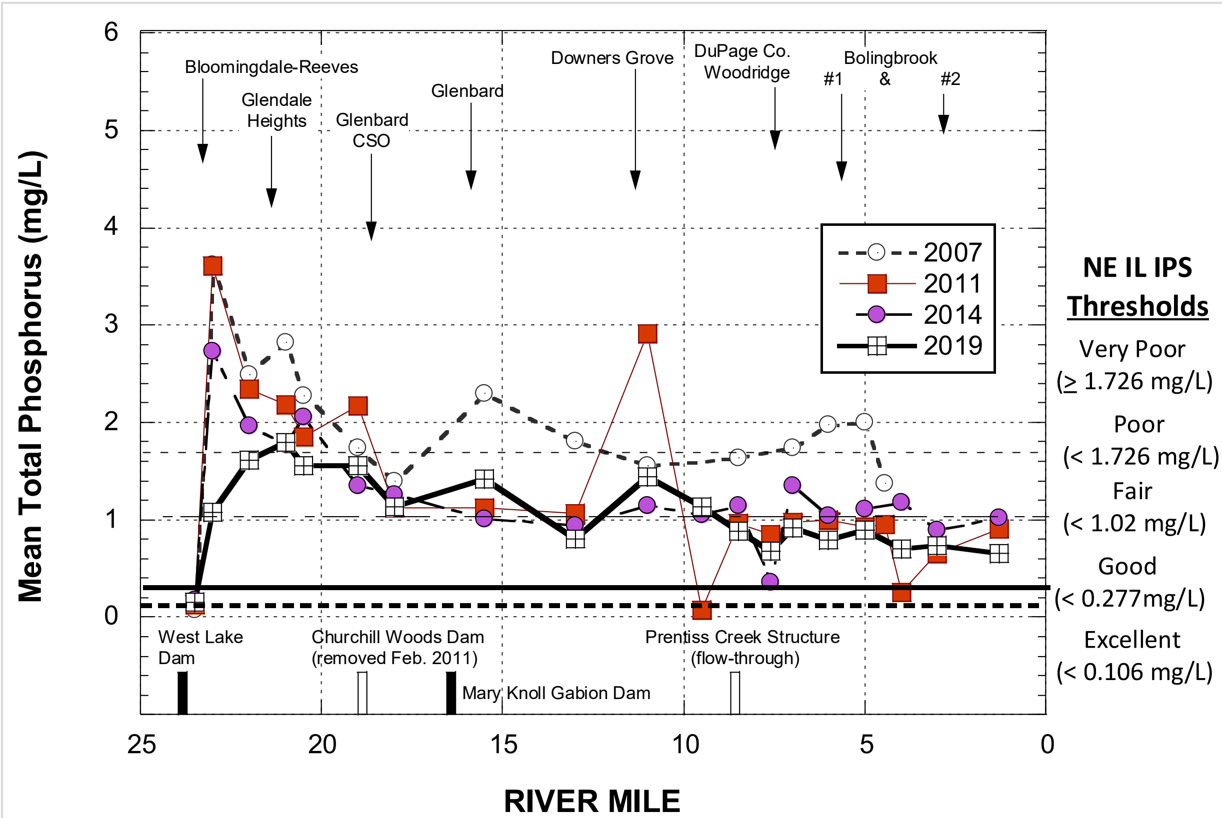


Figure 35. East Branch DuPage River mean instream TP concentrations for Basin Assessment years 2007, 2011, 2014, and 2019.

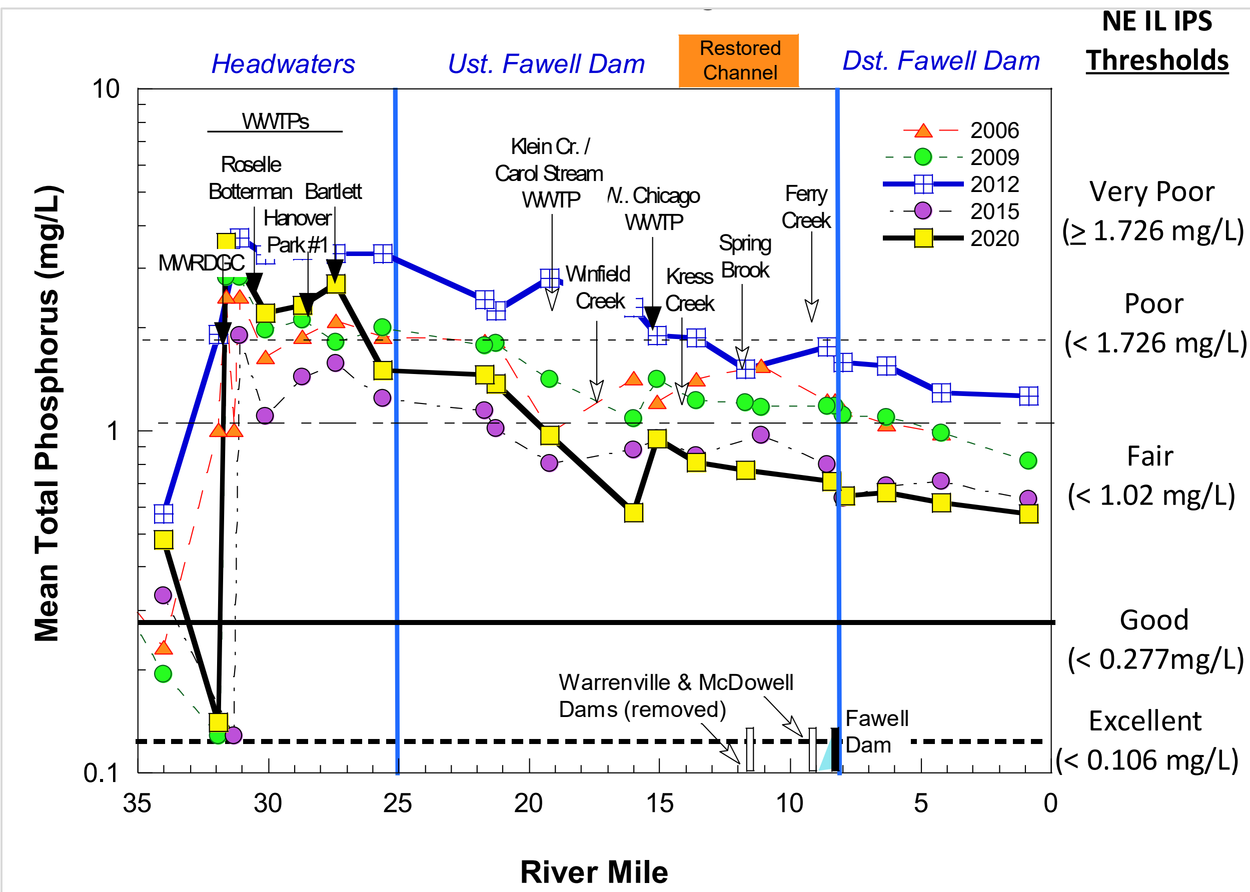


Figure 36. West Branch DuPage River mean instream TP concentrations for Basin Assessment years 2006, 2009, 2012, 2015, and 2020.

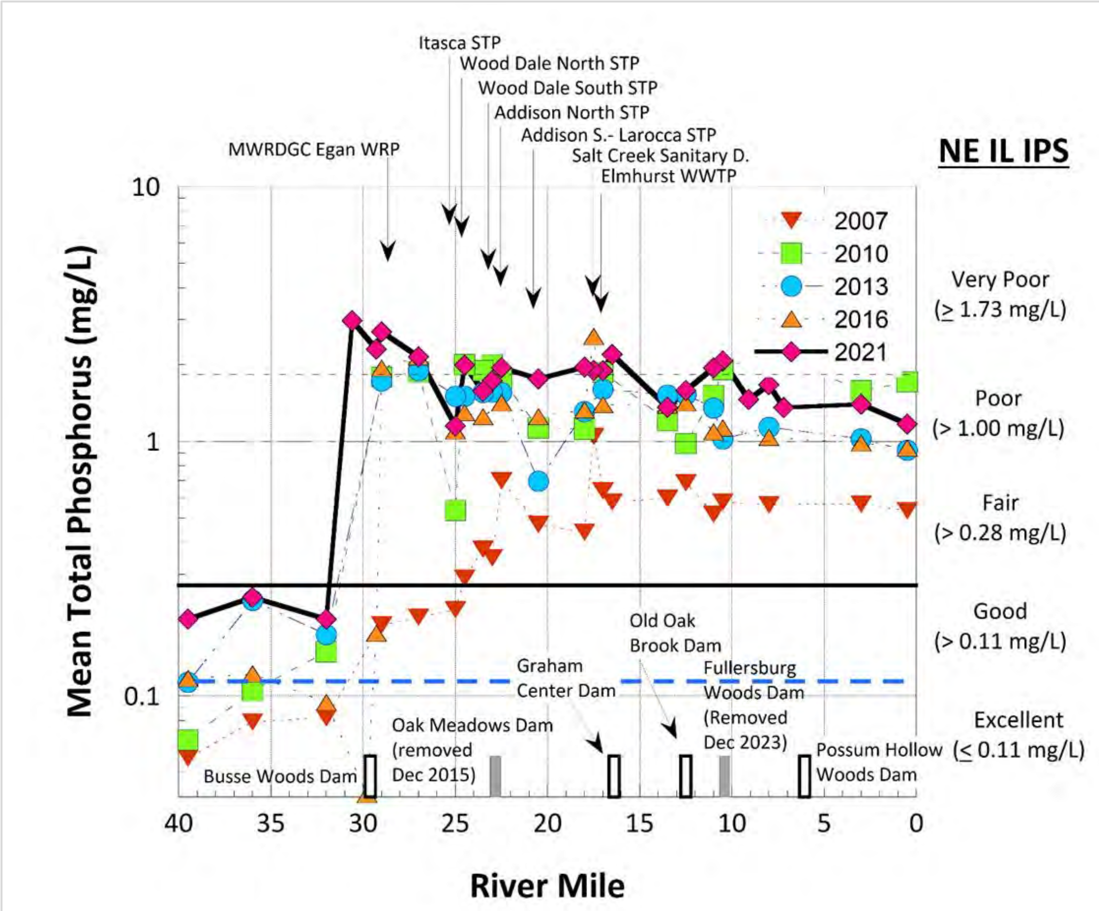


Figure 37. Salt Creek mean instream TP concentrations for Basin Assessment years 2007, 2010, 2013, 2016, and 2021.

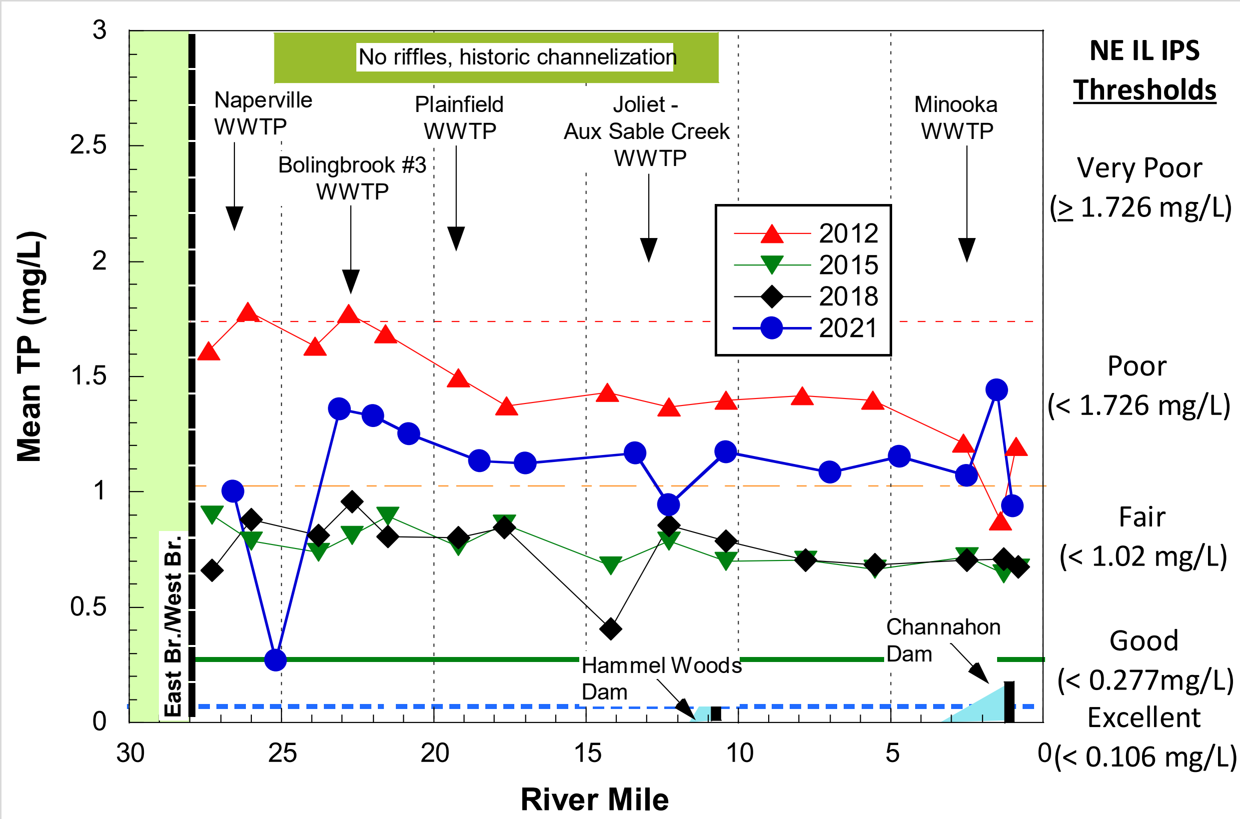


Figure 38. Lower DuPage River mean instream TP concentrations from Basin Assessment years 2012, 2015, 2018, and 2021 (downstream of the East and West Branches of the DuPage River).

During the 2007 assessment on Salt Creek, the typically observed pattern of higher TP concentration downstream of the Egan WRP at river mile 29 was absent (Figure 37). This was due to a temporary demonstration project conducted at the Egan WRP from February 5, 2007, to December 23, 2008, when the plant operated to achieve an effluent TP limit of 0.50 mg/L via chemical addition. During the 2007 basin assessment period (June to September), the WWTP discharge mean effluent concentration was 0.51 mg/L TP, compared to more typical effluent TP concentrations of 4.27 mg/L (for 2006, Zhang et al. 2010 and MWRDGC-supplied data). This TP reduction at the Egan WRP, which typically supplies over 50% of total WWTP effluent discharged to the Salt Creek basin, resulted in an observable decrease in TP concentrations downstream of the plant, from 1–2 mg/L in the no-action years to 0.2–0.3 mg/L during the project year. The impacts of the reduction were observed all the way to the mouth of the river (Figure 37). While temporary, this demonstration project clearly illustrates the potential for reductions in TP effluent concentrations to influence mainstem ambient TP concentrations.

The year-to-year variations from 2007 to 2022 in the mainstem TP concentrations (with the exception of 2007 for Salt Creek due to the Egan WRP demonstration project) exhibit an inverse relationship with streamflow. For example, the highest TP concentrations in the West Branch DuPage River were observed in 2012, the same year that the waterway experienced the lowest mean flows of all the assessment years. The lowest concentrations in the West Branch were observed for calendar years 2015 and 2020, which were the two assessment years with the highest annual flows.

Table 31 lists the mean annual flow for each basin for 2000–2021 and the mean TP concentrations for mainstem and tributary monitoring sites for the assessment years. Additional flow statistics for 2000–2021 are shown in Table 32. Mainstem TP concentrations fall in all mainstem data sets as flows increase. As

Table 31 shows, the same inverse relationship exists in tributaries except for the West Branch, whose tributaries show a modest increase in TP concentrations at higher flows.

With the exception of Salt Creek during 2007 due to the Egan WRP demonstration project, tributaries consistently had lower TP concentrations than mainstems (Figure 39). Figure 40 through Figure 43 show the distribution of TP concentrations for all mainstem and tributary sites for each basin for all assessment years. For the various assessment year periods, mean TP concentrations for all the waterways ranged from 0.078–0.94 mg/L for tributaries and 0.90–1.29 mg/L for mainstems (Table 31). The increased concentrations in the mainstems are due to their relatively higher contribution from WWTP effluent flows. Table 32 shows mean TP concentrations for tributaries and mainstems by mean annual flow, demonstrating again the variation between the two classes of sites and the impact of annual flow levels on ambient TP concentrations.

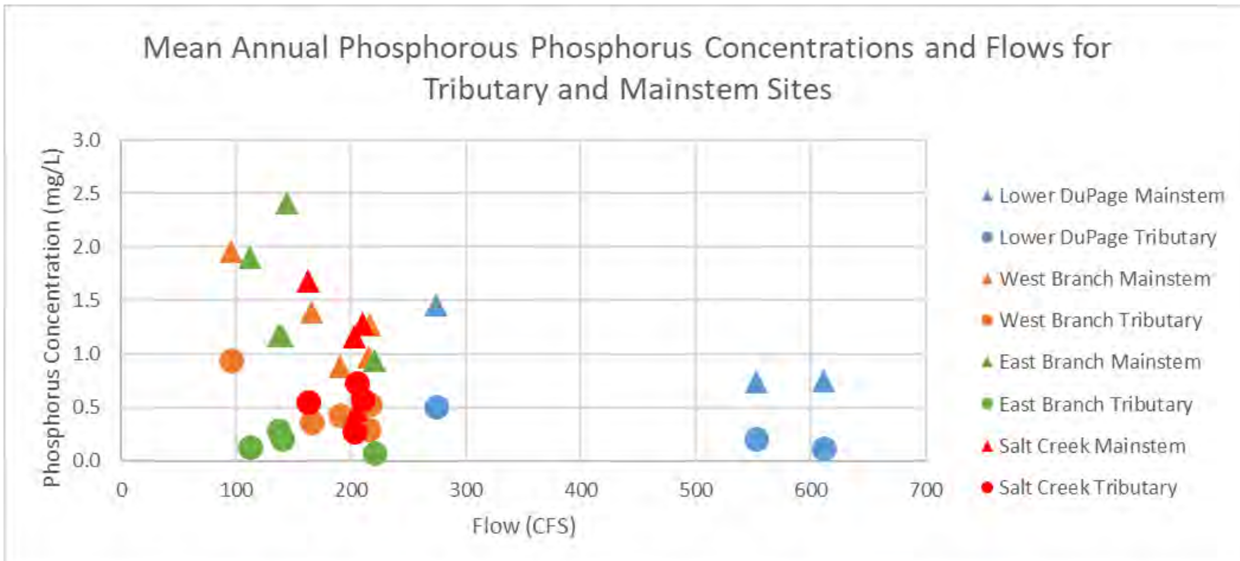


Figure 39. Mean annual TP concentrations for mainstem and tributary sites relative to streamflow for each basin assessment year by watershed.

Table 31. Mean annual flow (cfs) and mean annual phosphorus concentrations[1] (mg/L) for mainstem river sites (mainstem) and tributary river sites (tributaries) in the East Branch, West Branch, and Lower DuPage rivers and in Salt Creek

	East Branch DuPage River			West Branch DuPage River			Salt Creek			Lower DuPage River		
Year	Flow	Mainstem TP	Tributary TP	Flow	Mainstem TP	Tributary TP	Flow	Mainstem TP	Tributary TP	Flow	Mainstem TP	Tributary TP
2000	101	-	-	126	-	-	169	-	-	389	-	-
2001	124	-	-	207	-	-	223	-	-	491	-	-
2002	99	-	-	151	-	-	180	-	-	387	-	-
2003	92	-	-	117	-	-	161	-	-	349	-	-
2004	99	-	-	135	-	-	164	-	-	394	-	-
2005	80	-	-	96	-	-	119	-	-	309	-	-
2006	122	-	-	166	1.40	0.36	209	-	-	487	-	-
2007	111	1.90	0.14	175	-	-	204	0.47	0.72	475	-	-
2008	153	-	-	242	-	-	257	-	-	666	-	-
2009	154	-	-	216	1.28	0.53	260	-	-	679	-	-
2010	140	-	-	192	-	-	207	-	-	553	-	-
2011	140	1.17	0.21	210	-	-	235	-	-	612	-	-
2012	73	-	-	95	1.96	0.94	119	-	-	273	1.46	0.51
2013	144	-	-	194	-	-	210	1.28	0.58	539	-	-
2014	137	1.18	0.29	182	-	-	206	-	-	536	-	-
2015	137	-	-	190	0.88	0.43	218	-	-	552	0.74	0.21
2016	135	-	-	175	-	-	202	1.16	0.28	538	-	-
2017	165	-	-	213	-	-	249	-	-	651	-	-
2018	161	-	-	220	-	-	292	-	-	611	0.75	0.12
2019	220	0.94	0.07	287	-	-	331	-	-	836	-	-
2020	161	-	-	215	0.98	0.30	243	-	-	568	-	-
2021	103	-	-	119	-	-	162	1.68	0.55	368	-	-
TP Statistics:	MAINSTEM Mean: 1.22 Median: 1.00 Samples: 719		TRIBUTARY Mean: 0.18 Median: 0.10 Samples: 222	MAINSTEM Mean: 1.29 Median: 1.16 Samples: 965		TRIBUTARY Mean: 0.50 Median: 0.13 Samples: 353	MAINSTEM Mean: 1.20 Median: 1.04 Samples: 721		TRIBUTARY Mean: 0.52 Median: 0.21 Samples: 393	MAINSTEM Mean: 0.90 Median: 0.89 Samples: 397		TRIBUTARY Mean: 0.25 Median: 0.08 Samples: 204

[1] Deviation above the watershed threshold of 0.28 mg/L TP is denoted by color: red (result > 0.28 + 0.50 mg/L) and orange (result 0.28 + 0.01 to 0.28 + 0.50 mg/L).

Table 32. Annual flow statistics 2000–2022 at the most-downstream USGS gage for each waterway

Flow Statistic	Lower DuPage	West Branch	East Branch	Salt Creek
USGS Gage	**05540500**	**05540130**	**05540250**	**05531500**
Minimum (cfs)	273	95	73	119
25th Percentile (cfs)	392	143	102	175
Median (cfs)	536	182	135	207
Average (cfs)	513	178	130	210
75th Percentile (cfs)	590	212	148	239
Maximum (cfs)	836	287	220	331
Model Year	2018	2020	2019	2016
Model Year Flow	611	215	220	202
Model Year Flow Statistic	75th Percentile	~75th Percentile	Maximum	Median

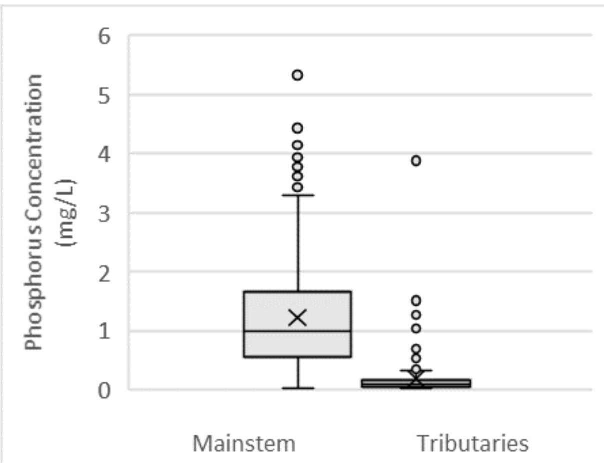


Figure 40. Box plots of TP concentrations in the mainstem and tributaries of the East Branch DuPage River during 2007–2019.

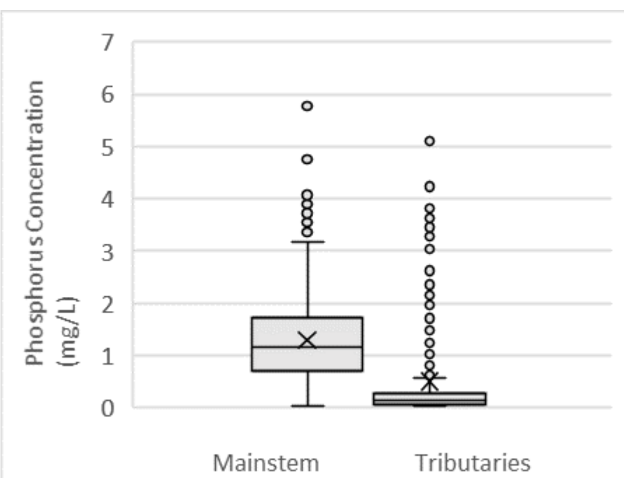


Figure 41. Box plots of TP concentrations in the mainstem and tributaries of the West Branch DuPage River during 2006–2020.

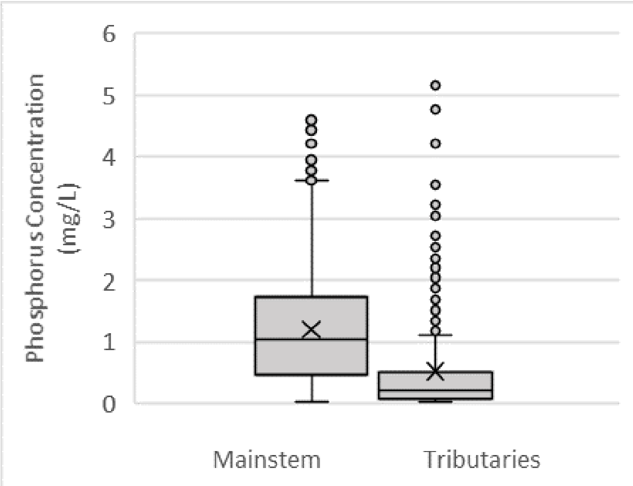


Figure 42. Box plots of TP concentrations in the mainstem and tributaries of Salt Creek during 2007–2021.

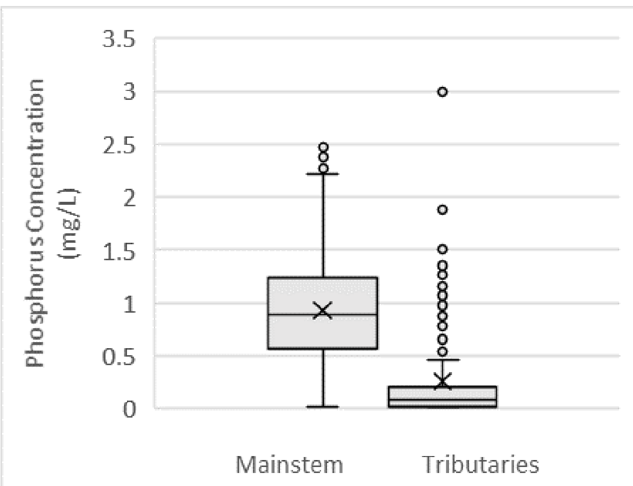


Figure 43. Box plots of TP concentrations in the mainstem and tributaries of the Lower DuPage River during 2012–2018.

6.2 TOTAL PHOSPHORUS SOURCES

To understand these systems better, it is valuable to not only to visualize instream TP concentrations spatially across the watershed (Figure 44), but also to explicitly compare instream TP concentrations from mainstem sites and tributary sites but also to further parse the data between monitoring locations that are influenced by wastewater (downstream of a WWTP outfall) and those not influenced by wastewater (these urban sites are a product of background and MS4 flows only). This data evaluation reveals a marked difference between these two types of sites, emphasizing the impact of WWTPs on instream TP concentrations. Table 33 shows the mean TP concentrations for urban sites and WWTP-influenced sites paired with annual mean flow data for each basin by year. Mean TP concentrations at sites across all watersheds downstream of WWTPs range from 0.71 mg/L to 2.12 mg/L, while sites not influenced by WWTPs experience TP concentrations nearly an order of magnitude lower, 0.03 mg/L to 0.53 mg/L (Figure 45).

Comparing the previous information from Section 6.1 of TP differences on mainstems and tributaries (Table 31 and box plots Figure 40 through Figure 43) and this Section 6.2 on differences impacted by WWTPs or not (Table 33 and box plots Figure 46 through Figure 49), the differences in magnitude of the various phosphorus sources become more clearly defined. Tributary sites reasonably approximate urban sources, and the dominance of WWTP inputs becomes even more apparent when sites influenced by them are isolated. Viewing the annual means for the two sets of sites by year (Table 32), in total aggregate (box plots Figure 46 through Figure 48 and Table 33) or geographically (Figure 44) demonstrates that waters downstream of WWTPs outfalls have a TP concentration significantly above the watershed threshold of 0.28 mg/L in all years.

