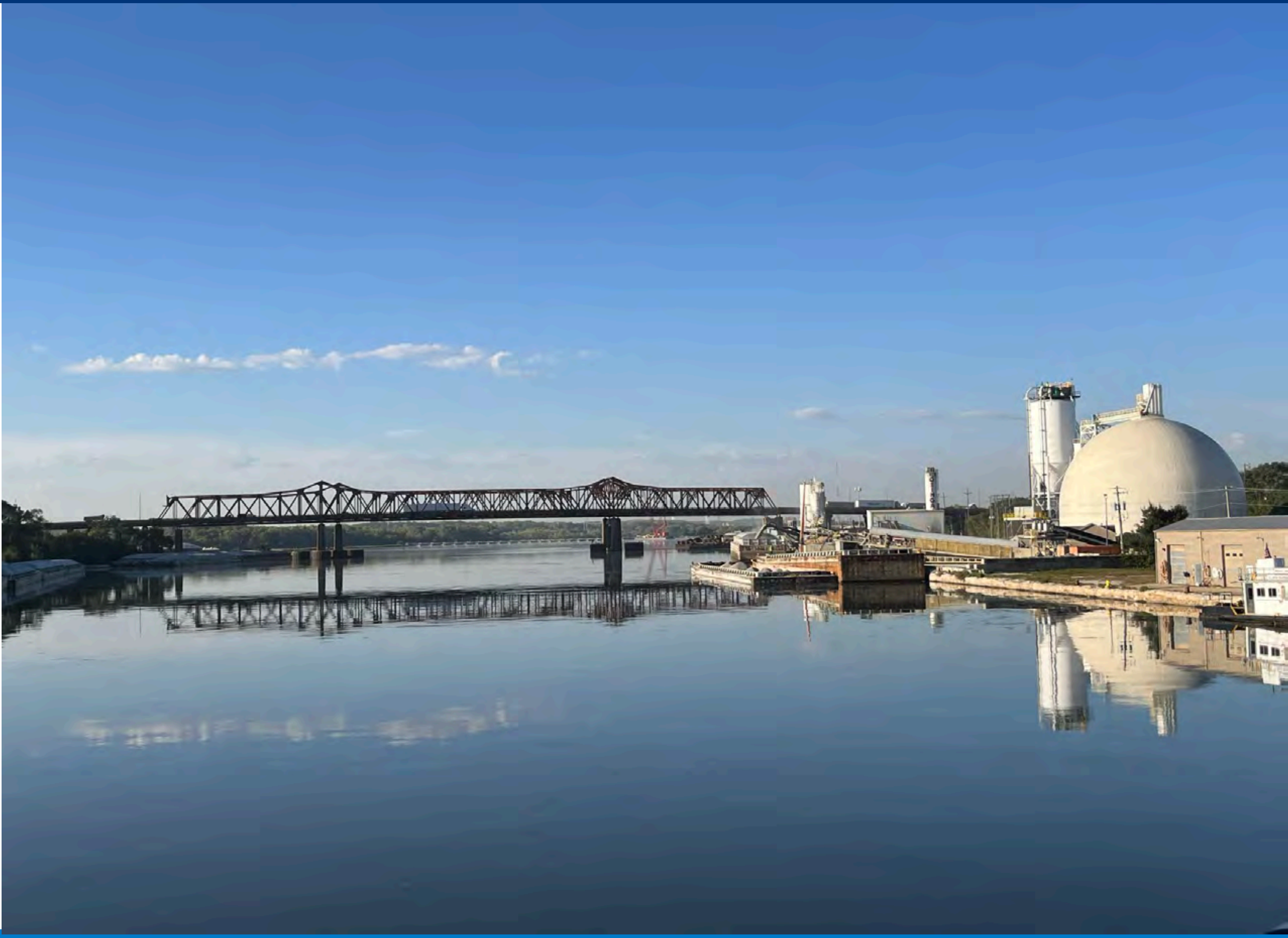
Nutrient Assessment and Reduction Plan

Lower Des Plaines River Watershed – Willow Creek to Confluence with Kankakee River

Lower Des Plaines Watershed Group



Nutrient Assessment and Reduction Plan for Lower Des Plaines River and Tributaries

December 22, 2023

PRESENTED TO

Illinois Environmental Protection Agency
Division of Water Pollution Control
Permit Section
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

PRESENTED BY

Lower Des Plaines Watershed Group
10S404 Knock Knolls Road
Naperville, Illinois 60565

SUPPORT BY

DuPage River Salt Creek Workgroup
10S404 Knoch Knolls Road
Naperville, IL 60565

Lower DuPage River Watershed Coalition
10S404 Knoch Knolls Road
Naperville, IL 60565

The Conservation Foundation
10S404 Knoch Knolls Road
Naperville, IL 60565

Tetra Tech
4000 Sancar Way, Suite 200
P.O. Box 14009
Research Triangle Park, NC 27709

Midwest Biodiversity Institute
4673 Northwest Parkway
Hilliard, Ohio 43026

EXECUTIVE SUMMARY

Aquatic life and dissolved oxygen (DO) are intersecting products of complex interactions of water chemistry, physical stream conditions, and weather. Both are influenced by phosphorus but attempts in Illinois to establish State or eco region protective phosphorus criteria have been unsuccessful. This failure is due to our 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 that can better account for regional variation, as recommended under the development of Nutrient Assessment and Reduction Plans (NARPs). These plans were mandated in NPDES 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 Lower Des Plaines Watershed Group (LDWG) has developed this NARP 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 (IEPA).

A crucial step in developing this NARP was establishing a watershed threshold concentration for TP that is protective of aquatic life for the NARPP area. Because of the differences between wadeable and nonwadeable streams within the Lower Des Plaines River watershed, this NARP has a two pronged approach to implementation. For wadeable streams, a relationship between TP concentrations and fish species, macroinvertebrate taxa and their indices of biotic integrity was established by a multivariate analysis published in 2023 by the DuPage River Salt Creek Workgroup (DRSCW) and Lower DuPage River Watershed Coalition (LDRWC). The analysis, which drew on paired biological, chemical, and physical data from 640 sites in NE Illinois found fish species and Fish Index of Biotic Integrity (fIBI) were more sensitive to TP concentration variation than macroinvertebrate taxa and Macroinvertebrate Index of Biotic Integrity (mIBI). 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 0.28 milligrams per liter (mg/l). This analysis does not apply to Lower Des Plaines River mainstem as it is not a wadeable stream. This same approach will be utilized to develop an instream TP threshold for nonwadeable streams using and/or collecting additional paired data from the Des Plaines River and other nonwadeable streams of similar characteristics.

The 0.28 mg/L TP instream threshold will be utilized to develop appropriate effluent targets for the eleven major WWTPs that discharge to tributaries. This step will be completed in 2024 as part of a holistic plan for Lower Des Plaines Tributaries, coinciding with the December 31, 2024 NARP deadline for many of the WWTPs. For the seven major WWTPs that discharge to the Des Plaines River the implementation plan outlines steps to be taken to develop a nonwadeable stream version of the IPS Tool to establish nutrient related thresholds that would be applicable to the Lower Des Plaines River and the modeling needed to propose TP effluent targets.

Analysis of mean TP concentrations at tributary sites monitored by the watershed groups' first round of bioassessments show a clear differentiation between sites. Average concentrations at sites downstream of WWTPs, a product of both wastewater, and non-wastewater (stormwater and background sources, summarized as urban) ranged from 0.1 – 1.89 mg/l, concentrations at urban only sites (no wastewater) had significantly lower TP concentrations ranging from 0.05 – 0.45 mg/L. 19 out of 46 sites influenced by wastewater (~41%) had average TP concentrations above the watershed threshold with the maximum average value of 1.89 mg/L TP. All but two of the 29 sites not influenced by wastewater were below the 0.28 mg/L TP threshold. The two sites had average TP concentrations of 0.39 and 0.45 mg/L. This ambient data along with discharge data will be the basis for developing proposed effluent targets for tributary WWTPs in 2024.

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PURPOSE OF DOCUMENT

The Nutrient Assessment and Reduction Plan (NARP) is submitted on behalf of all of the agencies managing wastewater treatment plants (WWTPs) who are members of the Lower Des Plaines Watershed Group (LDWG) to fulfill the following National Pollutant Discharge Elimination System (NPDES) permit Special Condition:

> *"The Agency has determined that the Permittee's treatment plant effluent is located upstream of a waterbody or stream segment that has been determined to have a phosphorus related impairment. This determination was made upon reviewing available information concerning the characteristics of the relevant waterbody/segment (such as extent of aquatic habitat and nature of the biological community) and the relevant facility (such as quantity of discharge flow and nutrient load relative to the stream flow).*
>
> *A. A phosphorus related impairment means that the downstream waterbody or segment is listed by the Agency as impaired due to dissolved oxygen and/or offensive condition (algae and/or aquatic plant growth) impairments that is related to excessive phosphorus levels.*
>
> *B. The Permittee shall develop, or be a part of a watershed group that develops, a Nutrient Assessment Reduction Plan (NARP) that will meet the following requirements:*
>
> *C. The NARP shall be developed and submitted to the Agency by December 31,2023. This requirement can be accomplished by the Permittee, by participation in an existing watershed group or by creating a new group. The NARP shall be supported by data and sound scientific rationale.*
>
> *D. The Permittee shall cooperate with and work with other stakeholders in the watershed to determine the most cost-effective means to address the phosphorus related impairment. If other stakeholders in the watershed will not cooperate in developing the NARP, the Permittee shall develop its own NARP for submittal to the Agency to comply with this condition.*
>
> *E. In determining the target levels of various parameters necessary to address the phosphorus related impairment, the NARP shall either utilize the recommendations by the Nutrient Science Advisory Committee or develop its own watershed-specific target levels.*
>
> *F. The NARP shall identify phosphorus input reductions by point source discharges and non-point source discharges in addition to other measures necessary to remove phosphorus related impairments in the watershed. The NARP may determine, based on an assessment of relevant data, that the watershed does not have an impairment related to phosphorus, in which case phosphorus input reductions or other measures would riot be necessary. Alternatively, the NARP could determine that phosphorus input reductions from point sources are not necessary, or that phosphorus input reductions from both point and nonpoint sources are necessary, or that phosphorus input reductions are not necessary and that other measures, besides phosphorus input reductions, are necessary.*
>
> *G. The NARP shall include a schedule for the implementation of the phosphorus input reductions by point sources, non-point sources and other measures necessary to remove related impairments. The NARP schedule shall be implemented as soon as possible, and shall identify specific timelines applicable to the Permittee.*
>
> *H. The NARP can include provisions for water quality trading to address the phosphorus related impairments in the watershed. Phosphorus/Nutrient trading cannot result in violations of water quality standards or applicable antidegradation requirements.*

I. *The Permittee shall request modification of the permit within 90 days after the NARP has been completed to include necessary phosphorus input reductions identified within the NARP. The Agency will modify the NPDES permit, if necessary.*

J. *If the Permittee does not develop or assist in developing the NARP, and such a NARP is developed for the watershed, the Permittee will become subject to effluent limitations necessary to address the phosphorus related impairments. The Agency shall calculate these effluent limits by using the NARP and any applicable data. If no NARP has been developed, the effluent limits shall be determined for the Permittee on a case-by-case basis, so as to ensure that the Permittee's discharge will not cause or contribute to violations of the dissolved oxygen or narrative water quality standards."*

These agencies and their facilities are listed in Table 1. Of the twenty-one facilities listed, ten have a NARP due date of December 31, 2023, seven have a NARP due date of December 31, 2024 and four are minors and do not have a NARP requirement in their NPDES permit, but are active members of the LDWG.

The NARP is focused on developing a plan to target an ambient instream phosphorous concentration that is protective of aquatic life.

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.

Table 1 Agencies and WWTPs contributing and participating in the NARP

Agency Name	Facility Name	NPDES Permit
Channahon, Village of	Channahon STP	IL0069906
Crest Hill, City of	Crest Hill East STP	IL0064998
DuPage County	Knollwood	IL0065188
Elwood, Village of	Elwood - Deer Run STP	IL0074713
Frankfort, Village of	Frankfort Regional WWTP	IL0072192
Illinois American Water	Santa Fe	IL0032760
Illinois American Water	Chickasaw Hills WRF	IL0031984
Illinois American Water	Oak Valley	IL0055981
Illinois American Water	Derby Meadows WRF	IL0045993
Illinois American Water	Arbury Hills	IL0032778
Joliet, City of	City of Joliet Eastside STP	IL0022519
Joliet, City of	City of Joliet Westside STP	IL0033553
Lockport, City of	Lockport STP	IL0029611
Lockport, City of	Lockport - Bonnie Brae STP	IL0021261
Manhattan, Village of	Manhattan STP	IL0020222
Metropolitan Wastewater District of Greater Chicago	James Kirie WRP	IL0047741
Mokena, Village of	Mokena	IL0024201
New Lenox, Village of	New Lenox STP #1	IL0020559
New Lenox, Village of	New Lenox STP #2	IL0046264
New Lenox, Village of	New Lenox STP #3	IL0075957
Romeoville, Village of	Romeoville Wastewater Treatment Facility	IL0048526

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ACRONYMS/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 Division of Stormwater Management
DDT	dichlorodiphenyltrichloroethane
DMR	discharge monitoring report
DO	dissolved oxygen
DRSCW	DuPage River Salt Creek Workgroup
fIBI	Fish Index of Biotic Integrity
FIT	goodness-of-fit statistical factor
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
IPCB	Illinois Pollution Control Board
IPS	Identification and Prioritization System
kg	kilogram

Acronym/Abbreviation	Definition
lbs	pounds
LDWG	Lower Des Plaines Watershed Group
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
PAHs	polycyclic aromatic hydrocarbons
PARP	Phosphorus Assessment and Reduction Plan
PCBs	polychlorinated biphenyls
QHEI	Qualitative Habitat Evaluation Index
RF	random forest
RM	river mile
ROW	right of way
SOD	sediment oxygen demand
SRT	solid retention time
SSI	Sensitive Species Index
SSURGO	Soil Survey Geographic
STP	sewage treatment plant
TARP	Tunnel and Reservoir Plan

Acronym/Abbreviation	Definition
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
WQS	water quality standards
WRC	water reclamation center
WRP	water reclamation plant
WWTP	wastewater treatment plant

1.0 BACKGROUND

Background information related to the Lower Des Plaines watershed including overall summary of the established watershed group, and workgroup programs.

1.1 ESTABLISHED WATERSHED GROUP

The Lower Des Plaines Watershed Group (LDWG) covers the mainstem Des Plaines River from the confluence of Willow Creek to the north down to the confluence with the Kankakee River.

1.1.1 Lower Des Plaines Watershed Group

The LDWG is an Illinois nonprofit organization bringing together municipalities, wastewater treatment plants, and other governmental agencies like park district, forest preserve districts, counties and townships as well as industrial dischargers, engineering companies and other interested organizations across the watershed. A complete list of LDWG members can be found in Table 2 and at www.LDPWatersheds.org.

The LDWG formed in 2018 in response to new NPDES permit requirements that could be better addressed through a watershed approach. One of the first tasks was to define the boundary for the organization. The northern boundary was set to include the Willow Creek watershed to capture the MWRDGC James Kirie Water Reclamation Plant, down to the confluence with the Kankakee River. The Salt Creek and DuPage River Watersheds are specifically not included within the planning area of the LDWG as those watersheds are managed by the DuPage River Salt Creek Workgroup and the Lower DuPage River Watershed Coalition. The Ship and Sanitary Canal is also specifically excluded from the LDWG planning area. Figure 1 depicts the watershed boundary for the LDWG.

In 2018 the LDWG developed and began implementation of a bioassessment program across the mainstem and all 14 tributary streams to provide a baseline of water quality conditions and provide support for NARP development. The LDWG began coordination the Lower Des Plaines portion of the TLWQS for Chlorides in 2021 and developed a Lower Des Plaines Chloride Reduction Plan for the remainder of the watershed 2022. The LDWG partners with the Lower DuPage River Watershed Coalition to produce and share watershed outreach materials and to support the Salt Smart Collaborative in efforts to reduce the impacts of chlorides on local water resources.

Table 2 Lower Des Plaines Watershed Group members by type.

Member Type	Agency Name	Agency Name
Agency Members	Village of Burr Ridge	City of Lockport
	Village of Channahon	Village of Manhattan
	City of Crest Hill	Metropolitan Wastewater District of Greater Chicago
	DuPage County	Village of Mokena
	Village of Elwood	Village of New Lenox
	Village of Frankfort	Village of Riverside
	Village of Hinsdale	Village of Romeoville
	Illinois American Water Company	Village of Western Springs
	Illinois Dept. of Transportation	Village of Westmont
	City of Joliet	Will County
Associate Members	Exxon Mobil	New Lenox Township
	INEOS	

The LDWG worked with the Illinois EPA to develop a series of NPDES special conditions for members related to participation & supporting bioassessment monitoring to fulfil instream monitoring requirements, jointly working on NARP development and joint reporting. Examples of how these conditions have been incorporated into permits are provided below:

> *Special Condition xx.* *The Permittee shall participate in the Lower Des Plaines Watershed Group (LDWG). The Permittee shall work with other watershed members of the LDWG to determine the most cost-effective means to remove dissolved oxygen (DO) and offensive condition impairments in the Lower Des Plaines Watershed to the extent feasible. The Permittee shall participate in the LDWG for the completion of the Bioassessment Monitoring Program Plan of the Lower Des Plaines Watershed Bioassessment Quality Assurance Project Plan dated July 27, 2018 (hereinafter the Plan) which will include biological, chemical and physical monitoring of the Lower Des Plaines River Watershed.*
>
> *A. The LDWG will conduct the following activities in accordance with the Plan during the term of this permit:*
> *1. Conduct stream monitoring in Lower Mainstem Des Plaines River in 2018;*
> *2. Conduct stream monitoring in Upper Mainstem and tributaries of the Des Plaines River in 2019;*
> *3. Conduct stream monitoring in Hickory Creek Watershed in 2020;*
> *4. Conduct stream monitoring in remaining tributaries of the Des Plaines River in 2021; and*
> *5. Assess stream monitoring and develop recommendations for future stream monitoring in 2022:*
> *B. The Permittee shall submit an annual progress report on the activities identified in (A) above to the Agency by March 31 of each year. The Permittee may work cooperatively with the LDWG to prepare a single annual progress report that is common among LDWG members.*
> C. *In its application for renewal of this permit, the Permittee shall consider and incorporate recommended LDWG activities listed in any annual progress report or Nutrient Assessment Reduction Plan that the Permittee will implement during the next permit term.*
>
> *Special Condition XY:* *The Agency has determined that the Permittee's treatment plant effluent is located upstream of a waterbody or stream segment that has been determined to have a phosphorus related impairment. This determination was made upon reviewing available information concerning the characteristics of the relevant waterbody/segment and the relevant facility (such as quantity of discharge flow and nutrient load relative to the stream flow).*
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> *A phosphorus related impairment means that the downstream waterbody or segment is listed by the Agency as impaired due to dissolved oxygen and/or offensive condition (algae and/or aquatic plant growth) impairments that is related to excessive phosphorus levels.*
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E. The NARP shall include a schedule for the implementation of the phosphorus input reductions by point sources, non-point sources and other measures necessary to remove phosphorus related impairments. The NARP schedule shall be implemented as soon as possible, and shall identify specific timelines applicable to the Permittee.

F. The NARP can include provisions for water quality trading to address the phosphorus related impairments in the watershed. Phosphorus/Nutrient trading cannot result in violations of water quality standards or applicable antidegradation requirements.

G. The Permittee shall request modification of the permit within 90 days after the NARP has been completed to include necessary phosphorus input reductions identified within the NARP. The Agency will modify the NPDES permit, if necessary.

H. If the Permittee does not develop or assist in developing the NARP, and such a NARP is developed for the watershed, the Permittee will become subject to effluent limitations necessary to address the phosphorus related impairments. The Agency shall calculate these effluent limits by using the NARP and any applicable data. If no NARP has been developed, the effluent limits shall be determined for the Permittee on a case-by-case basis, so as to ensure that the Permittee's discharge will not cause or contribute to violations of the dissolved oxygen or narrative water quality standards.

The LDWG works closely with the DRSCW and LDRWC to share data and technical resources, particularly with the utilization of the Integrated Prioritization System Tool (IPS), comparative analysis of DRSCW modeling efforts and analysis of urban wash off sources of total phosphorus.

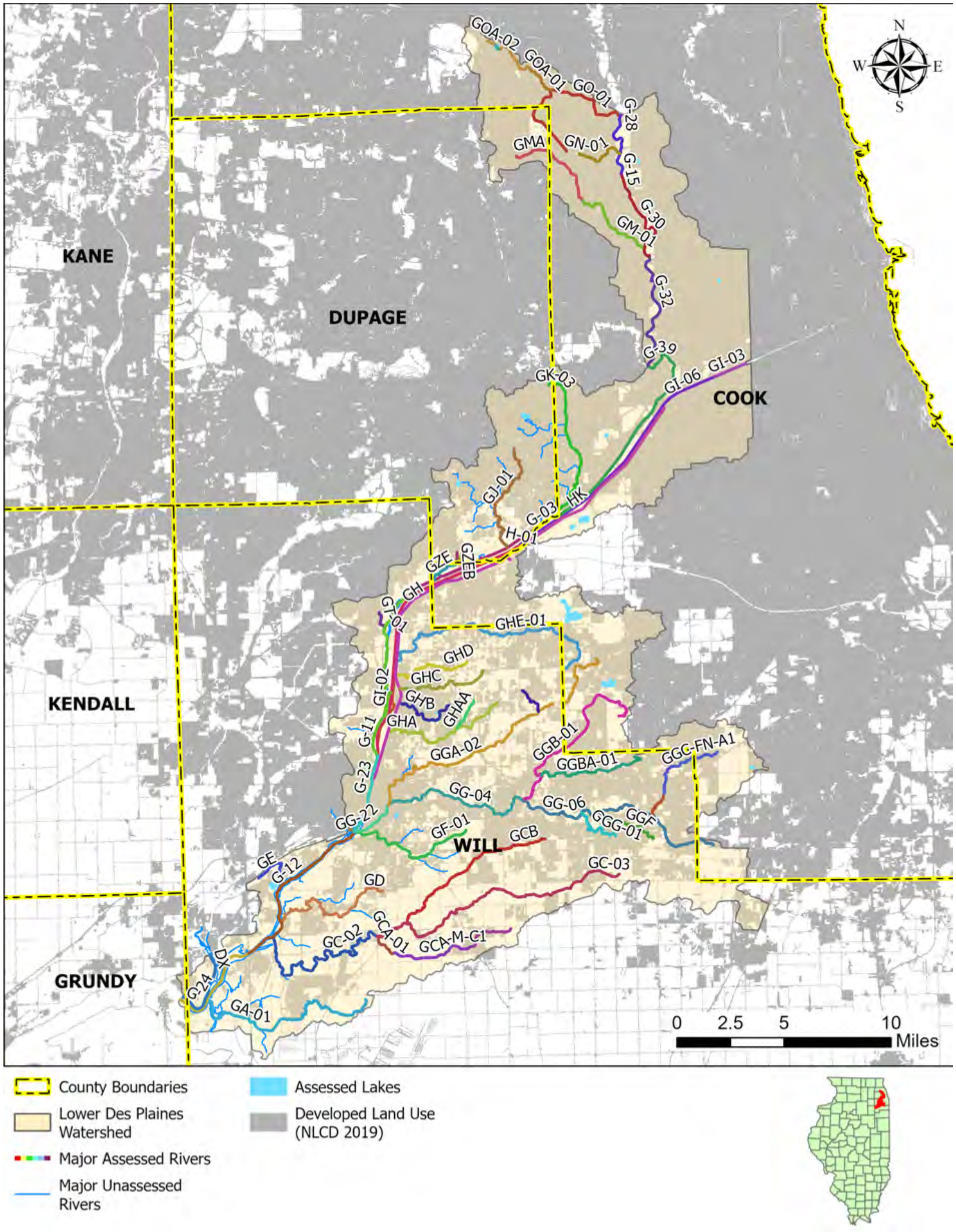

Figure 1 Lower Des Plaines Watershed Group Boundary.

1.2 WORKGROUP STUDIES

The LDWG has initiated an extensive water quality monitoring program with the explicit goal of understanding how to preserve and protect instream conditions for aquatic life. Summaries of relevant monitoring efforts utilized in development of this NARP are included in this section.

1.2.1 Monitoring Programs

Relevant monitoring programs conducted throughout the Lower Des Plaines watershed include a bioassessment sampling program and expanded DO monitoring efforts, and continuous conductivity/temperature monitoring in partnership with USGS.

1.2.1.1 Bioassessments

In 2018 LDWG developed a bioassessment program modeled after work being done in the Salt Creek and DuPage River watersheds. Due to the size and complexity of the Lower Des Plaines watershed, monitoring is completed in a five-year rotation. The mainstem is split over year one and two, the second year also included several tributaries in the upstream portion of the planning area. Year 3 is dedicated to the Hickory Creek subwatershed, the largest tributary within the study area and year 4 focused on the remaining tributaries. The fifth year in the rotation is an off year for field work to catch up on reporting. Table 3 details the bioassessment sampling dates for each portion of the watershed.

Table 3. Bioassessment sampling dates for the LDWG watershed

Watershed	Years with Completed Sampling	Next Upcoming Sampling Year
Downstream Des Plaines River	2018	2023
Upstream Des Plaines + Willow Creek, Crystal Creek, Silver Creek & Schiller Trib	2019, resampled subset in 2020	2024
Hickory Creek	2020	2025
Grant, Jackson, Cedar, Sugar, Fraction Run, Mline, Fiddyment, Big Run, Long Run, Deep Run, Sawmill and Flag Creeks	2021	2026

The LDWG bioassessment program utilizes 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; and
3) Add to the broader databases for the Des Plaines River watershed 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 and contains a summary of major findings and recommendations for future monitoring, follow-up investigations, and any immediate actions that are needed to resolve readily diagnosed impairments. As these bioassessment reports are completed they will be posted on the LDWG website https://ldpwatersheds.org.

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 CSOs, dams, major stormwater sources, and WWTP outfalls). The number of sampling sites by method/protocol and watershed are listed in Table 4.

In addition to the LDWG sampling sites, data is collected from selected regional reference sites in northeastern Illinois in partnership with DRSCW and LDRWC. One purpose of this data will be to index the biological methods used in the bioassessment that are different from IEPA and/or DNR to the reference condition and biological index calibration as defined by Illinois EPA. In addition, the current IEPA reference network does not yet include smaller headwater streams; hence reference data is needed to accomplish an assessment of that data. Currently, 13 reference sites have been established for bioassessment monitoring.

Table 4. Number of sampling sites in the LDWG watershed

Method/Protocol	Downstream Des Plaines (2019)	Upstream Des Plaines + Northern Tributaries (2019/20)	Hickory Creek (2020)	Remaining Tributaries (2021)	Reference Sites (2006-2023)	Total Sites
Biological Sampling						
Fish	28	33	40	48	13	162
Macroinvertebrates	28	33	40	48	13	162
QHEI	28	33	40	48	13	162
Water Column Chemical/Physical Sampling						
Nutrients/Demand	28	33	40	48	6	155
Water Quality Metals	28	31	40	48	6	153
Sediment Sampling	28	30	19	14	6	93

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 a 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 the collection of fish at wadeable sites is performed using a tow-barge or longline pulsed direct current (D.C.) electrofishing apparatus (MBI 2006). A Wisconsin DNR battery powered backpack electrofishing unit is used as an alternative to the long line 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. Sampling effort is indexed to linear distance and ranged from 150-200 meters in length. Non-wadeable sites are sampled with a raft-mounted pulsed D.C. electrofishing device in a downstream direction (MBI 2007). Sampling efforts are indexed to linear distance over 0.5 kilometer. Sampling is conducted during a June 15-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 D.O. levels in the water and to minimize mortality. Fish not retained for voucher or other purposes were released back into the water after they had been identified to species, examined for external anomalies, and weighed either individually or in batches. While the majority of captured fish are identified to species in the field, any uncertainty about the field identification required their preservation for later laboratory identification. Identification is made to the species level at a minimum and to the sub-specific level if necessary. Vouchers are deposited and verified at The Ohio State University Museum of Biodiversity (OSUMB) in Columbus, OH.

The macroinvertebrate assemblage is sampled using the Illinois EPA (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, calculation of the macroinvertebrate IBI followed IEPA methods in using genera as the lowest level of taxonomy 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 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 used to determine the QHEI score which generally ranges from 20 to less than 100. QHEI scores and physical habitat attribute 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 frequency of sampling increasing as drainage size increases. Sediment sampling is done at a subset of sites using the same procedures as IEPA.

The parameters sampled for are included in Table 5 and can be grouped into oxygen-demanding parameters, nutrients, metals, and organics. Total number of samples collected by watershed and the number of samples by analyte group for each watershed are given in Table 6 . All water sampling occurs between May and October, and sediment sampling occurs October to December.

Table 5. 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
	Dissolved Oxygen
	pH
	Temperature
	Conductivity
	BOD5
	Chloride
Metals	Cadmium
	Calcium
	Copper
	Iron
	Lead
	Magnesium
	Zinc
Organics	PCBS
	Volatile Organic Compounds
	Pesticides
	Semi volatile Organics
MS4 Parameters	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
	PCBS
	Percent Moisture
	Semi volatile Organics
	Volatile Organic Compounds

Table 6. Number of Samples in Each Watershed by Analyte Group in the Bioassessment Program

Watershed	# of Sites	Water Chemistry		Sediment Chemistry	
		Demand & Nutrients	Metals	Metals	Organics
Downstream Des Plaines	28	224	224	28	28
Upstream Des Plaines + North Tributaries	33	246	230	30	30
Hickory Creek	40	214	214	19	19
Remaining Tributaries	48	228	228	14	14

1.2.1.2 Continuous Dissolved Oxygen Monitoring

The Metropolitan Wastewater Reclamation District of Greater Chicago (MWRDGC) operates a Continuous Dissolved Oxygen Monitoring (CDOM) program at 20 sites across its service area. Three CDOM sites are located on the Des Plaines River as detailed below in Table 7. MWRDGC provides data to the LDWG for assessment purposes.

Table 7. Continuous DO monitoring locations maintained by MDWRGC

Site ID	Stream Name	River Mile	Latitude	Longitude	Location
Metropolitan Wastewater Reclamation District of Greater Chicago					
58	Des Plaines River	60.8	41° 59' 45.35"	-87° 51' 34.14"	Devon Avenue
62	Des Plaines River	56.9	41° 57' 11.37"	-87° 51' 14.91"	Irving Park Road
63	Des Plaines River	43.3	41° 49' 15.00"	-87° 48' 37.86"	Ogden Avenue

1.2.1.3 Expanded Dissolved Oxygen Monitoring

In 2020, the LDWG began their “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 Section 1.2.1.1).

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 each 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 parameters listed in Table 8. Along with water chemistry, one benthic algae sample is also collected at each site from the substrate.

Table 8. Parameters sampled once per sampling period as part of the Expanded DO Monitoring Program

Program Sampling Parameters
5-Day Biological Oxygen Demand
5-Day Carbonaceous Biological Oxygen Demand
Total Suspended Solids
Volatile Suspended Solids
Total Dissolved Solids
Chloride
Conductivity
Total Organic Carbon
Total Dissolved Carbon
Ammonia
Nitrite
Nitrate
Total Kjeldahl Nitrogen
Total Phosphorus
Orthophosphate
Total Dissolved Phosphorus
Chlorophyll-*a* (Sestonic and Benthic)

1.2.1.4 Winter Continuous Chloride Monitoring

The LDWG contracts with the U.S. Geological Service to maintain real-time monitoring of conductivity and temperature on the Des Plaines River near the Interstate 55 bridge. The LDWG utilizes a conductivity to chloride relationship developed through the development of a Time-Limited Water Quality Standard for Chloride to track estimated chloride levels in the river throughout the year. This data is available through USGS.

1.3 INTEGRATED PRIORITIZATION SYSTEM (IPS) TOOL

While the LDWG does not include the watersheds of the Salt Creek and DuPage River, there are many areas where collaborative efforts make sense. Below is a description of the development and use of the IPS Tool. With the update that was completed in 2023, utilizing a wider dataset, including many tributaries of the Des Plaines River, it makes sense to utilize the benchmarks identified in this Tool for wadeable streams, i.e. the tributaries, in the LDWG study area.

