

FINAL REPORT

Regional Water Study

Water Demand and Availability in the St. Joseph and Maumee River Basins
of the Northeast Indiana Region

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Executive Summary

The Northeast Indiana Region (**Figure ES- 1**), comprising the St. Joseph and Maumee River Basins faces a water future that is, overall secure, but with an intensifying *seasonal* risk profile for water availability. This study evaluated regional water demand and availability from 2020 - 2070 to determine whether the Region's water resources can meet the needs of its communities, farms, and industries, and to identify where targeted planning and investment are most needed.

This study was prepared for the Indiana Finance Authority (IFA), at the request of the Indiana Department of Natural Resources (IDNR), pursuant to Executive Order 25-63, to evaluate whether sufficient water resources exist within the Region to meet projected water supply needs through the year 2070. The results of this study are intended to support state and local decision-makers, public water utilities, and regional stakeholders in planning for reliable and sustainable water supplies across the Region.

Specific objectives of the study are to:

- Quantify current water withdrawals across the Region's major water-use sectors;
- Develop projections of future water demand for public water supply, industry, energy, and agricultural water sectors through 2070;
- Evaluate current surface water and groundwater availability;
- Estimate how availability may change under future climate conditions;
- Compare projected demand with available supplies to identify potential deficits or areas of limited availability; and
- Identify risks, constraints, and potential strategies to improve long-term water supply resilience.

Key Findings

- Land cover in Northeast Indiana Region is over 60% agriculture, with cultivated crops comprising 54% of total.
- Seventy-two out of 76 public water suppliers exclusively utilize groundwater as their source of supply.
- Current and Future water demand is dominated by irrigation and public water supply withdrawals.
- Regional annual average withdrawals are expected to increase 94 MGD from 197 MGD in 2020 to 291 MGD in 2070.
- Irrigation demand, driven by climate, is projected to rise from about 49 MGD in 2020 to about 121 MGD in 2070 and accounts for 77% of the region's projected total increase.
- Irrigation withdrawals dominate the St. Joseph Basin. These high consumptive use withdrawals are expected to increase in the future, causing rivers to drop below the minimum instream flow more often.
- In the Maumee Basin, annual water availability will only decrease slightly through 2070. More significant changes are expected seasonally, with significant decreases in winter availability and significant increases in Fall availability.

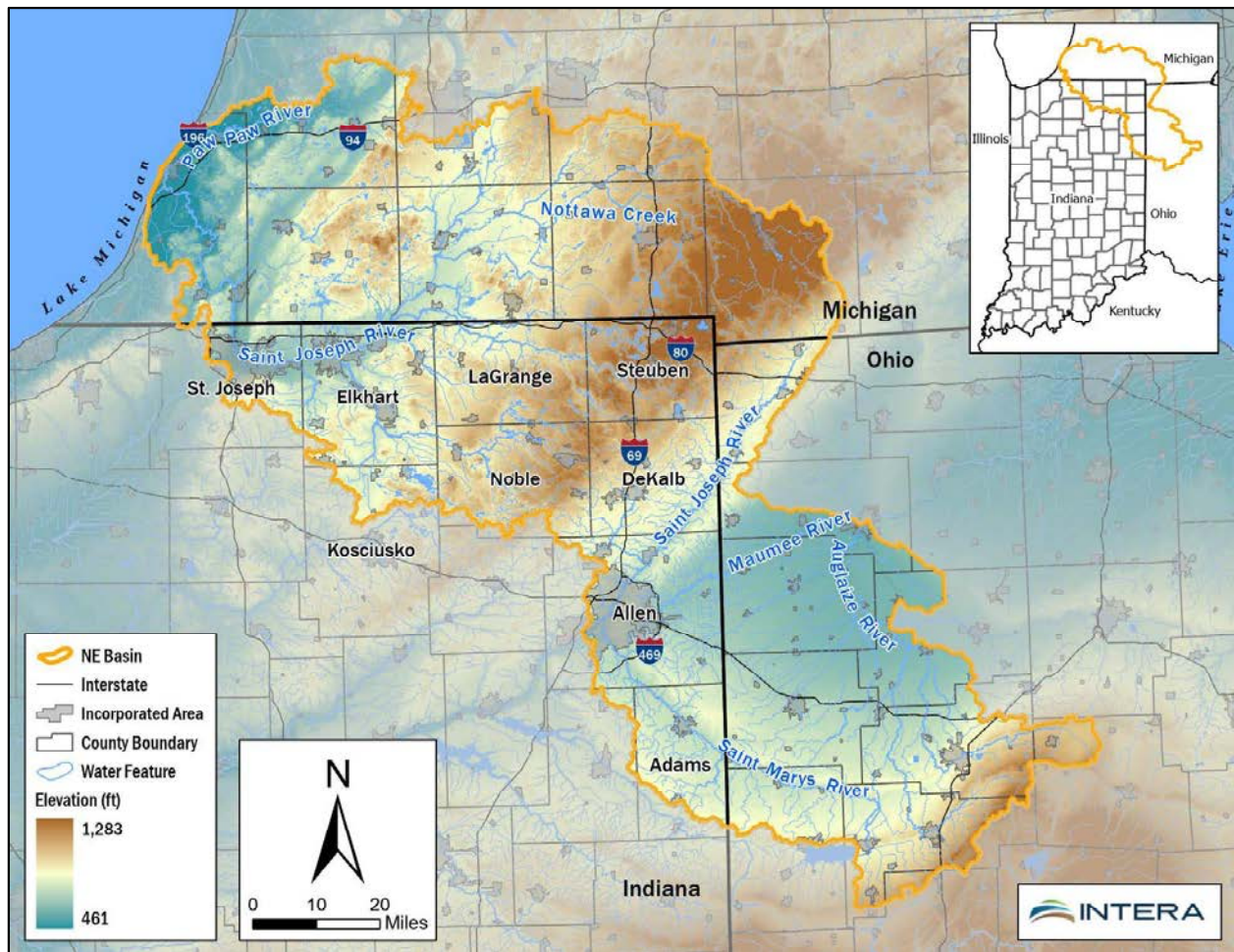


Figure ES- 1. Location of the Northeast Indiana Water Study Region (Region).

Approach

The study is structured around three major analytical components: 1) development of a forecast of regional water demand, 2) evaluation and forecasting of regional water availability, and 3) comparison of demand and availability to identify potential future water-supply gaps and opportunities for improved water management.

Water demand estimates were developed using population projections, economic trends, climate information, and other factors to forecast future demand through 2070. Water withdrawals were used as a proxy for demand, and both groundwater and surface water resources were evaluated to determine the capacity of regional resources to meet projected needs.

Water availability was evaluated using historical streamflow records, reported water withdrawals, return flows, and future climate projections to estimate how much water is likely to remain available under future conditions while maintaining minimum streamflow needed to support rivers and aquatic ecosystems.

Setting

The Northeast Indiana Region (**Figure ES- 1**) encompasses all or portions of nine counties spanning five Hydrologic Unit Code (HUC-8) watersheds across two major hydrologic systems. The St. Joseph River Basin, in the northwestern portion of the Region, is a low-relief, glaciated landscape with abundant natural lakes and wetlands that drains northward to Lake Michigan. The Maumee River Basin, occupying the central and eastern portion of the Region, drains eastward through Ohio to Lake Erie.

Population is concentrated in two primary centers: the South Bend–Elkhart–Mishawaka corridor in the St. Joseph Basin and the Fort Wayne metropolitan area, the Region’s largest single population center, in the Maumee River Basin.

Public water supply is provided by 76 municipal and community utilities serving more than 650,000 people; 72 of the 76 utilities rely exclusively on groundwater from productive unconsolidated aquifer systems. Fort Wayne City Utilities, the region’s largest system, is the only major utility relying on surface water, drawn from the St. Joseph River (Maumee Basin).

Northeast Indiana Region Fun Facts

- Covers parts of 9 Indiana counties
- 2 major river basins
 - St. Joseph River
 - Maumee River
- 5 HUC-8 watersheds
- 76 public water utilities
- 72 public utilities use groundwater
- Public water utilities serve over 650,000 residents
- Irrigation is the largest growing water use

Outside the urban corridors, land use is predominantly agricultural, with irrigation concentrated in the glacial outwash aquifers of the St. Joseph Basin, particularly in Elkhart, LaGrange, and Kosciusko counties.

Water Demand

Total regional water demand across all use sectors is projected to rise from approximately 197 MGD in 2020 to approximately 291 MGD in 2070, an increase of roughly 48 percent (**Figure ES- 2**). This growth is driven almost entirely by irrigation, projected to increase from about 49 MGD in 2020 to about 121 MGD in 2070 as warmer, drier projected growing seasons increase irrigation acreage and demand.

Irrigation demand is concentrated in the glacial outwash aquifers of Elkhart, LaGrange, and Kosciusko counties in the St. Joseph River Basin, and is both the largest source of projected growth and the most climate-sensitive, uncertain sector in the forecast.

Public water supply demand is projected to ease slightly, from about 75 MGD to about 74 MGD, as ongoing per-capita efficiency gains outpace modest population growth; self-supplied, residential, power generation, and commercial and industrial demand are each projected to remain essentially flat over the planning horizon.

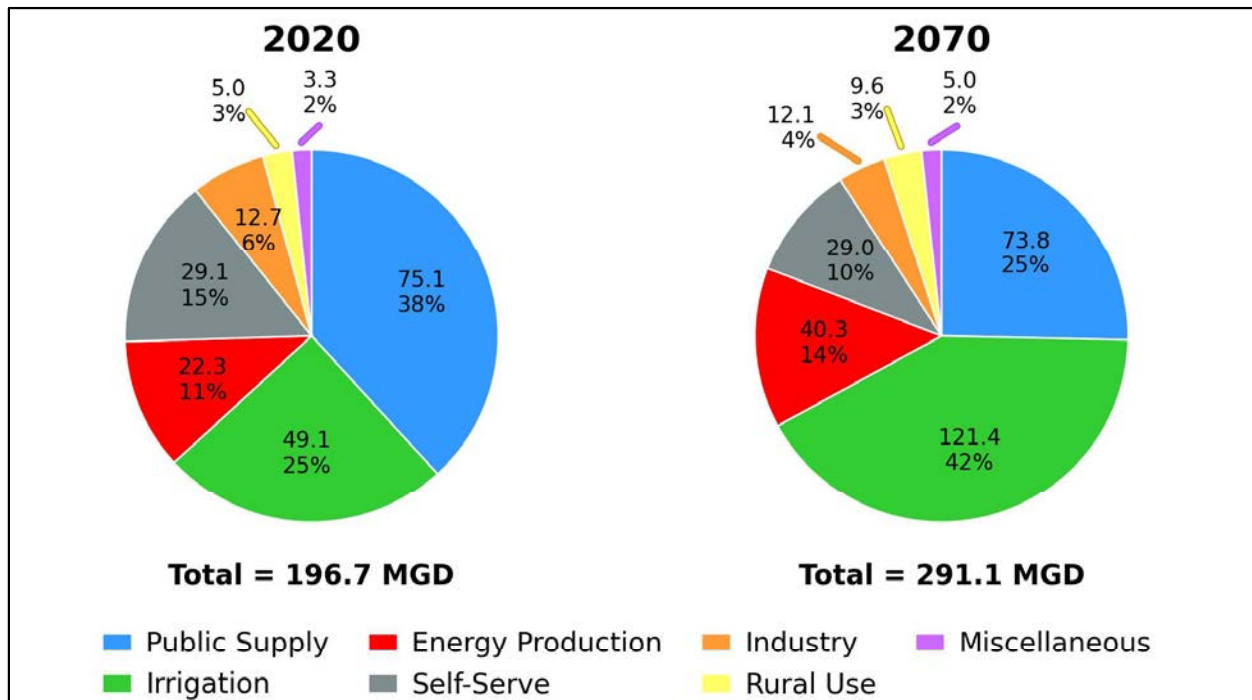


Figure ES- 2. Regional water withdrawals by water-use sector for the Northeast Indiana Region in 2020 and 2070.

Water Availability

Water availability is assessed on a sub-basin scale, with the Region divided into 18 sub-basins. Historical water availability, assessed for the period 2007–2023, is positive across most of the Region’s sub-basins on an annual and seasonal basis, indicating that existing water withdrawals are generally supported by naturally occurring streamflow after accounting for minimum instream flow targets. However, the two basins diverge sharply looking forward to future availability.

In the St. Joseph River Basin, rising irrigation demand is projected to coincide with declining seasonal availability producing increasingly frequent periods where streamflow falls below minimum instream flow targets by 2070.

In the Maumee River Basin, future consumptive use is projected to remain similar to historical levels, and while water availability is projected to decline in most sub-basins, particularly in Winter and Spring, Fall conditions are projected to improve in most sub-basins.

Consumptive Use

Consumptive use is the portion of water withdrawn from a source that is not returned and is effectively removed from the immediate water system.

Findings and Recommendations

The water demand and availability analysis indicate that the Northeast Indiana Region is not approaching a region-wide water deficit, but faces a clear and intensifying seasonal risk, concentrated in the irrigation-dependent St. Joseph River Basin.

The risk analysis classifies a sub-basin as at-risk if it experienced at least one seasonal occurrence of negative cumulative excess water availability, meaning the average seasonal streamflow dropped below a minimum streamflow (instream flow) target at least once within a given period. The instream flow target is a minimum flow necessary to maintain the water quality and ecological health of the stream. A negative seasonal cumulative excess water availability indicates a condition associated with stream degradation and the sub-basin it occurs in is therefore classified as at-risk.

The analysis shows that in the historical period (2007-2023), shown on the left of **Figure ES-3**, the St. Joseph River Basin has two sub-basins (Sub-Basins SJ2 and SJ7) with at least one season where the streamflow dropped below the instream flow target. The Maumee River Basin had zero occurrences of negative cumulative excess water availability in the historical period.

In the projected planning period (2024-2070), shown on the right of **Figure ES-3**, the analysis indicates that every sub-basin in the St. Joseph River Basin will have at least one occurrence of negative cumulative excess water availability in the future. The Maumee River Basin has one sub-basin at-risk in the future (Sub-Basin M2).

Instream Flow

Instream flow is a minimum streamflow target that protects the water quality, ecological health, and recreational uses of a stream. If the flow in a stream drops below the instream flow target for an extended period time, the health of the stream may be impacted. The Indiana Regional Water Studies have adopted two statistical measures of streamflow to define instream flow: the 7Q10 and the annual Q90.

The deficit in the St. Joseph River Basin is contextualized against much larger absolute flow volumes in this basin (instream flow values of 288 MGD and 606 MGD at the downstream ends of Sub-Basins SJ2 and SJ7, respectively), indicating substantially greater total water availability and consumptive use relative to the Maumee Basin.

Layered onto this seasonal water availability risk, are ongoing risks from climate, water quality, aging infrastructure, and emerging large-scale demand. Addressing these risks proactively, and with attention to the meaningful differences between the Region's two basins, will be essential to ensuring reliable, sustainable water supplies through 2070.

As regional planning progresses in the Northeast Indiana Region, the following specific target areas and subsequent recommendations will benefit the water resources:

1. **Irrigation and St. Joseph Basin availability** - Target irrigation efficiency, soil-moisture-based scheduling, and drought-contingency planning in Elkhart, LaGrange, Kosciusko, and St. Joseph Counties, where seasonal cumulative excess water availability is projected to fall below zero.
2. **Public water supply infrastructure** – Continue the Region-wide capital needs and condition-rating inventory for the 76 public water utilities, prioritizing state revolving fund/Indiana Finance Authority funding toward smaller systems with high per-connection project costs.

3. **Peak-day demand management** - Adopt local ordinances or incentive programs addressing discretionary Summer outdoor water use (watering schedules, turf reduction, increasing-block rates) to reduce peak-day demand and associated infrastructure sizing costs.
4. **Water quality protection** - Expand nitrate monitoring in the St. Joseph River Basin outwash aquifers and Maumee River Basin agricultural streams; continue Per- and poly- fluoroalkyl substances (PFAS) compliance support for utilities ahead of federal compliance deadlines; support continued combined sewer overflow separation planning.
5. **Data centers and emerging demand** - Establish a coordinated review of cumulative water withdrawals, associated power-generation cooling water, wastewater discharge, and wetland impacts from data center development in Allen and St. Joseph Counties (and others as they arise).
6. **Regional monitoring and data** - Continue and expand Significant Water Withdrawal Facility reporting compliance and biennial water loss audits; track peaking-factors and demand data across utilities to refine future planning updates to this study.

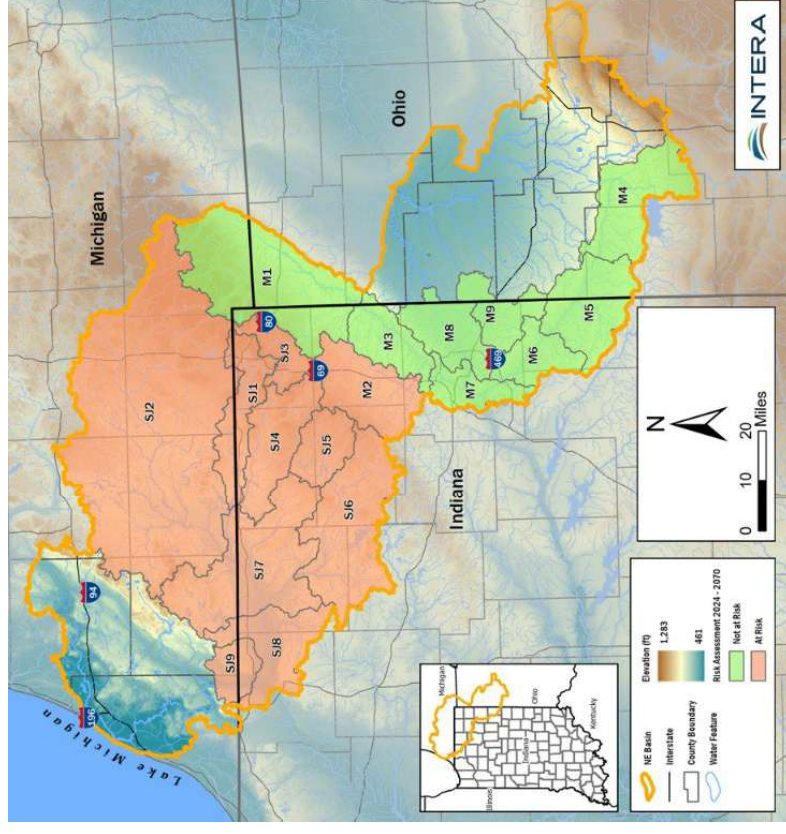
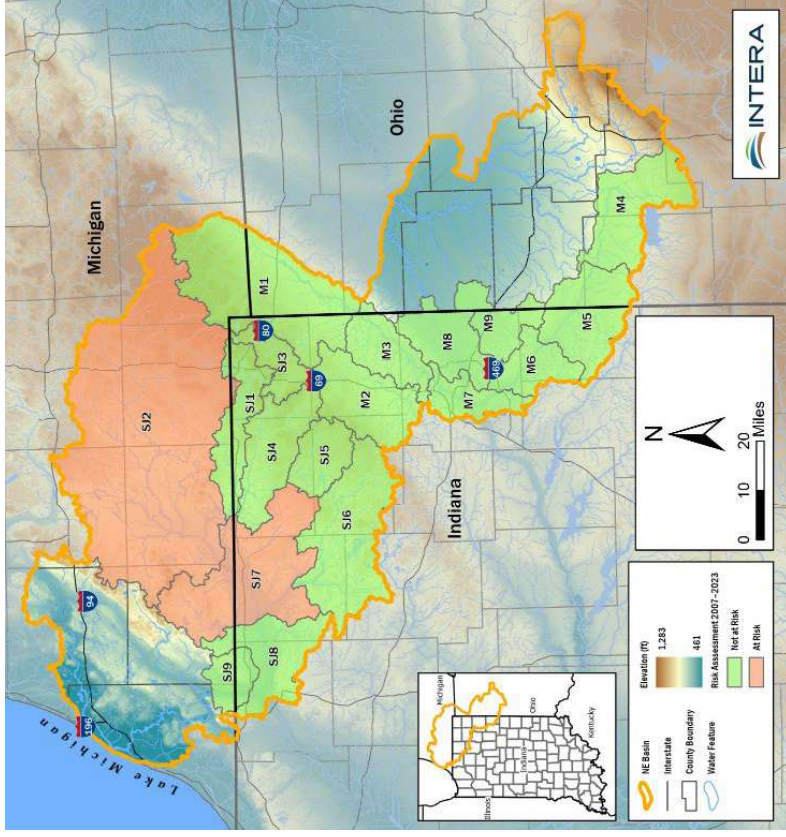


Figure ES- 3. Historical (left) and future (right) sub-basin risk based on water availability. Green represents basins that have not exceeded their seasonal cumulative excess water availability. Orange shows sub-basins that have dropped below the instream flow target at least once.

Table of Contents

1.0	Introduction.....	1
1.1	Study Objectives	2
1.2	Northeast Indiana Region.....	3
1.3	Regional Overview.....	4
1.3.1	Population Centers.....	5
1.3.2	Climate	8
1.3.3	High-Capacity Water Users	10
1.3.4	Public Water Utilities	13
1.3.5	Industry and Agriculture.....	16
1.3.6	Power Generation.....	17
1.3.7	Land Cover.....	17
1.3.8	Tile Drains.....	19
1.3.9	Geology	20
1.3.10	Water Resources and Trends.....	24
1.3.11	Dams and Reservoirs.....	29
1.3.12	Great Lakes Compact	32
1.4	Spatial Scale of Demand and Availability Analyses	33
2.0	Water Demand.....	37
2.1	Historical Water Withdrawal	37
2.1.1	Public Water Supply	38
2.1.2	Self-Supplied Residential Water Supply	44
2.1.3	Agricultural Water Withdrawal.....	45
2.1.4	Power Production	55
2.1.5	Industrial Water Supply	59
2.1.6	Miscellaneous.....	62
2.2	Water Demand Forecasts	66
2.2.1	Methodology	66
2.2.2	Total Demand Forecast.....	66
2.2.3	Public Water Supply	71
2.2.4	Self-Supplied Residential Water Supply	73
2.2.5	Irrigation	74
2.2.6	Concentrated Animal Feeding Operations	78
2.2.7	Power Generation.....	79
2.2.8	Industrial Water Supply	81
2.2.9	Miscellaneous and Rural Use.....	83
2.3	Uncertainty in Demand Projections.....	87

3.0	Water Availability	89
3.1	Historical Water Availability.....	90
3.1.1	Instream Flows.....	90
3.1.2	Cumulative Excess Water Availability	92
3.1.3	Summary of Historical Water Availability	101
3.2	Water Availability Forecasts	101
3.2.1	Methodology.....	102
3.2.2	Results: St. Joseph River Basin	103
3.2.3	Results: Maumee River Basin	106
4.0	Risks to Water Supply	110
4.1	Water Availability Risk Analysis	110
4.1.1	Risks: St. Joseph River Basin	110
4.1.2	Risks: Maumee River Basin.....	111
4.2	Climate	114
4.3	Water Quality.....	115
4.3.1	Groundwater	115
4.3.2	Surface Water	118
4.4	Infrastructure.....	121
4.5	Data Centers	121
5.0	Conservation	123
5.1	Water Use Consumption.....	123
5.2	Conservation Recommendations.....	124
6.0	Findings and Recommendations	126
6.1	Water Demand.....	126
6.2	Water Availability	126
6.3	Risks to Water Supply	127
6.4	Recommendations.....	128
7.0	Glossary	129
8.0	References	134

List of Appendices

Appendix A	Mann-Kendall Trend Tests
Appendix B	Demand Model and Projections
Appendix C	Historical Water Availability
Appendix D	Water Availability Projections
Appendix E	Annual and Seasonal Summaries
Appendix F	County Fact Sheets

List of Figures

Figure 1.	Hydrologic extent of the Northeast Indiana Water Region. The Region includes the St. Joseph and the Maumee River Basins.	2
Figure 2.	Counties in the Northeast Indiana Region.	4
Figure 3.	Population centers in the Northeast Indiana Region. Numbers correspond to identifying information in Table 1.	6
Figure 4.	Locations of high-capacity water withdrawals within the Northeast Indiana Region. Figure shows groundwater wells and surface water intakes active in 2023.	12
Figure 5.	Water utility service areas in the Northeast Indiana Region. Numbers correspond to identifying information in Table 3.	14
Figure 6.	Land cover within the Northeast Indiana Region based on the 2021 National Land Cover Database (Dewitz, 2023).	18
Figure 7.	Extent of tile drainage in the Northeast Indiana Region (Valayamkunnath et al., 2020).	20
Figure 8.	Thickness of the surficial unconsolidated deposits in the Northeast Indiana Region (IGS, 2015).	22
Figure 9.	Bedrock geology of the Northeast Indiana Region. Generalized stratigraphic column (modified from Thompson et al., 2016).	24
Figure 10.	Groundwater wells in the unconsolidated aquifers (left) and groundwater wells in the bedrock (right) aquifers in the Northeast Indiana Region. Figures show wells that were active in 2023.	27
Figure 11.	Recent annual trends in streamflow and groundwater levels. See Appendix A for details on the period assessed for each location.	29
Figure 12.	Dams and reservoirs in the Region, classified by purpose and normal storage volume in acre-feet. Dams shown in Michigan and Ohio are included only if they lie in regions contributing to flow in Indiana.	32
Figure 13.	Sub-basins and corresponding flow schematic of the St. Joseph River Basin of the Northeast Indiana Region. Cross-hatching indicates areas outside the River Basin, or areas in the Basin downstream of the study area.	34
Figure 14.	Sub-basins and corresponding flow schematic of the Maumee River Basin of the Northeast Indiana Region. Cross-hatching indicates areas outside the River Basin, or areas in the Basin downstream of the study area.	35
Figure 15.	Total water withdrawals in the Region as reported in the SWWF database from 1985-2023.	38
Figure 16.	Public water supply facilities including groundwater wells and surface water intakes from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.	40
Figure 17.	Annual average public supply withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.	41
Figure 18.	Annual public supply withdrawal by county, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	42
Figure 19.	Irrigation wells and surface water intakes from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.	47
Figure 20.	Annual average Irrigation withdrawal for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.	48
Figure 21.	Annual average irrigation withdrawal by county from the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	49
Figure 22.	Rural use water wells and intakes from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.	51
Figure 23.	Annual average rural use withdrawal for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.	52

Figure 24.	Annual average rural use withdrawal by county, 1985-2023. No rural withdrawals were reported in DeKalb and Kosciusko. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Noble, and St. Joseph.	53
Figure 25.	Confined animal feeding operations in the Northeast Indiana Region (IDEM, 2021).	55
Figure 26.	Registered wells and surface water intakes used for energy production from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.	57
Figure 27.	Annual average energy production withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.	58
Figure 28.	Annual average energy production withdrawal by county as reported in the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, and St. Joseph.	58
Figure 29.	Registered groundwater wells and surface water intakes for industrial supply from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.	60
Figure 30.	Annual average industrial withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.	61
Figure 31.	Annual average industrial withdrawals by county as reported in the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	62
Figure 32.	Registered groundwater wells and surface water intakes for miscellaneous supply from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.	63
Figure 33.	Annual average miscellaneous withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.	64
Figure 34.	Annual average miscellaneous withdrawals by county as reported in the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	65
Figure 35.	Historical and projected water demand in the Region by water-use sector, 1985-2070. Self-Serve indicates the Self-supplied residential sector, and CAFO withdrawals are added to the rural use sector.	67
Figure 36.	Demand by use sector in 2020, 2045, and 2070. Self-Serve indicates the Self-supplied residential sector, and CAFO withdrawals are added to the rural use sector.	68
Figure 37.	Demand by county in 2020, 2045, and 2070. Only data from within the Region are presented in the graph. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	69
Figure 38.	Historical and predicted average annual public supply demand by county from 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	71
Figure 39.	Irrigated area by county, 1985 to 2070, with each county's cap shown as a dashed line. Note the y-axis differences between counties.	75
Figure 40.	Historical and forecast irrigation demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	76
Figure 41.	Historical and forecast energy-production demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, and St. Joseph.	79
Figure 42.	Historical and forecast industry and commerce demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	81

Figure 43.	Historical and projected miscellaneous demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	83
Figure 44.	Historical and projected rural-use demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Noble, and St. Joseph.	85
Figure 45.	Irrigation forecast (red line), observed annual withdrawals (black dots), and the simulated range (blue band), spanning the 5th to the 95th percentile of about 6,000 simulated futures.	88
Figure 46.	Minimum annual average cumulative excess water availability, 2007-2023.	93
Figure 47.	Minimum Winter cumulative excess water availability, 2007-2023.	94
Figure 48.	Minimum Spring cumulative excess water availability, 2007-2023.	95
Figure 49.	Minimum Summer cumulative excess water availability, 2007-2023.	96
Figure 50.	Minimum Fall cumulative excess water availability, 2007-2023.	97
Figure 51.	Explanation of the box and whisker plots used to show the variation in an annual time series.	98
Figure 52.	Seasonal cumulative excess water availability (CXS WA) in sub-basins of the St. Joseph River Basin, 2007-2023.	99
Figure 53.	Seasonal cumulative excess water availability (CXS WA) in sub-basins of the Maumee River Basin, 2007-2023.	100
Figure 54.	Example: Historical (top) and projected (bottom) cumulative excess water availability for Sub-Basin 6 of the St. Joseph River Basin.	104
Figure 55.	Current and projected annual excess (left) and cumulative excess water availability (right) for sub-basins in the St. Joseph River Basin.	105
Figure 56.	Current and projected Summer (left) and Fall (right) excess (top) and cumulative excess water availability (bottom) for sub-basins in the St. Joseph River Basin.	105
Figure 57.	Current and projected Winter (left) and Spring (right) excess (top) and cumulative excess (bottom) water availability for sub-basins of the St. Joseph River Basin.	106
Figure 58.	Example: Historical (top) and projected (bottom) seasonal cumulative excess water availability for Sub-Basin M8 of the Maumee River Basin.	107
Figure 59.	Current and projected annual excess (left) and cumulative excess (right) water availability in the sub-basins of the Maumee River Basin.	107
Figure 60.	Current and projected Summer (left) and Fall (right) excess (top) and cumulative excess (bottom) water availability in the sub-basins of the Maumee River Basin.	108
Figure 61.	Current and projected Winter (left) and Spring (right) excess (top) and cumulative excess (bottom) water availability in the sub-basins of the Maumee River Basin.	109
Figure 62.	Historical (left) and projected future (right) sub-basin risk. Green represents basins that are not at risk historically or projected to be at risk in the future. Orange shows sub-basins that have or are expected to have negative seasonal values of cumulative excess water availability.	113
Figure 63.	Potential sources of contamination and existing nitrate concentrations in the Northeast Indiana Region.	120

List of Tables

Table 1.	Population centers in the Northeast Indiana Region with 2020 population greater than 1,000.	7
Table 2.	High-capacity water withdrawal locations by sector and source, active in 2023.	11
Table 3.	Public water utilities that serve over 1,000 people in the Northeast Indiana Region.	15
Table 4.	Number of dams in the St. Joseph River Basin sorted by primary purpose and normal storage capacity.	31
Table 5.	Number of dams in the Maumee River Basin sorted by primary purpose and normal storage capacity.	31
Table 6.	Sub-basins in the St. Joseph River Basin.	36
Table 7.	Sub-basins in the Maumee River Basin.	36
Table 8.	Peaking factors (peak day ÷ average day) calculated for public water supply systems within the Northeast Indiana Region (IFA, 2025).	43
Table 9.	Self-supplied residential per-capita use rate by county.	44
Table 10.	Summary of self-supplied demand by county.	45
Table 11.	Calculated CAFO water withdrawal (MGD) for the county areas within the Northeast Indiana Region (IDEM, 2021).	54
Table 12.	Total water demand for all water-use sectors within the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	70
Table 13.	Public water supply demand in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	72
Table 14.	Self-supplied residential water demand forecast by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	73
Table 15.	Irrigation water demand forecast by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	77
Table 16.	Confined Feeding Operation/Concentrated Animal Feeding Operation water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	78
Table 17.	Energy production water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, and St. Joseph.	80
Table 18.	Industry water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	82
Table 19.	Miscellaneous water demand forecast by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.	84
Table 20.	Rural use water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Noble, and St. Joseph.	86
Table 21.	Instream flow values used in the water availability analysis for the St. Joseph River Basin of the Northeast Indiana Region.	91
Table 22.	Instream flows used in the water availability analysis for the Maumee River Basin of the Northeast Indiana Region.	91
Table 23.	Minimum annual and seasonal cumulative excess water availability in the St. Joseph River Basin, 2007-2023.	92

Table 24.	Minimum annual and seasonal cumulative excess water availability in the Maumee River Basin, 2007-2023.....	93
Table 25.	Historical sub-basin risk. Green represents sub-basins with positive seasonal cumulative excess water availability from 2007-2023, over 68 seasons. Orange shows sub-basins with at least one occurrence of negative seasonal cumulative excess water availability from 2007-2023.	112
Table 26.	Future sub-basin risk. Green represents sub-basins that are expected to have positive seasonal cumulative excess water availability in the future, 2024-2070, over 188 seasons. Orange shows sub-basins that are projected to have at least one occurrence of negative seasonal cumulative excess water availability in the future.....	112
Table 27.	Nitrogen (Nitrate-Nitrite) results by county, 2010-2018 (IDEM Statewide Ground Water Monitoring Network).....	116
Table 28.	Summary of recommendations by focus area and lead entities.....	128

Acronyms and Abbreviations

°F	Degrees Fahrenheit
7Q10	Lowest 7-day average flow that occurs every 10 years (on average)
CAFO	Concentrated Animal Feeding Operation
CFO	Confined Feeding Operation
CFS	Cubic feet per second (stream discharge)
CSO	Combined Sewer Overflow
CXS WA	Cumulative excess water availability (regionally aggregated upstream-to-downstream)
DO	Dissolved oxygen
DRP	Dissolved reactive phosphorus
EPA	U.S. Environmental Protection Agency
GLERL	Great Lakes Environmental Research Laboratory
GPCD	Gallons per capita per day
GW	Groundwater
GWMN	Groundwater Monitoring Network (IDEM)
HAB	Harmful algal bloom
HUC	Hydrologic Unit Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
IFA	Indiana Finance Authority
MCL	Maximum contaminant level
MGD	Million gallons per day
MW	Megawatts
NID	National Inventory of Dams
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System (EPA)
PCBs	Polychlorinated biphenyls
PER	Preliminary Engineering Report
PFAS	Per- and poly- fluoroalkyl substances
PFOA	Perfluorooctanoic acid
PFOS	Perfluorooctanesulfonic acid
Q80	Minimum flow that is present 80% of the time
Q90	Minimum flow that is present 90% of the time
SIC	Standard industrial classification
SW	Surface water



SWWF	Significant Water Withdrawal Facility (high-capacity water pumping)
TCE	Trichloroethylene
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VOC	Volatile organic compounds
WBM	Water balance model
WA	Water availability
XS WA	Excess water availability (locally generated)

1.0 Introduction

Water resources support Indiana's communities, economy, and natural ecosystems. Careful planning is essential to ensure reliable water supplies for future generations. As population growth, economic activity, and climate variability continue to influence water demand and availability, regional-scale assessments are increasingly important for long-term planning and resource management.

This study evaluates current and future water demand and water availability in the Northeast Indiana Region. The Region covers five 8-digit Hydrologic Unit Code (HUC-8) watersheds (**Figure 1**):

- St. Joseph (Lake Michigan; HUC-8 04050001)
- St. Joseph (Maumee; HUC-8 04100003)
- Upper Maumee (HUC-8 04100005)
- Auglaize (HUC-8 04100007)
- St. Marys (HUC-8 04100004)

The watersheds extend outside of Indiana into Michigan and Ohio. Conditions in the other states have an impact on downstream conditions in Indiana, and they are included in the study. The focus, however, is on the portions of the watershed lying in Indiana.

The analysis focuses on public water supply needs from 2020-2070 while also considering other significant water-use sectors. Water withdrawals are used as a proxy for demand, and both groundwater and surface water resources are evaluated to determine the capacity of regional water resources to meet projected needs. The study integrates historical water-use data, demographic and economic projections, and hydrologic analyses to provide a comprehensive understanding of water demand and water availability within the Region.

The work is structured around three major analytical components:

1. Development of a forecast of regional water demand (**Section 2.0**).
2. Evaluation and forecasting of regional water availability (**Section 3.0**).
3. Comparison of demand and availability to identify potential future water-supply gaps and opportunities for improved water management (**Section 4.0**).

The results of this study are intended to support state and local decision-makers, public water utilities, and regional stakeholders in planning for reliable and sustainable water supplies across the region.

St. Joseph River Naming in this Report

Note that two distinct HUC-8 watersheds within the Region share the name “St. Joseph River Basin,” reflecting separate river systems.

The northwestern basin (HUC-8 04050001) drains to Lake Michigan via the St. Joseph River. We will refer to this as “St. Joseph River” or “St. Joseph River Basin” in this report.

“St. Joseph River (Maumee Basin)” will refer to the St. Joseph River tributary to the Maumee River, which ultimately drains to Lake Erie in the eastern basin (HUC-8 04100003).

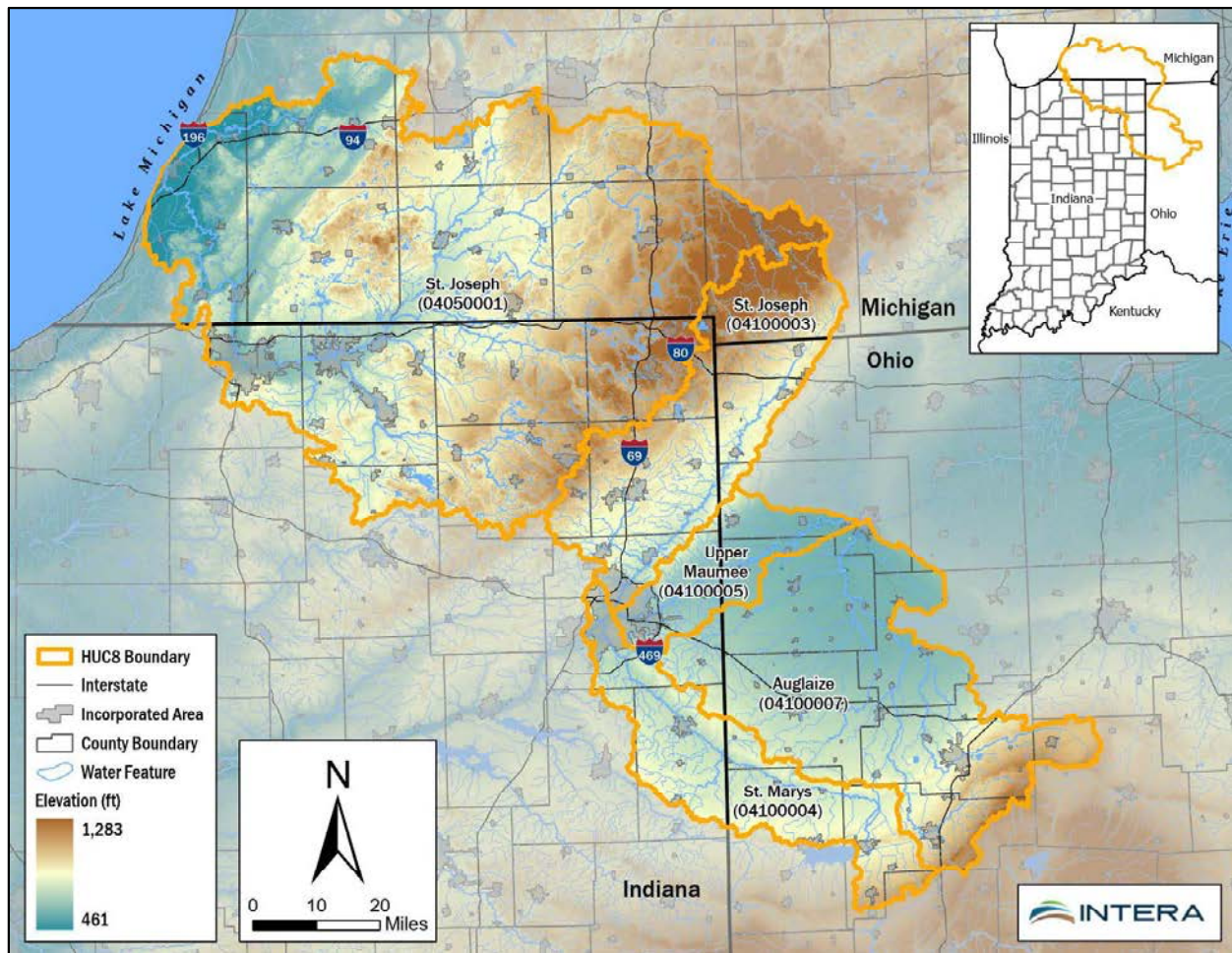


Figure 1. Hydrologic extent of the Northeast Indiana Water Region. The Region includes the St. Joseph and the Maumee River Basins.

1.1 Study Objectives

The objective of this study is to evaluate whether sufficient water resources exist within the Northeast Indiana Region to meet projected water supply needs through the year 2070. The analysis focuses on understanding both current conditions and how water demand and water availability may evolve over time in response to demographic, economic, and climatic factors. This study provides a regional planning assessment and is not intended to replace detailed local or site-specific evaluations, which may be needed for specific infrastructure or water development projects. The results of this study are intended to support state and local decision-makers, public water utilities, and regional stakeholders in planning for reliable and sustainable water supplies across the Region.

Specific objectives of the study include:

- Quantify current water withdrawals across major water-use sectors within the Region.

- Develop projections of future water demand for public water supply and other significant sectors through 2070.
- Evaluate current surface water and groundwater availability within the Region.
- Estimate how water availability may change over time under future climate conditions.
- Compare projected water demand with available water supplies to identify potential deficits or areas of limited availability.
- Identify risks, constraints, and potential strategies to improve long-term water supply resilience.

1.2 Northeast Indiana Region

The Northeast Indiana Region is located in the northeastern corner of Indiana and includes areas that ultimately drain to either Lake Michigan via the St. Joseph River or to Lake Erie via the Maumee River (**Figure 2**). Counties included wholly or partially within the Region include:

- | | | |
|-------------------|-----------------------|------------------------|
| ▪ Adams (partial) | ▪ Elkhart (partial) | ▪ Noble (partial) |
| ▪ Allen (partial) | ▪ Kosciusko (partial) | ▪ Steuben (whole) |
| ▪ DeKalb (whole) | ▪ LaGrange (whole) | ▪ St. Joseph (partial) |

All data presented in the report, unless specifically identified, are for the portions of the counties within the Region’s hydrologic boundaries.

The Region spans two primary hydrologic systems. The St. Joseph River Basin, located in the northwestern portion of the Region, drains northward into Michigan and ultimately to Lake Michigan. This basin is characterized by low-relief, glaciated terrain with abundant natural lakes and wetlands. In contrast, the Maumee River Basin occupies the central and eastern portions of the Region and drains eastward into Ohio before discharging to Lake Erie. The boundary between these basins is defined by subtle, glacially derived topographic divides that influence both surface water and groundwater flow directions. Together, these basins capture the range of hydrologic conditions present in northeastern Indiana, including interconnected stream networks, lake systems, and groundwater flow regimes shaped by glacial processes.

Major population centers include the South Bend–Elkhart corridor in the northwest and the Fort Wayne metropolitan area in the southeast. Key interstate corridors, including I-69 and I-90, traverse the Region and provide connectivity between communities. This watershed-based framework supports evaluation of regional water demand and availability across two major Great Lakes tributary systems while presenting results in a format applicable to local planning and resource management.

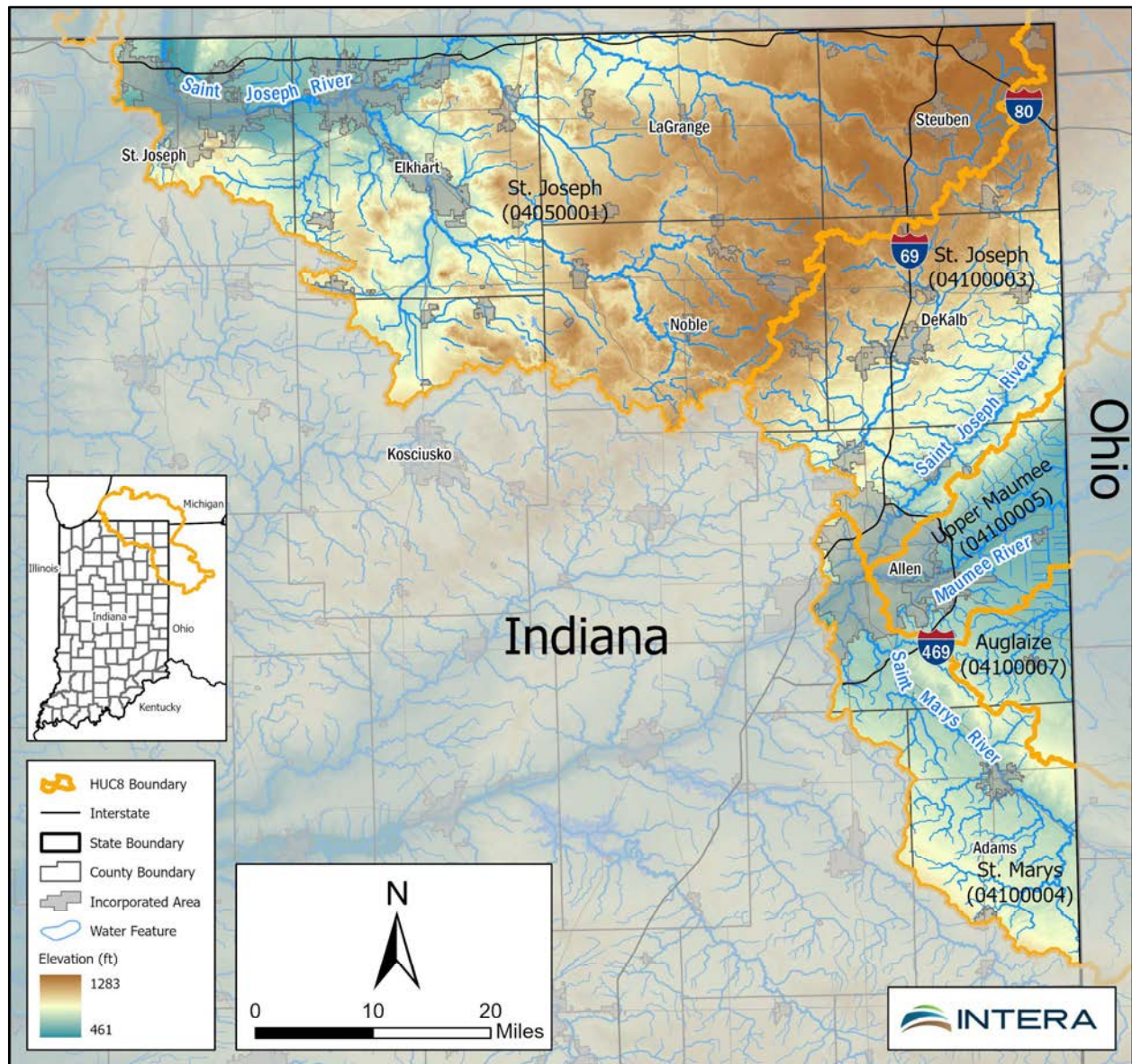


Figure 2. Counties in the Northeast Indiana Region.

1.3 Regional Overview

The Northeast Indiana Region encompasses a diverse hydrologic setting characterized by contrasting land use, population distribution, and water withdrawal patterns across the basin. These differences influence where water demand is concentrated, what water sources are used, and where future water-resource challenges may emerge.

Water demand and availability are influenced by the interaction of urban development, agricultural production, and the underlying hydrogeologic framework. Groundwater derived from unconsolidated

aquifer systems is the primary source of supply for most communities and agricultural users across the Region; however, the Region's largest municipal water system, the City of Fort Wayne, relies primarily on surface water from the St. Joseph River (Maumee Basin), supplemented by reservoir storage, reflecting the diversity of supply strategies within the Region.

Together, these regional characteristics provide the physical and socioeconomic context needed to understand the water-demand and water-availability analyses presented in later chapters.

1.3.1 Population Centers

Population centers within the Region are concentrated primarily within incorporated areas distributed across the basins, with the highest densities occurring in the South Bend–Elkhart corridor and the Fort Wayne metropolitan area (**Figure 3; Table 1**). These urbanized areas represent the dominant hubs of municipal, industrial, and commercial activity and correspond to the Region's highest water demand.

The South Bend–Elkhart corridor, located within the St. Joseph River Basin, forms a continuous band of urban and suburban development extending into southern Michigan. This area includes the cities of South Bend, Mishawaka, and Elkhart along with surrounding communities. The concentration of incorporated areas in this Region reflects both historical industrial development and proximity to major transportation corridors, including Interstate 80/90. Surface water and groundwater resources in this portion of the basin are integrated through numerous lakes, streams, and connected aquifer systems supporting municipal supply.

The Fort Wayne metropolitan area, located in the southeastern portion of the Region within the Maumee River Basin, represents the single largest population center in the Region. Fort Wayne and its surrounding incorporated areas form a dense cluster of development near the confluence of the St. Joseph (Maumee Basin), St. Marys, and Maumee Rivers. This area serves as a major regional economic center and is associated with substantial surface water withdrawals.

Outside of these primary urban centers, incorporated areas are more sparsely distributed throughout the basin and are generally associated with smaller municipalities, town centers, and transportation corridors. These smaller population centers are typically surrounded by agricultural land and rely predominantly on groundwater for public water supply. While individually smaller in demand, these communities collectively contribute to regional water withdrawal and may exert localized stress on aquifer systems, particularly where high-capacity wells are concentrated.

The spatial distribution of population centers highlights the contrast between densely developed urban corridors and predominantly rural areas within the Northeast Indiana Region. This distribution is an important consideration for evaluating regional water demand, infrastructure needs, and the sustainability of both groundwater and surface water resources.