In contrast, the inverse is observed at urban sites, with all years except two had annual mean concentrations below the threshold. Only West Branch DuPage River 2012 and Salt Creek 2021 had mean concentrations above the threshold (0.33 mg/L and 0.53 mg/L, respectively) at the urban sites. For the West Branch, this was 95 cfs—the lowest flow observed in the 21-year period examined for this NIP. On Salt Creek, the flow of 162 cfs was the lowest in the period that coincided with an assessment year; lower flows were observed in 2003 (161 cfs) and 2012 (119 cfs), but flows in 2021 were still comfortably below the 25th percentile flow for the basin (Table 32). Similarly, 2012 was also the lowest flow year in the Lower DuPage River (273 cfs), but the urban TP concentrations were comfortably below the watershed threshold at 0.21 mg/L.

This analysis suggests that the watershed threshold is invariably exceeded downstream of WWTPs but is met in sites with only urban flow as long as the flow rate is above the 25th percentile of flows set out in Table 32. This suggests that meeting the threshold will rely on reductions at WWTPs.

When trying to interpret the potential impacts of TP on aquatic life, it is important to explore both the mass of TP loading from various sources and how TP concentrations vary spatially across the watersheds. The pattern of increasing TP concentrations downstream of WWTPs on both the mainstems and tributaries is evident in Section 6.1.

Table 33. Mean annual flow (cfs) and mean annual phosphorus concentrations[1] (mg/L) for sites not impacted by WWTPs (urban) and impacted by WWTPs (WWTP) throughout the East Branch, West Branch, and Lower DuPage rivers and Salt Creek

	East Branch DuPage River			West Branch DuPage River			Salt Creek			Lower DuPage River		
Year	Flow	Urban TP	WWTP TP	Flow	Urban TP	WWTP TP	Flow	Urban TP	WWTP TP	Flow	Urban TP	WWTP TP
2000	101	-	-	126	-	-	169	-	-	389	-	-
2001	124	-	-	207	-	-	223	-	-	491	-	-
2002	99	-	-	151	-	-	180	-	-	387	-	-
2003	92	-	-	117	-	-	161	-	-	349	-	-
2004	99	-	-	135	-	-	164	-	-	394	-	-
2005	80	-	-	96	-	-	119	-	-	309	-	-
2006	122	-	-	166	0.23	1.42	209	-	-	487	-	-
2007	111	0.14	1.80	175	-	-	204	0.10	0.69	475	-	-
2008	153	-	-	242	-	-	257	-	-	666	-	-
2009	154	-	-	216	0.13	1.34	260	-	-	679	-	-
2010	140	-	-	192	-	-	207	-	-	553	-	-
2011	140	0.13	1.18	210	-	-	235	-	-	612	-	-
2012	73	-	-	95	0.33	2.12	119	-	-	273	0.21	1.41
2013	144	-	-	194	-	-	210	0.13	1.32	539	-	-
2014	137	0.16	1.21	182	-	-	206	-	-	536	-	-
2015	137	-	-	190	0.20	0.95	218	-	-	552	0.08	0.72
2016	135	-	-	175	-	-	202	0.11	1.15	538	-	-
2017	165	-	-	213	-	-	249	-	-	651	-	-
2018	161	-	-	220	-	-	292	-	-	611	0.03	0.71
2019	220	0.07	0.75	287	-	-	331	-	-	836	-	-
2020	161	-	-	215	0.11	0.98	243	-	-	568	-	-
2021	103	-	-	119	-	-	162	0.53	1.44	368	-	-
TP Statistics:	URBAN Mean: 0.12 Median: 0.10 Samples: 213		WWTP Mean: 1.22 Median: 1.02 Samples: 728	URBAN Mean: 0.19 Median: 0.12 Samples: 304		WWTP Mean: 1.35 Median: 1.21 Samples: 1,014	URBAN Mean: 0.23 Median: 0.08 Samples: 269		WWTP Mean: 1.19 Median: 1.03 Samples: 842	URBAN Mean: 0.09 Median: 0.06 Samples: 150		WWTP Mean: 0.90 Median: 0.86 Samples: 450

[1] Deviation above the watershed threshold of 0.28 mg/L TP is denoted by color: red (result > 0.28 + 0.50 mg/L) and orange (result 0.28 + 0.01 to 0.28 + 0.50 mg/L).

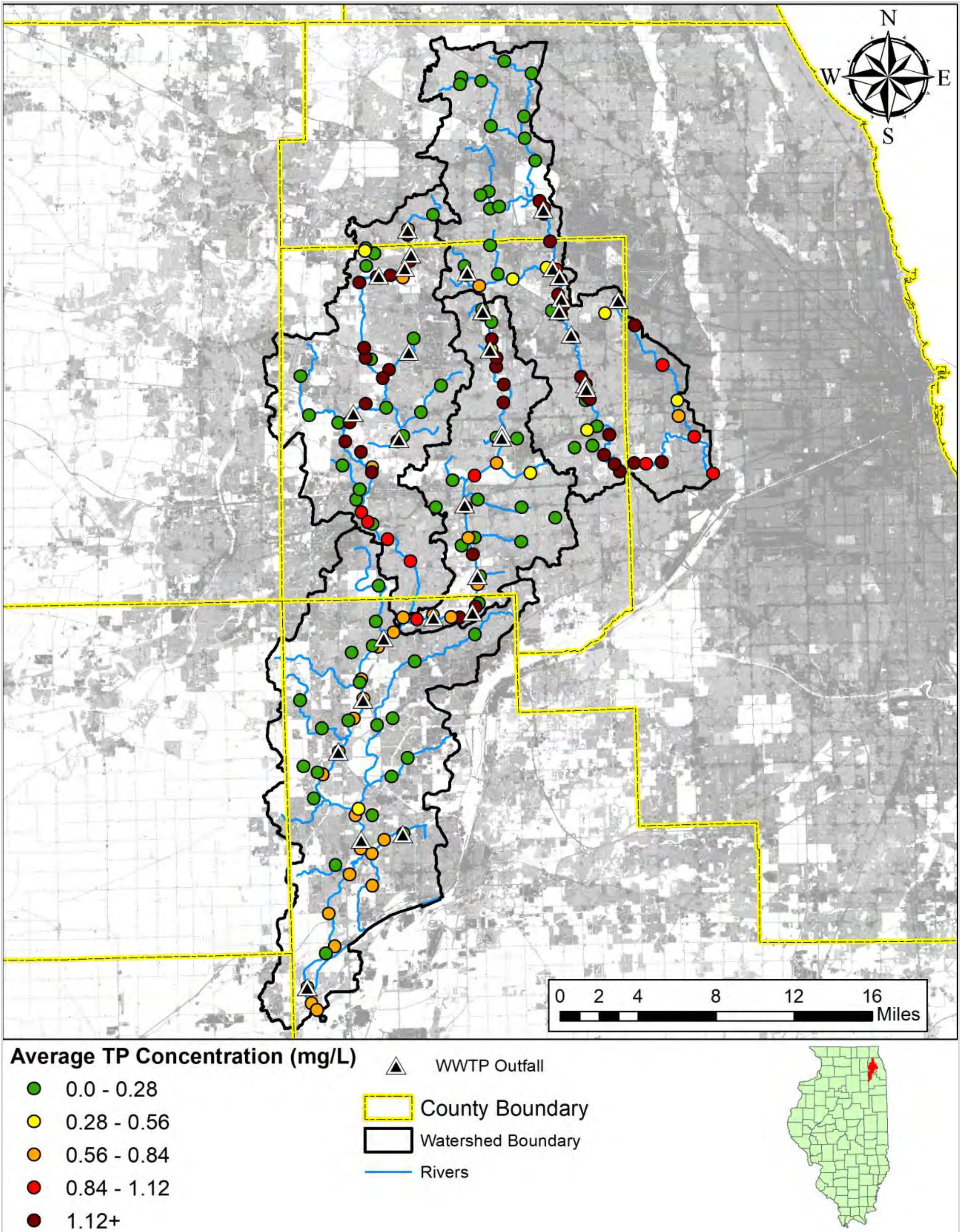


Figure 44. Mean instream TP concentrations for the DuPage and Salt Creek watersheds, 2006–2021.

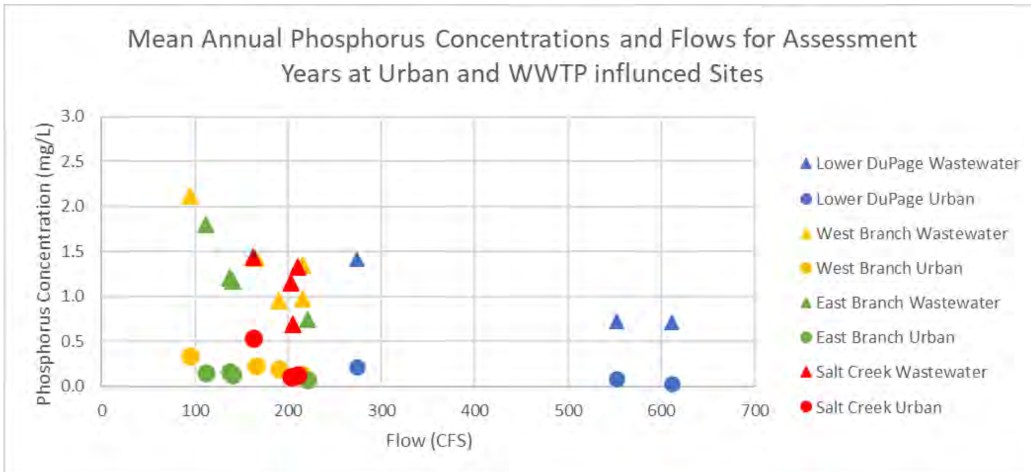


Figure 45. Mean annual TP concentrations for mainstem and tributary sites relative to streamflow for each basin assessment year by watershed.

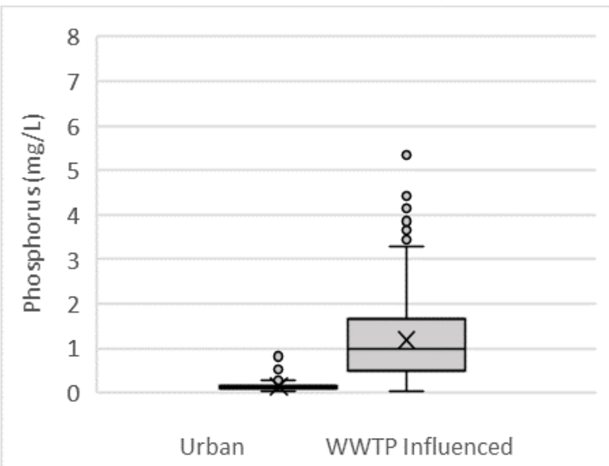


Figure 46. Box plots of TP concentrations in urban and wastewater-influenced segments of the East Branch DuPage River during 2007–2014.

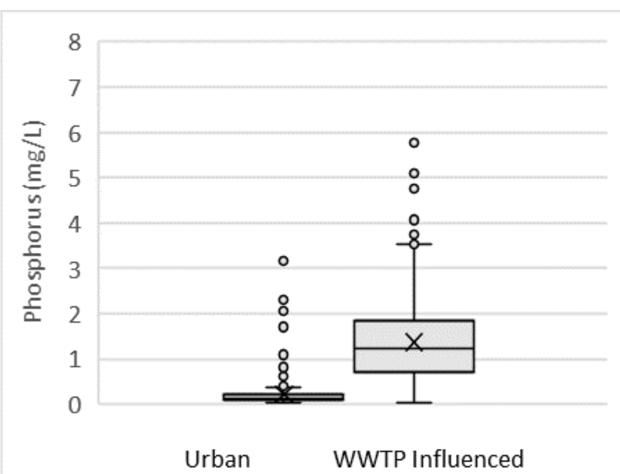


Figure 47. Box plots of TP concentrations in urban and wastewater-influenced segments of the West Branch DuPage River during 2006–2015.

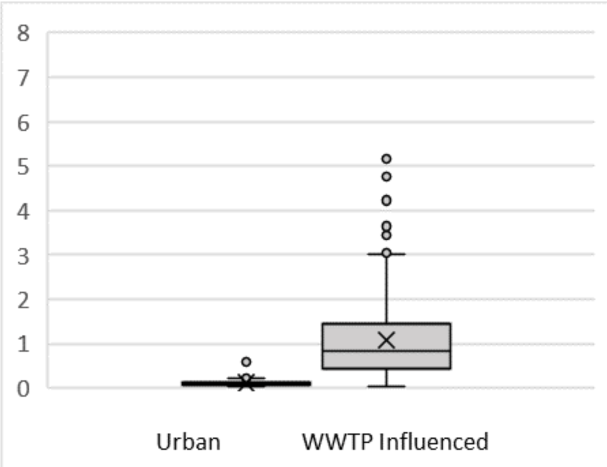


Figure 48. Box plots of TP concentrations in urban and wastewater-influenced segments of Salt Creek during 2007–2021.

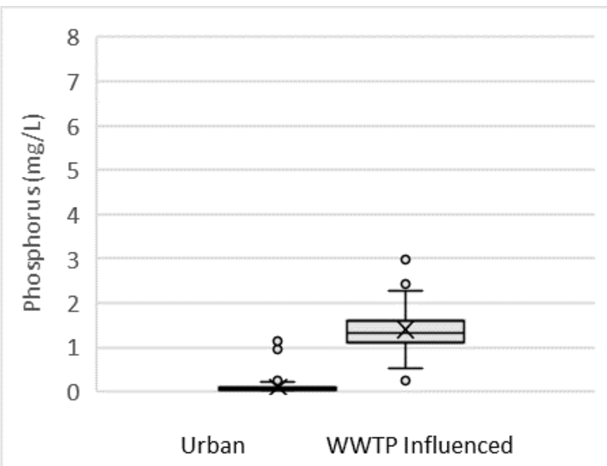


Figure 49. Box plots of TP concentrations in urban and wastewater-influenced segments of the Lower DuPage River during 2012–2018.

Monthly DMRs are submitted to IEPA by NPDES-permitted WWTPs and include records of effluent flow and water quality. Parameters required for monitoring and reporting are selected by IEPA based on specific WQS (e.g., DO) or due to special attention by the State of Illinois (e.g., TP). Table 34 shows a subset of DMR data, including flow and mean TP concentration and loading from WWTPs for selected years. As illustrated by this observed data from the WWTPs, the average effluent ranges from 0.48 mg/L to 5.46 mg/L TP, and the flows range from 0.10 MGD to 23.71 MGD. The scales of both flow and TP concentrations further support the hypothesis that WWTPs are the main contributors of instream ambient TP concentrations.

An examination of flow and water quality data to support a TP modeling effort (see Section 7.1) for the mainstems, tributaries, and WWTPs for each basin was conducted to calculate the relative contributions that various sources play in both flow and TP loading to the mainstems (Figure 50 through Figure 53). The allocations of different contributions were calculated using a water-balance approach, attributing annual average flows to major tributaries and headwaters based on observed flows from WWTP DMRs and USGS flow gages throughout the watersheds. The most recent year of expanded monitoring across each specific watershed available at the time of analysis (2019 for East Branch, 2021 for West Branch, 2022 for Lower DuPage, and 2016 for Salt Creek) were used to calculate annual flows and TP loading.

After calculating average flows from the various contributors for each model year (aggregated as either WWTP or nonpoint sources, including MS4s), TP loading was estimated based on average observed TP concentrations from DMR data for WWTPs and from the most downstream bioassessment tributary monitoring site for nonpoint sources. WWTPs that discharge to tributaries (Wheaton Sanitary District and Carol Stream Water Reclamation Facility on the West Branch DuPage River, Roselle Botterman, and Bensenville Sewage Treatment Plant [STP] on Salt Creek, and Crest Hill on the Lower DuPage River) are not explicitly accounted for but are included implicitly within the "tributaries with WWTPs" sections (yellow wedge).

The graphic illustrations of the flow and TP load contributions show that while WWTPs contribute from 13% (West Branch DuPage River) to more than 28% (Salt Creek) of annual flow, they are the source of approximately 85% of the ambient TP in the DuPage mainstem and more than 80% of the TP in the Salt Creek basin annually. These percent contributions from WWTPs increase during dry summer months when background and MS4 inputs (urban flow) are lowest.

Table 34. Mean effluent flow, design average flow, mean annual TP concentration, and total annual TP load by WWTP as simulated for each QUAL2Kw water quality model year (Section 7.1).

Watershed (Model Year)	WWTP	NPDES ID	Design Average Flow (MGD)	Mean Flow (MGD)	Mean TP (mg/L)	Annual TP Load (kg/yr)
East Branch DuPage River (2019)	Bloomingdale-Reeves WRF	IL0021130	3.45	2.97	2.87	11,305
	Glendale Heights STP	IL0028967	5.26	3.81	2.41	12,157
	Glenbard WW Authority STP	IL0021547	16	10.00	2.43	32,473
	Downers Grove Sanitary District	IL0028380	11	12.46	2.86	47,072
	DuPage County Woodridge	IL0031844	12	10.77	1.84	26,097
	Bolingbrook STP #1	IL0032689	2.04	1.80	5.46	13,671
	Bolingbrook STP #2	IL0032735	3	3.28	3.34	15,163
West Branch DuPage River (2020)	MWRDGC Hanover Park WRP	IL0036137	12	7.59	1.91	17,938
	Roselle – J Botterman WWTP	IL0048721	1.22	0.78	3.79	4,007
	Hanover Park STP #1	IL0034479	2.42	1.25	2.43	3,969
	Bartlett WWTP	IL0027618	3.679	2.37	2.85	8,610
	West Chicago/Winfield Wastewater Authority RWTP	IL0023469	7.64	6.15	1.91	14,585
	Carol Stream STP	IL0026352	6.5	3.61	3.23	16,111
	Wheaton Sanitary District	IL0031739	8.9	6.57	2.92	26,507
Salt Creek (2016)	MWRDGC Egan WRP	IL0036340	30	23.71	3.18	102,393
	Itasca STP [1]	IL0079073	3.2	1.65	0.57	1,330
	Wood Dale North STP	IL0020061	1.97	1.61	3.20	6,781
	Wood Dale South STP	IL0034274	1.13	0.34	2.26	1,059
	Addison North STP	IL0033812	5.3	3.65	3.58	16,824
	Addison South – AJ LaRocca	IL0027367	3.2	2.06	2.92	7,748
	Salt Creek Sanitary District	IL0030953	3.3	3.70	2.62	12,898
	Elmhurst WRF	IL0028746	8	7.38	2.56	25,132
	Roselle-Devlin STP	IL0030813	2	0.78	3.12	3,362
	DuPage County Nordic	IL0028398	0.77	0.24	1.06	352
	Bensenville STP [1]	IL0021849	4.7	3.91	1.03	5,564
Lower DuPage River (2018)	Naperville Springbrook WRC	IL0034061	26.25	19.71	2.79	75,328
	Bolingbrook STP #3	IL0069744	2.8	3.19	3.32	14,905
	Plainfield STP [1]	IL0074373	7.5	4.59	0.58	3,614
	Joliet Aux Sable Plant [1]	IL0076414	7.7	7.12	1.85	17,018
	Camelot	IL0045381	0.1	0.11	1.60	222
	Minooka STP [1]	IL0055913	2.2	1.03	0.48	635
	Crest Hill West STP	IL0021121	1.3	1.12	4.28	6,623

Note:
[1] These WWTPs have implemented their NPDES permit limit of 1.0 mg/L TP monthly average.

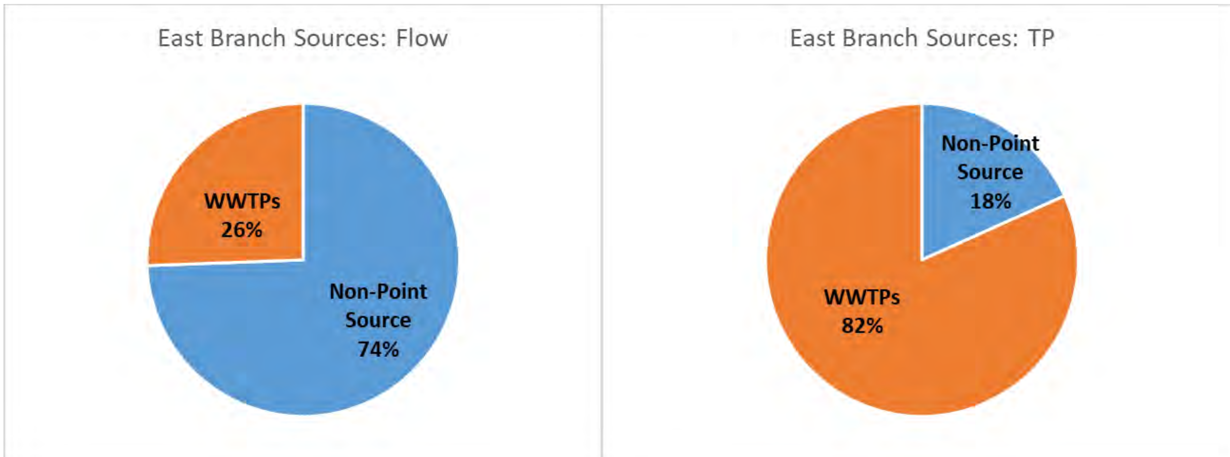


Figure 50. Distribution of source flow and TP loading to mainstem (2019): East Branch DuPage River.

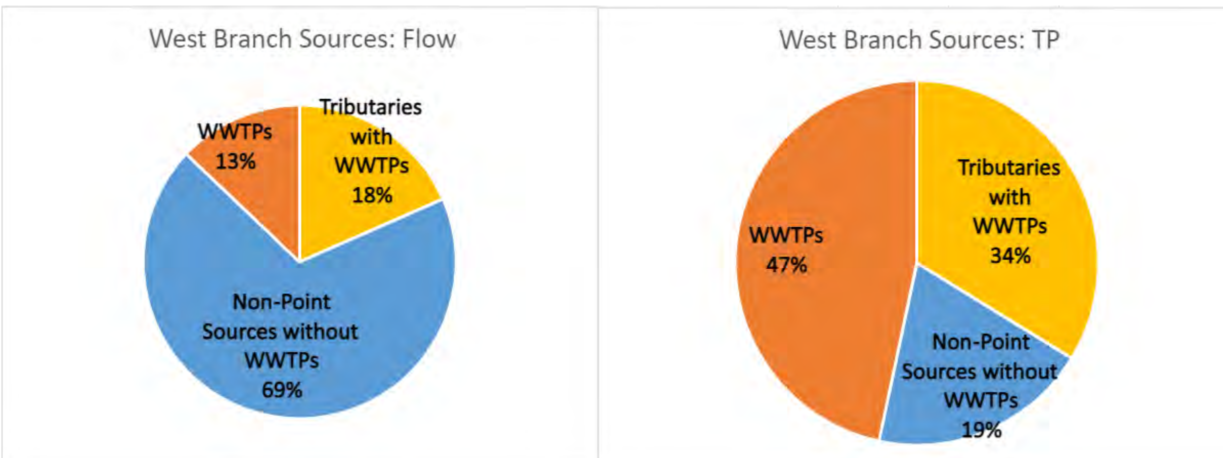


Figure 51. Distribution of source flow and TP loading to mainstem (2021): West Branch DuPage River.

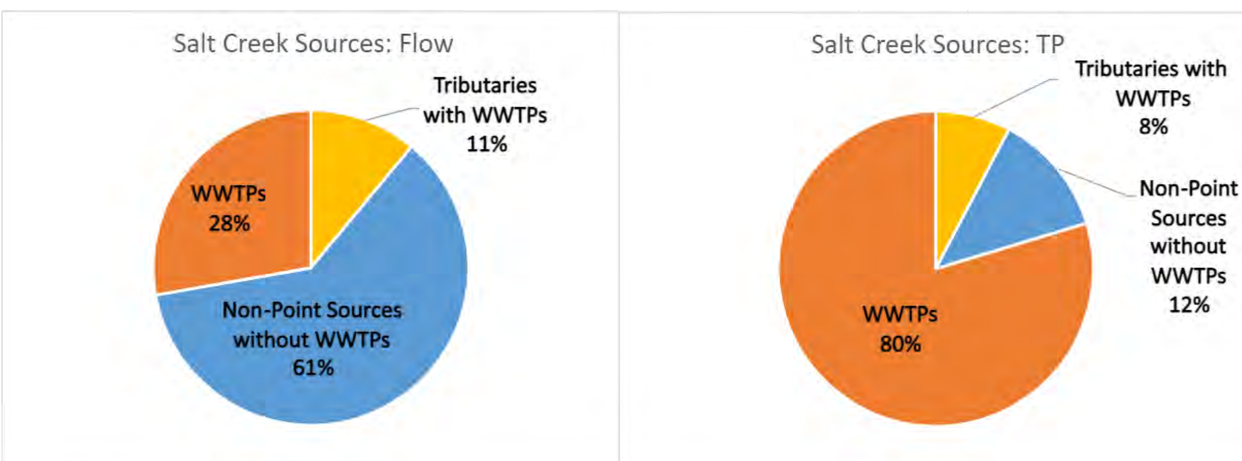
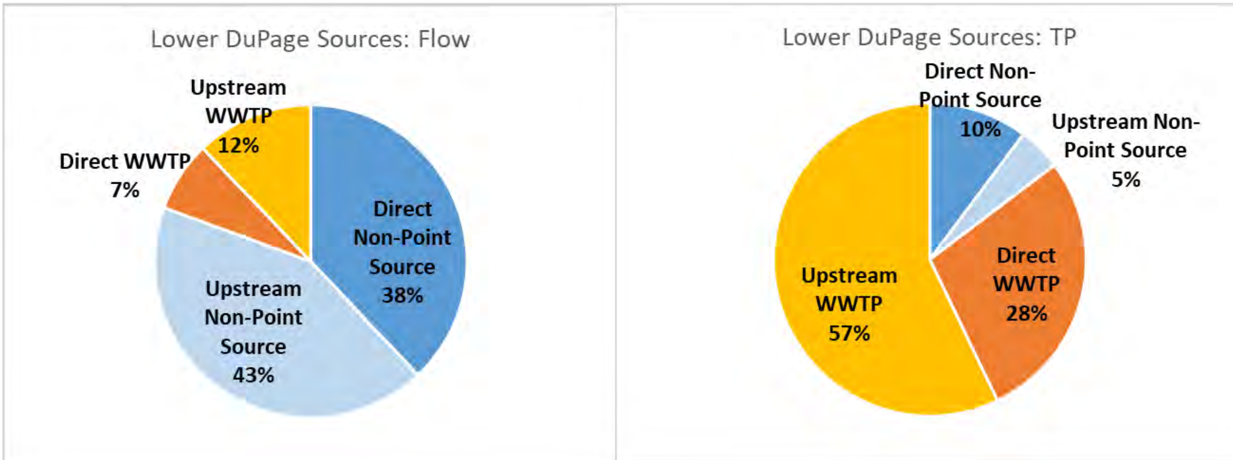


Figure 52. Distribution of source flow and TP loading to mainstem (2016): Salt Creek.



Note: Rock Run was not included in the tabulations of point sources because the inflow location is at the furthest downstream location on the mainstem.

Figure 53. Distribution of source flow and TP loading to mainstem (2020): Lower DuPage River.

6.3 CHANGES TO SOURCES POST-ANALYSIS

During the period covered by this analysis (2006–2021) five WWTPs initiated TP removal processes: Itasca STP (IL0079073; 2012), Bensenville STP (IL0021849; 2019), Plainfield STP (IL0074373; 2011), Joliet Aux Sable Plant (IL0076414; 2020), and Minooka STP (IL0055913; 2006–2007). With the exception of the Joliet Aux Sable Plant, these reductions are included in the data presented in Table 34 and Figure 50 through Figure 53, all of which were compiled using data gathered after treatment implementation. The TP limits were mandated as the WWTPs in question were undergoing plant expansions. The other WWTPs listed in Figure 38 operated under the 2015 Special Condition and did not undergo expansion in that period.

The 2015 Special Conditions allowed member WWTPs of both watershed groups to extend the implementation schedule of adopting a 1.0 mg/L effluent standard in return for implementing their watershed plan priorities. The delay was 10 years for plants adopting a chemical phosphorus removal treatment and 11 years for those who are using primarily biological phosphorus removal. In 2021, IEPA agreed to extend this condition for another permit cycle (five years). Six WWTPs have opted out of this extension (Table 35) and remain on the original permitted implementation schedule. These six WWTPs will implement an interim monthly average TP effluent limit of 1.0 mg/L between 2025 and 2028. All WWTPs listed in Table 35 discharge to the DuPage River basin, and with a conservative effective effluent concentration of 1.0 mg/L, reduce total annual load in the DuPage Basin by 57,752 kg (127,321.4 lbs).