1.3.1 IPS Tool Development (2010)

In the mid-2010s, the DRSCW partnered with the Midwest Biodiversity Institute (MBI) to develop the Integrated Prioritization System (IPS) Tool. The IPS was a key Tool in selecting projects for inclusion in the 2015 DRSCW Implementation Plan. Using robust relational analysis of the stressors responsible for aquatic life (low DO) impairments based on biological responses, the IPS Tool was utilized to aid DRSCW in selection of 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 many 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 sub-components 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 also considers stressor relationships with specific species and taxa from which IBIs are constructed. The methods used in the IPS Tool are based on the EPA Causal Analysis/Diagnosis Decision Information System (CADDIS) methodology and include cluster analysis, Non-metric Multidimensional Scaling (NMDS) and Classification and Regression Trees (CART).

Nine priority stressors were identified by the IPS Tool statistical analyses as having the most significant correlation with the 2007-2013 IBI values used in the analysis. The nine stressors identified were:

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

Quantile regression was used to examine the relationships between individual stressors and 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 the priority stressors identified by the IPS. Although neither stressor was used in the statistical evaluation for methodological reasons, both have explanatory power in IBI variation, the former in longitudinal IBI plots and the latter is ubiquitous in sediment samples.

Stream segments were then graded according to their estimated “restorability”. To accomplish this, a composite score based on three factors was created:

- Site score was positively weighted if 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 to allow for physical enhancement projects.
- Site score was negatively weighted relative to the cumulative number of proximate stressors (stressors identified as being statistically correlated with biology based on the analysis outlined above) identified at the site. Having a low number of proximate stressors was assumed to mean that restoring biological integrity to the site would be less complex than at a site with a large number of proximate stressors.
- Site score was increasingly negatively weighted as an inverse to observed deviation from the IEPA biological 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 allows for potential restoration projects to be ranked on a nominal scale of 1-6 in descending order of restorability, and also generated a list of actions to undertake at the priority sites such as riparian buffer creation, chloride abatement, or restoration of channel meandering. The IPS Tool was validated by evaluating priority sites with field visits by stream restoration and water quality specialists.

1.3.2 IPS Tool Update (2023)

In 2019, the DRSCW, LDRWC, and two other regional watershed organizations elected to update and refine the IPS Tool. The updated Tool draws on a larger regional dataset consisting of paired biological, chemical, and physical data across seven northeastern (NE) Illinois Level IV subregions (53a, 53b, 54a, 54b, 54d, 54e, and 54f). The IPS Tool was utilized 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 NE Illinois IPS study area. The 87 stressors were identified from a total dataset including 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 factor reflecting statistical correlation, allowing each parameter to be rank-ordered from strongest to weakest stressor response.

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

- Expanded number of sampling sites, from 120 to 640, by including many from sampling efforts conducted by IEPA basin monitoring program, Lake and Will Counties (collected with a methodology consistent with DRSCW's), and DRSCW which had collected data from additional reference sites located outside the DRSCW area to supplement the dataset.
- Increased temporal dataset at the original sampling sites (one year of assessment data increased to three).
- Improved spatial dataset built on incorporation of a more heterogeneous geographical area. The DRSCW watersheds as the only dataset used in the original iteration of the IPS have experienced a high level of physical and chemical anthropomorphic modification, and therefore support only a truncated list of fish species and macroinvertebrate taxa. The inclusion of 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.
- Updated methodology for deriving stressor-response relationships. The modified approach included first identifying stressor-sensitive species and taxa, then linking 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 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 percent of species or taxa, depending on stressor “direction”. Stressor direction is controlled by naturally-occurring kinetic and chemical processes between the stressor and biological communities. Classically 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 a direct relationship with the biological communities.

Once the taxa and species had been identified the number of stressor sensitive species/taxa at each site in IPS study area were then observed, weighted (numbers of individuals present at each site) and the sensitive species index (SSI) this generated 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 IL IBI across the sites but also gauge if the IL IBI is sensitive to the stressor under consideration. The sites with their SSI and IBI rankings are then plotted against the stressor values in scatter plots and using quantile regression to characterize "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 (for positively correlated stressors e.g. QHEI) or 75th percentile (for inversely correlated stressors such as chloride) stressor value of sites for both fIBI or mIBI values for each category was then identified as the threshold corresponding to the IL biological threshold for fish and macroinvertebrates. The more sensitive of the two communities (fish or macroinvertebrates) was adopted as the basis for the threshold. These steps for threshold derivation are shown in Figure 2.

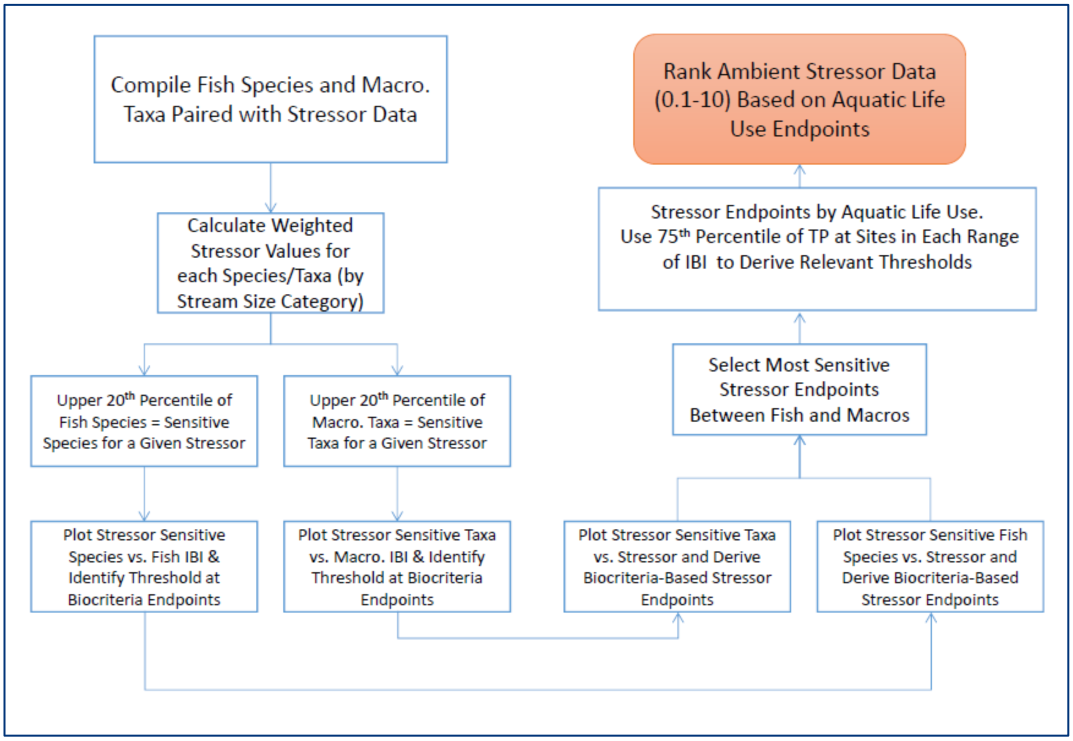

Figure 2. Steps in Threshold Development in Updated IPS Tool

Aquatic assemblages are not equally impacted by each category of stressor, or even by stressors within the same category. Weights for the stressor thresholds (scaled from 0.1 to 10) were based on graphically wedge-shaped relationships between each stressor and biological indicators pegged to the most stringent 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 back casted predicted stressor ranks based on the richness of stressor-specific fish species or macro-invertebrate taxa. 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 9 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 FIT scoring. Here again, habitat-based QHEI variables dominated the top of each RF analysis, illustrating the overarching importance of reach-level and small watershed-level cumulative habitat conditions. Proximate stressors identified for both fIBI and mIBI included (listed in order of rank) HUC-scale watershed QHEI, developed and impervious land use variables at the watershed and 500-meter spatial scales, site-level QHEI score, and site-level 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 explanation in 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 2.0).

The updated IPS Tool can be used to generate site restorability scores for creation of a prioritized project list.

Table 9. Measures 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)		RF Classification Tree Importance Rank (MSE[1]/Impurity)		
		Fish	Macros	fIBI	mIBI	Fish by Narrative	Macros by Narrative	General Use Attainment
HUC12 Mean QHEI	-	-	-	**1/1**	**2/2**	**1/1**	**3/3**	**1/1**
Impervious Land Use (500m)	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 (WS)	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	✓	✓	-	-	-	-	-
Total Phosphorus	0.04	✓	✓	-	17/15	15/ -	9/16	18/ -
Impervious Land Use (30m)	0.04	-	-	-	20/ -	10/15	18/ -	7/11
Impervious Land Use (30m 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	-	-

Stressor	FIT Score	Regression and Classification Tree		RF Regression Tree Importance Rank (MSE[1]/Impurity)		RF Classification Tree Importance Rank (MSE[1]/Impurity)		
		Fish	Macros	fIBI	mIBI	Fish by Narrative	Macros by Narrative	General Use Attainment
Developed Land Use (WS)	0.07	✓	✓	**3/4**	**3/4**	**2/2**	**2/1**	**5/3**
Minimum Dissolved Oxygen	0.10			9/11	9/10	-	-	- /12
Total Dissolved Solids	0.10			-	-	-	-	-
Impervious Land Use (WS)	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 (Wat.)	0.13	✓	✓	-	-	-	-	-
Hydro-QHEI Current Score	0.14			- /15	-	20/ -	-	-
TKN	0.14	✓	✓	-	12/15	-	19/20	-
QHEI Pool Score	0.15			-	-	18/19	17/15	-
Heavy Urban Land Use (WS)	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/ -
BOD (5-Day)	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

2.0 WATER QUALITY ASSESSMENT

This section details the designated uses, impairments, TMDLs, and water quality standards as relevant to the LDWG NARP.

2.1 DESIGNATED USES

The waters of Illinois are classified by site-specific designated uses (Table 10). Designated uses applicable to the Des Plaines River watershed 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 water 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 10. Illinois Designated Uses and applicable Water Quality Standards

Illinois EPA Designated Uses	Illinois Waters where Designated Use and Standards Apply	Applicable Illinois Water Quality Standards
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
Indigenous Aquatic Life	Specific Chicago-area Waters	Secondary Contact and Indigenous Aquatic Life Standards
Primary Contact	Streams, Inland Lakes	General Use Standards
	Lake Michigan Basin Waters	Lake Michigan Basin Standards
Secondary Contact	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
Public and Food Processing Water Supply	Streams, Inland Lakes, Lake Michigan basin Waters	Public and Food Processing Water Supply 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 which may include aquatic life, aesthetic quality, indigenous aquatic life (for specific Chicago-area waterbodies), primary contact (swimming), secondary contact (recreation), 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 CFR Part 130.7(b)(4). Several streams, lakes, and impoundments within the Lower Des Plaines watershed have been placed on the State of Illinois §303(d) list (Table 11 for streams; Table 12 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 stream; Figure 8 for lakes) and primary contact (Figure 9 for streams; Figure 10 for lakes).

Nine (9) mainstem river segments, nineteen (19) tributary segments, and eight (8) lakes/impoundments are identified as impaired in the Lower Des Plaines River Watershed on the 2020-22 303(d) lists (Table 11 for streams; Table 12 for lakes). Total phosphorus is listed as a cause of aquatic life impairment on six (6) mainstem segments, and ten (10) tributary segments in the Lower Des Plaines Watershed. Total phosphorus is also listed as an impairment to aesthetic quality in four (4) lakes. Dissolved oxygen listed as a cause of aquatic life impairment on nine (9) tributary segments. Dissolved oxygen listed as a cause of Indigenous Aquatic Life impairment on one (1) mainstem segment.

2.3 TMDL DEVELOPMENT IN THE WATERSHEDS

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

Two previous TMDL reports have been developed and approved in the Lower Des Plaines River Watershed. The development of the Des Plaines River/Higgins Creek Watershed TMDL Report was approved in May 2013 and Tampier Lake/Saganashkee Slough Watersheds TMDL Report was approved in 2010. Table 13 summarizes the TMDLs developed for each of these watersheds.

Table 11. Lower Des Plaines Watershed stream impairments and pollutants (2020-22 Illinois 303(d) List)

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Designated Use	Pollutant(s)	Potential Source(s)
IL_G-03	Des Plaines River	8.41	Aquatic Life	Chloride, pH, Total Phosphorus, Cause Unknown	Algae, Cause Unknown, Chloride, Flow Modification, pH, Stream Alteration, Total Phosphorus
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_G-11	Des Plaines River	9.05	Aquatic Life	Aldrin, Arsenic, Methoxychlor, Total Phosphorus	Aldrin, Arsenic, Cover Loss, Flow Modification, Methoxychlor, Nitrogen, Total Phosphorus
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
IL_G-12	Des Plaines River	8.5	Fish Consumption	Mercury, PCBs	Mercury, PCBs
IL_G-15	Des Plaines River	3.52	Aquatic Life	Cause Unknown, Total Phosphorus, Sedimentation/Siltation	Cause Unknown, Cover Loss, Nitrogen, Sedimentation/Siltation
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_G-23	Des Plaines River	3.82	Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Indigenous Aquatic Life	Dissolved Oxygen	Dissolved Oxygen
IL_G-24	Des Plaines River	5.2	Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_G-30	Des Plaines River	5.19	Aquatic Life	Cadmium, Cause Unknown, Nickel, Total Phosphorus, Total Suspended Solids	Cause Unknown, Cadmium, Nickel, Total Phosphorus, Total Suspended Solids
			Fish Consumption	Mercury, PCBs	Mercury, PCBs

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Designated Use	Pollutant(s)	Potential Source(s)
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_G-32	Des Plaines River	6.18	Aquatic Life	Cause Unknown, Chloride, Total Phosphorus	Cause Unknown, Chloride, Total Phosphorus,
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_G-39	Des Plaines River	11.25	Aquatic Life	Aldrin, Arsenic, Total Chromium, Lindane, Methoxychlor, Total Phosphorus	Aldrin, Arsenic, Cause Unknown, Chromium, Flow Modifications, Lindane, Methoxychlor, Total Phosphorus
			Fish Consumption	Mercury, PCBs	Mercury, PCBs
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_GA-01	Grant Creek	11.4	Aquatic Life	Cause Unknown	Cause Unknown
IL_GCB	Jackson Branch	8.83	Aquatic Life	Dissolved Oxygen, Total Phosphorus, Zinc	Aquatic Plants, Dissolved Oxygen, Flow Alteration, Nitorgen, Total Phosphorus, Zinc
IL_GCA-M-A1	Manhattan Creek	2.53	Aquatic Life	Chloride, Dissolved Oxygen, Sedimentation/ Siltation	Chloride, Dissolved Oxygen, Flow Alteration, Sedimentation/Siltation
IL_GCA-M-C1	Manhattan Creek	4.07	Aquatic Life	Cause Unknown, Total Phosphorus, Sedimentation/ Siltation	Cause Unknown, Flow Alterations, Total Phosphorus, Sedimentation/Siltation, Stream Alteration
IL_GF-01	Sugar Run	7.32	Aquatic Life	Arsenic, Manganese, Dissolved Oxygen, pH, Sedimentation/ Siltation	Arsenic, Dissolved Oxygen, Manganese, pH, Sedimentation/Siltation
IL_GG-22	Hickory Creek	2.25	Aquatic Life	Cause Unknown, Total Phosphorus,	Cause Unknown, Flow Alterations, Flow Modification, Stream Alteration, Total

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Designated Use	Pollutant(s)	Potential Source(s)
				Total Suspended Solids	Phosphorus, Total Suspended Solids
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_GGA-02	Spring Creek	15.29	Aesthetic Quality	Visible Oil	Oil
			Aquatic Life	Dissolved Oxygen, Total Phosphorus, Sedimentation/ Siltation	Dissolved Oxygen, Total Phosphorus, Sedimentation/ Siltation
IL_GGC-FN-A1	Union Ditch	4.08	Aquatic Life	Dissolved Oxygen, Sedimentation/ Siltation	Dissolved Oxygen, Flow Modification, Sedimentation/ Siltation, Stream Alteration
IL_GGC_FN-C1	Union Ditch	1.23	Aquatic Life	Total Ammonia, Chloride, Dissolved Oxygen, Total Phosphorus, Sedimentation/ Siltation	Ammonia, Chloride, Dissolved Oxygen, Flow Modification, Total Phosphorus Sedimentation/ Siltation, Stream Alteration
IL_GGF	Frankfort Trib	3.92	Aquatic Life	Total Phosphorus	Nitrogen, Total Phosphorus
IL_GHC	Fiddyment Creek	5.37	Aquatic Life	Total Phosphorus, Sedimentation/ Siltation	Total Phosphorus, Sedimentation/Siltation
IL_GJ-01	Sawmill Creek	6.62	Aquatic Life	Methoxychlor, PCBs	Cover Loss, Flow Alteration, Methoxychlor, PCBs
IL_GK-03	Flag Creek	7.91	Aquatic Life	Arsenic, Cause Unknown, DDT, Hexachlorobenzene, Methoxychlor, Total Phosphorus	Arsenic, Cause Unknown, DDT, Hexachlorobenzene, Methoxychlor, Nitrogen, Total Phosphorus
IL_GM-01	Silver Creek	4.57	Aesthetic Quality	Debris/Floatable/ Trash, Visible Oil	Debris/Floatable/Trash, Visible Oil
			Aquatic Life	Dissolved Oxygen	Cover Loss, Dissolved Oxygen, Flow Modification, Stream Alteration

Waterbody ID	Waterbody Name	Stream Segment Length (miles)	Designated Use	Pollutant(s)	Potential Source(s)
IL_GO-01	Willow Creek	8.22	Aquatic Life	Cadmium, Dissolved Oxygen, Total Phosphorus	Cadmium, Cover Loss, Dissolved Oxygen, Total Phosphorus, Stream Alteration
IL_GOA-01	Higgins Creek	1.69	Aquatic Life	Chloride, Total Phosphorus	Chloride, Dissolved Oxygen, Flow Alteration, Sedimentation/Siltation
			Primary Contact	Fecal Coliform	Fecal Coliform
IL_GOA-02	Higgins Creek	2.57	Aquatic Life	Cause Unknown	Cause Unknown, Chloride
			Primary Contact	Fecal Coliform	Fecal Coliform

Table 12. Lower Des Plaines Watershed lake impairments and pollutants, 2020-22 Illinois 303(d) List

Waterbody ID	Waterbody Name	Size (acres)	Designated Use	Pollutant(s)	Potential Source(s)
IL_RGZO	Tampier Lake	161.6	Aesthetic Quality	Total Suspended Solids	Total Suspended Solids
IL_RHZF	Bullfrog	16	Aesthetic Quality	Total Phosphorus, Total Suspended Solids	Algae, Aquatic Plants, Total Phosphorus, Total Suspended Solids
IL_SGF	Schiller Pond	6	Fish Consumption	Mercury, PCBs	Mercury, PCBs
IL_RGZZ	Lake Sedgewick	75	Aesthetic Quality	Total Phosphorus, Total Suspended Solids	Algae, Total Phosphorus, Total Suspended Solids
			Fish Consumption	Mercury	Mercury
IL_VGZA	Rock Run Rookery	224	Aesthetic Quality	Total Phosphorus	Total Phosphorus
IL_RGF	Opeka	5	Aesthetic Quality	Cause Unknown	Cause Unknown
IL_RHT	Columbus Park Lagoon	5	Aesthetic Quality	Cause Unknown	Cause Unknown
IL_WGZY	Swan (Indian Lake)	4	Aesthetic Quality	Total Phosphorus	Algae, Total Phosphorus

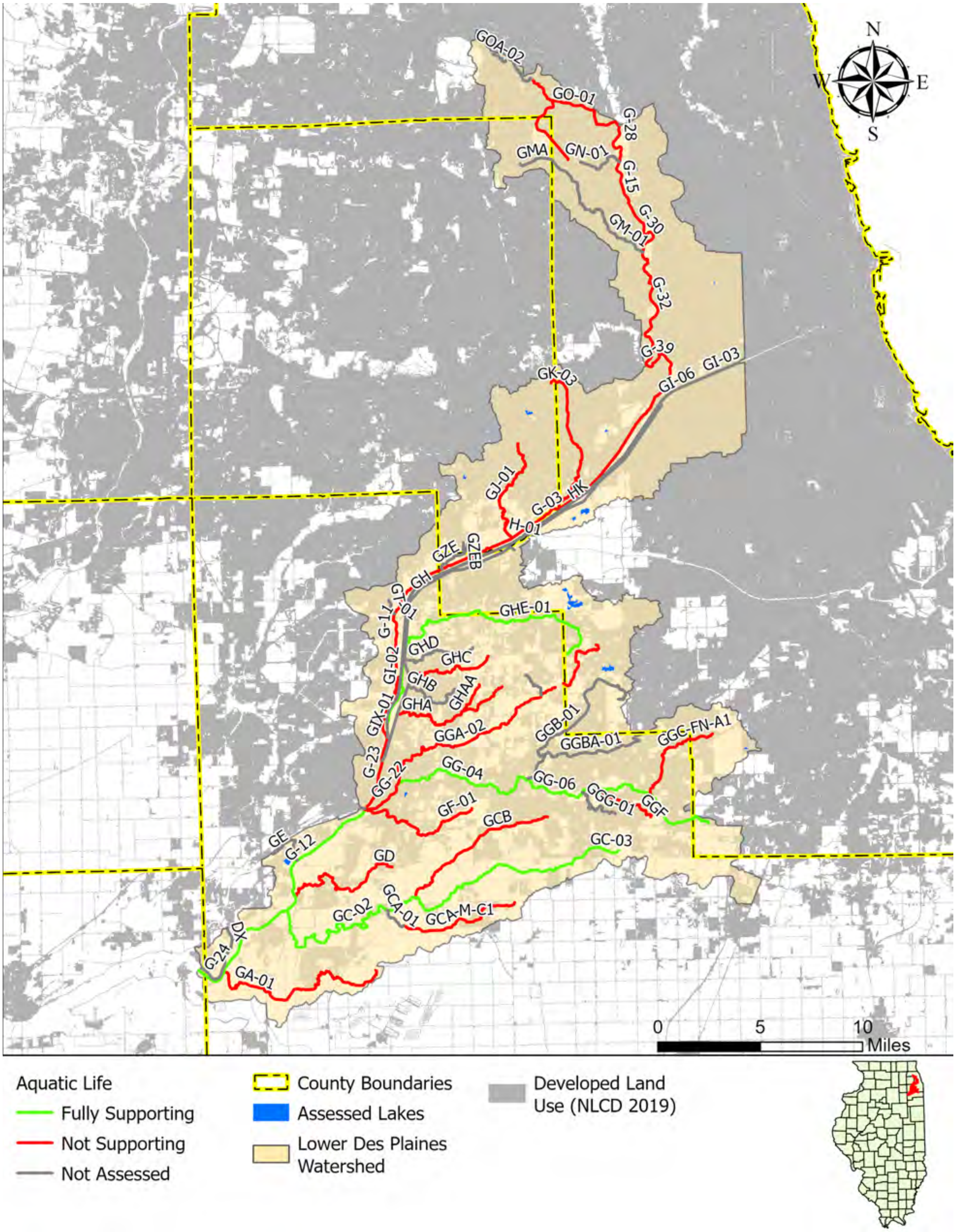

Figure 3. Aquatic Life Use Support in the Streams and Rivers in the Lower Des Plaines River Watershed

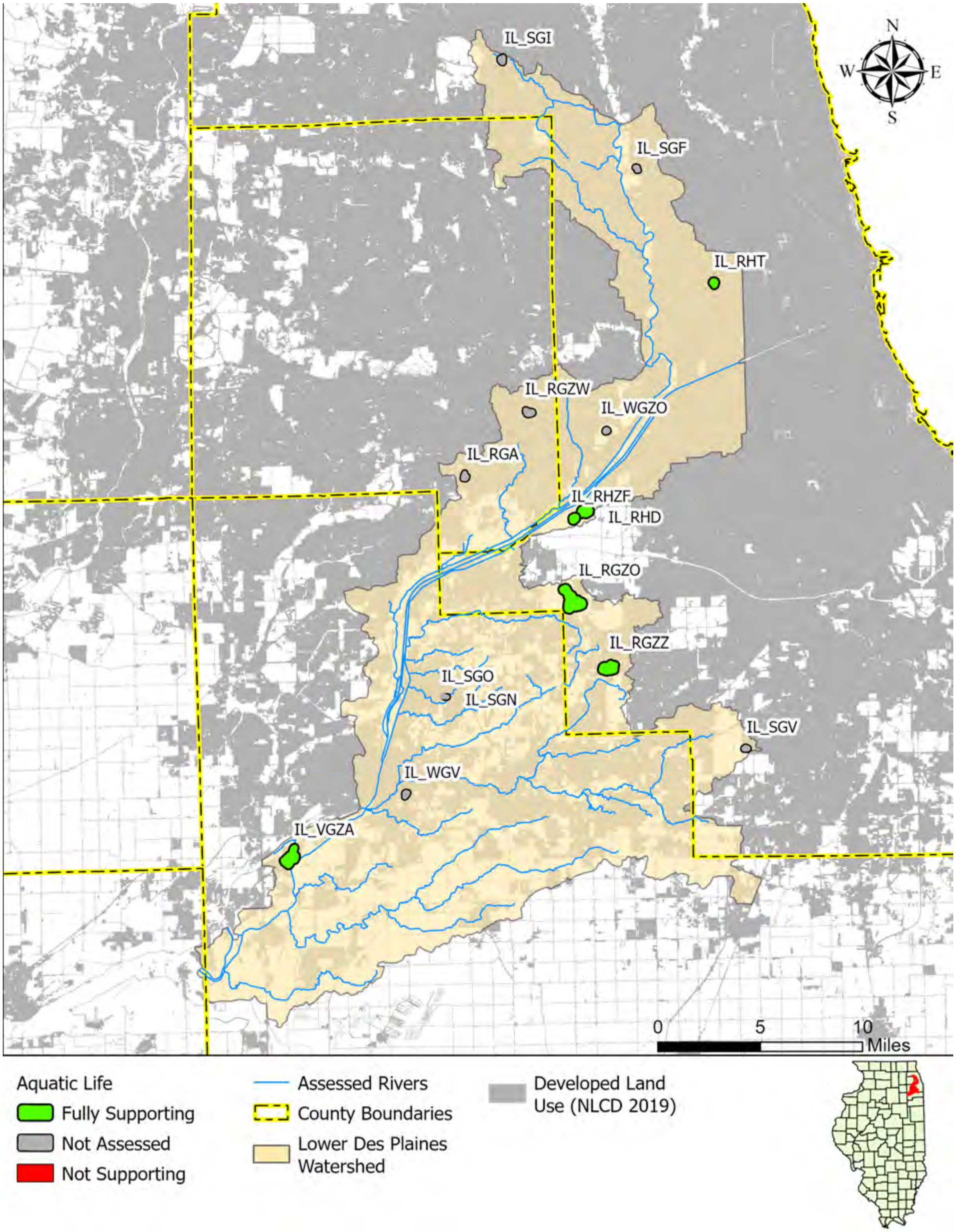

Figure 4 Aquatic Life Use Support in Lakes in the Lower Des Plaines River Watershed.

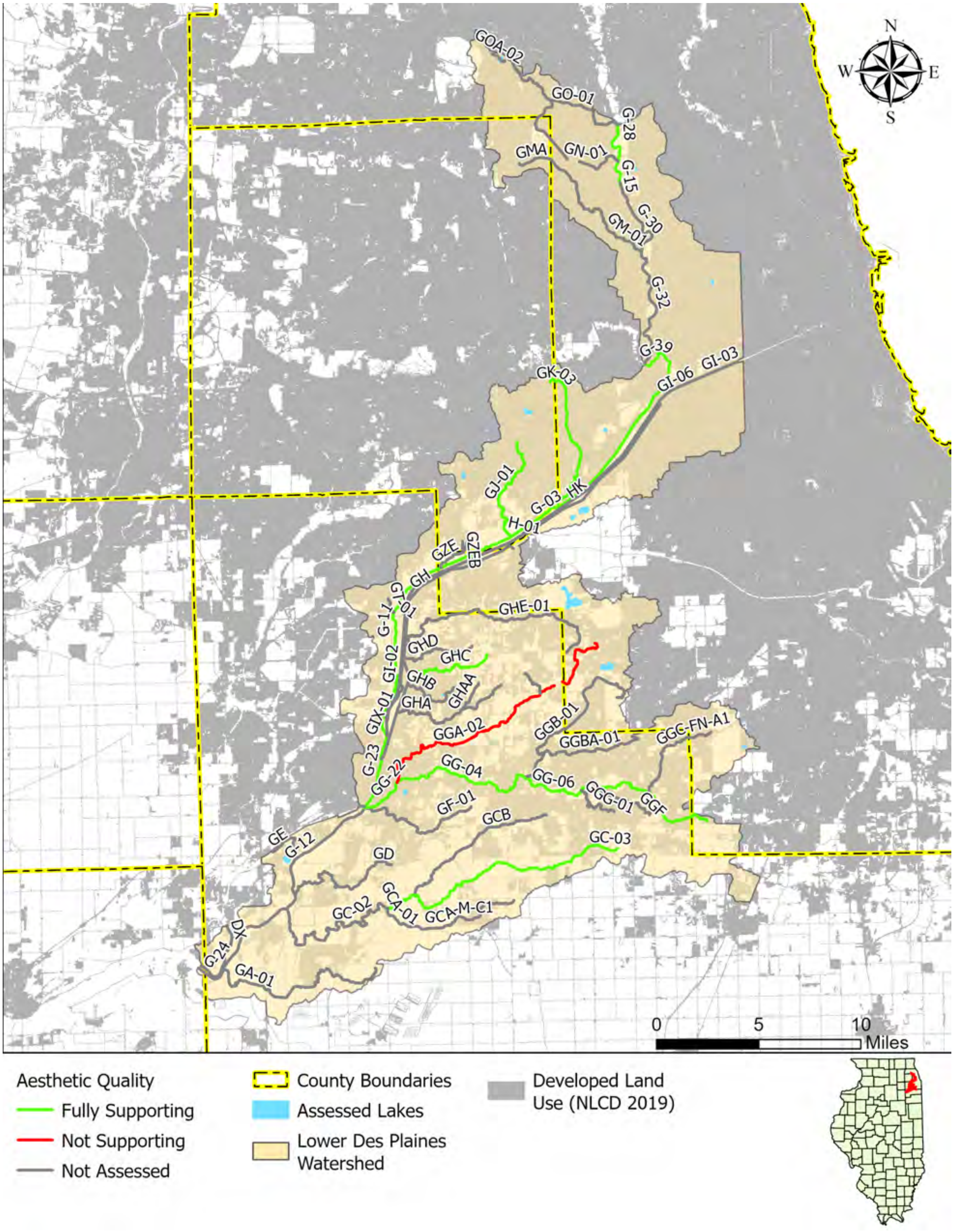

Figure 5. Aesthetic Quality Use Support in the Streams and Rivers in the in the Lower Des Plaines River Watershed

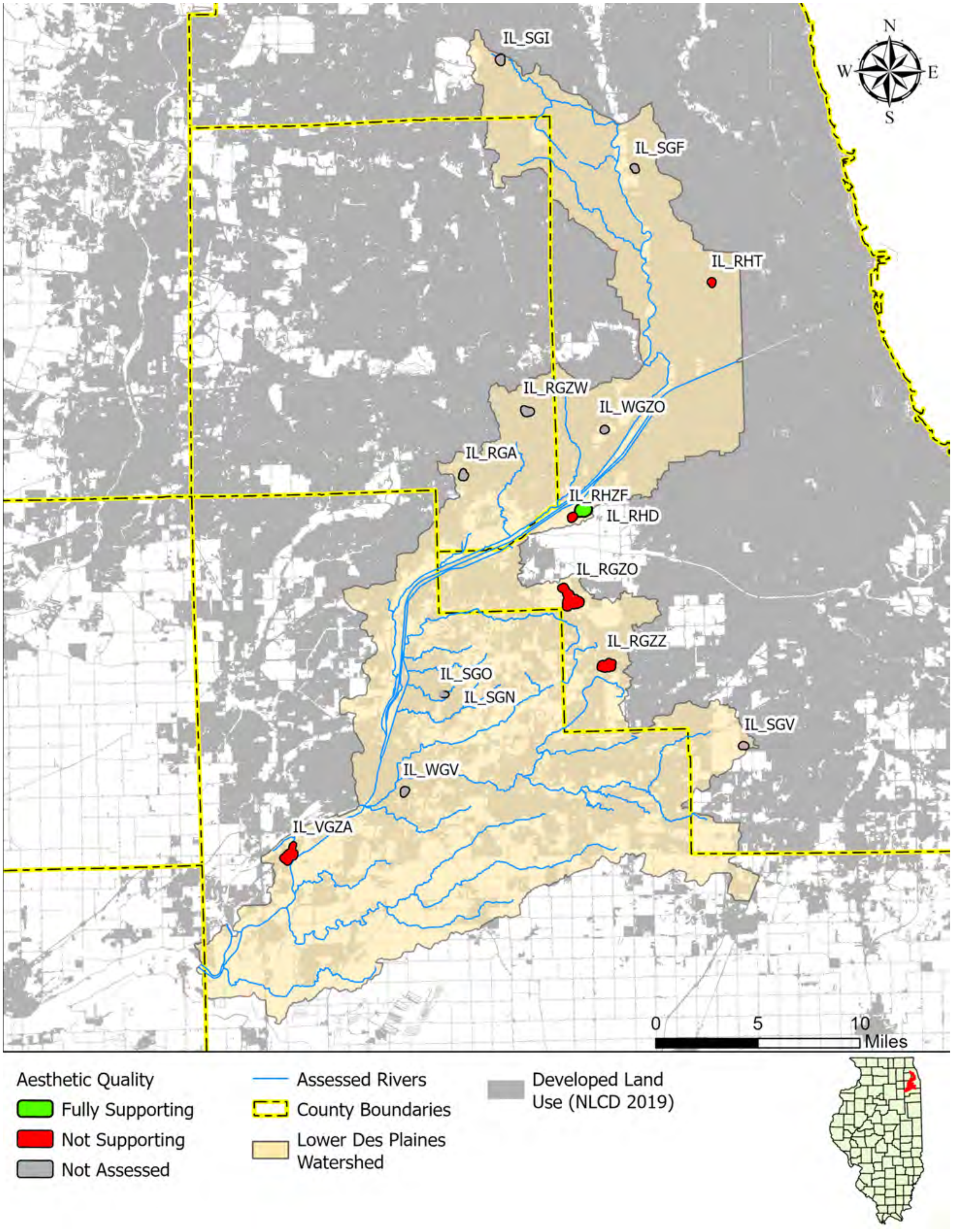

Figure 6. Aesthetic Quality Use Support in Lakes in the Lower Des Plaines River Watershed