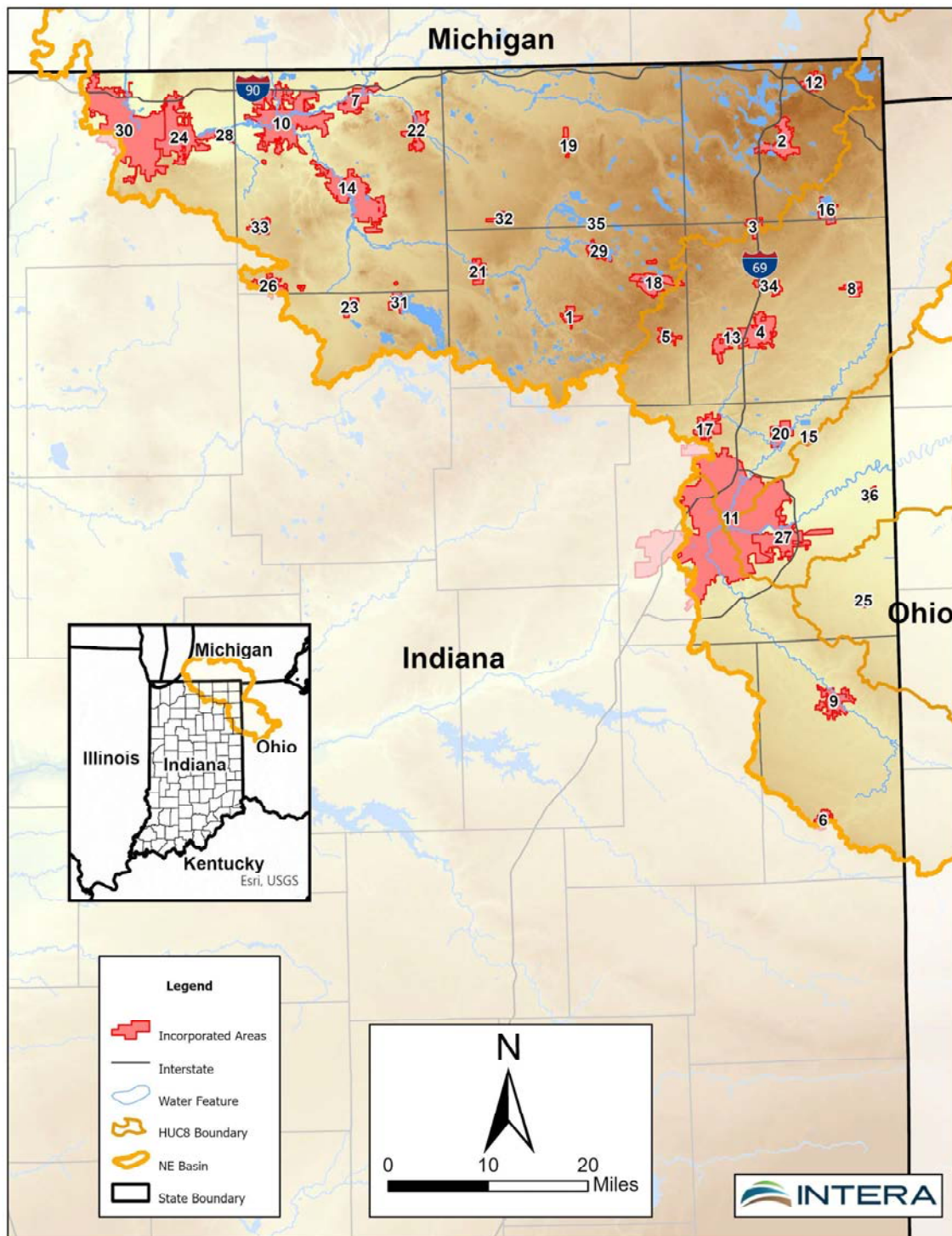


Figure 3. Population centers in the Northeast Indiana Region. Numbers correspond to identifying information in Table 1.

Table 1. Population centers in the Northeast Indiana Region with 2020 population greater than 1,000.

No.	Name of Incorporated Area	2020 Population	Area (Square Miles)	Population Density (People/Square Mile)
1	Albion	2,222	1.89	1,173
2	Angola	9,340	6.63	1,408
3	Ashley	1,026	1.89	542
4	Auburn	13,412	8.09	1,658
5	Avilla	2,438	1.69	1,445
6	Berne	4,173	2.34	1,780
7	Bristol	1,789	4.62	387
8	Butler	2,635	2.03	1,299
9	Decatur	9,913	6.12	1,619
10	Elkhart	53,923	28.90	1,866
11	Fort Wayne	263,886	110.98	2,378
12	Fremont	2,034	3.11	654
13	Garrett	6,542	4.16	1,574
14	Goshen	34,517	18.20	1,897
15	Grabill	1,112	0.65	1,700
16	Hamilton	1,529	3.02	506
17	Huntertown	9,141	7.88	1,161
18	Kendallville	10,271	6.21	1,654
19	LaGrange	2,715	1.76	1,544
20	Leo-Cedarville	3,624	3.86	940
21	Ligonier	4,568	2.80	1,633
22	Middlebury	3,466	4.60	754
23	Milford	1,614	1.52	1,061
24	Mishawaka	51,063	17.01	3,002
25	Monroeville	1,294	0.78	1,665
26	Nappanee	6,949	4.92	1,413
27	New Haven	15,583	12.75	1,222
28	Osceola	2,590	1.35	1,919
29	Rome City	1,322	2.46	537
30	South Bend	103,453	41.57	2,489
31	Syracuse	3,079	2.49	1,236
32	Topeka	1,206	1.61	748
33	Wakarusa	1,998	2.28	876
34	Waterloo	2,116	2.12	998
35	Wolcottville	1,004	1.05	959
36	Woodburn	1,551	1.03	1,512

1.3.2 Climate

The Northeast Indiana Region is characterized by a humid continental climate with warm Summers, cold Winters, and precipitation distributed relatively evenly throughout the year, with slightly higher totals during the warmer months. Climatic conditions in the Region are influenced by cold, dry air masses from the Arctic in Winter and warm, humid air masses from the Gulf of Mexico in Summer (National Oceanic and Atmospheric Administration [NOAA], 2022). Proximity to Lake Michigan further moderates temperatures in the northern portion of the Region, producing cooler Summers and warmer Winters, and enhances precipitation within the St. Joseph River Basin: annual snowfall near South Bend exceeds 70 inches and accounts for nearly 20 percent of average annual precipitation there, compared with less than 10 percent elsewhere in the basin (Indiana Department of Natural Resources [IDNR], 1987; NOAA, 2022).

Seasonal variability in temperature and precipitation plays a key role in controlling hydrologic processes, including evapotranspiration, groundwater recharge, streamflow variability, and surface water storage (Winter et al., 1998). Winter conditions can reduce groundwater recharge where frozen ground limits infiltration, though this effect is variable and depends on the timing and sequencing of freeze-thaw cycles and snowmelt events. Spring represents the primary period of groundwater recharge and elevated streamflow, driven by snowmelt and rainfall under low evapotranspiration conditions. As temperatures rise into Summer, increasing evapotranspiration progressively reduces net recharge despite continued precipitation.

1.3.2.1 Temperature

Mean (average) annual temperatures in the Region are approximately 48 to 51 degrees Fahrenheit (°F), with seasonal variation typical of the Midwest (NOAA, 2021). Winters are cold, with average temperatures in January generally ranging from the low 20s to low 30s°F, while Summers are warm and humid, with average July temperatures typically ranging from the mid-70s to low 80s°F (NOAA, 2021).

Temperature patterns influence both surface water and groundwater systems. During Winter months, frozen ground conditions limit infiltration and recharge, while snow accumulation contributes to delayed runoff during Spring thaw. In contrast, higher temperatures during the growing season increase evapotranspiration rates, which can reduce effective recharge despite higher precipitation.

Local variability in temperature may occur due to land cover, urbanization, and proximity to surface water bodies. Urban areas such as Fort Wayne and the South Bend–Elkhart corridor may experience slightly elevated temperatures relative to surrounding rural areas due to urban heat island effects.

1.3.2.2 Precipitation

Precipitation is the primary driver of both groundwater recharge and surface water flow in the Region. The timing, intensity, and seasonal distribution of precipitation directly influence streamflow patterns, lake levels, and aquifer recharge rates (Winter et al., 1998).

Average annual precipitation in the Region ranges from approximately 37 to 43 inches, with comparable totals across the Maumee and St. Joseph River Basins (NOAA, 2021). Lake Michigan's influence on the northern portion of the St. Joseph River Basin is most evident in snowfall rather than total precipitation:

normal annual snowfall near South Bend is roughly double that at Fort Wayne, driven by cold air passing over the warmer waters of the lake, causing some lake water to evaporate into the air. When the air cools, that moisture precipitates back to the ground in a process called lake-effect snow (NOAA, 2021; IDNR, 1987). Seasonal precipitation timing also differs between the basins: in the Maumee River Basin, totals peak in late Spring and early Summer and are lowest in Winter, while in the northern St. Joseph River Basin, lake-enhanced Winter snowfall makes Winter and early Spring the wettest seasons with Fall being the driest (NOAA, 2021).

Precipitation occurs as rainfall during warmer months and as snowfall during Winter. Snowfall can contribute to seasonal water storage and melt events in late Winter, and early Spring are generally understood to be an important source of groundwater recharge and runoff in this climate setting. Rainfall intensity and duration vary throughout the year, and convective thunderstorms during Summer can produce short-duration, high-intensity precipitation events.

1.3.2.3 Flooding

Flooding plays an important role in the regional hydrologic system, contributing to groundwater recharge in some areas while also posing risks to infrastructure, water quality, and land use. Understanding flood dynamics is therefore critical for water resource management, infrastructure planning, and hazard mitigation within the Region. The Region's relatively low-relief topography, abundant surface water features, and glacially derived soils contribute to variable runoff responses across the basin (Fenelon et al., 1994; IDNR, 1996). Areas with poorly drained soils, shallow water tables, or extensive wetland and lake systems may experience prolonged periods of elevated water levels following precipitation events (IDNR, 1996).

Flooding within the Region is primarily associated with seasonal precipitation patterns, snowmelt, and high-intensity rainfall events. Flooding most commonly occurs during late Winter and Spring, when snowmelt combined with rainfall can produce elevated runoff and increased streamflow. Additional flooding events may occur during Summer due to localized, high-intensity storm events (NOAA, 2022). Riverine flooding is most prominent along major waterways, including the St. Joseph River and the Maumee River and their tributaries. In urban areas such as Fort Wayne and South Bend, flooding risks may be exacerbated by impervious surfaces, stormwater infrastructure limitations, and altered drainage patterns (Indiana Department of Environmental Management [IDEM], 2007).

Collectively, these climatic patterns influence groundwater recharge, streamflow, irrigation demand, and seasonal water availability, making climate a key driver of both current and future water-resource conditions evaluated in this study.

1.3.3 High-Capacity Water Users

The Region is characterized by many Significant Water Withdrawal Facilities (SWWFs), also referred to in this report as high-capacity water users (**Figure 4**). Significant water withdrawal facilities are those that withdraw 100,000 gallons or more per day from either groundwater or surface water sources and are required to report their withdrawals to the IDNR. Because these facilities represent the vast majority of water withdrawals in the state, they provide the primary dataset used to characterize regional water demand. Each registered facility may have multiple withdrawal sites. A total of 1,272 SWWF withdrawal sites is recorded within the Northeast Indiana Region, comprising 1,153 groundwater wells and 119 surface water intakes (**Table 2**) with active withdrawals in 2023. While the number of withdrawal sites does not necessarily correspond to water withdrawals, it does provide insight into the type of water sources that are used and by which water sectors. For example, groundwater facilities account for most registered facilities across all use sectors, reflecting the Region's reliance on productive unconsolidated aquifer systems. Surface water intakes, while fewer in number, represent important withdrawal points primarily associated with irrigation and industrial uses in the St. Joseph River Basin.

Irrigation is the dominant use category by withdrawal-site count across both source types, with 738 groundwater irrigation wells and 93 surface water irrigation intakes active in 2023, totaling 831 sites (**Table 2**). Irrigation facilities are concentrated predominantly in the western and northern portions of the St. Joseph River Basin, where permeable outwash soils and accessible surface water support intensive agricultural water withdrawal. The Maumee River Basin contains comparatively fewer irrigation registrations, consistent with its more extensive tile-drained agricultural landscape and greater reliance on natural precipitation for crop production.

Public supply represents the second largest groundwater withdrawal category, with 239 groundwater wells actively serving municipal and community water systems across the Region in 2023 (**Table 2**). In contrast, only three public supply surface water intakes are registered within the Region, reflecting the limited use of surface water for municipal supply outside of the City of Fort Wayne, which relies on the St. Joseph River (Maumee Basin) as its primary source. The distribution of public supply groundwater wells spans both basins, with concentrations near urban centers including Fort Wayne, South Bend, Elkhart, and Angola.

Industrial facilities account for 98 groundwater wells and 18 surface water intakes active in 2023, with withdrawal sites distributed across both basins, reflecting the broader geographic distribution of manufacturing and processing operations in the Region. Energy production facilities include 8 groundwater wells and 2 surface water intakes active in 2023, with groundwater-dependent energy production facilities notably concentrated in the central portion of the St. Joseph River Basin. Miscellaneous uses account for 52 groundwater wells and 2 surface water intakes, while rural domestic use represents 18 groundwater wells and one surface water intake.

The preponderance of groundwater withdrawal facilities relative to surface water intakes in the Region, nearly 90%, underscores the importance of local aquifer systems in meeting regional water demand. The concentration of high-capacity withdrawals in the St. Joseph River Basin reflects both greater agricultural and municipal water demand and the presence of abundant groundwater and surface-water

resources capable of supporting large withdrawals. These patterns establish the regional framework for understanding historical withdrawals and future demand presented in **Section 2**.

Table 2. High-capacity water withdrawal locations by sector and source, active in 2023.

Sector	Groundwater Wells	Surface Water Intakes	Total
Irrigation	738	93	831
Public Supply	239	3	242
Industry	98	18	116
Energy Production	8	2	10
Miscellaneous	52	2	54
Rural Use	18	1	19
Total	1153	119	1272

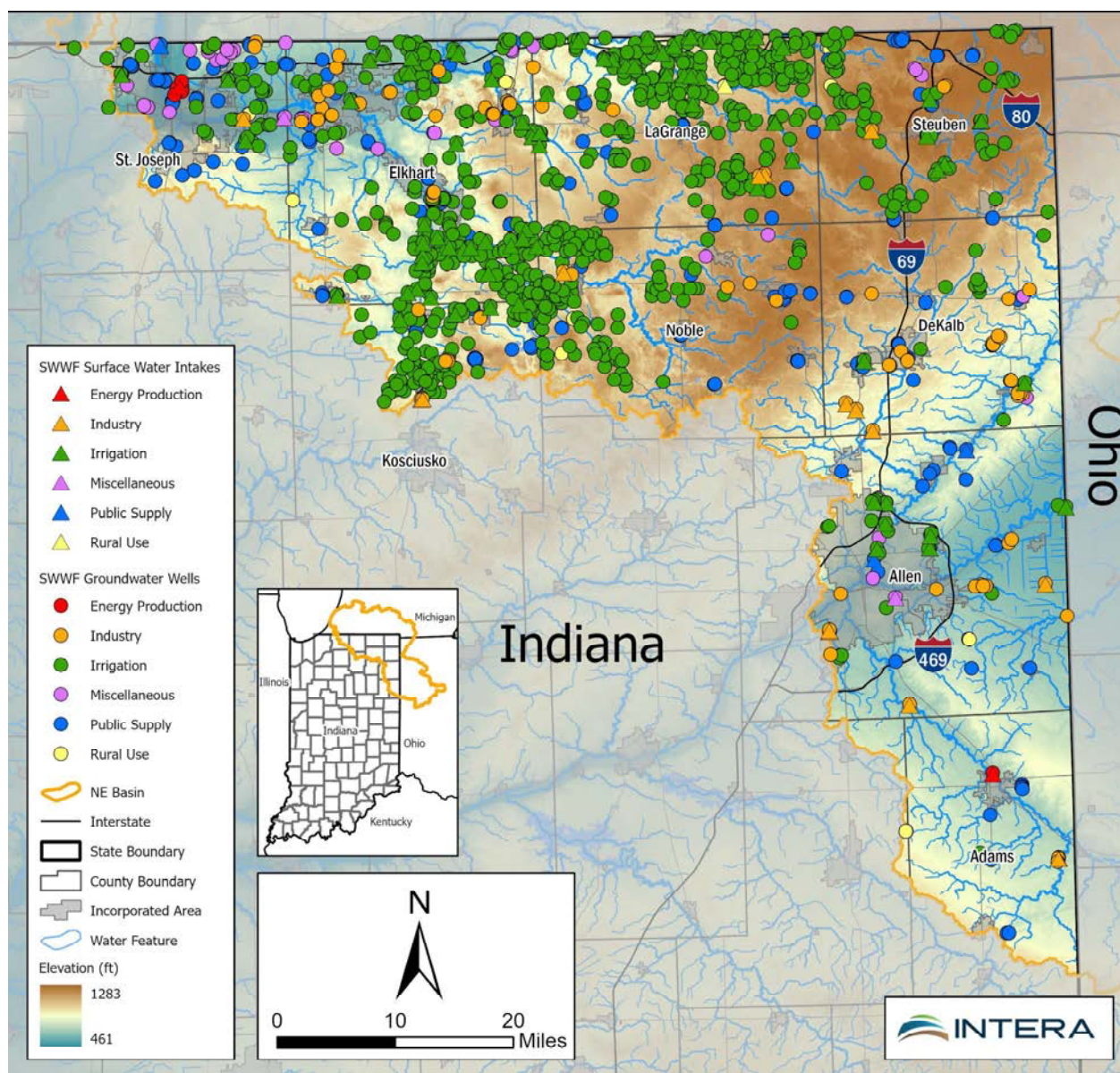


Figure 4. Locations of high-capacity water withdrawals within the Northeast Indiana Region. Figure shows groundwater wells and surface water intakes active in 2023.

1.3.4 Public Water Utilities

Public water supply within the Region is provided by a network of 76 municipal and community water utilities distributed throughout the Northeast Indiana Region (**Figure 5, Table 3**). These utilities collectively serve over 650,000 people across service areas ranging from less than 0.1 square mile for small community associations to more than 199 square miles for the Fort Wayne City Utilities system.

The regional water supply landscape is dominated by a small number of large urban systems. Fort Wayne City Utilities is the largest single utility in the Region, serving approximately 270,000 people (over 40% of the population served by utilities) across a 199 square-mile service area and representing the only large municipal system that relies on surface water, drawing from the St. Joseph River (Maumee Basin) via the Three Rivers Filtration Plant. The South Bend–Elkhart corridor collectively serves more than 210,000 people (over 30% of the population served by utilities) across three adjacent groundwater-based systems, with South Bend Water Works (115,000), Mishawaka Utilities (49,675), and Elkhart Public Works and Utilities (46,455) representing the largest groundwater utilities in the Region. Goshen Water Utility is another major groundwater-based public water system, serving approximately 32,000 people from groundwater sources.

Outside of these urban centers, the remaining utilities serve individual municipalities, towns, and rural service districts. These systems operate largely independently and rely on localized groundwater supplies from unconsolidated aquifers. Huntertown Water Works (14,058), New Haven Water Department (15,700), and Kendallville Water Department (10,300) represent the larger of these secondary systems. **Table 3** shows the 39 utilities that serve over 1,000 people. An additional 37 are smaller community systems that serve fewer than 1,000 people each.

Of the 76 utilities inventoried, 72 rely exclusively on groundwater as their primary supply source, reflecting the Region's dependence on productive unconsolidated aquifer systems. Only one utility, Fort Wayne City Utilities, produces surface water in the Region. They sell water to four other utilities; Grabill Water Works, New Haven Water Department, Maysville Regional Water and Sewer District, and Sunnymede Community Association. The predominance of groundwater-based supply across all but the largest urban systems underscores the central role of unconsolidated glacial aquifers in sustaining public water supply throughout the Region.

The distribution of public water utilities reflects a clear contrast between large, centralized systems in the Fort Wayne and South Bend–Elkhart metropolitan areas and the smaller, decentralized systems serving the remainder of the basin. This structural pattern has direct implications for regional water demand, infrastructure resilience, drought response, interconnections between systems, and long-term water supply planning.

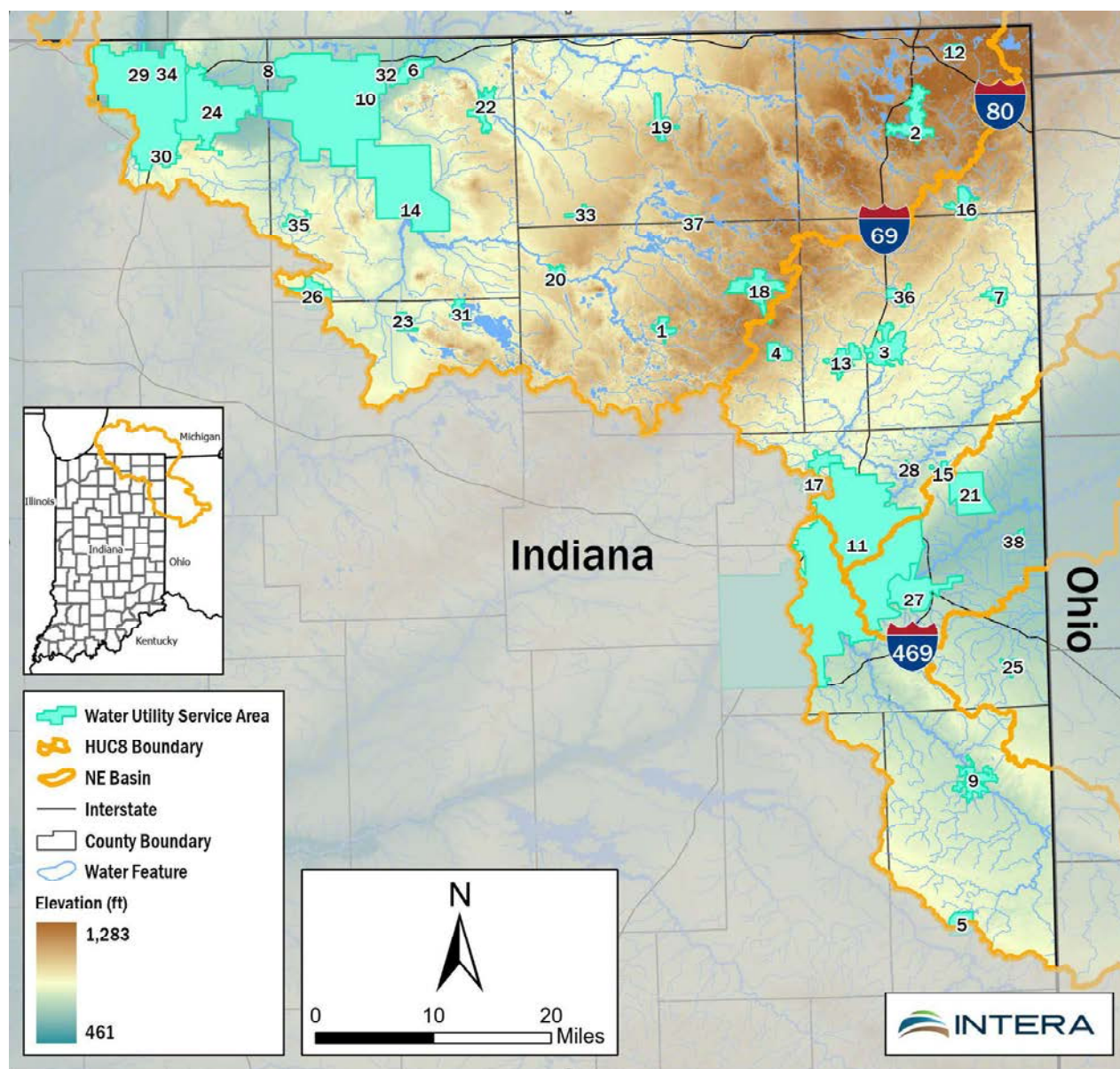


Figure 5. Water utility service areas in the Northeast Indiana Region. Numbers correspond to identifying information in Table 3.

Table 3. Public water utilities that serve over 1,000 people in the Northeast Indiana Region.

No.	Utility Name	Area (square miles)	Population Served	Density (people/ square mile)	Towns/Places Served	Source Type
1	Albion Water & Sewer	2.14	2,349	1096	Albion	GW
2	Angola Water Department	7.45	9,340	1254	Angola	GW
3	Auburn Water Department	12.08	12,800	1060	Auburn	GW
4	Avilla Water Department	2.84	2,700	951	Avilla	GW
5	Berne Water Department	3.69	4,388	1189	Berne	GW
6	Bristol Water Department	4.93	1,805	366	Bristol	GW
7	Butler Water Department	2.10	2,700	1287	Butler	GW
8	Churubusco Water Department	1.30	1,803	1389	Churubusco	GW
9	Cobus Green Mobile Home Park	0.13	1,042	7989	Osceola	GW
10	Decatur Water Department	6.09	9,900	1626	Decatur	GW
11	Elkhart Public Works and Utilities	64.65	46,455	719	Elkhart	GW
12	Fort Wayne City Utilities	199.77	269,994	1352	Fort Wayne	SW
13	Fremont Water Department	2.36	2,138	904	Fremont	GW
14	Garrett Water Utility	4.51	6,390	1416	Garrett	GW
15	Goshen Water Utility	21.51	32,267	1500	Goshen	GW
16	Grabill Water Works	1.78	1,163	654	Grabill	SW*
17	Hamilton Water Department	3.70	2,675	723	Hamilton	GW
18	Huntertown Water Works	9.53	14,058	1475	Huntertown	GW
19	Kendallville Water Department	8.53	10,300	1208	Kendallville	GW
20	Lagrange Department of Water Works	3.56	2,625	737	Lagrange	GW
21	Ligonier Water Works	3.06	4,405	1440	Ligonier	GW
22	Maysville Region. Water & Sewer District	3.65	1,634	447	Harlan	SW*
23	Middlebury Water Department	4.98	3,420	686	Middlebury	GW
24	Milford Water Department	1.66	1,556	938	Milford	GW
25	Mishawaka Utilities	28.65	49,675	1734	Mishawaka	GW
26	Monroeville, Town of	1.34	1,400	1043	Monroeville	GW
27	Nappanee Water Utility	7.07	6,800	962	Nappanee	GW
28	New Haven Water Department	15.12	15,700	1038	New Haven	SW*
29	Pioneer Water L.L.C.	0.95	2,076	2195	Leo	GW
30	Sisters of Holy Cross - St. Mary's College	0.22	2,111	9453	University	GW
31	South Bend Water Works	63.78	115,000	1803	South Bend	GW
32	Syracuse Water Company	2.21	2,810	1269	Syracuse	GW
33	Timberbrook Mobile Home Park	0.19	1,418	7664	Bristol	GW
34	Topeka Water Department	1.73	1,178	680	Topeka	GW

No.	Utility Name	Area (square miles)	Population Served	Density (people/square mile)	Towns/Places Served	Source Type
35	University of Notre Dame	1.50	7,400	4944	University	GW
36	Wakarusa Water Works	2.36	1,998	847	Wakarusa	GW
37	Waterloo Water Works	2.21	2,242	1013	Waterloo	GW
38	Wolcottville Water Works	1.09	1,035	946	Wolcottville	GW
39	Woodburn Water Utility	2.93	1,609	549	Woodburn	GW
* = Water is purchased from another public utility; GW = Groundwater; SW = Surface Water						

1.3.5 Industry and Agriculture

Economic activity within the Region reflects a mix of industrial development and intensive agricultural production. Urban areas such as Fort Wayne and the South Bend–Elkhart corridor support manufacturing and commercial activity, while the surrounding rural landscape is dominated by row crop agriculture and livestock operations.

Water withdrawals across these sectors vary based on land use, infrastructure, and resource availability. At the national scale, water withdrawals are dominated by a small number of sectors, primarily irrigation, thermoelectric power, and public supply, which together account for approximately 90 percent of total water withdrawals (Medalie et al., 2025). The regional conditions in northeastern Indiana generally mirror the national patterns, where agriculture, municipal supply, and industrial uses represent the primary drivers of demand.

1.3.5.1 Cultivated Crops and Animal Agriculture

Agriculture is the predominant land use across much of the Region and is the principal driver of water withdrawals and water-resource management. Row crop production, dominated by corn and soybeans, along with dairy, swine, and poultry operations, characterizes much of the agricultural landscape. These land-use patterns play an important role in shaping irrigation demand, groundwater withdrawals, runoff, and water quality.

Agricultural water withdrawal is primarily associated with irrigation, livestock watering, and facility operations. Although irrigation demand in Indiana is lower than in arid regions, it remains an important component of water use, particularly during periods of below-average precipitation.

Within Indiana, irrigated agriculture is concentrated in areas with permeable soils and productive aquifers, including portions of the St. Joseph River Basin, where irrigation development has historically been significant (Peters and Renn, 1988). Livestock water withdrawal is comparatively small but consistent, representing a steady demand that is primarily met through groundwater sources (Dieter et al., 2018).

Agricultural practices influence both water quantity and water quality. Irrigation withdrawals, nutrient application, and land management practices affect recharge rates, runoff, and water quality conditions in both surface water and groundwater systems.

1.3.6 Power Generation

Power generation within the Region is limited compared to other parts of Indiana, particularly those with large coal-fired power plants. Existing facilities within the Region are primarily natural gas or smaller-scale generation units, which contribute only a small portion of the Region's overall water demands.

At the national level, thermoelectric power generation is one of the largest water-use sectors, accounting for approximately 30 percent of total water withdrawals during 2010–2020, largely due to cooling water requirements (Medalie et al., 2025). However, consumptive use for thermoelectric power is comparatively low, averaging approximately four percent of freshwater withdrawals, because most water withdrawn for cooling is discharged back to the source after use (Medalie et al., 2025). The shift in powerplant infrastructure from once-through cooling systems toward recirculating cooling systems has contributed to a decline in thermoelectric withdrawals over the 2010–2020 period, even as the proportion of water consumed relative to withdrawals has increased (Medalie et al., 2025).

Power generation within the Region is primarily associated with natural gas combined-cycle facilities using recirculating cooling systems, which have substantially lower withdrawal volumes than large once-through coal plants. As a result, thermoelectric water withdrawal represents a relatively modest component of total regional water demand compared to other sectors.

1.3.7 Land Cover

Land cover within the Region is dominated by agricultural land uses, with cultivated crops representing approximately 54 percent of the Region based on the 2021 National Land Cover Database (NLCD; Dewitz, 2023) (**Figure 6**). Combined with hay and pasture (nine percent), agricultural land comprises more than 60 percent of the Region.

Developed land comprises approximately 12 percent of the Region and is concentrated within the South Bend–Elkhart corridor in the northwest and the Fort Wayne metropolitan area in the southeast. These areas include a mix of low-, medium-, and high-intensity residential, commercial, and industrial land uses. Outside of these urban centers, development is more dispersed and generally limited to low-intensity residential and rural uses.

Forested land cover is relatively limited, accounting for approximately 6 percent of the Region and occurring primarily as scattered patches of deciduous forest. Wetlands, including woody wetlands and emergent herbaceous wetlands, comprise approximately 10 percent of the Region and are typically associated with low-lying areas, glacial depressions, and river corridors.

Open water features, including lakes and reservoirs, account for approximately two percent of the basin and are more prevalent in the northern portion of the Region within the St. Joseph River Basin. This distribution reflects the glacial history of northeastern Indiana, which created numerous natural lakes and depressional features. In contrast, the Maumee River Basin is characterized by fewer lakes and a more drainage-oriented landscape.

Overall, land cover within the Northeast Indiana Region reflects a predominantly agricultural system with concentrated urban development and limited natural land cover. This distribution is consistent with

patterns observed across northern Indiana and has important implications for hydrology, including enhanced surface runoff in developed areas, widespread but diffuse recharge across agricultural lands, and the role of wetlands and surface-water features in moderating flow, storing water, and supporting ecological function.

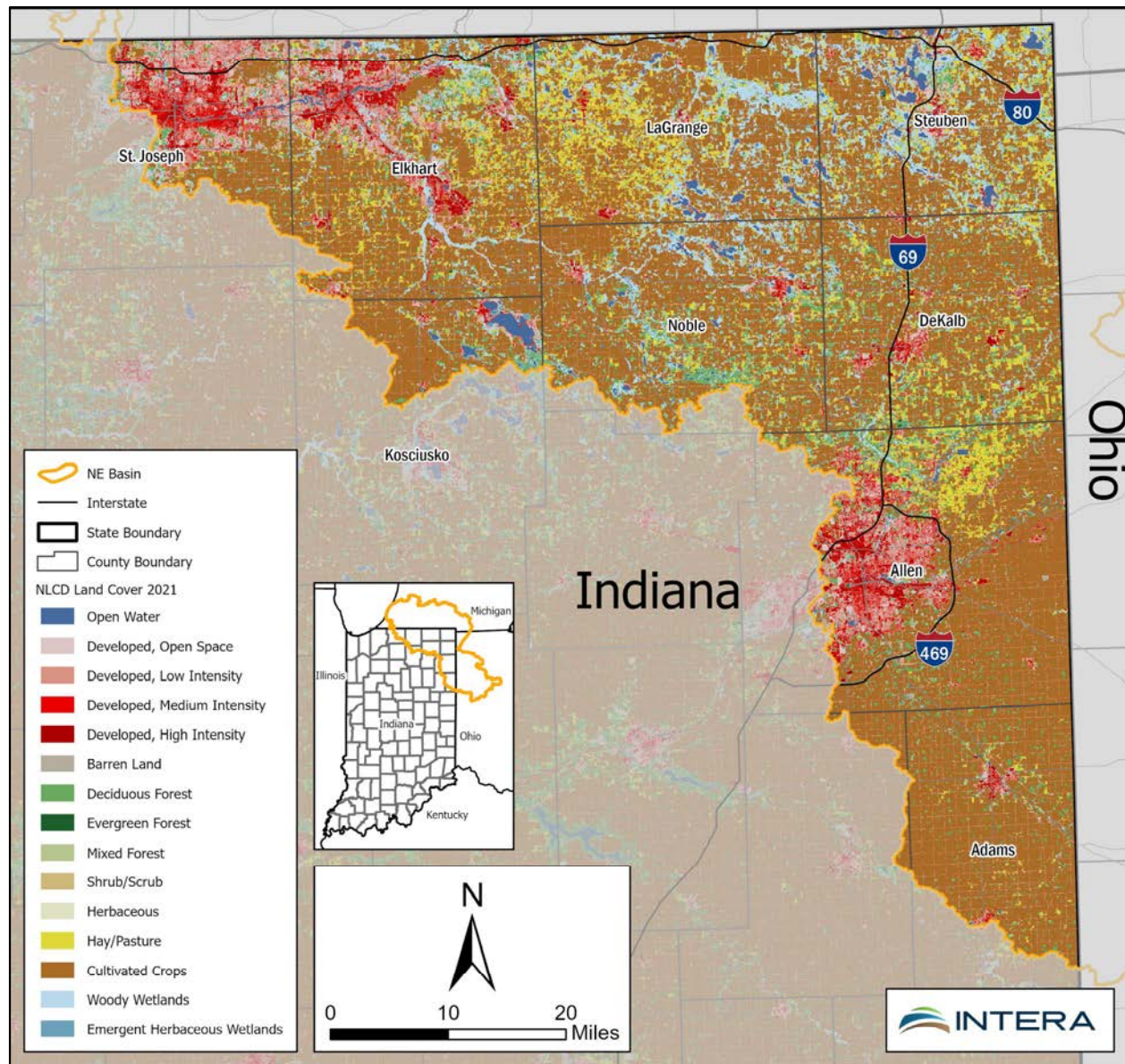


Figure 6. Land cover within the Northeast Indiana Region based on the 2021 National Land Cover Database (Dewitz, 2023).

1.3.8 Tile Drains

Agricultural tile drainage, the practice of installing subsurface drains to remove excess soil water, is among the most significant human modifications to the hydrologic system within the Northeast Indiana Region and is a defining characteristic of the regional landscape. As shown in **Figure 7**, tile drainage is extensive across both the St. Joseph and Maumee River Basins, though its distribution is spatially variable and reflects the underlying pattern of glacial deposits, soil drainage characteristics, and land use across the Region.

Indiana has the highest percentage of tile-drained cropland in the nation, with approximately 35 percent of cropland under subsurface drainage, covering more than 8 million acres statewide (Nakagaki and Wieczorek, 2016; Frankenberger and Kladvko, n.d.). The Region reflects and, in some counties, exceeds this statewide pattern. Tile drainage coverage is most intensive and nearly continuous across the Maumee River Basin, particularly in Adams, Jay, Wells, and Allen counties along the Ohio border, where the flat lacustrine plains and poorly drained glacial till of the former “Great Black Swamp” have been systematically drained since the late nineteenth century (IDNR, 1996). In contrast, tile drainage in the St. Joseph River Basin is more spatially fragmented, interrupted by morainal uplands, outwash plains, and the lake and wetland districts of LaGrange and Steuben counties in the northeast, where coarser and more permeable surficial materials provide natural drainage and reduce the need for artificial drainage systems.

The installation of tile drainage systems began with the drainage of the “Great Black Swamp” in the nineteenth century and continued through modern perforated plastic pipe installations. Tile drainage has fundamentally altered the water balance of the Region. Tile drainage lowers water tables to reduce waterlogging of root zones and accelerates the removal of excess soil water following precipitation events. At the watershed scale, these effects increase baseflow contributions to streams, decrease shallow groundwater travel times, reduce surface runoff, increase peak flows, and increase total annual water yield from the landscape (Valayamkunnath et al., 2022).

A large percent of tile drains, as well as surface drainage features in the Region are regulated drains. County Drainage Boards hold regulatory authority over regulated drains. Maintenance and reconstruction of regulated drains are funded through assessments of parcels within a drain’s watershed.

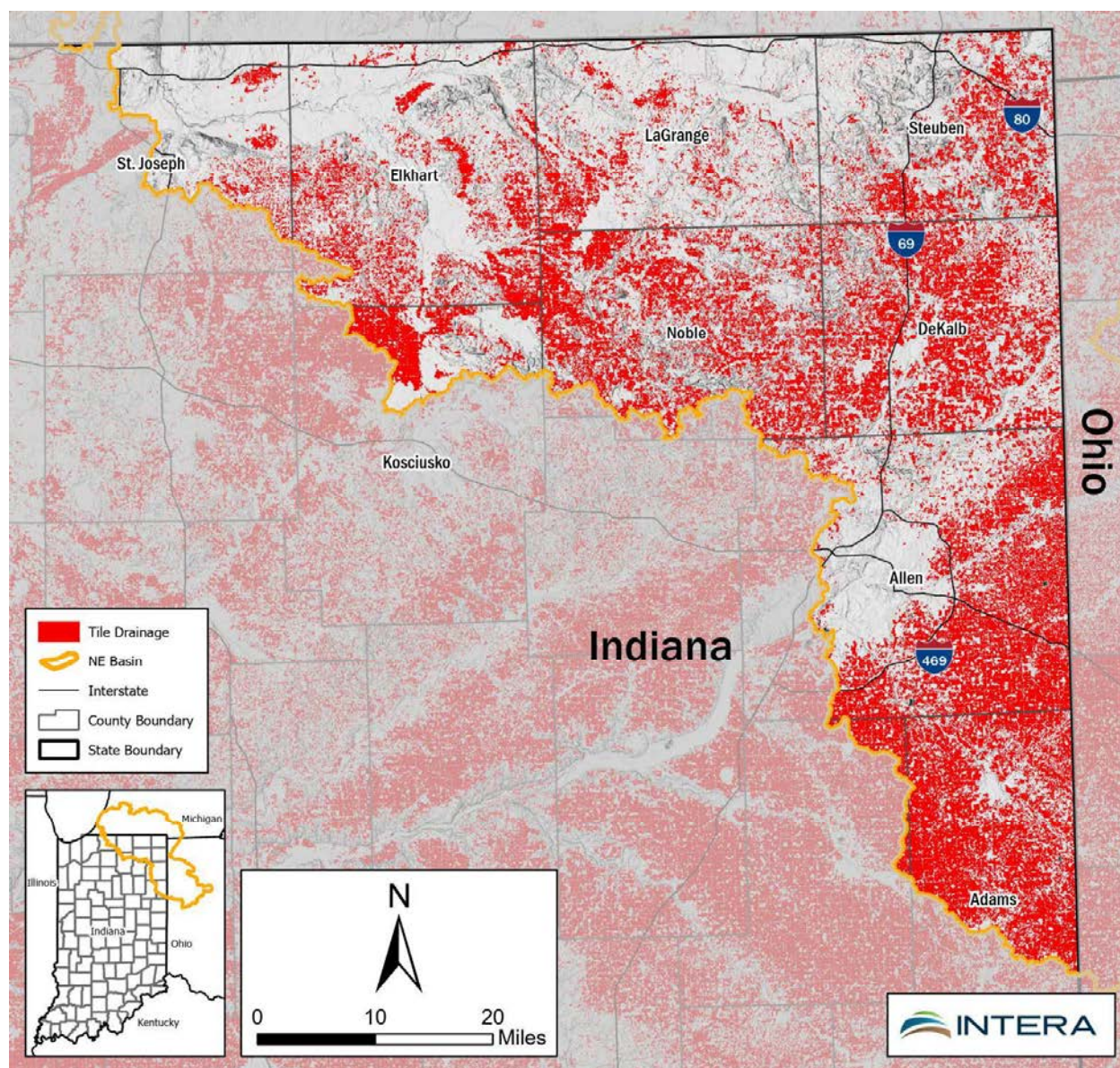


Figure 7. Extent of tile drainage in the Northeast Indiana Region (Valayamkunnath et al., 2020).

1.3.9 Geology

The St. Joseph and Maumee River Basins of the Northeast Indiana Region are underlain by a combination of unconsolidated glacial deposits and sedimentary bedrock that together control groundwater occurrence, movement, and availability. The geologic framework of the Region reflects Pleistocene glaciation, most recently during the Wisconsin stage, which reshaped the landscape and deposited a complex sequence of sediments overlying Paleozoic bedrock (Fenelon et al., 1994; IDNR, 1987; IDNR, 1996). The two basins differ in the character and thickness of their glacial deposits, reflecting the different glacial lobes and depositional histories that influenced each area. Unconsolidated glacial deposits host the most productive aquifers in the Region, while the underlying

Silurian and Devonian bedrock provides an additional but generally less productive source of groundwater. The hydrogeologic characteristics of these unconsolidated deposits and the underlying bedrock are described in the following subsections.

1.3.9.1 Unconsolidated Deposits

Unconsolidated deposits in the Northeast Indiana Region consist primarily of glacial sediments associated with Wisconsinan glaciation. These materials include till, glaciofluvial sand and gravel, lacustrine deposits, and discontinuous lenses of sand and gravel (Gray, 1989). The unconsolidated materials that form the principal aquifer systems within the Region are the primary source of groundwater for public, agricultural, and domestic use. The distribution and hydraulic properties of these deposits are highly variable due to the complex depositional environments associated with glacial advance and retreat across multiple lobes, including the Erie, Saginaw, and Huron-Erie Lobes (Fenelon and others, 1994; IDNR, 1996).

Unconsolidated deposits within the St. Joseph and Maumee River Basins vary substantially in thickness and composition, reflecting differences in deposition and underlying bedrock topography (**Figure 8**). The thickness of unconsolidated deposits varies widely across the Region, reflecting the influence of glacial deposition and preglacial topography, including buried bedrock valleys (Gray, 1989). In the St. Joseph River Basin, unconsolidated deposits are generally thicker and more laterally extensive, commonly ranging from approximately 100 to 500 feet thick, with the greatest extent occurring in outwash plains and buried bedrock valleys (IDNR, 1987; Fenelon et al., 1994). These deposits include extensive sand and gravel aquifers that support high-capacity groundwater production across much of the basin.

In contrast, the Maumee River Basin is characterized by thinner and more variable unconsolidated deposits, typically ranging from approximately 50 to 200 feet in thickness (Indiana Geological Survey [IGS], 2015) (**Figure 8**). Deposits in this basin are dominated by clay-rich till and lacustrine sediments, with sand and gravel aquifers generally occurring as discontinuous and localized lenses rather than laterally extensive units (IDNR, 1996; Fenelon et al., 1994). Locally, unconsolidated deposits in both basins may exceed 300 to 400 feet in thickness within buried bedrock valleys; however, these features are more regionally significant and hydraulically productive in the St. Joseph River Basin.

Overall, the St. Joseph River Basin supports more extensive and productive unconsolidated aquifer systems, while the Maumee River Basin contains more heterogeneous aquifer systems, with groundwater commonly occurring under confined conditions. These differences have important implications for groundwater availability, well yields, and regional water supply development across the Northeast Indiana Region and largely explain why high-capacity groundwater development has historically been concentrated in portions of the St. Joseph River Basin.

Glacial till is widespread throughout the Region and generally exhibits low permeability, limiting infiltration and restricting vertical groundwater movement. In contrast, stratified sand and gravel deposits formed by glacial meltwater represent the most productive aquifers and commonly occur along major drainageways and as outwash plains. Buried sand and gravel aquifers associated with glacially modified bedrock valleys are an important source of high-capacity groundwater supply where they are sufficiently thick and laterally continuous (IDNR, 1987; IDNR, 1996; Reussow and Rohne, 1975).

Fine-grained lacustrine deposits are present in areas formerly occupied by glacial lakes. In the Maumee River Basin, the Maumee Lacustrine Plain—a flat, nearly featureless former lake bottom occupying east-central Allen County—is a particularly significant lacustrine terrain that commonly acts as a confining unit restricting vertical groundwater movement (IDNR, 1996).

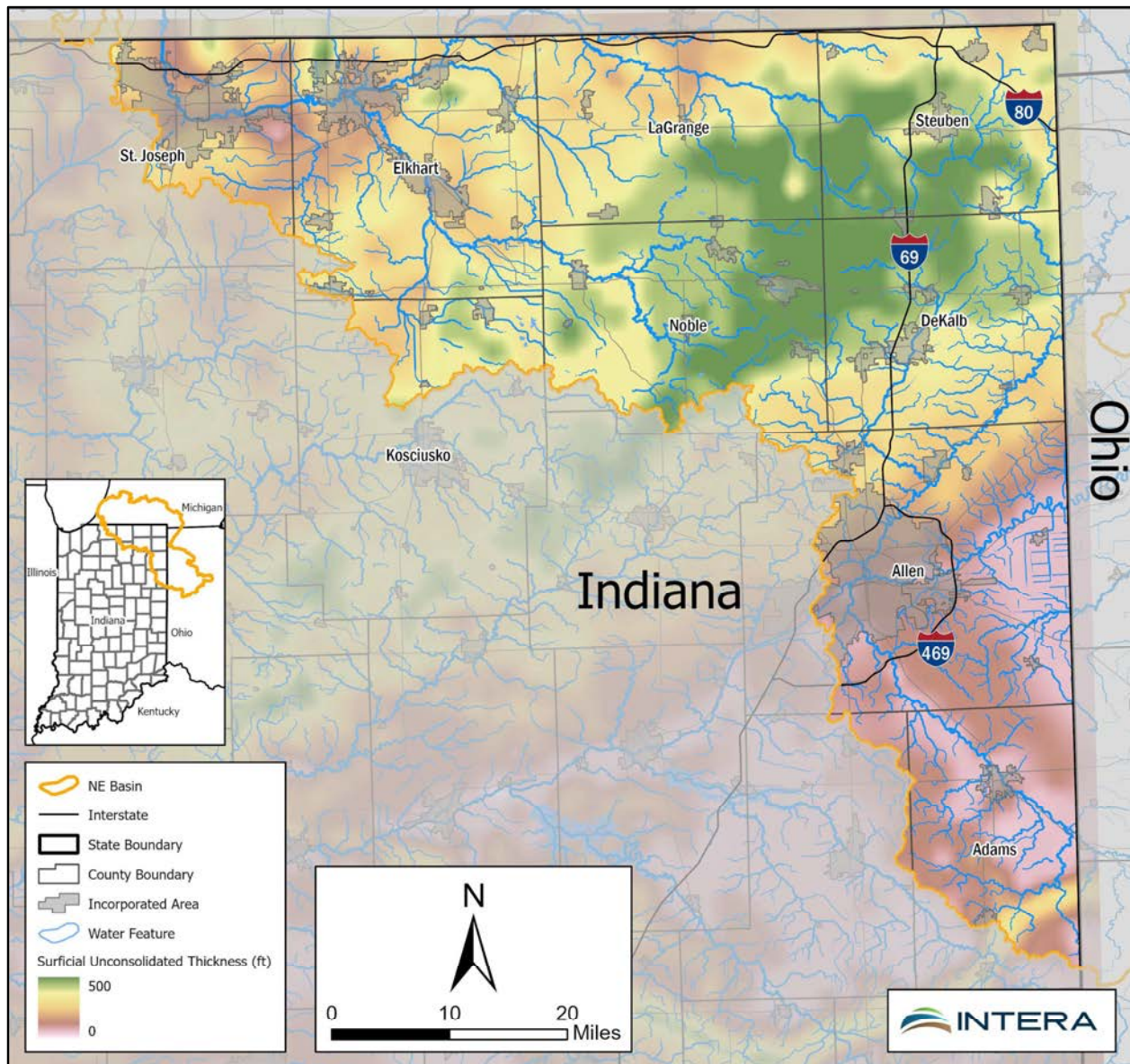


Figure 8. Thickness of the surficial unconsolidated deposits in the Northeast Indiana Region (IGS, 2015).

1.3.9.2 Bedrock

The Northeast Indiana Region is underlain primarily by sedimentary bedrock of Silurian and Devonian age (**Figure 9**). Carbonate rocks, consisting predominantly of limestone and dolostone, underlie much of the Region and form the principal bedrock aquifers. Silurian-age carbonate rocks are exposed at the bedrock surface across the southern portions of the Maumee River Basin and much of Adams County, while Devonian and Mississippian shale units become increasingly prevalent toward the north (Fenelon et al., 1994; IDNR, 1996).

The bedrock surface is irregular due to preglacial erosion and glacial modification, resulting in buried bedrock valleys that strongly influence the thickness and distribution of overlying unconsolidated deposits. Buried bedrock valleys are a primary control on the thickness and distribution of unconsolidated aquifers and, consequently, on groundwater availability across the Region (Gray, 1989; Fenelon et al., 1994; Thompson et al., 2016).