Table 35. WWTPs adopting an interim 1.0 mg/L TP limit, with estimated TP load reductions relative to flows and loads simulated for their respective QUAL2Kw water quality modeling year

Watershed (Model Year)	Facility	NPDES ID	Design Average Flow (MGD)	Mean Flow Modeled (MGD)	Mean TP (mg/L)	Annual TP Load (kg/yr)	Date Limit Changes to 1.0 mg/L TP	Annual TP Load for 1.0 mg/L TP Limit	Percent Load Reduction (Average)
East Branch DuPage (2019)	Glendale Heights STP	IL0028967	5.26	3.81	2.48	12,157	10/01/2025	5,264	57%
West Branch DuPage (2020)	West Chicago/ Winfield Wastewater Authority Regional WWTP	IL0023469	7.64	6.15	1.91	14,585	10/02/2025	8,491	42%
	Bartlett WWTP	IL0027618	3.679	2.37	2.85	8,610	10/01/2025	3,277	62%
	Wheaton Sanitary District	IL0031739	8.9	6.57	2.92	26,507	08/02/2026	9,078	66%
Lower DuPage (2018)	Naperville Springbrook WRC	IL0034061	26.25	19.71	2.79	75,328	12/31/2028	27,230	64%
	Bolingbrook STP #3	IL0069744	2.8	3.19	3.32	14,905	06/30/2025	4,406	70%

WWTPs adopting the 2021 Special Conditions extension will have their existing scheduled permit dates for implementing the 1.0 mg/L monthly average *superseded* by the schedule and effluent limit set out in this NIP. Per the 2021 Extension permit language (F1 (chemical phosphorus removal) and F2 (biological phosphorus removal) of the Special Conditions):

> *"If the Permittee will use chemical precipitation (or Biological removal) to achieve the limit, the effluent limitation shall be 1.0 mg/L on a monthly average basis, effective October 1, 2028,[11] (2029 for biological conditions) or in accordance with the implementation schedule included in the Nutrient Implementation Plan unless the Agency approves and reissues or modifies the permit to include an alternate phosphorus reduction program or limit pursuant to paragraphs G.1 thru G.8 below".*

To balance the competing funding demands of meeting the watershed TP threshold (Section 5.1) and essential habitat improvements (Section 7.1.2), the NIP is recommending a new implementation schedule for TP control at WWTPs. An implementation schedule for all WWTPs is provided in Section 9.

[11] Effective date is for the Village of Bloomingdale and will vary between individual permits.

7 MANAGEMENT OPPORTUNITIES

The IPS Tool identified and prioritized actions and locations to maximize the aquatic biology potential throughout the DuPage and Salt watersheds. Principally, the goal was to improve overall QHEI or the component factors of QHEI at the site and watershed level. The IPS Tool methodology found TP to be a proximate stressor and identified a watershed TP threshold of 0.277 mg/L as protective of aquatic biota for the General Use standard (Section 5.1).

Like aquatic life improvement, cost-effective TP reductions and the resolution of ambient DO deficiencies demand a clear understanding of the factors contributing to such deficiencies and the sensitivity of DO to changes in the independent factors. Calibrated QUAL2Kw models were used to investigate WWTP TP effluent reductions as a way to meet the watershed threshold and predict DO sags, and to estimate the impact of WWTP loading reduction on mean daily minimum DO during the growing season.

Improving the QHEI and targeting the TP watershed threshold are complementary actions that are essential for meeting aquatic life goals. The NIP sets out a framework to implement both cost-effectively.

7.1 INTEGRATED APPROACH FOR IMPROVING AQUATIC LIFE CONDITIONS

7.1.1 Physical Conditions Impacting Dissolved Oxygen

Improving instream TP conditions (decreasing TP concentrations) is a necessary step toward improving conditions for aquatic life and DO conditions in the DuPage River and Salt Creek watersheds; however, reducing TP alone is not sufficient to meet these goals. As discussed in Sections 1.3.1 and 0 on the analysis of aquatic life, both the 2010 and 2023 IPS Tool analyses determined that multiple stressors, not just TP concentrations, contribute to observed variation in fIBI and mIBI., Other dominant stressors identified included landscape conditions (e.g., a high percentage of impervious area, the prevalence of urban land uses), habitat features (e.g., overall quality, substrate and embeddedness), chlorides, and nutrients. Further analysis with the IPS Tool indicated that landscape condition is the most dominant explanatory stressor on the observed variation in aquatic life, followed by overall and individual habitat conditions (Table 13 in Section 0).

This suggests that implementing the proposed WWTP TP effluent limits (0.35 mg/L for WWTPs in the DRSWC watersheds and 0.50 mg/L in the LDRWC watershed) will only help these waterways meet the General Use standard if TP reductions are partnered with strategic improvements to riparian and instream habitat.

Similarly, instream DO conditions can be impacted by factors other than instream TP concentrations. Instream DO conditions (average concentrations, saturation, and diel range) are also the product of multiple additional factors, including nitrogen concentrations, air and water temperature, algal respiration activities, SOD, physical reaeration due to channel bed morphology and wind, water depth, total streamflow, shading from topography and riparian vegetation, oxygen-demanding substances like organic matter, and more. A significant number of factors that influence DO concentrations are habitat variables. These parameters and changes to them can also have synergistic impacts. The QUAL2Kw modeling scenarios explored as part of the East Branch/Salt Creek Dissolved Oxygen Improvement Project (Section 1.2.2) predicted that even if oxygen-demanding substances (simulated primarily as nutrients and carbonaceous biochemical oxygen demand [CBOD]) were eliminated in WWTP effluent, DO deficits currently observed upstream of dams on the East Branch (Churchill Woods) and Salt Creek (Fullersburg Woods and Oak Meadows) remained. These modeling results indicate that the physical structures of the waterways, and not just water chemistry, are driving forces in instream DO conditions. These findings played a significant role in the IEPA's *Link Between TMDLs and NPDES Permits for Salt Creek and the East Branch of the DuPage River: A Practical Application of Adaptive Management and a Phased Approach for Meeting the DO Standard* (IEPA 2004) set forth in the DRSCW 2015 Implementation Plan (Section 1.4.1), allowing the DRSCW opportunity to pursue a TMDL alternative following the publication of the 2004 DO TMDLs (CH2MHILL 2004a, 2004b).

The updated QUAL2Kw models developed to support this NIP (Section 7.2) reinforced the findings that TP load reductions alone cannot improve instream DO concentrations sufficiently to attain the General Use standard.

Figure 54 through Figure 57 illustrate the model-predicted (simulated) DO concentration-response for each watershed for:

1. Current WWTP loading conditions (baseline)
2. Modeled scenario with WWTP effluent concentrations of TP, TN, and CBOD removed (no demand)

Results are summarized for these model applications as the average daily minimum simulated DO concentration by model reach, as averaged across the growing seasons (May–October). The lowest simulated DO conditions on the East Branch DuPage River for both "baseline" and "no demand" models occur in the impoundment formed by the Crescent Boulevard culverts (also known as Churchill Woods Lake; see Figure 54), illustrating that the impoundments' physical conditions, as opposed to water chemistry, are driving the local DO concentrations. In this area of the East Branch, the river's natural flow has been restricted, causing the water to remain in place for an extended period, leading to poor DO conditions. The slow movement of water through the impoundment allows for the accumulation and settling of organic matter, which consumes oxygen during decomposition while also covering valuable macroinvertebrate and fish habitats. Reductions of any kind to upstream WWTP oxygen-demanding substances are not predicted to be sufficient to remove the DO sag currently observed at Churchill Woods Lake. It is anticipated that removal of the impoundment will be required to restore DO in this area. QHEI scores will also respond positively to the return to natural, free-flowing conditions.

Similar to the East Branch, model results shown in Figure 56 and Figure 57 indicate that existing observable DO sags on Salt Creek and the Lower DuPage River upstream of the former Fullersburg Woods (Graue Mill) and Hammel Woods dams, respectively. The QUAL2Kw model scenarios were developed to simulate the impact of dam removals based on existing hydraulic models of physical alterations of stream configurations. These model scenarios attempt to estimate the impacts of these dam removals on instream DO conditions; however, at the time of modeling, no instream DO data were available to refine the simulation. The DRSCW and the LDRWC will continue to monitor DO concentrations at these former impoundments to document changes in conditions associated with the dam removals. It should be noted that the DO sag historically associated with the former Oak Meadows dam on Salt Creek at mile 23 and simulated in Figure 56 is no longer present based on observations since the dam's removal in 2016.

The primary simulated DO sag on the West Branch DuPage River (Figure 55) is predicted in the headwaters upstream of any WWTP discharge. The headwaters of the West Branch are in a channelized concrete ditch with intermittent flows, little to no stream structure (i.e., lacks pools and riffles), and no native riparian buffer. These headwaters are likely most impacted by low DO concentrations due to nutrients and organic matter present in urban wash-off in combination with poor reaeration resulting from low flows and flow velocities.

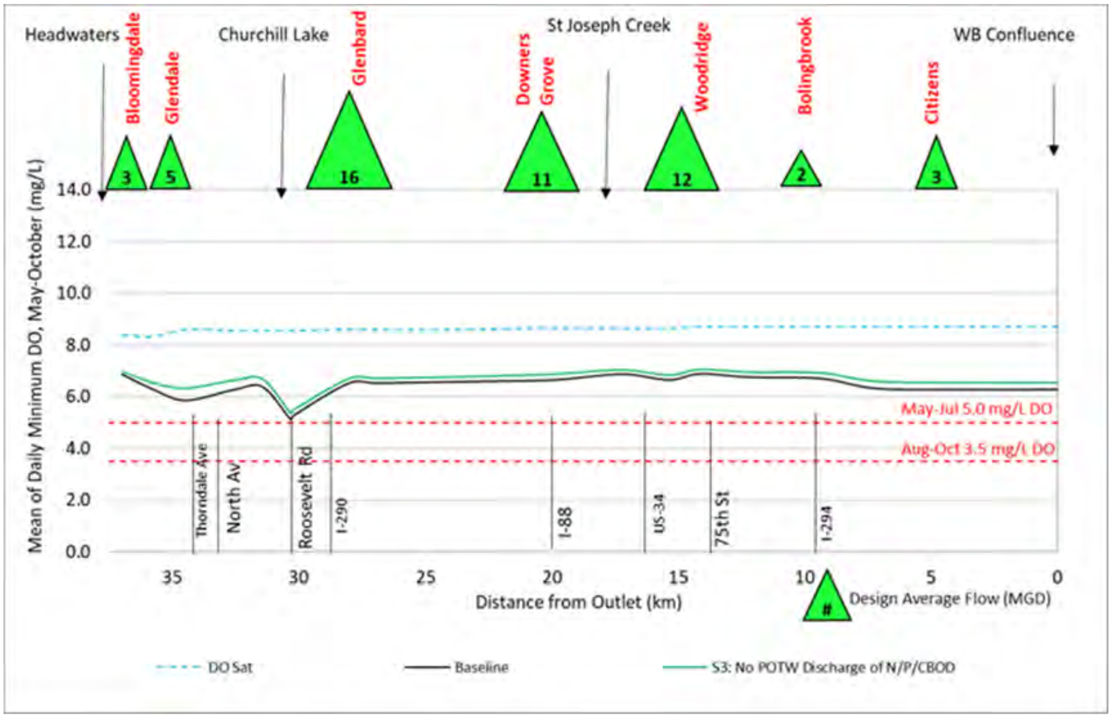


Figure 54. May–October mean of daily minimum DO concentrations longitudinally along East Branch DuPage River for baseline and for no discharge of nutrients and CBOD from WWTPs.

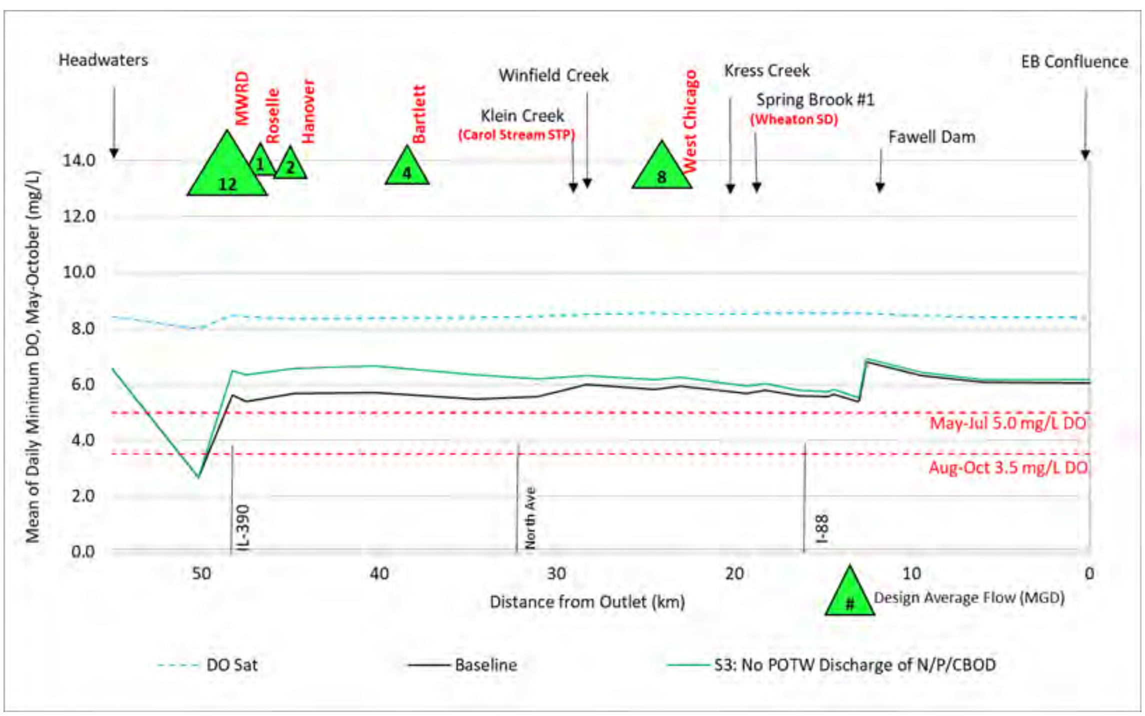


Figure 55. May to October mean of daily minimum DO concentrations longitudinally along West Branch DuPage River for baseline and for no discharge of nutrients and CBOD from WWTPs.

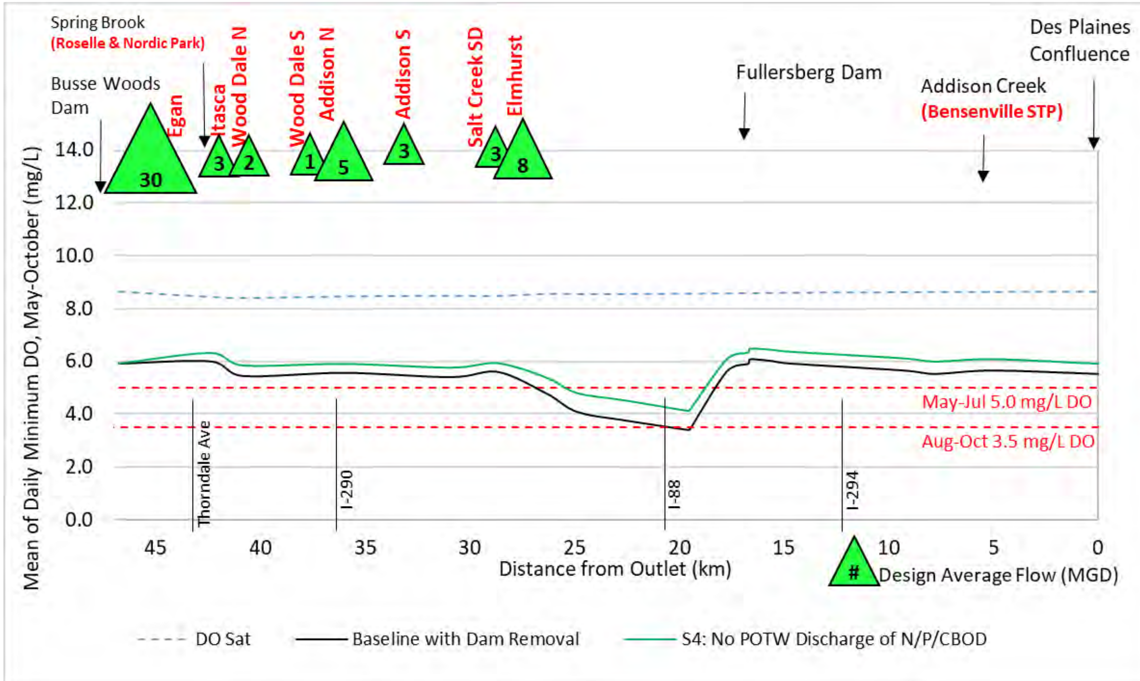


Figure 56. May to October mean of daily minimum DO concentrations longitudinally along Salt Creek for baseline and for no discharge of nutrients and CBOD from WWTPs.

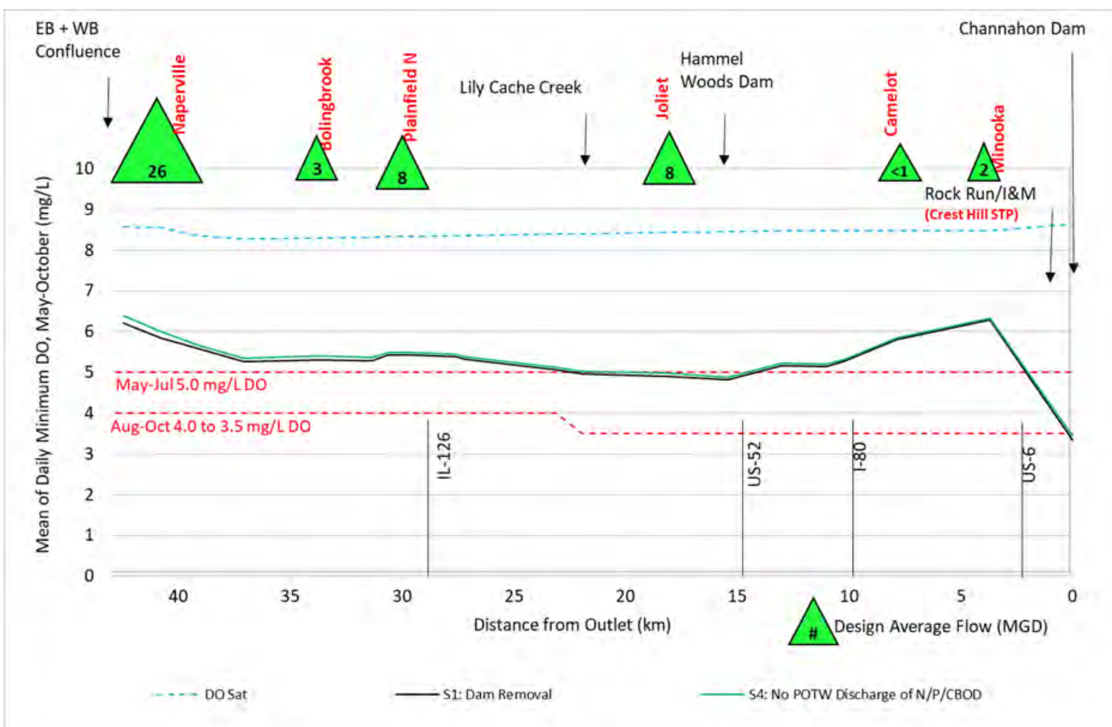


Figure 57. May to October mean of daily minimum DO concentrations longitudinally along Lower DuPage River for baseline and for no discharge of nutrients and CBOD from WWTPs.

Considering the correlation between low DO conditions and physical stream conditions in the DuPage River and Salt Creek watersheds (as supported by the IPS Tool and QUAL2Kw modeling results), this NIP makes several recommendations that are not directly related to TP loading. Instead, the recommendations are linked to the expression and assimilation of TP, the amelioration of DO sags, the improvement of habitat, and a focus on comprehensive improvements to support aquatic life.

Continuing watershed-scale aquatic life habitat improvement projects will be essential for cost-effectively improving DO, maximizing aquatic resources, and meeting the CWA's aquatic life goals. The schedule set out in Section 9 allows the DRSCW and LDRWC to continue implementing priority physical projects identified by applying the 2023 IPS Tool (see Section 0) for an additional permit cycle.

7.1.2 Practicality of Landscape and Habitat Restoration

In addition to developing stressor thresholds (Section 0 and Section 5.1 specifically for TP), applying the 2023 IPS Tool provides a framework for objectively sorting and ranking sites, reaches, and watersheds based on the potential for restoration that would bring these sites into full attainment related to existing aquatic life impairments. These quantifiable potentials for restoration or "restorability" rankings are calculated for impaired waters, while "susceptibility" and "threat" rankings are calculated for fully attaining waters. Restorability, susceptibility, and threat rankings are calculated at the site, reach, and watershed scales. The algorithm applied in the IPS Tool to develop restorability, susceptibility, and threat rankings is based on weighted scores associated with the aggregations of stressors, the magnitudes of biological departures, and the expectations for attainability with respect to the General Use standard. The basic assumption with the restorability rankings is that evaluation locations (sites, reaches, and watersheds) with the specific features are more or less likely to respond well to landscape and/or habitat restoration actions and efforts (Table 36).

Table 36. Assumptions for restorability based on landscape and/or habitat restoration activities

Likelihood of Positive Response to Restoration Activities	Stressors	Biological Impairment	Presence of Additional Factors that would Deter or Preclude Attainability
Less Likely	Relatively many stressors	More severe impairment	Irreversible factors are present
More Likely	Stressors are relatively few or no stressor present	Less severe impairment	Any factors present are reversible, or no factors are present

Another key principle of the IPS Tool is that success is more likely achieved by protecting currently attaining waters rather than attempting to restore already impaired ones. The concepts of environmental restorability, susceptibility, and threat characterization are among the most fundamental outputs of the IPS Tool framework because they provide a standardized quantifiable approach to ranking existing and potential projects and taking needed actions relative to the likelihood of success.

As most waters in the DuPage River and Salt Creek watersheds do not currently attain aquatic life designated uses, this NIP focuses on the IPS Tool rankings for restorability (as opposed to susceptibility or threat). Restorability refers to the capacity of impaired aquatic assemblages to attain the General Use standard conditions (or higher) by applying various implementation strategies (e.g., point source controls and/or best management practices [BMPs] for water quality treatment of urban stormwater). Sites with high restorability scores may already be close to the General Use standard attainment and influenced by relatively few stressors, most of which are readily reversible, or "fixable," with relatively straightforward interventions. Sites with lower restorability scores are more likely to have intractable or practically irreversible stressors (e.g., concrete channels, high urban land use in both the watershed and within riparian buffers, multiple severe stressor impairments). For each site and/or reach, specific restorability scores affect the determination of the most limiting stressors when developing restoration strategies.

The IPS Tool's restorability score's unique factors and relative weights are illustrated in Figure 58. Factors were developed from observed datasets and include:

1. The fIBI and mIBI (each ranked 1–10)
2. Percentage of sites attaining the General Use standard biological criteria for a single waterway (ranked 1–10)
3. Biological condition of sites within the same HUC12 watershed (ranked 1–10)
4. Local habitat rank (ranked 1–10)
5. Channel condition (ranked 1–20)
6. HUC12 watershed QHEI (ranked 1–20)
7. Land use within the catchment and riparian buffer (each ranked 1–10)
8. Ionic strength parameters (ranked 1–15)
9. Number of severe or intermediate chemical threshold exceedances by parameter category (e.g., nutrients, metal, and organics) (each ranked 1–10)

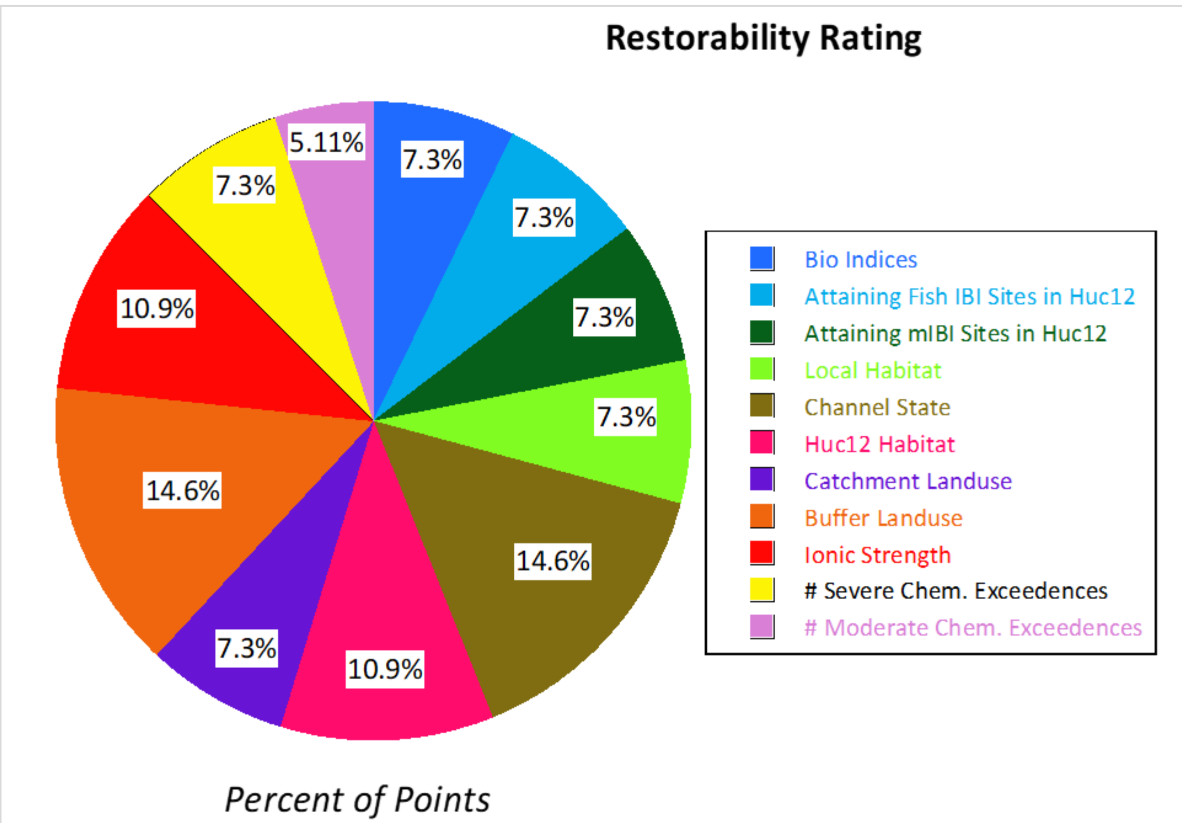


Figure 58. Maximum contribution of each restorability ranking factor for impaired sites in the IPS study area.

To standardize the interpretation of the complex environmental data, each with different measurement units and scales, used to calculate restorability rankings, each unique stressor and response variable (e.g., fIBI, local habitat rank) was normalized to an intuitively consistent scale, from 0 to 10 (Table 37). This scale is also linked to the range of narrative categories of the General Use standard for aquatic life. The Good range is indicative of meeting the General Use standard for aquatic life and serves as the baseline restoration goal under the CWA. The Excellent range serves as a high-end protection benchmark under a theoretical framework of use subcategories. The Fair, Poor, and Very Poor narratives do not meet the General Use standard, but the Fair and Poor ranges could serve as theoretical use subcategories when and if formal use attainability analyses are considered in the future.

The raw restorability ranking scores were then scaled from 0 (lowest restoration potential) to 100 (highest restoration potential). Scaling was completed for impaired sites based on the highest and lowest restorability rating scores (Table 37). Sites, reaches, and watersheds with restorability scores of very low (< 20) or low (20–40) are impaired by causes that are likely more difficult to restore fully. Recovery from this degree of impairment might only be incremental and slow to respond because of the ineradicable characteristics of the limiting stressor(s). Sites with high (> 60) or very high (> 80) restorability scores are more likely to be closer to attaining the General Use standard biocriteria and be subject to limiting stressors that are more readily abated (e.g., conventional chemical constituents, sites amenable to habitat restoration, or watersheds with more localized rather than watershedwide degradation). For sites with intermediate restorability scores (40–60), the severity and extent of the impairment within a reach or watershed and the types of limiting stressors should be examined on a case-by-case basis. The geographical extent of where these specific restorability scores and narrative conditions apply across the DuPage River and Salt Creek watersheds is provided in Figure 59.

Table 37. Summary of IPS Tool stressor ranks (0–10) and associated restorability scores (0–100) that coincide with specific narrative conditions and theoretical use subcategories

Narrative Condition	Theoretical Use Subcategory	Stressor Rank (0-10)	Restorability Scores (0-100)
Excellent	Exceptional	0.1–2.0	Not assigned to attaining sites[1]
Good	General Use	> 2–4	
Fair	Modified Use	> 4–6	Very High (> 80)
			High (> 60–80)
Poor	Limited Use	> 6–8	Intermediate (> 40–60)
			Low (> 20–40)
Very Poor	None	> 8	Very Low (< 20)

Note: Colors indicate restorability scores included in this table and Figure 59. Red colors reflect very low chance of restorability, orange colors reflect low scoring for potential restorability, green colors reflect a high potential for restorability, and blue colors reflect a very high potential for restorability.