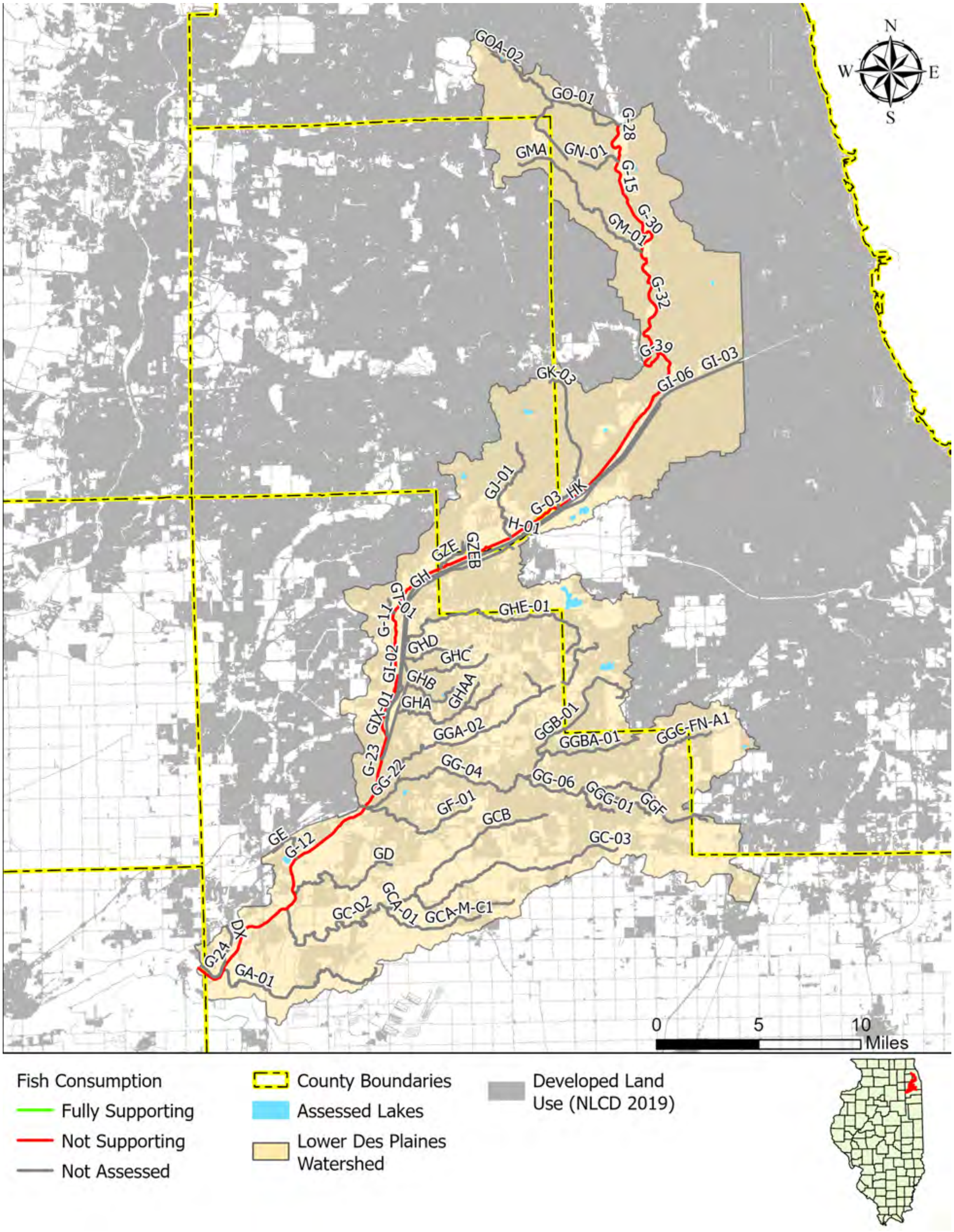

Figure 7. Fish Consumption Use Support in the Streams and Rivers in the Lower Des Plaines River Watershed

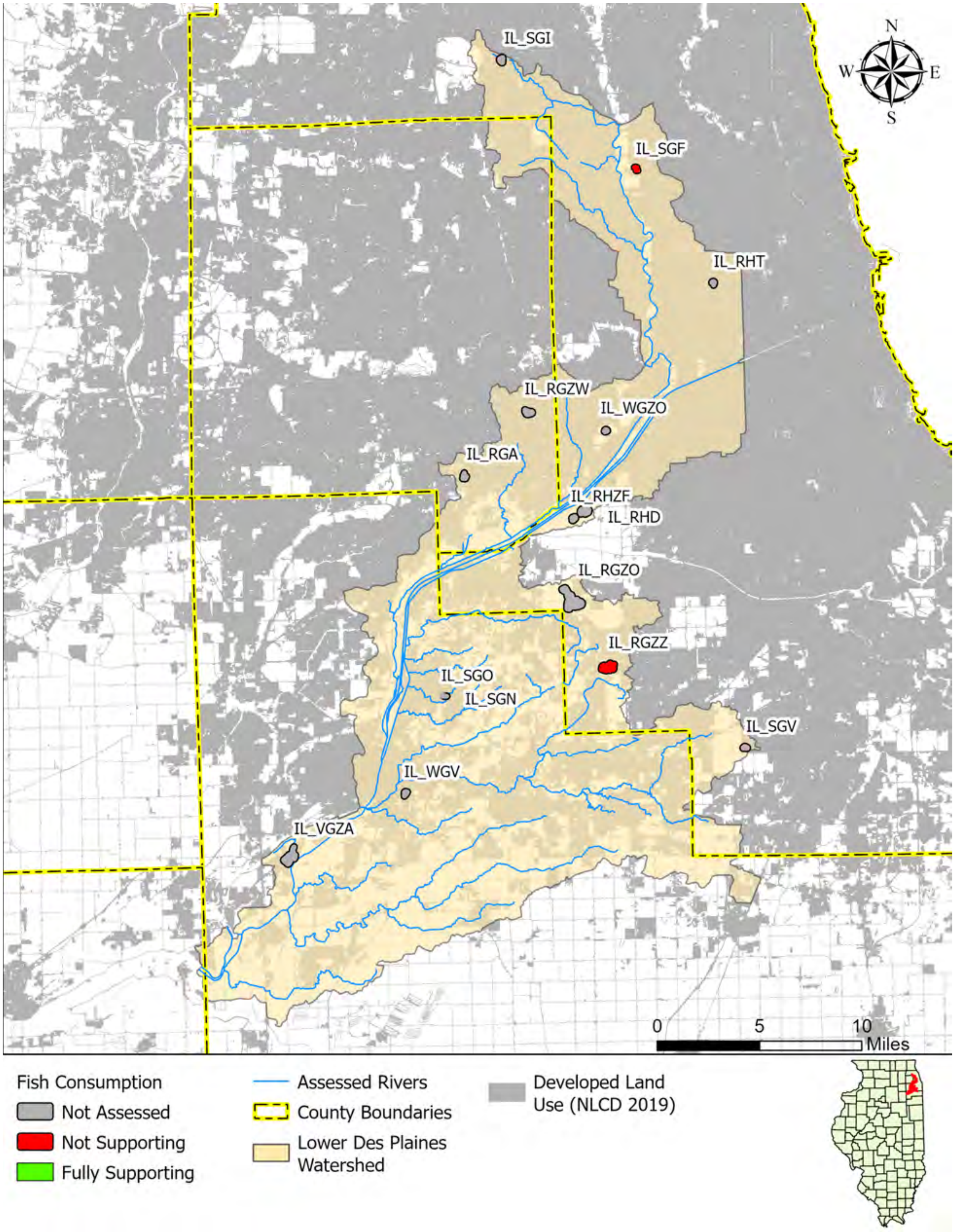

Figure 8. Fish Consumption Use Support in Lakes in the Lower Des Plaines River Watershed

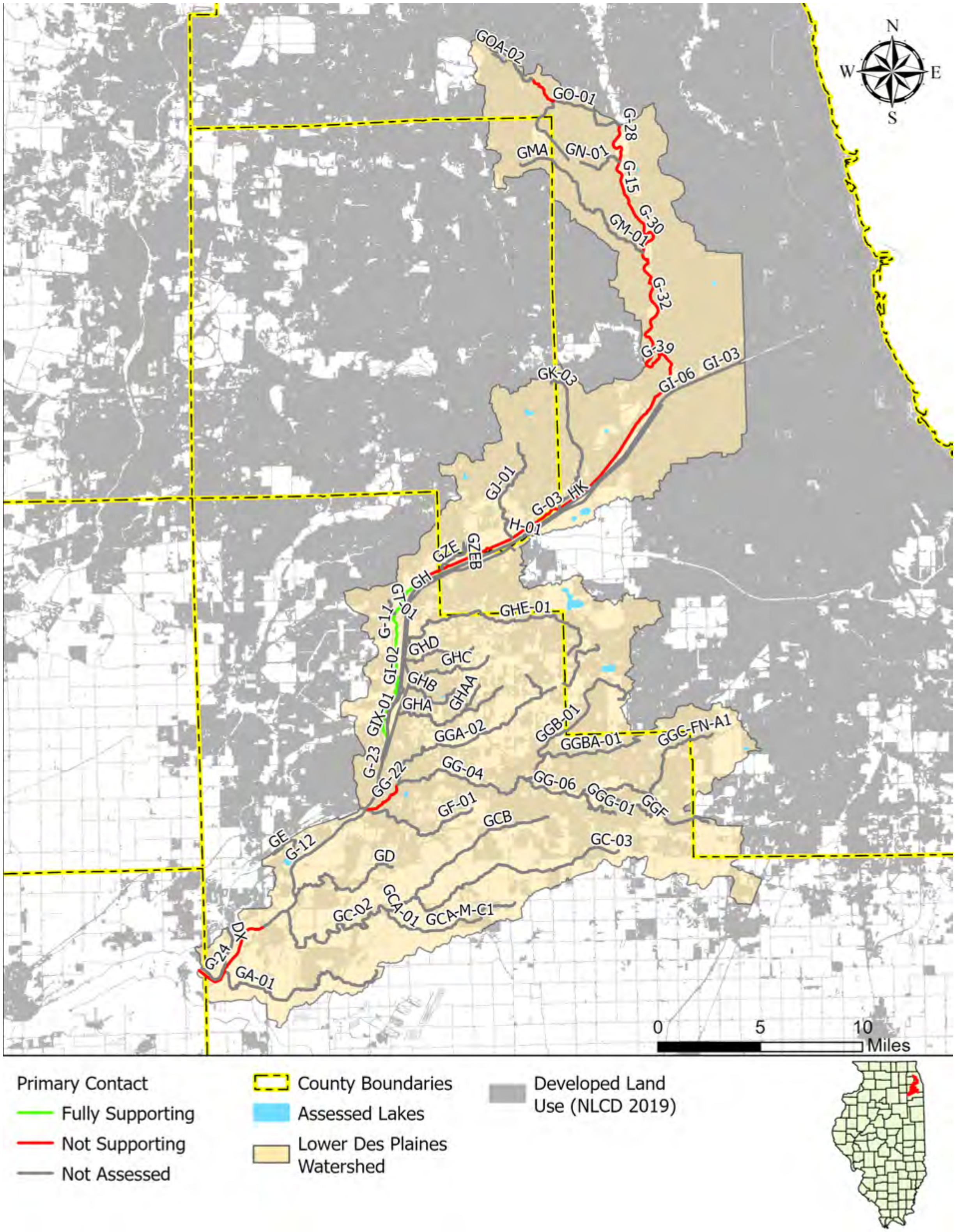

Figure 9. Primary Contact Recreation Use Support in the Streams and Rivers in the Lower Des Plaines River Watershed

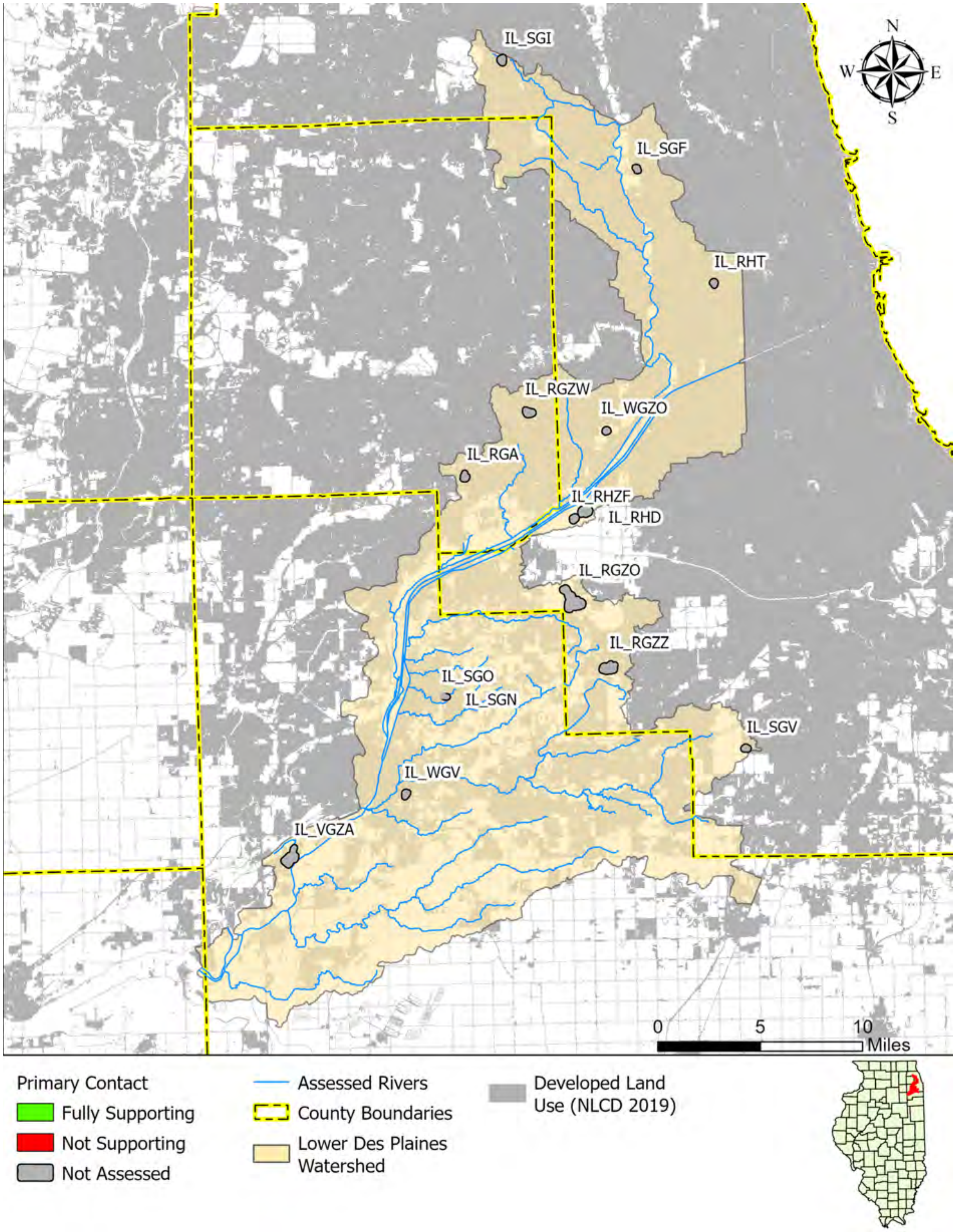

Figure 10. Primary Contact Recreation Use Support in Lakes in the Lower Des Plaines River Watershed

Table 13. Summary of Existing TMDLs in the Lower Des Plaines watershed

TMDL Project	TMDL Approval	Waterbody Name	Impaired Segments Addressed by TMDL	Pollutant(s) Addressed by TMDL
Des Plaines River/Higgins Creek Watershed TMDL Report[a]	2013	Higgins Creek	IL_GOA-01	Chloride, Fecal Coliform
			IL_GOA-02	Dissolved Oxygen
Tampier Lake/ Saganashkee Slough Watersheds TMDL Report[b]	2010	Tampier Lake	IL_RGZO	Total Phosphorus

[a] Higgins Creek is the only segment in the TMDL that is in the Lower Des Plaines Watershed.
[b] Saganashkee Slough is not within the Lower Des Plaines River Watershed boundary.

2.4 NARP 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 water quality standards promulgated by the IPCB. Relevant water quality standards associated with the Lower Des Plaines watershed NARP are provided in Table 14.

Table 14. Summary of relevant water quality standards

Standard Type	Parameter	General Use Water Quality Standard
Numerical Water Quality Standards	Chloride (mg/L)	500
	Dissolved Oxygen (mg/L) a	**For most waters:** • March-July > 5.0 min. & > 6.0 7-day mean • Aug-Feb > 3.5 min, > 4.0 7-day mean, & > 5.5 30-day mean **For waters with enhanced protection (i.e., GB-16):** • March-July > 5.0 min & > 6.25 7-day mean • Aug-Feb > 4.0 min, > 4.5 7-day mean, & > 6.0 30-day mean **Lakes:** Seasonally and waterbody dependent
	Total Phosphorus (mg/L)	**Lakes ≥ 20 acres**[b]**,** Acute: 0.05
Narrative Water Quality Standards	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.

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 total phosphorus standard at 35 Ill. Adm. Code 302.205 applies to lakes of 20 acres or larger.

The "most waters" DO standard applies to all other riverine waterways in the Lower Des Plaines watershed.

Illinois does not have an IPCB-approved standard for total phosphorus, total nitrogen, sestonic chlorophyll-*a* nor 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 total nitrogen, sestonic chlorophyll-*a* nor benthic chlorophyll-*a* for lakes.

2.4.1 Total Phosphorus Impairments on Section 303(d) List

Total phosphorus is listed as a cause of aquatic life impairment on six (6) mainstem Des Plaines River segments and ten (10) tributary segments, and for aesthetic quality impairment in four (4) lakes in the Lower Des Plaines watershed. These listings were based on violations of a non-standards 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 (NSAC) Recommendations

The Nutrient Science Advisory Committee (NSAC) consisted of scientific experts nominated by stakeholder sectors represented in the Illinois Nutrient Loss Reduction Strategy (INLS) Policy Working Group to assist IEPA with development of 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 total phosphorus and total nitrogen criteria developed by NSAC are detailed below (Table 15).

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

Table 15. 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.

3.0 WATERSHED CHARACTERIZATION

This section describes the general characteristics of the Lower Des Plaines River watersheds including location, topography, land cover, soils, population, climate, hydrology, and both point and nonpoint pollutant sources. The Lower Des Plaines River watershed is in northeastern Illinois and covers approximately 490 square miles (230,000 acres) in Cook, Will, Grundy, and DuPage counties. While the Des Plaines River begins in Wisconsin, the planning area for the LDWG begins at approximately river mile 60 where Willow Creek joins the Des Plaines River down to the confluence with the Kankakee River near Channahon. The planning area covers all or portions of thirteen (13) ten-digit hydrologic unit codes (HUC) listed in Table 16. The LDWG planning area excludes the DuPage River (HUC 0712000408) and Salt Creek (HUC 0712000404) as they are addressed through joint NARP development by the DuPage River Salt Creek Workgroup and the Lower DuPage River Watershed Coalition. Also excluded is the Chicago Ship and Sanitary Canal (HUC 712000301, 712000407) which is addressed through the Phosphorus Assessment and Reduction Plan (PARP) development by the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC).

Table 16. Lower Des Plaines River Watershed HUCs

Hydrologic Unit Code (HUC)	HUC Name
71200040706	Goose Lake-Des Plaines River
71200040705	Maple Lake-Chicago Sanitary and Ship Canal
71200040905	Des Plaines River
71200040904	Grant Creek
71200040901	Sugar Run
71200040603	Hickory Creek
71200040601	Headwaters Hickory Creek
71200040602	Spring Creek
71200040703	Long Run
71200040903	Jackson Creek
71200040902	Headwaters Jackson Creek
71200040704	Sawmill Creek
71200040701	Flag Creek

As the Des Plaines River joins the Kankakee River it forms 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 Lower Des Plaines River watershed, a United States Geological Survey (USGS) 30-meter resolution digital elevation model (DEM) was obtained from the Illinois Natural Resources Geospatial Data Clearinghouse to characterize topography (Figure 12). In general, the watershed is at a higher elevation in the northern sections, grading down to lower elevations towards the south and southwest as it meets the Kankakee to form the Illinois River. As expected, the tributaries to the east and west of the Des Plaines River start of a significantly higher elevations and grade down into the Des Plaines River valley. Within the study area, the Des Plaines River at Willow Creek is at an elevation of approximately 619 feet and falls to approximately 505 feet near Channahon. As reflected in Figure 11 below there are four distinct areas of elevation change. From Willow Creek at river mile 60 and elevation of 619 ft. to Ogden Avenue, just downstream of Salt Creek, at river mile 42 and elevation of 585 ft there is consist drop in elevation. The second section is very flat from Ogden Avenue to about I-355 at river mile 27 and elevation 585 ft with no elevation loss. The third section down to the Brandon Road Lock at river mile 13 falls to 537 ft and is consistently flat again after the lock at 505 ft to the confluence with the Kankakee River.

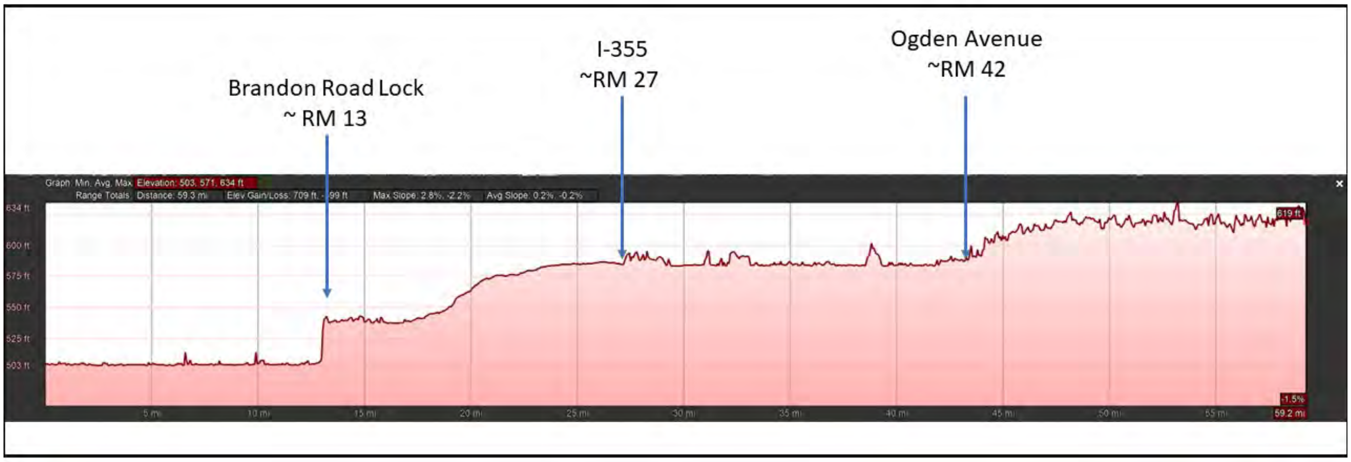

Figure 11. Lower Des Plaines River elevation graph from Google Earth

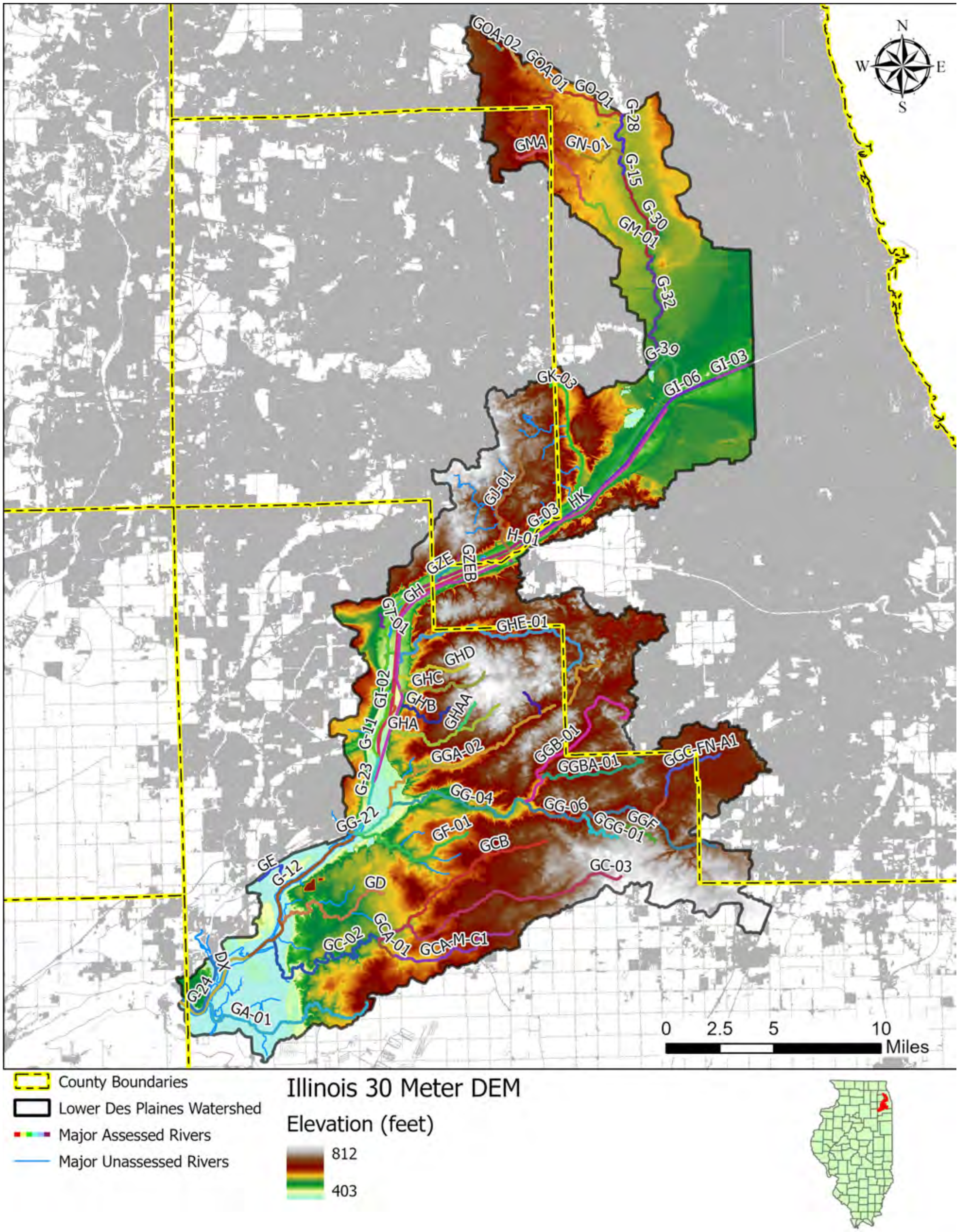

Figure 12. Lower Des Plaines River Watershed topography

3.2 LAND COVER

Land cover data for the watershed were extracted from the 2019 National Land Cover Database (NLCD). Table 17 summarizes the land cover for the Lower Des Plaines River Watershed. Figure 13 shows land cover in the Lower Des Plaines River watershed and indicates that higher density development is more dominant in the upstream portions of the watershed, while lower intensity development and agricultural land uses dominate the lower portions of the watershed. Development related land cover overall accounts for 65% of the total area and agricultural land cover comes in at approximately 18%.

Table 17. Summary of land cover data (NLCD 2019) for the Des Plaines River watershed

Land Cover Classification	Acreage	Percent	Aggregated Acreage	Aggregated Percent
Open Water	6,116	1.95%	6,116	1.95%
Developed, Open Space	22,795	7.26%	204,300	65.05%
Developed, Low Intensity	67,651	21.54%		
Developed, Medium Intensity	68,870	21.93%		
Developed, High Intensity	42,563	13.55%		
Barren Land	2,421	0.77%		
Deciduous Forest	18,714	5.96%	20,089	6.40%
Evergreen Forest	175	0.06%		
Mixed Forest	1,200	0.38%		
Shrub/Scrub	1,160	0.37%	9,481	3.02%
Herbaceous	8,321	2.65%		
Hay/Pasture	8,193	2.61%	56,238	17.91%
Cultivated Crops	48,045	15.30%		
Woody Wetlands	14,348	4.57%	17,860	5.69%
Emergent Herbaceous Wetlands	3,512	1.12%		

3.3 SOILS

Soils data and Geographic Information Systems (GIS) files from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) were used to characterize soils in the Lower Des Plaines River watershed. 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. SSURGO is the most detailed level of soil mapping prepared by the NRCS, with mapping scales generally ranging 1:12,000 to 1:63,360. 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.

SSURGO data was analyzed by hydrologic soil group (HSG) (Figure 14) and soil erodibility coefficient "K-factor" (Figure 15). HSG classifications identify soil groups with similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, poorly-drained clay soils have lower infiltration rates, while well-drained sandy soils have the higher infiltration rates. USDA has defined four HSGs for soils are A, B, C, or D. Group A soils have high infiltration potential while D soils have very low infiltration rates (Table 18).

The K-factor is a dimensionless measure of a soil's natural susceptibility to erosion. Factor values may range from zero for water surfaces to 1 (although in practice, maximum K-factor values do not generally exceed 0.67). Large K-factor values reflect greater potential for soil erodibility. Within the SSURGO database, soils are classified 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 Lower Des Plaines River watershed is shown in Figure 15. K-factors range from 0 to 0.5 in this watershed.