Groundwater flow within bedrock aquifers occurs primarily through secondary porosity features such as fractures, joints, and solution openings. As a result, bedrock wells generally produce lower and more variable yields than wells completed in unconsolidated sand and gravel aquifers. In the Maumee Basin, the most productive zones within the carbonate aquifer typically occur within the upper 100 feet of bedrock, with well yields commonly ranging from 100 to 500 gallons per minute in favorable locations (IDNR, 1996). Bedrock aquifers remain an important source of water where unconsolidated deposits are thin or lack productive sand and gravel units (IDNR, 1987, 1996).

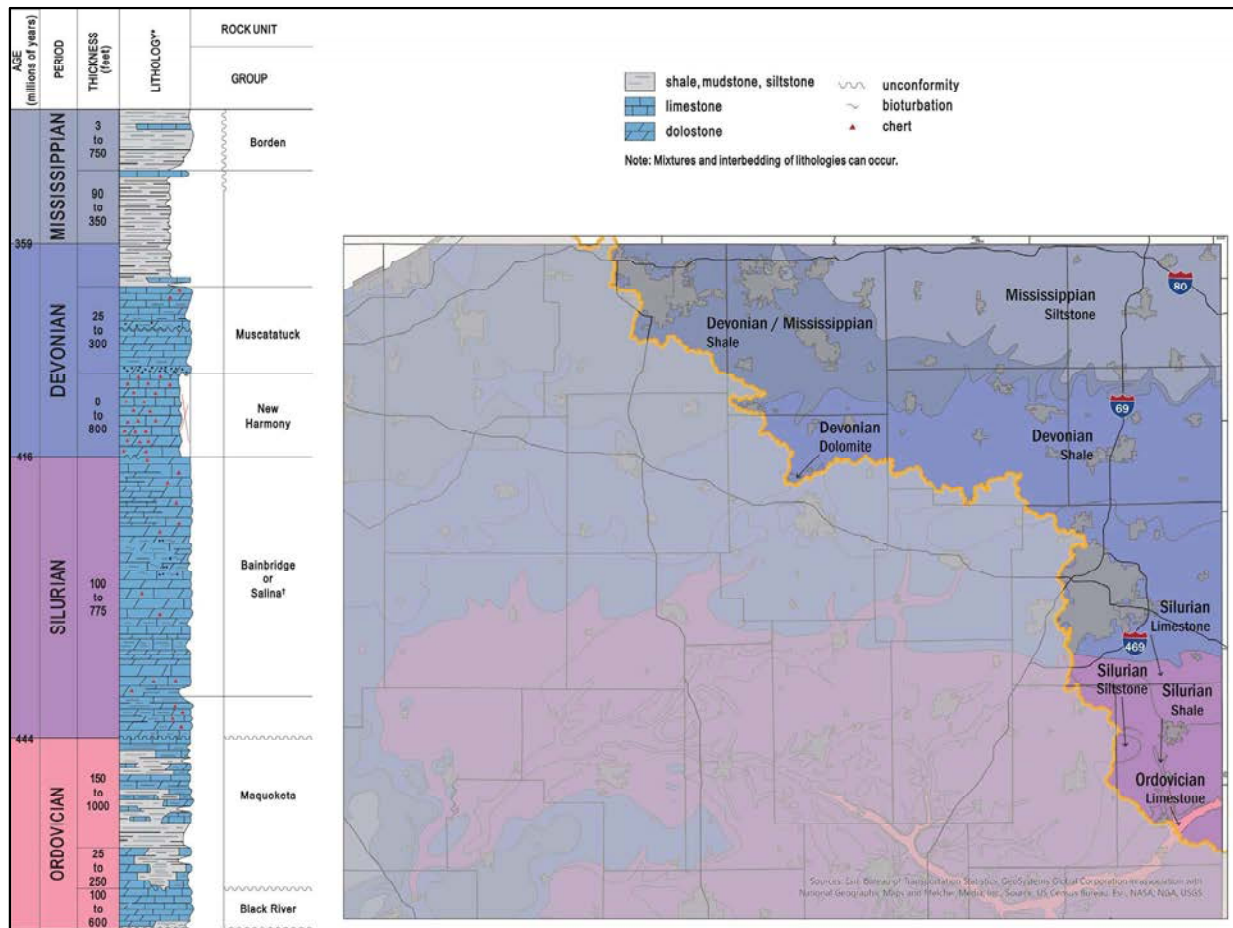


Figure 9. Bedrock geology of the Northeast Indiana Region. Generalized stratigraphic column (modified from Thompson et al., 2016).

1.3.10 Water Resources and Trends

Water resources within the St. Joseph and Maumee River Basins of the Northeast Indiana Region are derived from both surface water and groundwater systems that are closely interconnected. Surface water resources, including rivers, streams, and lakes, support a limited number of public water systems, while groundwater from unconsolidated and bedrock aquifers supplies most municipal, agricultural, industrial, and domestic water needs throughout the Region. The relative importance of each source varies spatially across the Region and is influenced by geologic conditions, infrastructure, and patterns of water demand (IDNR, 1987, 1996; Fenelon et al., 1994).

Surface water and groundwater systems in the Region are hydraulically linked, with baseflow contributions from aquifers sustaining streamflow during dry periods and surface-water bodies providing recharge to underlying aquifers in certain settings (Winter et al., 1998). This interaction is a defining characteristic of the hydrologic system in northeastern Indiana and is an important consideration for water resource management.

1.3.10.1 Aquifers

Groundwater resources within the Northeast Indiana Region are derived primarily from unconsolidated glacial aquifers, with additional contributions from underlying bedrock aquifers. Sand and gravel aquifers associated with glacial outwash and buried valley systems represent the most productive and widely utilized groundwater sources in the Region (Fenelon et al., 1994; IDNR, 1987, 1996).

These unconsolidated aquifers can yield significant quantities of water and are commonly used for public, agricultural, and industrial supply. Their productivity is influenced by factors such as deposit thickness, grain size, and hydraulic connectivity. Buried sand and gravel aquifers are important sources of high-capacity groundwater supply where they are sufficiently thick and laterally extensive (Reussow and Rohne, 1975). Groundwater withdrawals from the unconsolidated aquifer occur primarily within the outwash and outwash subsystems in the St. Joseph River Basin (**Figure 10**). In the Maumee River Basin, seven unconsolidated aquifer systems are present, including the Kendallville, Aboite, Hessen Cassel, New Haven, Cedarville, Eel River-Cedar Creek, and Teays Valley systems (IDNR, 1996).

Two major aquifer systems in the Region include the Michindoh Aquifer and the St. Joseph Aquifer. The Michindoh Aquifer includes unconsolidated deposits in the Maumee Basin in eastern Steuben and DeKalb counties and extends to the north and east into Ohio and Michigan (Riddle, et.al 2025). The St. Joseph Aquifer includes glacial outwash deposits adjacent to the St. Joseph River and tributaries from South Bend to Elkhart, and outwash deposits along the Elkhart River. The St. Joseph Aquifer was granted Sole Source status by the EPA in 1988. A petition was made to the EPA in 2007 to give Sole Source status to the Michindoh Aquifer; in 2013 that petition was suspended (EPA, 2026a). The Sole Source status is a federal designation that offers some protections to aquifers; the aquifer must provide at least 50% of the drinking water in the service area, and no alternatives for alternate supplies exist.

Bedrock aquifers, consisting primarily of Silurian and Devonian carbonate units, provide an additional source of groundwater but typically yield lower and more variable quantities of water compared to unconsolidated aquifers. These aquifers are most commonly used in areas where glacial deposits are thin or lack productive sand and gravel units (Fenelon et al., 1994; IDNR, 1996). **Figure 10** illustrates the limited number of high-capacity groundwater wells completed in the bedrock aquifers within the Northeast Indiana Region.

Recharge to aquifers occurs primarily through infiltration of precipitation, with rates influenced by the permeability of overlying soils and sediments, land use, and seasonal climatic conditions. In the Maumee River Basin, estimated recharge rates vary substantially, from approximately 50,000 gallons per day per square mile in till-dominated areas to 500,000 gallons per day per square mile in areas of thin, permeable surficial sands overlying productive aquifer systems (IDNR, 1996). Groundwater flow within these aquifers contributes to baseflow in rivers and streams, highlighting the interconnected nature of surface water and groundwater systems in the Region (Winter et al., 1998). These differences in recharge potential influence groundwater availability, baseflow contributions to streams, and the long-term sustainability of groundwater development, making them an important consideration for regional water-resource planning.

To evaluate potential long-term changes in groundwater conditions, annual and seasonal trends in groundwater levels were assessed using Mann-Kendall trend statistics for select USGS groundwater

monitoring sites in the St. Joseph River Basin, using the most recent 30-year period of record. All monitoring wells examined are in unconfined sand and gravel aquifers, and all show decreasing water level trends. Annual trends in groundwater levels are shown in **Figure 11**. Details of the Mann-Kendall statistics from the annual and seasonal tests are presented in **Appendix A**.

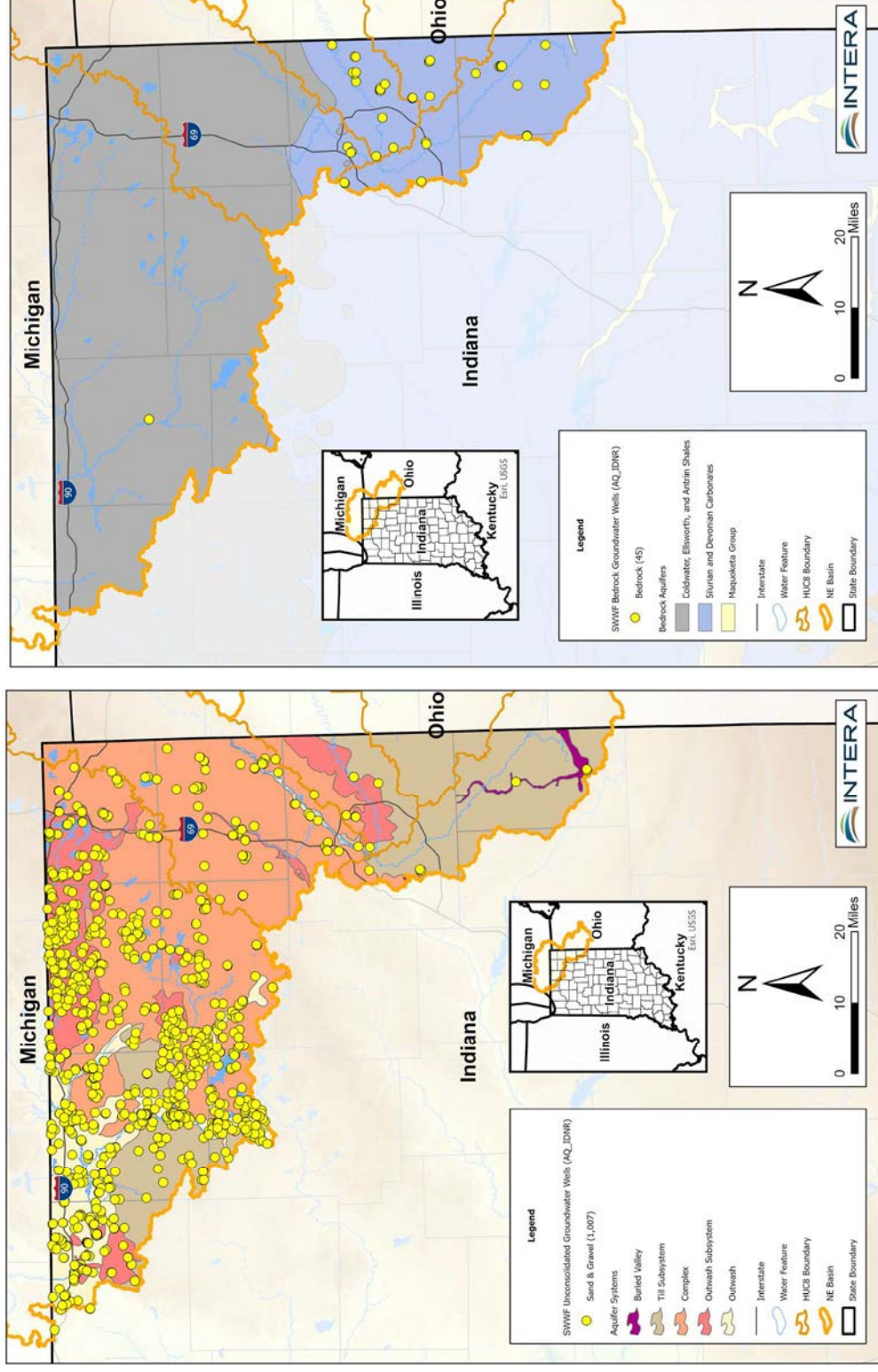


Figure 10. Groundwater wells in the unconsolidated aquifers (left) and groundwater wells in the bedrock (right) aquifers in the Northeast Indiana Region. Figures show wells that were active in 2023.

1.3.10.2 Rivers

The Region is divided between two major river systems: the St. Joseph River Basin (HUC-8 04050001) and the Maumee River Basin, both of which drain to the Great Lakes. The St. Joseph River flows generally northward into Michigan before discharging to Lake Michigan. The Maumee River and its principal Indiana tributaries, the St. Marys River and St. Joseph River (Maumee Basin) (HUC-8 04100003), flow eastward, ultimately discharging to Lake Erie (**Figure 1**) (IDNR, 1987, 1996). Much of the Region's hydrologic boundary in Indiana lies along the St. Lawrence River Continental Divide. The Divide separates surface drainage to the Great Lakes to north and drainage to the Gulf of Mexico to the south of the Divide.

Major tributaries within the Region contribute to these systems and form an interconnected network of surface-water features. In the St. Joseph River Basin (HUC-8 04050001), tributaries drain a landscape characterized by numerous lakes and wetlands, resulting in relatively stable baseflow conditions. The Maumee River Basin is characterized by a more extensively modified drainage network, with streamflow strongly influenced by historical drainage projects that removed wetlands and altered natural flow patterns, as well as ongoing contributions from groundwater baseflow (IDNR, 1996).

The larger streams in the Maumee River Basin support a range of withdrawal uses, including public water supply, industrial use, and energy production. Notably, the St. Joseph River (Maumee Basin) (HUC-8 04100003) serves as the primary surface-water supply source for the City of Fort Wayne.

To evaluate whether streamflow conditions have changed over time, annual and seasonal trends in streamflow were assessed using Mann-Kendall trend statistics for select U.S. Geological Survey (USGS) stream gages with a 30-year period of record. **Figure 11** illustrates results of the annual trend analysis. In the St. Joseph River Basin, streams have both increasing and decreasing annual trends. In the Maumee River Basin, all annual trends indicate decreasing streamflow. Details of the Mann-Kendall statistics from the annual and seasonal tests are presented in **Appendix A**.

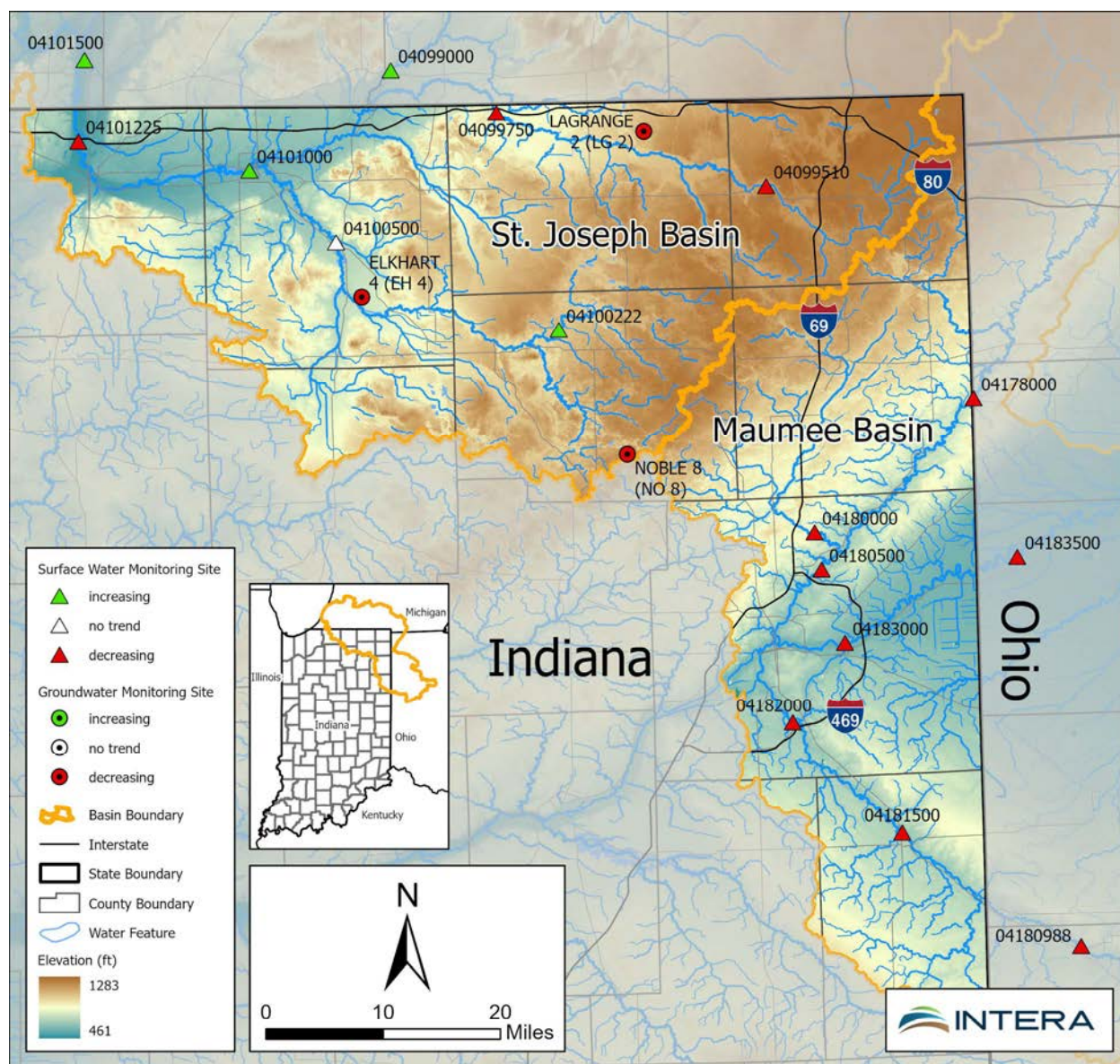


Figure 11. Recent annual trends in streamflow and groundwater levels. See Appendix A for details on the period assessed for each location.

1.3.11 Dams and Reservoirs

Information on dams and reservoirs in the Northeast Basin was obtained from the National Inventory of Dams (NID, 2026). A total of 115 dams listed in the NID within the Region are shown in **Figure 12**. In the St. Joseph River Basin, dams in Michigan are included. In Figure 12, dams are classified by their normal storage volume, defined by the NID as the amount of water stored in a reservoir under normal operating conditions, excluding flood-control or surcharge storage.

Table 4 and **Table 5** break down the 115 dams in the St. Joseph and Maumee River Basins by Primary Purpose as reported in the NID and the Normal Storage of the reservoir. These reservoirs are used primarily for recreational purposes and largely have small storage volumes. Several hydroelectric dams are present in the St. Joseph River Basin. All the hydroelectric dams in the St. Joseph River Basin are run-of-the-river operations; electricity is generated from the flow conditions present in the river at any time, with minimal use of reservoir storage.

In the Maumee River Basin, the Grand Lake St. Marys East Embankment Dam is the single recreation dam with a large storage capacity of 62,194 acre-feet. Water is discharged from the dam to a canal leading to the headwaters of the St. Marys River. A second dam on the lake discharges to the west, outside of the St. Marys watershed. The discharge from the lake was originally diverted to the Miami-Erie Canal and removed from the St. Marys River Basin. Currently, the discharge from the East Embankment Dam is treated as a natural inflow to the St. Marys Watershed.

The Hurshtown Reservoir in the Maumee River Basin, is a water supply reservoir maintained by the City of Fort Wayne with a capacity of 1.8 billion gallons. The reservoir was constructed in 1971 to provide a drought supply for the City of Fort Wayne but has never been used for that purpose. The reservoir is pumped storage, filled from the St. Joseph River (Maumee Basin). In periods of drought, the reservoir is designed to release water back to the St. Joseph River, upstream of the City intakes.

Overall, reservoirs in the Northeast Indiana Region provide important local recreational, hydropower, and water-management benefits. Apart from the Hurshtown Reservoir, they offer relatively limited storage for regional water-supply development due to their generally small size and operational characteristics.

Table 4. Number of dams in the St. Joseph River Basin sorted by primary purpose and normal storage capacity.

Primary Purpose	NS = Normal Storage (acre-feet)			
	NS < 1,000	1,000 ≤ NS <	10,000 ≤ NS	Total
Recreation	40	7	1	48
Hydropower	7	7	0	14
Fish and Wildlife	2	0	0	2
Other	6	0	0	6
Not Reported	4	0	0	4
Total	59	14	1	74

Table 5. Number of dams in the Maumee River Basin sorted by primary purpose and normal storage capacity.

Primary Purpose	NS = Normal Storage (acre-feet)			
	NS < 1,000	1,000 ≤ NS <	10,000 ≤ NS	Total
Recreation	28	3	1	32
Water Supply	2	1	0	3
Fish and Wildlife	1	0	0	1
Flood Risk Reduction	1	0	0	1
Tailings	1	0	0	1
Debris Control	1	0	0	1
Not Reported	0	0	2	2
Total	34	4	3	41

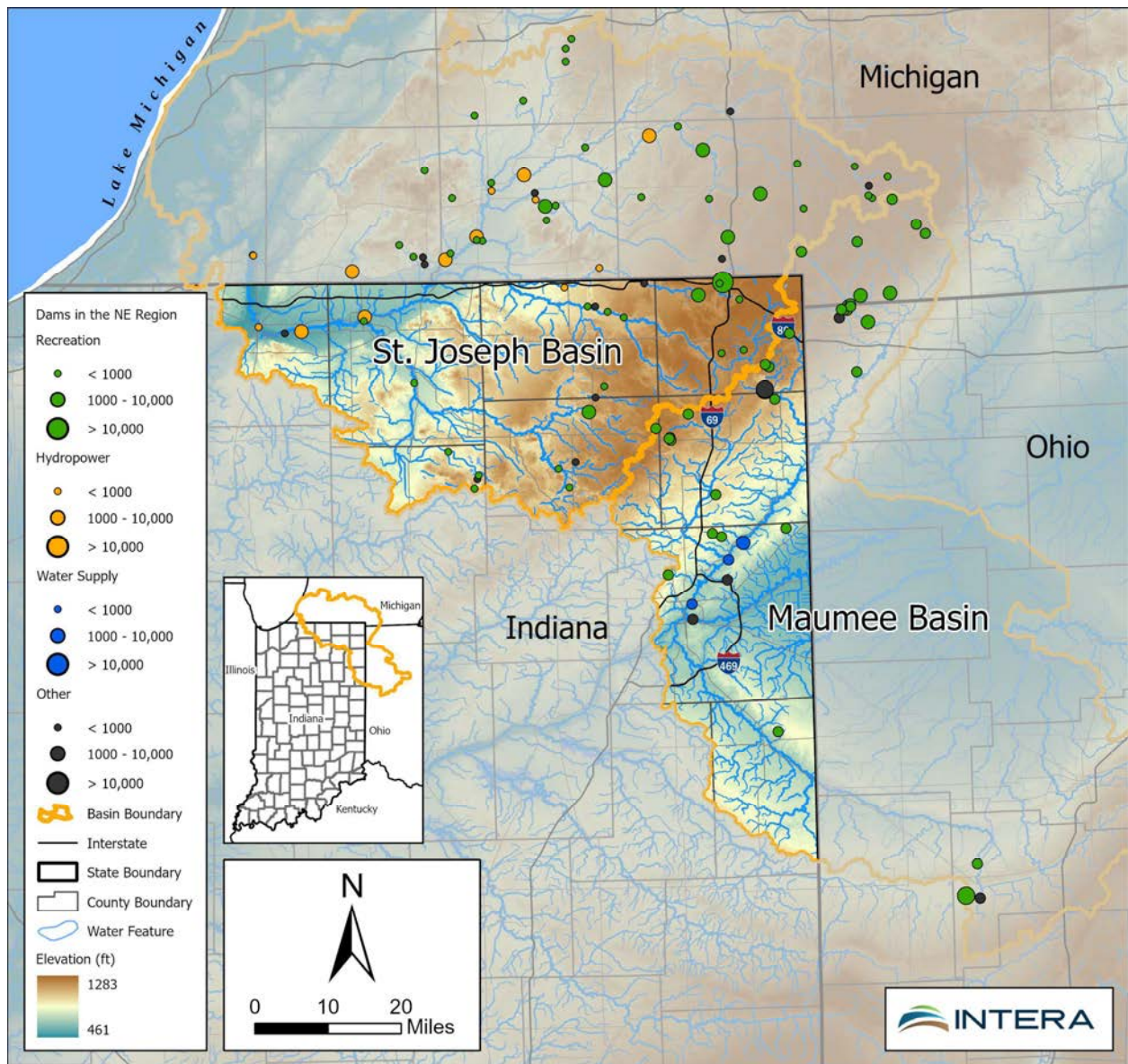


Figure 12. Dams and reservoirs in the Region, classified by purpose and normal storage volume in acre-feet. Dams shown in Michigan and Ohio are included only if they lie in regions contributing to flow in Indiana.

1.3.12 Great Lakes Compact

The Northeast Indiana Region lies entirely within the Great Lakes Basin, with the St. Joseph River Basin draining to Lake Michigan and the Maumee River Basin draining to Lake Erie. This position places all water resources within the Region under the jurisdiction of the Great Lakes–St. Lawrence River Basin Water Resources Compact (the Compact), a legally binding interstate agreement among eight Great Lakes states and the Canadian provinces of Ontario and Quebec that establishes the regulatory framework for water use, conservation, and diversion within the basin (Great Lakes Basin Compact,

2008). The Compact became effective on December 8, 2008, and Indiana enacted implementing legislation under Indiana Code 14-25-15, with administrative rules under 312 IAC 6.2 effective in 2014 (IDNR, 2026).

The Compact's primary requirements applicable to Indiana include: registration of all water withdrawals of 100,000 gallons per day or greater averaged over any 30-day period; development of water conservation and efficiency programs; regional review for new or increased consumptive uses of five million gallons per day or greater averaged over any 90-day period; and prohibition of diversions from the Great Lakes Basin except for straddling communities, communities in straddling counties, and intra-basin transfers (IDNR, 2026). Existing registered withdrawal volumes are treated as baseline amounts and are not subject to the new withdrawal standards, though any increases above those baselines trigger Compact review and, above applicable thresholds, permitting requirements.

The diversion prohibition has direct implications for long-term water planning in the Region. Water withdrawn from the Great Lakes Basin, whether from surface water or groundwater, may not be transferred outside the basin boundary without approval under the Compact's exception criteria. Any future transfer of water between the two basins within the Region—for example, augmenting Maumee River Basin supplies with St. Joseph River Basin water—would constitute an intra-basin transfer subject to Compact provisions and would require review accordingly.

All proposals for new or increased withdrawals must incorporate sound and economically feasible water conservation and efficiency measures. Indiana's conservation program within the Great Lakes Basin is voluntary and is described in the IDNR Report on Indiana Water Conservation and Efficiency Program (IDNR, 2025). Understanding these requirements and constraints is essential context for evaluating water supply options and projecting future demand across the planning horizon of this study.

1.4 Spatial Scale of Demand and Availability Analyses

Because water availability and demand vary considerably across the Northeast Indiana Region, analyses were conducted at the sub-basin scale to represent local hydrologic conditions and water-use patterns better. The Region is divided into two watersheds: the St. Joseph and the Maumee River Basins. Each watershed is further divided into sub-basins as shown on **Figure 13** and **Figure 14**. A USGS streamflow monitoring station (gaging station) is located at the downstream end of each sub-basin; sub-basins extend upstream from the station, terminating at a watershed divide or another USGS station. Schematics illustrating how the system of sub-basins are connected are also provided in the figures.

Table 6 and **Table 7** identify the sub-basin number, the USGS gaging station at the downstream end of each sub-basin, the sub-basin contributing area, the total watershed area contributing to the gage, and the period of record for each USGS station. Because streamflow at each USGS gage reflects runoff generated from the entire contributing watershed, availability analyses must extend upstream to the headwaters of each watershed. In the St. Joseph River Basin, this includes a large region in Michigan; in the Maumee River Basin, regions in both Michigan and Ohio are included.

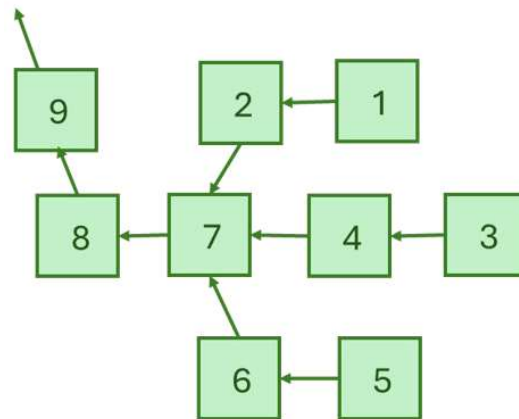
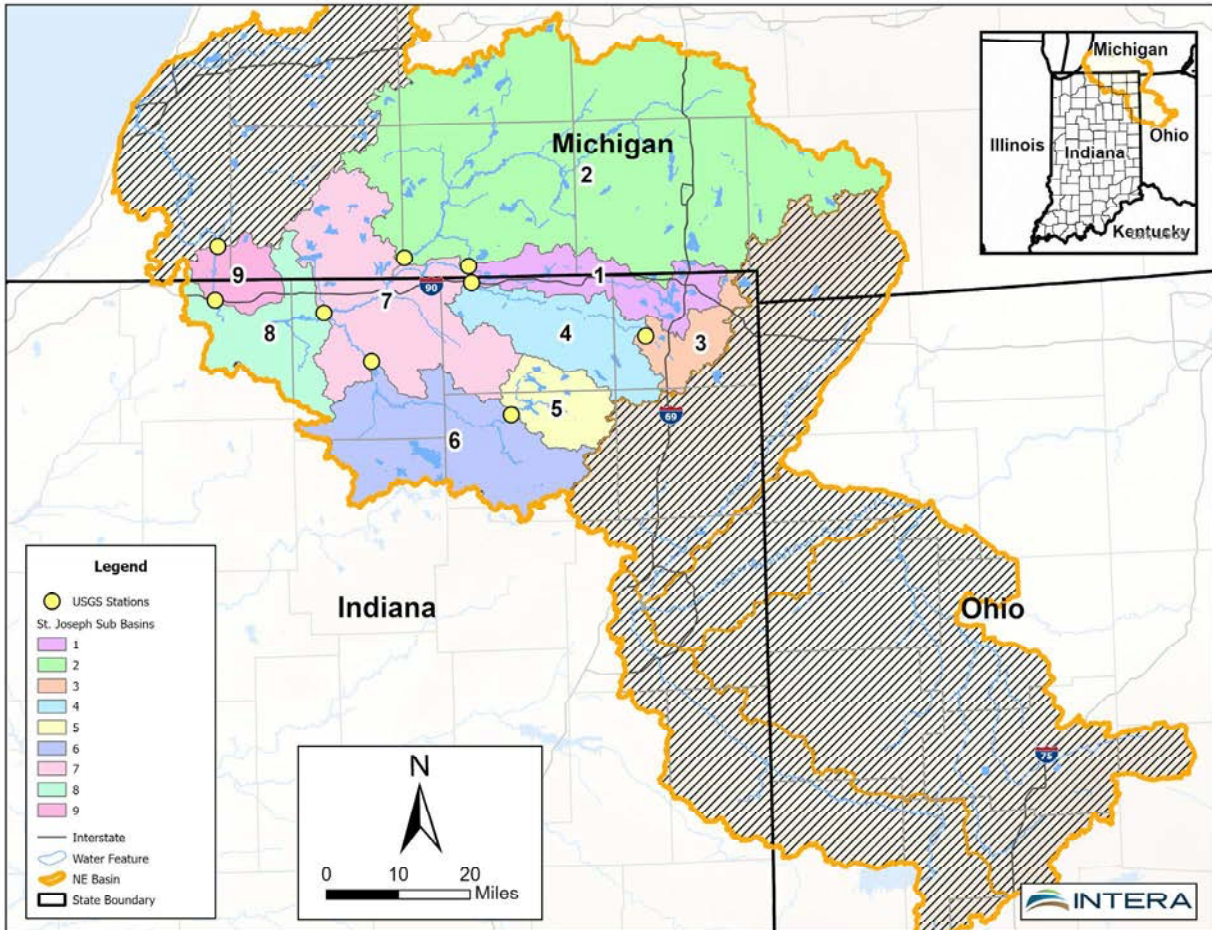


Figure 13. Sub-basins and corresponding flow schematic of the St. Joseph River Basin of the Northeast Indiana Region. Cross-hatching indicates areas outside the River Basin, or areas in the Basin downstream of the study area.

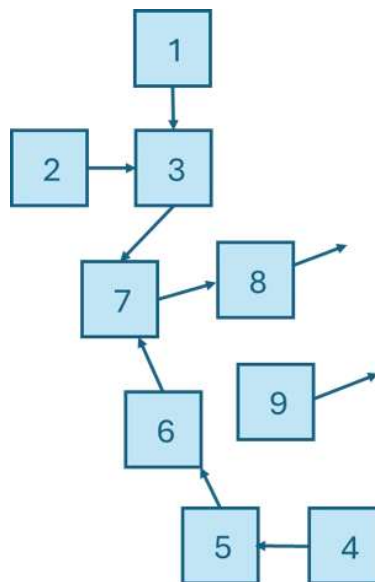
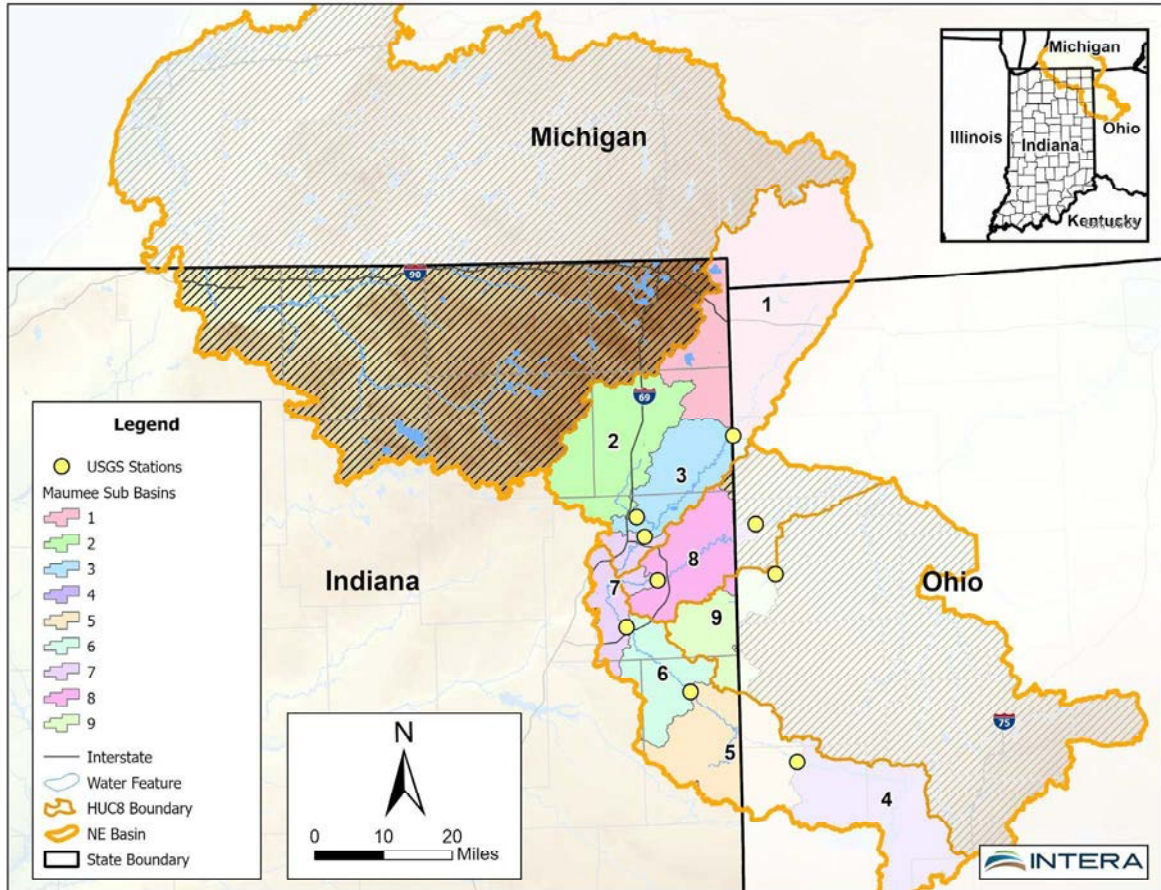


Figure 14. Sub-basins and corresponding flow schematic of the Maumee River Basin of the Northeast Indiana Region. Cross-hatching indicates areas outside the River Basin, or areas in the Basin downstream of the study area.

Table 6. Sub-basins in the St. Joseph River Basin.

Sub-Basin ID	Downstream USGS Station	Description	Sub-Basin Area (mi ²)	Watershed Area (mi ²)	Period of Record
1	04098500	Fawn River near White Pigeon, MI	192	192	1957-1975
2	04099000	St. Joseph River at Mottville, MI	1674	1866	1923-2025
3	04099510	Pigeon River near Angola, IN	106	106	1945-2025
4	04099750	Pigeon River near Scott, IN	255	361	1968-2025
5	04100222	Elkhart River near Cosperville, IN	142	142	1971-2025
6	04100500	Elkhart River near Goshen, IN	452	594	1931-2025
7	04101000	St. Joseph River at Elkhart, IN	549	3370	1947-2025
8	04101225	St. Joseph River at South Bend, IN	249	3619	2019-2025
9	04101500	St. Joseph River at Niles, MI	47	3666	1930-2025

Table 7. Sub-basins in the Maumee River Basin.

Sub-Basin ID	Downstream USGS Station	Description	Sub-Basin Area (mi ²)	Watershed Area (mi ²)	Period of Record
1	04178000	St. Joseph River near Newville, IN	618	618	1946-2025
2	04180000	Cedar Creek near Cedarville, IN	270	270	1946-2025
3	04180500	St. Joseph River near Fort Wayne, IN	172	1060	1941-2025
4	04180988	St. Marys River at Rockford, OH	340	340	2005-2025
5	04181500	St. Marys River at Decatur, IN	283	623	1947-2025
6	04182000	St. Marys River near Fort Wayne, IN	141	764	1930-2025
7	04183000	Maumee River at New Haven, IN	143	1967	1956-2025
8	04183500	Maumee River at Antwerp, OH	123	2090	1921-2025
9	04191378	Flatrock Creek near Payne, OH	144	144	2015-2016

2.0 Water Demand

This section characterizes current and future water demand across the Northeast Indiana Region. The historical water withdrawals establish the baseline conditions against which future demand is evaluated. Building on this historical record, the section then presents forecasts of water demand through the 2070 planning horizon, developed using statistical models that relate each sector's withdrawals to population, income, climate, and sector-specific drivers. Together, these historical and forecasted results provide the demand-side foundation for the water availability and risk analyses presented in the sections that follow.

Both historical and projected water withdrawals are presented here by county. Portions of six of the nine counties lie outside the Region; reported historical and projected water withdrawals for those counties include only the portions that lie inside the Region. The partial counties include Elkhart, St. Joseph, Kosciusko, Nobel, Allen, and Adams.

2.1 Historical Water Withdrawal

Historical water withdrawal records for the Region span the period from 1985 to 2023, providing a nearly four-decade record of water demand across six use sectors: public supply, irrigation, industry, energy production, miscellaneous, and rural use. This data, compiled from the SWWF database (IDNR, 2023) of registered water users maintained by the IDNR, document substantial changes in both the magnitude and composition of regional water demand over the study period and establishes the baseline conditions against which future demand projections are evaluated. Understanding historical water-use trends provides the foundation for evaluating current water demand and projecting future water needs across the Northeast Indiana Region. The following subsections describe historical withdrawal patterns by sector.

Total water withdrawals in the Region have ranged historically between 150 MGD to 200 MGD from 1985-2023 (**Figure 15**). Groundwater withdrawals typically account for more than 50% of the total withdrawals. The following sections discuss the variability of each of the water-use sectors historically.

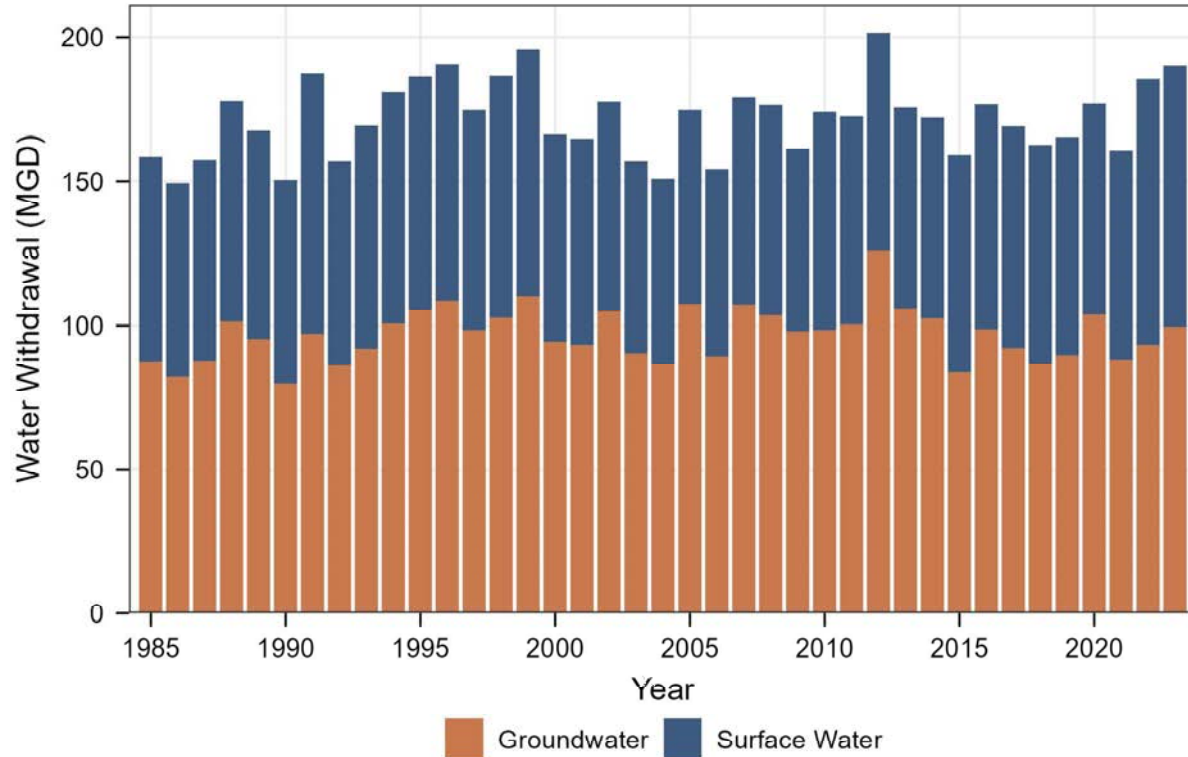


Figure 15. Total water withdrawals in the Region as reported in the SWWF database from 1985-2023.

2.1.1 Public Water Supply

Public water supply is provided by a network of 76 municipal and community water utilities distributed throughout the Region (see **Section 1.3.4** for more details). These utilities collectively serve over 650,000 people across service areas ranging from less than 0.1 square mile for small community associations to more than 199 square miles for the Fort Wayne City Utilities system.

The spatial distribution of registered public supply withdrawal facilities, comprising 239 groundwater wells and three surface water intakes active in 2023, is shown in **Figure 16**. Public supply groundwater wells are distributed broadly across both basins, with concentrations corresponding to the major urban centers and the network of smaller independent municipal systems that serve communities throughout the Region. Two of the three registered surface water intakes are in the Fort Wayne area, consistent with the Region's reliance on groundwater for public supply outside of the Fort Wayne metropolitan system. The distribution of public supply wells in the St. Joseph River Basin reflects the relatively dense network of smaller and mid-sized communities in that portion of the Region, while the Maumee River Basin shows a more dispersed pattern consistent with lower overall population density.

The regional water supply landscape is dominated by a small number of large urban systems (**Table 3**). Fort Wayne City Utilities is the largest single utility in the Region, serving approximately 270,000 people and representing the only large municipal system that relies primarily on surface water, drawing from the St. Joseph River (Maumee Basin) via the Three Rivers Filtration Plant.

Total public supply withdrawals ranged from approximately 85 to 100 million gallons per day (MGD) during the late 1990s, representing the period of peak regional demand, with groundwater accounting for the larger share of total withdrawals throughout the record (**Figure 17**). Since approximately 2003, total public supply withdrawals have declined to approximately 78 to 83 MGD in recent years, a reduction of roughly 15 to 20 percent from peak levels.

Groundwater withdrawals represent the dominant component of public supply, declining steadily from approximately 55 to 65 MGD in the late 1980s to approximately 40 to 45 MGD by the early 2020s, reflecting long-term reductions across the network of groundwater-dependent municipal systems serving the Region. Surface water withdrawals, associated primarily with Fort Wayne City Utilities, represent the smaller but more consistent component of public supply, fluctuating between approximately 25 and 35 MGD throughout the study period without a discernible long-term trend.

The overall decline in total public supply withdrawals is therefore driven almost entirely by reductions in groundwater withdrawals, while surface water demand has remained relatively constant, reflecting the contrasting trajectories of Fort Wayne's surface water system, which has maintained relatively consistent withdrawal volumes, and the groundwater-dependent systems serving South Bend, Elkhart, Mishawaka, and smaller communities, which have achieved sustained reductions over the study period.

Historical annual average withdrawals by county are shown in **Figure 18**. Allen County accounts for the dominant share of regional public supply withdrawal throughout the record, with its surface water component reflecting Fort Wayne's reliance on the St. Joseph River (Maumee Basin). St. Joseph County is the second largest contributor, with withdrawals drawn entirely from groundwater. The remaining counties each contribute smaller groundwater-based withdrawals consistent with the independent municipal systems serving those areas.

The prevalence of groundwater-based supply across all but the largest urban systems emphasizes the central role of unconsolidated glacial aquifers in sustaining public water supply throughout the Region. The spatial concentration of surface water withdrawals within the Fort Wayne system, combined with the region-wide dependence on groundwater for all other utilities, highlights the importance of maintaining both surface water quality and the long-term availability of groundwater across the Region.

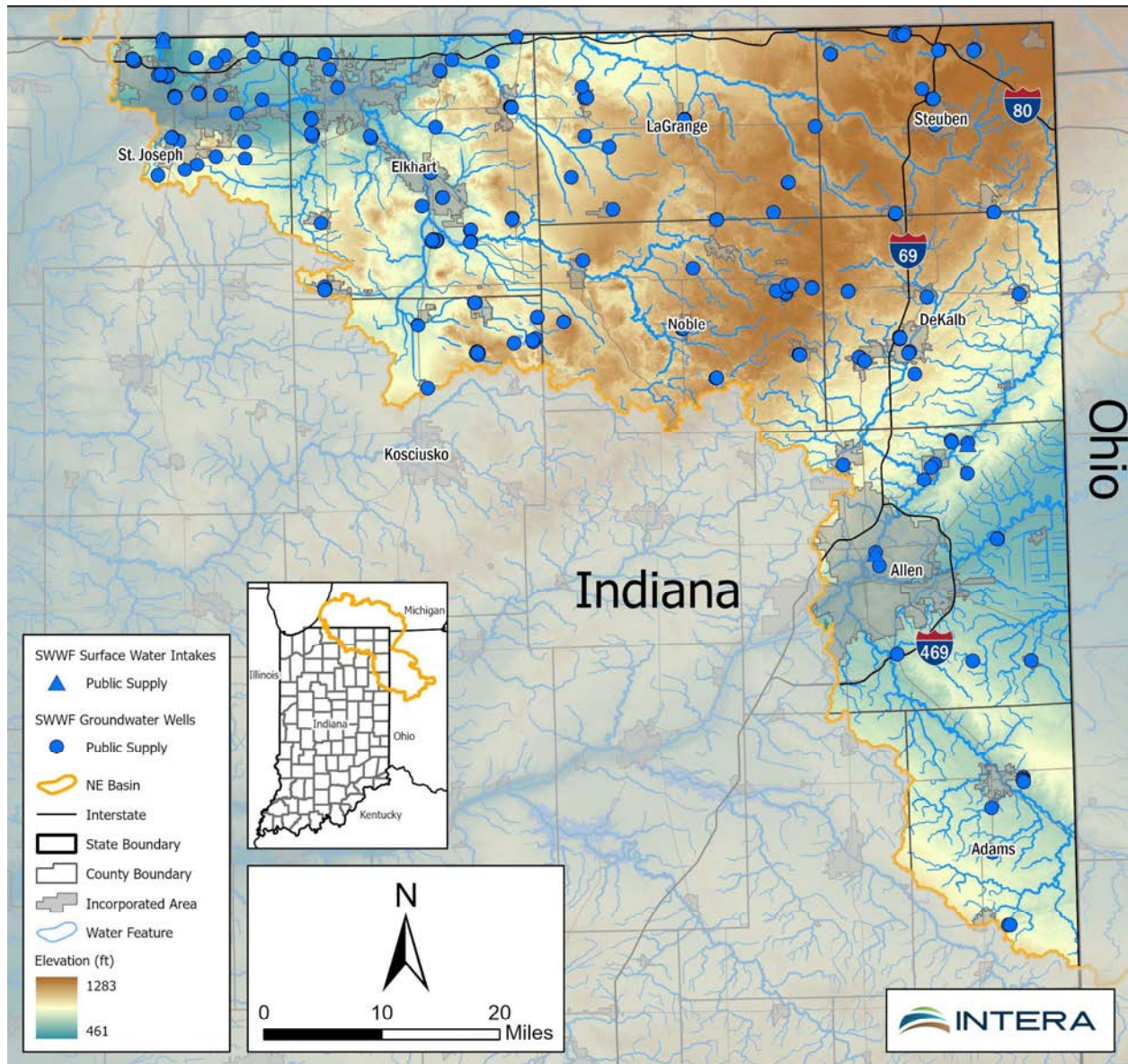


Figure 16. Public water supply facilities including groundwater wells and surface water intakes from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.