[1]Sites with good or excellent narrative conditions that attain the General Use standards are therefore assigned Susceptibility or Threat rankings (not restorability scores).

Priority sites for potential future restoration projects were identified in each watershed based on the co-location of high restorability scores and observable DO sags (see Section 7.1.1. The NIP will include both existing DRSCW and LDRWC projects and selected projects for the priority sites (Table 37). For each priority project, the relative magnitude of the key stressors at that location are categorized as severe, moderate, and minor as determined by the IPS Tool evaluation (Figure 58, Table 39). The severe stressors for priority projects are predominantly landscape conditions (urban development).

Table 38. Priority projects identified for potential implementation

Project Name	Short-Term Objective	Long-Term Objectives
Southern East Branch Phase III (EB32, EB34, EB40, EB43, EB43A, EB45, EB46, EB47)	Improve aquatic habitat (QHEI); reduce inputs of sediment and nutrients	Raise mIBI and fIBI
East Branch DuPage River Stream Restoration at Churchill Woods (Reconstruction of Crescent Boulevard Culverts) (EB36)	Improve DO conditions, improve aquatic habitat (QHEI), and reduce inputs of sediment and nutrients	Raise mIBI and fIBI
West Branch DuPage River Stream Enhancement at Winfield Mounds (WB17)	Improve aquatic habitat, improve aquatic habitat (QHEI), reduce sediment transport, and reduce inputs of sediment and nutrients	Raise mIBI and fIBI
West Branch DuPage River and Unnamed Tributary Stream Enhancement at Timber Ridge Forest Preserve (WB33, WB18)	Improve DO conditions, improve aquatic habitat (QHEI), and reduce inputs of sediment and nutrients	Raise mIBI and fIBI
Salt Creek Stream Enhancement near Eldridge Park and the Salt Creek Greenway (SC51, SC57)	Improve DO conditions, improve aquatic habitat (QHEI), and reduce inputs of sediment and nutrients	Raise mIBI and fIBI
Old Oak Brook Dam Removal and Salt Creek channel restoration (SC55, SC56)	Remove fish barrier, improve aquatic habitat (QHEI), and reduce inputs of sediment and nutrients	Raise mIBI and fIBI
Lower Salt Creek Stream Enhancement at Salt Creek Woods Nature Preserve (SC49, SC60)	Improve DO conditions, improve aquatic habitat (QHEI), and reduce inputs of sediment and nutrients	Raise mIBI and fIBI
Lower DuPage River Stream Enhancement Phase II (LD12, LD13, LD25)	Improve flow conditions, improve aquatic habitat, reduce aquatic plant growth, and reduce inputs of sediment and nutrients	Raise mIBI and fIBI
Wolf Creek Stream Enhancement (LD33)	Improve aquatic habitat (QHEI)	Raise mIBI and fIBI
Lily Cache Creek Stream Enhancement (LD33)	Improve DO conditions, improve aquatic habitat (QHEI), and reduce inputs of sediment and nutrients	Raise mIBI and fIBI

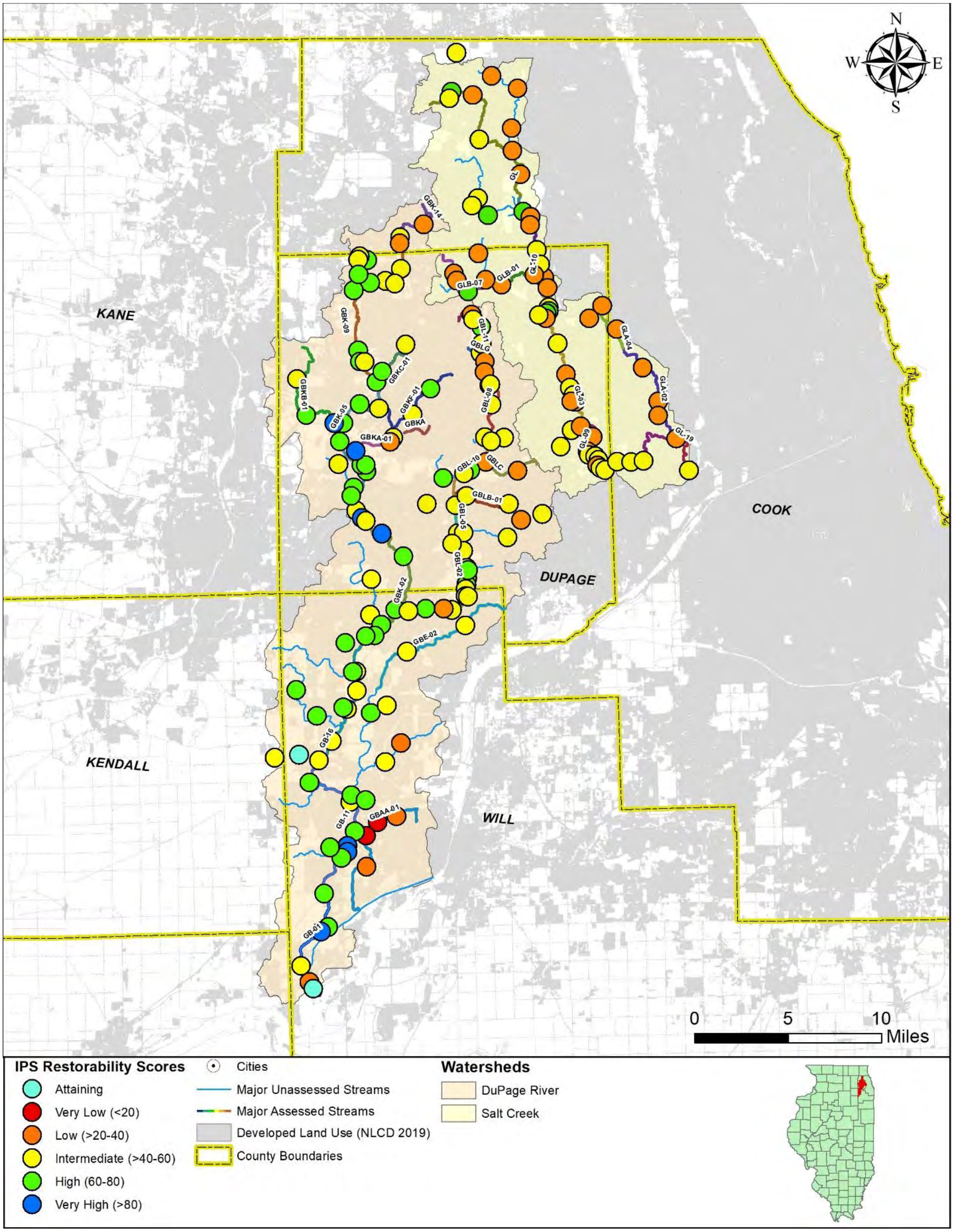


Figure 59. Restorability rankings for bioassessment sites in the DuPage River and Salt Creek watersheds.

Table 39. Priority project sites with severity magnitude of key stressors identified by the IPS Tool

Watershed	Site ID	River Mile	Restor-ability Score [a]	Severe Magnitude Stressors	Moderate Magnitude Stressors	Minor Magnitude Stressors
East Branch DuPage River	EB36	19.0	40.35	Urbanization – Watershed Scale (Urban-WS); Developed Land Uses – Watershed Scale (Dev-WS); Substrate; Water Column (WC) Metals	TP; QHEI	Impervious Area – 500m Radius (Imperv-500m); Nitrate; Channel; Chloride
	EB32	8.5	42.64	Urban-WS; Impervious Area (30m Radius Upstream Only (Imperv-30C); Dev-WS	WC Metals	Imperv-500m; Impervious Area – Radius (Imperv-30); TP; Nitrate; QHEI; Substrate; Channel; Chloride
	EB40	7.6	49.6	Urban-WS; Dev-WS	--	TP; Nitrate; QHEI; Channel; Chloride
	EB43	7.0	64.92	Urban-WS; Dev-WS	--	QHEI;
	EB43A	6.60	56.28	Dev-WS	--	QHEI; Channel
	EB34	5.0	55.48	Urban-WS; Dev-WS	WC Metals	TP; Nitrate; QHEI; Substrate; Chloride
West Branch DuPage River	WB17	19.2	75.2	Urban-WS; Dev-WS	--	TP; Nitrate; QHEI; Substrate; Chloride
	WB33	21.30	70.9	Urban-WS; Dev-WS; VSS	TP	Biological Oxygen Demand (BOD); Nitrate; Substrate
Unnamed Tributary to West Branch DuPage River	WB18	0.5	55.56	Urban-WS; Dev-WS; Substrate	BOD	TKN; QHEI; Channelization
Salt Creek	SC51	17.0	50.57	Urban-WS; Dev-WS; VSS	Imperv-500m; TP; Chloride	Low DO; TKN; BOD; Substrate; Conductivity; TDS; Turbidity; Sediment Metals
	SC57	16.5	33.64	Urban-WS; Dev-WS; TP	Imperv-500m; Chloride	Imperv-30; Imperv-30C; Low DO; TKN; QHEI; Substrate; Channel; Conductivity; TDS; Turbidity; Sediment; Metals
	SC55	13.5	28.04	Urban-WS; Dev-WS; Substrate; Channel	Imperv-500m;TP; Low DO; QHEI; Chloride	Imperv-30; TKN; Nitrate; Conductivity; TDS
	SC56	12.5	32.87	Urban-WS; Dev-WS	TP; Low DO; Substrate; Channel; Chloride	Imperv-500m; Imperv-30; Imperv-30C; TKN; BOD; Nitrate; QHEI; Conductivity; TDS
	SC49	8.0	44.19	Urban-WS; Dev-WS	TP; Chloride	Imperv-30; Low DO; TKN; BOD; Nitrate; Channel; Conductivity; TDS; Turbidity; Sediment Metals

Watershed	Site ID	River Mile	Restor-ability Score [a]	Severe Magnitude Stressors	Moderate Magnitude Stressors	Minor Magnitude Stressors
	SC60	7.20	52.88	Urban-WS; Dev-WS	TP; Chloride	Low DO; TKN; BOD; Nitrate; Substrate; Conductivity; TDS; Turbidity; Sediment Metals
Lower DuPage River	LD12	22.00	54.7	Urban-WS; Dev-WS	TP	Imperv-500m; Low DO; BOD; Nitrate; Max DO; QHEI; Channel; Chloride; Turbidity; Sediment Metals
	LD13	23.10	52.22	Urban-WS; Dev-WS	Imperv-500m; TP	Low DO; TKN; BOD; Nitrate; Max DO; QHEI; Channel; Chloride; Turbidity; Sediment Metals
	LD25	25.2	60.44	Urban-WS; Dev-WS; VSS	--	Imperv-500m; Low DO; TKN; BOD; Channel; Chloride; Turbidity; Sediment Metals
Wolf Creek	LD33	0.14	77.4	--	--	Imperv-500m; Urban-WS; Dev-WS; QHEI; Substrate; Channel
Lily Cache Creek	LD20	0.36	72.54	VSS	Urban-WS; Dev-WS; Low DO; Substrate; Chloride	Imperv-500m; TP; BOD; QHEI; Channel; Conductivity; TDS; TSS

Note:
[a] See Table 37 for narrative description of the restorability score.

7.1.3 Relationship between Chloride and Phosphorus

Recent studies have linked elevated instream chloride concentrations with increased dissolved phosphorus concentrations in rivers and streams (McIsaac et al. 2022; Novotny et al. 2009). Chloride concentrations in bioretention green infrastructure facilities, lakes, and detention ponds have also been linked to increased phosphorus in such features (Erickson et al. 2022). It is hypothesized that increased chloride may have a role in desorbing phosphate ions from sediment, leading to increased dissolved phosphorus in the water column and potentially resulting in nuisance conditions.

The 2010 IPS Tool (Section 1.3.1) identified chloride as a priority stressor on aquatic life in the Upper DuPage River and Salt Creek watersheds. Additionally, the FIT analysis conducted as part of the updated IPS Tool (Section 0 Table 13) placed both chloride (FIT score of 0.17) and conductivity (a proxy for chloride; FIT score of 0.05) in the top third of stressors limiting aquatic species across NE Illinois (the explanatory power increases as the FIT value approached 1).

To improve aquatic life conditions, municipalities in the DuPage River and Salt Creek watersheds have participated in a Chloride Reduction Program since 2006, explicitly focused on chlorides and winter management of impervious surfaces.[12,13] Data from this program show that mean winter and summer chloride concentrations have been declining in these watersheds (Baxter and Woodman 2023). Total chloride loading increased slightly over that period—likely a function of weather, with more ice and intense

[12] https://drscw.org/activities/chlorides-and-winter-management/
[13] https://ldpwatersheds.org/outreach/salt-smart/

winter storms in recent years. The DRSCW and LDRWC chloride reduction programs will continue with the implementation of this NIP. Chloride management implementation activities include:

- Hosting annual workshops covering numerous aspects of chloride management at various levels of program involvement, from plow drivers to elected officials.
- Encouraging peer-to-peer mentoring among snow professionals.
- Using questionnaires and other measures to track the implementation and adaptation of chloride BMPs by public works and highway departments.
- Conducting continuous winter monitoring (near the headwaters and near the confluence with the downstream receiving water in each of the four watersheds) to collect instream chloride concentration data to evaluate changes seasonally, annually, and spatially.
- Monitoring chloride loads in street sweeping waste to assess the potential for calculating chloride-removal rates. Data are being gathered to allow street sweeping to be evaluated as a chloride-reduction BMP. Analyses conducted in three NIP study communities found that annual street sweeping waste had a mean annual chloride concentration of 1,218 mg/kg of waste collected.
- Collaborating with local governments to develop guidance for evaluating and optimizing street sweeping activities as a chloride reduction BMP. This needs to be done in conjunction with the TP optimization measures provided in Section 8.3.
- Participation in the Salt Smart Collaborative[14] by the DRSCW and LDRWC.

Additionally, the LDRWC will continue to develop shared outreach material on chloride-reduction BMPs and related topics. Education campaigns include social media posts, videos, and graphics for Lower DuPage River watershed residents. Outreach materials and campaigns associated with residential chloride reduction efforts in DuPage County watersheds will be conducted in partnership with DC SWM.[15]

7.2 RECEIVING WATER MODELING

This section describes the efforts made to best understand and simulate existing water quality conditions instream of the DuPage River and Salt Creek waterways using receiving water modeling. Environmental modeling can be a versatile and informative decision-making tool for management opportunities, by simulating future impacts in the modeling environment after capturing existing conditions well. Modeling applications for decision-making is only as useful as the robustness of the datasets available to inform the model inputs, such as meteorological forcing, hydraulic parameterization, boundary inflows from point and nonpoint sources, and the availability of instream water quality data for model calibration. A model that captures existing conditions well, particularly across a range of flow and water quality conditions, can be used to inform potential nutrient management scenarios. Four separate models were developed for the DuPage River and Salt Creek waterways, including one each for: (1) the East Branch of the DuPage River; (2) the West Branch of the DuPage River; (3) the Lower DuPage River, whose boundary condition was informed by the terminal reaches of the two upstream models; and (4) Salt Creek.

[14] https://saltsmart.org/

[15] https://dupagecounty.gov/government/departments/stormwater_management/

7.2.1 Modeling History

The QUAL2K model is a quasi-steady state water quality model. It is an enhanced version of the USEPA preceding QUAL2E and QUAL-II models that includes a spreadsheet-based user interface for model input parameters and boundary conditions, including meteorology and boundary inflows for headwaters, tributaries, diffuse flows, and point sources (Chapra et al. 2012; Brown and Barnwell 1987). QUAL2K offers comprehensive hydraulic functions, diel heat budget and thermal dynamics, and dynamic water quality kinetics. The Washington Department of Ecology recently released QUAL2Kw Version 6, which provides the option to simulate nonsteady, nonuniform flow using kinematic wave flow routing; this version is capable of continuous simulation up to one year, with time-varying boundary conditions. In addition, optional surface and hyporheic transient storage zones are provided in the upgraded application.

The DRSCW and LDRWC have collaborated on developing an extensive environmental dataset and research findings for the entire DuPage River and Salt Creek watersheds (existing studies and datasets are summarized in Section 1.2). Due to the longstanding history of extensive hydromodification, dense urbanization, large wastewater treatment facility contributions to streamflow volumes, and concerns for aquatic life conditions, several watershed, hydraulic, and water quality models have been developed across the DuPage River and Salt Creek watersheds since the 1980s:

- 1980s: DuPage River QUAL-II model was developed to explore observed low DO summer conditions.
- 1996: Salt Creek QUAL2E model was developed, calibrated, and validated based on 1995 IEPA data.
- 2004: TMDLs were completed for the East and West Branch DuPage River and Salt Creek based on the prior QUAL2E models, focused on low DO impairments.
- 2008–2009: DO improvement feasibility studies for East Branch DuPage River and Salt Creek were completed, including updating and refining the 2004 QUAL2E models into the QUAL2K modeling environment based on observed data from 2006–2007.
- 2009: QUAL2K model was developed for a portion of the West Branch DuPage River and Lower DuPage River for the TMDL, including SOD data.
- 2019: QUAL2K model was developed for a tributary to and headwaters of West Branch DuPage River and the upper half of the Lower DuPage River for the TMDL using limited data from 2006–2016.

The suite of QUAL models (most recently QUAL2K and QUAL2Kw) is a well-established modeling framework appropriate for representing diel variability in DO concentrations and algal responses in flowing streams and run-of-river impoundments.

7.2.2 New QUAL2Kw Models Developed for the NIP

The QUAL2Kw modeling platform release provides many improvements relative to previous QUAL model versions, including enhanced phytoplankton and bottom algae routines and continuous water quality simulation capability. Existing model simulations throughout the DuPage River and Salt Creek mainstems were historically focused solely on representation of single or multiday critical conditions; however, by transitioning river modeling to the dynamic continuous QUAL2Kw environment, it is possible to capture existing conditions throughout these waterways across an entire calendar year. The QUAL2Kw models developed for Salt Creek (Tetra Tech 2023e), East Branch (Tetra Tech 2023b), West Branch (Tetra Tech 2023c), and Lower DuPage (Tetra Tech 2023d) rivers improve upon existing simulations with a more accurate representation of water temperatures, pH, conductivity, and DO concentrations. Previous modeling efforts were not calibrated to the robust instream nutrient data that have since been developed in recent years (See Section 1.2.1).

The model linkage between the East Branch, West Branch, and Lower DuPage River simulations was also employed to better simulate the relationship between these upstream rivers and downstream conditions in the Lower DuPage River. The new continuous QUAL2Kw models were developed and calibrated for all four mainstem waterways using the vast amount of data, reports, and historical modeling available.

These new QUAL2Kw models were developed to both better characterize and understand existing conditions instream and to support management scenario simulations developed to aid in decision-making for meeting the NIP goals for improving aquatic life conditions (scenario application detailed in Section 7.2.9.

The datasets presented in Section 6.1.2 were used for several purposes, including determining the initial parameterization, developing boundary conditions, and conducting model calibration. The updated QUAL2Kw models made use of pertinent information from the previous steady-state QUAL2K models in the region to establish the initial parameterization. Datasets containing information such as headwater, WWTP, tributary, and diffuse flows were used to develop boundary conditions for the receiving waterway. To verify the accuracy and quality of each model, mainstem datasets were compared to simulated outputs for model calibration.

7.2.3 Data Inventory

Development and calibration of each of the four QUAL2Kw models used recent and relevant monitoring datasets for flow, water quality, bioassessment monitoring, SOD, DO improvement feasibility studies, WWTP discharge data, dam configurations, meteorological datasets, and regional hydraulic models. Although some data sources varied by waterway, each model was developed similarly and was calibrated to the same types of available instream datasets to ensure a reasonable approximation of existing conditions (Table 40). Detailed information covering each of the four QUAL2Kw models can be found in the respective model development reports (one for each watershed).

Table 40. Data sources used in QUAL2Kw model development for DuPage River and Salt Creek

Data Item	Source	Description
Gage record of flow and channel hydro-geometry	United States Geological Survey (USGS)	Active USGS flow monitoring across DuPage River and Salt Creek watersheds
Bioassessment Monitoring Reports and datasets (chemistry and habitat)	MBI (DRSCW & LDRWC contract)	Annually rotating schedule of field monitoring for waterways in the region that includes grab sampling, field sampling, and long-term sonde deployment (water chemistry, biological, and habitat data) for waterways in the region (see Section 1.2.1.1 for more detail on this data)
Continuous Monitoring Program: sondes for DO, temperature, pH, conductivity	DRSCW, LDRWC, MWRDGC	Stations within the DuPage River and Salt Creek watersheds that take hourly water quality measurements between April and October of each year (see Section 1.2.1 for more detail on this data)
SOD Monitoring	HDR, CDM (DRSCW and IEPA Contract)	SOD data previously measured within each watershed
Existing Hydrologic and Hydraulic Models	Varies	Previous modeling efforts (QUAL2K, HSPF, HEC-RAS, FEQ) used for data gaps and initial parameterization
Stream Habitat Assessment Procedure Reports	Illinois EPA	Qualitative stream morphology summaries

Data Item	Source	Description
WWTP Discharge Monitoring Reports: flow and water quality	Illinois EPA NPDES program	Monthly flow and water quality reports for permitted discharge by WWTPs
Combined Sewer Overflow Reports	Illinois EPA NPDES program	Report of permitted overflow occurrences for combined sewer systems
Dam Structure Summaries	DRSCW, LDRWC	Overview of dam structures located within each watershed
Meteorological Forcing	North American Land Data Assimilation System – Phase 2 (NLDAS-2), and North American Regional Reanalysis	Gridded hourly meteorological datasets: Air and dew point temperatures, wind speed, solar radiation, and cloud cover (3-hour)

7.2.4 Simulation Period and Spatial Extent

DRSCW and LDRWC employ a multiyear cycling program for conducting targeted monitoring on specific waterways regionally. The model simulation year selected for each model was based on recent intensive sampling datasets for each respective waterway: 2019 for East DuPage River, 2020 for West DuPage River, 2018 for Lower DuPage River, and 2016 for Salt Creek. The East Branch DuPage QUAL2Kw model extends for 23.0 miles from Amherst Lake (West Lake Dam) to the confluence with the West Branch DuPage River. The West Branch DuPage QUAL2Kw model is 31.2 miles long, beginning from its designated headwaters near West Schaumberg Road until the confluence with the East Branch DuPage River. The Lower DuPage QUAL2Kw model begins at the point of confluence between the East Branch DuPage River and the West Branch DuPage River and extends 26.4 miles downstream to Channahon Dam before its confluence with the Des Plaines River. The spatial extent of the Salt Creek QUAL2Kw model encompasses the mainstem of Salt Creek, beginning at the outlet of Busse Woods Reservoir and Dam, and extends 26.3 miles to its confluence with the Des Plaines River. The decision to omit the approximately 11 miles of mainstem Salt Creek upstream of Busse Woods Dam was due to the absence of any WWTPs on that portion of the watershed. The segment was also omitted by the 2004 TMDLs (IEPA 2004) and the subsequent 2008–2009 DO improvement feasibility studies (HDR 2009) for the same reason.

7.2.5 Meteorology and Stream Shading

QUAL2Kw model inputs for air temperature, solar radiation, dew point temperature, wind speed, and stream shading were developed using the same methodology for all waterways. Gridded hourly NLDAS-2 data were used to develop inputs for air temperature, dew point temperature, solar radiation, and wind speed as spatially averaged across each watershed. Dew point temperatures were calculated using other various NLDAS-2 datasets. Cloud cover data series were generated using gridded North American Regional Reanalysis datasets with a temporal resolution of 3 hours and a spatial resolution of 32 kilometers on a Conformal Conic grid. Stream shading of each waterway was evaluated based on channel width, aerial imagery, and previous modeling applications, such that these large, wide rivers were modeled with no riparian stream shading.

7.2.6 Boundary Conditions

Each of the four QUAL2Kw models were constructed by incorporating primary flow inputs based on boundary conditions to the receiving mainstem, including headwaters, point sources (e.g., municipal wastewater discharges), and tributaries. Flow inputs were derived from a combination of continuous hourly USGS flow gage data and WWTP DMR records. Daily tributary and headwater inflows were derived for each model segment using a flow-balance approach between flow gages, known WWTP discharges, and site-specific, drainage-area-based flow contributions. Water quality parameterization for boundary conditions for headwaters and tributaries were developed using the most recent instream data sourced by DRSCW and LDRWC intensive sampling efforts across these watersheds (Section 1.2). Water quality parameterization for model inputs for all boundary conditions include DO, temperature, pH, conductivity, chlorophyll-*a*, nitrogen species, phosphorus species, CBOD, and more. Inputs were based on discrete grab sampling, field observations, and continuous sonde deployment data. Member WWTPs discharging directly to each of the four mainstem rivers were simulated explicitly in the model, while WWTPs discharging to tributaries were simulated implicitly based on the combined flow from that tributary to the mainstem. Occasionally, data gaps were identified in required model input datasets for boundary conditions, such as tributaries without significant cold-weather monitoring or WWTP discharges without organic nitrogen monitoring. These missing inputs were derived from the best available information, such as interpolation and extrapolation based on existing datasets. NPDES-permitted CSOs present in these watersheds were not simulated explicitly, given the infrequency of occurrence and the limited availability of water quality monitoring data.

7.2.7 Model Calibration

Each mainstem QUAL2Kw model simulated result was compared to observed data, including channel hydrogeometry, water temperature, DO, algae (simulated as sestonic and benthic chlorophyll-*a* concentrations), nutrients, and CBOD where available. First, it is important that the water quality model represents accurate flow conditions before adjusting any parameterization related to temperature. The focus of calibration then moves to nutrients, followed by calibration of algae kinetics and DO concentrations simultaneously. QUAL2Kw simulates several kinetic relationships relevant to DO concentrations in the water column, including SOD, reaeration at the air-water interface, temperature impacts on oxygen solubility, decay of oxygen-demanding substances (e.g., CBOD), oxygen-demanding chemical transformations (e.g., nitrification), and benthic algae and free-floating phytoplankton photosynthesis and respiration.

Where datasets were available, simulation results for each group of parameters were compared to observed measurements, with a primary focus on several key mainstem locations. A weight-of-evidence approach for model calibration was used to determine that each of the four QUAL2Kw models accurately simulated their respective model years' observed conditions. Mainstem calibrated models that reasonably represent observed existing waterway conditions make it possible to develop specific model applications that can simulate the potential conditions and instream impacts of potential future nutrient management scenarios.

While individual model development reports provide in-depth documentation of various boundary conditions and parameterization, a snapshot of the model simulations from a representative calibration point on each waterway was selected for reference. Figures included in this section depict modeled and observed TP and DO concentrations at these specific comparison locations for the entire respective simulation periods.

Model calibration for the East Branch is shown for Reach 20, relative to monitoring data collected at that location, site EB41 (Figure 60 and Figure 61). Site EB41 included 11 TP concentrations observed during model year 2019, as well as point-in-time DO concentrations measured in the field during grab sampling and several weeks of data from a continuously logging sonde in July. Model calibration for TP indicates a slight overestimation of TP concentrations at this location; however, given the relatively small number of observation points and the strong confidence in parameterization of point source inputs from DMR data, this simulation is reasonable. The diel cycle of DO is also well-captured in predicting both field visit and continuous sonde data during the summer period, which experiences significant diel fluctuation due to aquatic respiration and photosynthesis patterns.

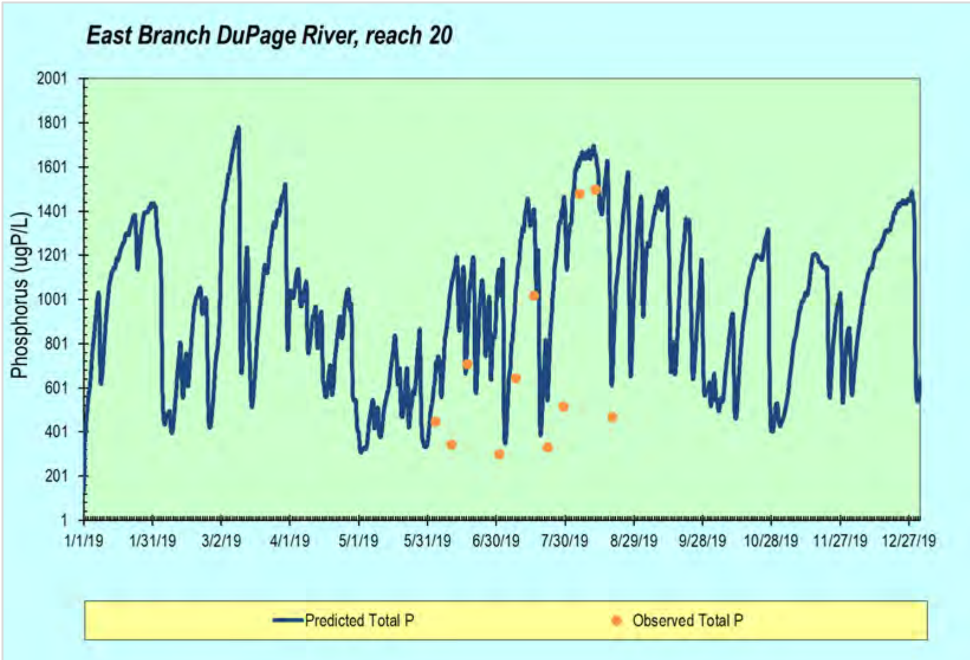


Figure 60. East Branch DuPage River: TP calibration at Reach 20, relative to monitoring site EB41.