Table 18. Relative characteristics of hydrologic soil groups

Hydrologic Soil Group	Runoff Potential	Infiltration Rate
A	Low	High
A/D	High*	Very Low*
B	Moderate	Moderate
B/D	High*	Very Low*
C	High	Low
C/D	High*	Very Low*
D	High	Very Low*
No Data (Water, Gravel Pits, Landfill, Urban Land)	--	--

*Undrained soils in the natural condition

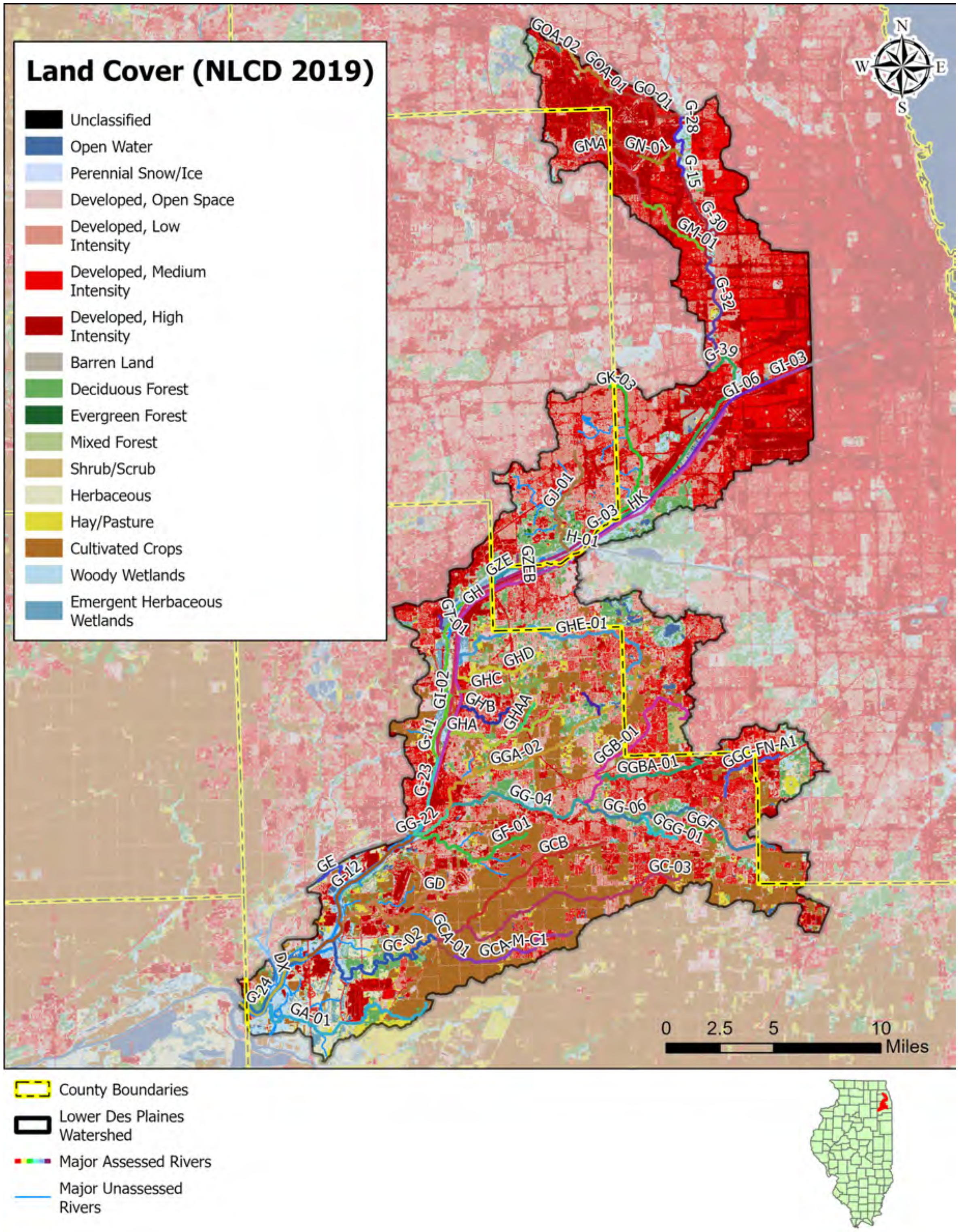

Figure 13. Lower Des Plaines River Watershed land use, IEPA codes supplied for State-assessed reaches

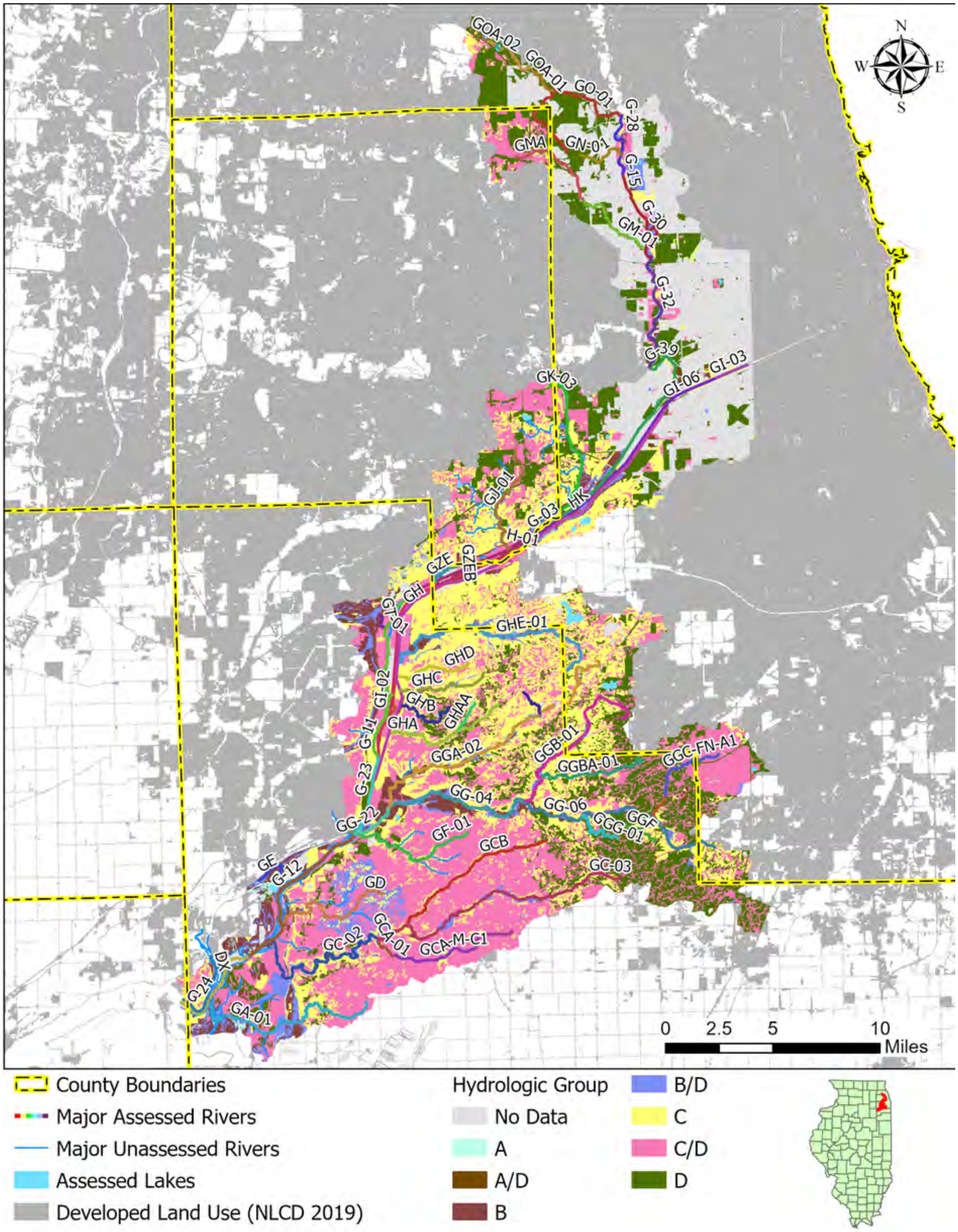

Figure 14 Lower Des Plaines River Watershed hydrologic soil groups.

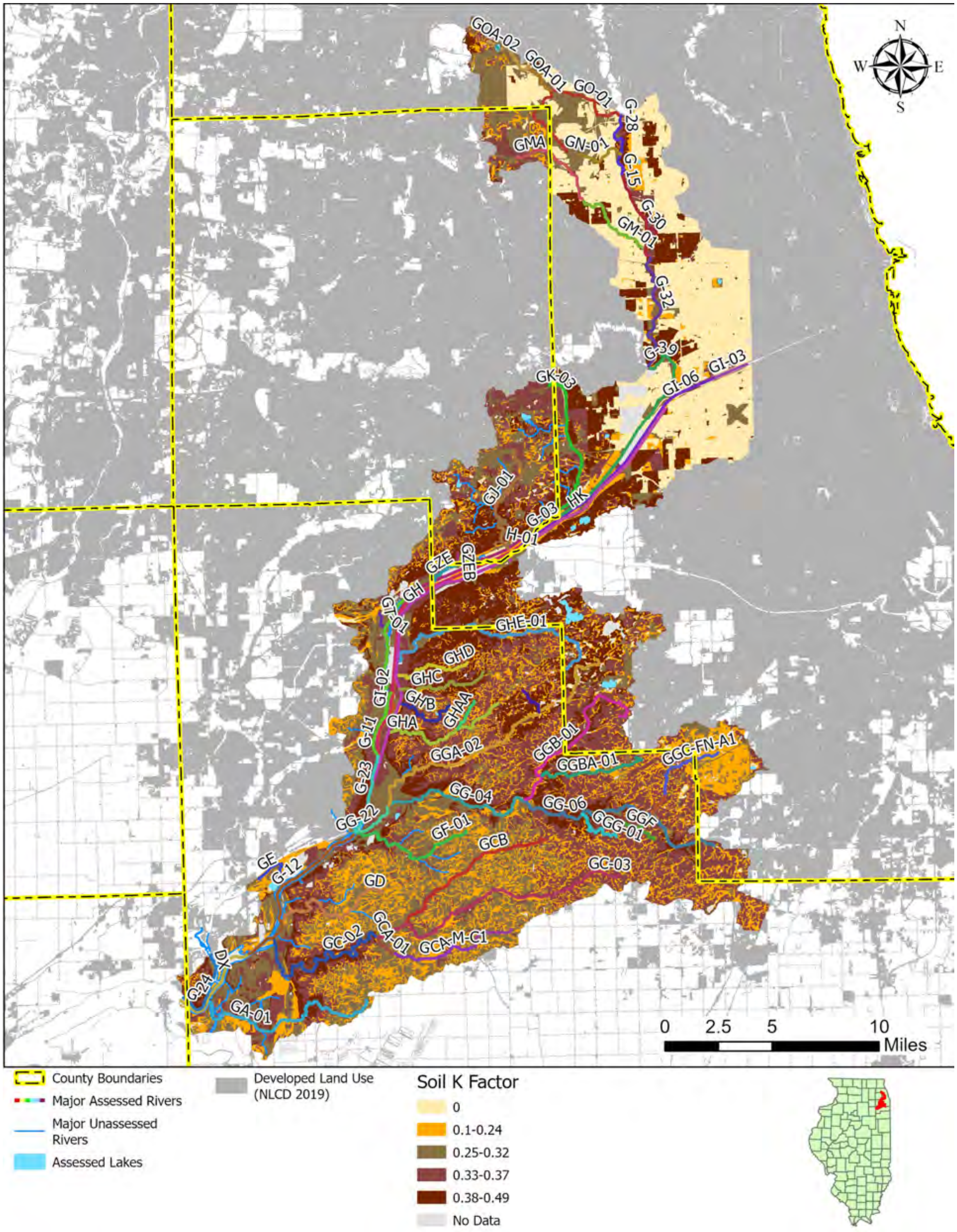

Figure 15 Lower Des Plaines River Watershed SSURGO K-Factor.

3.4 POPULATION

Circumstances in the Lower Des Plaines River watershed today 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, the construction of the I&M Canal has cut off direct flow of many tributaries and the development of the Illinois Waterway for shipping has armored and deepened the river. These alterations have also affected water runoff patterns and pathways across the landscape in increased volume and velocity, resulting in potential increase in pollutant transport.

Figure 16 depicts the projected percent population change in the watershed from 2020 to 2050. In general, the southern portion of the Des Plaines River watershed is expected to have the most growth, with 100-200% combined growth around and to the south of Joliet. Based on these data, development will grow dramatically in the southern portion of the watershed, but in general, the entire watershed will continue to increase in population over the upcoming years.

3.5 CLIMATE

Northeast Illinois has a continental climate with highly variable weather. The temperatures of continental climates are not buffered or tempered 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 National Oceanic and Atmospheric Administration National Weather Service website (www.weather.gov). Two weather stations were used to characterize the Lower Des Plaines River watershed area. O’Hare International Airport at the upstream end and Midway International Airport for the more downstream and tributary portions of the watershed.

Climate data were analyzed for the O’Hare and Midway Airports between the years of 1991 and 2020. The mean high summer air temperature was 73.27° F and 74.53° F, respectively, and the mean low air temperature in winter was 28.17 °F and 29.20° F, respectively. (Table 19 and Table 20). Mean monthly precipitation norms and snowfall norms are also included in the tables.

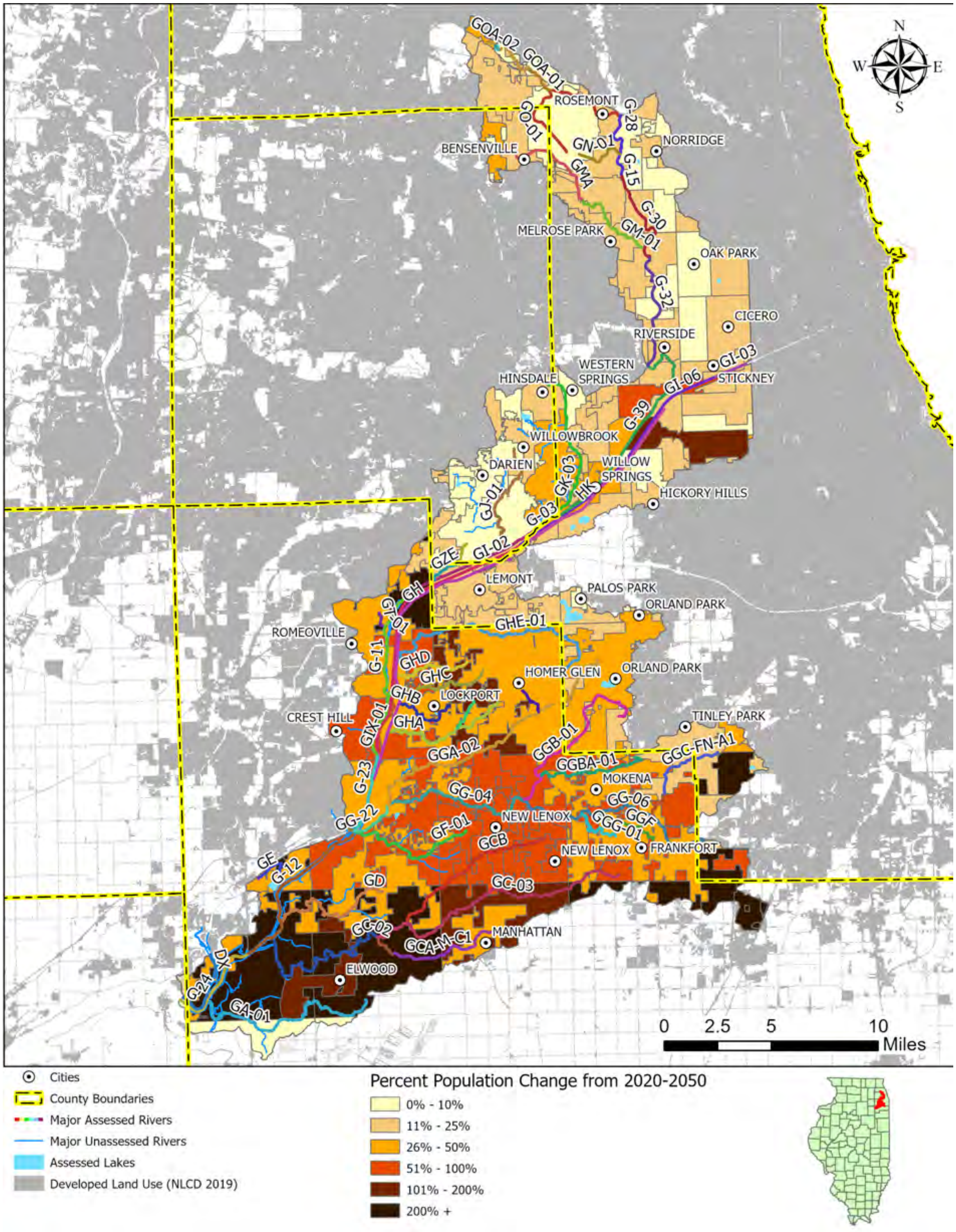

Figure 16 Lower Des Plaines River Watershed population projection.

Table 19. Climate characterization, O’Hare Int’l Airport (1991-2020)

Averaging Period	Mean Max Temperature Normal (°F)	Mean Min Temperature Normal (°F)	Mean Avg Temperature Normal (°F)	Average Precipitation (inches)	Average Snowfall (inches)
January	31.6	18.8	25.2	1.99	11.3
February	35.7	21.8	28.8	1.97	10.7
March	47	31	39	2.45	5.5
April	59	40.3	49.7	3.75	1.3
May	70.5	50.6	60.6	4.49	
June	80.4	60.8	70.6	4.1	
July	84.5	66.4	75.4	3.71	
August	82.5	65.1	73.8	4.25	
September	75.5	57.1	66.3	3.19	
October	62.7	45.4	54	3.43	0.2
November	48.4	34.1	41.3	2.42	1.8
December	36.6	24.4	30.5	2.11	7.6
Annual	**59.5**	**43**	**51.3**	**37.86**	**38.4**
Seasonal: Spring	58.83	40.63	49.77	10.69	
Seasonal: Summer	82.47	64.10	73.27	12.06	
Seasonal: Fall	62.2	45.5	53.9	9.04	
Seasonal: Winter	34.63	21.67	28.17	6.07	

Table 20. Climate characterization, Midway Int’l Airport (1991-2020)

Averaging Period	Mean Max Temperature Normal (°F)	Mean Min Temperature Normal (°F)	Mean Avg Temperature Normal (°F)	Normal Precipitation (inches)	Average Snowfall (inches)
January	32.8	19.5	26.2	2.3	12.5
February	36.8	22.9	29.9	2.12	10.1
March	47.9	32	39.9	2.66	5.7
April	60	41.7	50.9	4.15	
May	71.5	52.4	61.9	4.75	
June	81.2	62.7	71.9	4.53	
July	85.2	68.1	76.7	4.02	
August	83.1	66.9	75	4.1	
September	76.5	59.2	67.8	3.33	
October	63.7	46.8	55.3	3.86	0.1
November	49.6	35.2	42.4	2.73	1.5
December	37.7	25.3	31.5	2.33	7.9
Annual	**60.5**	**44.4**	**52.5**	**40.88**	**38.8**
Seasonal: Spring	59.80	42.03	50.90	11.56	

Seasonal: Summer	83.17	65.90	74.53	12.65	
Seasonal: Fall	63.3	47.1	55.2	9.92	
Seasonal: Winter	35.77	22.57	29.20	6.75	

3.6 HYDROLOGY

Understanding hydrologic pathways is a key component of characterizing watershed conditions. All parameters listed in the previous sections (i.e., topography, land cover, soils, population dynamics, and climate) impact the hydrology of a watershed. 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.

Three USGS gage stations (on the Des Plaines River were chosen to evaluate stream flow: Des Plaines River at Riverside, IL USGS 05532500 (1944-2023), near Lemont, IL USGS 05533600 (2011-2023) and at Route 53 at Joliet, IL USGS 05537980 (2005-2023) (Figure 17). Annual average discharge over the last 10 years is 929, 1022, and 4055 cubic feet/second respectively. Figure 18 provides monthly average flow in cubic feet per second (CFS) from each of these stations and depicts the quadrupling of flow at Joliet after the Chicago Ship and Sanitary Canal (CSSC) enters the system. Additionally, USGS gage stations on Long Run near Lemont, USGS 05537500 (Figure 19) with a 29.3 CFS 10 year annual average discharge; and on Hickory Creek at Joliet USGS 05539000 (Figure 20) with a 155 CFS 10 year annual average, provide a comparison of flow inputs from tributaries. On average the lowest flows occur in August-September except for downstream of the CSSC where the lowest flows occur in November.

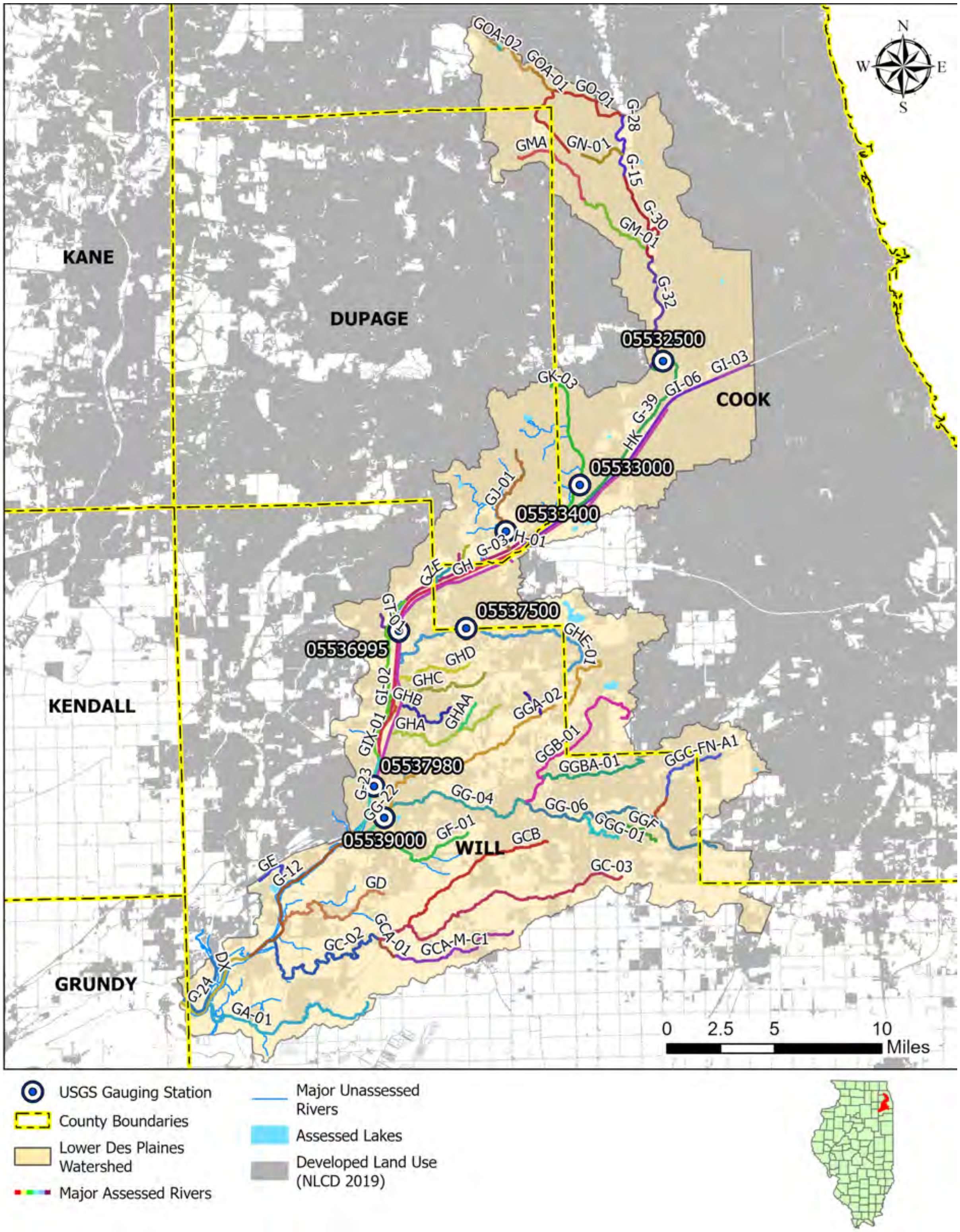

Figure 17 Lower Des Plaines River Watershed USGS gaging stations.

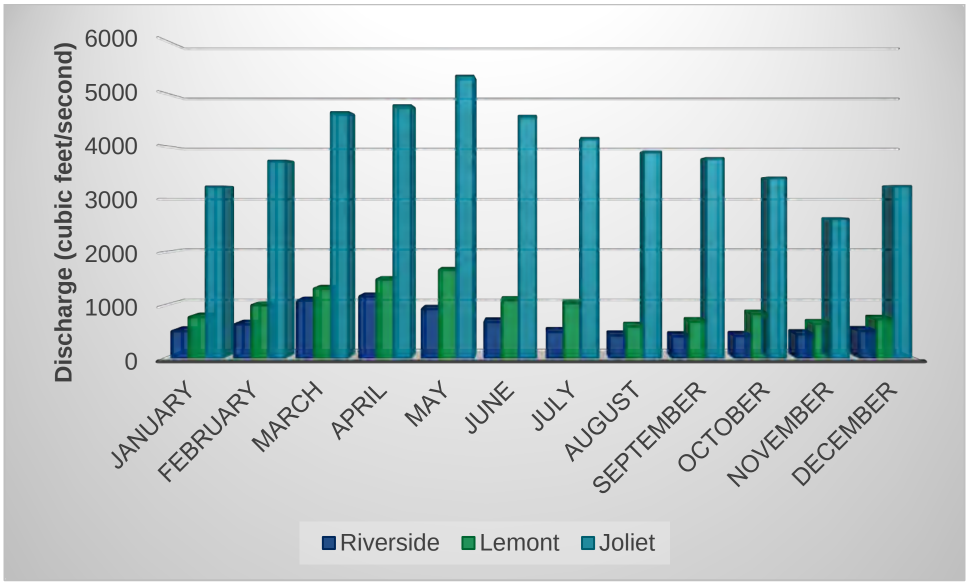

Figure 18. Mean monthly flow in Des Plaines River from USGS Gage Stations

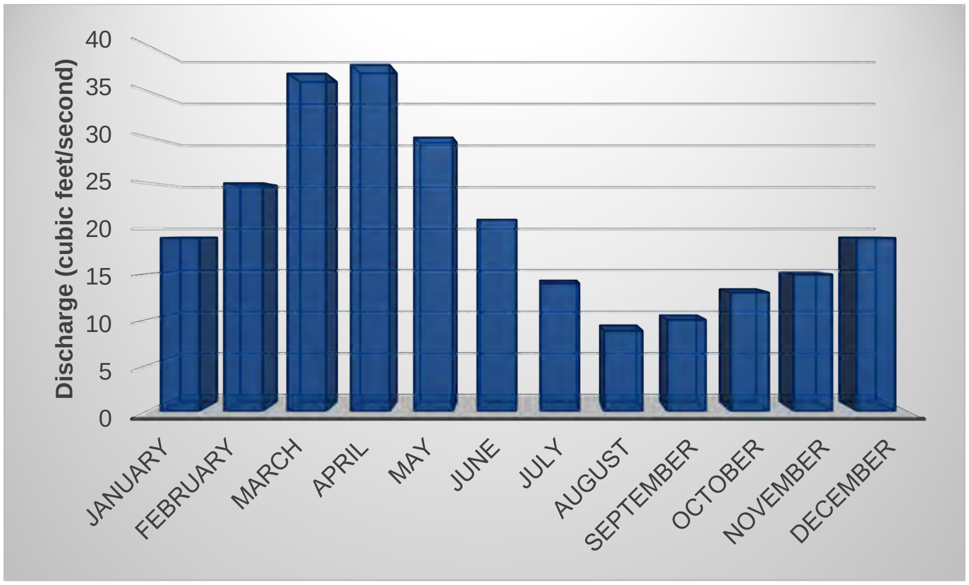

Figure 19. Mean monthly flow in Long Run USGS 05537500

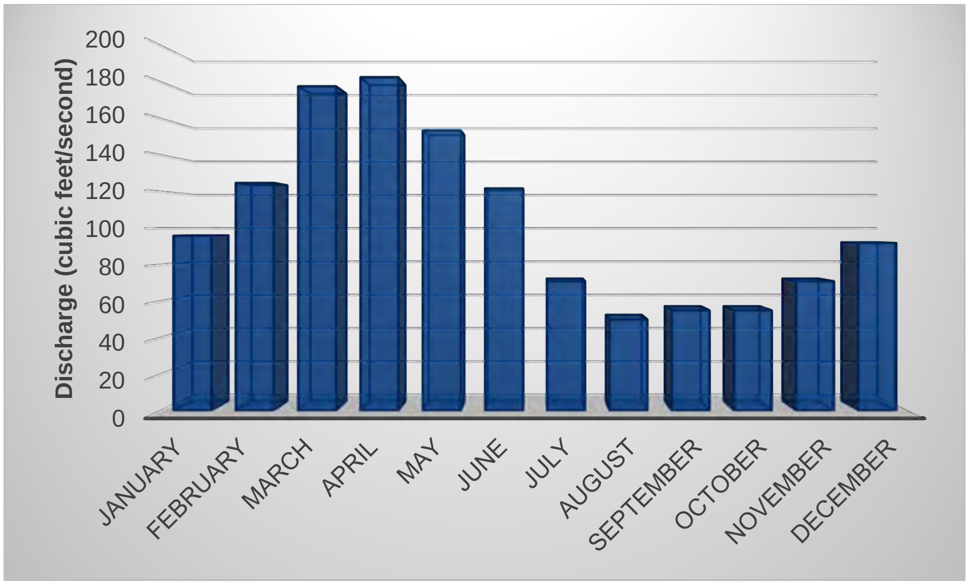

Figure 20. Mean monthly flow in Hickory Creek USGS 05539000

3.6.1 Dams

Dams have played a big role in the Des Plaines River over the last 100+ years, whether for navigation or recreation. These structures impact river systems by impeding flow, slowing water and dropping out sediment and covering important habitat. They can also serve to prevent fish migration and contribute to low DO conditions due to slow moving or stagnant waters in upstream pools. Since 2011 eleven dams on the Des Plaines River have been removed between the Illinois/Wisconsin border and Joliet in cooperative efforts between the Army Corps of Engineers (ACOE), Illinois Department of Natural Resources, Lake County Forest Preserve District, Forest Preserves of Cook County and the Village of Riverside.

Two remaining dams of note are the Brandon Road Lock and Dam in Joliet and the Pilcher Park Dam on Hickory Creek (Figure 21). A full survey of dam or other impoundment structures on Des Plaines River tributaries has not been completed at this time.

3.6.1.1 Lower Des Plaines River

Brandon Road Lock and Dam: This structure is located at river mile 13.3 in Joliet and was constructed between 1927 – 1933 to provide navigation assistance for barge and other boat traffic traveling to and from Chicago through the Chicago Ship and Sanitary Canal. It is operated by the ACOE. This structure is also a part of the barrier system also operated by the ACOE to manage the upstream movement of invasive carp species. The barrier system is a combination of electric, sound, bubble/air curtain and locking mechanism designed to flush any remaining lifeforms from the lock before it opens. While the intention is to block invasive carp species from gaining access to the Great Lakes, it also blocks movement of native species as well.

3.6.1.2 Hickory Creek

Pilcher Park Dam: The Pilcher Park Dam was built through the Works Progress Administration program for recreational purposes. It is owned by the Joliet Park District. Located at river mile 4.5, the twelve-foottall structure blocks the movement of fish to upstream reaches. It also creates a half-mile long pool upstream that has filled in with sediment, covering much of the substrate/bottom habitat.

There are several smaller water control structures in headwater tributaries to Hickory Creek that further impact the movement of aquatic species. A full survey of these smaller control structures or on-line detention have not yet been surveyed.

3.6.1.3 Jackson Creek

Dam at Round Barn Park: There is a small run-of-the-river concrete dam on Jackson Creek at river mile 16.2 at Round Barn Park, owned by the Manhattan Park District. The structure has been circumvented on the south side of the river, but still backs up flow and drops out sediment.