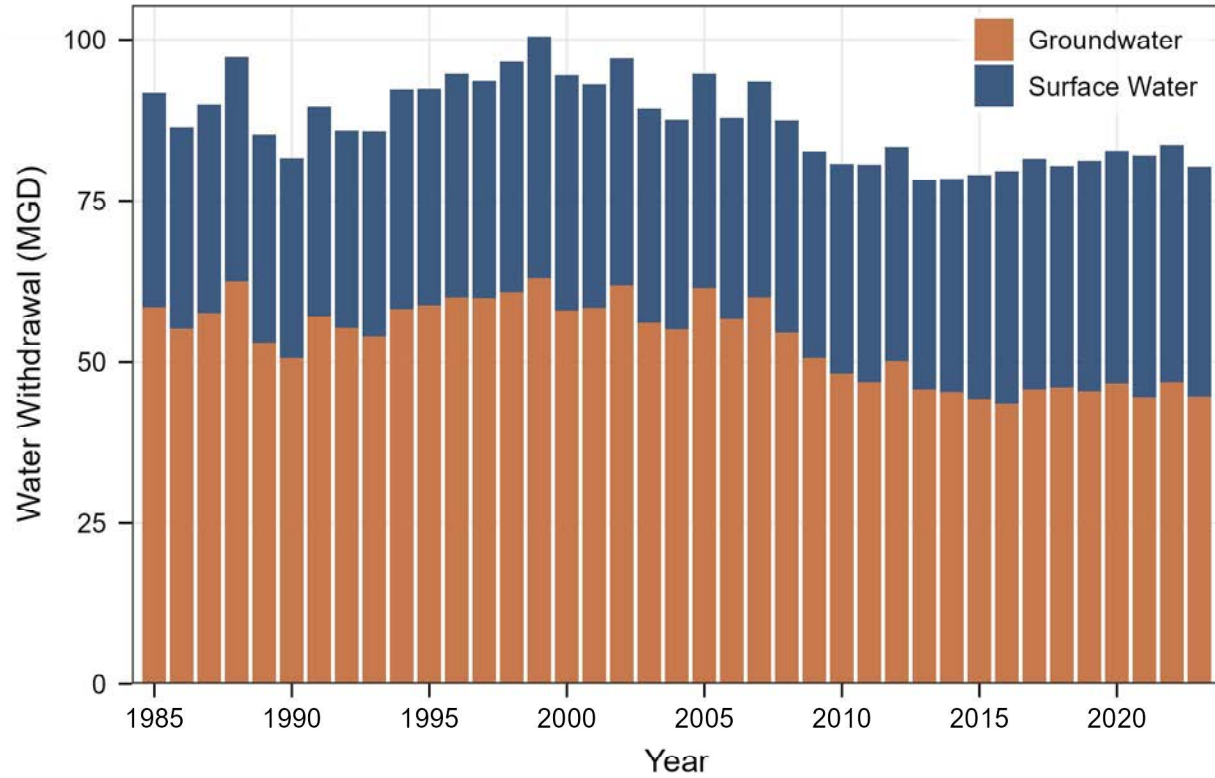


Figure 17. Annual average public supply withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.

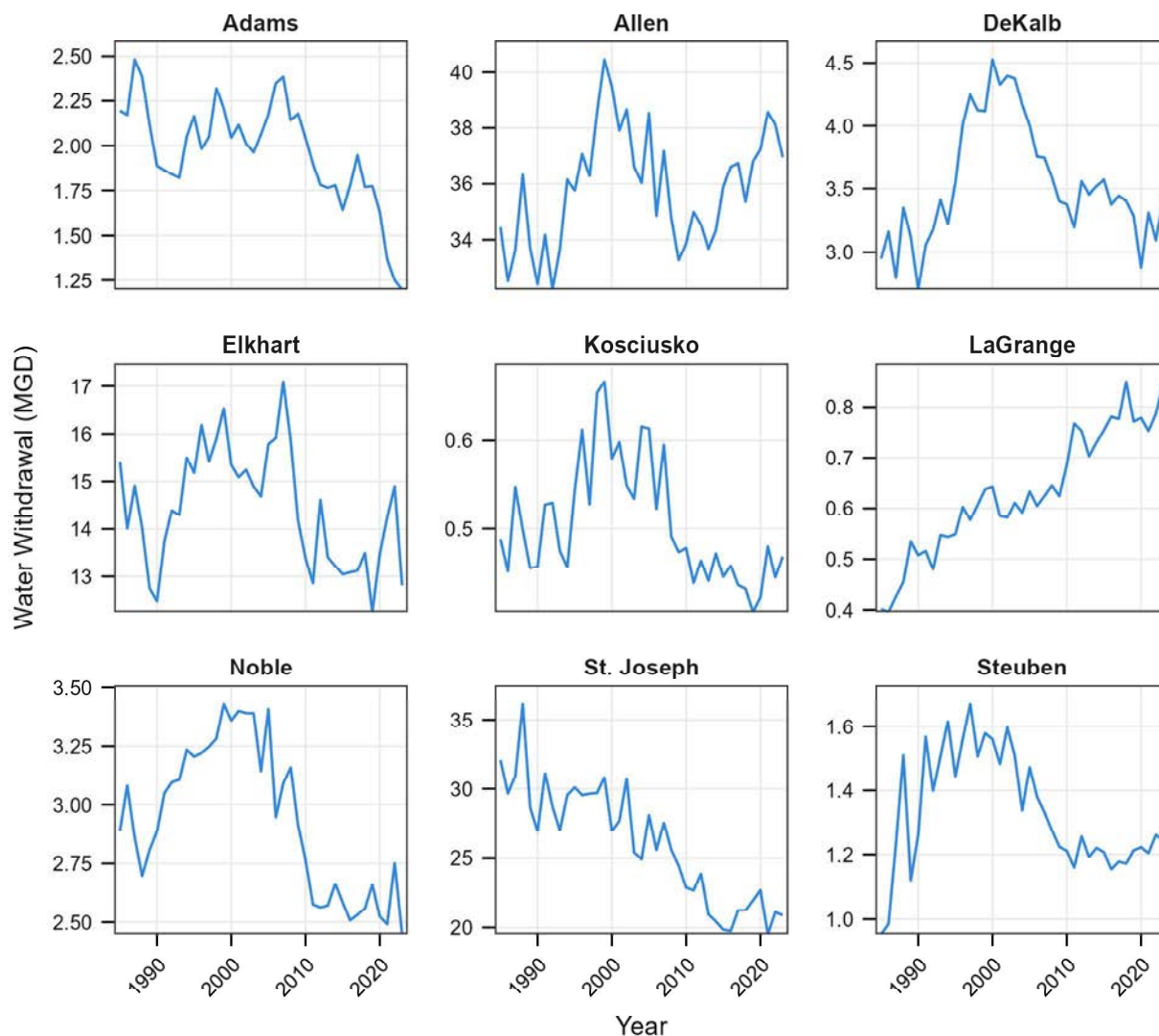


Figure 18. Annual public supply withdrawal by county, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

2.1.1.1 Peak Day Water Demand

Public water withdrawals across all the Region's counties exhibit a pronounced and consistent annual seasonal cycle, with peak demand occurring in the Summer months (typically June through August) and minimum demand in Winter. This pattern is normal for public water suppliers and is driven primarily by outdoor water use, lawn and landscape irrigation, car washing, and pool filling, which adds substantial non-essential demand on top of the relatively stable year-round domestic base demand. Elevated Summer temperatures and reduced rainfall further compound this effect by increasing evapotranspiration and irrigation requirements, while cooling-water demand from commercial and institutional users adds an additional increment during peak heat. Because this discretionary outdoor

demand scales with the size of the customer base and irrigated landscape area, the seasonal swing tends to grow or shrink in proportion to overall system withdrawals over time, rather than remaining a fixed volume.

Public water utility water withdrawals and water production are often discussed as average annual use, like the data presented in this report. However, water utilities cannot properly design and size treatment plants, wells, pumps, storage tanks, or distribution mains around the average annual water use. Instead, systems must be sized to reliably meet the maximum day demand and, for distribution piping and storage, the even higher instantaneous peak hour demand. The ratio between a system's peak day use and its average day use is expressed as a peaking factor; it is this factor, not the average day figure alone, that governs how much capacity a utility must build and maintain.

Table 8 summarizes the peaking factors (peak day ÷ average day) calculated for public water supply systems where both values were available in Preliminary Engineering Reports (PERs) provided by the Indiana Finance Authority (IFA, 2025).

As with most Indiana water systems, peaks in this Region are driven primarily by outdoor irrigation during hot, dry Summer months; by predictable daily surges in the morning and early evening tied to household routines; and by the specific mix of residential, commercial, and industrial customers each utility serves. A utility whose peaking factor is 2.0 must build and maintain treatment and supply capacity roughly twice the size that its average day demand alone would suggest. This is capacity that goes underutilized for much of the year but is essential during the highest-demand periods of the Summer. Recognizing each utility's peak day demand and peaking factor, rather than relying on average day figures alone, is therefore an essential input to sizing improvements to treatment, storage, and distribution.

Table 8. Peaking factors (peak day ÷ average day) calculated for public water supply systems within the Northeast Indiana Region (IFA, 2025).

County	Peaking Factors
Adams	2.18
Allen	1.95
DeKalb	1.79
Elkhart	2.17
Kosciusko	2.07
LaGrange	2.71
Noble	1.92
St. Joseph	1.92
Steuben	Insufficient data

2.1.2 Self-Supplied Residential Water Supply

Self-supplied residential demand represents households on private wells that are not served by a public utility and therefore are not included in the SWWF database. Demand was estimated directly as the share of each county's population not served by utilities, but within project limits of each county and multiplying that population by an assumed per-capita use rate. Because historical utility serviced populations are unavailable, a meaningful historical record of self-supplied residential demand could not be developed. Consequently, estimates were prepared only for current conditions and were not projected backward in time.

The assumed per-capita water use rate is 80 gallons per capita per day (GPCD), consistent with conventional self-supplied domestic water use estimates reported by Dieter et al. (2018). In counties with substantial Amish populations, county-specific per-capita use rates were adjusted by blending the standard 80 GPCD rate with an assumed Amish water use rate of 40 GPCD, weighted according to each county's Amish population reported in the 2010 religious census (Manns, 2012). Amish households are assumed to use 40 GPCD; no measured Amish rates exist. The value is estimated as the low end of the range specified in EPA estimates of typical water use for homes with modern fixtures (EPA, 2002). As a result, only Adams, Allen, Elkhart, and LaGrange counties have estimated per-capita use rates below 80 GPCD (**Table 9**). County-level estimates of current self-supplied residential demand are summarized in **Table 10**. This is a conservative choice: Amish households are predominantly rural and on private wells, so the Amish fraction of the self-supplied population is likely higher than the county-wide fraction used here. Current (2023) self-supplied residential demand is estimated at approximately 29.14 MGD across the Northeast Indiana Region.

Table 9. Self-supplied residential per-capita use rate by county.

County	Self-supplied rate (GPCD)
LaGrange	64.9
Adams	72.6
Elkhart	78.7
Allen	79.6
All other counties in the NE Region	80.0

Table 10. Summary of self-supplied demand by county.

County	Self-supplied demand (MGD)
Adams	1.14
Allen	5.87
DeKalb	1.51
Elkhart	8.56
Kosciusko	0.78
LaGrange	2.29
Noble	1.85
St. Joseph	5.60
Steuben	1.54
TOTAL	29.14

2.1.3 Agricultural Water Withdrawal

Agricultural water withdrawals within the Region are reported in the SWWF database under two primary registration categories: Irrigation and Rural Use. Additionally, livestock feeding operations, both confined feeding operations (CFOs) and concentrated animal feeding operations (CAFOs), also withdraw water from the basin resources; however, most of these withdrawals are not captured in the SWWF database and were therefore estimated separately. Together, these categories represent the primary components of agricultural water withdrawals within the Region and are discussed in the subsections that follow.

The Irrigation category includes withdrawals associated with crop production, including both field irrigation and horticultural operations, and represents by far the larger of the categories by facility count and withdrawal volume. Turf irrigation by golf courses, country clubs, and homeowner associations are also included in the Irrigation category, although these demands represent a very small portion of withdrawals in the Region. The Rural Use category includes non-irrigation agricultural withdrawals, such as aquaculture and similar agricultural support uses. Rural use withdrawals are typically smaller in volume, more uniformly distributed across the Region, and less sensitive to seasonal precipitation variability than irrigation withdrawals, reflecting the comparatively steady and weather-independent nature of aquaculture water demand.

2.1.3.1 Irrigation

Irrigation is the largest water withdrawal sector by facility count in the Region, with 831 registered withdrawal sites comprising 738 groundwater wells and 93 surface water intakes active in 2023. The spatial distribution of irrigation facilities, shown in **Figure 19**, reflects the concentration of irrigated agricultural production in the St. Joseph River Basin, where the density of both groundwater wells and surface water intakes is substantially higher than in the Maumee River Basin. Irrigation groundwater

wells are distributed broadly across the northern and western portions of the Region, with the highest densities occurring in Elkhart, LaGrange, Kosciusko, and St. Joseph counties, consistent with the productive outwash and buried valley aquifer systems that underlie those areas. Surface water irrigation intakes are concentrated along major drainageways and lake systems in the same counties. The comparatively sparse distribution of irrigation facilities in the Maumee River Basin reflects the lower aquifer productivity of the till-dominated landscape and the greater prevalence of tile-drained rainfed agriculture in that portion of the Region.

Irrigation withdrawals are highly variable from year to year, reflecting the strong dependence of agricultural water demand on seasonal precipitation and drought conditions (**Figure 20**). Withdrawals are drawn almost entirely from groundwater, with surface water representing only a minor fraction of total irrigation supply. Annual totals range from approximately 10 MGD in wet years to more than 60 MGD during drought years, with pronounced spikes corresponding to major drought events, most notably in the 2012 drought, which produced the highest single-year irrigation withdrawal in the period of record. Despite this pronounced annual variability, the long-term record suggests a gradual increase in baseline irrigation demand over the period of record.

County-level withdrawal records (**Figure 21**) identify Elkhart, LaGrange, and Kosciusko counties as the highest irrigation users in the Region. This distribution reflects the concentration of productive unconsolidated glacial aquifers and irrigated cropland in the northern portions of the Region. Irrigation withdrawals are sharply seasonal, concentrated almost entirely within the June through September growing season, with negligible withdrawals during the remainder of the year.

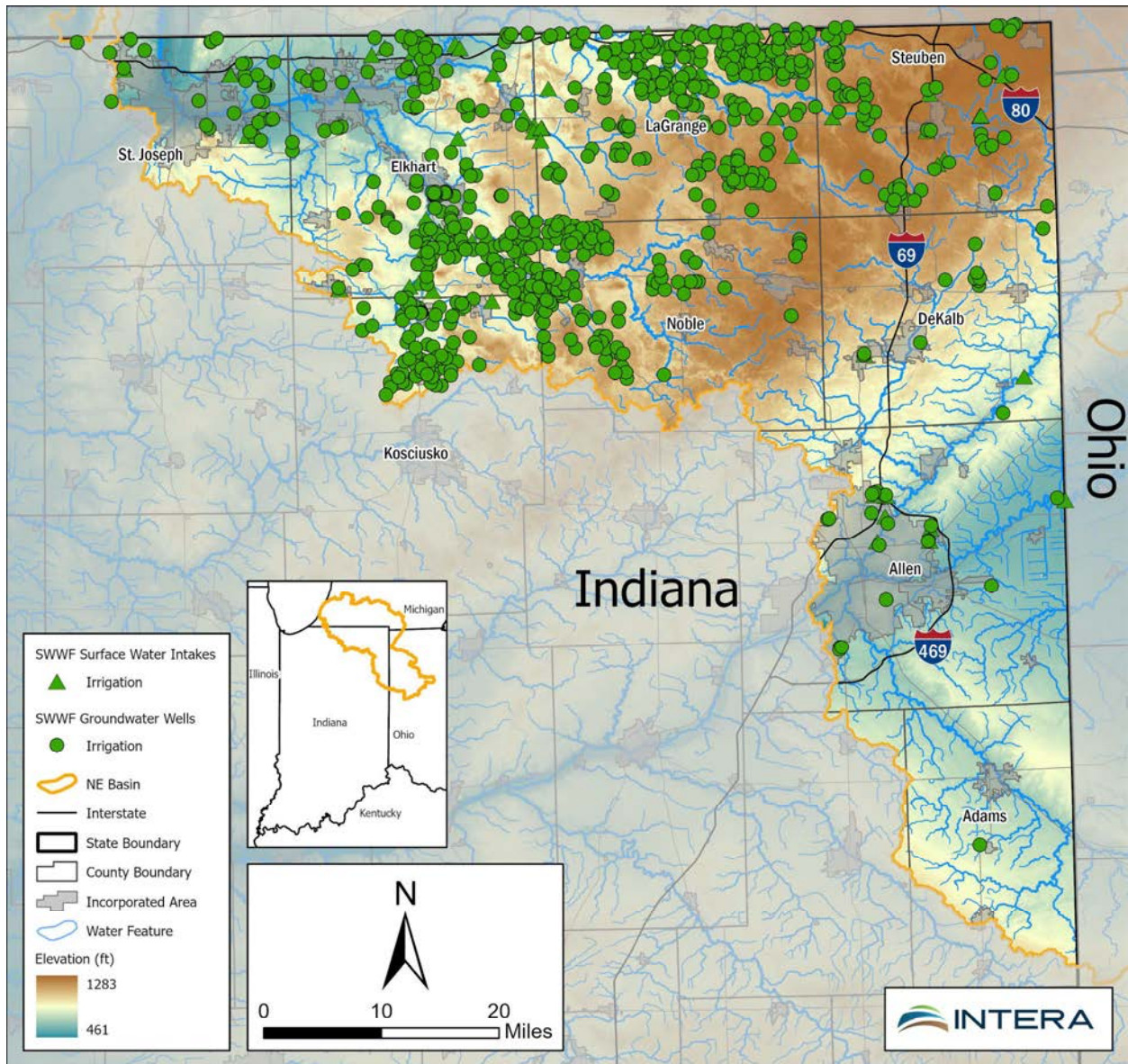


Figure 19. Irrigation wells and surface water intakes from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.

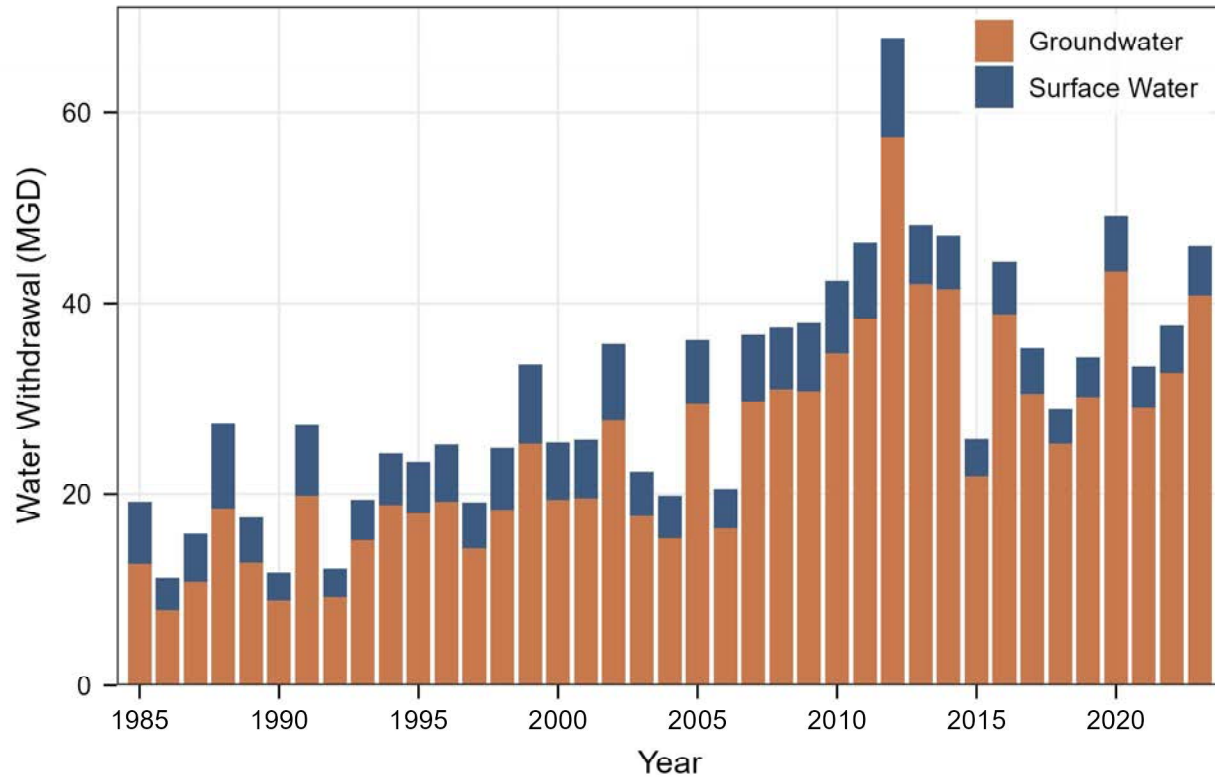


Figure 20. Annual average Irrigation withdrawal for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.

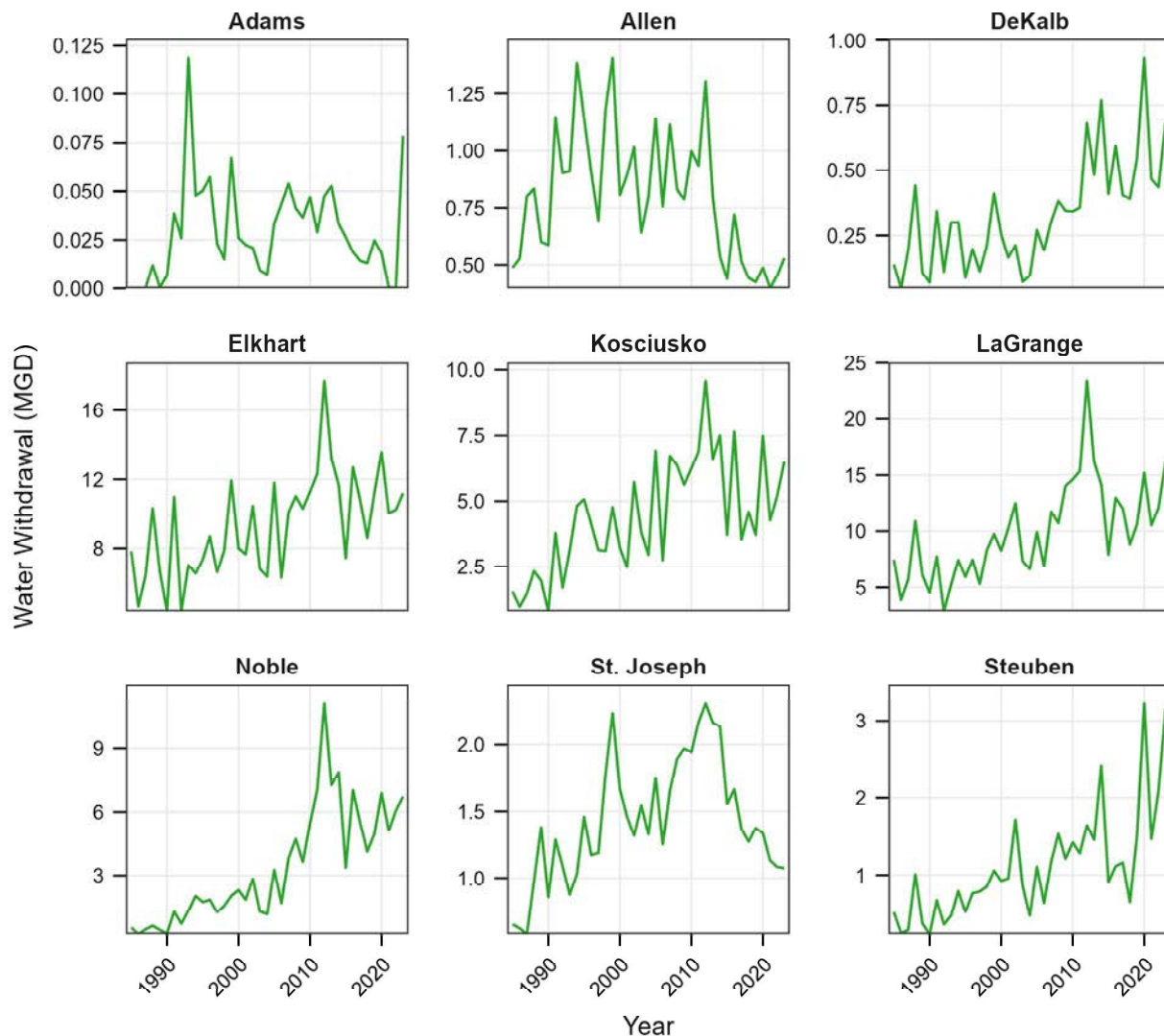


Figure 21. Annual average irrigation withdrawal by county from the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

2.1.3.2 Rural Water Withdrawals

Rural use represents the smallest registered withdrawal sector in the Northeast Indiana Region, with 18 groundwater wells and one surface water intake active in 2023. As shown in **Figure 22**, rural use facilities are sparsely and widely distributed across the Region, with no strong geographic concentration in either basin. This dispersed pattern reflects the nature of rural domestic and livestock water supply, which is typically served by individual wells rather than centralized systems and is distributed in proportion to the rural population across the Region. The registered facilities reporting withdrawals in 2023 for rural use include IDNR fish rearing stations, a duck farm and other farms reporting withdrawals for livestock watering and irrigation, and an agricultural cooperative reporting withdrawals for public supply. The

absence of rural use withdrawals in some counties likely reflects a combination of low rural population density and reliance on private domestic wells below the SWWF registration threshold of 100,000 gallons per day, rather than a true absence of rural water withdrawals.

Rural use represents the smallest registered withdrawal sector in the Region, with total volumes consistently ranging between 3-6 MGD throughout the study period (**Figure 23**). Withdrawals are distributed across multiple counties with no single dominant contributor. Rural use exhibits a modest upward trend since the early 2000s, potentially reflecting gradual population growth in rural portions of the Region and increasing registration compliance.

The county-level record identifies LaGrange, Steuben, and St. Joseph counties as the highest rural water withdrawals in the Region (**Figure 24**). A seasonal peak is discernible during Summer months, consistent with increased outdoor and agricultural use during the growing season.

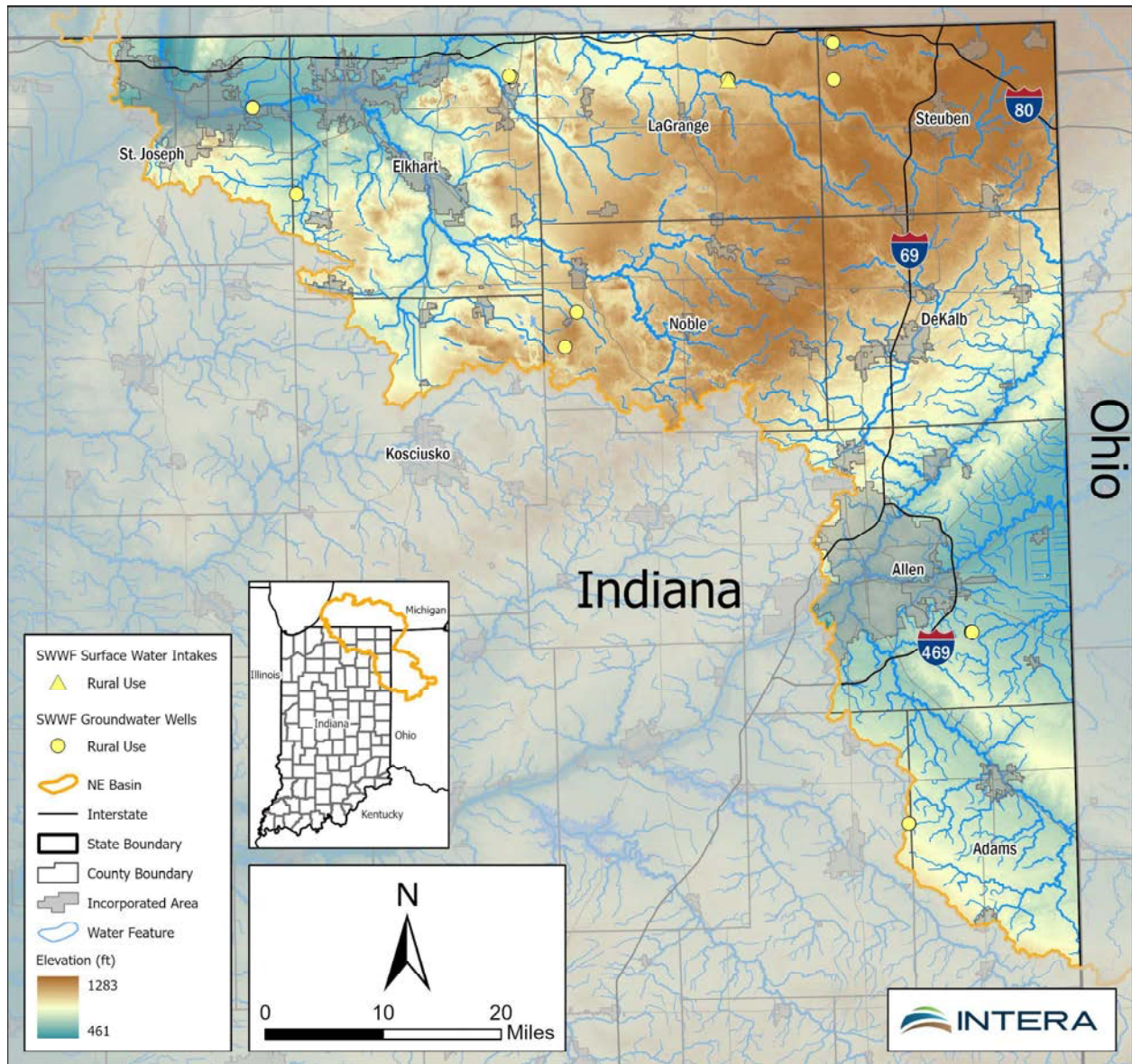


Figure 22. Rural use water wells and intakes from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.

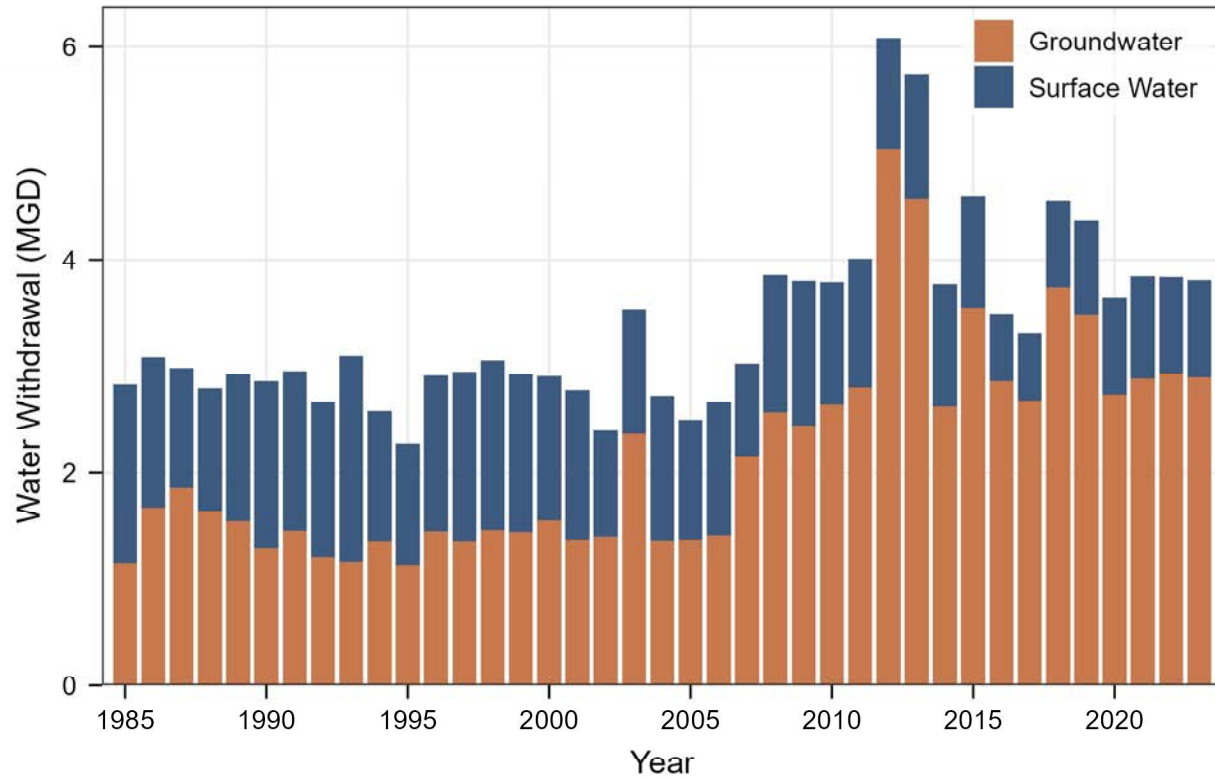


Figure 23. Annual average rural use withdrawal for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.

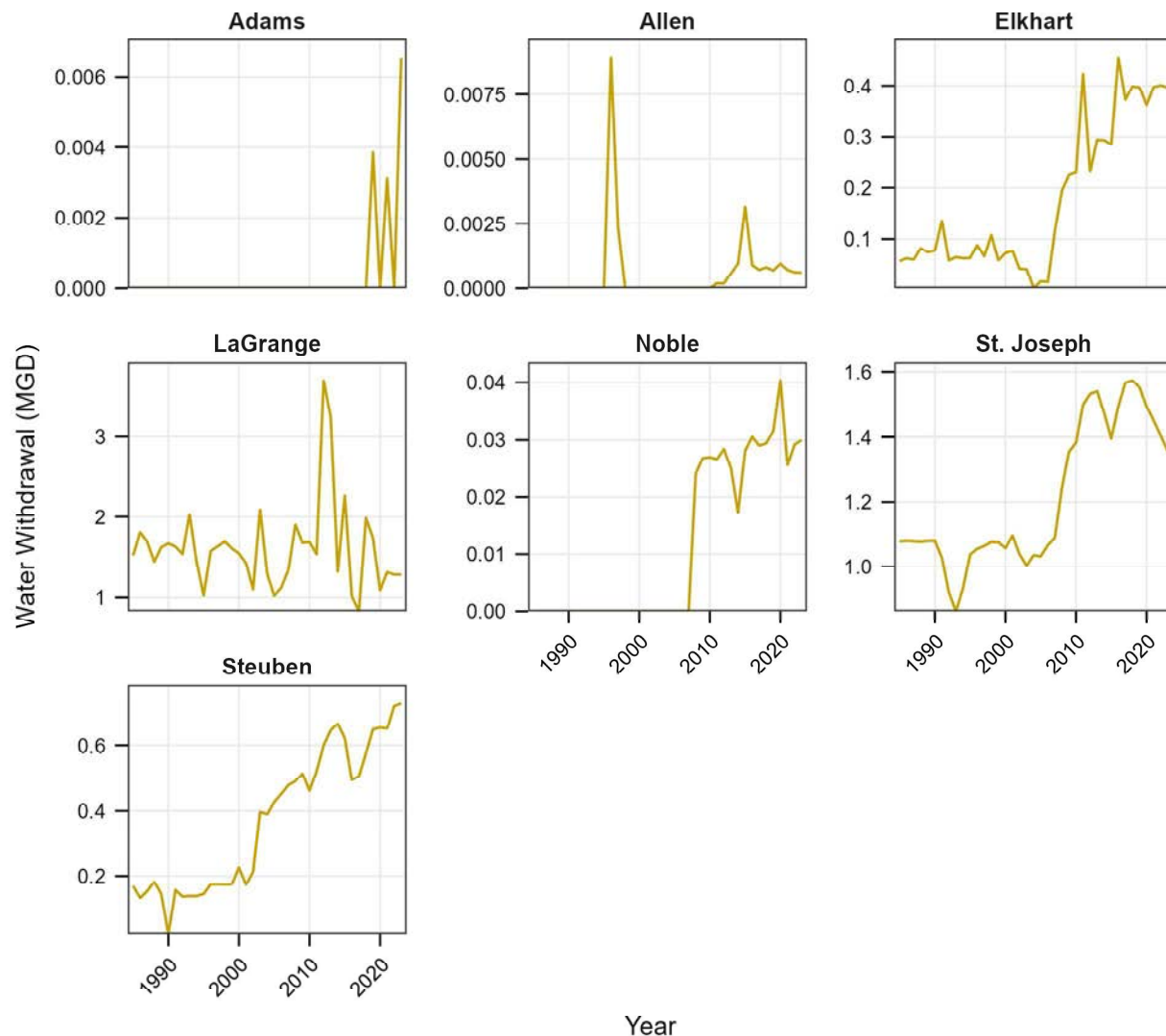


Figure 24. Annual average rural use withdrawal by county, 1985-2023. No rural withdrawals were reported in DeKalb and Kosciusko. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Noble, and St. Joseph.

2.1.3.3 Concentrated Animal Feeding Operations

In Indiana, livestock feeding operations over a certain size are regulated by IDEM, Office of Land Quality, under IC 13-18-10 of the Indiana Code. CFOs and the larger CAFOs are subject to a permitting process and inspections of associated building and manure storage structures. CFOs are farms that have more than 300 cattle, 600 pigs or sheep, 30,000 poultry, or 500 horses. CAFOs are farms with more than 700 dairy cows, 1,000 beef cattle, 2,500 adult pigs, 10,000 adolescent swine, 500 horses, 10,000 sheep, 55,000 turkeys, or between 30,000 and 125,000 chickens (depending on type and manure handling system). Both types of operations are referred to as CAFOs in this report.

The IDEM Office of Land Quality reports on the current location, type, and number of animals (**Figure 25**) for all CAFOs in Indiana. While poultry represents the largest CAFO type by far based on number of animals, pigs represent the largest CAFO water use. Of the poultry CAFOs, nearly all the largest are in Kosciusko County, with significant users being Midwest Poultry Services, various Creighton Brothers farms, and Precision Pullet. The remaining poultry CAFOs are largely concentrated in Elkhart, Noble, and Lagrange counties. Additionally, Indiana produces millions of ducks per year, primarily through two companies; Maple Leaf and Culver Farms. This production occurs almost entirely in Kosciusko, Elkhart, and Noble Counties.

The distribution of pig CAFOs follows a similar pattern to those of poultry, with the major concentrations occurring in Kosciusko, Noble, and Lagrange counties. Unlike the poultry CAFOs, however, there are many high-producing pig CAFOs located in Adams County as well, particularly Maple Creek Pork, one of the largest pig CAFOs. Other major pig CAFOs include JV Farms in Noble County, and Bacon Hill in Kosciusko County. The cow CAFOs within the Region are more evenly distributed than the other CAFO types and represent almost entirely dairy operations. Operations are located primarily in Adams, Noble, Kosciusko, Elkhart, and Lagrange Counties, with some large operations also taking place in De Kalb County. One of the larger dairy CAFOs located in Elkhart County has a co-located biogas facility; Green Cow Power.

These reported data from 2021 were used to estimate CAFO water withdrawals within the basin by multiplying the number of animals with a per animal water-use coefficient (**Table 11** and **Appendix B**). To understand how CAFOs have changed over time, the United State Department of Agriculture's (USDA) reported historical inventory of animals (all livestock, not just CAFOs) in each county was used as a surrogate. These data provided a historical trend to use in the predictive analysis (**Section 2.2.6**).

Table 11. Calculated CAFO water withdrawal (MGD) for the county areas within the Northeast Indiana Region (IDEM, 2021).

County	CAFO Water Withdrawals (MGD)
Adams	0.33
Allen	0.08
De Kalb	0.17
Elkhart	0.17
Kosciusko	0.07
Lagrange	0.19
Noble	0.27
St Joseph	0.02
Steuben	0.04
Total	1.34

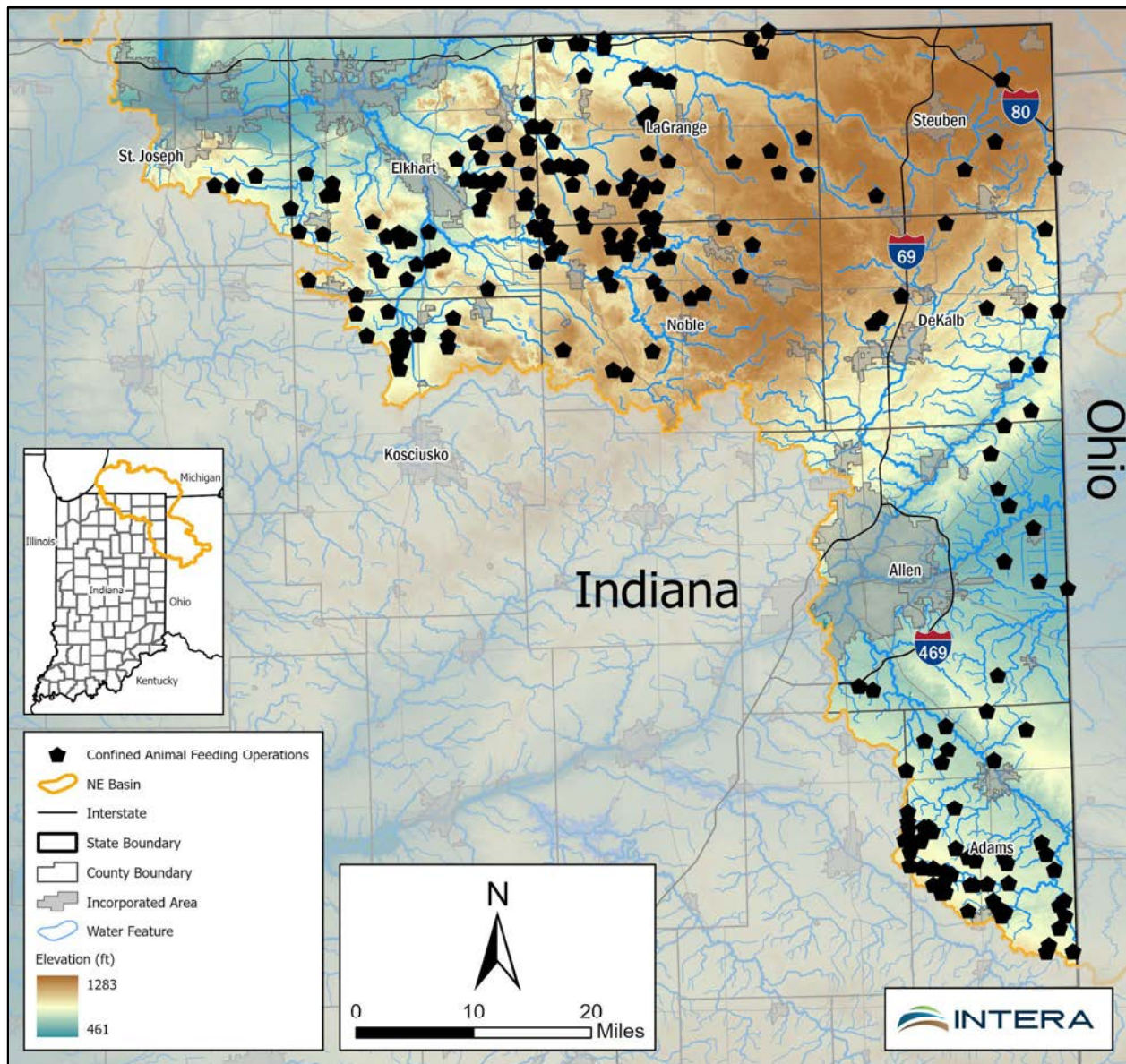


Figure 25. Confined animal feeding operations in the Northeast Indiana Region (IDEM, 2021).

2.1.4 Power Production

Energy production withdrawals within the Region are associated primarily with cooling water supply, process-water, and related operational needs at power generation and energy-related facilities. As shown in **Figure 26**, energy production facilities comprise 8 registered groundwater wells and two surface water intakes active in 2023, with a spatial distribution that differs notably from most other sectors in the Region. Energy production facilities are distributed across both.

Energy production withdrawals are drawn almost entirely from surface water with groundwater, representing a comparatively small component of total regional water demand (**Figure 27**). The record

shows that total withdrawals have historically been in the range of approximately 15-30 MGD for the period of record, but there has been a significant increase to approximately 40 MGD starting in 2022. During the period of record, annual groundwater withdrawals have consistently been below 5 MGD.

Energy production withdrawals exhibit a strong and consistent seasonal pattern driven almost entirely by St. Joseph County, which accounts for the overwhelming majority of regional energy production withdrawal volume (**Figure 28**). Allen and Adams counties contribute comparatively minor and relatively stable withdrawal volumes throughout the year. The monthly withdrawal records show that St. Joseph County energy production withdrawals peak sharply during Summer months, reaching 40 to 60 MGD at peak, and decline to near-zero levels during Winter, producing a pronounced annual cycle that repeats consistently throughout the study period (**Figure 28**). This pattern is characteristic of cooling withdrawals at power generation facilities, where demand tracks ambient temperature and electricity generation load. The seasonal amplitude of St. Joseph County's energy production withdrawals is among the largest of any individual county-sector combination in the regional withdrawal record and has important implications for evaluating peak-season water availability in that portion of the Region.

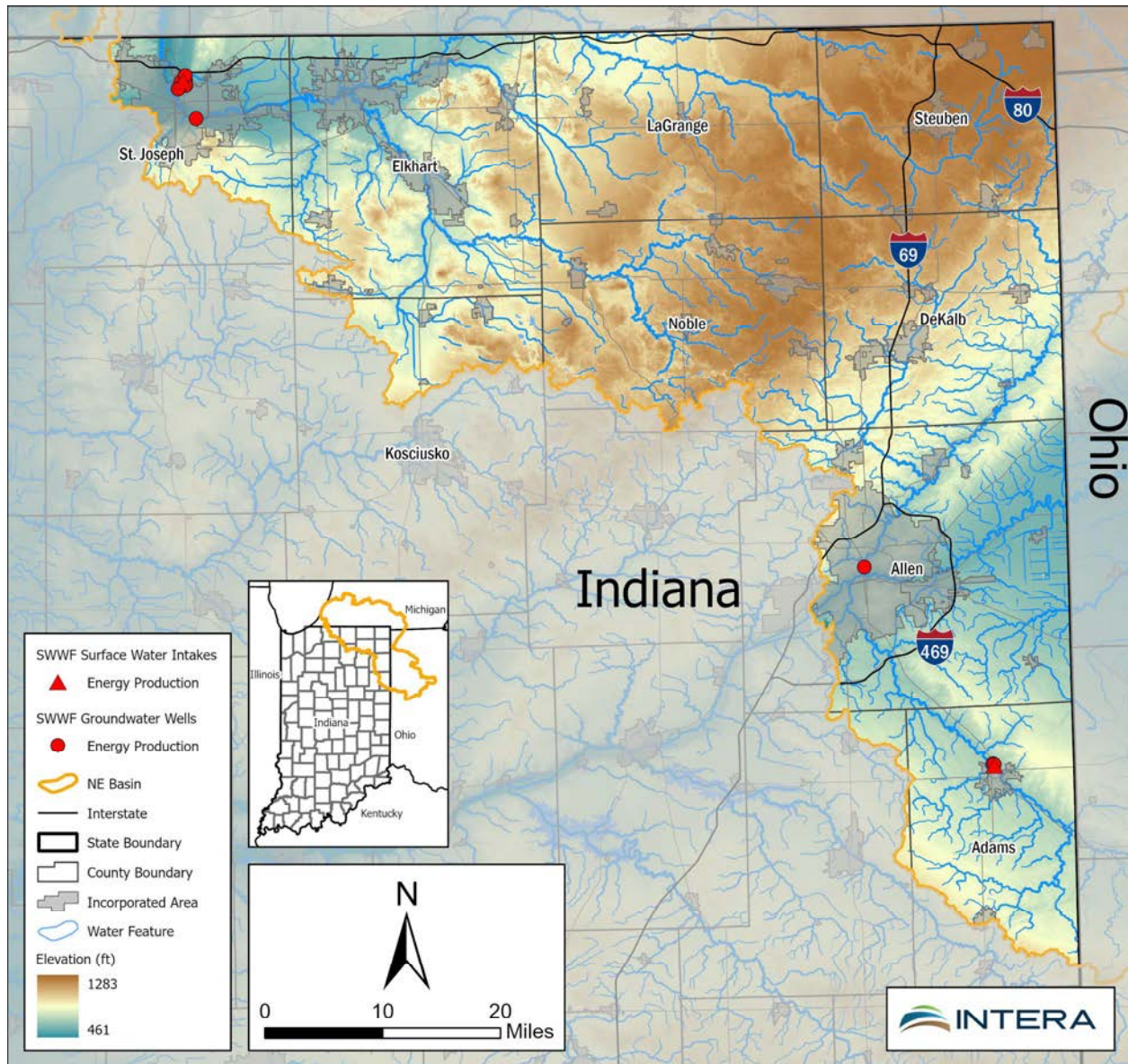


Figure 26. Registered wells and surface water intakes used for energy production from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.