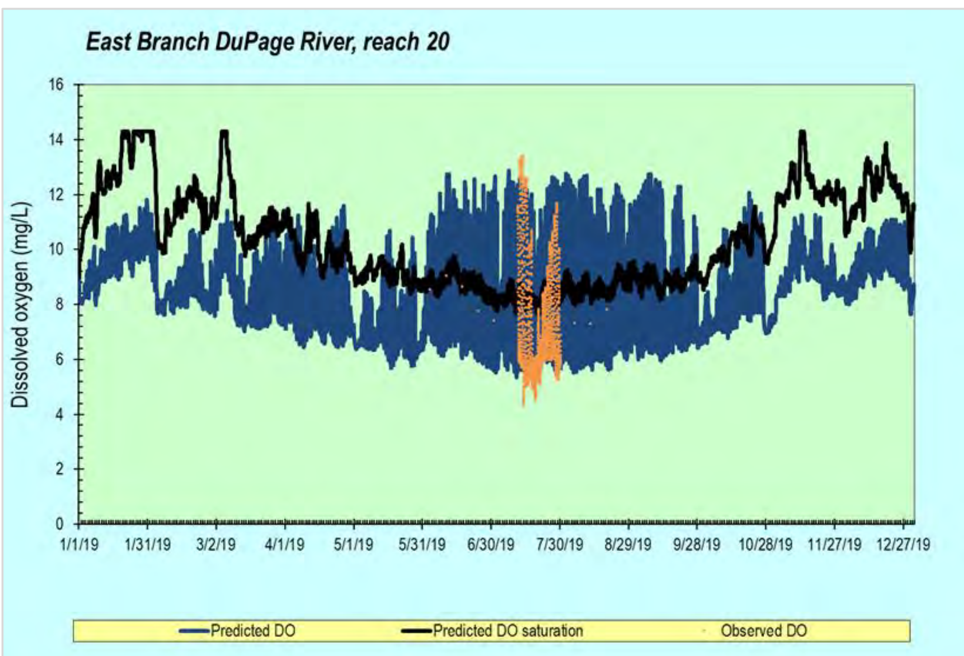


Figure 61. East Branch DuPage River: DO calibration at Reach 20, relative to monitoring site EB41.

Model calibration for the West Branch is shown for Reach 20, relative to monitoring at site WB35 (Figure 62 and Figure 63). With 12 TP grab samples measured from May through August at this site, the model captures the clear trend of increasing TP concentrations that occurs during the summer as observed during model year 2020. Additionally, observed DO concentrations are captured well during an extended sonde deployment period from May to October. Occasional DO abnormalities, such the one observed at deployment with very high DO concentrations at the beginning of May, are not captured by the model, perhaps because some anomalous, unmonitored, and therefore unmodeled event may have occurred that the model cannot capture, or the data represents an error in the sampling equipment itself.

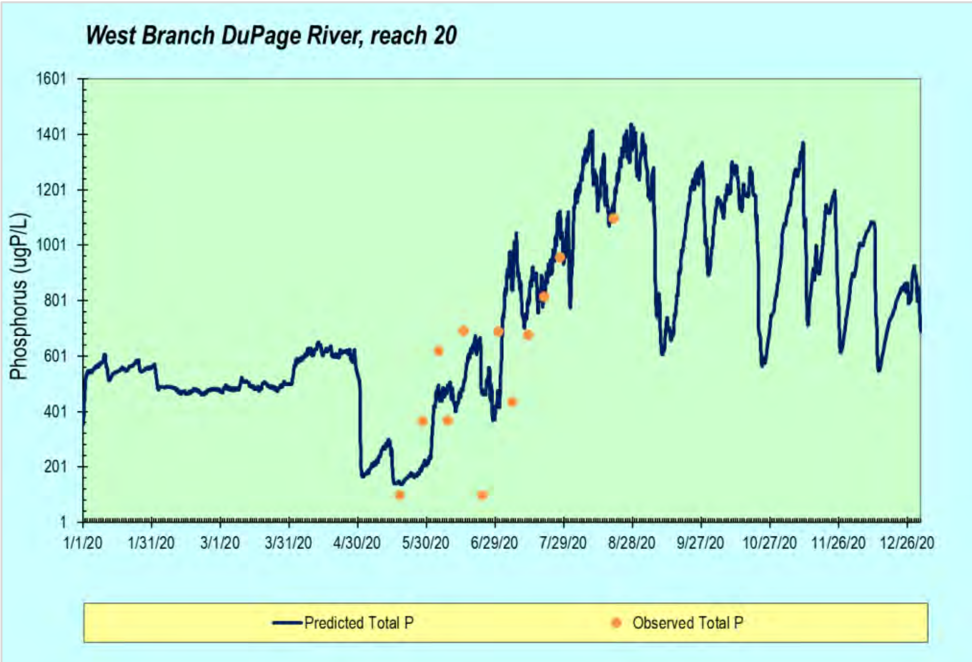


Figure 62. West Branch DuPage River: TP calibration at Reach 20, relative to monitoring site WB35.

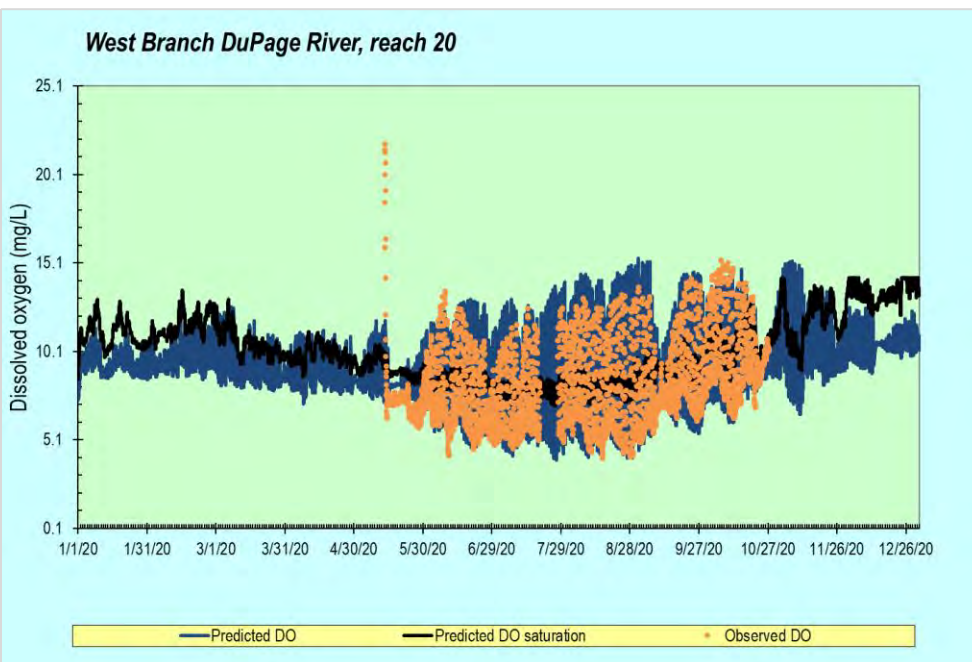


Figure 63. West Branch DuPage River: DO calibration at Reach 20, relative to monitoring site WB35.

Model calibration for Salt Creek is shown for Reach 12 relative to monitoring data at site SCGD (Figure 64 and Figure 65). Salt Creek did not experience a clear rise in TP concentrations across the summer, which is more like the East Branch than the West Branch or Lower DuPage. However, TP concentrations are well represented over the summer based on well-documented point source inputs. DO concentrations for Reach 12 in 2016 were observed and simulated to have generally lower average concentrations than those observed along the other mainstems, but the model is able to capture these trends, particularly as super-saturation occurs due to algal activity during the summer months.

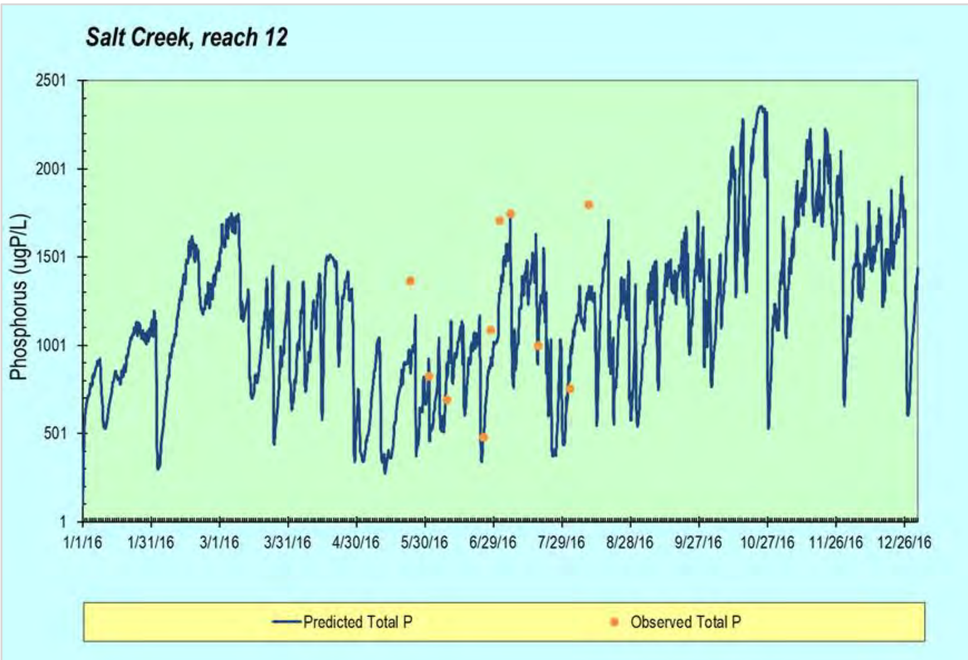


Figure 64. Salt Creek: TP calibration at Reach 12, relative to monitoring site SCGD.

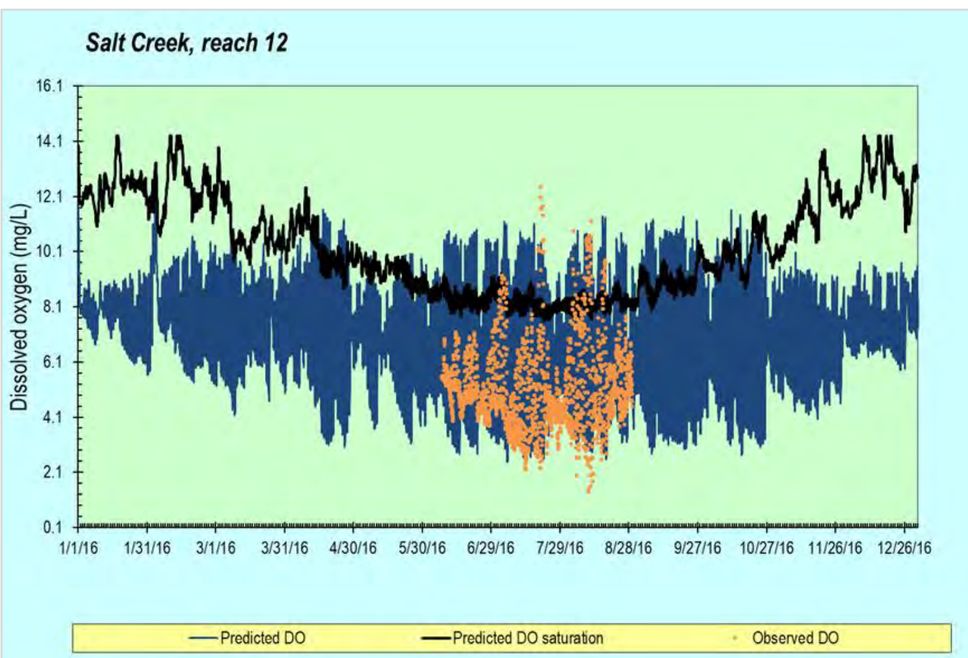


Figure 65. Salt Creek: DO calibration at Reach 12, relative to monitoring site SCGD.

Model calibration for the Lower DuPage is shown for Reach 9 relative to monitoring site LD09 (Figure 66 and Figure 67). This model also captures similar trends in clear increases of TP concentrations across the early summer period as observed on the West Branch. Continuous sonde data at this site shows higher diel variation in DO concentrations than was predicted by the model; however, the central trends of the data are similar, with the exception of the early September 2018 DO crash which might reflect an anomalous, unmonitored, and therefore unmodeled occurrence or an unidentified error in the sampling equipment itself. With limited data for benthic and sestonic algae and the inability to capture submerged aquatic vegetation with the model, it can be difficult to capture observed diel swings without potential overparameterizing the QUAL2K model (e.g., with reach-specific algae growth parameters).

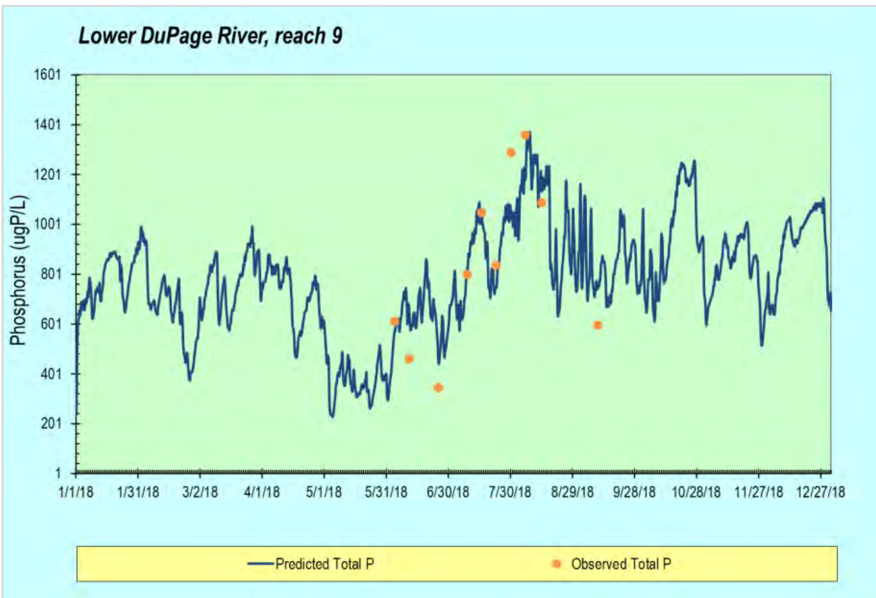


Figure 66. Lower Branch DuPage River: TP calibration at Reach 9, relative to monitoring site LD09.

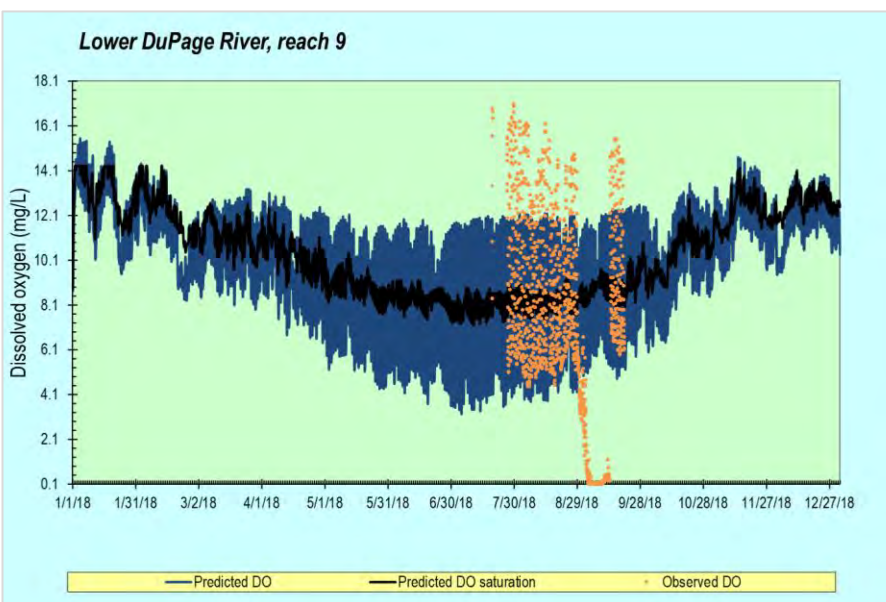


Figure 67. Lower Branch DuPage River: DO calibration at Reach 9, relative to monitoring site LD09.

7.2.8 Model Sensitivity

Each calibrated QUAL2Kw model was evaluated for sensitivity to a specific suite of input parameters by modifying those parameters consistently and reviewing model results relative to the DO simulation. While the IPS Tool determines the statistical biological significance of various observed parameters relative to each other, the QUAL2Kw sensitivity analyses were conducted to determine which model inputs were driving simulated DO concentrations at specific locations.

For each sensitivity test, inputs or conditions were altered for the entire year-long simulation period. Sensitivity was evaluated as the simulated change in minimum DO concentration between March and July relative to the baseline-calibrated condition for each respective model year. Sensitivity results were summarized below based on locations near the downstream end of each mainstem, where robust data were available for these sites during model calibration as well. Note that model sensitivity can vary both spatially and temporally.

The minimum DO concentration between March and July was selected as the response metric for the sensitivity tests because it is consistent with Illinois WQS, which specify that DO is to be above 5.0 mg/L at any time during these months. Note that bidirectional (i.e., increase and decrease) sensitivity tests were completed for most stressors evaluated; for example, the SOD rate was increased by 25% for one sensitivity test and then decreased by 25% for a subsequent sensitivity test. It was not feasible to simulate a decrease in riparian and topographic shade because shade is negligible for all baseline calibrated models. Sensitivity testing is not related to the true feasibility of potential management options.

Univariate leverage coefficients were computed to evaluate normalized response variable sensitivity for each scenario: $L_i = ((s_i - b_i) / b_i) / a$, where L_i is the leverage coefficient for response variable i (minimum DO concentration), s_i is the sensitivity test value for response variable i, b_i is the baseline value for response variable i, and a is the percent change in the stressor (e.g., 25%). Therefore, a leverage coefficient of one indicates that a 25% reduction/increase in a stressor (e.g., SOD, WWTP phosphorus loading) produces a 25% reduction/increase in the response variable, which is the minimum DO concentration across the simulation period. Leverage coefficients for minimum DO in March–July were calculated for each waterway separately (Table 41). Positive leverage coefficients (Figure 68; see the right-hand side of the example leverage coefficient "tornado plot" in example for the East Branch) indicate an increase in the minimum DO concentration and negative leverage coefficients (see the left-hand side of the tornado plot) indicate a decrease in the minimum DO concentration. Blue bars are used for scenarios that increase the variable (e.g., shade up 25%), and orange bars are used for scenarios that decrease the variable.

Physical and kinetic governing equations and well-documented relationships impact instream DO concentrations, such as temperatures that impact oxygen solubility in the water column, algal respiration activities, SOD, and other biogeochemical processes. Based on these analyses, minimum DO conditions at the downstream end of each of the four mainstems were found to be generally more sensitive to parameters such as benthic and sestonic algae abundance, stream shading, SOD, and occasionally boundary condition flow volumes and DO concentrations. Minimum instream DO concentrations were found to be least sensitive to nutrient loading from boundaries (primarily WWTPs) modeled as both TP, TN, and combined TP and TN loading. These sensitivity results are as expected based on well-documented biological relationships between instream nutrient concentrations and biological community responses that impact cyclic DO concentrations. Modeled responses in DO relative to nutrient reductions are minimal because critical thresholds of water quality that result in observable changes in biological assemblages and associated DO concentrations are not observed at instream nutrient concentrations as high as those observed in the DuPage River and Salt Creek systems (Evans-White et al. 2013; Dodds et al. 1998). It is anticipated that decreases in nutrient loading from WWTPs will move instream conditions in the right direction for restoring healthy conditions for instream aquatic organisms over time, even if DO concentrations are not predicted to be improved as an immediate response.

Table 41. Sensitivity test results for QUAL2Kw model inputs and relative impacts to minimum DO concentrations averaged March–July at specific locations

Model sensitivity parameters evaluated	East Branch DuPage	West Branch DuPage	Salt Creek	Lower DuPage
Location Evaluated →	*Downstream End*	*Downstream End*	*Above Graue Mill Dam*	*Above Channahon Dam*
1 (most sensitive)	Boundary DO	Algae	Algae	Algae
2	SOD	Shade	Boundary Flow	Shade
3	Algae	Boundary Flow	Shade	Boundary DO
4	Shade	SOD	SOD	Air Temperature
5	Boundary Flow	Air Temperature	Boundary N & P	SOD
6	Boundary N & P	Boundary P	Boundary N	Boundary Flow
7	Boundary N	Boundary N & P	Air Temperature	Boundary N & P
8	Air Temperature	Boundary DO	Boundary DO	Boundary N
9 (least sensitive)	Boundary P	Boundary N	Boundary P	Boundary P

Notes: N = nitrogen; P = phosphorus

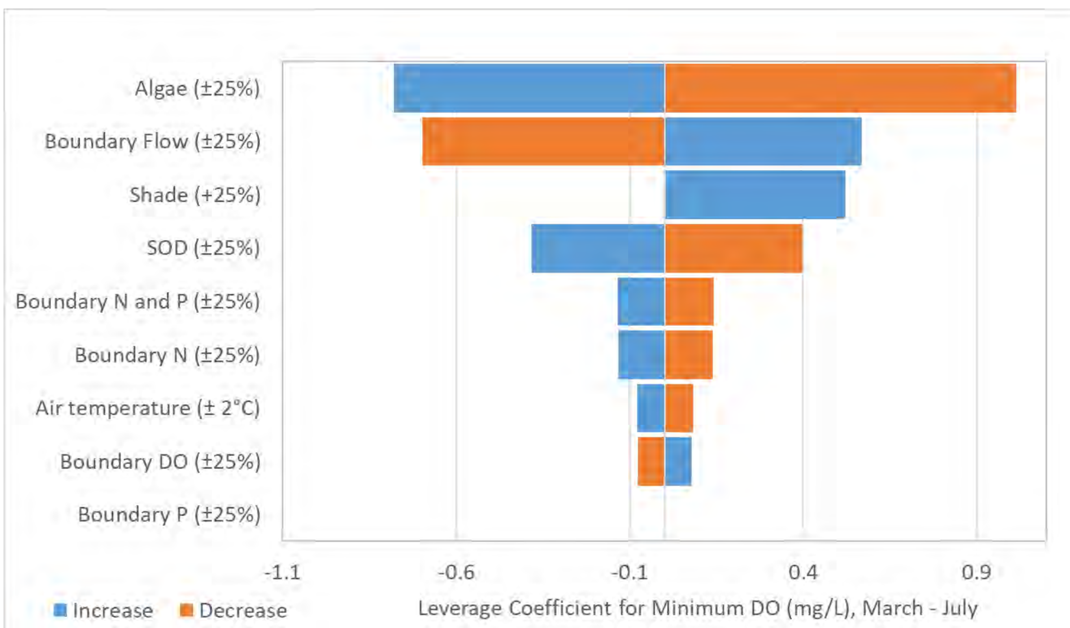


Figure 68. Example QUAL2Kw model sensitivity tornado diagram: leverage coefficients for model parameters relative to minimum DO concentration, Salt Creek above Graue Mill Dam (March–July).

7.2.9 Modeled Point Source Management

The calibrated baseline QUAL2Kw models for each of the four waterways (referenced as Scenario 0) were altered with respect to various management scenarios. The primary focus of these scenarios was on decreasing WWTP TP loading relative to existing conditions due to the percentage of total source loading that is attributable to point sources along each of these rivers. Improvements instream for scenario application were focused on meeting an instream TP threshold of less than or equal to 0.28 mg/L, as identified by MBI using the IPS Tool, to be protective of phosphorus-sensitive aquatic fish species (MBI 2023). Many potential scenarios were modeled, and several were tailored to each waterway, with the primary goal of identifying watershed-specific WWTP TP concentration limits that can achieve the instream TP threshold for these wadeable streams.

All modeling scenarios are summarized based on scenario type as the purpose for simulation (Table 42). Various scenarios were conducted to simulate the impact of systemwide and/or targeted or tiered approaches to compliance with the growing-season instream threshold of 0.28 mg/L TP:

- **Baseline**
  - Calibrated model mainstem models were used as the baseline condition for all additional modeling scenarios.
- **Physical Project**
  - Three watershed-specific scenarios were developed based on physical projects that have already taken place (e.g., removal of Hammel Woods Dam from the Lower DuPage River), are scheduled to be conducted in the near term (e.g., removal of the Fullersburg/Graue Mill Dam from Salt Creek) or have been simulated for future project consideration (e.g., hydromodification/restoration of the Churchill Woods Lake area on the East Branch). The Hammel Woods Dam and Fullersburg Dam removals were considered the new baseline for all subsequent scenarios based on existing project status.
- **TP Limit**
  - The first pass for scenarios based on WWTP TP management included modeling annual average TP discharge limits of 0.35 mg/L for all DRSCW and LDRWC member WWTPs. This limit was simulated with an effective effluent TP concentration of 0.28 mg/L, assuming that typical operations will perform with a 20% margin of safety relative to their permitted maximum. Scenarios were also run for all four models for which the annual TP discharge limit was set to 0.50 mg/L, simulated as an effective effluent of 0.40 mg/L under normal operations. One additional scenario was tested for the East Branch, where the 0.35 mg/L TP limit was modeled at an effective effluent of 0.35 mg/L.
  - **Seasonal**
    - All four models included management scenarios employing seasonally variable TP discharge limits: 0.35 mg/L May–October and 0.50 mg/L November–April.
  - **Targeted**
    - Various management scenarios were conducted for most mainstem models that evaluated the potential for targeted TP reductions at specific member WWTPs. These scenarios included TP limits of 0.10–0.50 mg/L at the largest dischargers on given waterways to explore the possibility of targeted reductions that could provide economy-of-scale relative to the much smaller member facilities with fewer resources and more variable levels of treatment technology. None of the targeted scenario results offered a clear opportunity for TP management between WWTPs.
- **Reference**
  - Various reference scenarios were run for exploratory purposes rather than practical reasons for each mainstem. Two of these scenarios for each mainstem baseline model included one where all existing WWTPs were set to zero-flow, and another where existing WWTP flows were maintained but the discharges had no primary oxygen-demanding substances (CBOD and nitrogen/phosphorus species). These reference scenarios allowed for a better understanding of what the system could be capable of in the absence of the

flow and nutrients coming from the regional WWTPs—to better assess the current condition of the rivers in the absence of point sources.

- Two additional reference scenarios were run for the East Branch where the flows not attributed to point source input were decreased to represent a more average flow condition, given that the model calibration year was a high rainfall year, which potentially created higher dilution. The median flow condition model was run for both WWTP TP management scenarios of limits 0.35 mg/L and 0.50 mg/L. Results from these models indicated relatively small effects of changes to nonpoint source flows relative to instream TP concentrations.
- One scenario was conducted for the Lower DuPage River to evaluate whether LDRWC members would be required to implement any TP limit reductions if the upper East and West Branches of the DuPage River implement TP limits of 0.35 mg/L. In the end, this scenario was not feasible, as TP concentrations within the Lower DuPage River continued to exceed the 0.28 mg/L TP threshold if LDRWC members maintained their current effluent concentrations.