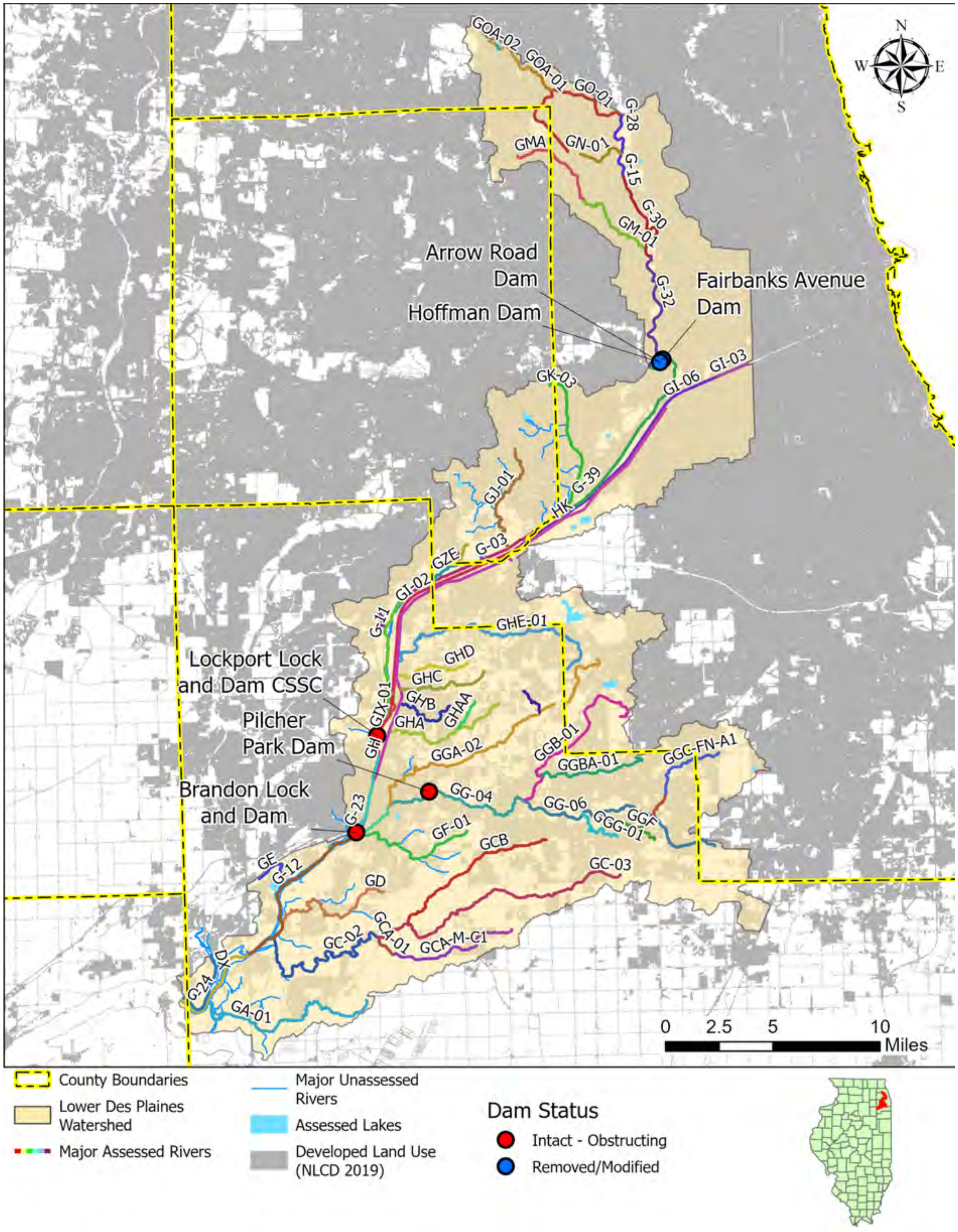

Figure 21. Dams in the Lower Des Plaines River Watershed.

3.7 POINT SOURCES

Point source is defined by the Federal Clean Water Act (CWA) §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 municipal separate storm sewer systems (MS4s). There are no permitted CAFOs in the DuPage River and Salt Creek watersheds.

3.7.1 NPDES-Permitted Facilities

NPDES-permitted facilities within the watershed include municipal and industrial WWTPs of various sizes. Permitted major municipal WWTPs in the Lower Des Plaines River watershed are summarized in Table 21 and included in Figure 22. Minor municipal WWTPs are summarized in Table 22 and also included in Figure 22. Industrial discharges in the watersheds are summarized on Table 23.

Five NPDES-permitted facilities also have permitted combined sewer overflows (CSOs) in the Lower Des Plaines River watershed (Table 24 and Figure 23). CSOs occur as the result of wet weather, which is not of specific concern for this NARP as the wet weather season is not the critical condition for DO, which is during warm, dry, low-flow periods. When CSO events occur, untreated wastewater enters rivers and streams, potentially discharging pollutants such as fecal coliform, solids, chloride, and nutrients like phosphorus. There is an ongoing Long-Term Control Plan (LTCP) established to eliminate CSO events across these watersheds. Two 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. These facilities that are part of the TARP program are not required to submit separate LTCPs.

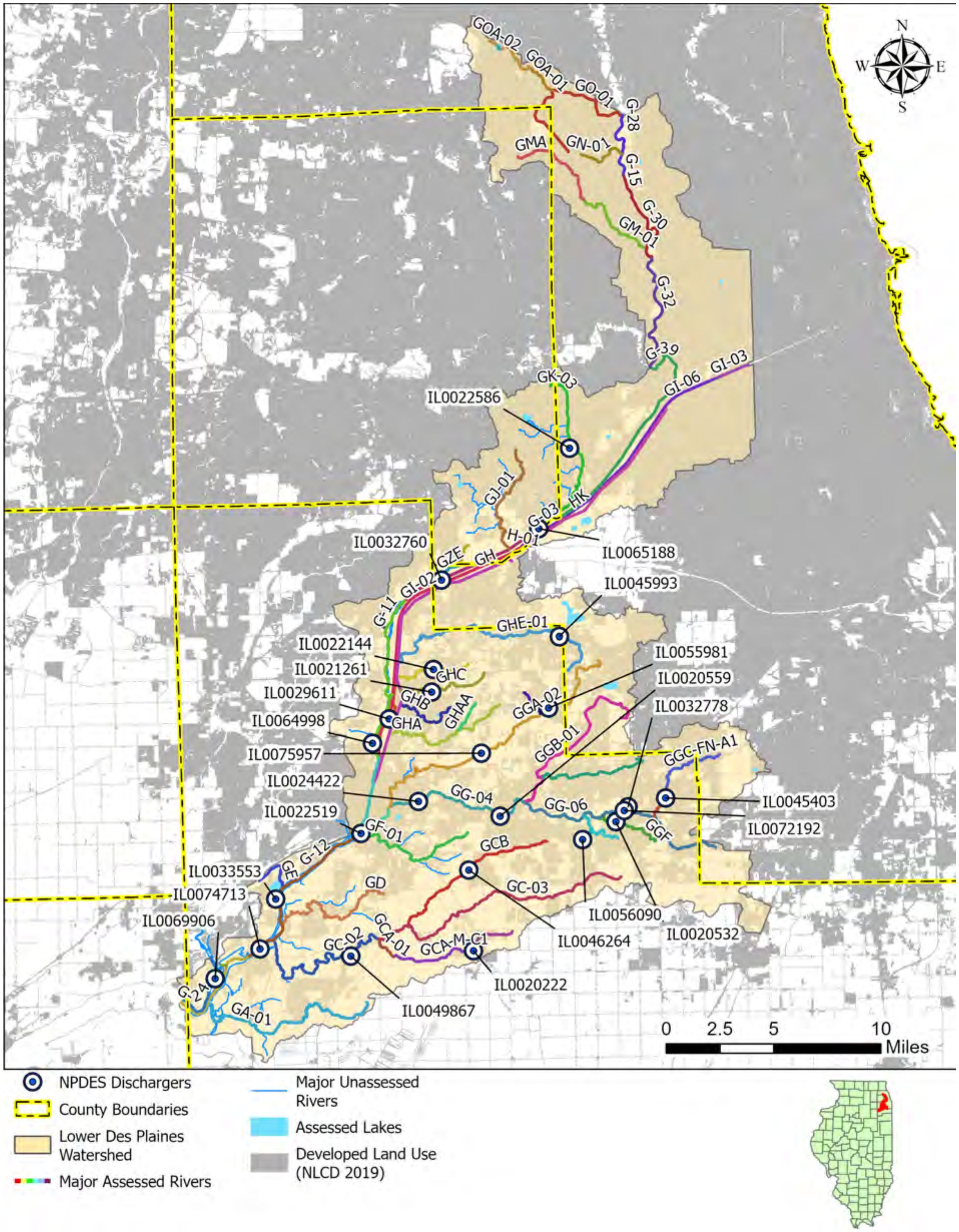

Figure 22. Major and Minor Municipal WWTPs in the Lower Des Plaines River Watershed

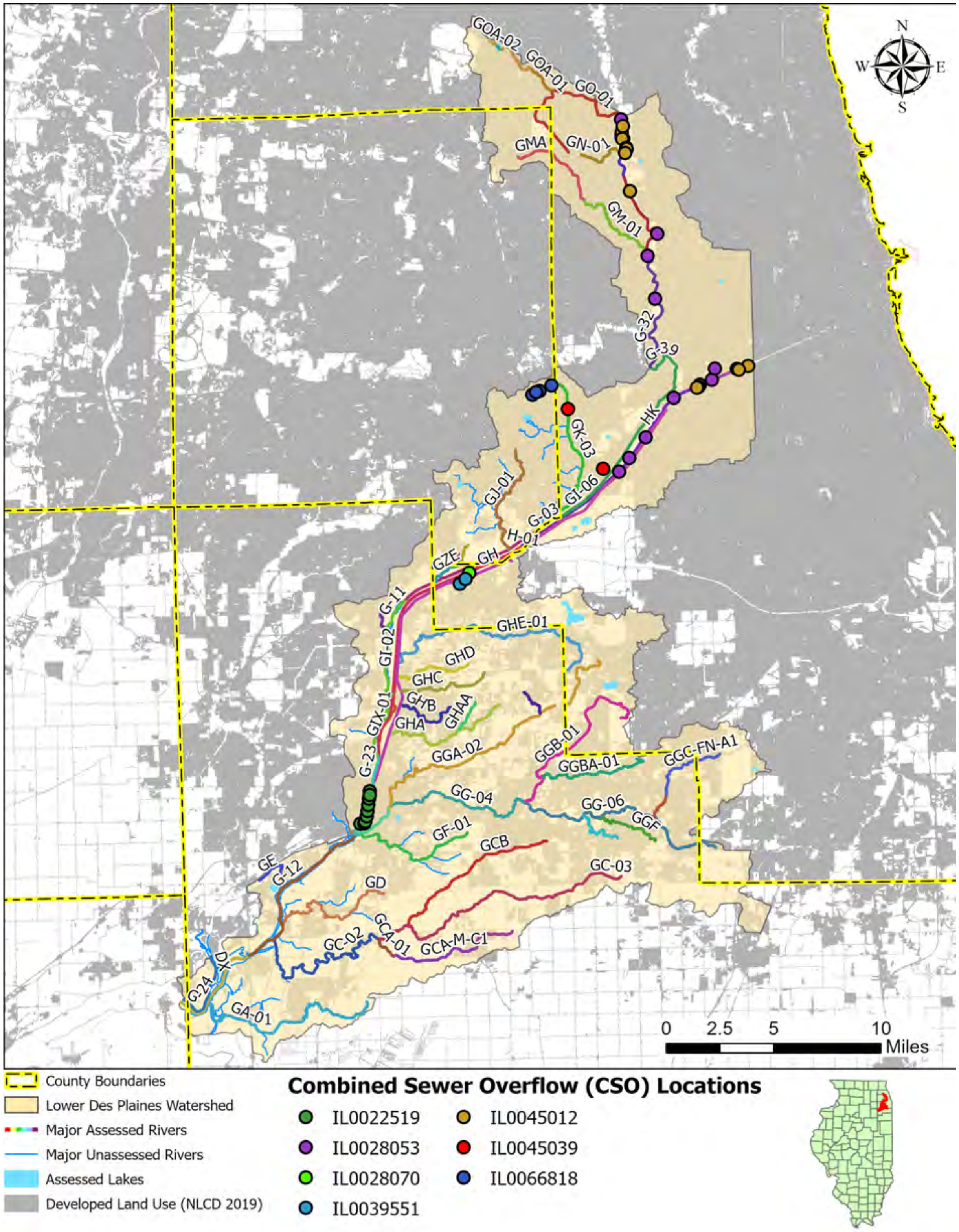

Figure 23. CSOs in the Lower Des Plaines River Watershed

Table 21. Major Municipal WWTPs in the Lower Des Plaines River Watershed

Water Body	NPDES Number	Facility and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Design Average Flow (MGD)	Design Maximum Flow (MGD)
Des Plaines River	IL0065188	DuPage County - Knollwood	Des Plaines River	G-03, G-11, G-23	10	27
	IL0032760	Illinois Am. Water - Santa Fe	Des Plaines River	G-11, G-23	1	2.5
	IL0048526	Romeoville Wastewater Treatment Facility	Des Plaines River	G-11, G-23	7.5	15
	IL0064998	City of Crest Hill East STP	Des Plaines River	G-11, G-23	1.7	5.1
	IL0022519	City of Joliet Eastside STP	Des Plaines River	G-23	18.2	45.5
	IL0033553	City of Joliet Westside STP	Des Plaines River	G-23	14	28
	IL0069906	Village of Channahon STP	Des Plaines River	None	1.43	4
Tributaries	IL0047741	MWRDGC-James Kirie WRP	Higgins Creek	GOA-01, GO-01, G-15	52	110
	IL0022586	Flagg Creek WRD	Flag Creek	GK-03, G-03, G11	12	30
	IL0031984	Illinois Am. Water - Chickasaw Hills WRF	Long Run	None	1.3	2.41
	IL0021261	Lockport - Bonnie Brae STP	Fiddyment Creek	GHC	2.26	6.98
	IL0029611	Lockport STP	Deep Run	None	5	13.75
	IL0072192	Frankfort Regional WWTP	Hickory Creek	GG-22	4.67	14
	IL0020559	New Lenox STP #1	Hickory Creek	GG-22	2.516	5.103
	IL0055981	Illinois Am. Water - Oak Valley	Spring Creek	GGA-02, GG-22	1.5	3.75
	IL0024201	Mokena	East Branch Marley Creek	Not assessed	2.5	6.5
	IL0020222	Manhattan STP	Manhattan Creek	GCA	1.35	3.8
	IL0046264	New Lenox STP #2	Jackson Branch	GCB	0.732	2.21

Table 22. Minor Municipal WWTPs in the Lower Des Plaines River Watershed

Water Body	NPDES Number	Facility and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Design Average Flow (MGD)	Design Maximum Flow (MGD)
Des Plaines River	IL0074713	Village of Elwood - Deer Run STP	Des Plaines River	None	0.75	2.32
Tributaries	IL0045993	Illinois Am. Water - Derby Meadows WRF	Long Run	None	0.9	2.655
	IL0032778	Illinois Am. Water - Arbury Hills	Hickory Creek	GG-22	0.62	4
	IL0024422	Oak Highlands	Hickory Creek	GG-22	0.25	0.5
	IL0075957	New Lenox STP #3	Spring Creek	GGA-02, GG-22	0.36	1.24

Table 23. Industrial dischargers in the Des Plaines River Watershed

NPDES Number	Facility Name and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Discharge
ILG840016	MATERIAL SERVICE CORP YARD 61 - 0010, 0030	Des Plaines River	G-11	QUARRY DEWATERING, SW, PROC STON
IL0002208	MIDWEST GENERATION, LLC-WILL CO - 0020	Des Plaines River	G-11	RECYCLE WASTEWATER TREATMENT
IL0001341	PECHINEY ROLLED PRODUCTS, LLC - 0020, 0031, M0050	Des Plaines River	G-39	NONCONTACT COOLING, SW, OIL SKIMMER BYPASS
IL0001619	BASF CORP-JOLIET PLT - 0010, R0020, R0030	Des Plaines River	NONE	TR PROCESS AND SANITARY WASTE, SW
IL0001643	BP AMOCO CHEMICAL-JOLIET - 0010, R0020, R0030, 0040, R0050	Des Plaines River	NONE	TREATED PROCESS WATER, SW, TREATED SANITARY WASTE
IL0001732	CATERPILLAR, INC.-JOLIET - 0010, R0020, R0030, R0040, R0050	Des Plaines River	NONE	TREATED PROCESS WASTEWATER, SW
IL0002020	OLIN CORP-JOLIET - RC010, D010, 0010, 0020, R0030	Des Plaines River	NONE	SW, EMERGENCY OVERFLOW, TREATED STORMWATER/GYPSUM POND WATER, OVERFLOW GYPSUM POND, SW
IL0002038	LODERS CRONKLAAN - 0010	Des Plaines River	NONE	TR PROCESS, SANITARY WASTE, SW
IL0002216	MIDWEST GENERATION, LLC-JOLIET9 - 001A, 001B, 001C, 0010, 0020, 003A, R0030, R0040, 0050, R0060, R0070, 0080	Des Plaines River	NONE	DEMINERALIZER REGENERANT, MAIN STP, BOILER BLOWDOWN, CONDENSER COOLING, BREAKER HOUSE STP, CHEMICAL TREATMENT SYSTEM, RUNOFF, COAL PILE RUNOFF, QUARRY ASH POND DISCHARGE, CRIBHOUSE RUNOFF, MATERIAL ACCESS RD RUNOFF, INTAKE SCREEN BACKWASH
IL0002453	STEPAN COMPANY-ELWOOD - 0010, R0100, R0110	Des Plaines River	NONE	PROCESS WW, CW, SANITARY, SW
IL0002569	CROSFIELD CHEMICALS INC. - 0100	Des Plaines River	G-23	NC COOLING & STORM WATER
IL0002615	STONE CONTAINER CORPORATION - 0110	Des Plaines River	NONE	TREATED PROC, SAN, BBDM & NCCW

IL0002844	VULCAN MATERIALS-LEMONT QUARRY - 0010, 0020	Des Plaines River	G-11	PIT PUMPAGE AND STORMWATER
IL0002861	EXXONMOBIL OIL-JOLIET REFINERY - TCOMB, 0010, 0020, R0030, R0040, R0050, R0060, R0070, R0080, R0090	Des Plaines River	NONE	TRT. PROCESS, SANITARY, STORM, NONCONTACT COOLING WATER, SW RUNOFF FROM TANKAGE, WHARF, NE DRAINAGE, EAST DRAINAGE, INTERCEPTOR, AND NORTH DR AREA
IL0024431	CF INDUSTRIES, INC. - 0010	Des Plaines River	NONE	NON-CONTACT COOLING WATER; SW
IL0026581	CANAL BARGE INC.-CHANNAHON - 0020	Des Plaines River	NONE	STEAM CONDENSATE
IL0033375	MATERIAL SERVICE CORPORATION - 0010	Des Plaines River	G-11	SANITARY WASTEWATER
IL0035785	VULCAN MATERIALS-MCCOOK LIME - 0010	Des Plaines River	G-39	GROUNDWATER SEEPAGE & STRMWTR
IL0036013	PENRECO - 0010	Des Plaines River	G-30	STEAM CONDENSATE AND SW
IL0037737	VULCAN MATERIALS CO - 0010, 0020	Des Plaines River	G-39	PIT PUMPAGE, PROCESS WATER, SW
IL0037851	DOW CHEMICAL COMPANY-JOLIET PL - 0010, 0020, 003A, 003B, R0030, 004A, 004B, 0040	Des Plaines River	NONE	SW, NCCW, HOPPER CAR WASH WTR, TREATED SANITARY WASTE, TREATED CONTAIMINATED GROUNDWTR, SW FROM TERMINAL AREA, CLEANING OF EQUIPMENT EXTERIOR, BOILER BLOWDOWN, STRND BATH
IL0059064	COMMONWEALTH EDISON-MAYWOOD - R0010, R0020	Des Plaines River	G-39	NORTH SEPARATOR, SOUTH SEPARATOR
IL0063061	EXXON MOBIL CORPORATION - 0010, 0020	Des Plaines River	NONE	BOILER BLOWDOWN, STEAM COND, SW, EMERGENCY BYPASS
IL0063479	WASTE MGMT, LARAWAY RDF - R0010	Des Plaines River	NONE	SW DISCHARGE ANALYSES
IL0064254	MIDWEST GENERATION,LLC-JOLIET - 001A, R001B, 001C, 001D, 001G, R0020, R0030, R0010	Des Plaines River	NONE	DEMINERALIZER REGENERANT WASTE, DRAINS, COAL PILE, W BASIN OVERFLOW, BOILER BLOWDOWN UNITS 7&8, STP, LOCAL FIELD ASH POND EFFLUENT, CONDENSER COOLING WATER, HSE SER, JUNCTION TOWER AREA RUNOFF, ABANDONED ASH DISOPOSAL RUNOFF
IL0064408	ASHLAND DISTRIBUTION COMPANY - R0010, 0020	Des Plaines River	G-39	STORMWATER, TREATED STORM AND/OR GROUNDWATER
IL0069086	COMDISC0-ROSEMONT - 0010	Des Plaines River	G-15	NON-CONTACT COOLING WATER; SW
IL0070530	VULCAN MATERIALS-JOLIET SO 390 - 0010	Des Plaines River	NONE	Pit pumpage and stormwater
IL0070572	MATERIAL SERVICE CORP-YARD 18 - 0010	Des Plaines River	G-39	GROUNDWATER SEEPAGE AND SW
IL0073407	ATC/VANCOM, INC.-HODGKINS - 0010	Des Plaines River	G-39	TREATED GROUNDWATER
IL0073458	ALLIANCE PIPELINE-HYDROSTATIC - M0050	Des Plaines River	NONE	HYDROSTATIC TEST EFFLUENT
IL0073733	CITGO PETROLEUM-NORRIDGE - 0010	Des Plaines River	G-15	TREATED CONTAMINATED GROUNDWTR
IL0073857	ANR PIPELINE-HYDROSTATIC TEST - 0040	Des Plaines River	NONE	HYDROSTATIC TEST WATER

IL0002151	CANADIAN PACIFIC RAILWAY - R0281, 0290, R0300	Bensenville Ditch	GM-01, G-30	STORM WATER, PROCESS WATER
IL0076384	WOLVERINE PIPE LINE-LOCKPORT - 0010	Big Run	NONE	TREATED GROUNDWATER
IL0046779	PEOPLES ENERGY RESOURCE GROUP - 001A, 001B	Cedar Creek	NONE	TREATED PROCESS, SANITARY, SW, SERVICE WATER
IL0074811	ELWOOD ENERGY III, LLC 0 M0010	Cedar Creek	NONE	EVAPORATIVE COOLING WTR & SW
IL0076147	GUARDIAN PIPELINE-NOTHERN ILL - 0010	Cedar Creek	NONE	HYDROSTATIC TEST WATER
IL0002283	CHICAGO-OHARE AIRPORT CITY OF - TWQ10, TWQ20, TWQ30, R0010, R0110, R0210, R0310, R0410, R0610, R0710, R081A, R0810, R091A, R0910, R1010, R1110, R1120, R1130, R1140, R1210, R1410, R3720, R3730, R4710	Crystal Creek	G-15	LAKE O'HARE OVERFLOW, STORMWATER, N AIRFIELD BASIN OVERFLOW, N AIRFIELD BASIN DISCHARGE/BYPASS
IL0071901	VALVOLINE COMPANY-WILLOW SPRGS - 001A	Flag Creek	GK-03	STORAGE TANK HYDROSTATIC TESTG
IL0062618	MATHESON TRI-GAS INC - 0100	Hickory Creek	GG-22	NON-CONTACT COOLING WATER
IL0074900	MPG INDUSTRIES, INC. - M0010	Hickory Creek	GG-22	STEAM CONDENSATE
IL0025461	CITGO PETROLEUM CORPORATION - 0010	Higgins Creek	GOA-02, GOA-01	SWRO, TANK WTRDRS, & WSHDN WTR
IL0034347	BP PRODUCTS-OHARE TERMINAL M001A, 001Q, M0010	Higgins Creek	GOA-01	HYDROSTATIC TEST WATER, STORMWATER
IL0042242	UNOVEN-DESPLAINES TERMINAL - 0010, 0020	Higgins Creek	GOA-02, GOA-01	TDK AREA OIL/WTR SEP. DISCHARG, LOT OIL, WATER SEP. DISCHARGE
IL0046736	EQUILON ENTERPRISES-DESPLAINES - M0010	Higgins Creek	GOA-02, GOA-01	SW, SEPARATED TANK WTR, MISC WW
IL0062791	MARATHON ASHLAND PETROLEUM, LLC - 0010	Higgins Creek	GOA-02, GOA-01	HYDROSTATIC TEST WATER; SW
IL0066362	EXXONMOBIL CORP-DESPLAINES - 003A, R003S, R0030, 008A, 008S, R0080	Higgins Creek	GOA-02, GOA-01	HYDROSTATIC TEST WATER, STORMWATER RUNOFF
IL0068101	KEARNEY NATIONAL-DESPLAINES - 001S, 0010	Higgins Creek	GOA-02, GOA-01	REMEDIATION SYSTEM EFFLUENT
IL0004952	ANDREW CORPORATION - 001A, 0010	Marley Creek	NONE	CONTACT COOLING WATER; SW
IL0035025	CASE CORPORATION-BURR RIDGE - 0010	Sawmill Creek	GJ-01	NON-CONTACT COOLING WATER
IL0034592	ARGONNE NATIONAL LABS - N001A, N001B, 0010, 003A, 003B, 003C, 003D, 003E, 003F, 003G, 003H, 003I, 003J, 0040, 005C, 005E, 0060, 0070, R0080, R0100, 1080, R1130, R1140, 1150, 1160	Sawmill Creek, Des Plaines River	GJ-01	SANT WST/COAL PILE INTERNAL WS, SWIMMING POOL BACKWASH, DISCHARGE FROM BLDG 205, STEAM TRENCH, 300 AREA, SOUTHERN REACH@BLDG 201-FIRE, BLDG 212, 200, 211,213 EAST, 200 WEST, 203 WEST, COOLING TOWER BLOWDOWN, CANAL PLANT SW, ZGS COOLING WATER, STORMWATER RUNOFF, STEAM CONDENST
IL0045209	WILLIAMS PIPE LINE CO - R0020	Silver Creek	G-30	CATCH BASIN OVERFLOW
IL0072923	ALBERTSON'S, INC. - 0010	Silver Creek	G-30	TREATED GROUNDWATER

IL0002046	INTERNATIONAL TRUCK&ENGINE COR - 0010	Silver Creek	GM-01, G-30	NCCW, CONDENSATE, BLOWDOWN, SW
IL0056031	COMMONWEALTH EDISON-JOLIET HDQ - 0010	Sugar Run	GF-01, G-23	TR SANITARY WASTE; MISC WATER
ILG840069	VULCAN-JOLIET 340 - 0010	Sugar Run	GF-01, G-23	GROUNDWATER, SURFACE RUNOFF, SW
IL0066567	AIRPORT GRP INTERNTL-LOCKHEED - 0010	Willow Creek	GO-01	STORMWATER AND EQUIPMENT WASH
IL0068179	ILLINOIS TOOL WORKS - M0010	Willow Creek	GO-01	NON-CONTACT COOLING WATER

Table 24. Combined Sewer Overflows in the Lower Des Plaines River Watershed

Water Body	NPDES Number	Facility and Outfall Number(s)	Receiving Water	Downstream Aquatic Life Impairments	Status of Long-Term Control Plan
Des Plaines River	IL0045012	Chicago CSOS - C2260, C2270	Des Plaines River	G-15, G-30	TARP (no LTCP required)
	IL0028053	MWRDGC Stickney WRP - C1320, C1330, C1340, C1350, C1360	Des Plaines River	G-30, G-32	TARP (no LTCP required)
	IL0022519	Joliet East STP - C0060, C0070, C0080, C0090, C0100, C0110, C0120, C0160, C0170	Des Plaines River	G-23	Submitted 2010, most recently approved 2022
Flag Creek	IL0045039	Western Springs CSO - C0010, C0040	Flag Creek	GK-03, G-03	Approved 2015
	IL0066818	Hinsdale CSO	Flag Creek	GK-03, G-03	Approved 2011

3.7.2 Municipal Separate Storm Sewer Systems (MS4)

Stormwater alone is not a pollutant or pollutant source, but it acts as a significant 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, non-permitted 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 violation of water quality standards. 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 majority of the project area included within this NARP 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 Lower Des Plaines study area is provided in Table 25.

Table 25. MS4 communities in Lower Des Plaines River Watershed

Permit ID	MS4 Name
ILR400282	Arlington Heights
ILR400289	Bedford Park Village
ILR400292	Bensenville Village
ILR400293	Berwyn
ILR400529	Berwyn Township
ILR400298	Bolingbrook Village
ILR400301	Bridgeview Village
ILR400167	Broadview Village
ILR400302	Brookfield Village
ILR400304	Burr Ridge Village
ILR400623	Channahon
ILR400027	Channahon Township
ILR400739	Chicago
ILR400315	Cicero Town
ILR400544	Cicero Township
ILR400175	Clarendon Hills Village
ILR400485	Cook County Highway Dept
ILR400177	Country Club Hills
ILR400178	Countryside City
ILR400319	Crest Hill
ILR400320	Crestwood Village
ILR400180	Darien City
ILR400325	Des Plaines
ILR400040	Downers Grove Township
ILR400183	Downers Grove Village
ILR400041	Dry Grove Township
ILR400502	DuPage County
ILR400042	DuPage Township
ILR400048	Elk Grove Township
ILR400334	Elk Grove
ILR400188	Elmwood Park Village
ILR400702	Elwood
ILR400338	Forest Park Village
ILR400575	Frankfort
ILR400053	Frankfort Township
ILR400194	Frankfort
ILR400195	Franklin Park
ILR400351	Hickory Hills
ILR400354	Hillside
ILR400355	Hinsdale
ILR400356	Hodgkins
ILR400728	Village of Homer Glen
ILR400069	Homer Township
ILR400494	Illinois St Toll Highway
ILR400493	Illinois Dept of Transportation
ILR400358	Indian Head Park
ILR400361	Joliet
ILR400071	Joliet Township
ILR400362	Justice
ILR400364	LaGrange
ILR400365	LaGrange Park
ILR400497	Lemont
ILR400075	Lemont Township
ILR400076	Leyden Township
ILR400377	Lockport
ILR400080	Lockport Township
ILR400082	Lyons Township
ILR400220	Lyons Village
ILR400636	Manhattan
ILR400590	Manhattan Township
ILR400384	Maywood
ILR400224	McCook Village
ILR400386	Melrose Park
ILR400638	Minooka
ILR400496	Mokena
ILR400393	Mount Prospect
ILR400397	New Lenox
ILR400093	New Lenox Township
ILR400400	Norridge
ILR400229	North Riverside
ILR400406	Northlake
ILR400596	Oak Park Township
ILR400410	Oak Park
ILR400414	Orland Park
ILR400103	Orland Township
ILR400419	Palos Park
ILR400108	Palos Township
ILR400420	Park City
ILR400422	Park Ridge
ILR400604	Will County
ILR400429	River Forest
ILR400606	River Forest Township
ILR400430	River Grove
ILR400237	Riverdale Village
ILR400238	Riverside Village
ILR400115	Riverside Township
ILR400433	Rockdale
ILR400436	Romeoville
ILR400438	Rosemont
ILR400444	Schiller Park
ILR400133	Stickney Township
ILR400247	Stickney
ILR400248	Stone Park
ILR400457	Summit
ILR400460	Tinley Park
ILR400469	Western Springs
ILR400254	Westmont Village
ILR400272	Will County
ILR400472	Willow Springs
ILR400255	Willowbrook Village

3.8 NON-POINT 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 MS4 is considered a controllable point source. Runoff from nonregulated areas, in this case limited to agricultural areas, is the main nonpoint source of pollutants to impaired streams. In addition, sediment oxygen demand in streams also contributes to low dissolved oxygen conditions. Septic systems can also be a source of nonpoint pollution if they are not maintained properly.

Agricultural areas can have significant effects on water quality if proper best management practices are not in place, specifically contributing to high biochemical oxygen demand and nutrients that can affect the dissolved oxygen conditions in streams. Similar to MS4 permitted stormwater water, 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 typically are considered a potential source of nutrient enrichment in waterbodies which results in increased BOD and is linked to lower dissolved oxygen conditions. Sediment oxygen demand 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.

4.0 NUTRIENT ASSESSMENT AND REDUCTION PLAN FOCUS ON BIOLOGY

4.1 WHY IS BIOLOGY THE FOCUS OF THE NARP

It is the objective of the Clean Water Act (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 has been better known as the CWA. Perhaps most well-known is the CWA goal that “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 Water Quality Standards (WQS) that are used to measure and manage water quality via monitoring and assessment and water quality-based regulation of sources of pollution. A WQS consists of the designated use and 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 (U.S. EPA 2007). The systematic watershed monitoring carried out by the DRSCW since 2006, the LDRWC since 2012, and the LDWG since 2018, 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 broad focus of the CWA on the restoration and protection of aquatic life uses by considering all causes and sources of impairment.

DRSCW, LDRWC, and LDWG have supported using the IEPA biological indices as direct measures of attainment and non-attainment of the General Use standard for aquatic life. In Illinois, WWTP permit conditions are drawn from the State's 303 (d) list (Section 2.2). The 2020-22 Illinois Integrated Water Quality Report and Section 303 (d) lists 29 segments out of 34 assessed stream segments in the DuPage River and Salt Creek watersheds and 16 segments out of 23 assessed stream segments in Lower Des Plaines tributaries 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, uses Index of Biotic Integrity (IBI) for fish and macroinvertebrates to measure aquatic diversity and compliance. The direct measurement of IBIs allows for the direct measurement of current condition, 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 which 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 the aquatic life impairment are not subject to direct regulatory action as they do not have an adopted numerical standard. With the exception of the few narrative standards (example 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 utilized in regulatory actions such as the implementation of Total Maximum Daily Loads (TMDLs) (Section 2.3) as recommendations for lower effluent limits in WWTP permits, can result in unnecessary expenditures by public utilities and a lack measurable improvement as 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 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. This then 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 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 exposes a significant portion as being impaired.