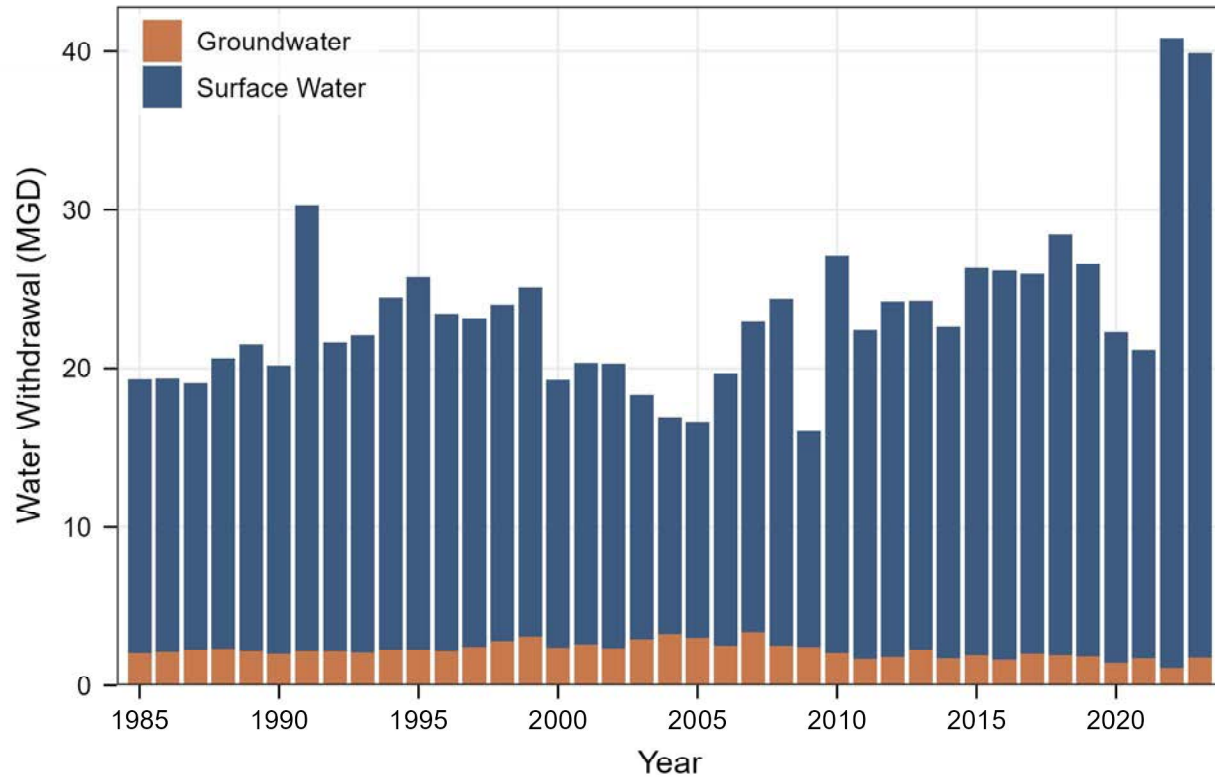


Figure 27. Annual average energy production withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.

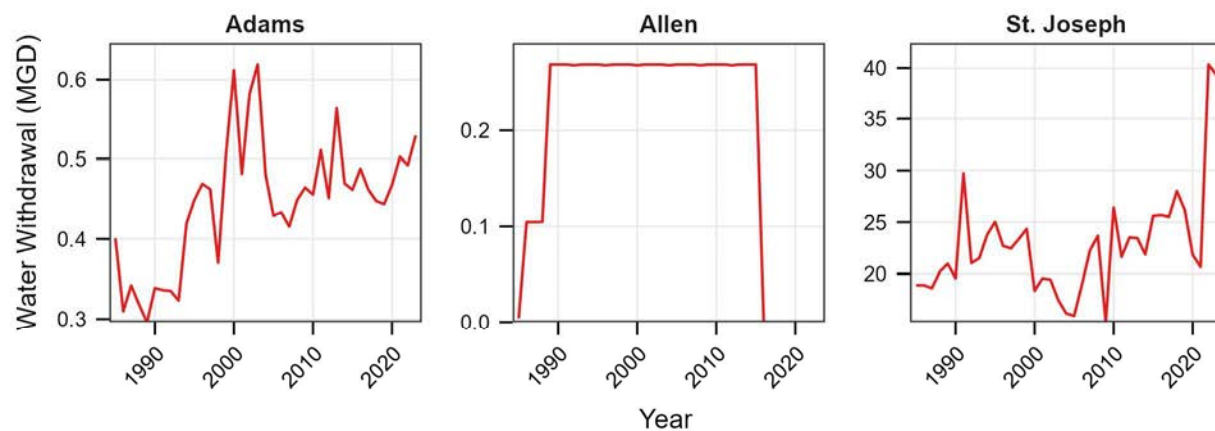


Figure 28. Annual average energy production withdrawal by county as reported in the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, and St. Joseph.

2.1.5 Industrial Water Supply

Industrial water withdrawal within the Region reflects the Region's diverse manufacturing base, encompassing a range of water-intensive industries including food and beverage processing, metal fabrication, chemical manufacturing, and the recreational vehicle and manufactured housing industries concentrated in the South Bend–Elkhart corridor. As shown in **Figure 29**, industrial facilities comprise 98 registered groundwater wells and 18 surface water intakes active in 2023, with a spatial distribution more evenly balanced between the two basins than most other sectors. The highest concentration of industrial facilities is located along the US-20/I-90 corridor in the northwestern St. Joseph River Basin, where the South Bend–Elkhart manufacturing corridor accounts for a substantial share of regional industrial withdrawal. A secondary concentration is present in the Maumee River Basin along the I-69 corridor in Allen County. Surface water intakes are distributed across both basins, reflecting the use of rivers and streams as industrial process and cooling water sources at facilities with direct access to surface water features.

Industrial water withdrawal has undergone the most significant long-term decline of any sector in the Region, with total withdrawals falling from approximately 30 to 35 MGD in the late 1980s to approximately 15 to 20 MGD by the early 2020s, a reduction of roughly 40 to 50 percent over the study period (**Figure 30**). This decline likely reflects broader structural changes in the regional manufacturing economy, including facility closures, process efficiency improvements, water recycling and reuse practices, and the contraction of water-intensive industrial operations. The decline is relatively continuous throughout the study period, with a notable step-down evident around 2000 to 2005 corresponding to significant industrial restructuring in the regional economy.

Industrial withdrawals draw on both groundwater and surface water sources, with the relative contribution of each source varying across facilities and counties. Allen County accounts for the largest share of industrial withdrawal, consistent with the concentration of manufacturing in the Fort Wayne metropolitan area (**Figure 31**). Industrial water demand exhibits relatively limited seasonal variation compared to irrigation, reflecting the continuous nature of manufacturing operations.

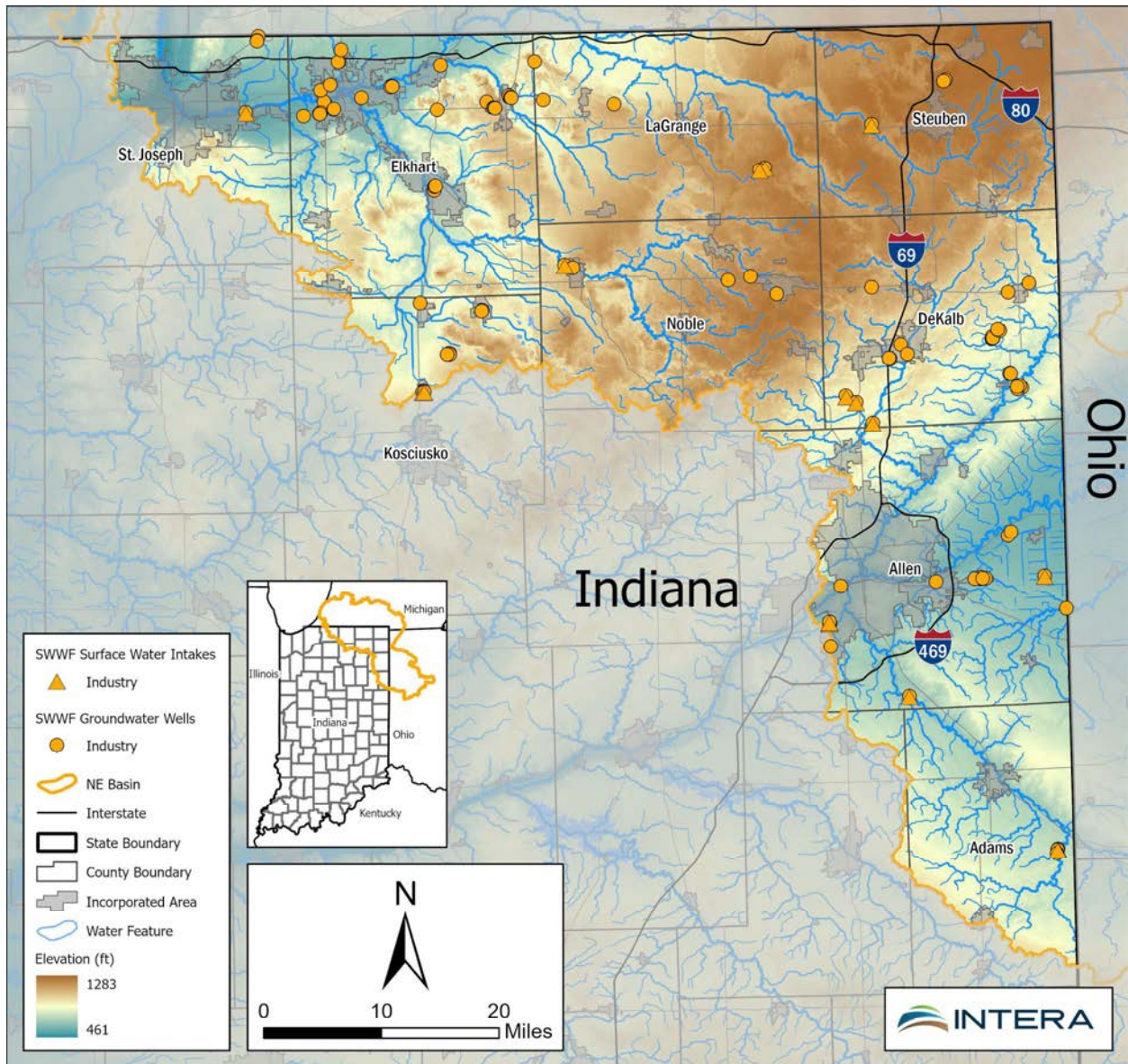


Figure 29. Registered groundwater wells and surface water intakes for industrial supply from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.

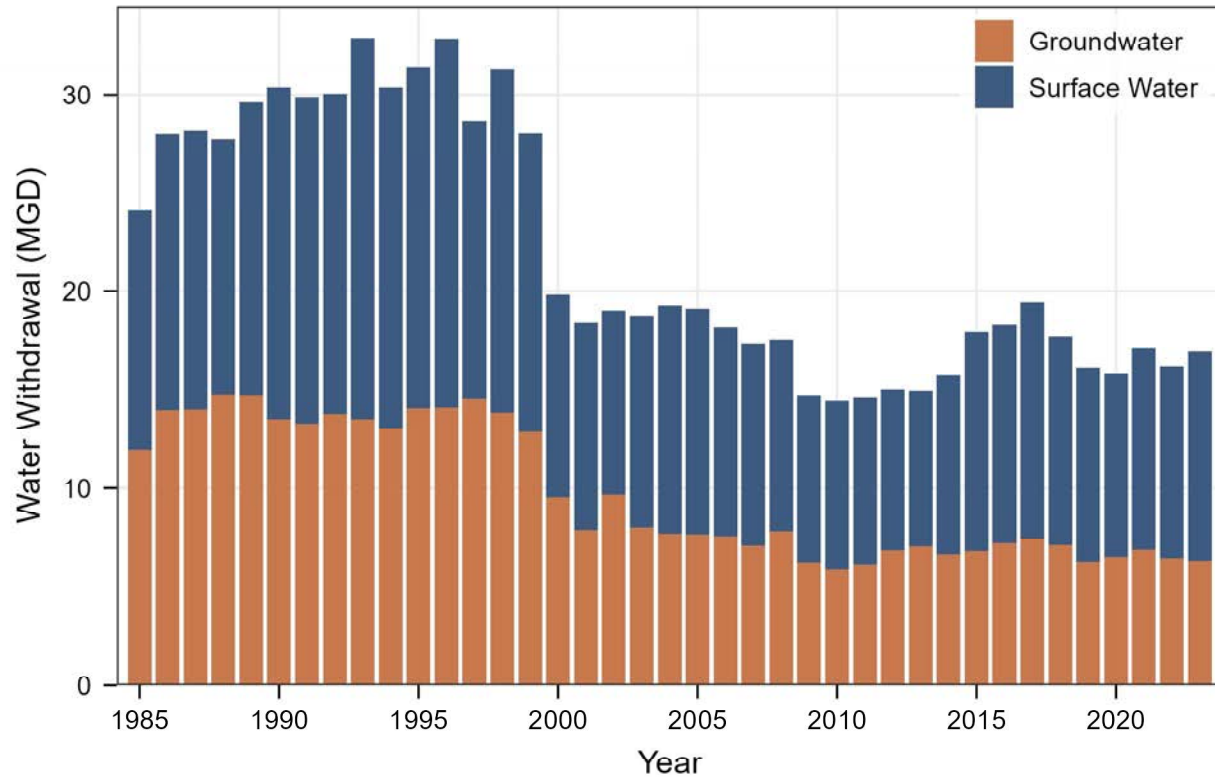


Figure 30. Annual average industrial withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.

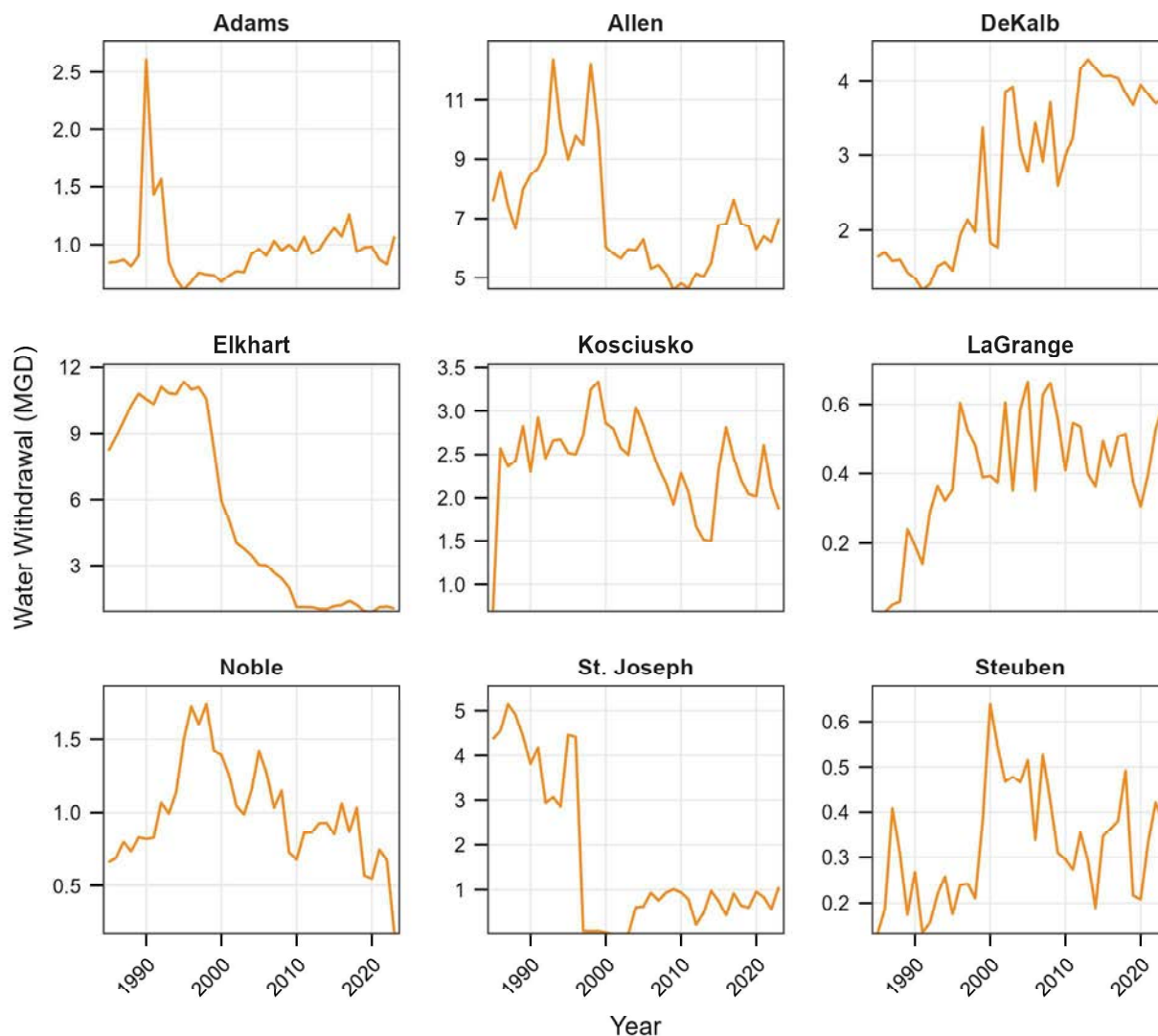


Figure 31. Annual average industrial withdrawals by county as reported in the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

2.1.6 Miscellaneous

The miscellaneous sector in the Region includes water withdrawals for fire suppression and protection, construction and foundation dewatering, dust control, groundwater remediation, and lake-level maintenance. As shown in **Figure 32**, miscellaneous facilities comprise 52 registered groundwater wells and two surface water intakes active in 2023. Miscellaneous withdrawals within the Region are primarily from groundwater (**Figure 33**), with recent declines from 11 MGD in 1995 to 3 MGD in 2023. The withdrawals by county (**Figure 34**) are highly variable from year to year and show no apparent trend. This reflects the transient nature of the water use sector, where continuous withdrawals over many years are unlikely. Rather, facilities register withdrawals as needed and then become inactive.

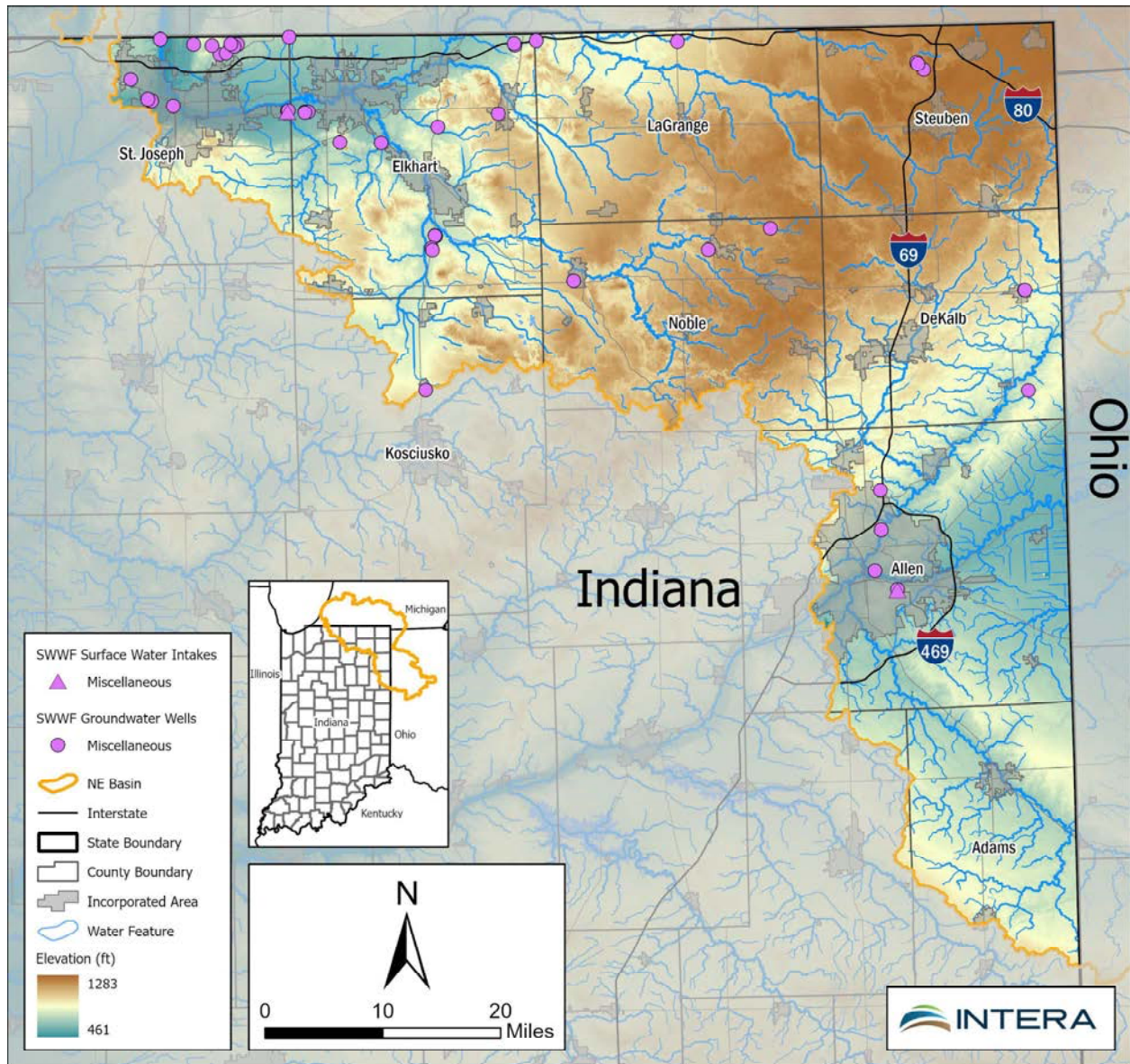


Figure 32. Registered groundwater wells and surface water intakes for miscellaneous supply from the SWWF database. Figure shows groundwater wells and surface water intakes that were active in 2023.

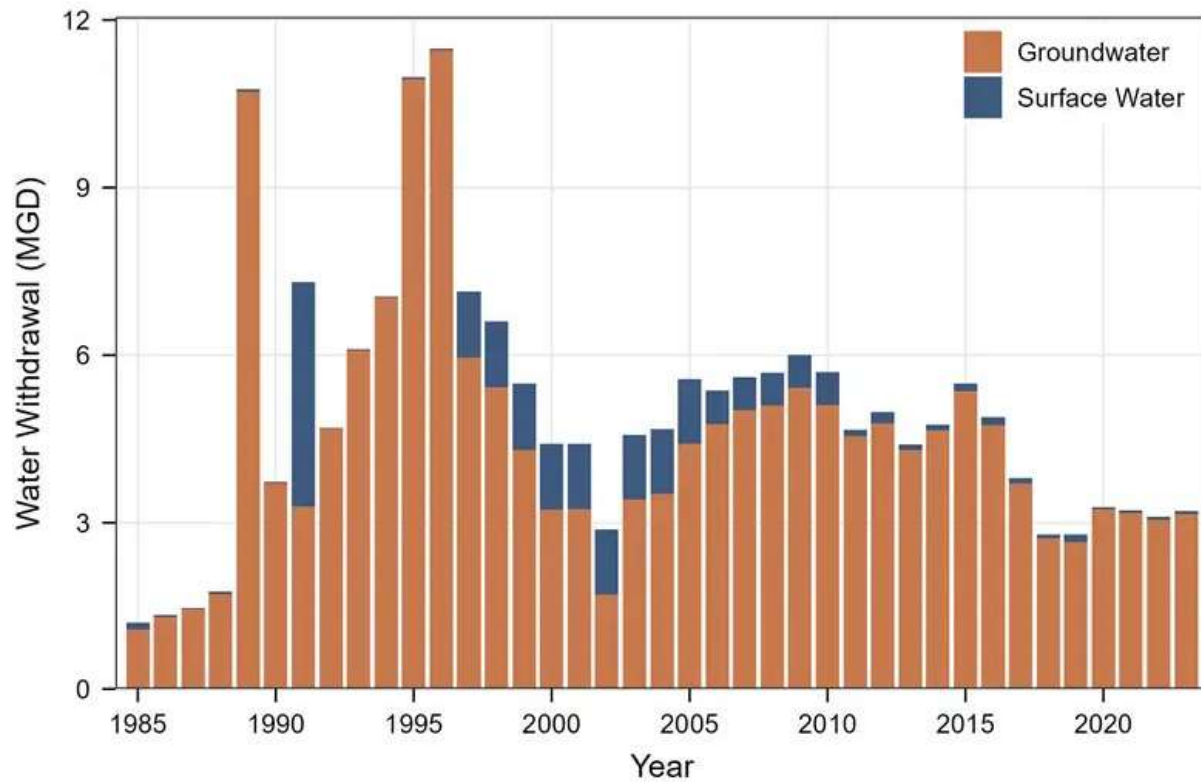


Figure 33. Annual average miscellaneous withdrawals for the Northeast Indiana Region by source as reported in the SWWF database from 1985-2023.

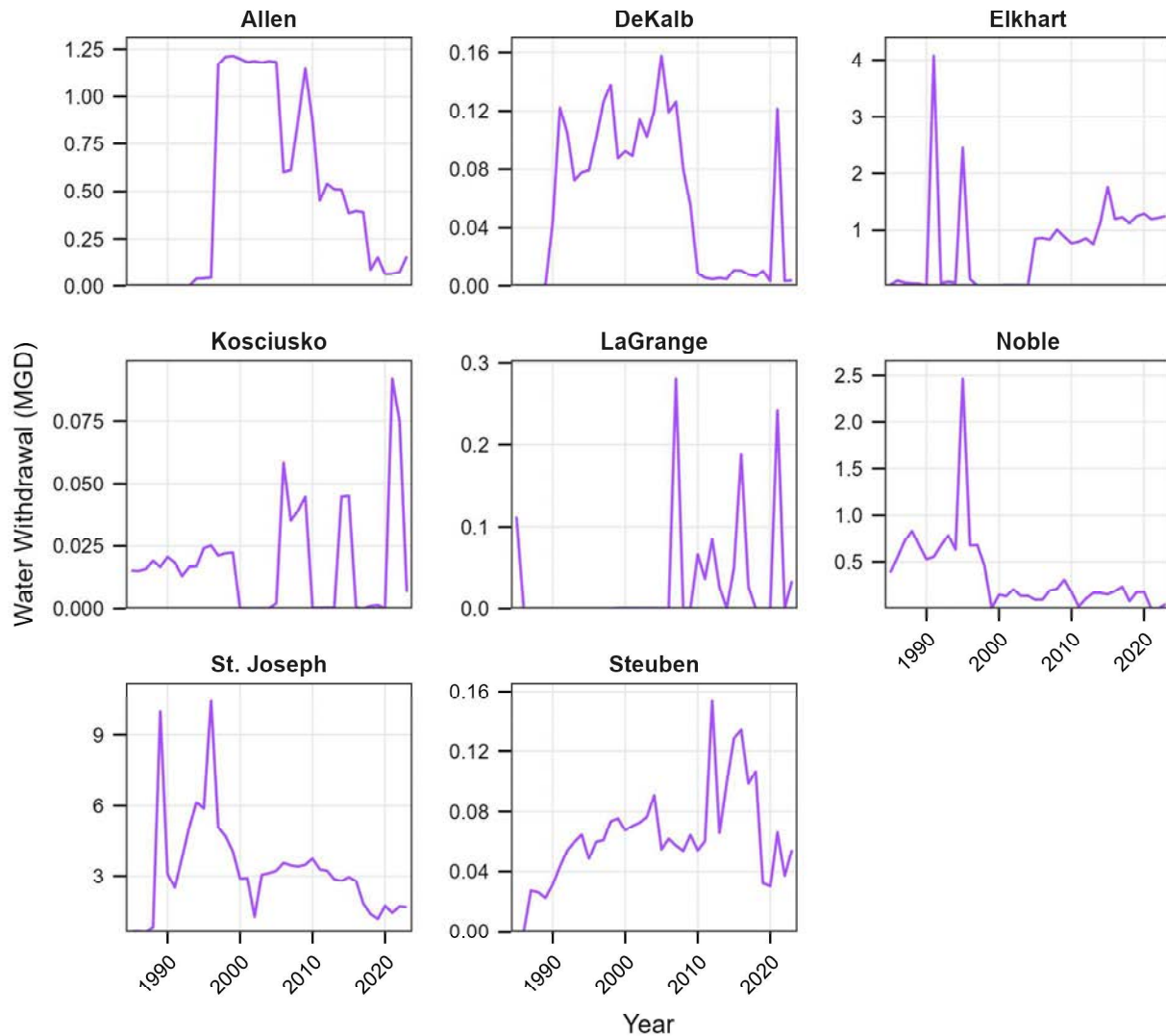


Figure 34. Annual average miscellaneous withdrawals by county as reported in the SWWF database, 1985-2023. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

2.2 Water Demand Forecasts

Significant water withdrawal facilities form the foundation of the demand analysis. Facilities capable of withdrawing 100,000 gallons per day or more are required to report monthly withdrawals to the IDNR, and these reported withdrawals form the basis of the demand analysis. Withdrawal is the quantity a user removes from either groundwater or surface water sources to meet a need. For planning purposes, the volume withdrawn represents the volume the Region must be capable of supplying. For most use sectors, the terms “withdrawal” and “demand” are therefore used interchangeably throughout this section, except for public water supply, where demand is evaluated separately from withdrawals.

The SWWF program categorizes withdrawals by user sector, which form the basis of the demand forecast: public water supply, irrigation and agriculture, industry and commerce, power generation, and a small set of miscellaneous and rural-use withdrawals. Two additional sectors fall outside the SWWF program because their individual users each withdraw less than the 100,000 gallon-per-day threshold that triggers registration. These are self-supplied residential water users, which include households on private wells not connected to a public system and animal agriculture (confined feeding operations and livestock watering). Both are estimated separately and added to the SWWF-based sectors to give a complete picture of regional demand; self-supplied residential is reported as a new sector, while CAFO withdrawals are added to the rural use sector.

All demand quantities are reported in MGD, and both groundwater and surface water withdrawals are included. The models are fit on the 1985–2023 historical record. Results are summarized on a county basis and were subsequently allocated to the project sub-basins for the water availability analyses.

2.2.1 Methodology

Demand forecasts were developed by fitting statistical models to the historical record of monthly withdrawals and projecting those relationships through the 2070 planning horizon. The models relate demand to a set of explanatory drivers (population, income, and climate, together with sector-specific factors), so that the forecast responds to expected future changes in those drivers rather than simply continuing a past trend.

The forecasts use a linear mixed-effects model based on the following predictors: population, per-capita income, climate, and sector-specific drivers. A complete description of the modeling approach is provided in **Appendix B**.

The order of presentation of sector forecasts follows **Section 2.1**, with some changes related to forecast methodology; the simplest models (RU and MI) are described last.

2.2.2 Total Demand Forecast

Combining all use sectors gives the total demand forecast for the Northeast Indiana Region. Total demand is projected to rise from about 197 MGD in 2020 to about 291 MGD in 2070, an increase of 48 percent over the planning horizon. The projected increase is driven almost entirely by irrigation, the only sector with substantial projected growth; public supply and industry edge down slightly, rural use rises

modestly from a small base, and power generation, self-supplied residential, and miscellaneous use are essentially flat.

Demand projections through 2070 by use sector are summarized in **Figure 35** and **36**; projections of total demand by county are summarized in **Figure 37** and enumerated in **Table 12**.

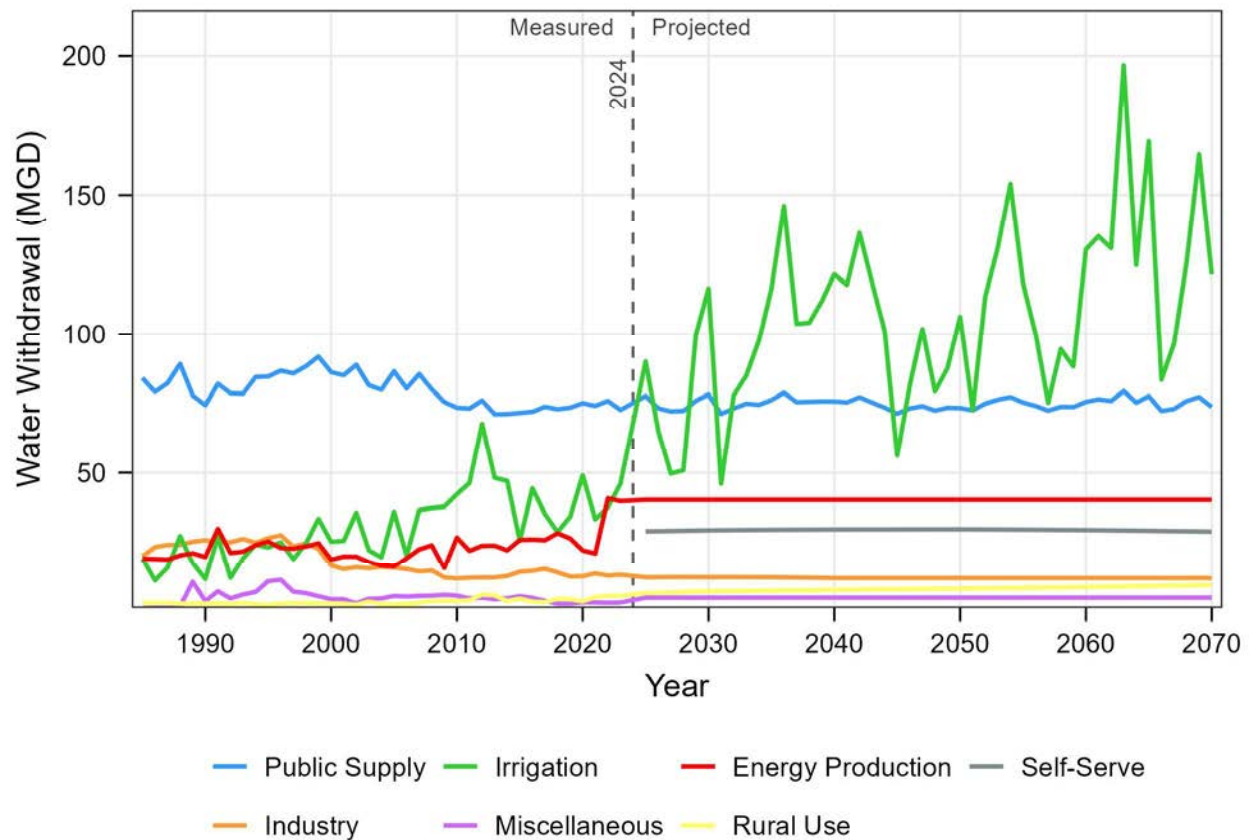


Figure 35. Historical and projected water demand in the Region by water-use sector, 1985-2070. Self-Serve indicates the Self-supplied residential sector, and CAFO withdrawals are added to the rural use sector.

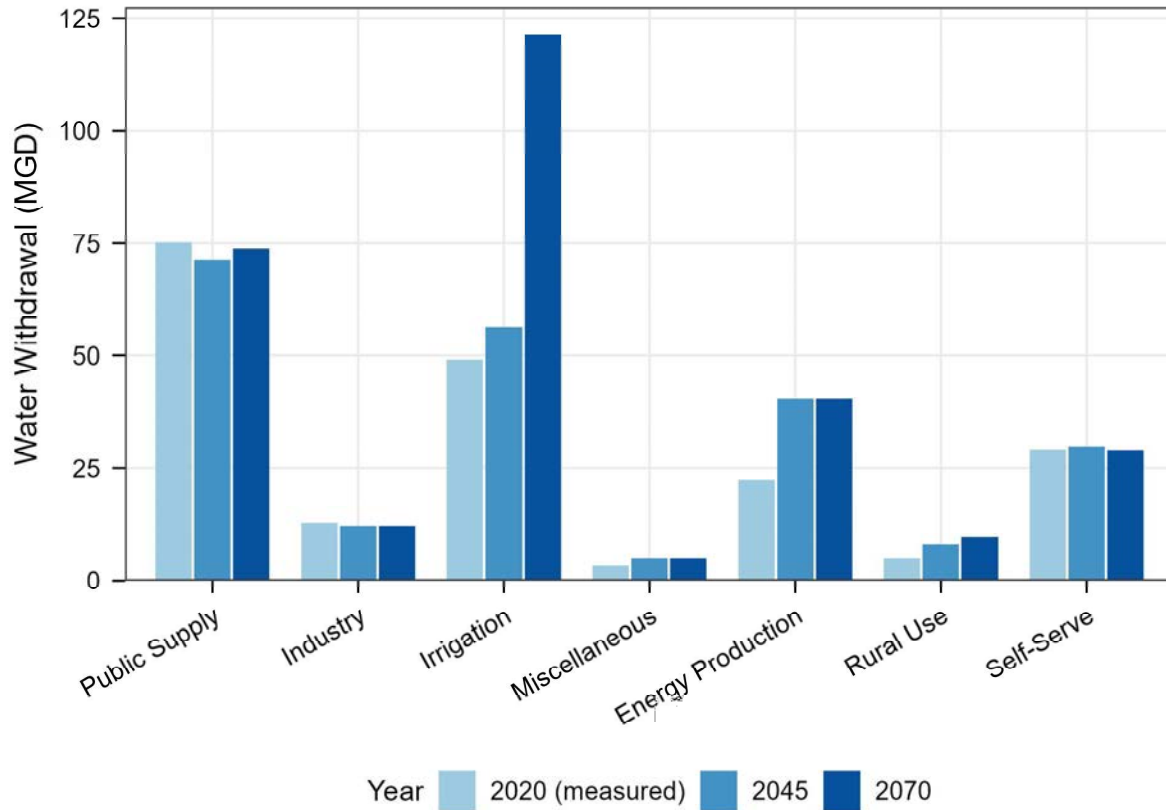


Figure 36. Demand by use sector in 2020, 2045, and 2070. Self-Serve indicates the Self-supplied residential sector, and CAFO withdrawals are added to the rural use sector.

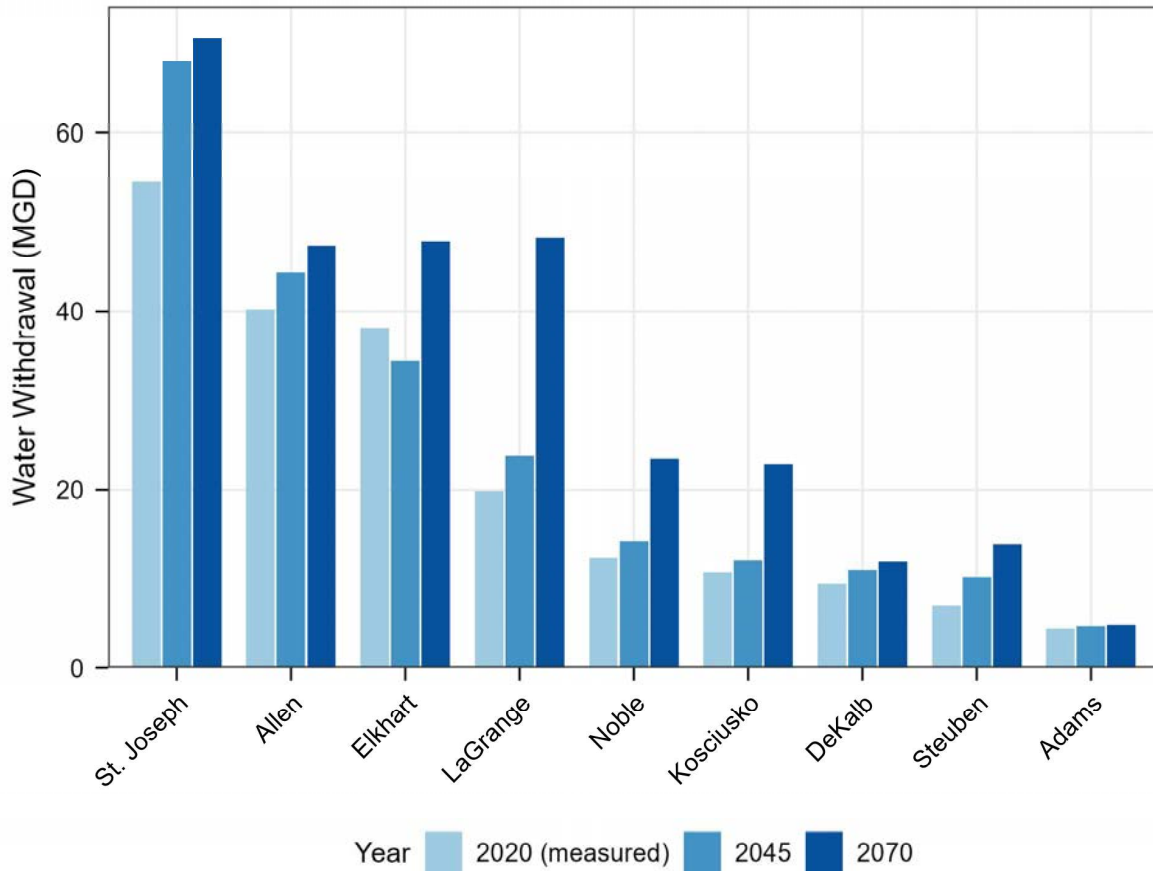


Figure 37. Demand by county in 2020, 2045, and 2070. Only data from within the Region are presented in the graph. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Table 12. Total water demand for all water-use sectors within the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Year	Adams	Allen	DeKalb	Elkhart	Kosciusko	LaGrange	Noble	St Joseph	Steuben	Totals
2020	4.47	40.25	9.44	38.19	10.74	19.83	12.29	54.50	6.93	197
2025	4.53	44.77	11.40	43.85	19.41	31.79	20.13	74.38	10.75	261
2030	4.53	46.76	12.32	49.07	24.86	38.71	23.80	75.38	13.55	289
2035	4.58	46.10	12.19	46.32	23.37	42.00	24.04	73.26	15.39	287
2040	4.68	45.65	12.69	47.91	24.07	42.46	26.34	73.21	15.06	292
2045	4.71	44.38	10.99	34.45	12.01	23.75	14.27	68.07	10.18	223
2050	4.79	45.46	12.15	43.50	18.68	41.38	24.60	70.11	14.40	275
2055	4.86	46.99	12.43	45.99	23.48	44.19	24.95	71.87	14.54	289
2060	4.88	47.27	12.31	50.52	25.52	47.05	26.63	73.07	14.34	302
2065	4.92	48.81	13.01	55.70	37.18	59.32	32.17	74.61	16.90	343
2070	4.90	47.40	11.88	47.76	22.83	48.21	23.49	70.69	13.95	291

2.2.3 Public Water Supply

Public supply demand is projected to remain broadly stable, easing from about 75 MGD in 2020 to about 74 MGD in 2070 as a continuing decline in per-capita use slightly outpaces modest population growth. This per-capita decline is attributed to steadily improving water efficiency in fixtures, appliances, and outdoor use. This trend is assumed to level off by 2030.

Results including historical and forecasted public supply demand by county are presented in **Figure 38** and **Table 13**. Note the y-axis differences between counties in the figure.

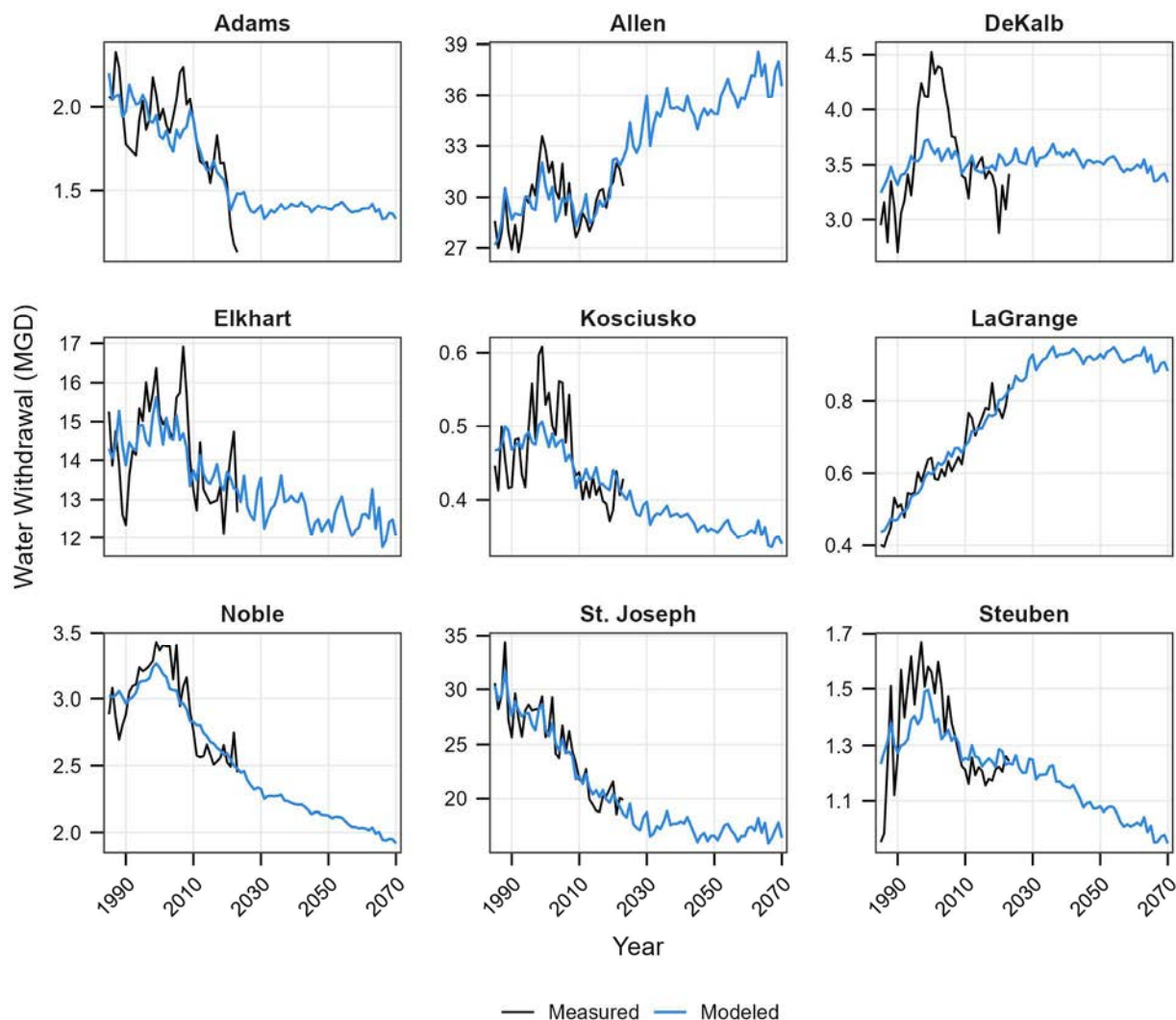


Figure 38. Historical and predicted average annual public supply demand by county from 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Table 13. Public water supply demand in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Year	Adams	Allen	Dekalb	Elkhart	Kosciusko	Lagrange	Noble	St. Joseph	Steuben	Totals
2020	1.53	30.89	2.88	13.34	0.39	0.78	2.52	21.58	1.22	75
2025	1.49	34.38	3.64	13.60	0.41	0.87	2.46	19.55	1.26	78
2030	1.41	35.98	3.65	13.55	0.40	0.93	2.32	18.76	1.25	78
2035	1.39	35.40	3.62	13.13	0.39	0.93	2.27	17.90	1.22	76
2040	1.41	35.16	3.61	12.97	0.38	0.93	2.21	17.93	1.15	76
2045	1.37	33.98	3.47	12.08	0.36	0.90	2.14	16.03	1.08	71
2050	1.39	34.90	3.53	12.49	0.36	0.93	2.13	16.62	1.08	73
2055	1.41	36.26	3.53	12.64	0.36	0.93	2.08	17.12	1.05	75
2060	1.39	36.46	3.47	12.61	0.36	0.92	2.03	17.34	1.02	76
2065	1.38	37.82	3.49	12.80	0.36	0.92	2.00	17.82	1.01	78
2070	1.33	36.54	3.34	12.05	0.34	0.88	1.92	16.44	0.95	74

2.2.4 Self-Supplied Residential Water Supply

Self-supplied residential demand covers households on private wells that are not served by a public utility and so does not appear in the SWWF record. This demand is not fit with a demand model; instead, it is computed directly as the share of each county's population that is not served by utilities multiplied by an assumed per-capita use rate.

The per-capita rate is 80 GPCD for the general population (a conventional self-supplied domestic rate, after Dieter et al., 2018) blended with a lower 40 GPCD for the Amish population (who use less plumbing- and appliance-driven water), weighted by each county's Amish share from the 2010 religious census (Manns, 2012). Amish households are assumed to use 40 GPCD; no measured Amish rates exist. The value is estimated as the low end of the range specified in EPA estimates of typical water use for homes with modern fixtures (EPA, 2002). Only the four counties with a recorded Amish population therefore fall below 80 GPCD (see **Table 9**).

Both the served/unserved split and the per-capita rate are held constant over time, so the forecast tracks projected county population alone (**Table 14**). Because the Region's projected residential population is roughly flat, self-supplied residential demand is projected to be nearly flat around 29-30 MGD from 2025 to 2070. The sector does not respond to climate.

Table 14. Self-supplied residential water demand forecast by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Year	Adams	Allen	Dekalb	Elkhart	Kosciusko	Lagrange	Noble	St. Joseph	Steuben	Totals
2020	1.14	5.87	1.51	8.56	0.78	2.29	1.85	5.60	1.54	29
2025	1.14	5.87	1.51	8.56	0.78	2.29	1.85	5.60	1.54	29
2030	1.15	6.04	1.53	8.66	0.78	2.33	1.84	5.62	1.55	29
2035	1.16	6.17	1.54	8.71	0.77	2.37	1.82	5.62	1.52	30
2040	1.17	6.29	1.55	8.74	0.77	2.39	1.78	5.61	1.49	30
2045	1.18	6.39	1.55	8.76	0.76	2.41	1.76	5.58	1.46	30
2050	1.19	6.47	1.55	8.77	0.75	2.42	1.73	5.56	1.42	30
2055	1.18	6.56	1.54	8.69	0.74	2.42	1.69	5.55	1.38	30
2060	1.17	6.64	1.52	8.61	0.73	2.40	1.65	5.53	1.33	30
2065	1.15	6.70	1.49	8.51	0.72	2.36	1.61	5.50	1.29	29
2070	1.13	6.75	1.47	8.40	0.70	2.31	1.56	5.46	1.25	29

2.2.5 Irrigation

Irrigation is the most weather-sensitive sector and the dominant source of projected growth in regional demand. Demand is driven by the area of irrigated land and by the growing-season moisture deficit, so the forecast responds both to expected changes in irrigated acreage and to a warmer, drier projected climate.