Table 42. Generalized narrative descriptions for each scenario (selected NIP scenarios highlighted)

River	Scen.	Scenario Type	NIP Scenario Description
East Branch DuPage	0	Baseline	Calibrated Model
	1	TP Limit	WWTP Discharge TP 0.35 mg/L
	2	Reference	No WWTP Discharge
	3	Reference	No WWTP Discharge of N/P/CBOD
	4	TP Limit	WWTP Discharge TP 0.50 mg/L
	5	Physical Project	Scenario 1 + Churchill Lake area improved physical channel
	6	Seasonal TP Limit	WWTP discharge seasonal TP: 0.35 mg/L May–Oct, 0.50 mg/L Nov–Apr
	7	TP Limit	WWTP discharge at 0.35 mg/L TP actual (not 0.28 mg/L)
	8	Reference	Median NPS flow conditions, 0.35 (0.28 TP)
	9	Reference	Median NPS flow conditions, 0.50 (0.40 TP)
West Branch DuPage	0	Baseline	Calibrated Model
	1	TP Limit	WWTP Discharge TP 0.35 mg/L
	2	Reference	No WWTP Discharge
	3	Reference	No WWTP Discharge of N/P/CBOD
	4	Targeted TP Limit	Targeted WWTP TP reductions
	5	Seasonal TP Limit	WWTP Discharge TP seasonally: 0.35 mg/L May–Oct, 0.50 mg/L Nov–Apr
	6	TP Limit	WWTP Discharge TP 0.50 mg/L
Salt Creek	0	Baseline	Calibrated Model
	1	Physical Project	Dam Removal
	2	TP Limit	WWTP Discharge TP 0.35 mg/L
	3	Reference	No WWTP Discharge
	4	Reference	No WWTP Discharge of N/P/CBOD
	5	Targeted TP Limit	WWTP Discharge TP no change except Egan TP limit 0.35 mg/L
	6	Targeted TP Limit	WWTP Discharge TP no change except Egan TP limit 0.10 mg/L
	7	Targeted TP Limit	WWTP Discharge TP 1.0 mg/L and Egan TP limit 0.35 mg/L
	8	Seasonal TP Limit	WWTP Discharge seasonal TP: 0.35 mg/L May–Oct, 0.50 mg/L Nov–Apr
	9	TP Limit	WWTP Discharge TP 0.50 mg/L
Lower DuPage [a]	0	Baseline	Calibrated Model
	1	Physical Project	Dam Removal
	2	TP Limit	WWTP Discharge TP 0.35 mg/L
	3	Reference	No WWTP Discharge
	4	Reference	No WWTP Discharge of N/P/CBOD
	5	Targeted TP Limit	Targeted TP reductions for all WWTPs
	6	Reference	West Branch (WB) & East Branch (EB) TP reductions, Lower DuPage (LD) WWTPs held same
	7	Targeted TP Limit	Targeted TP reductions (Naperville & Crest Hill), WB & EB 0.35 mg/L
	8	Seasonal TP Limit	WWTP Discharge seasonal TP: 0.35 mg/L May–Oct, 0.50 mg/L Nov–Apr
	9	TP Limit	WWTP Discharge TP 0.50 mg/L
	10	Targeted TP Limit	WB & EB 0.35, EB median flow, LD WWTPs 0.50 mg/L, Camelot no change
	11	Targeted TP Limit	WB & EB 0.35, EB median flows, LD dischargers at 0.50 mg/L, Camelot no change, Naperville and Bolingbrook at 0.35 mg/L

Note:
[a] Most scenarios include the combined impact of effluent TP reductions along the East and West Branches upstream.

7.2.10 Identifying WWTP Limits to Meet Instream TP Threshold

An essential aspect of this NIP is the identification of a watershed-specific TP concentration to facilitate removal of DO and offensive condition impairments in the DuPage River and Salt Creek watersheds. Using the updated IPS Tool, the DRSCW and LDRWC have derived that an instream TP concentration of 0.106–0.277 mg/L would be conservatively protective of aquatic communities that meet the Illinois General Use standard; therefore, they had set a TP concentration of 0.28 mg/L as the watershed-specific target (or threshold) (Section 5.1). Using the calibrated QUAL2Kw models, the DRSCW and LDRWC simulated instream TP concentrations following the implementation of lower TP effluent limits at all watershed WWTPs. Two TP effluent limit management scenarios were modeled: 0.50 mg/l and 0.35 mg/L (reflecting a 0.40 mg/L and 0.28 mg/L effective effluent concentration).

The 0.50 mg/L effluent limit was included in this analysis because it is an interim effluent level agreed to by the various pertinent partners in Illinois to be achieved by 2030. In 2018, a "three-party agreement" was approved by the Illinois Association of Wastewater Agency (IAWA), the IEPA, and environmental advocacy groups; it sets out a path for most of the major WWTPs in Illinois to meet an effluent limit of 0.50 mg/L TP annual geometric mean on a rolling 12-month basis, beginning January 1, 2030 (unless certain factors are present, including the necessity of chemical removal [in which case the date becomes 2025] or the use of biological nutrient removal (BNR) [in which case the date becomes 2035]). Additionally, an effluent limit of 0.50 mg/L would meet the objectives for point sources set out by the Illinois Nutrient Loss Reduction Strategy (Illinois NLRS). The Illinois NLRS has a goal of a statewide reduction of TP of 25% by 2025 and a long-term reduction of 45% reduction; if all major WWTPs in the state meet an effluent limit of 0.50 mg/L, the goals for point sources set forth in Illinois NLRS would be met. The 0.50 mg/L TP effluent limit was modeled as a concentration of 0.40 mg/L TP with the understanding that each WWTP typically sets a 20% safety factor, thus yielding an effluent limit of 0.50 mg/L TP, which would result in an effective mean concentration of 0.40 mg/L TP..

As a means of determining the reductions in effluent discharges of TP that would be needed to meet the instream watershed-specific TP threshold of 0.277 mg/L, an effluent limit of 0.35 mg/L TP was used in the analysis. The 0.35 mg/L TP effluent limit was modeled as an effective effluent concentration of 0.28 mg/L TP with the understanding that each WWTP typically sets a 20% safety factor. Table 43 illustrates the predicted instream concentrations from water quality modeling at the 75th percentile daily average TP concentrations for both the 0.50 mg/L and the 0.35 mg/L scenarios for May–October. The 75th percentile of daily average concentrations rather than the mean is used to compensate for several factors: the annual variation in background instream TP storm concentrations and flows, the uncertainty about the scale and frequency of TP concentrations above the mean and their impact, and the inherent inaccuracy in modeling ambient systems.

The annual variation in background mean TP concentrations appears relatively small (around 0.05 mg/L based on 2007–2021 bioassessment data) (see Section 6, Existing Phosphorus Conditions and Sources). In all watersheds, and in all years, urban TP means were higher than medians (by an average of 0.05 mg/L), suggesting that a small number of relatively concentrated urban TP spikes were disproportionately important in effecting means. The majority of the variation in instream dilution of effluent is a function of storm flow volume. This is especially important when considering the East Branch calibration year results (2019), when storm flow in the model calibration year was the highest average annual average storm flow observed in the East Branch for the 2000–2021 period. Streamflows in the other waterways for the model calibration years were more representative of mean streamflows. The West Branch and the Lower DuPage were both approximately at the 75th percentile of annual average streamflows, and Salt Creek was slightly less than the median of annual average streamflows (all for the 2000–2020 period). However, even in these cases, caution is warranted. In the Lower DuPage River, for example, dilution from urban flows would have been less in 15 of the last 20 years. As the dilution factor present in the East Branch model was the maximum observed for 2000–2020, the East Branch data presented in Table 43 is from a model run where the urban flow input was modified to match the basin median storm flow figures. In the 2019 calibration run, urban sources accounted for 71% and point sources accounted for 29%. In the median dilution scenario, nonpoint sources are 60% and point sources are 40% of total streamflow.

Table 43. 75th percentile of daily average TP concentrations (May–October) by reach and scenario

75th Percentile of daily average TP concentration from May to October, by reach (for each waterway and key scenario reduction in effluent TP concentrations)												
Reach	East Branch DuPage[1]			West Branch DuPage			Salt Creek			Lower DuPage[2]		
	Baseline	0.50 Scenario	0.35 Scenario[3]	Baseline	0.50 Scenario	0.35 Scenario[3]	Baseline	0.50 Scenario	0.35 Scenario[3]	Baseline	0.50 Scenario[3]	0.35 Scenario
1	1.99	0.29	0.22	0.20	0.20	0.20	2.80	0.33	0.24	1.06	0.22	0.18
2	1.64	0.24	0.19	2.62	0.38	0.27	2.67	0.32	0.23	1.25	0.24	0.21
3	1.50	0.27	0.20	2.74	0.37	0.27	2.09	0.33	0.24	1.14	0.22	0.20
4	1.24	0.22	0.17	2.68	0.36	0.26	1.95	0.29	0.21	1.08	0.22	0.19
5	1.09	0.20	0.16	2.73	0.34	0.25	1.84	0.28	0.21	1.09	0.22	0.19
6	1.09	0.22	0.18	2.47	0.31	0.23	1.76	0.28	0.21	1.07	0.22	0.19
7	1.09	0.22	0.18	2.15	0.29	0.22	1.69	0.27	0.21	1.03	0.21	0.19
8	1.42	0.26	0.20	2.04	0.30	0.22	1.61	0.26	0.20	1.02	0.22	0.19
9	1.38	0.25	0.19	2.02	0.31	0.22	1.43	0.25	0.19	1.00	0.21	0.19
10	1.18	0.22	0.17	1.96	0.30	0.22	1.43	0.25	0.19	0.99	0.21	0.19
11	1.76	0.26	0.20	1.74	0.27	0.20	1.35	0.24	0.19	0.97	0.21	0.19
12	1.69	0.26	0.20	1.72	0.27	0.20	1.34	0.24	0.19	0.96	0.21	0.19
13	1.52	0.25	0.20	1.66	0.27	0.20	1.34	0.24	0.19	0.94	0.21	0.19
14	1.47	0.25	0.20	1.49	0.28	0.22	1.31	0.24	0.19	0.92	0.21	0.19
15	1.45	0.27	0.21	1.48	0.28	0.22	1.30	0.24	0.18	0.92	0.21	0.19
16	1.51	0.27	0.20	1.45	0.28	0.22	1.23	0.22	0.18	0.90	0.20	0.19
17	1.54	0.26	0.20	1.45	0.28	0.22	1.21	0.22	0.18	0.88	0.20	0.19
18	1.46	0.25	0.19	1.43	0.27	0.22	1.19	0.22	0.17	0.88	0.20	0.18
19	1.32	0.24	0.19	1.30	0.26	0.21	1.13	0.23	0.18	0.87	0.20	0.18
20	1.24	0.23	0.19	1.18	0.24	0.20	-	-	-	0.85	0.20	0.18
21	-	-	-	1.00	0.23	0.19	-	-	-	0.82	0.20	0.19
(red)		≥ 0.28 mg/l										
(orange)		= 0.27 mg/l										
(yellow)		= 0.26 mg/l										

Notes:
Colors represent proximity to (yellow or orange) or exceedance of (red) upper limit of IPS threshold. For Lower DuPage, the scenario outcome is also a product of the same scenario being implemented in the upstream branches.
[1] Although streamflows observed during the simulation year for the East Branch were higher than usual, sensitivity testing was conducted to ensure that a median flow year produces negligible difference in model results.
[2] For both the 0.35 mg/L and 0.50 mg/L scenarios for the Lower DuPage, upstream conditions were held at the 0.35 mg/L scenario for both the East and West Branches.
[3] Selected scenario for each respective waterway.

As shown in Table 43, in the East Branch, West Branch, and Salt Creek watersheds, an effluent discharge limit of 0.50 mg/L does not meet the instream threshold of 0.28 mg/L TP in all stream reaches some 75th percentile of the time to allow for an additional margin of safety. Therefore, this management scenario was not developed further for the DRSCW watersheds. Figure 69 to Figure 71 show the simulated instream TP concentrations for the calibrated baseline model and the 0.35 mg/L TP reduction scenario compared on a reach-by-reach basis for East Brach, West Branch, and Salt Creek. The 0.35 mg/L TP scenarios achieve the instream threshold of 0.28 mg/L TP for all reaches as averaged across the growing season in these watersheds. An additional statistical evaluation was conducted to ensure instream TP thresholds were achieved during 75% of the growing season to provide an extra margin of safety.

In the Lower DuPage River watershed, an effluent discharge limit of 0.50 mg/L by WWTPs discharging directly to the mainstem of the Lower DuPage River was simulated to meet the instream threshold of 0.28 mg/L TP in all stream reaches. This is due to the increased dilution from urban flows and assimilation capacity moving downstream, which is attributed to the 0.35 mg/L effluent limit being implemented at the East Branch and West Branch WWTPs located upstream.

Figure 72 shows simulated instream TP concentrations for the calibrated baseline model and the 0.50 mg/L TP reduction scenario on a reach-by-reach basis for the Lower DuPage River watershed. The 0.50 mg/L TP scenario for mainstem WWTPs achieves the instream threshold of 0.28 mg/L TP for all reaches as averaged across the growing season in this watershed.

The Crest Hill West WWTP discharges to a Lower DuPage River tributary, Rock Run. Although Rock Run was not explicitly simulated in QUAL2Kw, in order for Rock Run to meet the instream threshold of 0.28 mg/L TP, it is expected that the Crest Hill West facility would need to meet a 0.35 mg/L TP effluent limit as is the case for all other facilities located on tributaries in these watersheds.

A TP concentration limit of 0.35 mg/L was determined to be applicable for treated effluent from member WWTPs in the East Branch DuPage River, West Branch DuPage River, and Salt Creek. A higher WWTP TP concentration limit of 0.50 mg/L was determined to be appropriate for the mainstem Lower DuPage River due to increased dilution and assimilative capacity moving downstream and the reliance on the aforementioned proposed WWTP TP reductions upstream on the East and West Branches.

Complete documentation for all scenario applications and results can be found in the Scenario Report (Tetra Tech 2023a).[16]

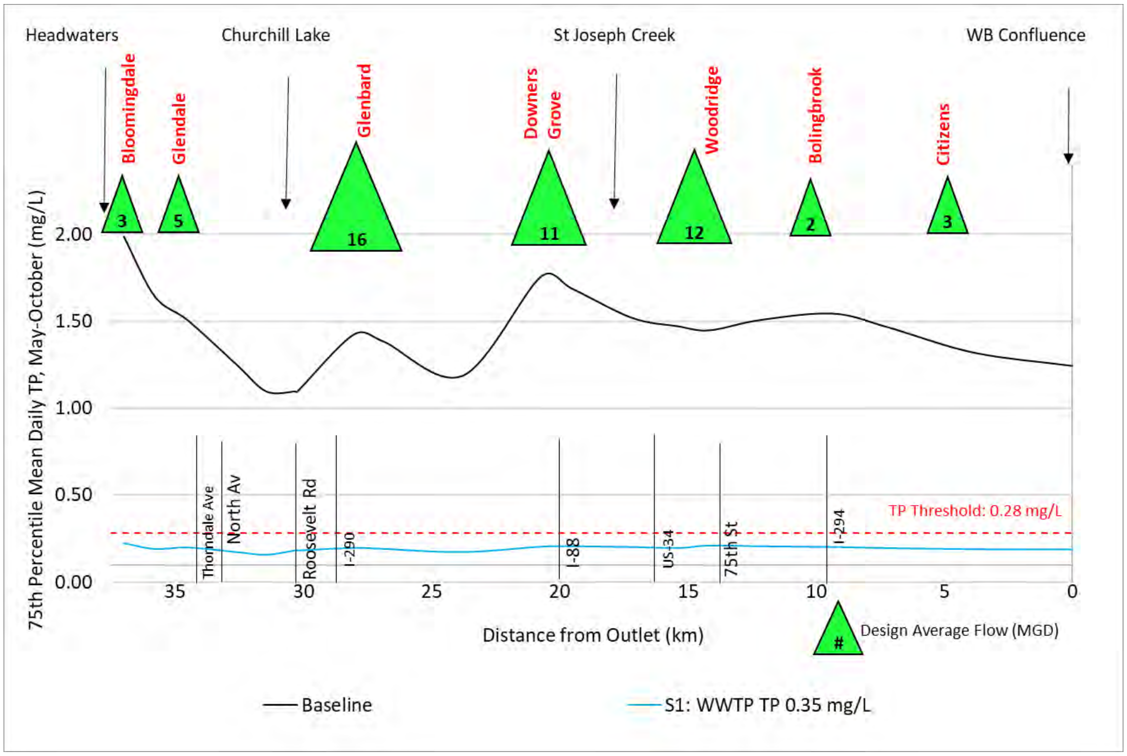


Figure 69. May–October 75th percentile daily average TP concentration longitudinally along East Branch DuPage River for baseline and selected management scenario (WWTP limit of 0.35 mg/L TP).

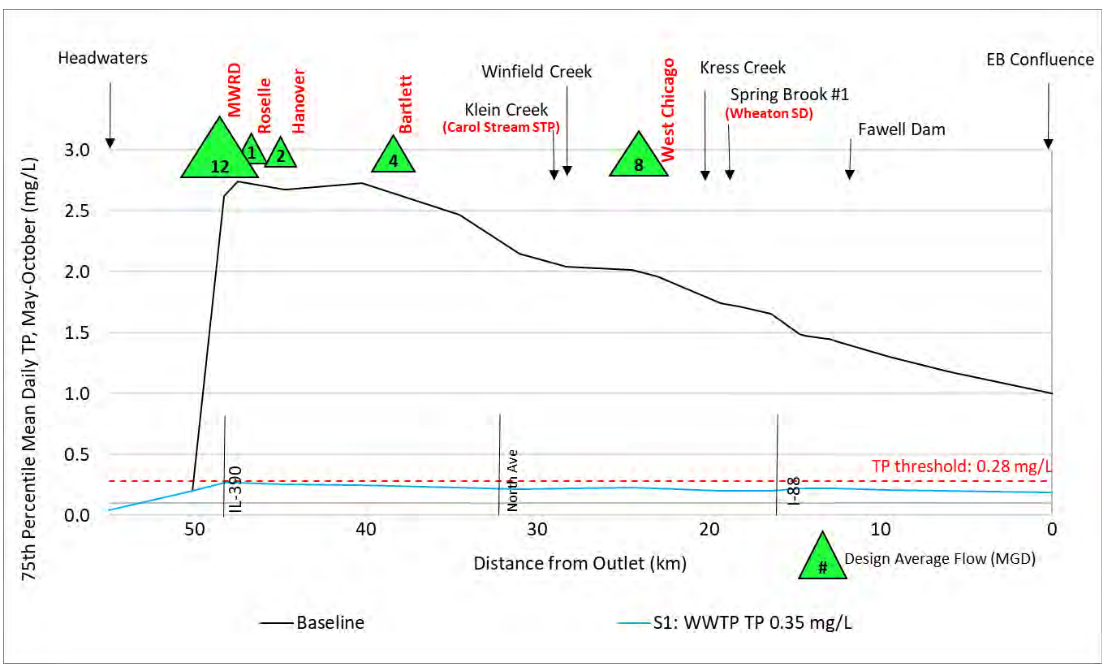


Figure 70. May–October 75th percentile daily average TP concentration longitudinally along West Branch DuPage River for baseline and selected management scenario (WWTP limit of 0.35 mg/L TP).

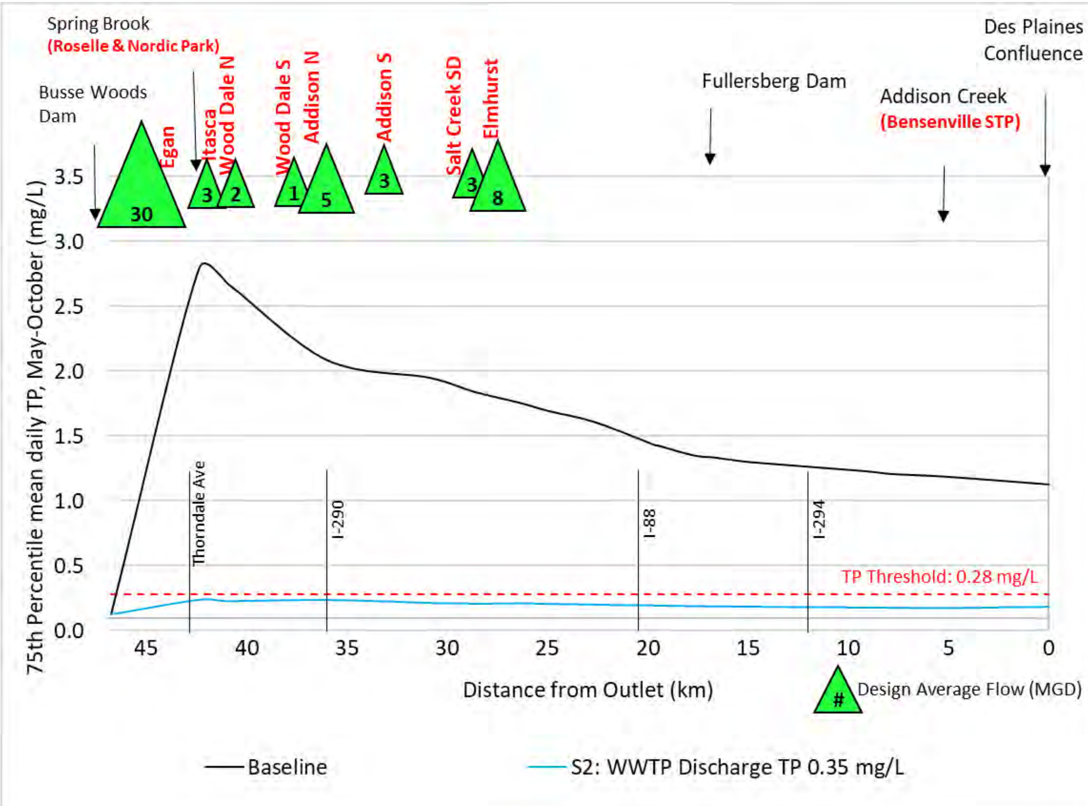


Figure 71. May–October 75th percentile daily average TP concentration longitudinally along Salt Creek for baseline and selected management scenario (WWTP limit of 0.35 mg/L TP).

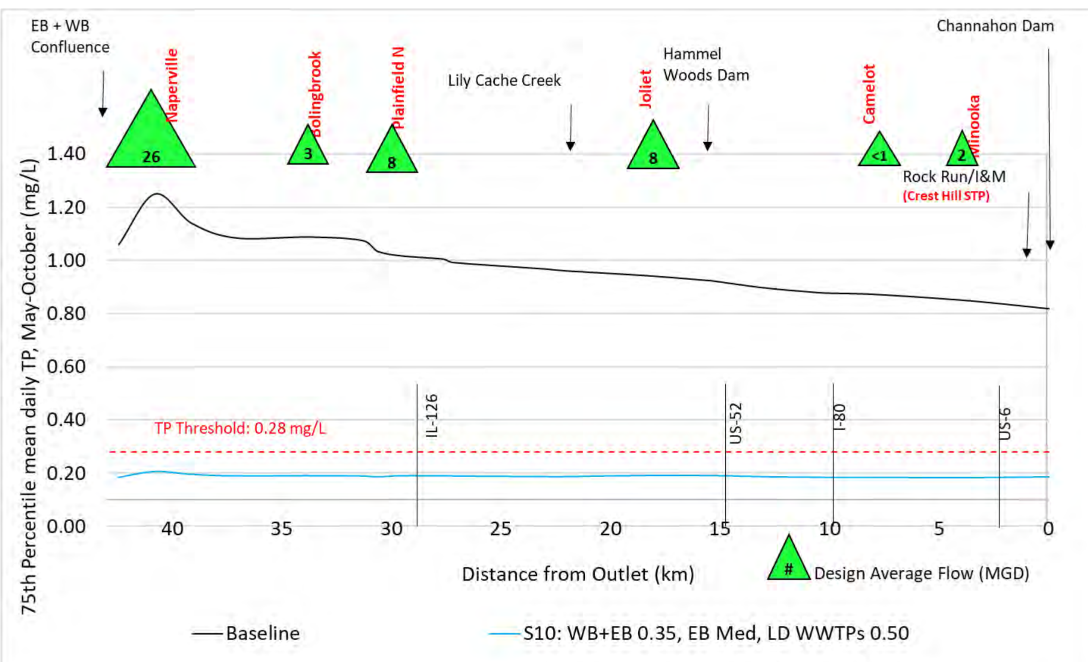


Figure 72. May–October 75th percentile daily average TP concentration longitudinally along Lower DuPage River for baseline and selected management scenario (WWTP limit of 0.50 mg/L TP).

7.3 DOWNSTREAM IMPACTS OF TP MANAGEMENT

As discussed in Section 5.1 (Deriving a TP Threshold Protective of Aquatic Life), the watershed-specific instream threshold of 0.28 mg/L TP was developed to be protective of aquatic communities that meet the Illinois General Use standard. However, the negative impacts of nutrient loading should also be considered downstream of the DuPage River and Salt Creek watersheds in the Illinois River, Mississippi River, and Gulf of Mexico. Consideration of nutrient conditions at the downstream end of the DuPage and Salt watersheds is integral to the larger goals of the USEPA Mississippi River and Gulf of Mexico Hypoxia Task Force. Simulated instream TP concentrations at the terminal reach of each waterway illustrate the decreases from baseline conditions relative to the selected scenario conditions (Table 44). Baseline and selected scenario results show the significant decreases in TP concentrations at the downstream end of each waterway based on TP limit reductions to 0.35 mg/L (East Branch, West Branch, Salt Creek) and 0.50 mg/L (Lower DuPage). Depiction of results at the outlet of each waterway are shown for both the more conservative, 75th percentile of daily average TP concentrations for May–October as well as the more typical conditions of May–October average of daily means.

Table 44. Simulated TP concentrations for each waterway terminal reach for baseline and various selected scenarios (May–October)

Reach Outlet	Baseline		Effluent limit 0.35 mg/L TP		Effluent limit at 0.35 mg/L TP for DRSCW WWTP and 0.50 mg/L TP for LDRWC	
	75th Percentile	Mean	75th Percentile	Mean	75th Percentile	Mean
East Branch	1.24	0.90	0.19	0.17	-	-
West Branch	1.00	0.73	0.19	0.17	-	-
Salt Creek	1.13	0.94	0.18	0.17	-	-
Lower DuPage	0.82	0.66	0.19[a]	0.15[a]	0.20	0.17

Note:
[a] This scenario was not selected, but the results are included to show predicted instream TP concentrations if the Lower DuPage River also adopted the 0.35 mg/L TP limit.

NSAC recommends a 0.113 mg/L instream TP concentration for wadeable north ecoregion waterways with 95% confidence intervals of 0.193 mg/L (upper) and 0.033 mg/L (lower) (Section 2.4.2). The simulated average May–October TP concentrations at the terminus of the Lower DuPage River at its confluence with the Des Plaines River for the selected scenario is 0.17 mg/L, which is within the confidence intervals of the recommended TP limit identified by NSAC. The simulated average May–October TP concentrations at the terminus of Salt Creek, based on the 0.35 mg/L WWTP TP management scenario, are also predicted to be within the confidence intervals recommended by NSAC (at 0.17 mg/L). Based on these management scenario evaluations, it is concluded that the proposed TP limits for WWTP dischargers are sufficiently protective of downstream conditions.

8 FEASIBILITY OF INCREASING TP CAPTURE FROM URBAN STORMWATER WASH-OFF

Ambient TP concentrations resulting from stormwater-driven sources (urban runoff and naturally occurring background conditions) are covered in Section 5.0. This “urban” TP has multiple potential sources, including organic matter (leaves, flowers, pollen, lawn clippings), animal feces, lawn fertilizers, atmospheric dust deposition, and soil erosion (Berretta and Sansalone 2011; Waller 1977). In urban environments, impervious surfaces like roadways decrease natural infiltration capacity while concentrating stormwater runoff, which can increase the speed and total load of TP to storm sewers. Storm sewer systems lead directly to flowing surface waters with little to no pollutant capture or reduction protections. Introducing pollutant capture for TP derived from urban stormwater is complex and difficult to implement on a large scale. Structural BMPs like bioretention cells can have limited application on a large scale because they compete for valuable and limited urban space. Structural BMPs require regular maintenance and may become TP sources themselves (Taguchi et al. 2020; Erickson et al. 2022). Structural BMPs may also be ineffective during periods of high precipitation outside of their design parameters, perhaps most critically during spring and fall, which are seasons of ecological importance for aquatic life egg laying and high stormwater TP loading stormwater, respectively.

Structural BMP applicability faces financial and technical issues (available space, system performance, maintenance, prevalence of dissolved phosphorus). Additionally, structural BMPs address loading that has arrived downstream through conveyance rather than reducing phosphorus loading at the source. DRSCW and LDRWC have elected to focus this NIP on methods for nonpoint source phosphorus load reduction potential which target source loading such as leaf management and street sweeping. This NIP advocates for a practical approach to managing urban TP loading that is not reliant on the constraints and potential issues associated with a large, expensive, diffuse network of structural BMPs.