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 Clean Water Act reauthorization delivers a much broader and holistic definition (from Clean Water Act 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 in a piecemeal fashion 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 the single most complete measure of existing stream resource quality, including for 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 rather 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 ultimately the primary determinator of success or failure in meeting the terms and conditions of the NARP and any other restoration plan or project. 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 attainment of the General Use for aquatic life in the DuPage River, Salt Creek and Tributaries of the Lower Des Plaines River watersheds. At the same time the DRSCW, LDRWC and LDWG recognize the need to establish causal linkages between the objectives of the NARP to address D.O. 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.

4.2 MEASURING BIOLOGICAL RESPONSE

The fIBI and mIBI are multimetric indices that IEPA uses to measure attainment and non-attainment of the General Use for aquatic life (IEPA 2022), hence they are the established methods of 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., Marzina et al. 2012) such that one index may be attaining its biocriteria while the other reveals an impairment. This is consistent with the U.S. EPA (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 be the product of 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 Sensitive Species Distributions (SSD). This was used to develop a compendia of biological response-based stressor thresholds for use in the NE Illinois watershed bioassessments. The SSDs were then linked that 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 and Section XX)

4.3 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 CEE was documented in a U.S. EPA methodological document entitled Biological Assessment Program Review: Assessing Level of Technical Rigor to Support Water Quality Management (U.S. EPA 2013). While a number of 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 was examined by Gerritsen et al. (2011) who found the coefficient of variation at least disturbed sites was 9.5%, but was higher at impaired sites, which is not to be 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.

4.4 THE CENTRAL ROLE OF BIOLOGICAL RESPONSE

Taken together the structure of the indicators and parameters employed in the systematic monitoring and assessment employed by DRSCW, LDRWC, and LDWG 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 24). Using an IBI to measure the aquatic biota integrates these five factors and reveals their combined effects in a river or stream. Hence, the biota contains multiple types of information in response to each of these factors and the subcomponents of each including hundreds of chemical pollutants. This reinforces the predominance of using biological indicators to assess not only aquatic life use status, but causes and sources of impairments and 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 25, 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 the protection and restoration of 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 in determining attainment and non-attainment status (Karr 1991).

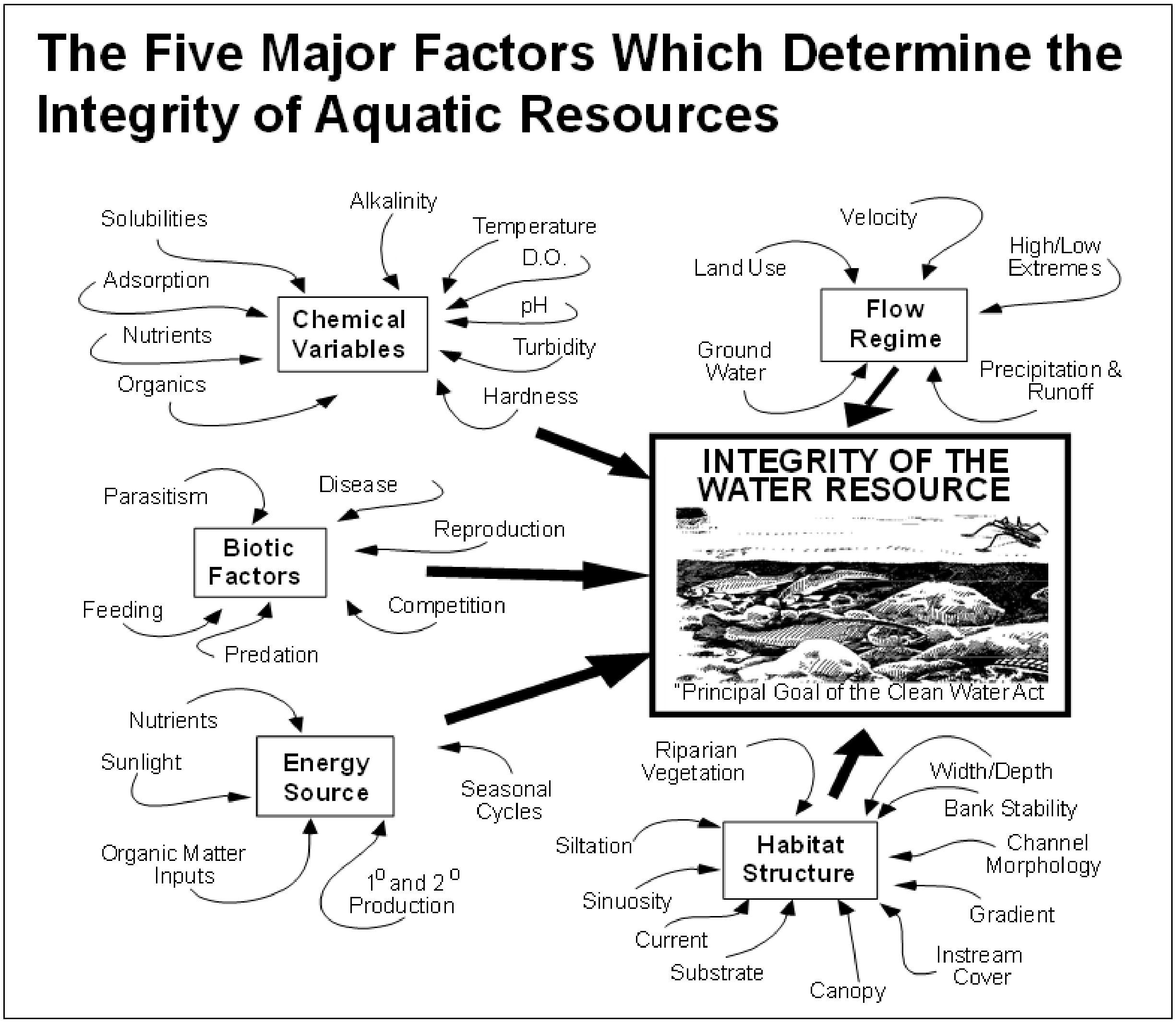

Figure 24. The five factors that comprise and determine the integrity of an aquatic resource (after Karr et al. 1986). Bioassessment serves as an integration of the five factors and a composite of their integration in an aquatic ecosystem.

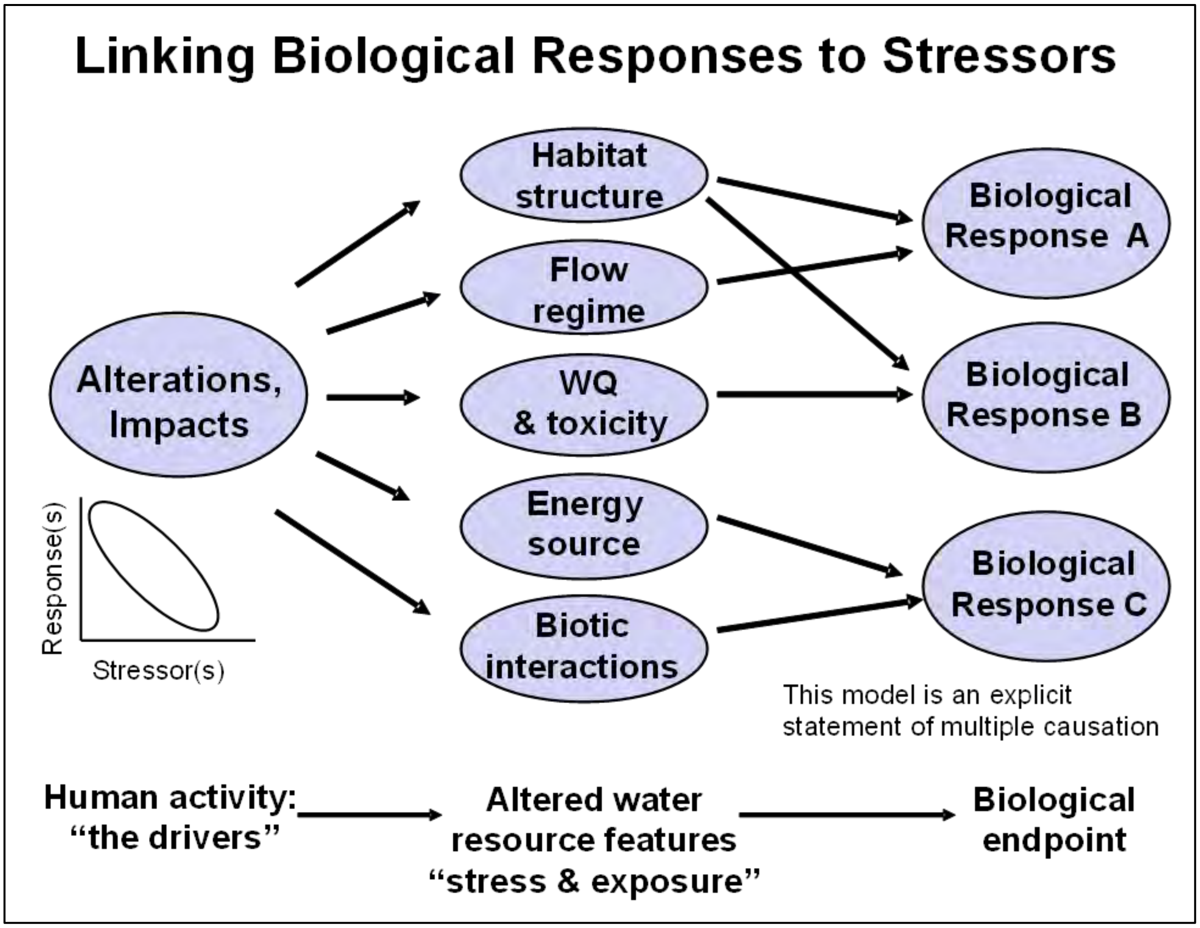

Figure 25. Linkages between stressors (or drivers of ecosystem change) through the five major factors of water resource integrity (as altered by stressors) to the biological responses produced by the interactions. The biological response is the endpoint of primary interest and is the focus of water quality 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 26 illustrates two examples of the five factors linkage model to two common stressors in the DuPage and Salt Creek watersheds as well as many of the tributaries to the Lower Des Plaines River, 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 Distribution (SSD) FIT score. Nutrients, mainly TP, ranked fourth in terms of the FIT score 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 linked the ability to attain the General Use standard for aquatic life to the most limiting stressors at the site, watershed, and HIUC12 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 26 by the width of the arrows extending from each of the five factors to the biological response for that category of stressor. Without the integrative capacity of the biota to respond to multiple stressors, the alternative would be 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 serves as a reality check on such assumptions.

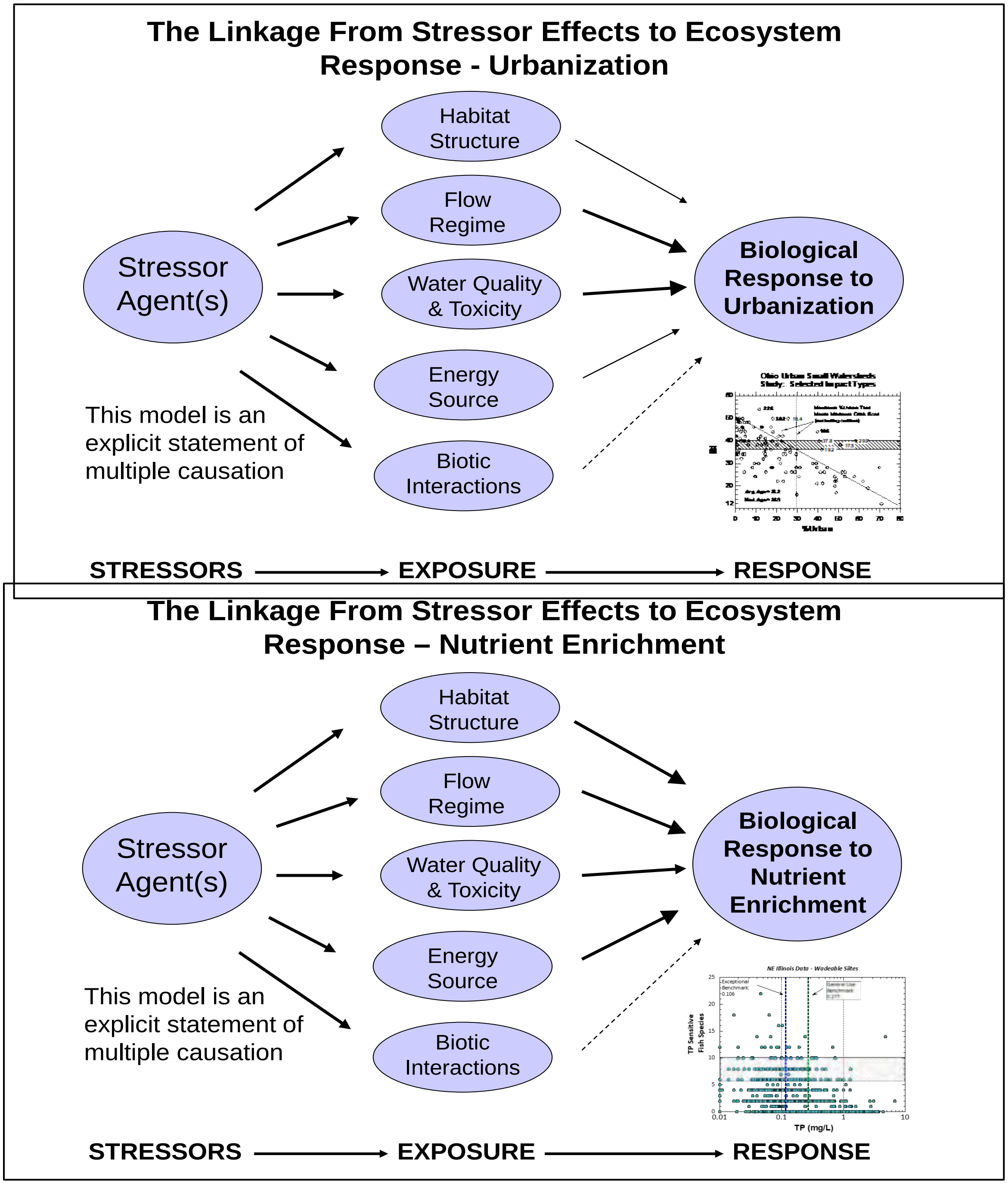

Figure 26. Two stressor linkage models which illustrate that the biological response will exhibit different characteristics specific to a stressor. The response to watershed stressors that are common across NE Illinois, urbanization (upper) and nutrient enrichment (lower) are illustrated. The thickness of the arrows between one of the five factors to biological response illustrates the relative importance of that factor in each example.

5.0 DES PLAINES RIVER VS. TRIBUTARY APPROACH

As described in Section 3.0– Watershed Characterization, the Lower Des Plaines Watershed are covers approximately 490 square miles split across thirteen HUC12s. This represents sixty miles of mainstem Des Plaines River and seventeen of nineteen tributaries (Salt Creek and the DuPage River are covered under a separate NARP) not including the Chicago Ship and Sanitary Canal (CSSC) or the Illinois and Michigan Canal (I&M Canal). The range in drainage area sizes, stream order and the wadeable/nonwadeable nature of the various waterways presents a challenge in defining a single instream target for the whole watershed, as well as how the target should be met. While there are many aspects of the plan that apply to the watershed as a whole, like the focus on biological response and the tie between chlorides and phosphorus, there are also many reasons to separate out tasks, like target derivation based on wadeability. This separation is based on the tools that have been chosen and reflects the NSAC approach to divide targets between wadeable and nonwadeable streams.

At this point, the document will define separate approaches for the mainstem Des Plaines River and the tributaries. Section 5.0 will focus on the approach for the tributaries including a summary of TP sources, current phosphorus removal activities, rationale for utilizing IPS Tool, derivation of the TP threshold and next steps to develop effluent targets to meet the instream threshold. Nonpoint sources of TP will also be discussed in this section as the associated management activities are more relevant at the tributary scale and cover the whole Lower Des Plaines Watershed area. Section 5.0 will apply to the WWTPs listed in Table 26, particularly those that have a December 31, 2023 NARP deadline. Section 5.6 includes implementation tasks that will be completed in 2024 as part of the holistic NARP for Lower Des Plaines tributaries to meet the December 31, 2024 NARP deadline for the remaining WWTPs.

Section 7.0 will focus on the approach for the mainstem Des Plaines River and will summarize the current TP loading to the Des Plaines River, phosphorus removal activities, and the approach to create a new version of the IPS Tool based on large river/nonwadeable sites to derive a TP threshold for nonwadeable streams of similar characteristics. The new threshold will then be utilized in a modeling effort to propose appropriate effluent targets. Section 7.0 will apply to WWTPs listed in Table 27 and will include implementation tasks and schedule.

Table 26 Tributary WWTP NARP due dates.

NPDES Number	Facility Name	Receiving Water	NARP Due
IL0029611	Lockport STP	Deep Run	2023
IL0072192	Frankfort Regional WWTP	Hickory Creek	2023
IL0024201	Mokena	E. Branch Marley Creek	2023
IL0020559*	New Lenox STP #1	Hickory Creek	2023
IL0046264*	New Lenox STP #2	Jackson Branch	2023
IL0047741	MWRDGC-James Kirie WRP	Higgins Creek	2024
IL0031984	Illinois Am. Water - Chickasaw Hills WRF	Long Run	2024
IL0021261	Lockport - Bonnie Brae STP	Fiddyment Creek	2024
IL0055981	Illinois Am. Water - Oak Valley	Spring Creek	2024
IL0020222	Manhattan STP	Manhattan Creek	2024
IL0075957*	New Lenox STP #3	Spring Creek	NA
IL0032778	Illinois Am. Water - Arbury Hills	Hickory Creek	NA
IL0024422	Oak Highlands	Hickory Creek	NA
IL0045993	Illinois Am. Water - Derby Meadows WRF	Long Run	NA

* WWTPs to be consolidated into New Lenox WRF

Table 27 Mainstem WWTPs NARP due dates.

NPDES Number	Facility Name	Receiving Water	NARP Due
IL0065188	DuPage County - Knollwood	Des Plaines River	2023
IL0048526	Romeoville Wastewater Treatment Facility	Des Plaines River	2023
IL0064998	City of Crest Hill East STP	Des Plaines River	2023
IL0033553	City of Joliet Westside STP	Des Plaines River	2023
IL0069906	Village of Channahon STP	Des Plaines River	2023
IL0022519	City of Joliet Eastside STP	Des Plaines River	2024
IL0032760	Illinois Am. Water - Santa Fe	Des Plaines River	2024
IL0074713	Village of Elwood - Deer Run STP	Des Plaines River	NA

6.0 NARP APPROACH FOR TRIBUTARY STREAMS

The seventeen tributaries (Table 28) included in this NARP are considered wadeable streams and will be addressed holistically utilizing the IPS Tool threshold for TP as an instream target as described below. **With a mix of due dates for WWTPs that discharge to tributaries this document will include several action items to be completed in 2024 coinciding with the December 31, 2024 NARP deadline.**

To determine the best potential opportunities to decrease TP concentrations instream, it is critical to evaluate TP contributions by source. As the instream TP threshold concentration is the basis for the majority of analysis, source contributions are generally expressed in that form (TP concentration as opposed to TP loads). The primary data source used for analyzing existing instream TP conditions and sources was the first round of bioassessments carried out by LDWG from 2018-2022. A detailed summary of the LDWG Bioassessment Program is in Section 1.2.1.1

6.1 AMBIENT SOURCES OF TP & WASTEWATER INFLUENCE

Of the seventeen tributaries included in the LDWG study area, seven have one or more WWTPs that discharge somewhere in their subwatershed. The remaining ten tributaries are dominated by urban runoff (Table 28). The first round of the Bioassessment Program collected data in 2020 and 2021 at 88 sites across the seventeen tributaries. Total Phosphorus (TP), as well as the suite of parameters in Table 5, was collected at all sites, anywhere from two to eight times during the sampling season based on site complexities.

In order to understand these systems better it is valuable to compare instream TP concentrations from sites influenced by wastewater (downstream of a WWTP discharge) and those which are not influenced by wastewater (these sites are a product of TP in background and urban runoff). This data evaluation reveals a marked difference between these two types of sites, emphasizing the impact of WWTPs on instream TP concentrations. Figure 27 shows the average of TP concentrations, displayed as box plots of urban vs. wastewater influenced for LDWG tributary sites. Average concentrations at wastewater influenced sites ranged from 0.1 – 1.89 mg/l, average concentrations at urban influenced sites had significantly lower TP concentrations that ranged from 0.05 – 0.45 mg/L. 19 out of 46 sites influenced by wastewater (~41%) had average TP concentrations above the watershed threshold with the maximum average value of 1.89 mg/L TP. All but two of the 29 sites not influenced by wastewater were below the 0.28 mg/L TP threshold. The two sites had average TP concentrations of 0.39 and 0.45 mg/L. The average TP concentrations for each site is mapped out in Figure 28, in relation to meeting the IPS instream threshold of 0.28 mg/L TP. It should be noted that this represents one year's sampling data and set of flow conditions for each site, these levels may fluctuate with changing flow regimes from year to year.

Table 28 LDWG tributaries impacted by wastewater vs. urban runoff

Tributaries Impacted by Wastewater	Tributaries Impacted by Urban Runoff
Willow Creek	Crystal Creek
Flag Creek	Silver Creek
Long Run	Schiller Woods Trib
Fiddyment Creek	Big Run
Deep Run	Milne Creek
Hickory Creek	Fraction Run
Jackson Creek	Sawmill Creek
	Sugar Run
	Cedar Creek
	Grant Creek

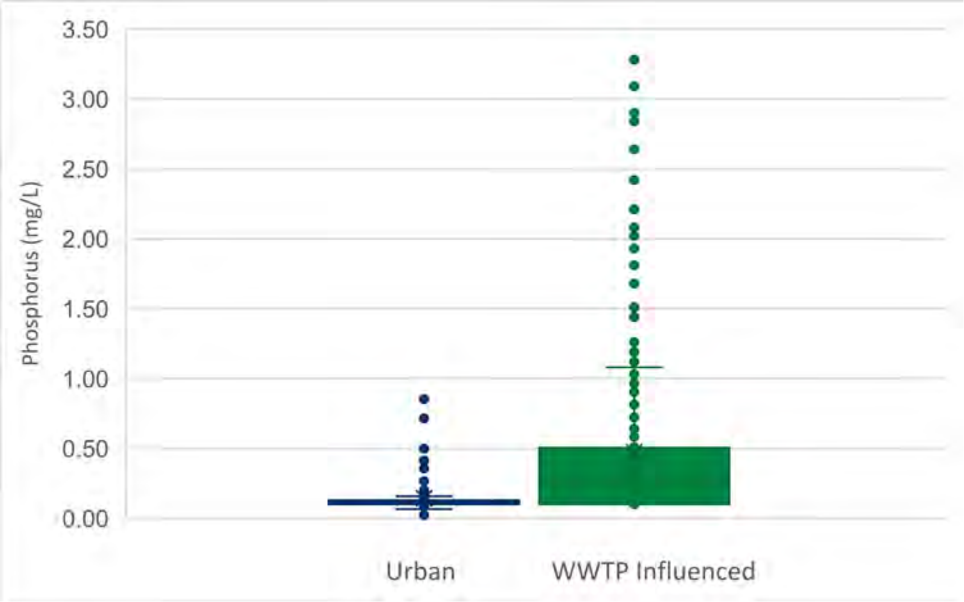

Figure 27 Box plots of TP concentrations in urban and wastewater influenced segments of LDWG tributaries, 2020-2021.

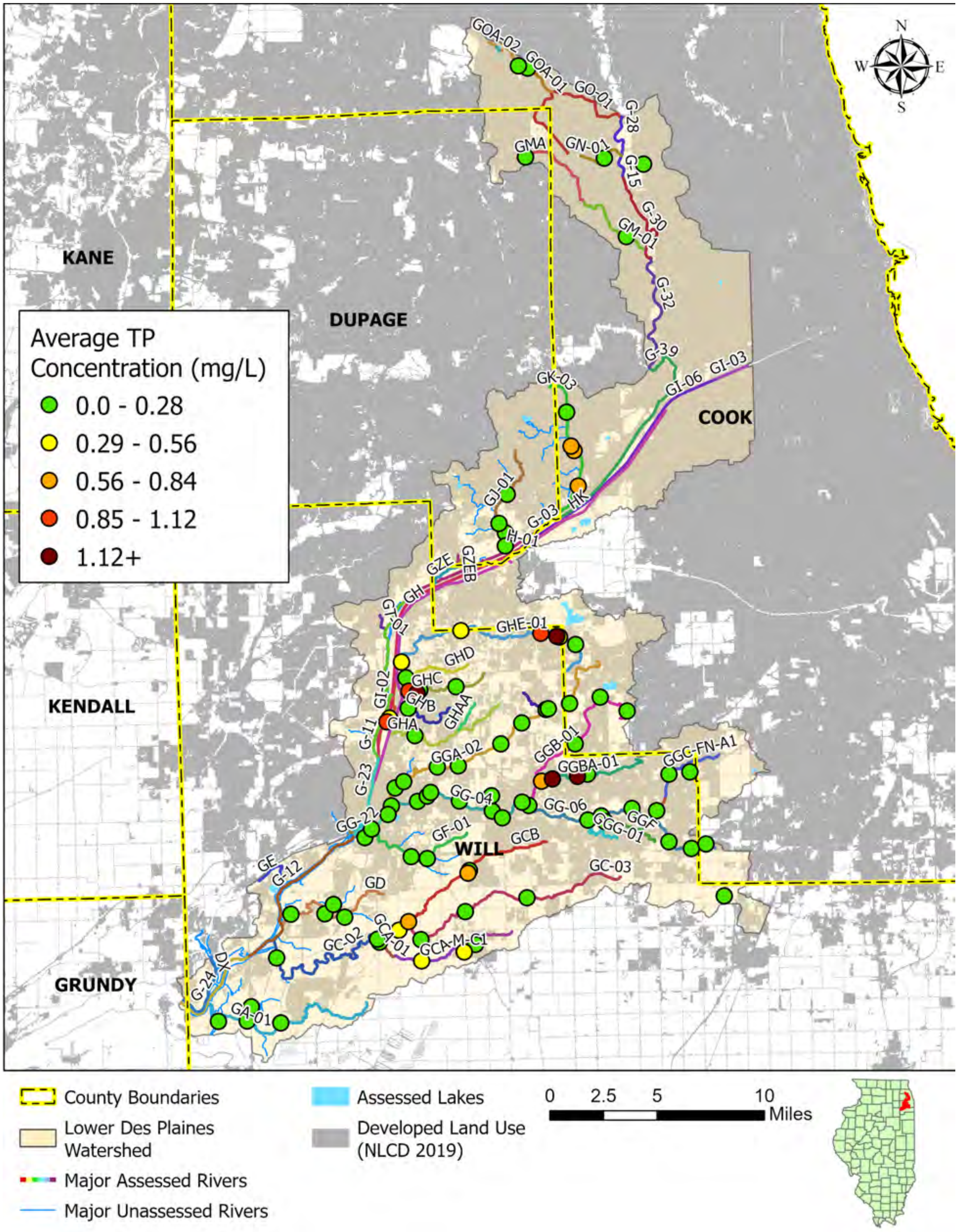

Figure 28 Mean TP concentrations for LDWG Tributaries, 2020-2021.

6.2 NONPOINT SOURCES OF TP

Ambient TP concentrations resulting from stormwater-driven sources (urban runoff and naturally occurring background conditions) are covered in Section 5.1. 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 & 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 as 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 attempted to reduce phosphorus loading at the source. LDWG has elected to focus this NARP on methods for non-point source phosphorus load reduction potential which target source loading such as leaf management and street sweeping. This NARP advocates for a practical approach for management of urban TP loading that is not reliant on the constraints and potential issues associated with a large, expensive, diffuse network of structural BMPs.

6.2.1 Street Sweeping and Leaf Litter Collection Study

DRSCW & 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 29). 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, 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 30). Results from October indicate that these interventions reduced 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.

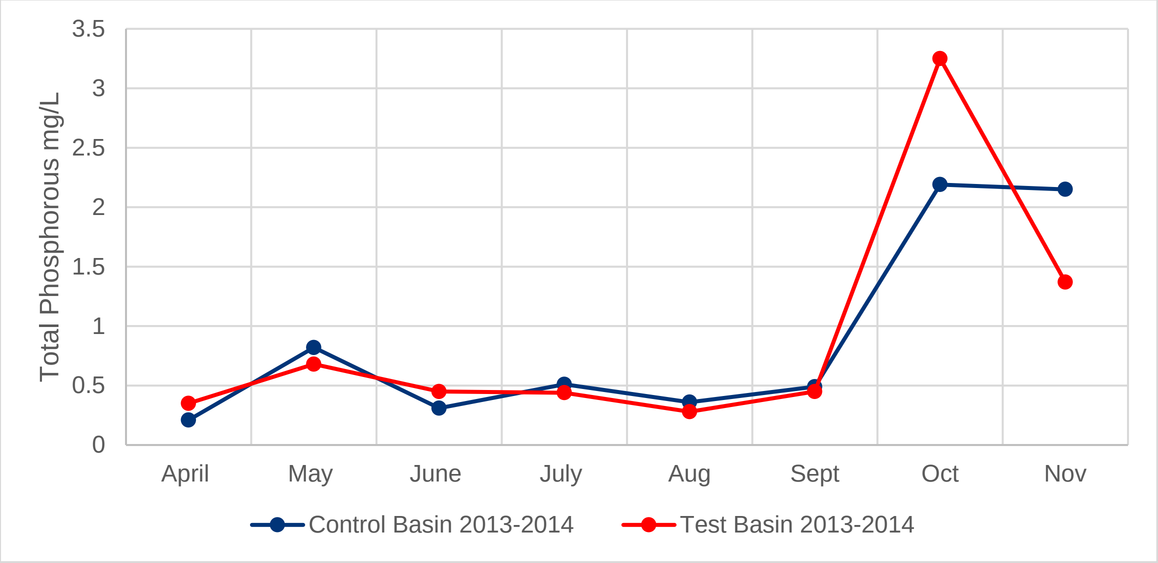

Figure 29. Mean monthly stormwater TP concentrations for two urban drainage areas observed 2013 – 2014 to establish baseline concentrations prior to any mitigative measures for TP removal.

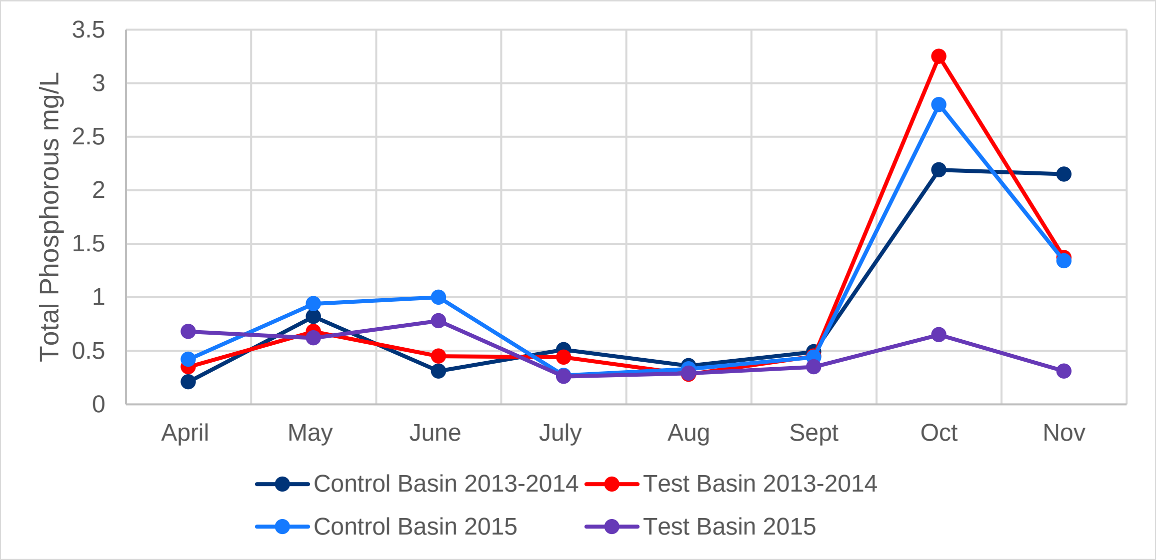

Figure 30 Mean monthly stormwater TP concentrations for two urban drainage areas prior to (2013 – 2014) and after (2015) mitigative measures for TP removal were applied to the test basin only.