In the model, projected demand is the water requirement per acre multiplied by the irrigated area, which makes the projected area one of the most important inputs to the forecast. Irrigated area is taken from the USDA Census of Agriculture (USDA, 2024), which reports irrigated acres by county every five years, and five censuses fall within the study period. A continuous annual series was built for each county by fitting a straight line through its reported values, so that a single unusual census year does not create an artificial step in demand. Before the first census the area is held constant at a level inferred from the irrigation withdrawals reported in those years; after the last census the fitted line is extended forward, except for Allen County, whose trend is declining and which is conservatively held constant rather than projected toward zero. Climate enters this projection only implicitly. It is one of the factors that has driven the historical growth in irrigated land and will continue to influence how much land is irrigated, but it is not an explicit predictor of the extrapolated area. In the forecast, a changing climate acts through the water requirement per acre alone.

The forward projection of irrigated acreage is capped at twice each county's fitted area in the final census year. In LaGrange County the projected 2070 irrigated acreage reaches about 40 percent of the total agricultural land area; this is the highest in the Region. Region-wide, the average irrigated acreage is about 19 percent of the total agricultural land. The resulting area series is shown by county in **Figure 39**.

Irrigation demand is projected to rise from about 49 MGD in 2020 to about 121 MGD in 2070, a 147 percent increase, and accounts for essentially all the Region's projected total increase. Almost all this growth is climate-driven, which increases both irrigated acreage and water demand. The projected warming and drying of the growing season increase the moisture deficit and irrigation responds quickly to that deficit. This makes irrigation both the most climate-sensitive sector and the most uncertain; its forecast is largely dependent on future climate conditions which are highly uncertain.

Irrigation also shows the largest year-to-year swings of any sector, and—as noted under the climate predictor—these swings reflect the general variability of the modeled climate rather than predictions of demand in any specific year. A summary of the historical and forecast irrigation demand from 1985 to 2070 by county is presented in **Figure 40** and **Table 15**. Note the y-axis differences between counties in the figure.

Additional information on the assumptions made in the irrigation demand model and uncertainties in the predictions are presented in **Section 2.3**.

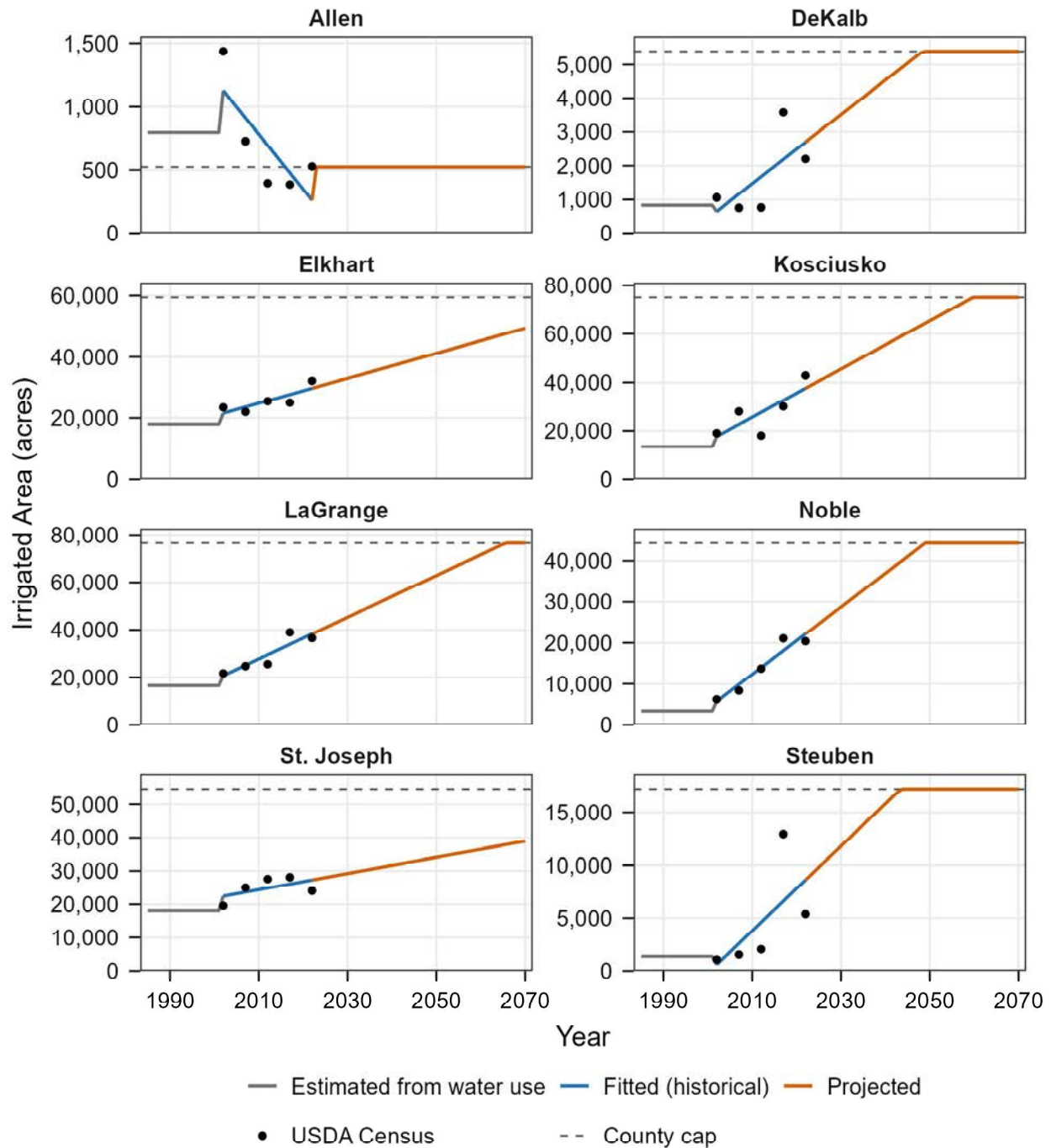


Figure 39. Irrigated area by county, 1985 to 2070, with each county's cap shown as a dashed line. Note the y-axis differences between counties.

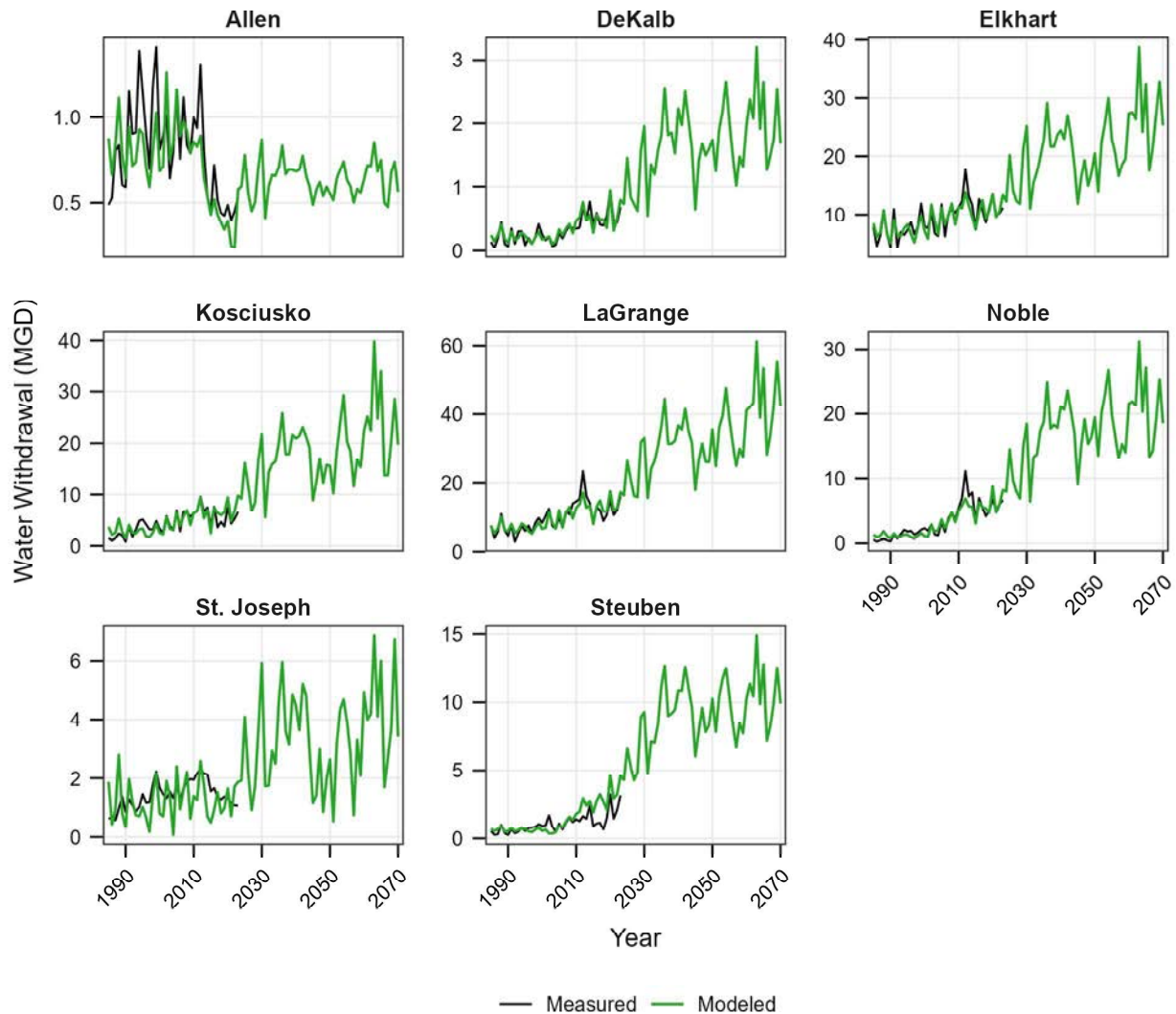


Figure 40. Historical and forecast irrigation demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Table 15. Irrigation water demand forecast by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Year	Adams	Allen	DeKalb	Elkhart	Kosciusko	LaGrange	Noble	St Joseph	Steuben	Totals
2020	0.02	0.49	0.93	13.58	7.49	15.19	6.88	1.31	3.23	49
2025	0.00	0.78	1.45	20.17	16.07	26.33	14.52	4.01	6.61	90
2030	0.00	0.87	1.96	25.21	21.66	33.11	18.45	5.80	9.28	116
2035	0.00	0.71	1.81	22.80	20.18	36.35	18.74	4.52	11.13	116
2040	0.00	0.68	2.23	24.48	20.95	36.70	21.13	4.38	10.85	121
2045	0.00	0.49	0.65	11.88	8.91	17.99	9.12	1.14	6.04	56
2050	0.00	0.55	1.74	20.49	15.57	35.57	19.44	2.59	10.25	106
2055	0.00	0.63	2.02	22.85	20.36	38.34	19.83	3.85	10.41	118
2060	0.00	0.64	1.96	27.44	22.42	41.18	21.57	4.81	10.24	130
2065	0.00	0.75	2.65	32.47	34.07	53.40	27.14	5.87	12.80	169
2070	0.00	0.56	1.67	25.32	19.74	42.29	18.55	3.33	9.90	121

2.2.6 Concentrated Animal Feeding Operations

The historical water withdrawal calculation was described in **Section 2.1.3**. To make projections for future water withdrawals for CAFOs, the linear trend for each county was calculated from the historical dataset. The historical linear trend for each county was used to project the future water withdrawals in the Region. A summary of the projected water withdrawals, expected to increase from 1.3 to 3.6 MGD, is provided in **Table 16**. The details of the projection process are provided in more detail in **Appendix B**.

Table 16. Confined Feeding Operation/Concentrated Animal Feeding Operation water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Year	Adams	Allen	Dekalb	Elkhart	Kosciusko	Lagrange	Noble	St. Joseph	Steuben	Totals
2020	0.33	0.08	0.17	0.17	0.07	0.19	0.27	0.02	0.04	1
2025	0.47	0.09	0.23	0.26	0.09	0.28	0.37	0.03	0.04	2
2030	0.52	0.10	0.25	0.29	0.10	0.31	0.41	0.03	0.04	2
2035	0.58	0.10	0.26	0.31	0.11	0.34	0.45	0.03	0.05	2
2040	0.64	0.11	0.28	0.34	0.12	0.37	0.49	0.04	0.05	2
2045	0.70	0.11	0.29	0.37	0.13	0.40	0.53	0.04	0.06	3
2050	0.76	0.12	0.31	0.39	0.14	0.43	0.57	0.05	0.06	3
2055	0.82	0.12	0.32	0.42	0.15	0.47	0.61	0.05	0.06	3
2060	0.87	0.13	0.34	0.44	0.17	0.50	0.65	0.05	0.07	3
2065	0.93	0.13	0.35	0.47	0.18	0.53	0.69	0.06	0.07	3
2070	0.99	0.14	0.37	0.50	0.19	0.56	0.73	0.06	0.08	4

2.2.7 Power Generation

Power-generation demand occurs at multiple facilities in the Region but is dominated by a single facility: the combined heat-and-power plant serving the University of Notre Dame in St. Joseph County, which accounts for about 97 percent of the Region’s power-generation withdrawal. The sector is projected to remain flat at about 40 MGD across the planning horizon. The historical record shows a sharp one-time step in 2022, from roughly 21–28 MGD over 2010–2021 to about 40 MGD, that reflects a plant reconfiguration (a move to combined-cycle generation with new lake-cooled chillers) rather than a rise in demand. It is therefore treated as a one-time regime-level shift, anchored at the post-2022 level and held flat rather than extrapolated. Historical and forecast demand for energy production by county are provided in **Figure 41** and **Table 17**. Note the y-axis differences between counties in the figure.

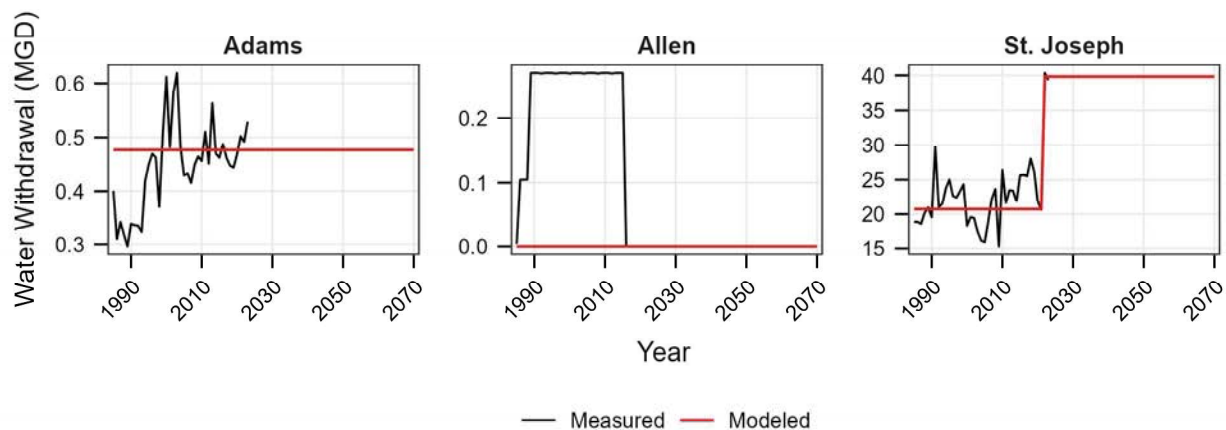


Figure 41. Historical and forecast energy-production demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, and St. Joseph.

Table 17. Energy production water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, and St. Joseph.

Year	Adams	Allen	Dekalb	Elkhart	Kosciusko	Lagrange	Noble	St. Joseph	Steuben	Totals
2020	0.47	0.00	0.00	0.00	0.00	0.00	0.00	21.83	0.00	22
2025	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2030	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2035	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2040	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2045	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2050	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2055	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2060	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2065	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40
2070	0.48	0.00	0.00	0.00	0.00	0.00	0.00	39.84	0.00	40

2.2.8 Industrial Water Supply

Self-supplied industrial and commercial demand reflects the manufacturing and processing activity that facilities meet from their own withdrawals. It is projected to remain roughly flat, holding near 12 MGD across the planning horizon (about 12.4 MGD in 2025 to 12.1 MGD in 2070, a slight decline of about 3 percent). As noted under public supply, this sector captures only the water that facilities withdraw themselves; industrial water purchased from a public utility is embedded in the public-supply record and is not projected as an industrial trend. A summary of historical and projected demand by county from 1985-2070 is presented in **Figure 42** and **Table 18**. Note the y-axis differences between the counties in the figure.

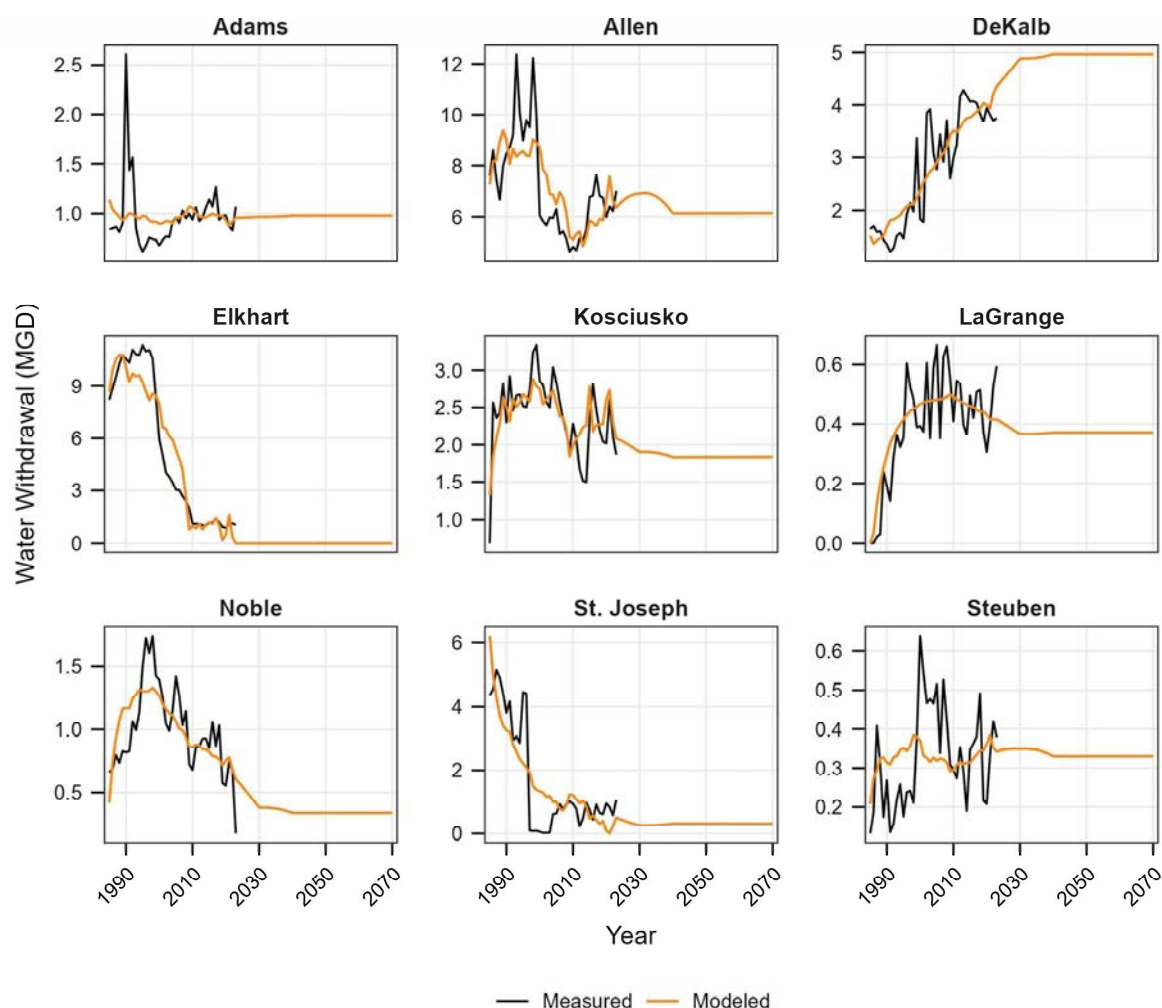


Figure 42. Historical and forecast industry and commerce demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Table 18. Industry water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Year	Adams	Allen	Dekalb	Elkhart	Kosciusko	Lagrange	Noble	St Joseph	Steuben	Totals
2020	0.98	2.86	3.94	0.89	2.02	0.31	0.55	0.95	0.21	13
2025	0.96	3.17	4.50	0.00	2.04	0.40	0.54	0.42	0.35	12
2030	0.97	3.30	4.88	0.00	1.91	0.37	0.38	0.27	0.35	12
2035	0.97	3.25	4.90	0.00	1.89	0.37	0.37	0.27	0.35	12
2040	0.98	2.93	4.97	0.00	1.84	0.37	0.34	0.32	0.33	12
2045	0.98	2.93	4.97	0.00	1.84	0.37	0.34	0.32	0.33	12
2050	0.98	2.93	4.97	0.00	1.84	0.37	0.34	0.32	0.33	12
2055	0.98	2.93	4.97	0.00	1.84	0.37	0.34	0.32	0.33	12
2060	0.98	2.93	4.97	0.00	1.84	0.37	0.34	0.31	0.33	12
2065	0.98	2.94	4.96	0.00	1.84	0.37	0.34	0.31	0.33	12
2070	0.98	2.94	4.96	0.00	1.84	0.37	0.34	0.31	0.33	12

2.2.9 Miscellaneous and Rural Use

The remaining SWWF categories, Miscellaneous and Rural use, account for a small share of regional demand and are carried through the forecast for completeness. Miscellaneous use (a heterogeneous catch-all of remediation, construction dewatering, recreational-lake upkeep, and fire protection) has no common driver and is held flat at its observed average of about 5 MGD. Rural use (fish hatcheries and SWWF-registered animal agriculture) is forecast with a climate-light version of the demand model and is projected to rise modestly from a low base, about 3 MGD in 2020 to about 6 MGD in 2070. A summary of historical and projected demand by county from 1985-2070 is presented in **Figure 43**, **Figure 44**, **Table 19**, and **Table 20**. Note the y-axis differences between the counties in the figures.

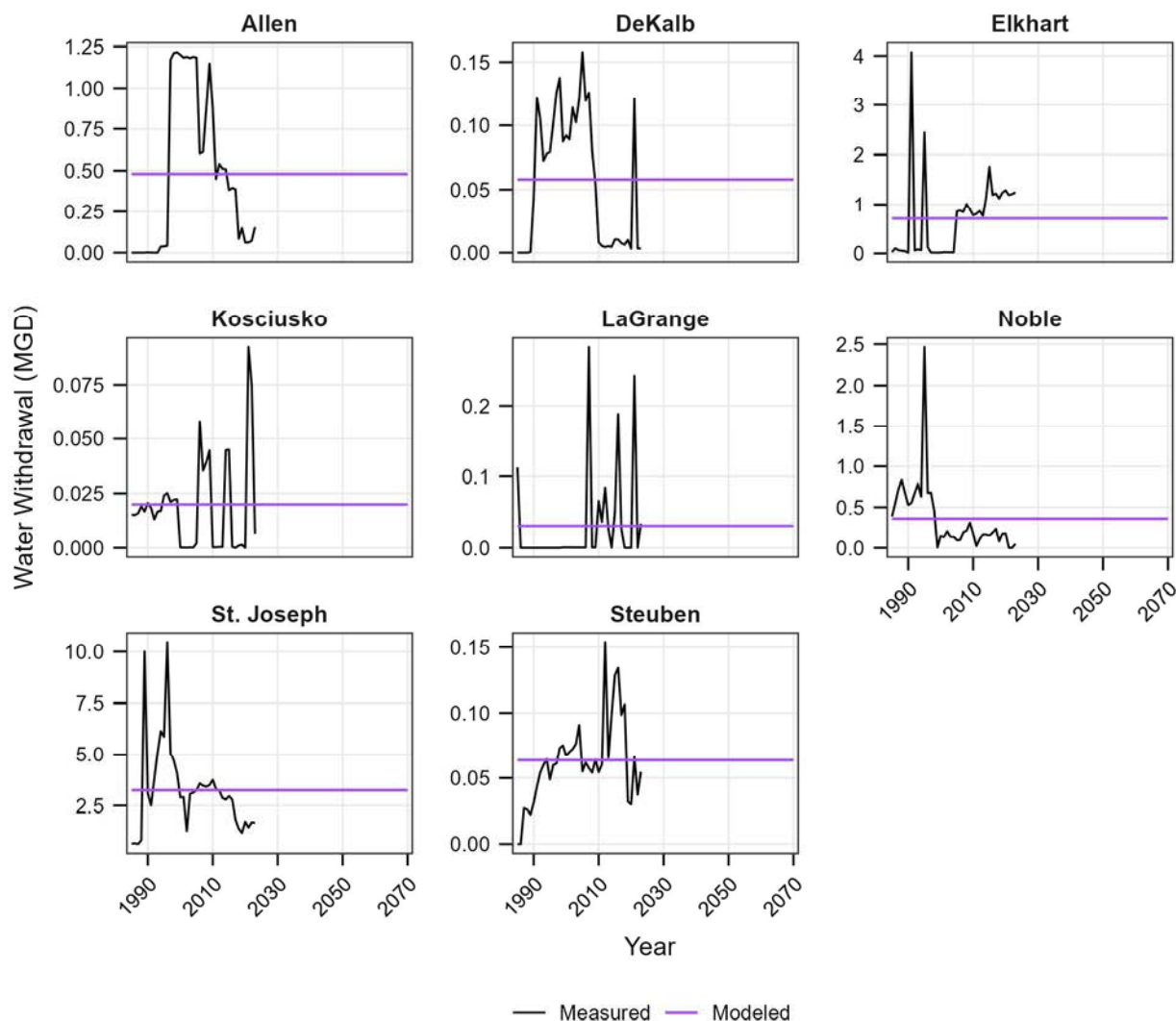


Figure 43. Historical and projected miscellaneous demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Table 19. Miscellaneous water demand forecast by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Kosciusko, Noble, and St. Joseph.

Year	Adams	Allen	Dekalb	Elkhart	Kosciusko	Lagrange	Noble	St. Joseph	Steuben	Totals
2020	0.00	0.06	0.00	1.29	0.00	0.00	0.18	1.73	0.03	3
2025	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2030	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2035	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2040	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2045	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2050	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2055	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2060	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2065	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5
2070	0.00	0.48	0.06	0.71	0.02	0.03	0.36	3.24	0.06	5

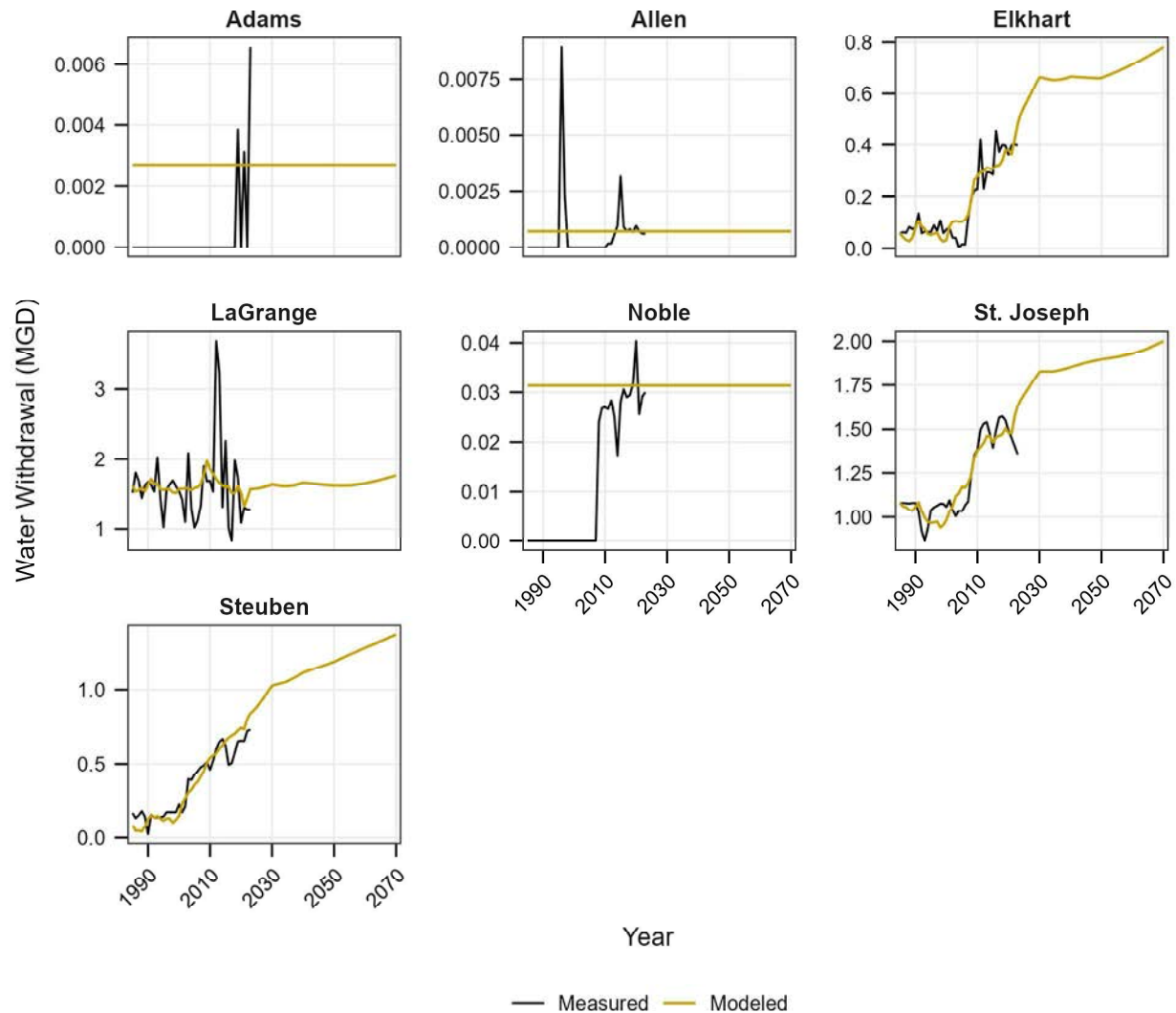


Figure 44. Historical and projected rural-use demand by county, 1985-2070. Only data from within the Region are presented in the graphs. Counties that lie partially within the Region include Adams, Allen, Elkhart, Noble, and St. Joseph.

Table 20. Rural use water demand forecast in the Northeast Indiana Region by county, in MGD. Only data from within the Region are presented in the table. Counties that lie partially within the Region include Adams, Allen, Elkhart, Noble, and St. Joseph.

Year	Adams	Allen	Dekalb	Elkhart	Kosciusko	Lagrange	Noble	St. Joseph	Steuben	Totals
2020	0.000	0.001	0.00	0.36	0.00	1.09	0.04	1.49	0.65	4
2025	0.003	0.001	0.00	0.55	0.00	1.58	0.03	1.69	0.88	5
2030	0.003	0.001	0.00	0.66	0.00	1.64	0.03	1.82	1.03	5
2035	0.003	0.001	0.00	0.65	0.00	1.62	0.03	1.83	1.06	5
2040	0.003	0.001	0.00	0.67	0.00	1.66	0.03	1.85	1.12	5
2045	0.003	0.001	0.00	0.66	0.00	1.64	0.03	1.88	1.15	5
2050	0.003	0.001	0.00	0.66	0.00	1.63	0.03	1.90	1.19	5
2055	0.003	0.001	0.00	0.69	0.00	1.63	0.03	1.91	1.24	5
2060	0.003	0.001	0.00	0.71	0.00	1.65	0.03	1.93	1.29	6
2065	0.003	0.001	0.00	0.75	0.00	1.70	0.03	1.96	1.33	6
2070	0.003	0.001	0.00	0.78	0.00	1.77	0.03	2.00	1.37	6

2.3 Uncertainty in Demand Projections

There is uncertainty present in all the demand models. For the historical period, the uncertainty can be expressed as a standard error of the model fit to the historical data. The uncertainty in demand projections into the future is driven by the many assumptions that the projections rest on, including how the climate will change, how much land will be irrigated, and how population and income will grow. The uncertainty in the historical fit carries forward into the projection, but the assumptions add to it and become the main source of uncertainty 50 years out.

In this section, more details are provided about the assumptions made in the demand model for the irrigation sector, and results of an uncertainty analysis performed for the sector are presented. The focus is the Irrigation sector as this is the largest driver of future water availability in the St. Joseph Basin.

The forecast chooses a single climate model and a single demand model and produces one deterministic set of predictions, but that single trajectory carries substantial uncertainty. The sources fall into three groups: the observed record the model is fit to, the fitted model itself, and the projected inputs that drive the forecast forward.

Those sources were combined by running about 6,000 simulated futures, each drawing a different combination of demand model, coefficient set, climate model, and emissions scenario, plus a random amount representing how far the model typically misses the observed withdrawals. The spread of the resulting predictions is a representation of total model uncertainty. Year-to-year weather variability comes with the climate model, each of which carries its own sequence of wet and dry years. A total of 36 candidate demand models were carried through rather than only the one used for the reported forecast. The projected irrigated area is held fixed across all the simulations, so the range does not take the uncertainty in that projection into account. Nor does it cover changes that fall outside the modeled relationships altogether, such as a shift in the dominant crop or in irrigation technology, conversion of farmland to other uses, or a future restriction on high-capacity withdrawals. The method, and the contribution each source makes to the range, are described in **Appendix B**.

The result is shown in **Figure 45**. Over the historical period the range is comparatively tight, roughly 27 to 67 MGD in 2023, because the climate over that period is observed rather than projected. It widens sharply after 2024, and by 2070 it spans about 41 MGD to about 254 MGD against a reported forecast of about 121 MGD.

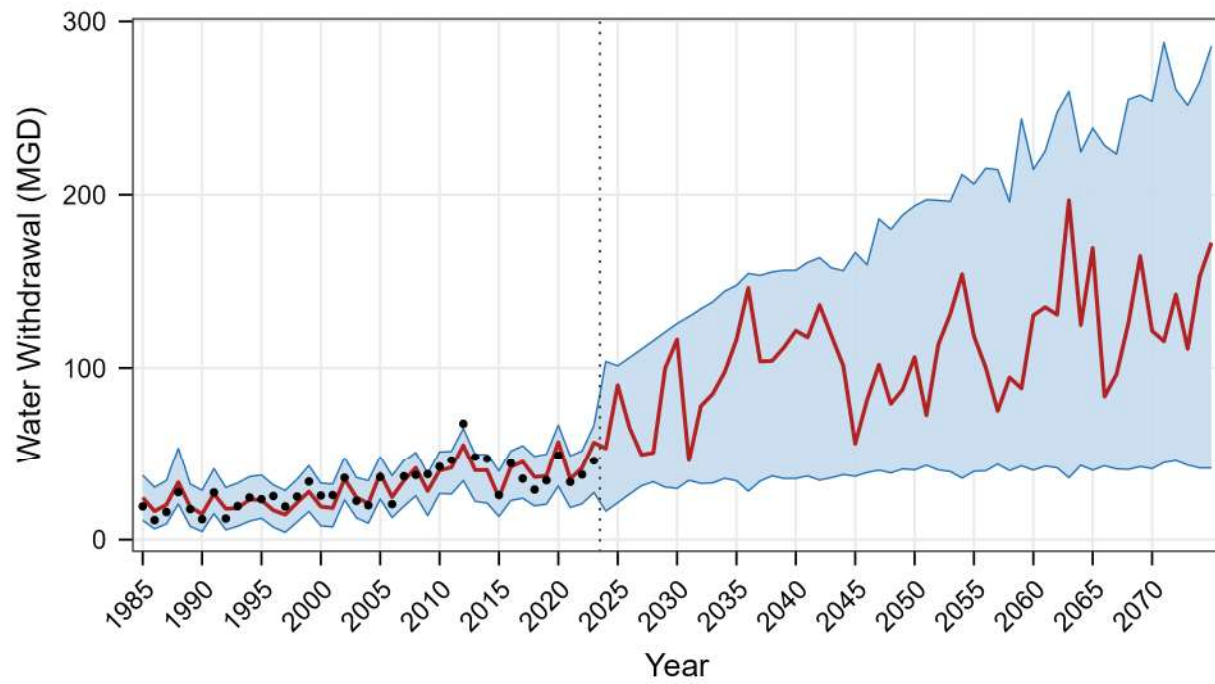


Figure 45. Irrigation forecast (red line), observed annual withdrawals (black dots), and the simulated range (blue band), spanning the 5th to the 95th percentile of about 6,000 simulated futures.

3.0 Water Availability

The methods used to evaluate water availability are completely described in the Central Indiana Water Availability report (IFA, 2021, Chapter 2 and Appendix A). Water availability is assessed on a sub-basin scale (see **Section 1.4**) and reported as annual and seasonal averages. Water availability is evaluated using three related metrics:

- **Water Availability (WA):** the portion of natural baseflow generated within a sub-basin and remaining in the stream at the sub-basin outlet after instream flow requirements in the sub-basin are accounted for. Natural baseflow is an estimate of the natural groundwater discharge to the stream that would occur in the watershed in the absence of groundwater withdrawals and return flows. Instream flows are minimum stream flows required to support the ecological health of the stream, recreational use, and water quality. Water availability within a sub-basin may be supplemented by flows released from reservoir storage. While the net baseflow generated in a sub-basin may be negative, the water availability in a sub-basin cannot be less than zero.
- **Excess Water Availability (XS WA):** the portion of water availability within a sub-basin that could be used to support additional surface water or groundwater withdrawals without impacting instream flows or existing water withdrawals. Excess water availability is calculated as the water available in the sub-basin under natural baseflow conditions reduced by existing water use (i.e., existing withdrawals minus returns). A positive value indicates that there is unused water in the sub-basin, while a negative value indicates that more water is being used than is generated naturally within the sub-basin.
- **Cumulative Excess Water Availability (CXS WA):** the excess water availability summed over all upstream sub-basins. Sub-basins with negative excess water availability are using the positive excess water availability from upstream sub-basins to supply demand. Most values of cumulative excess water availability are positive; a negative value means that the streamflow falls below the minimum instream flow target. The streamflow itself is always positive.

Components of the water budget analysis described in the Central Indiana Regional Study (IFA, 2021, Chapter 2) include:

- **Measured Streamflow:** historical USGS daily streamflow for all gages at sub-basin outlets (see **Table 6** and **Table 7**).
- **Instream Flow:** in the Indiana Regional Water Availability studies, instream flow is defined as the Q90 flow metric in the Winter and Spring seasons and as the 7Q10 during the Summer and Fall seasons. The Q90 is the minimum daily streamflow that is exceeded 90% of the time; the 7Q10 is the lowest average seven-consecutive-day flow that occurs on average once every ten years. These flow statistics are computed from the measured streamflow using standard statistical analysis.
- **Reservoir Storage:** Reservoir storage was not included in the analysis of water availability in the Northeast Indiana Region: the many dams and reservoirs on rivers in the Region are too small to significantly influence the analysis (see 1.3.9). The only exception to this is the Hurshtown Reservoir in the Maumee River Basin, which is a drought supply reservoir maintained by the City of Fort Wayne with a capacity of 1.8 billion gallons. As the reservoir storage is separate from the St. Joseph River (Maumee Basin), the supply is also kept separate in the sub-basin calculations of water availability.

3.1 Historical Water Availability

Historical water availability is assessed using USGS daily streamflow records, records of water withdrawals from the SWWF database, withdrawal data obtained from the states of Michigan and Ohio, and wastewater return flows obtained from the EPA ECHO database of discharge monitoring reports. The EPA data are only available beginning in 2007, and the SWWF data extended through the end of 2023. Therefore, our historical period for which water availability is analyzed is from January 2007 through December 2023.

Water availability metrics are computed on an annual average and seasonal average basis and are provided in units of MGD. The Winter season corresponds to the months of December, January, and February; the Spring season corresponds to the months of March, April, and May; the Summer season corresponds to the months of June, July, and August; and the Fall season corresponds to months of September, October, and November. Details of the Historical Water Availability analysis are provided in **Appendix C**.

3.1.1 Instream Flows

Instream flows are defined as the minimum amount of natural baseflow that should be left in a stream to support the ecological health of the stream, recreational use, and water quality. The Indiana Natural Resources Commission is authorized to determine and establish minimum instream flows based on Indiana Code 14-25-7-14. The statute does not explicitly define minimum instream flows for river systems but suggests that, when values are established, they should be based on the varying low flow characteristics of streams and the importance of instream and withdrawal uses. Instream uses means any use of water that uses surface water in place, including commercial and recreational navigation, hydroelectric power generation, waste assimilation, fish and wildlife habitat, general recreation, and maintenance of environmental and aesthetic values.

Indiana's Water Shortage Plan (IDNR, 2015) provides some background on minimum instream flow values in Indiana. Historically, the streamflow equivalent to the 7Q10 is considered the absolute minimum instream flow. This metric is critical to protect water quality and is used as a factor in determining the level of treatment required for discharges into the State's rivers and streams. Recognizing that it is desirable to protect the 7Q10 flow to maintain water quality in addition to other instream uses, the Water Shortage Plan recommends initiating reductions to water withdrawals during drought conditions before flow decline to the 7Q10, typically when the Q80 (the daily average flow that is exceeded 80% of the time) is met. For the months of May through October, the Q80 is a trigger to initiate a local action process to protect aquatic and riparian habitat, which could include monitoring of water withdrawals, voluntary reduction of water withdrawals, or development of local or regional policies that reflect public preferences regarding water use priorities.

Consistent with recent regional water studies in Indiana (IFA, 2021), this study uses both the 7Q10 and the Q90 (the daily average flow that is exceeded 90% of the time) to define minimum instream flows within each sub-basin. The 7Q10 is used to define minimum instream flow values, consistent with the Water Shortage Plan, during the typically drier months of June through November (Summer and Fall). The Q90 is used to define minimum instream flow values during the wetter months of December

through May (Winter and Spring). There is no guidance in the Water Shortage Plan for defining minimum instream flows outside of shortage conditions and outside of the drier Summer months—the Q90 metric is often used as a presumptive standard for environmental flow protection when instream flow values are not defined (Gleeson and Richter, 2018).

The 7Q10 and Q90 were evaluated from USGS gage daily flow records for the period 1995 to 2024, a period that reflects recent climate and streamflow trends (Blum et al., 2019) and is consistent with other regional water studies (Letsinger and Gustin, 2024). If the full record from 1995 to 2024 was not available, a shorter record was used. **Table 21** and **Table 22** present the 7Q10 and Q90 values at the outlet of each sub-basin, along with the assessment periods used to calculate the values.

Table 21. Instream flow values used in the water availability analysis for the St. Joseph River Basin of the Northeast Indiana Region.

Gage	Name	Period	7Q10 (cfs)	7Q10 (MGD)	Q90 (cfs)	Q90 (MGD)
04098500	Fawn River near White Pigeon, MI	1957-1975	42	27	67	43
04099000	St. Joseph River at Mottville, MI	1995-2024	446	288	770	498
04099510	Pigeon River near Angola, IN	1995-2024	11	7.1	21	14
04099750	Pigeon River near Scott, IN	1995-2024	83	54	137	88
04100222	Elkhart River near Cosperville, IN	1995-2024	4	2.6	28	18
04100500	Elkhart River near Goshen, IN	1995-2024	63	41	163	105
04101000	St. Joseph River at Elkhart, IN	1995-2024	937	606	1490	963
04101225	St. Joseph River at South Bend	1995-2018	984	636	1790	1160
04101500	St. Joseph River at Niles, MI	1995-2024	1123	726	1750	1130

Table 22. Instream flows used in the water availability analysis for the Maumee River Basin of the Northeast Indiana Region.

Gage	Name	Period	7Q10 (cfs)	7Q10 (MGD)	Q90 (cfs)	Q90 (MGD)
04178000	St. Joseph River near Newville, IN	1995-2024	33	21	63	41
04180000	Cedar Creek near Cedarville, IN	1995-2024	20	13	35	23
04180500	St. Joseph River near Fort Wayne,	1995-2024	47	30	131	85
04180988	St. Marys River at Rockford, OH	2005-2024	4	2.6	17	11
04181500	St. Marys River at Decatur, IN	1995-2024	13	8.4	30	19
04182000	St. Marys River near Fort Wayne, IN	1995-2024	15	9.7	35	23
04183000	Maumee River at New Haven, IN	1995-2024	103	66	197	127
04183500	Maumee River at Antwerp, OH	2014-2024	110	71	239	154
04191378	Flatrock Creek near Payne, OH	2007-2023	0	0	0.15	0.10

3.1.2 Cumulative Excess Water Availability

While each of the water availability metrics provides information about the spatial distribution of water use and hydrologic conditions, the cumulative excess water availability is perhaps the most useful metric for water supply planning; it represents the total available excess water upstream of any point in a watershed, independent of what any individual sub-basin contributes to the total. Water withdrawals are not typically limited to the portion of excess available water generated within a single sub-basin.

The annual and seasonal cumulative excess water availability for the Northeast Indiana Region is summarized in the following subsections by the minimum value of the metric in the 17-year period of record, and box and whisker plots showing the range of values that occur throughout the period of record.

Results of the other metrics of water availability are summarized in **Appendices C and D**.

3.1.2.1 Minimum Annual and Seasonal Cumulative Excess Water Availability

The historical record consists of 17 years of data. The minimum annual or seasonal metric for that period roughly corresponds to an 18-year recurrence interval. Therefore, the minimum value of each metric during the period of record represents seasonal drought conditions that can be expected to occur, on average, every 18 years. This allows a level of risk to be assigned to the drought conditions, which is important for water supply planning.

The minimum annual average and seasonal average cumulative excess water availability are presented in **Table 23** for the St. Joseph River Basin and **Table 24** for the Maumee River Basin. The values are presented graphically in **Figure 46** through **Figure 50**.

Table 23. Minimum annual and seasonal cumulative excess water availability in the St. Joseph River Basin, 2007-2023.

Sub-Basin	Annual (MGD)	Winter (MGD)	Spring (MGD)	Summer (MGD)	Fall (MGD)
S1	56.8	40.4	51.4	9.2	27.8
S2	457.9	173.9	261.2	-65.3	38.2
S3	23.7	4.8	21.8	5.7	3.9
S4	88.3	20.5	77.5	27.1	15.1
S5	48.8	14.7	34.7	9.1	7.4
S6	175.3	49.5	164.8	38.0	38.8
S7	826.5	273.4	519.1	-68.0	101.5
S8	883.9	269.9	534.7	38.4	228.1
S9	958.2	346.6	646.4	58.3	249.6

Table 24. Minimum annual and seasonal cumulative excess water availability in the Maumee River Basin, 2007-2023.

Sub-Basin	Annual (MGD)	Winter (MGD)	Spring (MGD)	Summer (MGD)	Fall (MGD)
M1	112.1	26.3	138.2	11.3	12.2
M2	52.5	5.5	52.9	5.8	2.5
M3*	210.7	31.5	252.1	32.9	28.8
M4	32.2	6.6	59.3	9.2	1.7
M5	52.5	17.0	114.6	14.1	2.2
M6	90.9	49.7	131.3	15.3	5.2
M7*	415.8	185.5	523.7	43.3	46.1
M8*	453.2	185.7	588.2	46.4	47.9
M9	9.1	0.5	7.3	0.1	0.0

*The Hursttown Reservoir is not included in these results. Including the reservoir storage for 1 season adds an additional 20 MGD to the starred sub-basins.

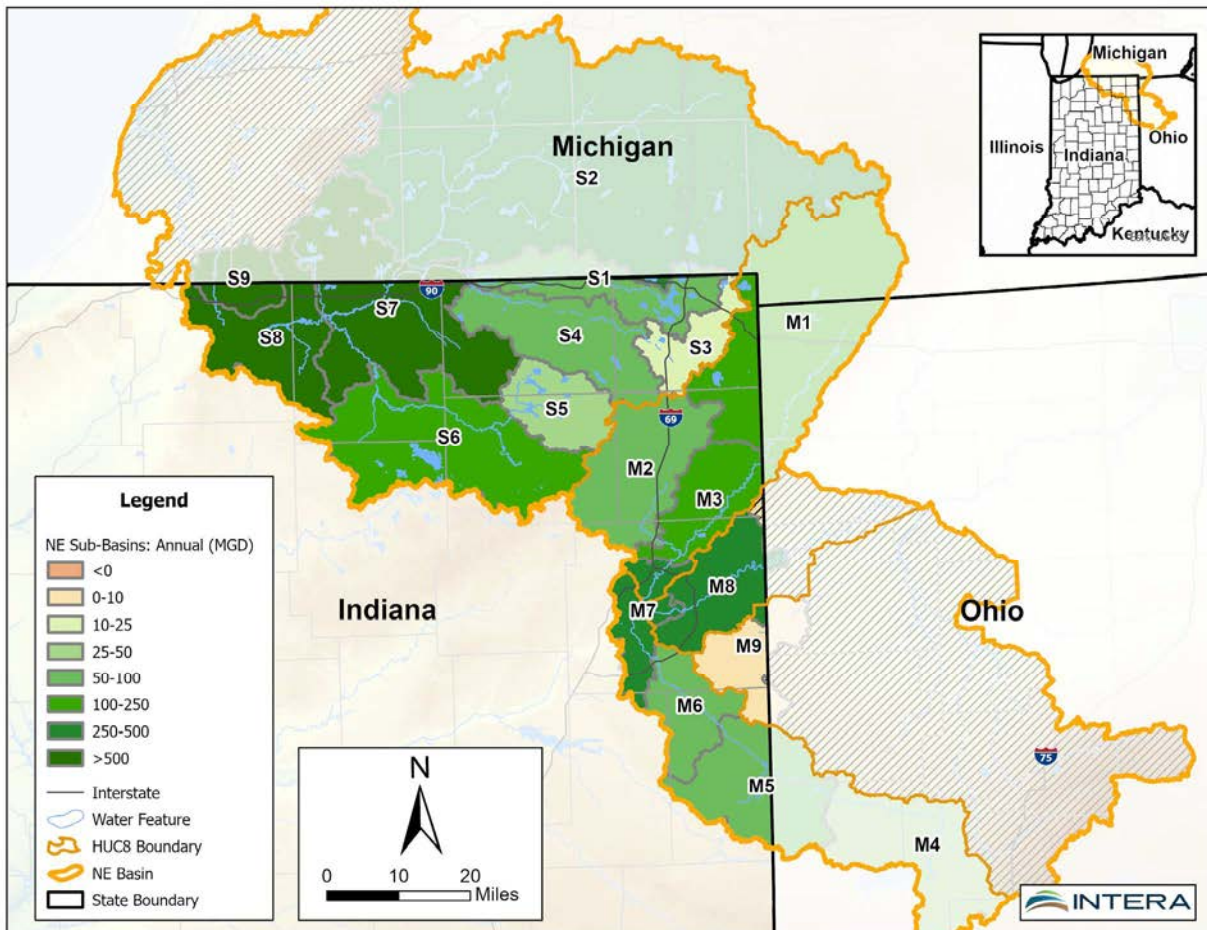


Figure 46. Minimum annual average cumulative excess water availability, 2007-2023.