8.1 STREET SWEEPING AND LEAF LITTER COLLECTION STUDY

DRSCW and LDRWC assisted with funding of USGS studies on urban stormwater wash-off to better understand urban TP loading sources and transport (Selbig 2016). This intensive urban stormwater runoff monitoring from residential areas suggests that nearly 60% of annual warm-weather TP loading occurs in the fall, associated with leaf litter biomass (Figure 73). The study found that 59% of TP leaching from leaf litter biomass was in the dissolved fraction. Dissolved phosphorus is the most bioavailable form of TP for aquatic algae growth, but it is also the most difficult TP form to capture using structural BMPs. The USGS study was conducted to measure the impact of various intervention practices to keep bioavailable dissolved phosphorus out of the stormwater system, as compared to basins where no intervention practices are conducted. For the study, the interventions conducted included complete organic material removal via weekly, pre-precipitation event street sweeping and leaf litter collection from the entire catchment area monitored. While this level of high-intensity leaf litter and street sweeping management is likely not feasible for municipal agencies, results should represent the maximum TP reduction potential for these invention methods for urban stormwater wash-off. After a calibration period in 2013 to establish baseline TP concentrations for the two study basins, interventions of intensive street sweeping and litter collection were conducted in 2014 within the “test” catchment, while no interventions were conducted within the “control” catchment (Figure 74). Results from October indicate that these interventions reduced the mean total and dissolved phosphorus concentrations in the test catchment by approximately 80% (relative to baseline conditions in that catchment measured during the 2013 “calibration” phase in 2013).

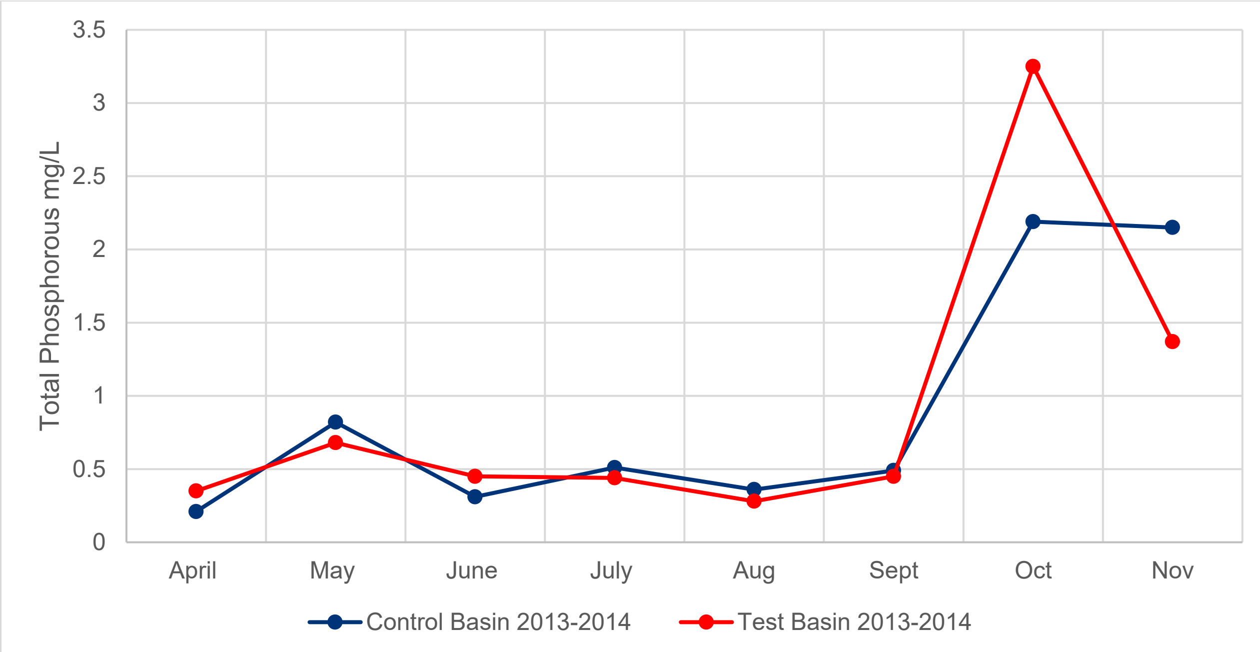


Figure 73. Mean monthly stormwater TP concentrations for two urban drainage areas observed 2013–2014 to establish baseline concentrations before any mitigative measures for TP removal.

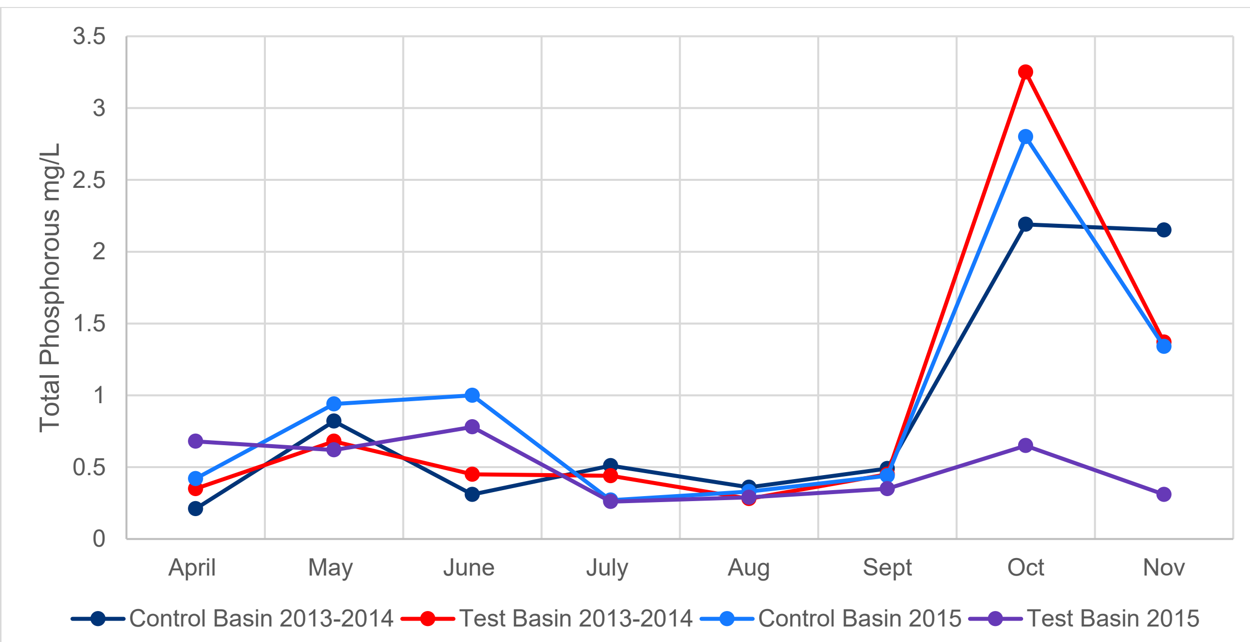


Figure 74. Mean monthly stormwater TP concentrations for two urban drainage areas before (2013–2014) and after (2015) mitigative measures for TP removal were applied to the test basin only.

Urban stormwater TP source-reduction practices like street sweeping and leaf litter collection used in the study are already ubiquitous in the watersheds and municipal budgets. Agencies that manage public road systems often engage in some amount of street sweeping either manually by hand or mechanical broom, or with vehicles such as regenerative air or vacuum filters. Such practices are understood to improve aesthetics, remove potential driving hazards, and keep storm sewer grates free from debris, which can lead to unsafe flooding conditions (per interviews with multiple public works departments). While performing these functions, street sweeping also captures pollutants from the road surface that would otherwise enter surface water.

Street sweeping activities have been identified through research as being critical to TP reduction from stormwater runoff. A 2020 study found that streets swept on a biweekly basis had approximately 21% more TP in stormwater compared to those swept more frequently (weekly basis) (Selbig et al. 2020). In this same study, where only leaf litter collection activities were conducted without street sweeping, there was no significant reduction observed in stormwater TP concentrations. Because leaves can leach phosphorus quickly, the study concluded that the actions of leaf collection and street sweeping on their own or together are less significant than their *frequency of implementation*. More frequent sweeping or leaf pickup meant that leaves did not have as much time to fragment and leach in stormwater wash-off.

8.1.1 Baseline TP Loading from Stormwater Wash-off for DuPage River and Salt Creek Watersheds

To better understand and quantify current conditions in the DuPage River and Salt Creek watersheds, the study developed a high-resolution geospatial dataset of "effective canopy cover." Effective canopy cover is a measure of tree canopy density and overhang over roadways and has been shown to be a major predictive factor in TP loading from urban areas (Hobbie et al. 2023). The geospatial canopy map allowed for the calculation of effective canopy cover by both location and land use type (Figure 75).

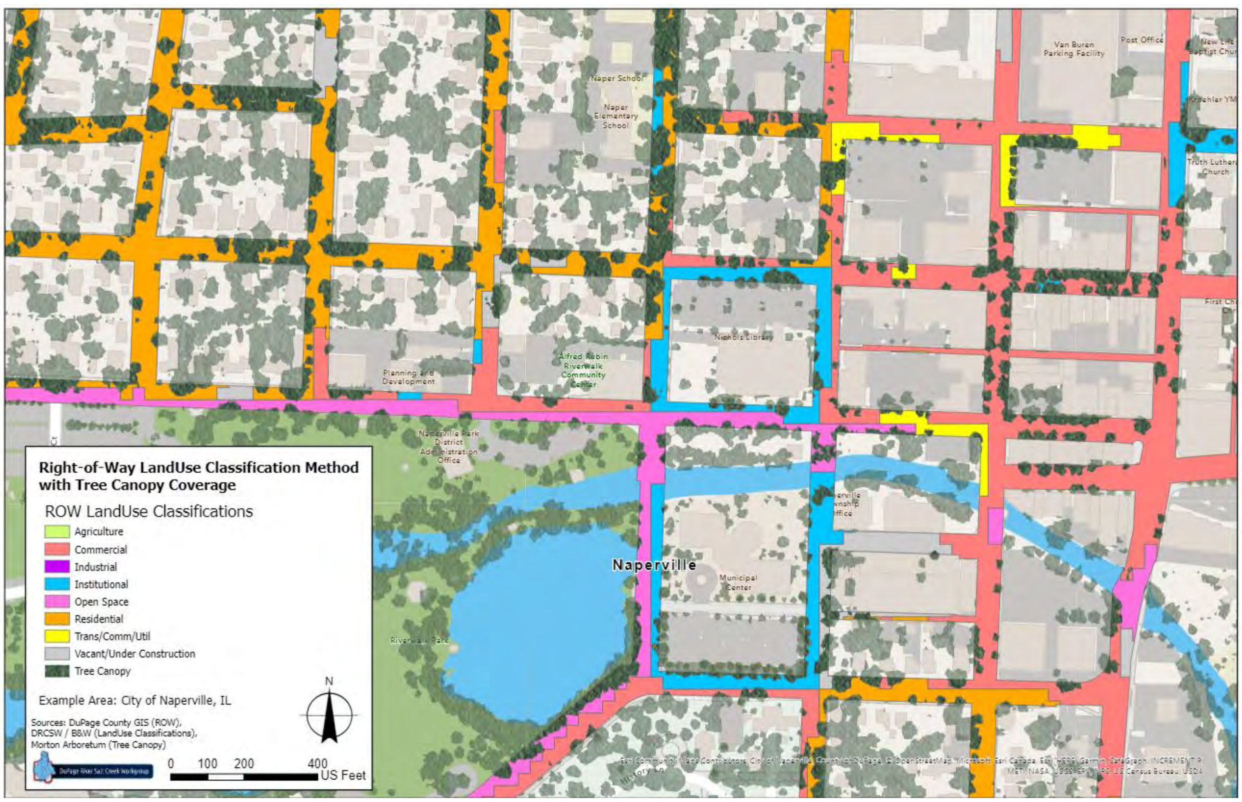


Figure 75. Land use classification and urban tree canopy geospatial data for the city of Naperville, IL.

A total of 95 agencies responsible for roadway maintenance activities were identified in the DuPage River and Salt Creek watersheds, managing a total right-of-way (ROW) area of 82.4 square miles. Of this total ROW area, 19.1 square miles were identified as covered by tree canopy, giving the entire watershed ROW area an average of 23.2% effective canopy cover across all roads, land use types, and communities/townships/agencies. An example of one of the many ways the geospatial canopy data could be analyzed relates to the "residential" land use type. Within residential areas (which account for most of the effective canopy coverage), effective canopy coverage ranges from as high as 62% to as low as 1%. Because of this wide range, the data suggests that effective canopy coverage should be used on a finer scale (such as at the agency level) rather than on a watershed scale when determining the allocation of resources for street sweeping and leaf litter collection. This type of data evaluation was crucial to understanding methods and recommendations to meet the NIP's objective of reducing TP loading to waterways.

8.2 STREET SWEEPING EFFORTS IN DUPAGE RIVER AND SALT CREEK WATERSHEDS

A questionnaire was sent to all 95 communities, townships, and agencies that operate a transportation network (roads) across the DuPage River and Salt Creek watersheds to collect data on the current implementation levels of street sweeping and leaf litter management. Responses to the questionnaire represent 77% of the area in the DuPage River and Salt Creek watersheds. The questionnaire focused on the existence of street sweeping programs and specific information about their data collection methods, routes, and frequencies. The questionnaire responses and effective canopy cover data were used to populate the Minnesota Pollution Control Agency Street Sweeping Tool[17] to estimate total load reductions from street sweeping activities.

Based on results from this evaluation, it is estimated that current practices across the watersheds remove approximately 7,000–12,000 lbs of TP per year at the 25th and 50th percentiles. Except for three agencies, all municipalities that responded to the survey have a street sweeping program in place, whether in-house or contracted out. Routes and frequency of street sweeping vary by agency and throughout the year, with most agencies increasing frequency in the spring, summer, and fall months. The three agencies that do not operate a street sweeping program are townships.

Except for four townships, all municipalities that responded to the questionnaire have an existing leaf litter collection program, whether in-house or contracted out. Routes and frequency of leaf collection vary by agency and throughout the year; however, 15 of the 48 responding communities already time the street sweeping to occur after leaf collection. Additional and specific details on the background, methodology, and recommendations of this study can be found in the *Non-Point Source Phosphorus Reduction Feasibility Analysis* report available on the DRSCW website (DRSCW 2021).

Road agencies in the DuPage River and Salt Creek watersheds already conduct various levels of street sweeping and leaf litter collection activities, which provide TP reduction from urban stormwater wash-off. In total, these two watersheds produce approximately 1,441,000 lbs of TP per year from all potential TP sources. Of that total, 83% of the load (about 1,201,000 lbs) is attributed to WWTPs. Based on the study, street sweeping and other current urban stormwater wash-off interventions capture approximately 7,000–12,000 lbs of TP reduction per year. Even at the 50th percentile, street sweeping and leaf litter collection methods within the DuPage and Salt watersheds capture an amount equal to only 1% of the total annual loading from WWTPs. Given that street sweeping activities are already conducted across these watersheds, this evaluation indicates that additional efforts to increase the capture of urban stormwater-derived TP through street sweeping and leaf litter collection would have a negligible impact on overall watershed TP loading.

Although the effect of watershedwide street sweeping activities on total TP loading is relatively insignificant, a reduction of urban sources of TP may be the best option for tributaries that receive only urban (non-WWTP) flow. As was shown in Section 6.2 and the box plots in Figure 46 through Figure 49, sites that are subject only to urban flow already achieve the protective range of TP concentrations adopted by this NIP. It is assumed for the purposes

[17] https://stormwater.pca.state.mn.us/index.php?title=Street_Sweeping_Phosphorus_Credit_Calculator

of this NIP that existing programs for street sweeping and leaf litter collection practices will continue in these locations at the same approximate intensity in the future.

Although TP load reductions attributed to urban stormwater wash-off mitigation measures are dwarfed by the potential reductions from WWTPs, it is possible that as the total TP load declines over time, the importance of urban stormwater reductions will increase. Both street sweeping and leaf litter collection activities have significant benefits other than TP load mitigation, including reduction of storm drain clogging due to organic and sediment debris, reduction of de-icing material wash-off associated with snow and ice management (upcoming DRSCW report), and reduction in particle-bound heavy metals and petroleum hydrocarbons (Miller et al. 2016), among others.

8.3 OPTIMIZING STREET SWEEPING AND LEAF LITTER COLLECTION.

Prevailing literature indicates that street sweeping can be a multi-benefit practice that could provide even greater reductions in TP and other pollutants when optimized for targeted application both spatially and temporally; many techniques for this are still being developed and improved (Hobbie et al. 2023; Ragazzi et al. 2023; Parsons 2023). Such optimizations are beyond the scope of this NIP, and it is recognized that optimizing for TP alone may degrade other benefits. However, certain optimization steps can be suggested, which may increase TP capture while not increasing cost or creating unforeseen environmental impacts such as more metal or chloride loading. These strategies are given below as suggestions. Implementing these suggestions is not required for NIP to succeed in meeting the goal set out in Section 4.1. Specific recommendations for improving current street sweeping and leaf litter collection efforts in the DuPage River and Salt Creek watersheds are detailed below and include increased use of weather forecasting in fleet deployment, spatial prioritization based on canopy cover, the timing of street sweeping after leaf collection, increased frequency during leaf month months, expansion of leaf litter collection programs, and continued public education and outreach.

8.3.1 Increasing Use of Weather Forecasting

Weather forecasting can be used to manage the timing of leaf collection activities. Collecting leaves before storm events will prevent leaves from washing into storm drains and reduce the total leached TP in runoff. Utilizing weather forecasting also has the added benefit of ensuring storm drains are clear before rainfall events that could cause localized flooding if blocked by debris. While it may be infeasible to sweep all roads in a large community before a storm, areas with higher tree canopy coverage could be generally prioritized at a low cost to the program.

8.3.2 Prioritizing based on Canopy Cover

A geospatial inventory of urban tree canopy cover in the ROW was developed for the DRSCW and LDRWC watersheds and for each community and township therein. Prioritizing street sweeping efforts in areas with relatively high canopy cover would increase the efficiency of removing TP from stormwater runoff. Cost increases from more street sweeping in high-canopy-cover areas could be offset by reducing the sweeping frequency in low-canopy areas. The prioritization of sweeping areas will also need to be balanced with the other objectives of street sweeping.

8.3.3 Timing after Leaf Collection

Street sweeping activities that occur after leaf collection activities remove residual leaf litter remaining the roadway before storm events. Changing the street sweeping schedules to align with leaf collection (both spatially and temporally) may not impact program cost to the extent that it can be performed by existing personnel and budget.

8.3.4 Increasing Frequency in Leaf Collection Months

Increasing the frequency of street sweeping during leaf collection months (spring and fall) would result in higher capture of leaf litter deposited between storm events. Higher frequency would capture more leaf litter volume, thus better preventing leaves and associated TP loading from entering the storm drain system. Increases in seasonal sweeping frequency could be offset by decreased sweeping during summer and winter to reduce cost impacts from modified scheduling.

8.3.5 Expanding Leaf Litter Collection Programs

For agencies without leaf collection programs, it is recommended that such a program be implemented in conjunction with an existing street sweeping program to maximize potential TP reduction from stormwater wash-off with these preventative measures. Where leaf litter collection programs are already present, there may be opportunities to adjust existing practices to better coordinate with street sweeping efforts.

8.3.6 Public Education Outreach

Public outreach materials (social media, emails, and mailers) can educate communities on the combined impacts of leaves and phosphorus on water quality. Outreach materials should provide information tailored to both residential homeowners and landscape maintenance companies regarding proper disposal and handling practices of landscape waste.

9 RECOMMENDATIONS AND IMPLEMENTATION

The following recommendations are made:

A. Target an ambient mean TP concentration of less than 0.277 mg/L during May–October in the basins of the DuPage River and Salt Creek while improving the streams' physical conditions to enhance aquatic life and reduce or eliminate remaining DO sags.

B. Continue the rotating watershed Bioassessment.

C. Update and continue holistic data analysis.

D. Develop proposed refinement of biological endpoints for Illinois urban areas.

E. Update adaptive management plan to reflect implemented NIP recommendations and the phasing out of Projects Assessments.

9.1 IMPLEMENTATION OF RECOMMENDATIONS

9.1.1 Recommendation A

Recommendation A. Target an ambient mean TP concentration of less than 0.277 mg/L during May–October in the basins of the DuPage River and Salt Creek while improving physical conditions to enhance aquatic life (QHEI) and reduce or eliminate remaining DO sags. These goals will be achieved by having:

I. QHEI and physical DO enhancement projects continue to be strategically implemented.

II. WWTPs discharging to the West Branch, East Branch and Salt Creek watersheds and to tributaries on the Lower DuPage (Crest Hill) adopt an NIP permit limit of 0.35 mg/L in May–October to be part of an annual geometric mean of 0.5 mg/L.

III. WWTPs discharging to the mainstem of the Lower DuPage adopt a permit limit of 0.5 mg/L annual geometric mean.

Recommendations A I, II, and III will be implemented simultaneously in the DRSCW and LDRWC watersheds to achieve multiple priorities, including improving QHEI; cost-effectively removing DO and offense condition impairments via physical projects (as predicted by the QUAL2Kw models); and reducing ambient TP concentrations to beneath the NIP threshold described in Section 5.1.

Recommendation A will be accomplished by continuing the DRSCW/LDRWC Special Conditions, with the NIP Special Conditions set out herein starting as the current permit condition ends (2025). Under the Special Conditions, participating WWTPs have the flexibility to temporarily contribute monetary resources (project assessments) rather than meeting the NIP-recommended TP effluent limit immediately. Project assessments will be used to implement physical stream enhancement projects (project assessments generated under the NIP will be referred to as the NIP project assessments).

Funding for implementing the QHEI and DO amelioration projects is in lieu of operations and maintenance (O&M) costs for TP removal, so the physical projects are scheduled to be implemented before implementation of A II and A III. Table 45 (DRSCW) and Table 46 (LDRWC) show the schedule for the generation of the NIP project assessments for funding A I, with assessments being paid between 2026 and 2035 (years vary based on the individual plant) and then being phased out after 2035 as WWTPs move financial resources towards capital upgrades and O&M costs incurred for implementing A II and A III.

Proposed NIP project assessment amounts by agency, year and watershed group are shown in Table 47 and Table 48.

As in previous Implementation Plans (2015 and 2021), project assessment levels are based on O&M expenditures forgone through postponing different levels of TP removal treatment. These levels of treatment forgone are 1 mg/L monthly (2026–2030) and 0.5 mg/L annual geometric mean (2030–2035 inclusive), which are the treatment levels and schedule set out in the “three-party agreement” (Section 7.2.10) for the other major WWTPs in the State. Predicted O&M costs for these levels of treatment were provided in each WWTP’s feasibility study. Assessments are calibrated to be no more than 30% of the relevant O&M costs.

Having paid the last year of their 2022 Special Condition Extension in 2025, WWTPs only removing TP on the NIP schedule will start paying NIP project assessments in 2026, based on forgoing treatment to 1 mg/L TP effluent quality. WWTPs currently removing TP or moving to do so under their current permit will start paying assessments in 2030 based on the difference in O&M costs between treating to 1 mg/L TP effluent quality and 0.5 mg/L TP effluent quality. WWTPs only removing TP on the NIP schedule will see their project assessments increase in 2030 to reflect the larger costs forgone to treat to 0.5 mg/L TP effluent quality. The final NIP project assessment for all WWTPs would be paid in 2035, and the WWTPs would move into the Capital Upgrade Period (CUP), which is 2036–2037. The final two rows of Table 47 (DRSCW) and Table 48 (LDRWC) show the annual totals for NIP project assessments by year and the accumulated total. Provisional totals based on full participation of all WWTPs are $25,820,282 for the DRSCW watersheds and $2,202,298 for the LDRWC watersheds. These totals will be reduced if any participating WWTPs implement recommendations A II and III ahead of the schedule. NIP project assessments will fund the development and construction of a new priority list of essential Instream Improvements addressing physical QHEI and DO enhancement projects. Projects drawn from the 2021 IPS Tool will be generated and implemented for each watershed. A draft list of potential projects is given in Table 3 in Section 1.1.1. These will be further reviewed and refined by the DRSCW and LDRWC prior to the issuance of the NIP-based permits described below.

Table 45 shows the implementation schedule for TP limits for DRSCW members. Two DRSCW WWTPs (Bensenville and Itasca) are already operating at 1 mg/L monthly average TP. Per their current permit, Bartlett, Glendale Heights, West Chicago, and Wheaton Sanitary District will start implementing to 1 mg/L monthly average in 2025, 2025, 2025, and 2026, respectively. These plants, denoted by green highlighting in Table 45, will have Special Conditions 1 placed in the permit at their next renewal. All other DRSCW WWTPs not removing TP until 2038 (effective 2040) will have the TP permit limits and schedules in their current permits replaced with recommendation A as set out in Special Condition 1 below immediately.

Table 46 shows the Recommendation A implementation schedule for TP limits for LDRWC members. All LDRWC WWTPs will implement a 1 mg/L monthly average prior to implementing the NIP TP limit. Three LDRWC WWTPs (Joliet Aux Sable WWTP, Plainfield North STP, and Village of Minooka STP) are already operating at 1 mg/L monthly average. Per their permits, Bolingbrook STP #3, Naperville Springbrook WRC, and Crest Hill will move to implement the 1 mg/L monthly average by 2026, 2032, and 2026 respectively. These plants, denoted by green highlighting in Table 46, will have Special Conditions 2 placed in the permit at their next renewal. Paragraph E (see Special Condition 1, the section that sets out the limit, averaging period, and effluent limit) of Crest Hill STP’s NIP Special Condition permit would match that set out in the DRSCW Special Condition 1.

Implementation of both NIP recommended TP effluent limit recommendations include:

- The effective date for the NIP recommended effluent limits be May 1, 2040.
- All permits include a two-year CUP and a two-year Treatment System Optimization Period (TSOP).
    - The CUP is designed to allow the construction of facilities to meet the relevant NIP permit limit. The CUP would start no later than 2036.
    - A two-year TSOP is also included. During the TSOP, WWTPs would be actively removing phosphorus but would not be at risk of DMR violations of the effluent target. The TSOP is considered essential as both biological and chemical TP removal have been found to be

significantly influenced by changes in flow, temperature, and operational factors such as pH, hydraulic retention time (HRT), solid retention time (SRT), DO, salinity, and the supply of carbon. A two-year optimization period is recommended to allow feedback from the process and equipment and managerial procedures to be calibrated and practiced, thereby reducing the potential for a violation once the new TP limit becomes effective.

- The recommended reduction in TP loads may be redistributed amongst the WWTPs if modeling demonstrates that it would produce similar load reductions and TP concentration profiles as shown in Section 7.2.10.

The NIP implementation plan set out in Table 45 and Table 46 also maximizes the possibilities for adoption of biological phosphorous removal (BPR) and BNR. When permit limits for TP were broached in 2015, all WWTPs in the NIP area were considering chemical removal. This was partially a function of the proposed limit (1 mg/L monthly) and partially a function of the eminency of the limits. A survey in October 2023 (Figure 76) revealed that under the NIP plan, 13 of the 30 WWTPs covered by this NIP—representing 45% of total NIP design average flow (DAF)—are proposing to use BNR as their primary method of TP removal. Ten WWTPs (36% of total NIP DAF) are planning to use BPR removal, and seven (19% of total NIP DAF) will use chemical phosphorus removal.

Table 45. DRSCW current TP status and schedule for NIP project assessment and TP removal

Agency Members	IL NPDES	Current Permit TP (1.0 mg/L Monthly Average) Implementation Date (for Chemical Treatment)[a]	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
DuPage River Salt Creek Workgroup (DRSCW)																
Addison - AJ LaRocca	IL0027367	1/1/2029	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Addison - North	IL0033812	1/1/2029	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Bartlett	IL0027618	10/1/2025					Δ	Δ	Δ	Δ	Δ	Δ				
Bensenville	IL0021849	Already at 1.0 mg/L					Δ	Δ	Δ	Δ	Δ	Δ				
Bloomingdale	IL0021130	10/1/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Bolingbrook #1	IL0032689	9/23/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Bolingbrook #2	IL0032735	7/2/2029	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Carol Stream	IL0026352	10/1/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Downers Grove Sanitary District	IL0028380	8/1/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
DuPage County Greene Valley	IL0031844	9/1/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Elmhurst	IL0028746	8/1/2031	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Glenbard WW Authority	IL0021547	9/23/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Glendale Heights	IL0028967	10/1/2025					Δ	Δ	Δ	Δ	Δ	Δ				
Hanover Park	IL0034479	10/1/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Itasca	IL0026280	Already at 1.0 mg/L					Δ	Δ	Δ	Δ	Δ	Δ				
MWRDGC (Egan WRP)	IL0036340	12/9/2030	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
MWRDGC (Hanover Park)	IL0036137	12/9/2030	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Roselle - Botterman	IL0048721	9/23/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Roselle - Devlin	IL0030813	9/23/2028	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Salt Creek Sanitary District	IL0030953	5/2/2029	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
West Chicago	IL0023469	10/1/2025					Δ	Δ	Δ	Δ	Δ	Δ				
Wheaton Sanitary District	IL0031739	8/2/2026					Δ	Δ	Δ	Δ	Δ	Δ				
Wood Dale - North	IL0020061	8/1/2031	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				
Wood Dale - South	IL0034274	1/2/2030	▲	▲	▲	▲	Δ	Δ	Δ	Δ	Δ	Δ				

Note:
[a] Implementation date is one year later, if WWTP uses biological treatment. Date would be suspended under the NIP unless the column to the right is highlighted green.