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 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 (Interviews with multiple Public Works Departments). While performing these functions, street sweeping also captures pollutants from the road surface that would otherwise get into 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, Buer, Bannerman, & Gaebler, 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.

6.2.2 Baseline TP Loading from Stormwater Wash-off for Lower Des Plaines River Watershed

To better understand and quantify current conditions in the Lower Des Plaines watershed and its tributaries, LDWG initiated a study that began by distributing a questionnaire to all agencies within the target watersheds that maintain and operate road way series. This includes municipal public works agencies, townships, County DOTs, Illinois Tollway, and any other agency that is responsible for right-of-way maintenance. The questionnaire requests information regarding the characteristics of the right-of-way within the agency's jurisdiction, details on the methods of operation of their street sweeping and leaf litter collection programs, and information regarding their catch basin cleanout procedures. It will be important to acquire a high response rate to the survey to ensure we accurately characterize activity and subsequent non-point source phosphorus loading in the watershed and to provide realistic and useful recommendations for optimization. Work will continue in 2024 to gather information missing from key parts of the watershed.

LDWG will also begin creating and using 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 will allow for the calculation of effective canopy cover by both location and land use type.

The last piece of the study will involve using the data from the questionnaire and the GIS canopy data to calculate phosphorus removal from current operations using the Minnesota Pollution Control Agency Street Sweeping Credit Tool. This street sweeping tool was originally developed for the purpose of generating credits for phosphorus reductions.

Data collected from the surveys, GIS calculations, and the MPCA Street Sweeping Credit Tool will enable LDWG to recommend optimizations to the current street sweeping and leaf litter operations in order to maximize phosphorus capture before it enters the rivers. Recommendations will be aimed at optimizing TP abatement in the sense that they seek to maximize capture of TP without increasing the resources allocated to leaf litter pickup and street sweeping. The feasibility of these recommendations will also be compared to the scale and marginal cost of capture of phosphorus at WWTPs.

6.2.3 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, lakes, and detention ponds have also been linked to increased phosphorus in such features (Erickson, 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, 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 goodness-of-fit (FIT) analysis conducted as part of the updated IPS Tool (Section 1.3.2 Table 9) placed both chloride (FIT score 0.17) and conductivity, (a proxy for chloride), (FIT score of 0.05) in the top third of stressors limiting aquatic species across Northeastern Illinois (explanatory power increases as the FIT value approached 1).

To improve aquatic life conditions, the LDWG has collaborated with the DRSCW and LDRWC on training and outreach activities related to best practices for winter maintenance with the goal of reducing chlorides since 2018. Many LDWG members are also TLWQS for Chloride petitioners, which was approved in 2021. The LDWG coordinates the Lower Des Plaines portion of the TLWQS for Chlorides and developed the Lower Des Plaines Watershed Group Chloride Reduction Plan (LDWG 2022) for those entities that are not permitted through the TLWQS for Chlorides. These programs will be continued as part of NARP and TLWQS implementation. Chloride reduction activities include:

- Hosting annual workshops covering various aspects of chloride management at various levels of program involvement, from plow drivers to elected officials.
- Contracting with US Geological Survey to maintain a conductivity and temperature probe on the Des Plaines River near Channahon to collect continuous data since 2018. Data is utilized to correlate conductivity to chloride concentrations.
- Promoting the Lower Des Plaines Chloride Reduction Plan (LDWG 2022) to provide guidance to non-TLWQS for Chloride permittees on the types of practices that should be included in municipal snow and ice management plans.

6.3 SUMMARY OF TP REMOVAL ACTIVITIES

Over the last five years as the LDWG has worked to collect important data to better understand the stressors to aquatic life and the role that nutrients play, there have been many efforts to reduce phosphorus discharges. Table 29 summarizes current and planned implementation of phosphorus removal at LDWG WWTPs. The “Planned Removal Practice” column refers to the likely practice to be implemented to meet a TP effluent limit below 1.0 mg/L. Prior to 2018 four of the fourteen WWTPs that discharge to LDWG tributaries were already implementing phosphorus removal to 1.0 mg/L TP. Two additional plants are now meeting a 1.0 mg/L TP effluent limit and three more will be meeting a 1.0 mg/L TP effluent limit in the next three years. The summary of instream TP concentrations presented in Section 2.1 may not fully reflect improvements in treatment at Frankfort Regional, and do not reflect improvements currently underway or planned at Kirie, Mokena or New Lenox. Also, of note, New Lenox has plans underway to consolidate discharges from Plants #1, #2 and #3 to a new regional facility adjacent to Plant #2 that will utilize Biological Nutrient Removal (BNR) practices.

Table 29 LDWG Tributary WWTPs TP removal status.

NPDES Number	Facility Name	Receiving Water	TP Limit	Date Implemented	Current Removal Practice	Planned Removal Practice
IL0047741	MWRDGC-James Kirie WRP	Higgins Creek	1.0 mg/L	8/1/2026	BPR	BPR
IL0031984	Illinois Am. Water - Chickasaw Hills WRF	Long Run	1.0 mg/L	12/1/2020	BPR	BPR
IL0021261	Lockport - Bonnie Brae STP	Fiddyment Creek	no limit - monitor only	N/A	N/A	
IL0029611	Lockport STP	Deep Run	1.0 mg/L	3/1/2008	Chemical P Removal	Chemical P Removal
IL0072192	Frankfort Regional WWTP	Hickory Creek	1.0 mg/L	7/31/2021	BPR	BPR
IL0020559	New Lenox STP #1	Hickory Creek	1.0 mg/L	11/1/2013	Chemical P Removal	Chemical P Removal
IL0055981	Illinois Am. Water - Oak Valley	Spring Creek	1.0 mg/L	8/4/2015	BPR	BPR
IL0024201	Mokena	East Branch Marley Creek	1.0 mg/L	3/1/2024	BPR	BPR
IL0020222	Manhattan STP	Manhattan Creek	1.0 mg/L	8/1/2006	Chemical P Removal	BNR
IL0046264	New Lenox STP #2	Jackson Branch	1.0 mg/L	7/1/2026	BNR	BNR
IL0045993	Illinois Am. Water - Derby Meadows WRF	Long Run	no limit - monitor only	N/A	N/A	BPR
IL0032778	Illinois Am. Water - Arbury Hills	Hickory Creek	no limit - monitor only	N/A	N/A	BPR
IL0024422	Oak Highlands	Hickory Creek	no limit - monitor only	N/A	N/A	N/A
IL0075957	New Lenox STP #3	Spring Creek	no limit - monitor only	N/A	N/A	N/A

6.4 IPS TOOL RATIONALE

The IPS Tool, as described in Sections 1.3, identifies the instream threshold of 0.28 mg/L total phosphorus (TP) for wadeable streams. This was developed using a broad dataset from across northeastern Illinois, including many Lower Des Plaines River tributaries. The Bioassessment Program also utilizes the IPS Tool as part of the assessment process across a broad list of parameters.

The LDWG has collaborated with DRSCW/LDRWC on additional work to further define relationships between dissolved oxygen and TP to support the use of the IPS threshold for TP for the NARP. The LDWG plans to use this threshold in the development of proposed effluent targets.

6.5 DERIVING A TP THRESHOLD PROTECTIVE OF AQUATIC LIFE

6.5.1 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, Salt Creek, Hickory Creek and other tributary streams in the Lower Des Plaines River watershed. 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 River, Salt Creek, and Lower Des Plaines tributaries, for wadeable streams is representative of quantifying attainment of the General Use Waters criteria. The process of TP threshold derivation process is illustrated in Figure 31, and detailed further below.

Step 1

- Developed a robust dataset of paired TP concentration and aquatic life abundance across sites with a gradient of aquatic health conditions.
- Identified which fish and macroinvertebrates are most TP-sensitive or TP-tolerant based on paired and weighted data and frequency distribution evaluation.

Step 2

- Establishment of whether fish or macroinvertebrates are most TP-sensitive (fish selected), and conservatively derive a TP threshold for those species or taxa.
- Verified correlative TP-sensitive fish species identification by evaluating site-specific abundance and local habitat conditions (e.g., IL fIBI score).

Step 3

- Determined the General Use crtieria as the 75th percentile TP concentration for sites that are both supporting Aquatic Life use *and* have at least two different TP-sensitive fish species present.

Figure 31. Simplified evaluation summary of TP threshold derivation for DuPage/Salt/LD Tribs wadeable streams.

The process of TP threshold derivation started with identifying the fish species and macroinvertebrate taxa most sensitive to TP concentrations. Each species or taxa was classified for its TP-sensitivity based on 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 TP-sensitive aquatic life are 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 were incorporated within the IPS Tool, allowing for a meaningful and robust correlative statistical analysis. Figure 32 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 both found to be sensitive to TP concentrations, with fish identified by the IPS Tool results to have 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 protective of both fish species and the less sensitive macroinvertebrates.

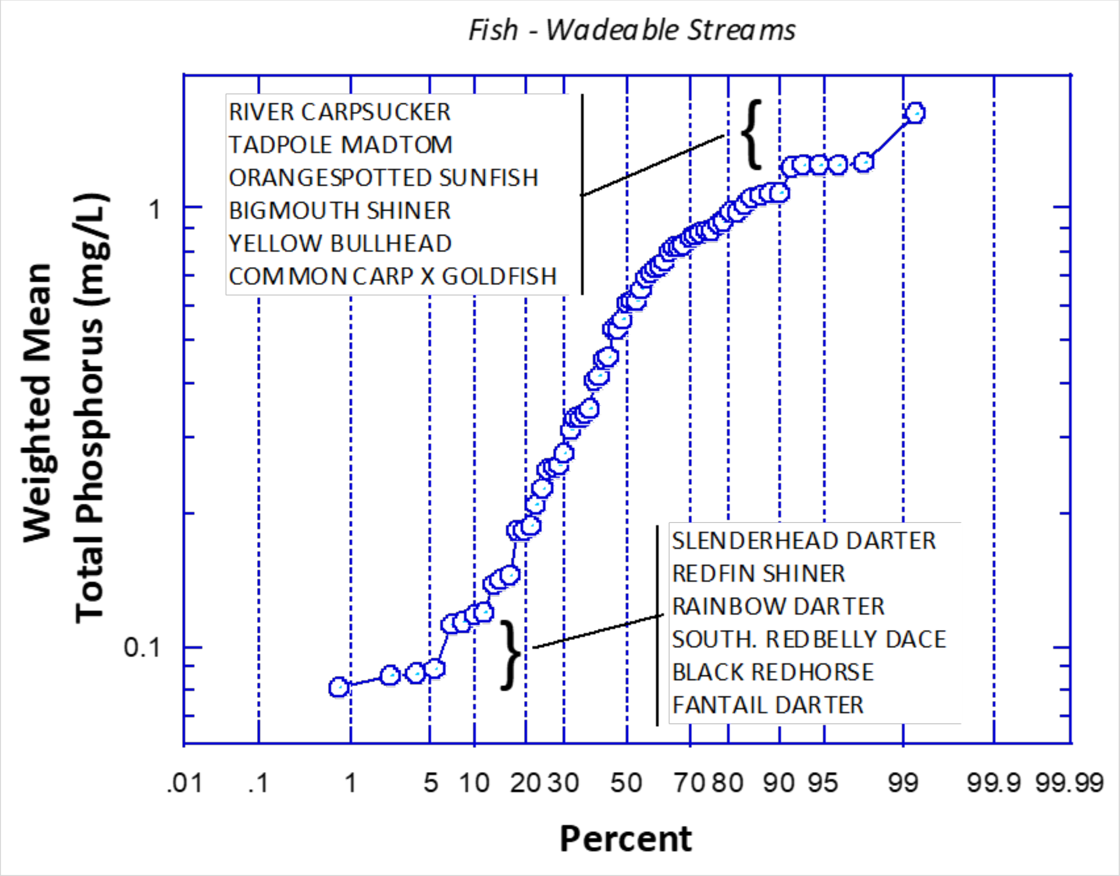

Figure 32. Field-data derived Sensitive Species Distribution (SSD) for fish species (most TP-sensitive and TP-tolerant species labeled), based on paired weighted mean TP concentrations as evaluated by the IPS Tool in northeastern Illinois.

After identifying the suite of TP-sensitive species, 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 33). 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.

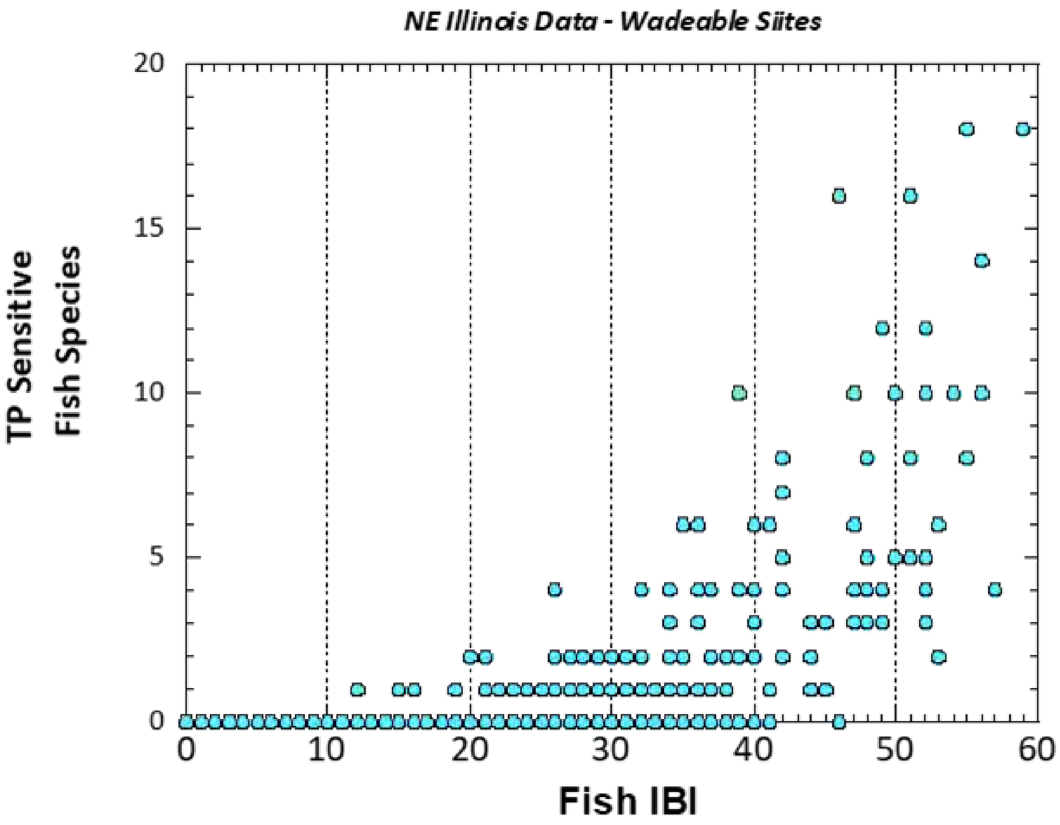

Figure 33. Scatterplot of observed TP-sensitive fish species abundance relative to fIBI scores in regional wadeable streams used as part of the derivation of the TP threshold support of General Use.

Fully supporting sites (fIBI > 41), with at least two different TP-sensitive species found (25th percentile of species abundance per Figure 33) were placed in two groups (IBI 41-49 and 50-60) were graphed on a probability plot (Figure 34). The TP threshold identified to reflect attainment of General Use 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, for exceptional sites, those with IBI's scoring 50-60 and more than 2 sensitive species, the threshold was 0.1 mg/L.

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

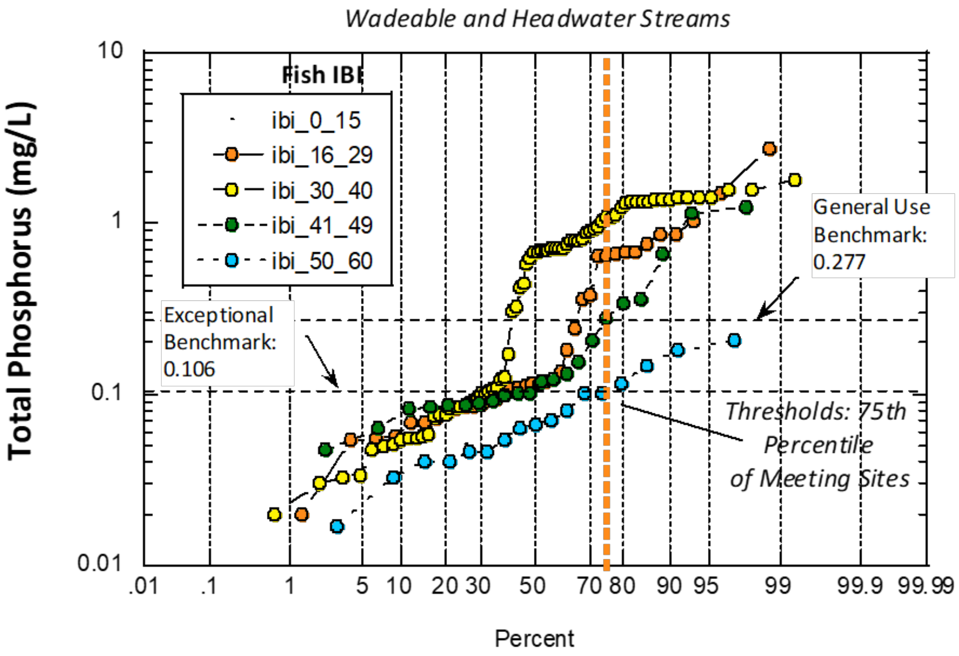

Figure 34. Probability plot of TP concentrations by narrative ranges of observed fIBI in regional wadeable streams used to identify the TP threshold supportive of General Use. The 75th percentile TP concentration associated with sites supporting good IBI (41-49) is clearly identifiable.

Using this same approach, an additionally informative sub-category (integrity class) of General Use attainment was derived to best characterize the observed relationship between TP and fIBI across a gradient of observed ranges. Figure 35 is a box-and-whisker plot showing the number of different TP-sensitive fish species observed relative to the range of observed fIBI values.

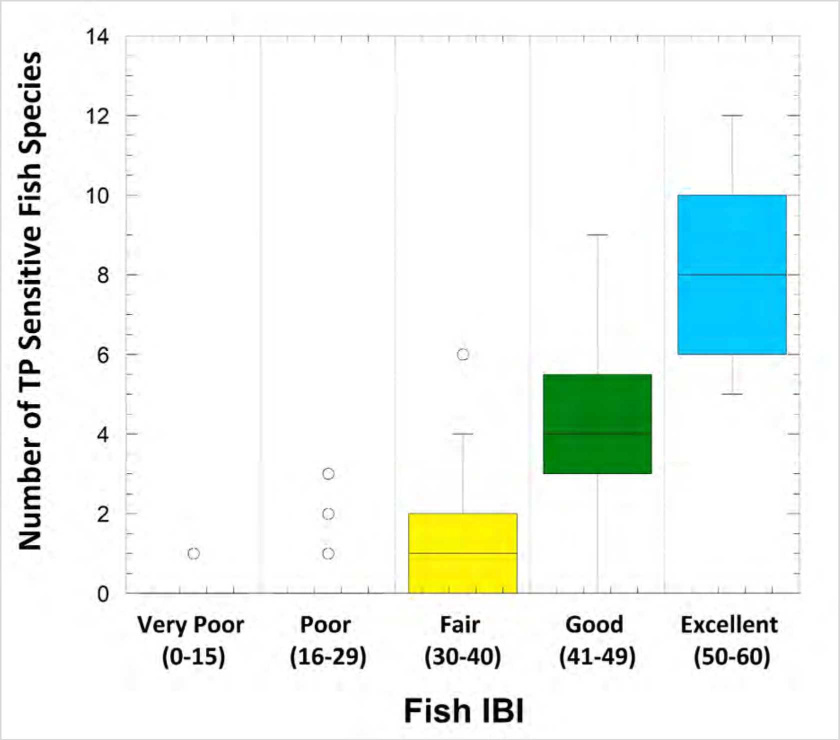

Figure 35. Box-and-whisker plot of TP-sensitive fish species abundance relative to site fIBI used in the northeast wadable streams Illinois IPS Tool.

This gradient includes General Use attainment integrity classes ranging (as IBI scores range) from Excellent, Good, Fair, Poor, and Very Poor depending on paired average 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 less than 0.11 mg/L TP Figure 34 and Figure 35). 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 fIBI score 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 criteria.
- Fair: sites with less than two different TP-sensitive fish species present and fIBI score 30 – 40. When fIBI scores fell below 30, no significant present of TP-sensitive fish species were observed at all, so this classification does not support General Use criteria attainment.
- Poor: sites with less than two different TP-sensitive fish species present and fIBI score 16 – 29. This classification does not support General Use criteria attainment.
- Very Poor: sites with less than two different TP-sensitive fish species present and fIBI score less than 16. This classification does not support General Use criteria 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 goodness of fit (FIT) measuring 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.

6.5.2 Proposed Application of TP Threshold Results

The mean TP concentration range 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 attainment. The FIT scoring shown in Table 9 in Section 1.3.2 showed that habitat (general QHEI and its component pieces) plays the dominant role in limiting stream biology.

This NARP 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 attainment as derived by IPS Tool evaluation of TP concentrations and fIBI categories.

The green highlighted area represents IL General Use Criteria for Aquatic Life attainment and the target TP concentration range for ambient conditions applicable to this NARP.

IPS-Derived Threshold Parameters	General Use 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

6.5.3 Peer Review of Derivation of the TP Threshold

The DRSCW and LDRWC retained engineering consulting firm Kieser & Associates, LLC to conduct an independent peer review of the updated IPS Tool developed by MBI. The peer review was conducted to evaluate 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.

Kaiser & 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 Species Sensitivity Distribution approach based on field data is relatively new.
- A more thorough description of 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 Tool 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/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.

6.6 IMPLEMENTATION PLAN AND SCHEDULE

The LDWG is utilizing a holistic approach for all of the tributaries within the study area. The following implementation actions will support finalizing the development of proposed effluent targets in 2024 and ongoing data collection and outreach efforts.

- Workgroup Participation & Outreach
    - LDWG members shall continue active workgroup participation.
    - Coordinate on any potential funding sources as needed.
    - Continue to develop and support development of public outreach, communication to support the goals of the NARP objectives.
    - Continue to work together to brainstorm opportunities to meet watershed goals efficiently, effectively, and with a science-based approach.
- Studies & Monitoring

    To be completed by December 31, 2024:

    - Draft speculative NPDES permit language related to NARP compliance, including the proposal of determination of WWTP effluent limits as based on IPS Tool thresholds.
    - Complete leaf litter/street sweeping questionnaire and analysis of data including calculation of effective canopy cover by both location and land use.

- Utilize data from the questionnaire and the effective canopy cover data to calculate phosphorus removal from current operations using the Minnesota Pollution Control Agency Street Sweeping Credit Tool and provide recommendations.

Ongoing activities:

- Continue to implement the robust water quality monitoring evaluations and bioassessment surveys conducted throughout the watershed.
- Allow for adaptive management of the monitoring program to support changing needs and/or shifting objectives of the workgroup.

7.0 MAINSTEM DES PLAINES RIVER APPROACH

To meet the objectives of the NARP as outlined in permit conditions the LDWG embarked on an extensive Bioassessment Program (Section 1.2.1.1) to better understand the existing conditions of the Lower Des Plaines River watershed. The data collected in first five-year rotation along with data collected in 2023 and to be collected in 2024 will provide the basis for proposed nonwadeable stream nutrient threshold derivation and water quality modeling efforts described below.

The Des Plaines River watershed is a complex system flowing from Wisconsin through Lake, Cook and Will Counties. There is a distinct difference in the river system upstream vs. downstream of where the Chicago Area Waterways (CAWs) joins the Des Plaines River in Joliet. This influx of flow and sources of nutrients is substantial and from this point down the river is utilized as a shipping channel. While the CAWs drainages are not included in the LDWG study area and are addressed through the Phosphorus Assessment and Reduction Plan under development by MWRDGC, the current loading and future load reductions are substantial and will need to be understood better as nutrient thresholds are developed.

To address the complexities of the Des Plaines River mainstem, the LDWG worked with consultants from Tetra Tech to develop a large river NARP strategy. Tasks included the review of available Des Plaines River data, development of NARP objectives, evaluation of water quality modeling, evaluation of available data for use in modeling efforts and development of strategy to meet NARP objectives.

7.1 TOTAL PHOSPHORUS SOURCE EVALUATION

As described in Section 3.7.1, there are eight wastewater treatment plants that discharge into the Des Plaines River within the study area with a total of 54.6 MGD (design average flow) discharge. Additionally, 87.9 MGD is discharged to LDWG tributaries and ultimately to the Des Plaines River. Although not part of the LDWG, there are several major municipalities and WWTPs which influence the Lower Des Plaines River including dischargers to the following watersheds: Upper Des Plaines River, Salt Creek, DuPage River, and Chicago Area Waterway System. Some of the largest NPDES dischargers to the CAWs are the MWRD Stickney (IL0028053) and Calumet (IL0028061) Water Reclamation Plants with average design flows 1,200 and 354 MGD respectively.

7.1.1 Water Balance

The Lower Des Plaines River flows from the confluence with Willow Creek to the confluence with the Kankakee River. Using average annual USGS flows and DMR data, a coarse water balance was calculated for the Lower Des Plaines River for calendar year 2020 (Tetra Tech 2023A); the results are presented in Figure 36. To generate the water balance, the following data sources were utilized:

- DMR flow data for all eight mainstem WWTPs: Knollwood, Santa Fe, Romeoville, Crest Hill East, Joliet Eastside, Joliet Westside, Elwood, Channahon
- DMR flow data for various significant WWTPs on tributaries: Stickney, Calumet, Kirie
- USGS gages on the mainstem: Des Plaines River at Algonquin Rd at Des Plaines (05530100), at Riverside (05532500), near Lemont (05533600), and at Route 53 at Joliet (0557980)
- USGS gages for primary boundary conditions: Salt Creek (05531500 and 05532000 on Addison Creek), Flagg Creek (05533000), Sawmill Creek (05533400), Sanitary and Ship Canal (05536890), I&M Canal (05537500 on Long Run), Hickory Creek (05539000), and DuPage River (05540500).
- USGS gages adjacent to the watershed: Kankakee River near Wilmington (05527500), and Illinois River at Morris (05542500) were utilized to interpolate flows for un-gaged location of the downstream end of the Des Plaines River.

Upstream of the Sanitary and Ship Canal, flow conditions are most significantly impacted by boundary conditions from the Upper Des Plaines River headwaters (57%), and Salt Creek (24%). There are four LDWG member WWTPs located upstream of the Sanitary and Ship Canal which together comprise approximately 3% of total streamflow in that portion of the waterway, while Willow Creek, which includes the discharge from MWRD Kirie WRP, accounts for 6% of total streamflow.

At the downstream end of the Lower Des Plaines River, the contribution of the Sanitary and Ship Canal is approximately 62% of total streamflow. The largest contributor to the Sanitary and Ship Canal flow is the Stickney WWTP, representing 29% of the total streamflow in the Lower Des Plaines River at the downstream end. Aside from the Sanitary and Ship Canal, additional primary contributors to the mainstem flow at the downstream end include the Upper Des Plaines headwater inflows (14%), and the DuPage River (12%). All eight mainstem WWTPs, who are members of the LDWG, represent 2% of the total streamflow of the Lower Des Plaines River.

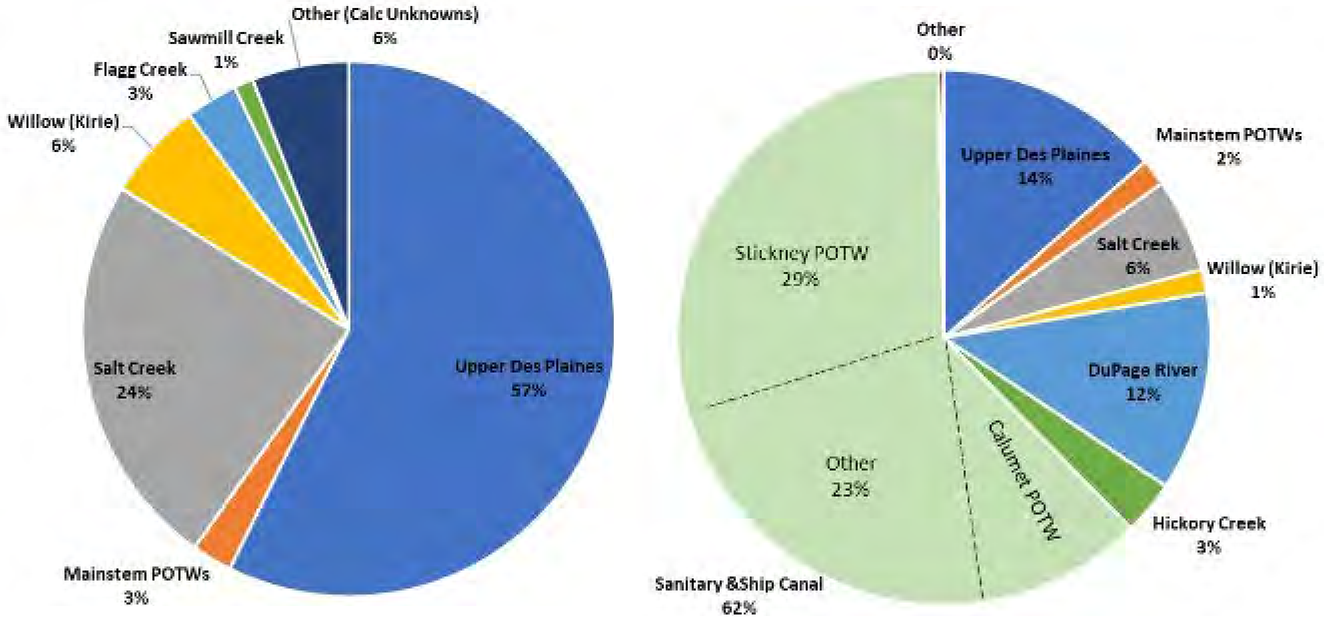

Figure 36 Preliminary water balance of the Lower Des Plaines River upstream (left) and downstream (right) of the Chicago Sanitary and Ship Canal confluence, annual average flows calendar year 2020

7.1.2 Total Phosphorus Source Loading

A TP source load attribution to the mainstem Lower Des Plaines River was conducted by identifying the major contributors of instream phosphorus and tabulating the average annual loads associated with those same sources from the water balance analysis. Average flows for calendar year 2020 were paired with ambient tributary monitoring from calendar year 2020, with WWTP DMR records from water year 2020; results are presented in Figure 37. Without the use of a receiving water quality model such as QUAL2K to provide direct linkage with nutrient cycling kinetics to the TP concentrations observed instream, these calculations represent source loading to the mainstem and do not account for phosphorus cycling and transformations within the river. By calculating TP loading as a function of average annual flow and average annual TP concentration, these should be considered coarse approximations as opposed to more refined consideration of specifically paired observed and/or interpolated or extrapolated flows and concentrations. To generate the TP source loading summary, the following data sources were utilized, with TP concentrations paired with flows tabulated during the water balance:

- DMR TP data for all eight mainstem WWTPs: Knollwood, Santa Fe, Romeoville, Crest Hill East, Joliet Eastside, Joliet Westside, Elwood, Channahon
- LDWG TP data for significant tributaries: Willow Creek (LDGO01), Crystal Creek (LDGN01), Schiller Creek (LDGX01), Silver Creek (LDGM01), Flagg Creek (LDGK01), Sawmill Creek (LDGJ02), Sanitary and Ship Canal (LDGI01), I&M Canal (LDGH01), Hickory Creek (LDGG01), Jackson Creek (LDGCB01), Grant Creek (LDGA01)
- LDRWC TP data for significant tributaries: DuPage River (LD16)
- MWRD TP data for significant tributaries: Salt Creek (WW_109), Sanitary and Ship Canal (WW_92)

Upstream of the Sanitary and Ship Canal the primary source of TP loading to the Lower Des Plaines River mainstem is Salt Creek (53%) then the Upper Des Plaines River (33%), even though those waterways account for 24% and 57% of the total flow balance respectively. Mainstem WWTPs account for 7% of the total TP source loading at this location. At the downstream end of the system, the Sanitary and Ship Canal accounts for 67% of TP source loading (comparable to its 62% of flow), with other contributors including the DuPage River (13%), Salt Creek (9%), Upper Des Plaines River (6%) and the sum of all mainstem WWTPs (3%).