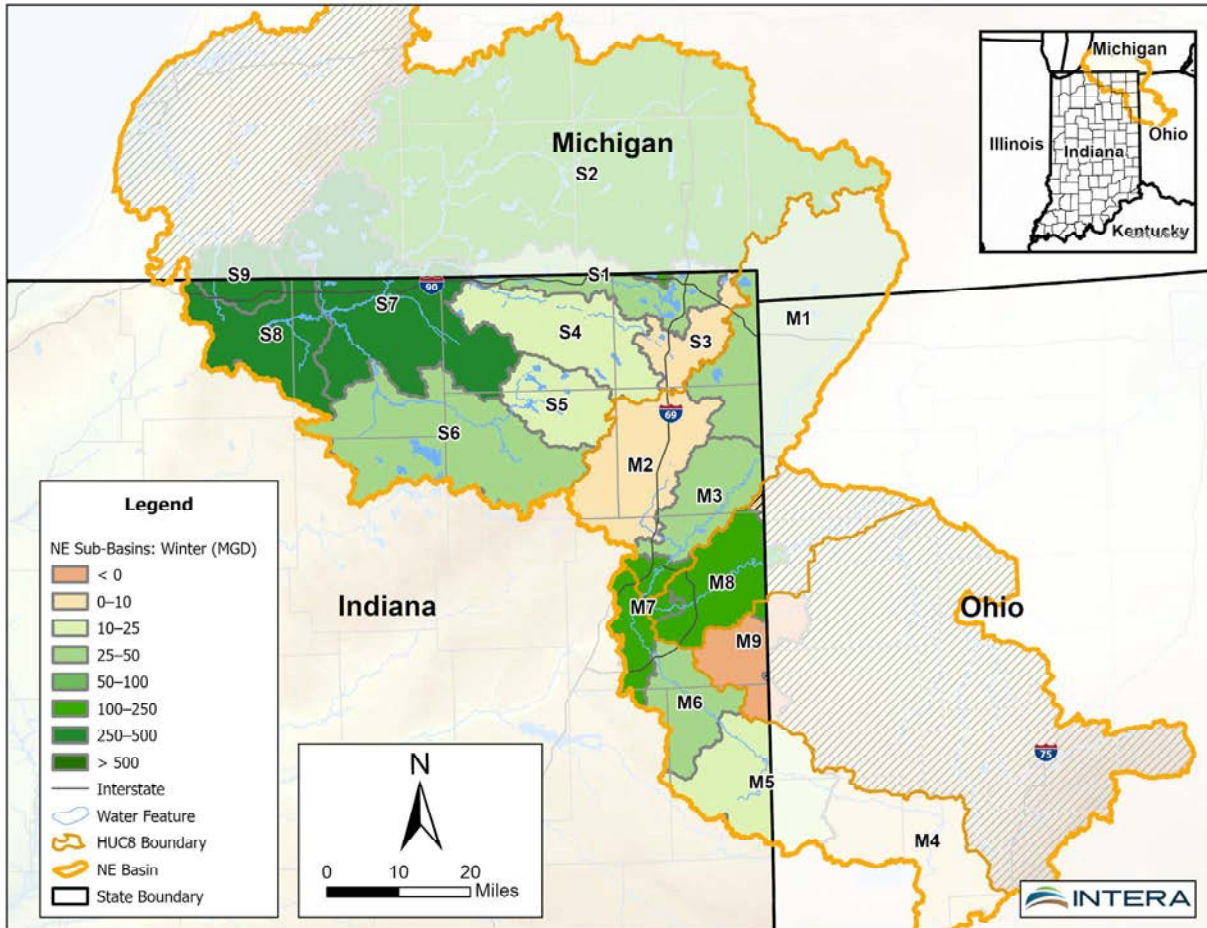


Figure 47. Minimum Winter cumulative excess water availability, 2007-2023.

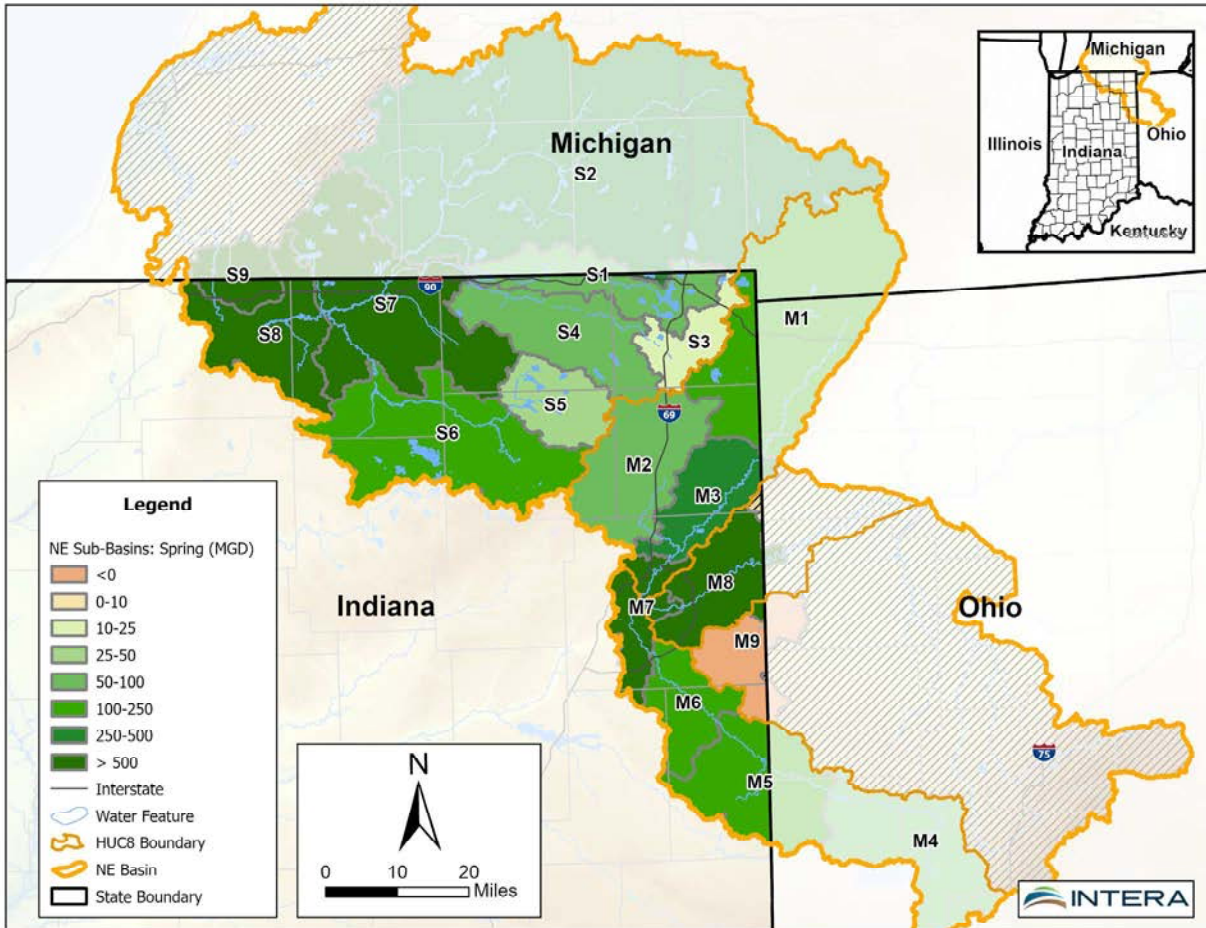


Figure 48. Minimum Spring cumulative excess water availability, 2007-2023.

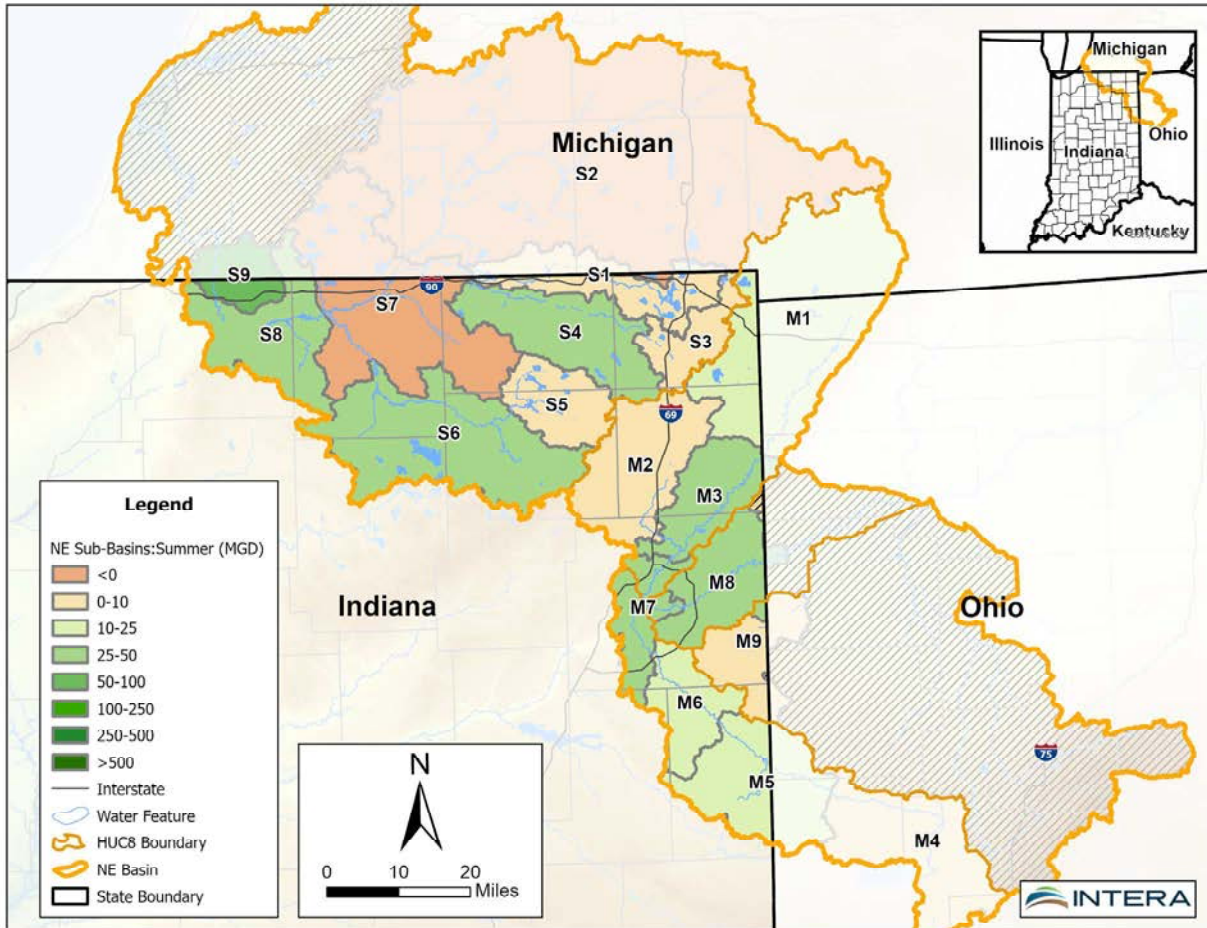


Figure 49. Minimum Summer cumulative excess water availability, 2007-2023.

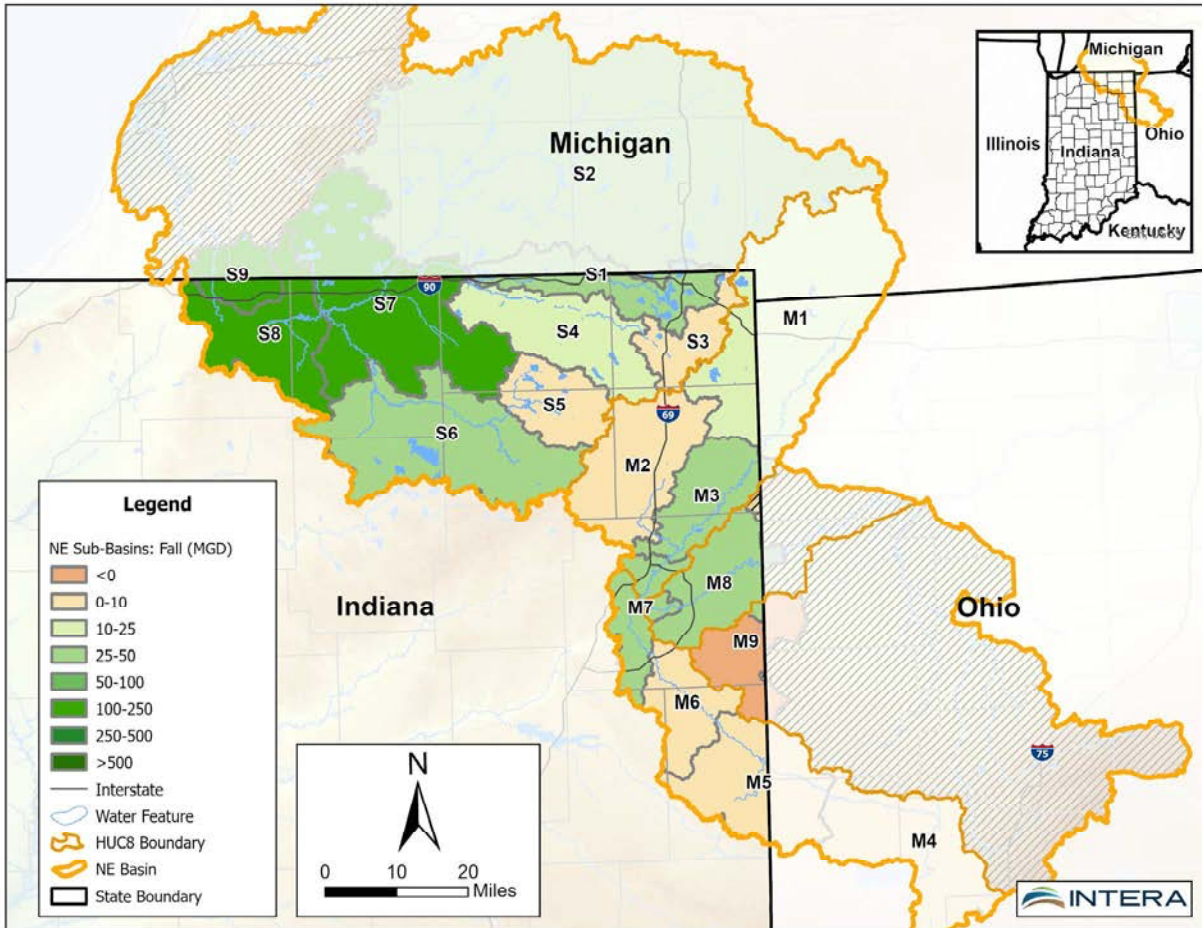


Figure 50. Minimum Fall cumulative excess water availability, 2007-2023.

3.1.2.2 Variations in Seasonal Cumulative Excess Water Availability

The variability of each water availability metric over the period of record is also important to assess. The variability can be shown compactly using box and whisker plots. **Figure 51** explains the box and whisker plot. An annual time series is shown on the left of the figure with a single value for each year in the period of record, 2007 to 2023; the time series shows the variation of the metric through time. The corresponding box and whisker plot is shown to the right of the figure. Each value from the time series is plotted, as a dot, on a single vertical line of the box and whisker plot. The box itself indicates the bounds of the mean or average (“x”), median (horizontal line), and the upper and lower quartile (top and bottom of the box) of the time series data. The whiskers, or vertical lines projecting from the box, indicate the range of values of the remaining 50% of the data. Any outliers are excluded from the whiskers, and the top and bottom of the whisker, denoted by the horizontal lines, represent the maximum and minimum values in the time series.

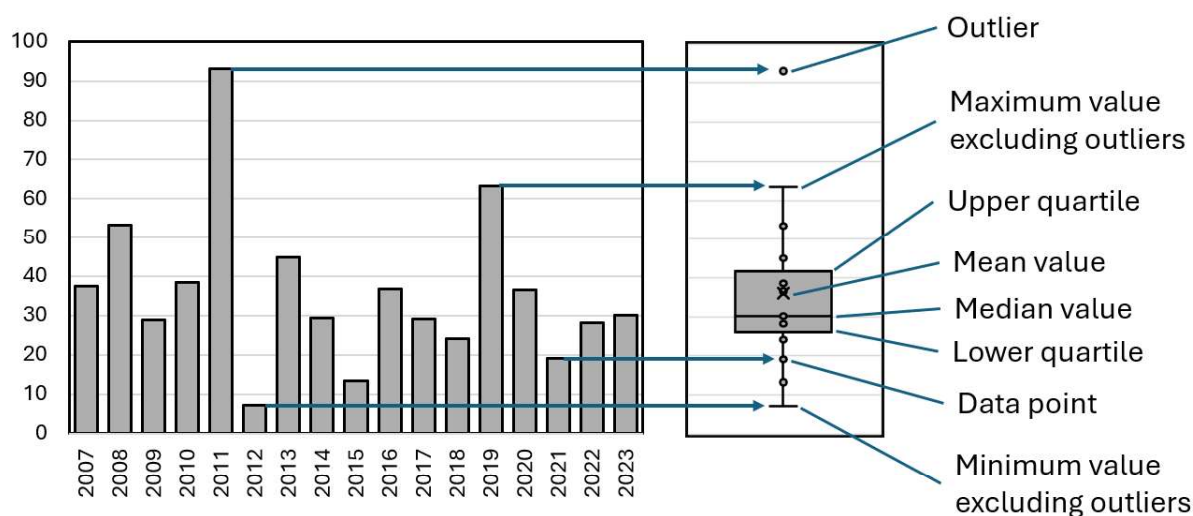


Figure 51. Explanation of the box and whisker plots used to show the variation in an annual time series.

Box and whisker plots are provided for the seasonal cumulative excess water availability in each of the sub-basins of the St. Joseph River Basins and the Maumee River in **Figure 52** and **Figure 53**, respectively. In general, each metric may vary over one to two orders of magnitude from the minimum value to the maximum value. For example, the figure for Maumee Sub-Basin 1 shows that Winter cumulative excess water availability (CXS WA) has varied from a minimum of 26 MGD to a maximum of 750 MGD with a median value of 230 MGD. Note differences on y-axes between sub-basins in each figure.

The figures indicate that there is a larger variability in cumulative excess water availability in the Winter and Spring seasons with larger median values than in the Summer and Fall seasons: the boxes in Winter and Spring are larger and positioned higher than those representing the Summer and Fall. Furthermore, the median Fall values in the Maumee River Basin are close to the Fall minimum values, indicating that Fall low flows occur frequently. In both the Maumee and St. Joseph sub-basins, minimum Winter values are like the Summer and Fall minimums, indicating that in the Northeast Indiana Region, Winter drought conditions can be impactful on water supplies.

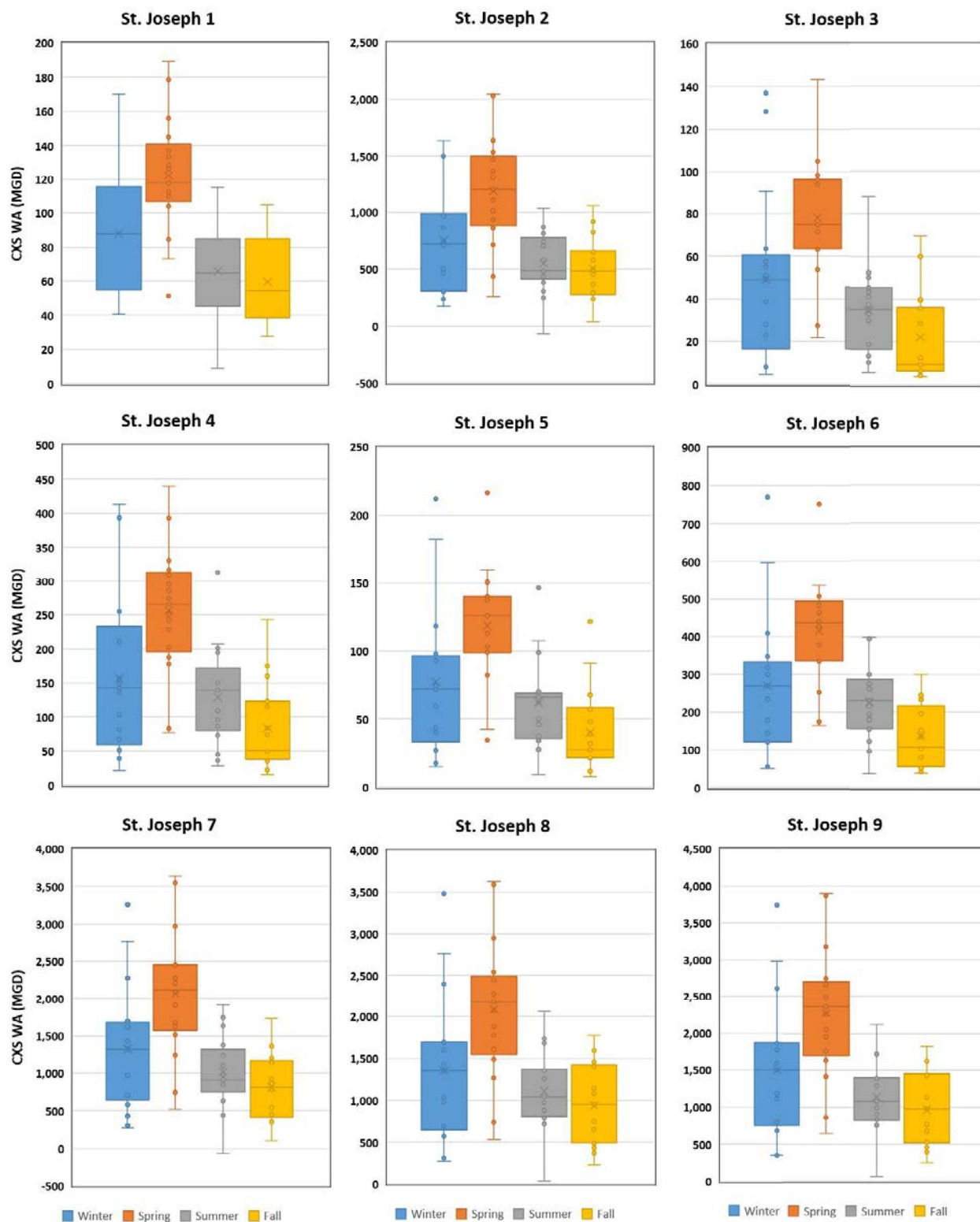


Figure 52. Seasonal cumulative excess water availability (CXS WA) in sub-basins of the St. Joseph River Basin, 2007-2023.

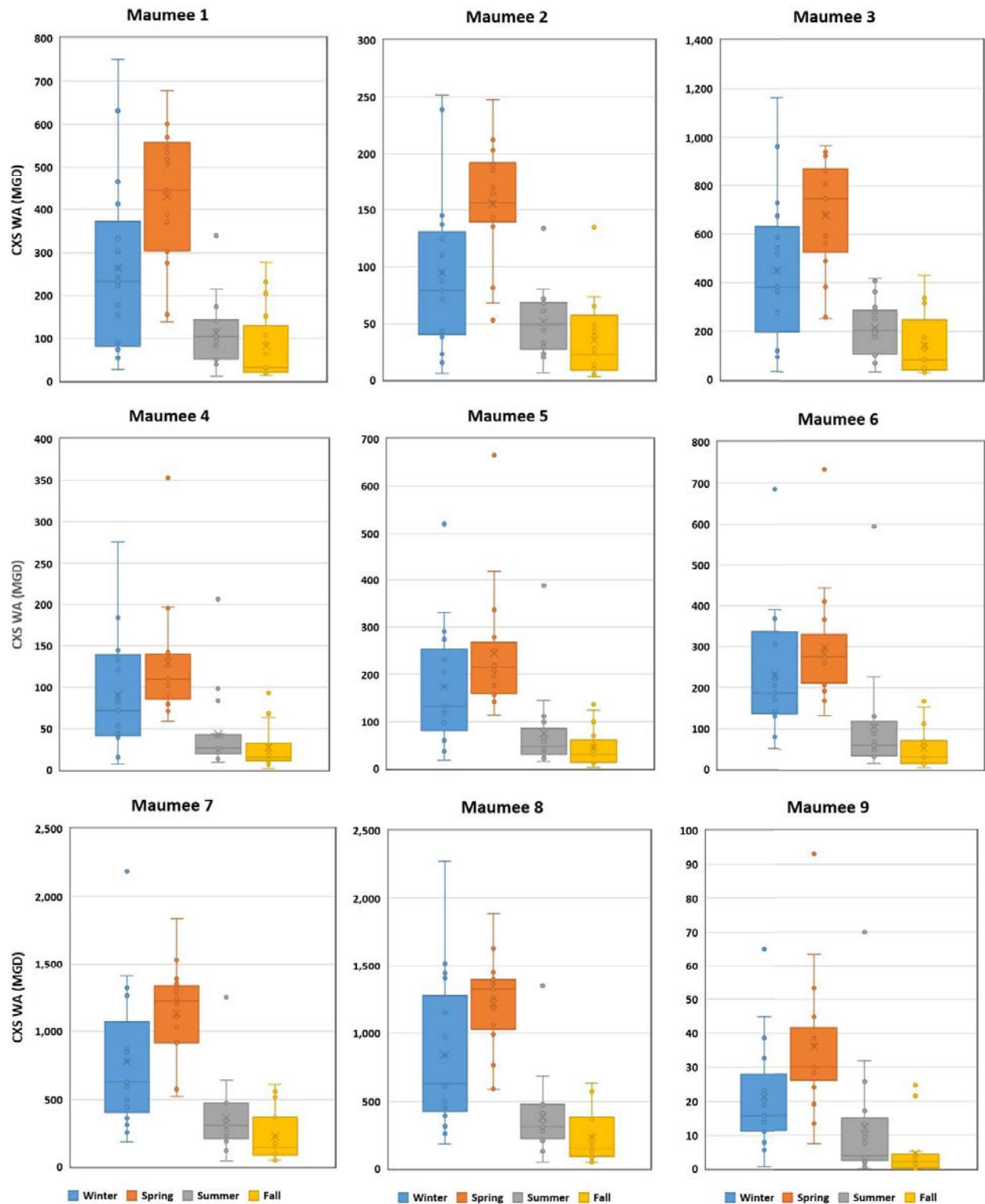


Figure 53. Seasonal cumulative excess water availability (CXS WA) in sub-basins of the Maumee River Basin, 2007-2023.

3.1.3 Summary of Historical Water Availability

St. Joseph River Basin. Water availability in the sub-basins of the St. Joseph River Basin is sustained by high baseflow in the streams and depleted primarily by large Summer withdrawals for agricultural irrigation. Due to the impacts of irrigation, the critical season in the watershed is the Summer. The large cumulative irrigation withdrawals have led to periods where streamflow is less than the minimum instream flow target, and the cumulative excess water availability becomes negative. Sub-Basins SJ2 and SJ7 both have negative minimum cumulative excess water availability (**Table 23**) approaching -70 MGD. While 70 MGD exceeds all minimum instream flow values in the Maumee River Basin, it represents only a portion of the minimum instream flow values of 288 MGD and 606 MGD at the downstream ends of Sub-Basins SJ2 and SJ7, respectively, in the St. Joseph River Basin. There is significantly more water availability in the St. Joseph River Basin than the Maumee River Basin, and there is significantly more consumptive water use.

Maumee River Basin. In the Maumee River Basin, the critical season—the season with the smallest cumulative excess water availability—is typically Fall. The basin is characterized by low water availability due to low baseflow levels throughout the year. The minimum cumulative excess water availability in the sub-basins of the St. Marys River (Sub-Basins M4, M5, and M6) are low, with moderate values in the sub-basins of the St. Joseph River (Maumee Basin) (Sub-Basins M1, M2, and M3). Sub-basins of the Maumee River (Sub-Basins M7 and M8) have minimum cumulative excess availability greater than 45 MGD. This number may be compared to the expected increase in public supply demand of Allen County of approximately 6 MGD by 2070. The current cumulative excess water availability in Sub-Basins 7 and 8 should be adequate to allow the moderate increase in demand expected in the future.

In addition, Fort Wayne Utilities operates the Hurshtown Reservoir, which was constructed in 1969 to serve as a drought supply for the city. The reservoir lies in Sub-Basin M3, adjacent to the St. Joseph River (Maumee Basin). Water levels in the reservoir are maintained by withdrawals from the St. Joseph River (Maumee Basin). The reservoir has a capacity of 1.8 billion gallons, which could provide a 3-month supply of 20 MGD for the city during a drought. Although the reservoir has never been used as an emergency supply, it is a valuable asset to maintain a resilient city water supply. This potential 20-MGD supply is not included in the historical estimates of water availability presented in **Table 24**; to include the reservoir supply, the seasonal cumulative excess water availability (**Table 24**) in Sub-Basins M3, M7, and M8 can be increased by 20 MGD.

3.2 Water Availability Forecasts

Projections of future water demand are combined with projections of future natural streamflow to estimate future water availability. A summary of the methodology is provided below and supplemented by information contained in **Appendix D**. Results for the St. Joseph River and Maumee River Basins are presented separately.

Complete tables of natural baseflow, water availability, excess water availability, and cumulative excess water availability are provided in **Appendix E** in 5-year intervals from 2010 to 2070.

3.2.1 Methodology

The methodology for water availability projections follows the analysis of historical water availability using future hydrology, water withdrawals, and consumptive use developed from the demand models and hydrologic models informed by historical conditions in the sub-basins. The process is described briefly below, with additional information provided in **Appendix D**.

Natural Streamflow Projections. Estimates of future natural streamflow are based on the Water-Balance Model (WBM) (Wolock and McCabe, 1999; McCabe and Wolock, 2011). The WBM is incorporated into the National Climate Change Viewer (Alder and Hostetler; 2014, Hostetler and Alder, 2016) and produces estimates of natural streamflow from inputs of temperature, precipitation, and potential solar radiation. The inputs are provided by the suite of Global Climate Models included in the NCCV. Output from a single global climate model was used to drive the streamflow model: CNRM-CM6-1, Scenario SSP2-4.5. More details on the choice of this global climate model are provided in **Appendix B**. Output from the WBM includes a monthly time series of natural streamflow, provided in inches per month on a HUC-8 spatial scale; the results were then scaled to each sub-basin or watershed within the HUC-8.

Bias Correction and Downscaling. The resulting natural stream flows generated for each sub-basin were then compared with the historical natural stream flows (2007-2023). Flow duration curves were created for the observed data and data from the same period for the WBM. In the Maumee River Basin, the flow duration curves were comparable, and the model results were accepted. In the St. Joseph River Basin, the comparisons were poor at the low-flow end of the flow duration

curves; this is likely due to very high base flow that is characteristic of the St. Joseph River Basin. Linear quantile bias correction (Hagemann et al., 2024) was applied to the model flows, along with quantile delta mapping for the streamflow projections. Downscaling within the St. Joseph Basin was also applied on the sub-basin level.

Natural Baseflow. As the projected natural streamflow from the WBM is at a monthly timescale, standard baseflow separation techniques, as described and used in previous regional studies (IFA, 2021) cannot be used to estimate natural baseflow. Instead, an analysis of the seasonal baseflow index was conducted using the historical record (2007-2023). Seasonal relationships for each watershed were developed between natural stream flow and natural baseflow and applied to the projected natural stream flows.

Instream Flows. Instream flow values used for forecasting water availability remain unchanged from the historical analysis (see **Table 21** and **Table 22**).

Demand Projections. Demand projections on the county scale were mapped to the sub-basins for all regions within the Indiana portion of the Region. No demand projections were made for areas in Ohio and Michigan. Water withdrawals in Michigan are tightly regulated and near capacity in the St. Joseph River Basin. The contributing portions of Ohio have minimal consumptive-use. Sub-basin scale

Flow Duration Curve

A flow duration curve graphically represents the relationship between streamflow magnitude and the frequency with which it is equaled or exceeded, providing key insights into hydrological behavior and water resource management.

consumptive use estimates for Ohio and Michigan for 2023, developed during the analysis of historical water availability, were projected forward to 2070.

Consumptive Use Factors. Sub-basin scale consumptive use factors were estimated during the analysis of historical water availability by relating water withdrawal sectors to return flows through the standard industrial classification (SIC) code present in the National Pollutant Discharge Elimination System (NPDES) records. In this way, consumptive use factors were obtained for each withdrawal sector by sub-basin. The resulting factors are presented in **Appendix D**. A constant consumptive use coefficient of 0.13 was applied to all self-supplied residential withdrawals. A factor of 0.9 was applied to all CAFO withdrawals. A consumptive use factor of 1.0 was applied to all projected irrigation withdrawals. These consumptive use factors are like the coefficients used in the Great Lakes Basin (Schaefer and Runkle, 2007).

Consumptive Use for Public Supply Withdrawals. Public supply withdrawals and the corresponding returns at wastewater treatment plants often exhibit seasonal patterns. Combined Sewer Overflow systems are present throughout the Northeast Indiana Region and therefore returns historically have exceeded withdrawals. Within a sub-basin, if returns historically exceed withdrawals throughout the year, a consumptive use factor of zero was applied to future public supply withdrawals. When returns and withdrawals exhibited seasonality with withdrawals exceeding returns during Summer and Fall, seasonal consumptive use coefficients were developed for those sub-basins.

3.2.2 Results: St. Joseph River Basin

In the St. Joseph River Basin, agricultural irrigation historically dominates all water withdrawals and is projected to increase in the future. Because of this, consumptive use in the St. Joseph River Basin is projected to increase significantly into the future. **Figure 54** illustrates the impacts of increasing consumptive use for agricultural irrigation in Sub-Basin SJ6; SJ6 is chosen as a representative sub-basin in the St. Joseph Basin. Seasonal cumulative excess water availability is less variable with no negative values in the historical period, with greater variability and frequent negative values appearing in Summer and Fall in the future. These negative values of cumulative excess water availability indicate that the rivers are projected to be depleted below the minimum instream flow targets more frequently in the future.

St. Joseph River Basin

Irrigation withdrawals dominate the St. Joseph Basin. These high consumptive use withdrawals are expected to increase in the future, causing rivers to drop below the minimum instream flow more often.

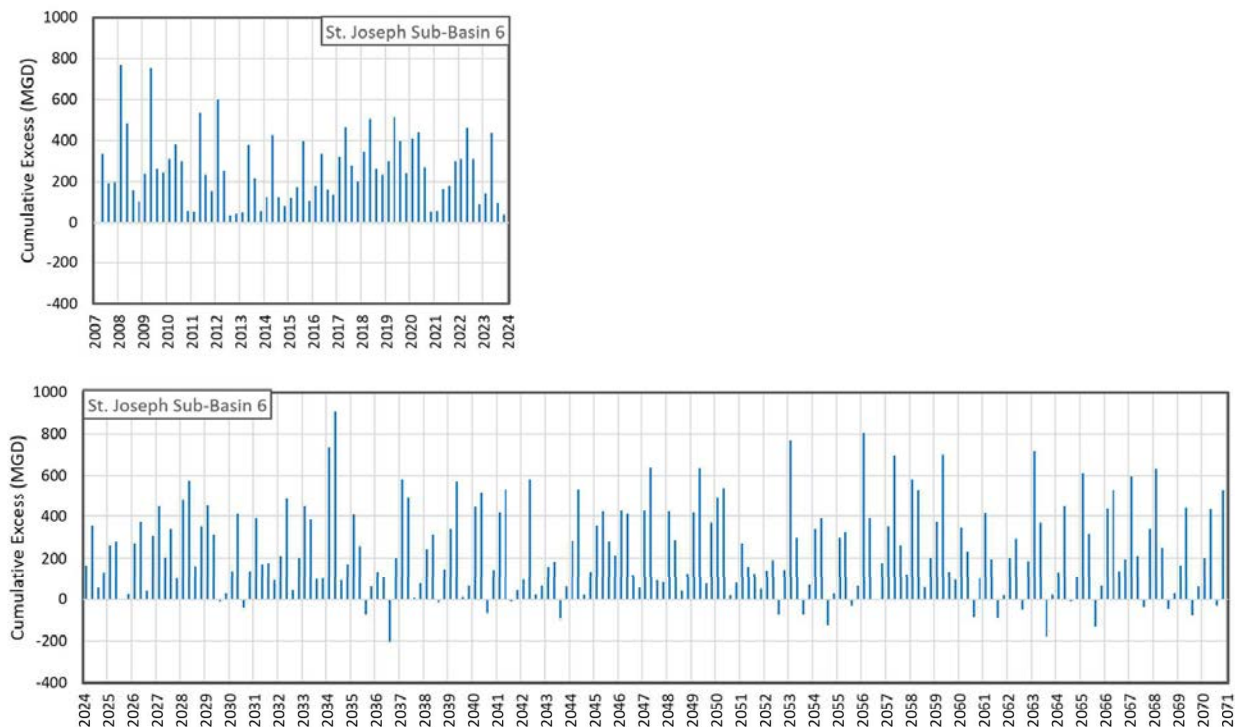


Figure 54. Example: Historical (top) and projected (bottom) cumulative excess water availability for Sub-Basin 6 of the St. Joseph River Basin.

Figure 55 illustrates the expected changes in annual excess water availability and cumulative excess water availability in the St. Joseph River Basin over the next 50 years. The excess water availability is projected to decrease slightly in most sub-basins through 2070; the cumulative excess is also projected to decrease slightly in most sub-basins, with small increases in Sub-Basin SJ7. The annual availability shows little variation in the future, but the seasonal metrics show a shifting of water availability throughout the year.

Figure 56 illustrates the projected changes in Summer and Fall excess and cumulative excess water availability. The Summer metrics decrease significantly by 2070, while the Fall metrics are projected to increase substantially in all sub-basins. **Figure 57** illustrates the current and projected Winter and Spring excess and cumulative excess water availability. Significant decreases are expected in the Winter with relatively minor changes in the Spring.

In general, model projections in the St. Joseph River Basin suggest that annual water availability metrics will decrease slightly through 2070. More significant changes are expected in the seasonal metrics with significant decreases in Summer and Winter availability and significant increases in Fall availability.

Note that **Figure 55** through **Figure 57** show three snapshots in time and don't necessarily represent the average trends in water availability through time. Complete tables of water availability, excess water availability, and cumulative excess water availability are provided in **Appendix E** in 5-year intervals from 2010 to 2070.

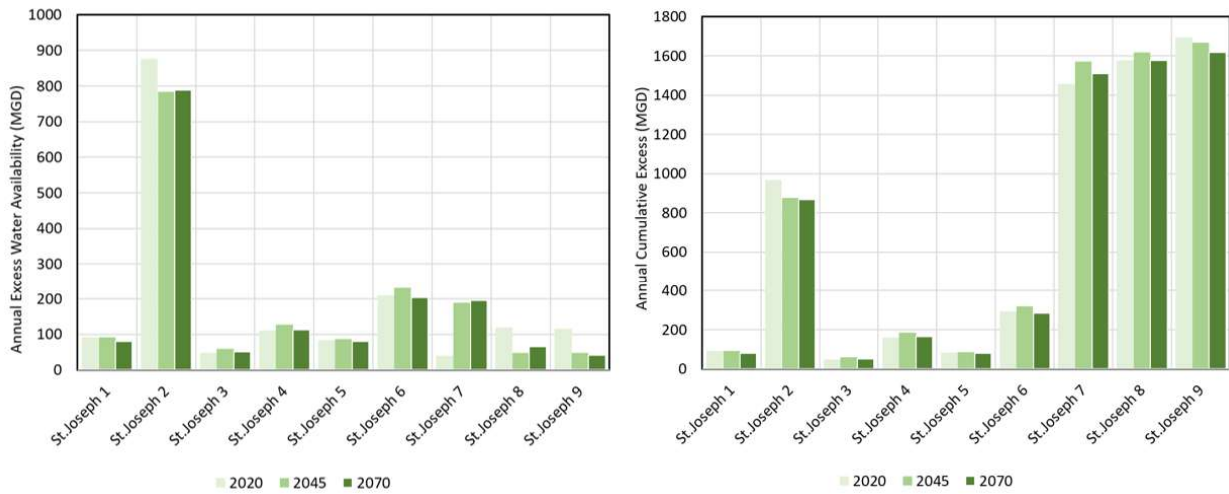


Figure 55. Current and projected annual excess (left) and cumulative excess water availability (right) for sub-basins in the St. Joseph River Basin.

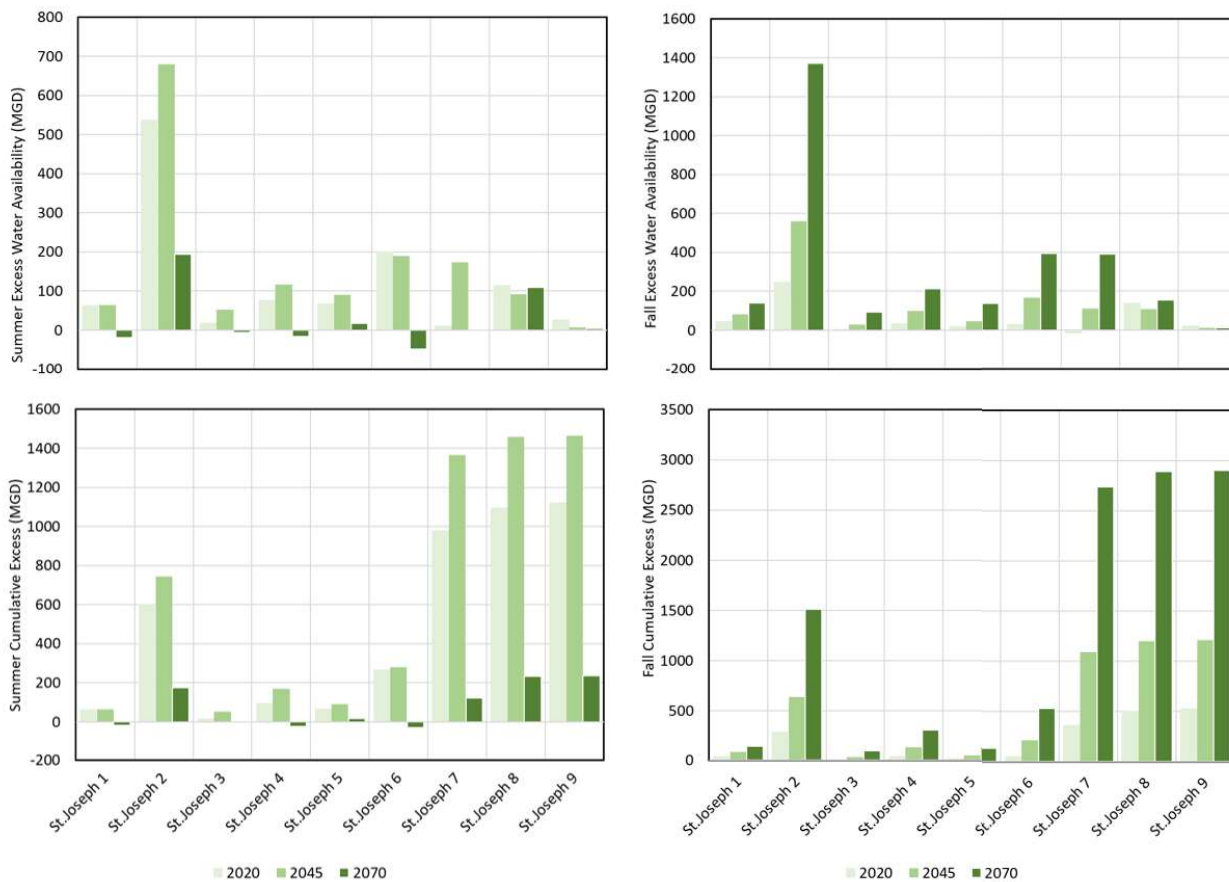


Figure 56. Current and projected Summer (left) and Fall (right) excess (top) and cumulative excess water availability (bottom) for sub-basins in the St. Joseph River Basin.

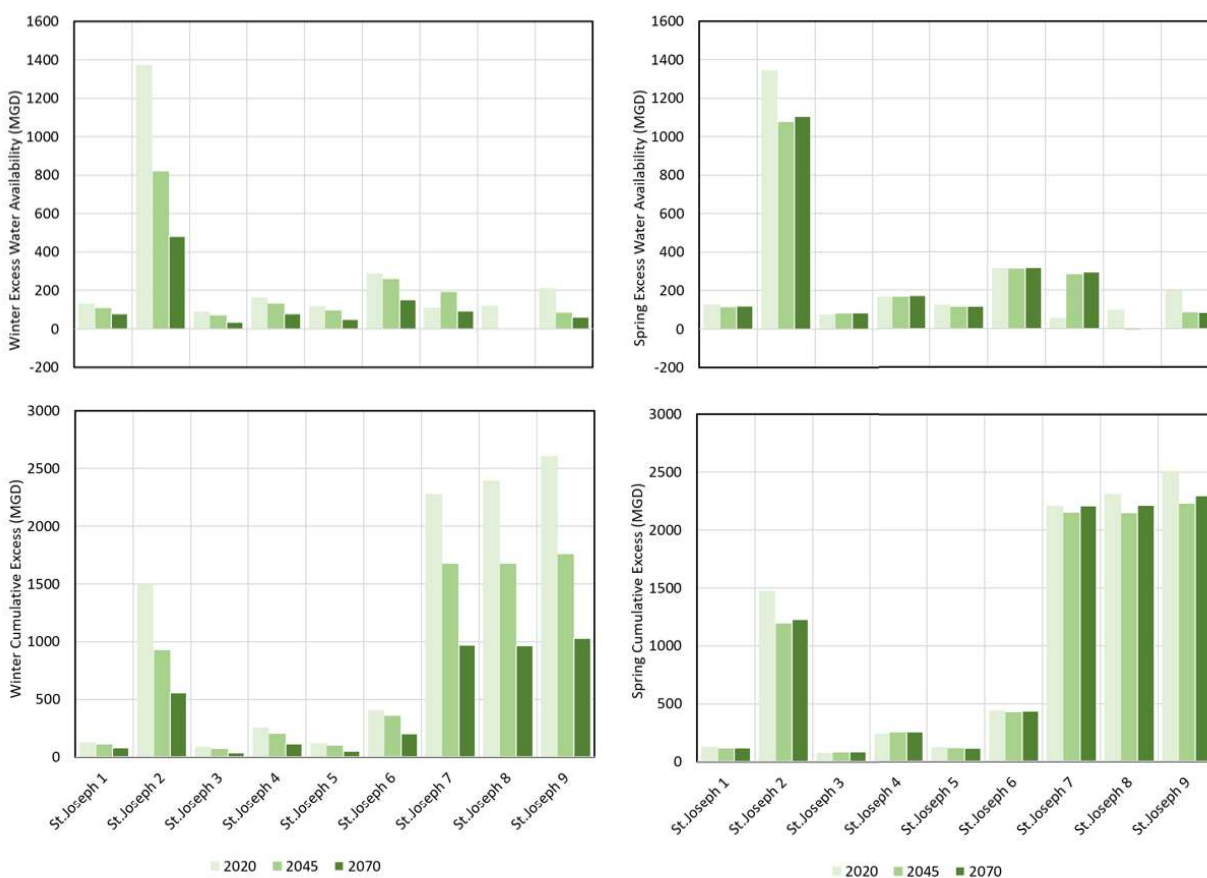


Figure 57. Current and projected Winter (left) and Spring (right) excess (top) and cumulative excess (bottom) water availability for sub-basins of the St. Joseph River Basin.

3.2.3 Results: Maumee River Basin

An example of the historical and forecast seasonal cumulative excess water availability is provided in **Figure 58** for Sub-Basin M8 as a complete time series, illustrating the seasonal and annual variations. Sub-Basin M8 was chosen as an example as it is the most downstream sub-basin in the Maumee Basin. In the Maumee River Basin, there is minimal agricultural irrigation, and future consumptive use remains similar to past consumptive use; there is little projected change in future conditions. Note that the cumulative excess water availability in Sub-Basin M8 is greater than zero during the entire historical and future period.

Results for excess water availability and cumulative excess water availability for all sub-basins are summarized in **Figure 59** through **Figure 61**, which compare current (2020) metrics with 25-year (2045) and 50-year (2070) annual and seasonal projections. Note that the figures show three snapshots in time and don't necessarily reflect

Maumee Basin

Model projections in the Maumee Basin suggest that annual water availability metrics will only decrease slightly through 2070. More significant changes are expected seasonally, with significant decreases in winter availability and significant increases in fall availability.

the trends in water availability through time. However, the figures do illustrate the seasonal shifts in water availability within each year.

Complete tables of water availability, excess water availability, and cumulative excess water availability for each sub-basin are provided in **Appendix E** in 5-year intervals from 2010 to 2070.