Legend

TP removal to 1.0 mg/l removed from permit
TP removal to 0.5 mg/l excluded from permit
▲ Assessment paid in lieu of TP treatment to 1.0 mg/l
Δ Assessment paid in lieu of TP treatment to 0.5 mg/l
Capital upgrade period (for construction of facilities to meet lower TP limit)
Treatment system optimization period (TP removal operational and being optimized to meet 0.35 mg/L TP limit by May 1, 2040)
WWTP removing TP to 1.0 mg/l

Table 46. LDRWC current TP status and schedule for NIP project assessment and TP removal

Agency Members	IL NPDES	Current Permit TP (1.0 mg/L monthly average) Implementation Date (for Chemical Treatment)[a]	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Lower DuPage River Watershed Coalition (LDRWC)																
Bolingbrook STP #3	IL0069744	6/30/2026					Δ	Δ	Δ	Δ	Δ	Δ				
Crest Hill West STP	IL0021121	6/1/2027					Δ	Δ	Δ	Δ	Δ	Δ				
Joliet Aux Sable WWTP	IL0076414	Already at 1.0 mg/L					Δ	Δ	Δ	Δ	Δ	Δ				
Naperville Springbrook WRC	IL0034061	1/1/2032							Δ	Δ	Δ	Δ				
Plainfield North STP	IL0074373	Already at 1.0 mg/L					Δ	Δ	Δ	Δ	Δ	Δ				
Village of Minooka STP	IL0055913	Already at 1.0 mg/L					Δ	Δ	Δ	Δ	Δ	Δ				

Note:
[a] Implementation date is one year later, if WWTP uses biological treatment.

Legend

Δ Assessment paid in lieu of TP treatment to 0.5 mg/l

TP removal to 0.5 mg/l excluded from permit

Capital upgrade period (for construction of facilities to meet lower TP limit 0.35 mg/l for Crest Hill, 0.5 all others)

Treatment system optimization period (TP removal operational and being optimized to meet 0.5 mg/L TP limit by May 1, 2040)

Treatment system optimization period (TP removal operational and being optimized to meet 0.35 mg/L TP limit by May 1, 2040)

WWTP implementing TP removal to 1.0 mg/l

WWTP removing TP to 1.0 mg/l

Table 47. DRSCW proposed NIP project assessments

DuPage River Salt Creek Workgroup Proposed NIP Assessments October 10, 2023	Proposed Assessments based on 1.0 mg/L TP				Proposed Assessments based on 0.5 mg/L TP			NIP			
Current DRSCW Agency members	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Subtotal
Assessment (as % of O&M costs)	30%	30%	30%	30%	30%	30%	30%	30%	30%	30%	-
Addison	$ 86,311	$ 88,900	$ 91,567	$ 94,314	$ 116,969	$ 120,478	$ 124,092	$ 127,815	$ 131,649	$ 135,599	$ 1,117,694
Bartlett	-	-	-	-	26,151	26,936	27,744	28,576	29,433	30,316	169,156
Bensenville	-	-	-	-	22,138	22,802	23,486	24,190	24,916	25,664	143,196
Bloomingdale	38,752	39,914	41,112	42,345	64,322	66,251	68,239	70,286	72,395	74,567	578,183
Bolingbrook (#1 & #2)	101,232	104,269	107,397	110,618	117,345	120,865	124,491	128,226	132,073	136,035	1,182,551
Carol Stream	117,860	121,396	125,038	128,789	135,384	139,446	143,629	147,938	152,376	156,947	1,368,803
Downers Grove SD	223,259	229,956	236,855	243,961	256,110	263,794	271,707	279,859	288,254	296,902	2,590,657
DuPage County	63,093	64,985	66,935	68,943	250,682	258,202	265,948	273,927	282,144	290,609	1,885,468
Elmhurst	151,268	155,806	160,481	165,295	186,262	191,850	197,605	203,533	209,639	215,929	1,837,668
Glenbard WW Authority	325,146	334,900	344,947	355,296	372,990	384,179	395,705	407,576	419,803	432,397	3,772,939
Glendale Heights	-	-	-	-	38,769	39,932	41,130	42,364	43,635	44,944	250,774
Hanover Park	49,117	50,590	52,108	53,671	56,344	58,035	59,776	61,569	63,416	65,318	569,944
Itasca	-	-	-	-	23,953	24,671	25,412	26,174	26,959	27,768	154,937
MWRDGC	609,739	628,031	646,872	666,279	742,715	764,997	787,947	811,585	835,933	861,011	7,355,109
Roselle	19,659	20,249	20,857	21,482	29,473	30,357	31,267	32,205	33,172	34,167	272,888
Salt Creek SD	51,684	53,235	54,832	56,477	64,801	66,745	68,747	70,810	72,934	75,122	635,387
West Chicago	-	-	-	-	127,762	131,595	135,543	139,609	143,798	148,112	826,419
Wheaton SD	-	-	-	-	58,502	60,257	62,065	63,927	65,844	67,820	378,415
Wood Dale	62,918	64,806	66,750	68,753	72,177	74,342	76,572	78,869	81,235	83,672	730,094
Totals	$ 1,900,038	$ 1,957,037	$ 2,015,751	$ 2,076,223	$ 2,762,849	$ 2,845,734	$ 2,931,105	$ 3,019,038	$ 3,109,608	$ 3,202,899	$ 25,820,282
Cumulative totals	$ 1,900,038	$ 3,857,075	$ 5,872,826	$ 7,949,049	$ 10,711,898	$ 13,557,632	$ 16,488,737	$ 19,507,775	$ 22,617,383	$ 25,820,282	$ 25,820,282

Table 48. LDRWC proposed NIP project assessments

Lower DuPage River Watershed Coalition Proposed NIP Assessments December 31, 2023	Proposed Assessments based on 1.0 mg/L				Proposed Assessments based on 0.5 mg/L						NIP
Current LDRWC Agency members	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Subtotal
Bolingbrook (#3)	0	0	0	0	$ 42,819	$ 44,104	$ 45,427	$ 46,790	$ 48,194	$ 49,640	$ 276,974
Crest Hill	0	0	0	0	30,268	31,176	32,111	33,074	34,066	35,088	195,783
Joliet	0	0	0	0	25,469	26,233	27,020	27,830	28,665	29,525	164,742
Minooka	0	0	0	0	51,222	52,759	54,341	55,972	57,651	59,380	331,325
Naperville	32,978	33,968	34,987	36,036	149,008	153,478	158,083	162,825	167,710	172,741	1,101,814
Plainfield	0	0	0	0	20,354	20,965	21,594	22,242	22,909	23,596	131,660
Totals	$ 32,978	$ 33,968	$ 34,987	$ 36,036	$ 319,140	$ 328,715	$ 338,576	$ 348,733	$ 359,195	$ 369,970	$ 2,202,298
Cumulative totals	$ 32,978	$ 66,946	$ 101,933	$ 137,969	$ 457,109	$ 785,824	$ 1,124,400	$ 1,473,133	$ 1,832,328	$ 2,202,298	$ 2,202,298

Chemical treatment for phosphorus removal involves the addition of trivalent metal salts (e.g., ferric chloride or aluminum sulfate) to react with soluble phosphate (trivalent metal ion and the orthophosphate ion) to form a solid precipitate that physical processes, including clarification and filtration, can then remove. While shown to be reliable and a commonly used phosphorus-treatment option, it has several disadvantages relative to BPR and BNR.

Principally, chemical addition increases WWTP operational costs by increasing sludge production by up to 40% in the primary treatment process and 26% in activated sludge plants (MPCA 2006). It also adversely affects effluent pH and increases solids-handling requirements (Kang et al. 2008; USEPA 2000). The Minnesota Pollution Control Agency (MPCA 2006) concluded that the long-term O&M of BPR systems is generally cost-effective compared to chemical phosphorus removal systems, with cost savings resulting primarily from the reduced chemical and sludge handling costs. This finding is reflected in the feasibility studies drafted by DRSCW and LDRWC members. These additional costs can be estimated, predicted, and accounted for, but chemical treatment also has environmental externalities that are more difficult to quantify but are likely significant. For example, the process of extracting and transporting nonrenewable minerals from the earth (Kang et al. 2008) increases chemical treatment's pollution footprint relative to BPR. The solids generated in chemical treatment are less useful agronomically. BPR solids have a higher phosphorus content (Coats et al. 2011) and provide more agronomic value to crops once land-applied. Foley et al. (2010) wrote that the use of BPR sludge as fertilizer can significantly offset the demand for synthetic fertilizers. In contrast, chemical sludge must often be landfilled or transported off-site for treatment (USEPA 2000). Finally, the caustic substances that come with chemical treatment require additional handling and storage.

Life-cycle analysis (Coats et al. 2011) calculated that to achieve 0.5 mg/L effluent phosphorus, a biological-only process would affect global warming potential 5.2% less than a chemical-only process. At an effluent quality of 0.1 mg/L (full-scale facilities), where a biological process augmented with chemicals was contrasted with a chemical-only process, the relative gap increases to 13.2%. The study also found that the adverse environmental effects increased as chemical usage increased, and it concluded that best practices would focus phosphorus removal first on the biological process, with chemical processes added only as necessary. For these reasons, it is generally accepted that BPR and BNR, if achievable, are economically and environmentally superior processes, and it has been an objective of the Special Conditions to create space, where possible, for their adoption.

The move towards biological-based removal by DRSCW and LDRWC WWTPs is a direct consequence of the extended schedule, which was started with the 2015 Implementation Plan. The longer schedule allows for better financial planning, any capital upgrades necessary to allow BPR and BNR to be integrated with other plant improvements or expansions, and time for new technologies and procedures to be developed and observed. Based on the schedule set out in Table 45 and Table 46, it is reasonable to predict that this trend will continue. Avoiding locking agencies into a chemical treatment pathway has been an ongoing priority for these programs. It is recognized that it might not be possible for all WWTPs to adopt BPR or BNR due to lack of space, tank configuration, or low influent carbon concentrations that limit the production of polyphosphate-accumulating organisms. However, the NIP seeks to maximize this possibility.

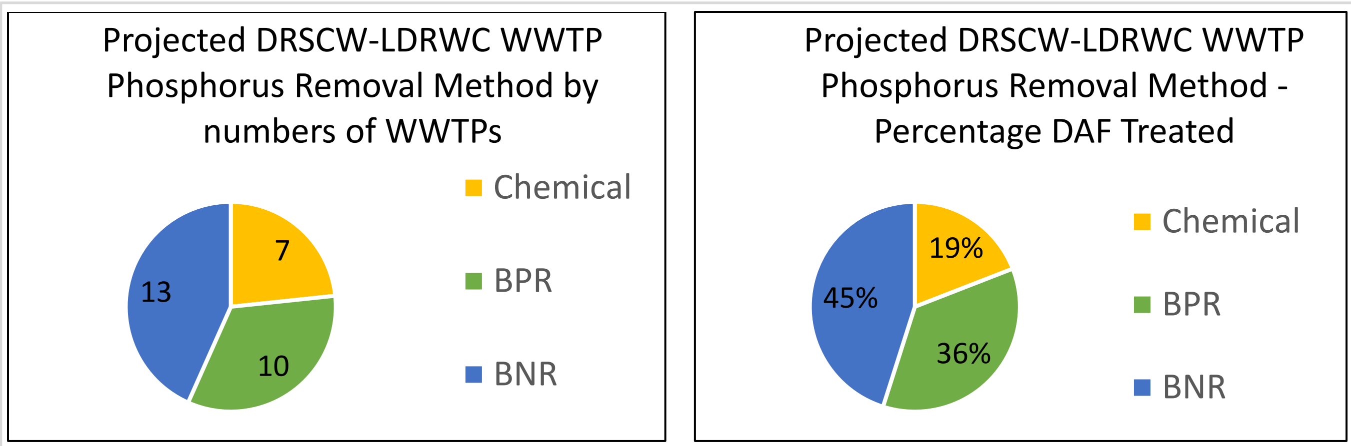


Figure 76. Primary TP removal method by number of WWTPs and by percentage of DAF treated. Results from October 2023 survey of DRSCW and LDRWC WWTP members.

9.1.2 Recommendation B

Recommendation B – The rotating watershed bioassessment is continued. This activity is scheduled to be carried out in each of the NIP basins on a rotating basis. Future bioassessments will allow verification that the watershed instream TP concentrations met expectations and that the biology and DO responded to physical projects implemented under Recommendation A. Bioassessments are funded using the DRSCW and LDRWG watershed group members' dues.

9.1.3 Recommendation C

Recommendation C – Holistic data analysis is continued and updated. This may include updates to water quality models, the IPS Tool, the collection of additional water quality and biological data, and other analysis. This would be funded using the NIP project assessments covered under Recommendation A.

9.1.4 Recommendation D

Recommendation D – Explore the refinement of biological endpoints for Illinois urban areas. The DRSCW and LDRWG watershed groups would work with IEPA and stakeholders to review if the current General Use standards are suitable for use in urban watersheds. This would be funded using the NIP project assessments covered under Recommendation A.

9.1.5 Recommendation E

Recommendation E – Update the adaptive management plan to reflect the implemented NIP recommendations and the phasing out of project assessments. As NIP recommendations are implemented, they will be evaluated alongside the findings of recommendations B, C and D. As NIP project assessments are drawn down, the necessity for identifying other sources of funding for watershed activities will be evaluated and investigated.

9.2 PROPOSED SPECIAL CONDITION 1. DRSCW WWTPS AND (SECTION E) CREST HILL

DRAFT NIP SPECIAL CONDITION FOR PERMIT

A. The Permittee shall participate in the DuPage River Salt Creek Workgroup (DRSCW). The Permittee shall work with other watershed members of the DRSCW to determine the most cost-effective means to remove dissolved oxygen (DO) and offensive condition impairments in the DRSCW watersheds.

B. The Permittee shall ensure that the following projects and activities set out in the Revised DRSCW Implementation Plan (June 2021) and the DRSCW and LDRWC Nutrient Implementation Plan (December 2023) are completed (either by the permittee or through the DRSCW) by the scheduled dates set forth below and that the short-term objectives are assessed for each by the time frames identified below (Table 49).

Table 49. Special Condition 1 project and implementation schedule

Project Name	Completion Date	Short-Term Objectives	Long-Term Objectives
Oak Meadows Golf Course Dam Removal	December 31, 2016 (Completed)	Improve DO	Improve fish passage
Oak Meadows Golf Course Stream Restoration	December 31, 2017 (Completed)	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBI
Fawell Dam Modification	December 31, 2024	Modify dam to allow fish passage	Raise fiBi upstream of structure
Spring Brook Restoration and Dam Removal	December 31, 2020 (Completed)	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and flBi
Fullersburg Woods Dam Modification Concept Plan Development	December 31, 2016 (Completed)	Identify conceptual plan for dam modification and stream restoration	Build consensus among plan stakeholders
Fullersburg Woods Dam Modification	December 31, 2024	Improve DO, improve aquatic habitat (QHEI)	Raise miBi and fiBi
Fullersburg Woods Dam Modification Area Stream Restoration	December 31, 2024	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
West Branch Physical Enhancement (Klein Creek)	December 31, 2023 (Completed)	Improve aquatic habitat (QHEI)	Raise miBi and fiBi
Southern East Branch Stream Enhancement (Phase I)	December 31, 2027[a]	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
QUAL 2w West Branch, East Branch and Salt Creek	December 31, 2023 (Completed)	Collect new baseline data and update model	Quantify improvements in watershed. Prioritize DO Improvement projects for years beyond 2024
NPS Phosphorus Feasibility Analysis	December 31, 2021 (Complete)	Assess NPS performance from reductions leaf litter and street sweeping	Reduce NPS contributions to lowest practical levels
East Branch Phase II	December 31, 2028	Improve aquatic habitat (QHEI), reduce Inputs of nutrients and sediment	Raise miBi andFiBi
Salt Creek Phase II	December 31, 2028	Improve aquatic habitat (QHEI), Remove fish barrier, reduce inputs of nutrients and sediment	Raise miBi and fiBi
West Branch Restoration Project	December 31, 2028	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
Additional Project TBD	TBD	TBD	TBD
Additional Project TBD	TBD	TBD	TBD
Additional Project TBD	TBD	TBD	TBD

Note:
[a] This date is provisional pending approval by IEPA

C. The Permittee shall participate in implementation of a watershed Chloride Reduction Program, either directly or through the DRSCW. The program shall work to decrease DRSCW watershed public agency chloride application rates used for winter road safety, with the objective of decreasing watershed chloride loading. An annual report on the annual implementation of the program identifying the practices deployed, chloride application rates, estimated reductions achieved, analyses of watershed chloride loads, precipitation, air temperature conditions and relative performance compared to a baseline condition shall be submitted electronically to EPA.PrmtSpecCondtns@illinois.gov with "Permit Number Special Condition 16.C" as the subject of the email and posted to the DRSCW's website by March 31 of each year. The annual report shall reflect the Chloride Reduction Program performance for the preceding year (example: 2019-20 winter season report shall be submitted no later than March 31, 2021). The Permittee may work cooperatively with the DRSCW to prepare a single annual progress report that is common among DRSCW permittees and may be submitted as part of a combined annual report with paragraph D below.

D. An annual progress report on the projects listed in the table of paragraph B above shall be submitted electronically to EPA.PrmtSpecCondtns@illinois.gov with "Permit Number Special Condition 16.D" as the subject of the email and posted to the DRSCW's website by March 31 of each year. The report shall include project implementation progress. The Permittee may work cooperatively with the DRSCW to prepare a single annual progress report that is common among DRSCW Permittees.

E. Total phosphorus in the effluent shall be limited as follows:

1. The Permittee shall meet the phosphorus limit identified in the 2023 DRSCW & LDRWC Nutrient Implementation Plan, in accordance with the schedule set out therein.

2. The effluent limitation shall be 0.35 mg/L seasonal geometric mean, May to October (to be reported once annually on the October DMR) with a 0.5 mg/L annual geometric mean, rolling 12-month basis (to first be reported on the DMR 12 full months from the effective date of the permit and monthly thereafter), effective May 1, 2040, unless the Agency approves and reissues or modifies the permit to include an alternate phosphorus reduction program or limit pursuant to paragraphs E.3 thru E.7 below. Phosphorus removal facilities shall be constructed and placed into operation no later than May 1, 2038, after which the Permittee will operate the facilities to optimize the treatment system performance.

3. The Permittee demonstrates that the Limit is not technologically feasible; or

4. The Permittee demonstrates the Limit would result in substantial and widespread economic or social impact. Substantial and widespread economic impacts must be demonstrated using applicable USEPA guidance, including but not limited to any of the following documents: 1. Interim Economic Guidance for Water Quality Standards, March 1995, EPA-823-95-002; 2. Combined Sewer Overflows - Guidance for Financial Capability Assessment and Schedule Development, February 1997, EPA-832- 97-004; 3. Financial Capability Assessment Framework for Municipal Clean Water Act Requirements, November 24, 2014; or

5. If the DRSCW has developed and implemented a cost optimization program for POTWs in the DRSCW watersheds, providing for reallocation of allowed phosphorus loadings between two or more POTWs in the DRSCW and Lower DuPage Watershed Coalition watersheds, that delivers the same results of overall watershed phosphorus point-source reduction and loading anticipated from the uniform, application of paragraph G.2 among the POTW permits in the Nutrient Implementation Plan area as modelled by the groups QUAL2kW model referenced in the Nutrient Implementation Plan; or

6. If the DRSCW has demonstrated and implemented an alternate means of reducing watershed phosphorus loading to a comparable result that removes DO and offensive condition impairments and meets the applicable dissolved oxygen criteria in 35 Ill. Adm. Code 302.206 and the narrative offensive aquatic algae criteria in 35 Ill. Adm. Code 302.203; or

7. If the Limit is demonstrated not to be technologically (e.g., no space available) or economically feasible, which shall be determined by an economic feasibility analysis by the date herein stipulated, but is feasible within a long timeline, then the permit shall include a compliance schedule requiring the discharger to comply with the phosphorus effluent limit as soon as possible, consistent with 40 C.F.R. § 122.47 (1), made applicable to Illinois at 40 C.F.R. § 123.25 (a)(18).

F. The Permittee shall monitor the wastewater effluent, consistent with the monitoring requirements on Page 2 of this permit, for total phosphorus, dissolved phosphorus, nitrate/nitrite, total Kjeldahl nitrogen (TKN), ammonia, total nitrogen (calculated), alkalinity and temperature at least once a month. The Permittee shall monitor the wastewater influent for total phosphorus and total nitrogen at least once a month. The results shall be submitted on electronic DMRs (NetDMRs) to the Agency unless otherwise specified by the Agency.

9.3 PROPOSED SPECIAL CONDITION 2. LDRWC WWTPS, FOR CREST HILL SECTION E, SEE PROPOSED SPECIAL CONDITION 1 (DRSCW AND (SECTION E) CREST HILL)

DRAFT NIP SPECIAL CONDITION FOR PERMIT

A. The Permittee shall participate in the DuPage River Salt Creek Workgroup (DRSCW). The Permittee shall work with other watershed members of the DRSCW to determine the most cost-effective means to remove dissolved oxygen (DO) and offensive condition impairments in the DRSCW watersheds.

B. The Permittee shall ensure that the following projects and activities set out in the Revised DRSCW Implementation Plan (June 2021) and the DRSCW & LDRWC Nutrient Implementation Plan (December 2023) are completed (either by the permittee or through the DRSCW) by the scheduled dates set forth below and that the short-term objectives are assessed for each by the time frames identified below (Table 50).

Table 50. Special Condition 2 project and implementation schedule

Project Name	Completion Date	Short-Term Objectives	Long-Term Objectives
Oak Meadows Golf Course Dam Removal	December 31, 2016 (Completed)	Improve DO	Improve fish passage
Oak Meadows Golf Course Stream Restoration	December 31, 2017 (Completed)	Improve aquatic habitat (QHEI), reduce Inputs of nutrients and sediment	Raise miBI
Fawell Dam Modification	December 31, 2024	Modify dam to allow fish passage	Raise fiBi upstream of structure
Spring Brook Restoration and Dam Removal	December 31, 2020 (Completed)	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fIBi
Fullersburg Woods Dam Modification Concept Plan Development	December 31, 2016 (Completed)	Identify conceptual plan for dam modification and stream restoration	Build consensus among plan stakeholders
Fullersburg Woods Dam Modification	December 31, 2024	Improve DO, improve aquatic habitat (QHEI)	Raise miBi and fiBi
Fullersburg Woods Dam Modification Area Stream Restoration	December 31, 2024	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
West Branch Physical Enhancement (Klein Creek)	December 31, 2023 (Completed)	Improve aquatic habitat (QHEI)	Raise miBi and fiBi
Southern East Branch Stream Enhancement (Phase I)	December 31, 2027[a]	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
QUAL 2w West Branch, East Branch and Salt Creek	December 31, 2023 (Completed)	Collect new baseline data and update model	Quantify improvements in watershed. Prioritize DO Improvement projects for years beyond 2024.
NPS Phosphorus Feasibility Analysis	December 31, 2021 (Complete)	Assess NPS performance from reductions leaf litter and street sweeping	Reduce NPS contributions to lowest practical levels
East Branch Phase II	December 31, 2028	Improve aquatic habitat (QHEI), reduce Inputs of nutrients and sediment	Raise miBi and fiBi
Salt Creek Phase II	December 31, 2028	Improve aquatic habitat (QHEI), Remove fish barrier, reduce inputs of nutrients and sediment	Raise miBi and fiBi
West Branch Restoration Project	December 31, 2028	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
Additional Project TBD	TBD	TBD	TBD
Additional Project TBD	TBD	TBD	TBD
Additional Project TBD	TBD	TBD	TBD

Note:
[a] Note this date is provisional pending approval by IEPA

C. The Permittee shall participate in implementation of a watershed Chloride Reduction Program, either directly or through the DRSCW. The program shall work to decrease DRSCW watershed public agency chloride application rates used for winter road safety, with the objective of decreasing watershed chloride loading. An annual report on the annual implementation of the program identifying the practices deployed, chloride application rates, estimated reductions achieved, analyses of watershed chloride loads, precipitation, air temperature conditions and relative performance compared to a baseline condition shall be submitted electronically to EPA.PrmtSpecCondtns@illinois.gov with "Permit Number Special Condition 16.C" as the subject of the email and posted to the DRSCW's website by March 31 of each year. The annual report shall reflect the Chloride Reduction Program performance for the preceding year (example: 2019-20 winter season report shall be submitted no later than March 31, 2021). The Permittee may work cooperatively with the DRSCW to prepare a single annual progress report that is common among DRSCW permittees and may be submitted as part of a combined annual report with paragraph D below.

D. An annual progress report on the projects listed in the table of paragraph B above shall be submitted electronically to EPA.PrmtSpecCondtns@illinois.gov with "Permit Number Special Condition 16.D" as the subject of the email and posted to the DRSCW's website by March 31 of each year. The report shall include project implementation progress. The Permittee may work cooperatively with the DRSCW to prepare a single annual progress report that is common among DRSCW Permittees.

E. Total phosphorus in the effluent shall be limited as follows:

1. The Permittee shall meet the phosphorus limit identified in the 2023 DRSCW & LDRWC Nutrient Implementation Plan, in accordance with the schedule set out therein.
2. The effluent limitation shall be 0.35 mg/L seasonal geometric mean, May to October (to be reported once annually on the October DMR) with a 0.5 mg/L annual geometric mean, rolling 12-month basis (to first be reported on the DMR 12 full months from the effective date of the permit and monthly thereafter), effective May 1, 2040, unless the Agency approves and reissues or modifies the permit to include an alternate phosphorus reduction program or limit pursuant to paragraphs E.3 thru E.7 below. Phosphorus removal facilities shall be constructed and placed into operation no later than May 1, 2038, after which the Permittee will operate the facilities to optimize the treatment system performance.
3. The Permittee demonstrates that the Limit is not technologically feasible; or
4. The Permittee demonstrates the Limit would result in substantial and widespread economic or social impact. Substantial and widespread economic impacts must be demonstrated using applicable USEPA guidance, including but not limited to any of the following documents: 1. Interim Economic Guidance for Water Quality Standards, March 1995, EPA-823-95-002; 2. Combined Sewer Overflows - Guidance for Financial Capability Assessment and Schedule Development, February 1997, EPA-832- 97-004; 3. Financial Capability Assessment Framework for Municipal Clean Water Act Requirements, November 24, 2014; or
5. If the DRSCW has developed and implemented a cost optimization program for POTWs in the DRSCW watersheds, providing for reallocation of allowed phosphorus loadings between two or more POTWs in the DRSCW and Lower DuPage Watershed Coalition watersheds, that delivers the same results of overall watershed phosphorus point-source reduction and loading anticipated from the uniform, application of paragraph G.2 among the POTW permits in the Nutrient Implementation Plan area as modelled by the groups QUAL2kW model referenced in the Nutrient Implementation Plan; or

6. If the DRSCW has demonstrated and implemented an alternate means of reducing watershed phosphorus loading to a comparable result that removes DO and offensive condition impairments and meets the applicable dissolved oxygen criteria in 35 Ill. Adm. Code 302.206 and the narrative offensive aquatic algae criteria in 35 Ill. Adm. Code 302.203; or
7. If the Limit is demonstrated not to be technologically (e.g., no space available) or economically feasible, which shall be determined by an economic feasibility analysis by the date herein stipulated, but is feasible within a long timeline, then the permit shall include a compliance schedule requiring the discharger to comply with the phosphorus effluent limit as soon as possible, consistent with 40 C.F.R. § 122.47 (1), made applicable to Illinois at 40 C.F.R. § 123.25 (a)(18).

F. The Permittee shall monitor the wastewater effluent, consistent with the monitoring requirements on Page 2 of this permit, for total phosphorus, dissolved phosphorus, nitrate/nitrite, total Kjeldahl nitrogen (TKN), ammonia, total nitrogen (calculated), alkalinity and temperature at least once a month. The Permittee shall monitor the wastewater influent for total phosphorus and total nitrogen at least once a month. The results shall be submitted on electronic DMRs (NetDMRs) to the Agency unless otherwise specified by the Agency.

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