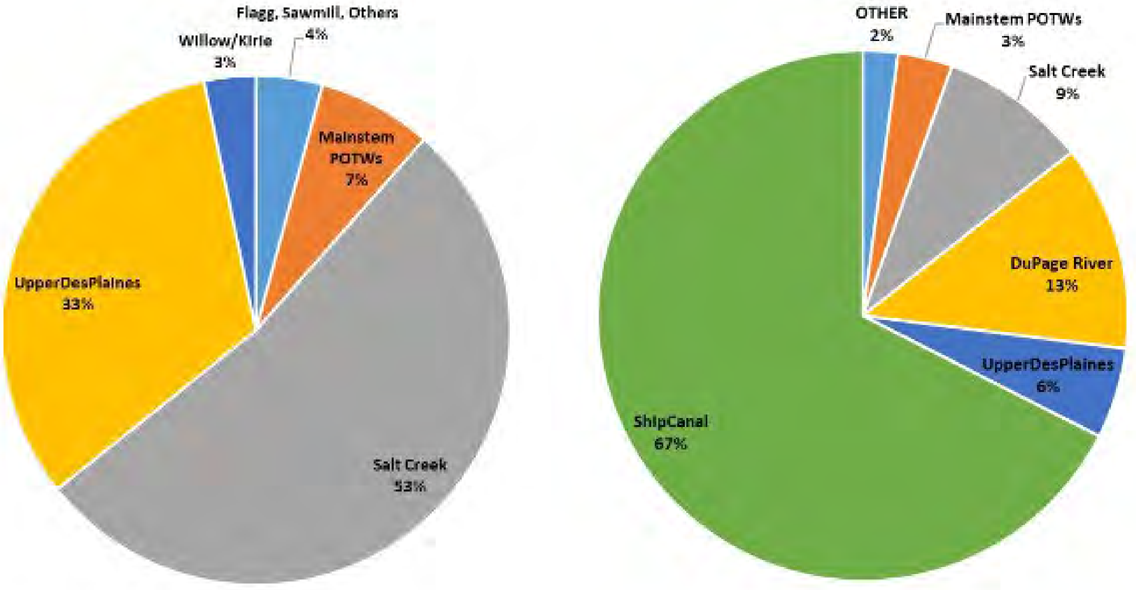

Figure 37 Preliminary TP source loading to the Lower Des Plaines River upstream (left) and downstream (right) of the Chicago Sanitary and Ship Canal confluence, approximate annual average 2020

7.1.3 Model Evaluation

Scientists, engineers, and decision-makers all rely on tools to simplify complex real-world problems for evaluation and simulation based on well-documented mathematical techniques. In the realm of water resources, tools for evaluation of water resources can include but are not limited to: physical models in a laboratory setting, hydrologic and hydraulic (H&H) modeling of in-channel conditions, watershed modeling across a landscape, water quality modeling, water quality and biological indices, and various types of optimization tools. Widely accepted tools and models rely on standard and understood relationships related to physics of flow and sediment transport, biological factors, and kinetic relationships.

When and why to employ various water resources tools and modeling applications varies depending on the water body type, system complexity, and decision-making purpose. Municipalities, utilities, and environmental managers often use quantitative tools and models both to understand historical or existing conditions, and to project potential future impacts based on natural or manmade changes. Water resources decision-makers use models for many purposes, including these examples:

- Assessing water quality conditions and causes of degradation

- Predicting how surface waters will respond to changes in their watersheds and the environment (e.g., future growth, climate change)
- Developing Total Maximum Daily Loads (TMDLs) and National Pollutant Discharge Elimination System (NPDES) permits
- Setting appropriate instream targets for water quality and ecological improvements
- Forecasting quantitative benefits of new water protection policies and plans
- Comparing anticipated changes to water quality and biological condition that may result from different management scenarios.

Frequently, effluent discharge limitations for point sources are derived based on an observable understanding of pollutant levels relative to impairment of aquatic species, human health criteria, or other such reasons related to water resources protection stemming from the Clean Water Act of 1972. For example, ammonia limits for wastewater treatment plants (WWTPs) are typically based on calculable acute and/or chronic toxicity levels for aquatic organisms. However, establishing scientifically defensible relationships between specific pollutants and various water quality impairments can be very complex, costly, and time-consuming, particularly when those relationships may be nonlinear.

In support of the Lower Des Plaines River NARP development, Tetra Tech examined the best approaches for establishing instream TP thresholds and development of proposed WWTP discharge TP limits (Tetra Tech 2023C).

7.2 DEVELOPING INSTREAM NUTRIENT THRESHOLDS FOR NONWADEABLE STREAMS

Site-specific instream numeric nutrient targets can be developed in many different ways, including the NSAC methodology of statistical interpretation of reference conditions, and an alternative evaluation of stressor/response data with various types of biota (i.e., fish species, benthic macroinvertebrates, diatoms).

The stressor/response approach can be conducted with the analytical Integrated Prioritization System (IPS) Tool that makes use of biological assessment and water quality data to establish numeric nutrient targets. For a detailed description of the IPS Tool as developed and how TP thresholds were derived for wadeable streams see Section 1.3.2 and Section 5.5 respectively.

For the mainstem, non-wadeable stream/river portion of the Lower Des Plaines River, a modified version of the IPS analytical approach can be employed to set a TP target for the Lower Des Plaines River NARP (Tetra Tech 2023C). Instead of considering all potential stressors, IPS analysis for the NARP would focus on a subset of key parameters that related to nutrients (e.g., TP, chlorophyll-*a*, nitrate, TKN, maximum DO, DO Flux) in the non-wadeable portion of the river system. MBI's work in larger, non-wadeable systems in Ohio suggests that it will be possible to derive TP thresholds using an IPS approach and paired data for the Lower Des Plaines.

At present, it appears that not enough biological assessment data have been collected to support IPS analysis for the Lower Des Plaines mainstem, but LDWG is planning future sampling. To provide a full range of conditions for analysis, including less degraded ("reference") conditions, samples from nearby waterways such as the Kankakee and Rock Rivers will be used to supplement Des Plaines River sampling efforts (tetra Tech 2023D). During summer 2023, LDWG conduct its second round of the Bioassessment Program collecting data at 25 sites on the mainstem Des Plaines River from the I-355 Bridge to the Kankakee River, along with one (1) site each on the Kankakee River, the Ship and Sanitary Canal, and the I&M Canal. The remaining 23 mainstem Des Plaines River stations will be sampled in 2024, from the I-355 bridge to upstream of Willow Creek Tributary in Rolling Meadows. Additional data in future years may be needed support derivation of an IPS Tool for the Lower Des Plaines River. Other bioassessment data may be available from IDNR, IEPA, or other sources.

Many methods can be used to develop instream target concentrations for nutrients. Developing biologically based nutrient criteria for surface waters is complex and currently ongoing across the United States. Although work to develop these standards is progressing, few states have adopted complete numeric nutrient water quality criteria for nitrogen and phosphorus. The IPS Tool offers a proven, data-driven approach for deriving a threshold that links water quality to biological condition.

In addition to the fish and benthic macroinvertebrate data used in the IPS Tool, other biological data may be useful in future development of nutrient thresholds. Diatoms are another potential biological indicator of water quality condition that may be useful to investigate, to determine whether diatom metrics can serve as effective and useful indicators of nutrient loads to the mainstem portion of the Lower Des Plaines.

7.2.1 IPS Tool Data Needs

The work MBI has conducted in large non-wadeable systems in Ohio suggests it will be possible to derive TP thresholds using the IPS approach in the Lower Des Plaines River. For the IPS Tool application, it is critical to have paired TP concentration and aquatic life data to develop Sensitive Species Distribution (SSD) curves to describe the relationship of tax (e.g., fish species or macroinvertebrate taxa) to a gradient of stressors (e.g., range of TP concentrations). Enough data must be collected for IPS Tool application to rank and identify aquatic species as intolerant, sensitive, or tolerant relative to instream TP concentrations.

At present, insufficient paired stressor and biological assessment data have been collected to support an abridged IPS Tool analysis for the Lower Des Plaines River mainstem. As detailed Section 1.3.1, the IPS Tool requires paired data across a range of both ecological conditions and instream TP concentrations. It is recommended that LDWG work with MBI to develop a robust monitoring plan that captures a range of conditions including the Lower Des Plaines River as well as less degraded non-wadeable rivers such as the Kankakee and Rock Rivers. The monitoring plan should leverage the following:

1. Existing LDWG bioassessment monitoring efforts, initiated summer 2023 at 25 sites on the Lower Des Plaines River, with single sites on Kankakee River, I&M Canal, and Ship & Sanitary Canal. Year 2024 sampling will include an additional 23 mainstem sites.
2. Data requests for potentially relevant existing monitoring data available from IEPA and IDNR, including the Cooperative Basin Program IBI score datasets, which should be explicitly requested for non-wadeable streams regionally.
3. Consideration of partnerships with other regional watershed groups associated with non-wadeable streams for potential cost sharing and expanded IPS Tool analysis.

7.3 DEVELOPING TP LIMITS FOR WWTPS USING QUAL2KW

The modeling platform QUAL2Kw was developed by the Washington Department of Ecology and built upon previous iterations of the model including QUAL2K and QUAL2E. QUAL2Kw can simulate non-steady, non-uniform flow using kinematic wave flow routing. The model is capable of continuous simulation up to one year with time-varying boundary conditions. Development of a robust QUAL2Kw model includes best available information for the following range of inputs and parameters associated with a specific simulation year, ideally selected based on available data quantity and quality:

- Reach hydraulics: elevation, length, and hydraulic model rating curve inputs based on power function relationships of flow and velocity and depth.

- Boundary conditions: flow and water quality such as temperature, nutrients, DO, and more for the following inflow types: Headwaters, Diffuse Inputs (groundwater, nonpoint sources), and Continuous Inputs (tributaries, point sources).
- Meteorology: Air temperature, dew point temperature, wind speed, cloud cover, solar radiation, and stream shading provided by topography and riparian vegetation.
- Governing parameters: various inputs related to light parameters, surface heat transfer models, reaeration models, biological algae kinetics, and rates associated constituent-specific global parameters such as nutrient cycling, oxidation rates, and settling velocities.

After QUAL2Kw model development for a specific time period, model output of the various flow and water quality constituents are compared to observed instream data. Model calibration is conducted by refining various governing parameters to best capture the observed existing conditions. Once the QUAL2Kw model is developed and calibrated, it may be employed to run predictive modeling applications based on various speculative management scenarios.

7.3.1 QUAL2KW Application for Nonwadeable Streams

QUAL2Kw model development and application is recommended for the non-wadeable mainstem of the Lower Des Plaines River (Tetra Tech 2023E). Due to the various ongoing NARP development activities in and around this watershed, the ability to predict the instream impact of various management scenarios involving boundary conditions will require receiving water quality modeling.

Development of a QUAL2Kw model for the Lower Des Plaines River would include selection of a simulation year with the best available model input data and available instream calibration data. Inputs for the model would be developed for reach hydraulics, meteorology, governing parameters, and boundary conditions. Boundary conditions and inflows from other watersheds have a significant impact on conditions to the Lower Des Plaines River mainstem. At the downstream end of the waterway, the relative impacts of the various sources as detailed in Section 2.1.2 estimate that 94% of instream flow volume is coming from the following sources: Chicago Sanitary & Ship Canal (62%), Upper Des Plaines River (14%), DuPage River (12%), and Salt Creek (6%), based on average annual United States Geological Survey (USGS) and Discharge Monitoring Report (DMR) flow data from 2020. Similarly, approximately 95% of the annual TP loading to the mainstem can be attributed to those same sources: Chicago Sanitary & Ship Canal (67%), Upper Des Plaines River (6%), DuPage River (13%), and Salt Creek (9%), based on a preliminary analysis of DMR and instream water quality data (LDWG, DRSCW, LDRWC and Metropolitan Water Reclamation District of Greater Chicago [MWRD]) from 2020.

It is recommended that a QUAL2Kw model be developed and calibrated for the Lower Des Plaines River mainstem to simulate existing conditions instream, which is reflective of existing average WWTP operating conditions. The calibrated QUAL2Kw model could then be applied for various management scenarios to predict how the mainstem may respond based on speculative permit limits for all boundary conditions to the mainstem:

- Upper Des Plaines River, which is under NARP development currently by DRWW at the headwaters.
- Chicago Sanitary & Ship Canal, which is undergoing nutrient management planning efforts by MWRD associated with their Phosphorus Assessment and Reduction Plan (PARP).
- Salt Creek and DuPage River, which are undergoing Nutrient Implementation Plan (NIP) development by DRSCW and LDRWC as key tributaries to the mainstem.

- Lower Des Plaines River tributaries with WWTPs, which are part of this NARP developed by LDWG.

The various potential outcomes of these management actions of the primary contributors to the mainstem Lower Des Plaines River are as follows, as related to an as-yet undetermined mainstem instream TP target:

1. The various management actions of boundary contributors are sufficient to meet the instream TP target, such that LDWG mainstem WWTP dischargers would likely propose new discharge limits of 0.5 mg/L TP.
2. The various management actions of boundary contributors are not sufficient to meet the instream TP target, such that LDWG mainstem WWTP dischargers may be required to reduce speculative discharge limits lower than 0.5 mg/L TP if scenario application indicates these have a meaningful impact on meeting the instream target.
3. The various management actions of boundary contributors are not sufficient to meet the instream TP target, and the impact of any TP limit reductions from LDWG mainstem dischargers has minimal or no impact on instream TP concentrations, such that mainstem WWTPs may not be required to reduce speculative discharge limits lower than 0.5 mg/L TP.

The LDWG member WWTPs that discharge to non-wadeable Lower Des Plaines River mainstem would be included in this speculative TP limit.

7.3.1.1 QUAL2KW Data Needs

QUAL2Kw model development requires various data and assumptions as detailed in the following subsections for the following: reach hydraulics, boundary conditions (headwaters, tributaries, WWTPs), meteorology and shade, governing parameters, observed monitoring data to support calibration, and planned changes for various management scenarios (Tetra Tech 2023D).

Additional decisions should be made on the distance of waterway simulated, the length of time the model with continuously simulate, and the time frame for which the model will represent. Regionally, continuous QUAL2Kw models have been developed for a full calendar year based on the best available quantity, quality, density, and recency of monitoring data. Wider breadths of data available for years around these simulation periods may be incorporated as well where conditions are relatively stable.

It is recommended that the mainstem QUAL2Kw model be developed of the mainstem Lower Des Plaines River from upstream of Willow Creek (at approximately Illinois Highway 72) to a downstream extent where the river joins the Kankakee River. It is possible based on best available monitoring data and the existing monitoring data schedule that the river be modeled in two sections (upstream and downstream of confluence with the Chicago Sanitary and Ship Canal), however, if the monitoring and boundary forcing data are sufficient similar across different years, it may be possible to model both sections simultaneously.

7.3.1.2 Reach Hydraulics

QUAL2Kw model parameterization for reach hydraulics are likely to include power function inputs that capture the nonlinear relationship at various locations along the mainstem of both flow and depth, and flow and velocity. Reach hydraulic power functions may be derived from a variety of potential resources including but not limited to:

- Existing HEC-RAS models and Hydrographic Surveys of the mainstem which may be available through the US Army Corps of Engineers or the Federal Emergency Management Agency flood modeling applications.

- USGS gage records of field measurements including channel data can be used to establish channel hydraulic equations based on observed flow, velocity, channel width, and channel area (channel depth can be inferred from area and width), at discrete locations.
- Engineering reports and/or diagrams associated with concrete channelized river channel topography and any existing lock and dam features.
- Any potential existing county-level or local modeling efforts that may include instream hydraulic parameterizations (e.g., HSPF, FEQ, HEC-RAS).
- Any regionally specific hydraulic relationships available through literature review that may be applicable.

Generally speaking, it is anticipated that varying approaches to reach hydraulic relationships may differ upstream and downstream of the Chicago Sanitary and Ship Canal confluence, where the mainstem shifts from a shallower earthen watercourse to a deeper confined channel.

7.3.1.3 Boundary Conditions

QUAL2Kw simulations are based on hourly resolution model inputs. Although inputs are hourly, it is not essential in most scenarios to require hourly monitoring data from various boundary conditions (e.g., headwaters, point sources, tributaries, groundwater inflows/outflows, etc.) to develop inputs based on more aggregated and best available data. Model inputs for all boundary conditions include hourly flow and the following water quality parameters: temperature, conductivity, inorganic suspended solids, dissolved oxygen, slow and fast reacting carbonaceous biochemical oxygen demand (CBOD), nitrogen species (organic, ammonia, nitrate), phosphorus species (organic, inorganic), phytoplankton, alkalinity, and pH.

7.3.1.4 Headwaters

The headwater boundary condition for the Lower Des Plaines River mainstem is the Des Plaines River itself upstream of the confluence with Willow Creek near O’Hare International Airport. Flow conditions at that location are best approximated using the nearby USGS flow gage Des Plaines River at Algonquin Rd (05530100). Inputs related to water quality constituents can be based on best available data from monitoring locations such as LDG47 located immediately upstream of Willow Creek on the mainstem.

7.3.1.5 Wastewater Treatment Plants

There are eight LDWG member WWTPs that discharge directly to the mainstem and would therefore be simulated in QUAL2Kw as explicitly modeled point sources discharging to the Lower Des Plaines River (Table 31). All other fifteen LDWG WWTPs are incorporated into the model implicitly based on their contributions to tributaries. For these explicitly simulated WWTPs, hourly model inputs would be developed for flow and water quality using the following three data source pathways:

- Publicly available monthly resolution Discharge Monitoring Report (DMR) data.
- Direct monitoring data records requests from mainstem LDWG WWTPs, likely to include more monitoring parameters as required by NPDES permit, and likely to be daily/weekly resolution.
- Assumptions for inputs as needed based on similarly configured adjacent WWTPs and/or literature.

It is common to combine various data sources to parameterize WWTPs based on best available information.

Table 31 LDWG WWTPs discharging directly to Des Plaines River for explicit simulation in QUAL2Kw.

NPDES ID	Facility	Design Average Flow (MGD)	Design Maximum Flow (MGD)
IL0065188	DuPage County - Knollwood	10	27
IL0032760	Illinois Am. Water - Santa Fe	1	2.5
IL0048526	Romeoville Wastewater Treatment Facility	7.5	15
IL0064998	City of Crest Hill East STP	1.7	5.1
IL0022519	City of Joliet Eastside STP	18.2	45.5
IL0033553	City of Joliet Westside STP	14	28
IL0069906	Village of Channahon STP	1.43	4
IL0074713	Village of Elwood - Deer Run STP	0.75	2.32

7.3.1.6 Tributaries

There are 16 significant tributaries that flow into the Lower Des Plaines River mainstem (Table 32). Streamflow from these tributaries can be parameterized based on existing gage records from USGS or can be estimated using a water balance approach relative to monitored nearby USGS and WWTP flows in the watershed. Water quality inputs for these tributaries may be parameterized as well using best available data from grab sampling or continuous sonde monitoring conducted throughout the area by LDWG, DRSCW, LDRWC, MWRD, IEPA, IDNR, or any other agencies identified. For model inputs, tributaries are simulated based on the flow and water quality conditions at their downstream end as it enters the mainstem only. Where gaps exist in existing datasets, gap-filling will be conducted based on best professional judgement and reasonable assumptions (e.g., a tributary with no WWTPs and no water quality data adjacent to a similarly sized tributary with no WWTP and water quality data may be used to parameterize water quality inputs for the first tributary). Data monitoring at locations upstream of WWTPs on tributaries is likely not to be incorporated into a mainstem QUAL2Kw model.

Table 32 Tributaries to the Lower Des Plaines River and data sources for QUAL2K model inputs.

Tributary	Flow Data Source	Water Quality Data Source
Willow Creek	Water balance approach and DMR flow data associated with the Kirie WRP (IL0047741)	LDWG site LDGO01
Crystal Creek	Water balance approach	LDWG site LDGN01
Schiller Woods Creek	Water balance approach	LDWG site LDGX01
Silver Creek	Water balance approach	LDWG site LDGM01
Salt Creek	Combined flows from USGS gage 05531500 (Salt Creek at Western Springs, IL) and 05532000 (Addison Creek at Bellwood, IL)	MWRD site WW_109 and DRSCW QUAL2Kw
Flag Creek	USGS gage 05533000 (Flag Creek near Willow Springs, IL)	LDWG site LDGK01
Sawmill Creek	USGS gage 05533400 (Sawmill Creek Near Lemont, IL)	LDWG site LDGJ02
Sanitary & Ship Canal	Combined flows from USGS gage 05536995 (Chicago Sanitary & Ship Canal at Romeoville, IL) and Lockport STP (IL0029611)	LDWG site LDGGI01 and MWRD site WW_92
I&M Canal	Combined flows from USGS gage 05537500 (Long Run Near Lemont, IL), Bonnie Brae (IL0021261), Citgo (IL0001589)	LDWG site LDGH01
Hickory Creek	USGS gage 05539000 (Hickory Creek at Joliet, IL)	LDWG site LDGG01
Sugar Run	Water balance approach	Estimation approach
Cedar Creek	Water balance approach	Estimation approach
Jackson Creek	Water balance approach	LDWG site LDGCB01
DuPage River	USGS gage 05540500 (DuPage River at Shorewood, IL)	LDWG site LD16 and DRSCW QUAL2Kw modeling
Grant Creek	Water balance approach	LDWG site LDGA01

Most water quality data for model parameterization of tributaries will come from LDWG monitoring sites, however, MWRD has a number of sampling locations downstream of some of their facilities which may be useful in parameterization or gap-filling (e.g., on Higgins Creek downstream of the Kirie WWTP, on Salt Creek, and on the Chicago Sanitary and Ship Canal). Note that it may not be necessary to explicitly model some of the smallest direct tributaries that have the most limited data and relatively low flow contributions such as Crystal Creek, Schiller Woods Creek, Sugar Run, and Cedar Creek. Also, at the downstream end of the mainstem, 80% of the flow instream is coming directly from the Sanitary & Ship Canal, DuPage River, and Salt Creek combined. These three primary tributaries combined also account for 89% of total TP source loading to the mainstem (Table 33).

Table 33 Estimated flow and total phosphorus loading contributions to the Lower Des Plaines River mainstem, as tabulated at the downstream end based on calendar year 2020 best available data.

Primary Sources to the Lower Des Plaines River Mainstem	Flow Contribution	TP Load Source Contribution
Sanitary & Ship Canal	62%	67%
Upper Des Plaines River	14%	6%
DuPage River	12%	13%
Salt Creek	6%	9%
All Other Tributaries (with and without WWTPs)	5%	2%
Mainstem WWTPs	2%	3%

7.3.1.7 Meteorology and Shade

Hourly meteorological data timeseries for QUAL2Kw may be derived from either ground observation stations or using gridded weather data products. Inputs include air temperature, dew point temperature, wind speed, cloud cover, and solar radiation. Tetra Tech developed meteorological inputs for the DuPage River and Salt Creek QUAL2Kw models using publicly available continuous gridded meteorological data, and it is recommended that the same approach be applied for the Lower Des Plaines River QUAL2Kw model. Air temperature, dew point temperature, wind speed, and solar radiation and data projects available through NLDAS-2 (North American Land Data Assimilation System - Phase 2) which may be averaged across the mainstem simulation area for the simulation period of interest. The NLDAS-2 gridded data project is a collaborative effort that involves the Environmental Modeling Center of National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Prediction (NCEP), the Hydrological Sciences Laboratory of National Aeronautics and Space Administration (NASA) Goddard Space Flight Center, Princeton University, the University of Washington, the NOAA National Weather Service Office of Hydrological Development, and the NOAA/NCEP Climate Prediction Center. This product provides hourly gridded meteorological data from 1979 to present at a 1/8-degree resolution. Cloud cover inputs may be derived from gridded meteorological data available through the NCEP North American Regional Reanalysis, an extension of the NCEP Global Reanalysis. Data includes three-hourly, daily, and monthly means from 1979 to present (with a half-month delay in availability). All hourly continuous meteorological data inputs required for QUAL2Kw may be developed using these gridded data projects which may be extracted and processed using Python scripts or similar tools.

Tetra Tech has estimated shade in previous modeling efforts through a combined review of observed water temperatures instream, aerial image photography, ground-level imagery, and where possible, the incorporation of shade measurements from the stream centerline using a fisheye camera or solar pathfinder tool. Given the width of the river and the lack of substantial riparian vegetation and topographic shading, it is likely that stream shading for the Lower Des Plaines River will be null.

7.3.1.8 Governing Parameters

incorporation of shade measurements from the stream centerline using a fisheye camera or solar pathfinder tool. Given the width of the river and the lack of substantial riparian vegetation and topographic shading, it is likely that stream shading for the Lower Des Plaines River will be null.

7.3.1.9 Calibration Data

The QUAL2Kw model for the Lower Des Plaines River would be calibrated to observed data for channel hydro-geometry, water temperature, DO, nutrients, and CBOD. Simulated streamflow is a function of boundary condition inputs such as headwaters, tributaries, and WWTP discharges. The simulated to observed streamflow comparison serves as a quality check for these model input time series as well as channel characteristics and hydraulics that affect streamflow timing through the segment network predicted by the QUAL2Kw model. A calibrated receiving water model is considered to represent observed stream conditions well, such that any potential management scenarios that are run using the existing calibrated model are likely to present a scientifically defensible representation of anticipated instream response.

7.3.1.10 Management Scenarios

Data inputs for management scenarios are anticipated to be focused on speculative changes to WWTP TP effluent limits both in and around the Lower Des Plaines River mainstem. The calibrated QUAL2Kw model would represent a baseline of existing conditions, for which boundary conditions may be changed to reflect current and ongoing NARP planning and implementation efforts. Management scenarios may include the following as individual and/or combined conditions:

- Modified headwater conditions to reflect NARP implementation planning for the Upper Des Plaines River per the Des Plaines River Watershed Workgroup (anticipated WWTP TP limit of 0.50 mg/L).
- Modified major riverine tributary inflows from adjacent watersheds to implementation planning from DRSCW and LDRWC for which anticipated WWTP TP limits are 0.50 mg/L for Lower DuPage River, and 0.35 mg/L for East Branch DuPage River, West Branch DuPage River, and Salt Creek.
- Modified major canal inflows to reflect MWRD implementation planning for the Chicago Area Waterway System anticipated to reflect TP limits of 0.50 mg/L for primary WWTPs.
- Modified LDWG management planning efforts for WWTPs discharging to tributaries within the Lower Des Plaines River watershed which will impact water quality with WWTP TP targets anticipated to be 0.35 mg/L to 0.50 mg/L impacting the following tributaries: Willow Creek, Jackson Creek, Hickory Creek, I&M Canal, and additional impacts to the Sanitary & Ship Canal.2
- Various potential modifications to TP limits for LDWG WWTPs discharging to the mainstem Lower Des Plaines River, anticipated to be less than or equal to 0.50 mg/L based on current regulations.

7.4 SUMMARY OF TP REMOVAL ACTIVITIES

Over the last five years as the LDWG has worked to collect important data to better understand the stressors to aquatic life and the role that nutrients play, there have been many efforts to reduce phosphorus discharges. Table 34 summarizes current and planned implementation of phosphorus removal at LDWG WWTPs. The “Planned Removal Practice” column refers to the likely practice to be implemented to meet a TP effluent limit below 1.0 mg/L. Prior to 2018 two of the seven major WWTPs were implementing TP effluent limit of 1.0 mg/L. Four additional plants came online since 2018 and the remaining plant will meet 1.0 mg/L TP effluent limit in 2024. The impact of phosphorus removal at the Joliet Westside Plant (2019), Joliet Eastside Plant (2021) and Channahon STP (2021) are not reflected in the data collected for the bioassessment that was conducted in 2018 covering the Des Plaines River from the confluence with the Kankakee River up to the I-355 bridge.

Table 34 LDWG Des Plaines River WWTPs TP removal status.

NPDES Number	Facility Name	Receiving Water	TP Limit	Date Implemented	Current Removal Practice	Planned Removal Practice
IL0065188	DuPage County - Knollwood	Des Plaines River	1.0 mg/L	8/1/2018	BPR	BPR + Chem
IL0032760	Illinois Am. Water - Santa Fe	Des Plaines River	1.0 mg/L	8/1/2015	BPR	BPR + Chem
IL0048526	Romeoville Wastewater Treatment Facility	Des Plaines River	1.0 mg/L	1/1/2012	Chemical P Removal	BNR
IL0064998	City of Crest Hill East STP	Des Plaines River	1.0 mg/L	2/29/2024	BPR	BPR + Chem
IL0022519	City of Joliet Eastside STP	Des Plaines River	1.0 mg/L	3/31/2021	BPR	BPR + Chem
IL0033553	City of Joliet Westside STP	Des Plaines River	1.0 mg/L	12/31/2019	Chemical P Removal	Chemical P Removal
IL0069906	Village of Channahon STP	Des Plaines River	1.0 mg/L	1/1/2021	BPR	BPR + Chem
IL0074713	Village of Elwood - Deer Run STP	Des Plaines River	no limit - monitor only	N/A	N/A	N/A

7.5 IMPLEMENTATION PLAN

The LDWG plan for implementation of management opportunities focuses on practicality, economies of scale, and the unique constraints encountered by a river system whose flow and nutrient loading are primarily sources from outside its watershed boundaries. The following recommendations will continue Workgroup activities that support IPS Tool and QUAL2Kw model development.

- Workgroup Participation
    - LDWG members shall continue active workgroup participation.
    - Coordinate on any potential funding sources as needed.
    - Identify opportunities to work with other regional watershed groups, particularly related to required monitoring, and modeling efforts that would support TP target development for non-wadeable streams, replicate existing collaborations, such as that with DRSCW to develop a TP target for wadeable streams.
    - Continue to work together to brainstorm opportunities to meet watershed goals efficiently, effectively, and with a science-based approach.
    - Consider future management options that may provide practical action items to address other watershed impairments and eliminate offensive algae and low DO conditions.
- Monitoring Studies
    - Continue to implement the robust water quality monitoring evaluations and bioassessment surveys conducted throughout the watershed, with prioritization on the data needs to support IPS Tool development.
    - Plan specifically for opportunities to conduct water quality and bioassessment monitoring to track changes to instream conditions (water quality, aquatic habitat, and species) as various management opportunities are carried out.

  - Allow for adaptive management of the monitoring program to support changing needs and/or shifting objectives of the workgroup.
- Documentation and Outreach
  - Continue to develop and support development of water quality study reports and potential management plans to support efforts of public outreach, communication, and furthering the goals of the NARP objectives.
  - Draft speculative NPDES permit language related to NARP compliance, including the proposal of determination of WWTP effluent limits as based on existing or future modeling.
- Bioassessment Data Evaluation
  - Work with MBI to ensure that data collected in support of an abridged IPS Tool application is well-planned, well-coordinated, and robust enough to populate across a nutrient gradient for determination of a non-wadeable streams TP target, working with MBI.
- Water Quality Modeling
  - Prioritize development and calibration of a continuous QUAL2Kw receiving water quality model for the non-wadeable mainstem Lower Des Plaines River, working with contractors where needed.
  - Collect and aggregate any and all data sources to support QUAL2Kw model development from USGS gage records, bioassessment data, IEPA water quality data, MWRD datasets, DMR records, etc.
  - Develop and run various management application scenarios for future conditions to understand potential impacts of various changes to regional and local WWTP discharge limits to TP concentrations with the IPS target for non-wadeable streams as the goal.

7.5.1 Implementation Schedule

The following schedule (Table 35) summarizes the activities already implemented and proposed activities defined above outlining a plan for the next five years with an end goal of identifying instream nutrient thresholds that are protective of aquatic life and propose effluent targets to meet the instream TP threshold. This schedule is applicable to WWTPs that discharge to the Lower Des Plaines River.

Table 35 Implementation Schedule for Mainstem Dischargers.

Calendar Year	Status	Implementation Action
2018	Complete	Lower Des Plaines Watershed Group formed
2018-2022	Complete	First round Bioassessment Program – 47 DR sites
2018-2023	Complete	1.0 mg/L TP implemented at DuPage Co, Joliet Westside, Channahon, Joliet Westside
2023	Complete	Bioassessment data collection on Des Plaines R. Pt. 1
2024	NARP Year 1	Bioassessment data collection on Des Plaines R. Pt. 2 and potentially other non-wadeable streams regionally (Rock, Kankakee), address other identified data gaps; 1.0 mg/L TP implemented at Crest Hill
2025	NARP Year 2	
2026	NARP Year 3	IPS Tool statistical evaluation
2027	NARP Year 4	IPS Thresholds identified, QUAL2Kw model development, calibration to best data year. Model various management application scenarios relative to an instream TP threshold derived by IPS Tool. Develop implementation schedule.
2028	NARP Year 5	

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