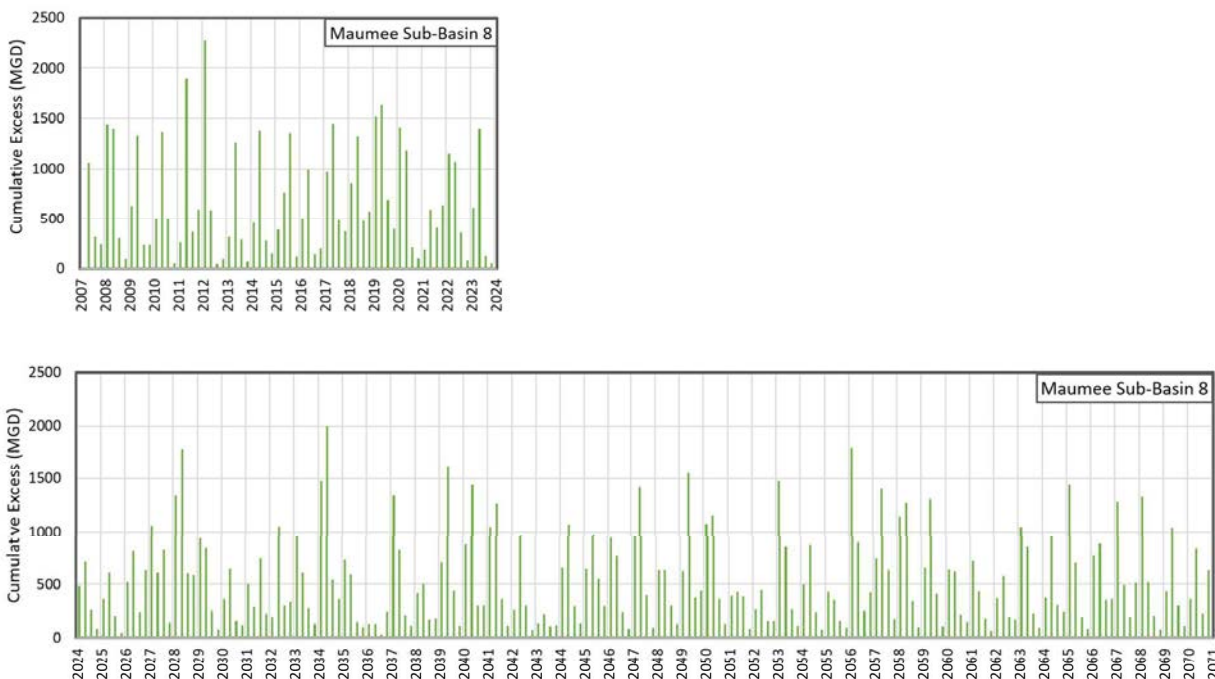


Figure 58. Example: Historical (top) and projected (bottom) seasonal cumulative excess water availability for Sub-Basin M8 of the Maumee River Basin.

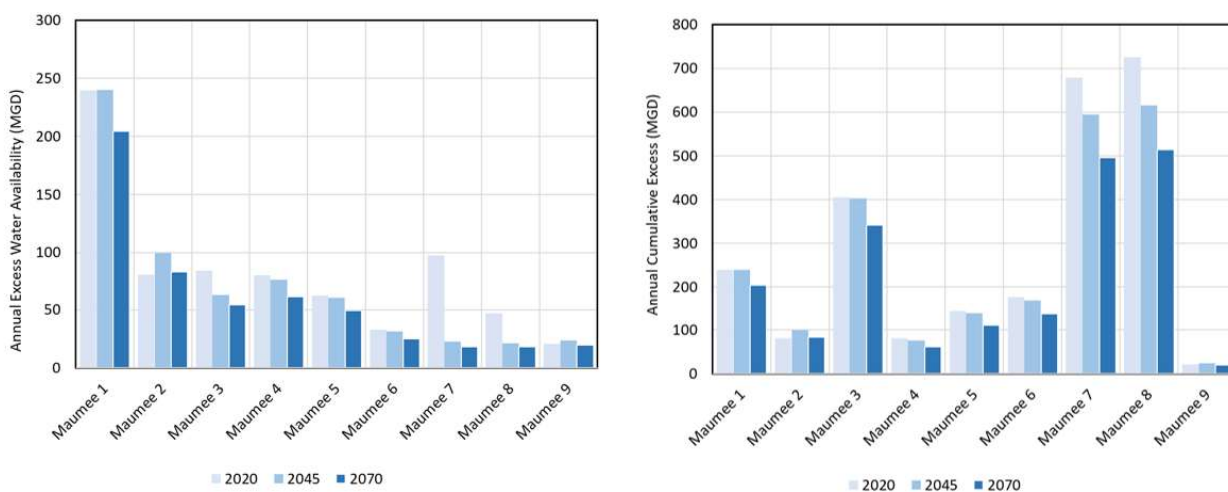


Figure 59. Current and projected annual excess (left) and cumulative excess (right) water availability in the sub-basins of the Maumee River Basin.

Figure 59 illustrates the expected changes in annual excess water availability and cumulative excess water availability in the Maumee River Basin over the next 50 years. The excess water availability is projected to decrease slightly in all sub-basins through 2070; the cumulative excess is also projected to decrease in most sub-basins, with the most significant decreases in the downstream Sub-Basins: M7 and M8. Like the St. Joseph River Basin, the annual availability shows little variation into the future, with the seasonal metrics show a shifting of water availability throughout the year.

Figure 60 illustrates the projected changes in Summer and Fall excess and cumulative excess water availability. The Summer metrics vary with some sub-basins showing increases and some showing decreases. The Fall metrics are projected to increase substantially in most sub-basins. **Figure 61** illustrates the current and projected Winter and Spring excess and cumulative excess water availability. All four metrics are projected to decrease slightly to moderately in all sub-basins.

In general, model projections in the Maumee River Basin suggest that annual water availability metrics will decrease slightly through 2070. More significant changes are expected in the seasonal metrics, with significant decreases in Winter availability and significant increases in Fall availability.

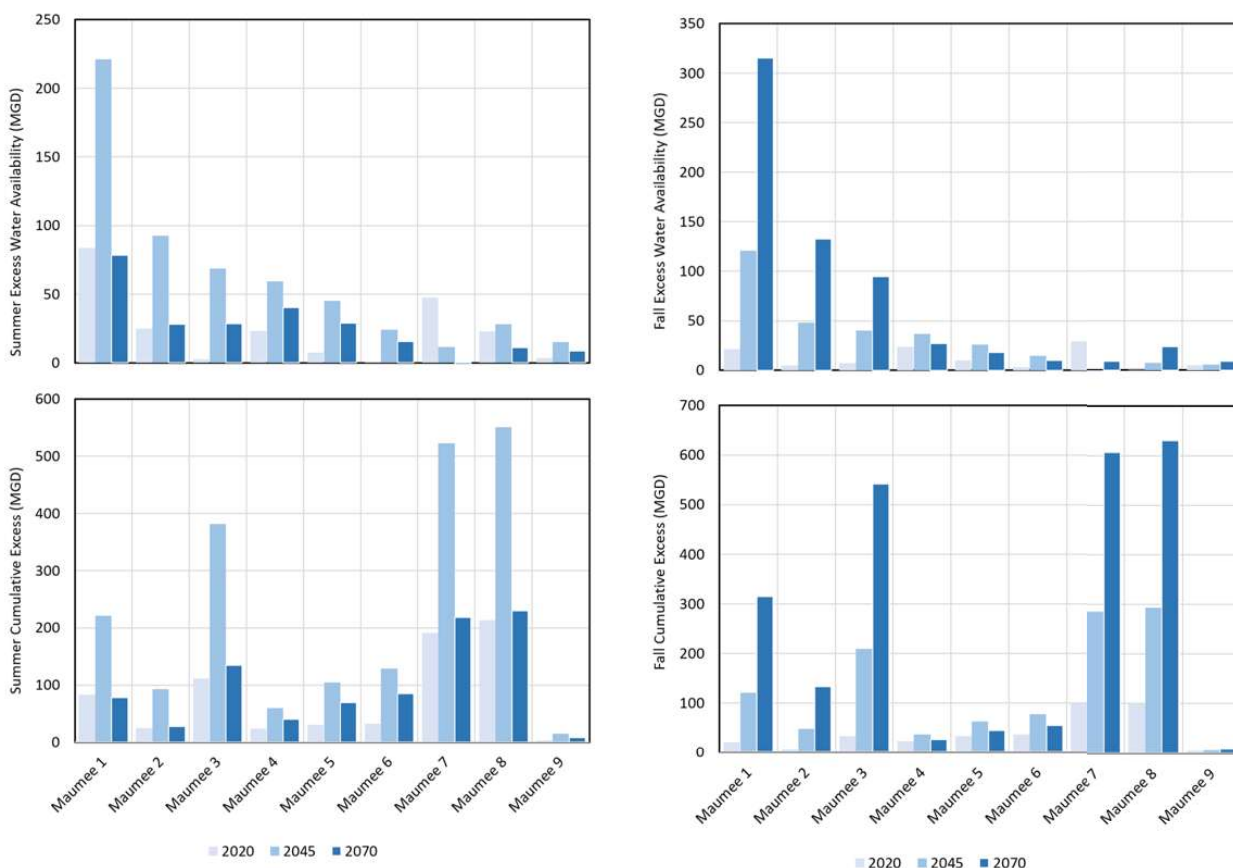


Figure 60. Current and projected Summer (left) and Fall (right) excess (top) and cumulative excess (bottom) water availability in the sub-basins of the Maumee River Basin.

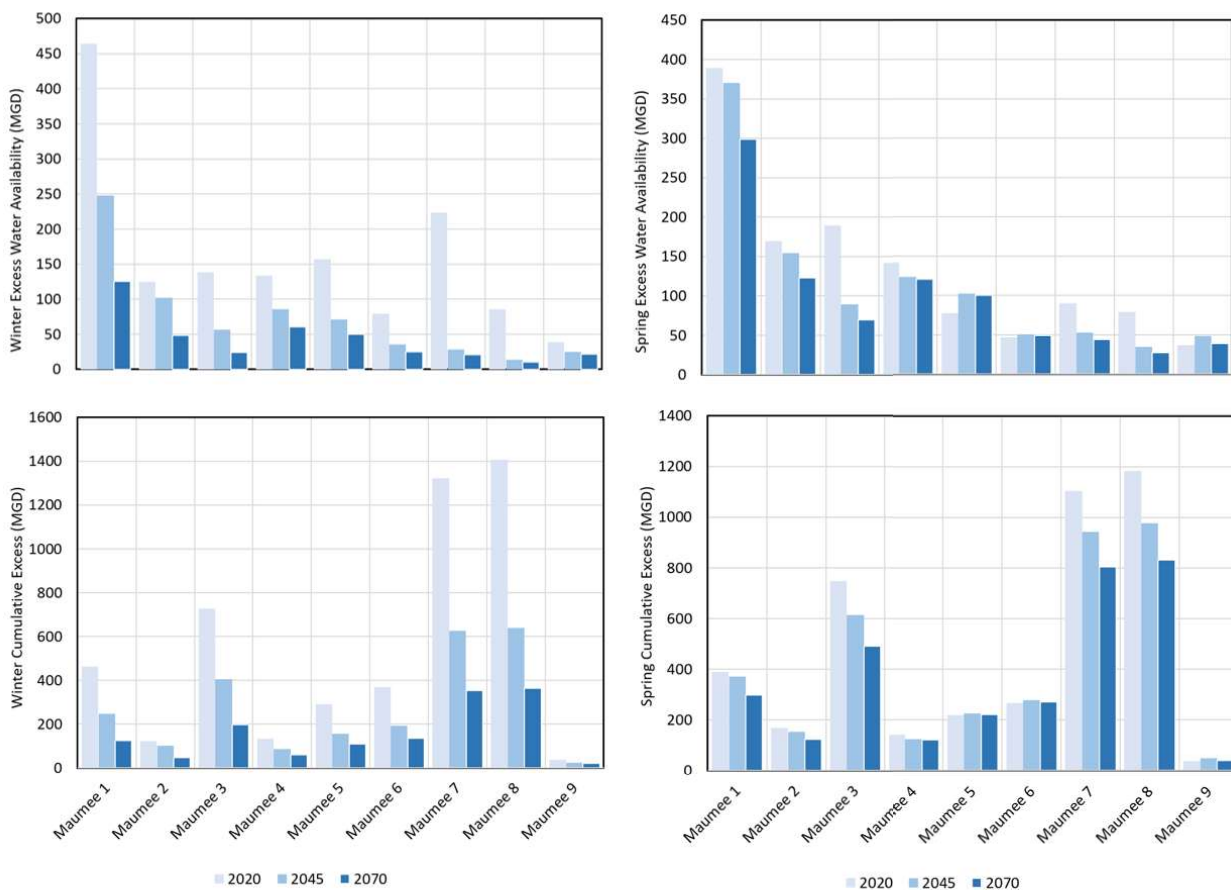


Figure 61. Current and projected Winter (left) and Spring (right) excess (top) and cumulative excess (bottom) water availability in the sub-basins of the Maumee River Basin.

4.0 Risks to Water Supply

Building on the demand and availability projections presented in the preceding sections, this section examines the factors that threaten the long-term reliability of water resources across the Northeast Indiana Region. While the regional water availability analysis does not project an annual, region-wide deficit through the 2070 planning horizon, it does reveal an intensifying pattern of seasonal risk, most acutely in the irrigation-dominated sub-basins of the St. Joseph River Basin but also emerging in the Maumee River Basin as Winter availability declines and demand from new water users grows.

These hydrologic risks do not exist in isolation. This section situates them within a broader risk landscape shaped by three interrelated pressures: climatic shifts toward flash drought, shrinking snowpack, and more intense precipitation events; water-quality degradation driven by agricultural land use and industrial legacy contamination; and aging water infrastructure that has already exceeded its typical design life. Together, these risk categories differ in character and severity between the Maumee and St. Joseph River Basins, and understanding these basin-specific differences is essential context for the conservation and management recommendations that follow.

4.1 Water Availability Risk Analysis

The future water availability analysis does not indicate a region-wide annual water deficit through the 2070 planning horizon. However, the analysis identifies a clear and intensifying **seasonal** risk profile: irrigation-driven, Summer depletion in the St. Joseph River Basin (already exhibiting negative cumulative excess availability in two sub-basins) is projected to worsen, and Winter supply constraints are projected to increase across both basins. The St. Joseph River Basin's irrigation-dominated sub-basins represent the region's most acute near-term water supply risk.

In our risk analysis, an historically at-risk sub-basin is defined as a sub-basin that has had at least one seasonal occurrence of a negative cumulative excess water availability during the historical period, 2007-2023. This means that the river has dropped below the minimum instream flow target at least once historically. Similarly, a projected at-risk sub-basin has at least one predicted occurrence of negative cumulative excess water availability in the period 2024-2070. **Table 25** and **Table 26** summarize the number of occurrences of negative seasonal cumulative excess water availability for the historical period and the projected period respectively. A negative, seasonal value of cumulative excess water availability indicates that streamflow has decreased below the minimum instream flow target within a 3-month period. This condition suggests a degradation of stream water quality, ecological health, and recreation use and is therefore defined as an at-risk condition. **Figure 62** shows the historically at-risk basins (left) and the projected at-risk sub-basins in the future (right).

4.1.1 Risks: St. Joseph River Basin

Consumptive use associated with agricultural irrigation is projected to increase significantly in the St. Joseph River Basin, producing more frequent and more negative cumulative excess water availability values during Summer and Fall — indicating that streamflow is depleted below minimum instream flow thresholds with increasing frequency.

As shown in **Figure 62** (left), Sub-Basins SJ2 and SJ7 have already exhibited negative cumulative excess availability (approaching -70 MGD) at times in the historical record, indicating that during the driest conditions on record, streamflow fell below the minimum instream flow target. **Figure 62** (right) shows that all sub-basins are predicted at times to fall below the minimum flow threshold in the future, representing a seasonal risk. Summer and Winter cumulative excess water availability is projected to decrease significantly, while Spring shows comparatively minor change.

The deficit in the St. Joseph River Basin is contextualized against much larger absolute flow volumes in this basin (7Q10 values of 288 MGD and 606 MGD at the downstream ends of Sub-Basins SJ2 and SJ7, respectively), indicating substantially greater total water availability and consumptive use relative to the Maumee Basin.

4.1.2 Risks: Maumee River Basin

In the Maumee River Basin, baseflow is comparatively low throughout the year. Minimum cumulative excess water availability is lowest in the St. Marys River Sub-Basins (M4, M5, M6) and moderate in the St. Joseph River (Maumee-side) Sub-Basins (M1, M2, M3). The downstream Maumee Sub-Basins (M7, M8) exhibit sufficient cumulative excess availability to accommodate the projected ~6 MGD increase in Allen County public-supply demand through 2070. The Hurshtown Reservoir (1.8 billion gallons; Sub-Basin M3), operated by Fort Wayne Utilities as an emergency drought supply, could provide an incremental 20 MGD for approximately three months; this capacity is excluded from the baseline availability calculations but is noted as a resilience asset.

Annual water availability metrics are projected to decline only marginally through 2070. However, seasonal redistribution is more pronounced, with Winter availability projected to decrease significantly and Fall availability projected to increase substantially. **Figure 62** shows that historically, the basin has positive cumulative excess water available, and most sub-basins are predicted to continue to have positive values in the future.

Table 25. Historical sub-basin risk. Green represents sub-basins with positive seasonal cumulative excess water availability from 2007-2023, over 68 seasons. Orange shows sub-basins with at least one occurrence of negative seasonal cumulative excess water availability from 2007-2023.

Sub-Basin	Historical Occurrences (68 seasons)	Sub-Basin	Historical Occurrences (68 seasons)
Maumee 1	0	St. Joseph 1	0
Maumee 2	0	St. Joseph 2	1
Maumee 3	0	St. Joseph 3	0
Maumee 4	0	St. Joseph 4	0
Maumee 5	0	St. Joseph 5	0
Maumee 6	0	St. Joseph 6	0
Maumee 7	0	St. Joseph 7	0
Maumee 8	0	St. Joseph 8	1
Maumee 9	0	St. Joseph 9	0

Table 26. Future sub-basin risk. Green represents sub-basins that are expected to have positive seasonal cumulative excess water availability in the future, 2024-2070, over 188 seasons. Orange shows sub-basins that are projected to have at least one occurrence of negative seasonal cumulative excess water availability in the future.

Sub-Basin	Future Occurrences (188 seasons)	Sub-Basin	Future Occurrences (188 seasons)
Maumee 1	0	St. Joseph 1	24
Maumee 2	1	St. Joseph 2	1
Maumee 3	0	St. Joseph 3	31
Maumee 4	0	St. Joseph 4	19
Maumee 5	0	St. Joseph 5	1
Maumee 6	0	St. Joseph 6	24
Maumee 7	0	St. Joseph 7	11
Maumee 8	0	St. Joseph 8	3
Maumee 9	0	St. Joseph 9	3

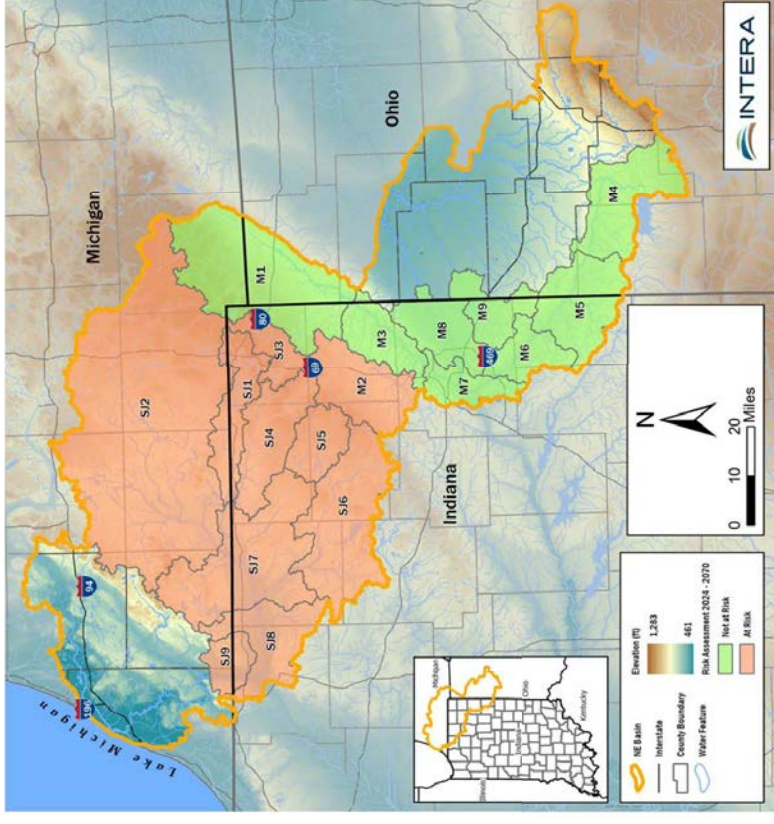
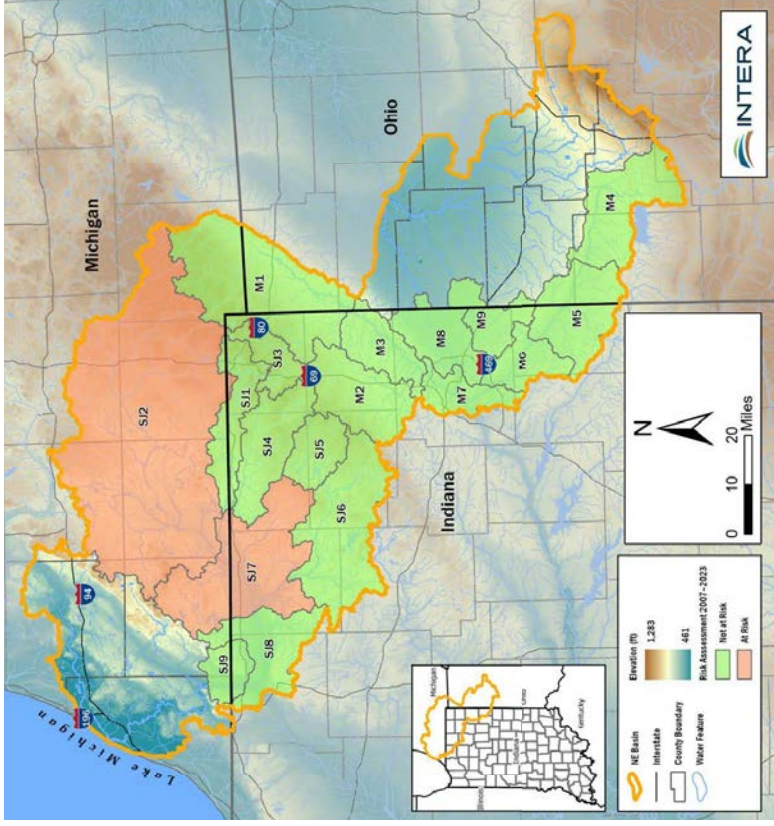


Figure 62. Historical (left) and projected future (right) sub-basin risk. Green represents basins that are not at risk historically or projected to be at risk in the future. Orange shows sub-basins that have or are expected to have negative seasonal values of cumulative excess water availability.

4.2 Climate

Statewide, Indiana has already warmed by about 1.2°F since 1895, and average annual precipitation has increased by roughly 5.6 inches over the same period, with a growing share arriving in heavy downpours rather than steady rainfall (Widhalm et al., 2018). This is consistent with the pattern seen on Lake Erie, where water levels fell sharply through the late 1990s and early 2000s during a period of warmer temperatures and higher evaporation, then swung to record highs by 2019 and 2020. Water levels in the Great Lakes have declined again, and large lake elevation swings are thought to become the new normal (Gronewold and Rood, 2019).

Present-day climate risk in this Region is flash drought, a rapid onset drought driven by low precipitation, abnormally high temperatures, high winds, and increased evapotranspiration rather than a slow seasonal decline in rainfall (NOAA National Integrated Drought Information System [NIDIS], 2023). Indiana experienced a clear flash drought episode in June 2022, when over 87 percent of the state fell into some level of dryness or drought within a few weeks (Hall, 2022), and again in mid-2023, when rapid intensification across the Midwest pushed topsoil moisture conditions below levels last seen during the 2012 drought (NOAA NIDIS, 2023).

Warming is also changing Lake Erie’s water chemistry in ways that reinforce the harmful algal bloom frequency and magnitude. Rising surface water temperatures and increasing wave energy during Summer storms have been linked to more frequent upwelling of cold, oxygen-depleted, high-phosphorus water from the lake’s deeper central basin into the shallower western basin, adding an internal phosphorus source on top of the external load arriving from the Maumee River (Jabbari, 2021). At the same time, the Maumee River harmful algal bloom has been starting earlier in the season, consistent with warmer Spring temperatures advancing early algal growth (NOAA, 2026).

Although, the growing season is predicted to be warmer and drier, total annual precipitation across Indiana is projected to increase 6 to 8 percent by mid-century and by as much as 10 percent by late century, with Winter and Spring precipitation increasing the most—all while snowfall is expected to decline (Widhalm, 2018). More Winter and Spring rain falling on a shrinking snowpack, rather than being stored as snow until a single Spring thaw, is expected to increase surface runoff and flooding risk (Hart et al., 2020) and potentially reduce Summer baseflow. Lake Erie and Lake Michigan are projected to see higher average water levels by mid-century under most climate model scenarios, increasing the risk of coastal and lakeshore flooding even as year-to-year variability between high and low extremes continues (AGU, 2022).

Flooding

One of Northeast Indiana’s climate hazards is rapid snowmelt flooding on the Maumee, St. Joseph (Maumee Basin), and St. Marys Rivers, which converge in Fort Wayne. The March 1978 flood exceeded the Maumee River’s previous peak stage of record at New Haven by more than two feet, an event with a recurrence interval comparable to a 75-year flood and caused an estimated 44 million dollars in damage across Adams and Allen counties (USGS, 1981). Four years later, the March 1982 flood, driven by rapid melting of a heavy snowpack combined with several inches of rain, produced Fort Wayne’s worst flooding since 1913, damaging 1,500 homes and 100 businesses, forcing roughly 9,000 evacuations, and causing more than 50 million dollars in damage.

4.3 Water Quality

Water quality represents a distinct but interrelated risk to long-term water supply reliability in the Region, shaped primarily by the Region's predominantly agricultural land use and its legacy of industrial development in the St. Joseph River Basin's urban corridors. Both basins exhibit well-documented impairments, including elevated nitrate concentrations linked to fertilizer application and tile drainage, emerging PFAS contamination now subject to new federal drinking water standards, persistent fecal coliform and E. coli impairment of surface waters, and legacy sediment, toxic substance, and VOC contamination tied to historical industrial and manufacturing activity. These conditions vary in character and severity between the two basins: the Maumee River Basin's water quality risk is dominated by nutrient and bacterial loading tied to agricultural runoff and combined sewer overflows, while the St. Joseph River Basin carries a more industrial contamination legacy alongside its own agricultural pressures. The following subsections describe each of these water quality concerns in turn, along with their implications for surface water, groundwater, and the Region's public water systems.

4.3.1 Groundwater

The aquifers that yield the most water in the Region, coarse sand and gravel glacial outwash deposits along river valleys, are also the aquifers most susceptible to surface contamination. In the St. Joseph River Basin, unconfined sand and gravel aquifer systems are considered highly susceptible to surface contamination; other systems, protected by low permeability till or lacustrine sediment, are less susceptible but also produce lower yields from pumping wells (IDNR, 1987). IDEM designated St. Joseph, Elkhart, and Kosciusko counties as priority geographic areas for groundwater protection based on the combination of aquifer susceptibility, contamination site density, and well density (Letsinger, 2015).

Man-made structures compound this natural vulnerability. Poorly constructed, unplugged, or improperly abandoned wells and open excavations may create contaminant pathways that bypass otherwise protective clay layers. Conversely, well designed structures can add protection beyond what the natural aquifer system provides. Shallow, poorly constructed, dug, or driven wells in the Maumee Basin showed higher pesticide detection rates (triazine and acetanilide residues) than properly drilled wells, indicating that well construction quality is a meaningful, independent risk factor (IDNR, 1996).

4.3.1.1 Nitrate

In the St. Joseph River Basin, historical sampling found nitrate above the 10 mg/L MCL in 13 of 410 sampled wells, with an additional 46 sites showing intermediate concentrations of 1 to 10 mg/L. These wells clustered in the same sand and gravel outwash systems independently were flagged as easily susceptible to contamination (IDNR, 1987; Letsinger, 2015).

More recently, IDEM's Statewide Ground Water Monitoring Network (GWMN) sampled private residential and public water-supply wells across the Region's counties from 2010–2018 (IDEM, 2026). Nitrate-nitrite concentrations were more frequently detected and substantially higher in the sand-and-gravel outwash counties of the St. Joseph River Basin than in the till-dominated counties of the Maumee Basin. Mean concentrations of roughly 2.5 to 5.0 mg/L in Elkhart, St. Joseph, Kosciusko, and LaGrange Counties, compared with 0.06 to 0.07 mg/L in Adams, Allen, and Whitley Counties. All nine of the

Region's GWMN samples exceeding the 10 mg/L nitrate-nitrite MCL occurred in the outwash counties; none occurred in the more clay-rich till-plain counties (**Table 27**). In Elkhart County, nitrate-nitrite was detected in 10 of 30 samples (33%) drawn from 22 wells, with a mean concentration of 2.7 mg/L and a maximum of 9.6 mg/L.

These county-level results are consistent with statewide patterns documented in IDEM's 2016 GWMN summary report (IDEM, 2016). Statewide, wells in aquifers classified as highly sensitive to surface contamination had both the highest nitrate-nitrite detection frequency (44%) and the highest average concentration (1.5 mg/L) (Letsinger, 2015; IDEM, 2016). Wells in areas of cultivated-crop land use showed higher average concentrations than wells in forested or developed areas (IDEM, 2016).

The elevated nitrate levels in the Region's sand and gravel aquifers reflect non-point agricultural sources likely from nitrogen fertilizer application and manure land-application associated with the Region's CAFOs. This is compounded in Elkhart County by wastewater systems. Septic system performance depends on adequate filtration through the soil column, failing or aging septic systems sited in coarse, highly permeable sandy soils are less able to attenuate nitrogen before reaching the water table, adding a residential nonpoint source alongside agricultural input (IDNR, 1987; IDEM, 2016). This is consistent with IDEM's designation of St. Joseph, Elkhart, and Kosciusko counties as priority areas for groundwater protection (IDEM, 1987; IDEM, 2016).

Table 27. Nitrogen (Nitrate-Nitrite) results by county, 2010-2018 (IDEM Statewide Ground Water Monitoring Network).

County	Basin (Setting)	Samples (n)	Detected (%)	Mean (mg/L)	Max (mg/L)	Samples > MCL (10 mg/L)
Adams	Maumee Basin (till plain)	18	17	0.06	0.1	0
Allen	Maumee Basin (till plain)	34	12	0.07	0.1	0
DeKalb	Maumee Basin (till plain)	1	0	0	0	0
Elkhart	St. Joseph Basin (outwash)	30	33	2.73	9.6	0
Kosciusko	St. Joseph Basin (outwash)	31	32	4.95	19.0	5
LaGrange	St. Joseph Basin (outwash)	79	41	2.88	15.0	3
Noble	St. Joseph Basin (outwash)	26	15	0.08	0.2	0
Steuben	Maumee Basin (till plain)	14	50	1.01	1.6	0
St. Joseph	St. Joseph Basin (outwash)	42	26	2.47	14.0	1

4.3.1.2 Volatile Organic Compounds and Industrial Solvents

Legacy manufacturing is concentrated in the Region's historically industrial cities of South Bend and Elkhart and correlates strongly with the VOC groundwater detections and Superfund site density. The St. Joseph River Basin documented industrial solvent contamination with 33 groundwater contamination sites in St. Joseph, Elkhart, and Kosciusko counties, predominantly in the industrial areas of South Bend and Elkhart (IDNR, 1987). Surveys of VOCs in Indiana public water supplies found detectable levels of at least one VOC in seven public water systems across St. Joseph, Elkhart, LaGrange, Steuben, and DeKalb counties (IDNR, 1987).

Elkhart County hosts multiple National Priorities List sites (Main Street Well Field, Lane Street, Lusher Street, Conrail Rail Yard, and the Himco Dump site, which is scheduled for another five-year EPA review beginning in 2026), making it one of the more concentrated clusters of industrial groundwater contamination in the state (EPA 2024b, 2024c, 2024d, 2024e, and 2026b).

Industrial vulnerability to VOCs and industrial solvent contamination in the South Bend-Elkhart corridor is a present and future concern for federal agencies and local management.

4.3.1.3 Per- and Polyfluoroalkyl Substances

PFAS are a large family of manufactured chemicals used since the 1940s in products such as firefighting foam, nonstick coatings, stain- and water-resistant materials, food packaging, and industrial processes. They are often called "forever chemicals" because many PFAS resist natural breakdown and can remain in the environment for decades.

Long-term exposure to certain PFAS, particularly well-studied compounds such as Perfluorooctanoic acid (PFOA) and Perfluorooctanesulfonic acid (PFOS), has been associated with increased cholesterol, reduced immune response, developmental and reproductive effects, liver and thyroid impacts, and increased risk of certain cancers.

PFAS contamination is especially important for drinking-water supplies. Once PFAS enter a groundwater aquifer or surface-water source, affected utilities may need advanced treatment, such as granular activated carbon, ion exchange, or reverse osmosis, or may need to develop an alternative source. These treatment technologies come at a very high cost, particularly compared to typical groundwater treatment costs to which the utilities in the Northeast Indiana Region are accustomed.

PFAS contamination predates widespread PFAS monitoring, but it is now one of the best-documented contemporary risks in this Region. Litigation filed by the Indiana Attorney General's office cites IDEM sampling that found PFAS above EPA health advisory levels in public drinking water (Indiana Office of the Attorney General, 2024). IDEM's statewide Community Public Water System sampling project detected various PFAS compounds in the raw water of 13 systems and the treated water of 10 systems statewide (IDEM, 2022). Additional testing later identified PFAS above federal health guidelines at 19 utilities across the state (IDEM, 2024).

The federal regulatory landscape is in flux, but as of the writing of this report, the EPA finalized the first National Primary Drinking Water Regulation for PFAS compounds, setting enforceable maximum contaminant levels of 4 parts per trillion for PFOA and PFOS (EPA, 2024a). EPA has proposed a new

deadline of 2031 for public water systems to implement treatment where levels exceed the new standards. Because PFAS is used across hundreds of products and industrial categories, sources are diffuse and difficult to trace. The Maumee and St. Joseph River Basins are a multi-source contributor to PFAS contamination because of their mix of legacy manufacturing, biosolids land application, and urban runoff.

4.3.2 Surface Water

Agricultural land use is the single most important explanatory variable for water-quality risk in Northeast Indiana. Cropland accounts for 54 percent of total land use in the Region. Agricultural drainage tiles, used throughout the Region to remove excess soil moisture, create pathways for nitrate and dissolved phosphorus to reach streams quickly (NOAA, 2026).

Wetlands act as sinks for nutrients and pathogens while supporting vegetation and microorganisms that process nitrogen and other contaminants. Continued wetland loss across the Region's agricultural landscape removes this natural buffering function where contamination sensitivity is already highest (IDNR, 1996).

4.3.2.1 Nitrate

Nitrate is the most pervasive and documented water-quality risk because of the Region's agricultural land use. Roughly 88% of the Maumee River Basin is classified as agriculture, and nitrogen fertilizer application is a major contributor to non-point-source nutrient loading. Median monthly nitrate-nitrite concentrations in the basin's major rivers stayed below the 10 milligram per liter (mg/L) drinking water maximum contaminant level (MCL), yet other studies show small and medium agricultural streams in the Region have been found to contain nitrate concentrations exceeding 10 mg/L (**Figure 63**) (IDNR, 1996).

4.3.2.2 Harmful Algal Blooms

Another contemporary surface water risk is not a risk to Indiana's own water supply but a downstream consequence that reflects directly on the water quality practices in the Indiana portion of the Maumee River Basin. The Maumee River basin is the largest source of phosphorus loading to Lake Erie (Maccoux et al., 2016) and the primary driver of the basin's recurring harmful algal blooms (HABs). These blooms produce microcystin toxins that have repeatedly threatened drinking water supplies; the 2014 bloom left roughly 500,000 Toledo-area residents without safe tap water for several days (Manning and Johnson, 2019).

Agricultural sources account for an estimated 80 to 90 percent of phosphorus loading, arriving via surface runoff, subsurface tile drainage, and erosion of phosphorus-enriched soil (NOAA Great Lakes Environmental Research Laboratory [GLERL], 2026). Heidelberg University's National Center for Water Quality Research reports that dissolved reactive phosphorus (DRP) loading from the Maumee River has shown no statistically significant downward trend since intensive monitoring began in 2009, even though total phosphorus and particulate phosphorus loads have declined (NOAA, 2026). Because the DRP fraction is the one most readily taken up by algae, and the one most closely tied to modern fertilizer application and tile drainage practices, the lack of decline despite two decades of nutrient management

investment is the clearest evidence that the underlying agricultural nutrient management challenge remains unresolved.

4.3.2.3 CAFOs

As discussed in **Section 2.0**, concentrated animal feeding operations (CAFOs) are present in the Region (**Figure 63**). The number of individual farms has been roughly stable or declining even as the number of animals per facility, and therefore the manure and nutrient management burden per facility has increased (Public News Service, 2024).

Research has shown that contaminants from CAFOs come from 1) leaking manure lagoons, or 2) overflow of lagoons when it rains, and 3) runoff from applications of waste to farm fields. These generally accepted livestock waste management practices do not adequately protect water resources from contamination from excessive nutrients, microbial pathogens, and pharmaceuticals present in the waste (Burkholder et al., 2006). Promotion of best management practices is needed to minimize inputs of nutrients and other chemicals from CAFOs.

4.3.2.4 Combined Sewer Overflows and Dissolved Oxygen

Combined sewer overflows (CSOs) occur in communities where stormwater and sanitary sewage are carried through the same sewer system. During heavy rain or snowmelt, the volume of water may exceed the capacity of the sewer system or wastewater treatment plant. To prevent backups and damage, the system releases excess flow, often a mixture of stormwater and untreated sewage, directly into a river, stream, lake, or other receiving water.

CSOs pose a risk to water quality because they may discharge (1) disease-causing bacteria, viruses, and parasites; (2) human waste and oxygen-demanding organic material; (3) nutrients such as nitrogen and phosphorus; (4) industrial and household chemicals; and (5) oil, sediment, trash, and other pollutants washed from streets. The locations of the combined sewers are shown in **Figure 63**.

Streams that receive water from CSOs often fail to sufficiently support aquatic life because of low dissolved oxygen (DO), driven by oxygen-consuming bacterial decay of organic matter and under-treated wastewater (IDNR, 1996). The St. Joseph DO monitoring shows a strong seasonal pattern meaning DO-related aquatic life impairment concentrates in the same Summer low-flow window when nutrient and bacterial concentrations also peak, further compounding water quality risk (IDNR, 1987).

South Bend has made measurable progress on the point-source side of this problem: a real-time "smart sewer" sensor and valve network has cut combined sewer overflow volume into the St. Joseph River by roughly 75 to 80 percent, and its updated long-term control plan was endorsed by EPA and the Department of Justice in 2021 at a fraction of the originally projected capital cost (Xylem, 2026; Notre Dame, 2026).

In 2024, Fort Wayne completed a five-mile deep-rock tunnel system which collects water from the combined sewer lines. A pumping station then pumps the water to the City's wastewater treatment plant, reducing the frequency and volume of uncontrolled discharges from the sewer system into rivers during heavy rainfall event.

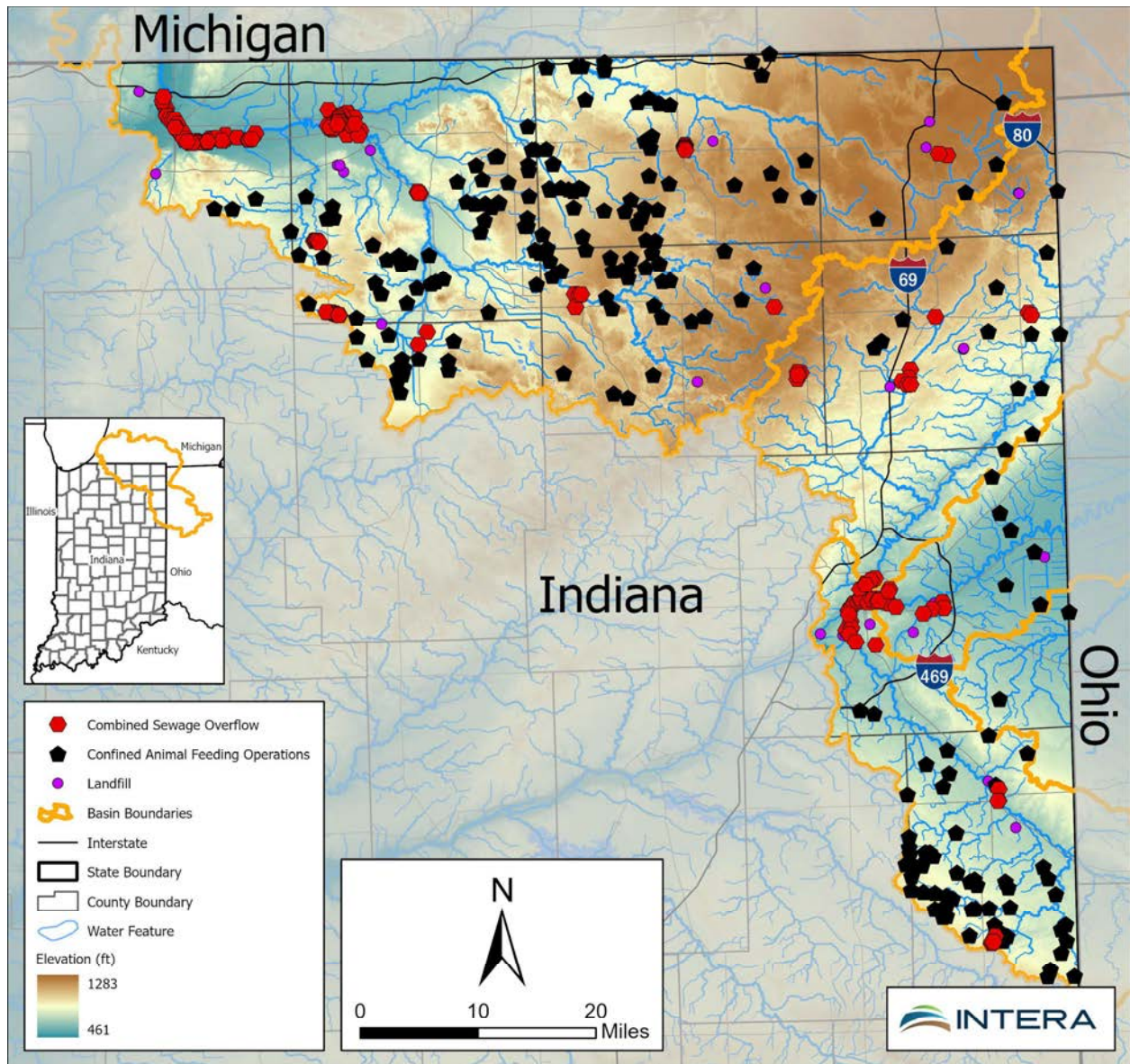


Figure 63. Potential sources of contamination and existing nitrate concentrations in the Northeast Indiana Region.

4.3.2.5 Fecal Coliform and E. coli

Bacterial contamination is another surface-water quality problem. In the Maumee River Basin, only 110 miles (14 percent) of rivers and streams fully support whole-body contact recreation, while the remaining 654 miles (86 percent) are non-supportive, the majority due to high coliform bacteria, specifically E. coli (IDEM, 2026b; IDNR, 1996). Sixty-three of 81 water quality sampling sites failed in whole or in part due to bacteria. Specific reaches, including the St. Marys River, Yellow Creek, Big Run Drain, Garrett City Ditch, and King Lake Ditch, were linked to sewage treatment facility non-compliance,

while the Maumee River mainstem, Habegger Ditch, Marsh Ditch, and Edgerton-Carson Ditch were linked to CSOs.

In the St. Joseph River Basin, fecal coliform violations for whole-body contact recreation increased markedly moving downstream from Elkhart to the Indiana-Michigan state line, despite improvement over time at the South Bend monitoring station (Purdue University, 2011; IDNR, 1987). Continued improvement of CSOs and sewage treatment upgrades may reduce contamination, yet these facilities are still active contributors of fecal coliform and E. coli.

4.4 Infrastructure

Aging infrastructure is consistently cited as a top concern in water industry surveys nationwide, and a review of Preliminary Engineering Reports (PERs) for 28 public water utilities across the Northeast Indiana Region confirms this is a current, present-day risk rather than a general industry talking point. The reviewed PERs show that a large share of the Region's core treatment infrastructure is well past a typical design life. Documented treatment plant construction dates range from the 1930s through the 1970s, and distribution systems in several communities retain legacy asbestos-cement or cast-iron mains installed 60 to 80 years ago

Old and deteriorating pipe materials increase the risk of main breaks, hydrant leaks, and service lateral leaks. These conditions translate directly into water loss, with annual water losses sometimes exceeding 15%. Outdated mechanical and electrical equipment, such as legacy SCADA and lift station systems further increases the likelihood of unplanned failures. Additionally, lead service lines remain a widespread concern, requiring costly replacement programs to meet current public health standards.

Treatment facilities face their own risks, often operating with single-train, non-redundant configurations that make it difficult to perform maintenance without interrupting service.

Collectively, these aging-infrastructure challenges expose utilities to greater risk of main breaks, service disruptions, and regulatory non-compliance, even where raw water supply and treatment capacity are otherwise sufficient to meet present and future demand.

4.5 Data Centers

Allen and St. Joseph counties are locations of two of the state's largest concentrations of data center development, adding significant water demand and land-use pressure to both basins. Statewide, Indiana hosts 19 operating data centers (1,507 megawatts [MW] combined capacity) and 58 planned projects (15,944 MW) as of mid-2026 (Cleanview, 2026).

In the Maumee River Basin, Google's Project Zodiac campus (700+ acres) in southeast Allen County is operating its first 400 MW phase, with a 1,200 MW second phase planned (Cleanview, 2026; Trueman, 2025). The Fort Wayne public water utility plans to supply the data center from the St. Joseph River (Maumee Basin). The utility reports that it has sufficient capacity both in its water supply and treatment capacity (Engage Fort Wayne, 2026). Another identified local risk is wetland loss with more than six acres of wetlands filled for the first two phases and a further 2.47 acres approved by IDEM in September 2025 (Trueman, 2025). The increased energy demand created by data centers requires increased water

withdrawals at the power plants serving the data centers. There may be a significant increase in water withdrawals, but the consumptive use for most power plants is a very small portion of the water withdrawn.

In the St. Joseph River Basin, a large data center is being constructed at Microsoft's Granger site in St. Joseph County (1,000 MW) (Cleanview, 2026). The City of Mishawaka is extending municipal water and sewer lines to serve the new facility.

No single agency currently evaluates the combined effect of data center site withdrawals, associated power-plant cooling withdrawals, wastewater discharge composition, and wetland loss as one cumulative water budget. This gap is acknowledged, yet concerning, given that several of these facilities sit inside or adjacent to the same outwash aquifers and wetland-dependent floodplains already identified as highly contamination-sensitive (Citizens Action Coalition, 2026).

5.0 Conservation

The following discussion identifies conservation and use-efficiency opportunities across the Region's major water use sectors, then translates those opportunities into targeted actions for the Region's water providers, counties, and state agencies to pursue.

5.1 Water Use Consumption

Water conservation and use efficiency are among the most cost-effective strategies available for extending the useful life of the water resources evaluated in this study, typically requiring far less capital investment than developing new source capacity, storage, or conveyance infrastructure. Conservation is also directly relevant to the Region's regulatory setting: because the Northeast Indiana Region lies entirely within the Great Lakes Basin, all proposals for new or increased withdrawals reviewed under the Great Lakes Compact must incorporate sound and economically feasible water conservation and efficiency measures (IDNR, 2026). Reducing consumptive demand across the Region's water use sectors also directly benefits the sub-basins identified in **Section 3.2** as having the most limited water availability during their respective critical seasons, particularly the Summer irrigation season in sub-basins of the St. Joseph River Basin, where minimum cumulative excess water availability is negative, and the low-baseflow Fall season in the Maumee River Basin.

Enhanced water conservation and water use efficiency for the Region could include the following, organized by water use sector:

- **Public water supply and non-revenue water:** Enhanced leak detection, meter testing, and more aggressive capital improvement planning for the 76 public water utilities serving the Region, particularly the many smaller systems (serving roughly 200 to 3,000 people) that typically have more limited capital resources. Indiana water utilities are required under IC 8-1-30.8 to submit validated water loss audits to the IFA every even-numbered year; the most recent statewide biennial report found that 450 of 527 utilities (85 percent) submitted a validated audit, with statewide non-revenue water totaling more than 46.8 billion gallons and an associated cost exceeding \$62.9 million in the audit year (IFA, 2024). Continued and expanded participation in this program by the Region's utilities, supported by state funding and technical assistance where available, represents a low-cost opportunity to reduce real and apparent losses from the aging distribution systems common among the Region's groundwater-dependent utilities.
- **Seasonal outdoor water use:** Public supply withdrawals across in the Region exhibit a pronounced Summer peak driven by lawn and landscape irrigation, car washing, and pool filling. Local ordinances or incentive programs that target discretionary outdoor use, such as watering schedules, turf reduction in public rights-of-way, and increasing block rate structures, could reduce peak-day demand and the associated infrastructure sizing burden without materially affecting essential domestic use.
- **Agricultural irrigation:** Irrigation is the dominant water use sector in the Region, with 831 groundwater and surface water withdrawal locations concentrated in Elkhart, LaGrange, Kosciusko, and St. Joseph counties. Because this demand is concentrated in the same St. Joseph River Basin sub-basins that show negative minimum cumulative excess water availability during the Summer growing season, efficiency improvements among irrigators—such as soil moisture-based scheduling,

conversion to low-pressure or drip systems, and drought-contingency planning—would directly target the Region’s most constrained sub-basins and critical season.

- **Industrial and commercial use:** Industrial withdrawals have declined by roughly 40 to 50 percent since the late 1980s, reflecting a combination of facility closures and the contraction of water-intensive manufacturing in the Region, along with process efficiency improvements and water recycling and reuse practices among the manufacturers that remain along the US-20/I-90 and I-69 corridors. Continued encouragement of water cycling systems and process optimization among the Region’s remaining industrial facilities, particularly the water-intensive food and beverage, metal fabrication, and recreational vehicle and manufactured housing industries, would help sustain this long-term downward trend.
- **Rural and self-supplied use:** Self-supplied residential and rural agricultural users, including livestock and aquaculture operations, are not captured by utility-level conservation programs because they rely on private wells. County-level outreach and education on fixture and livestock-watering system efficiency, delivered in coordination with county health departments and agricultural extension offices, would extend conservation benefits to this otherwise unreached share of regional water demand, which is already comparatively modest compared to other sectors.
- **Regional collaboration:** Fort Wayne City Utilities’ Hurshtown Reservoir provides up to 20 MGD, three-month drought supply that has never been activated as an emergency source. Formalizing this capacity as a regional mutual-aid or interconnection resource, rather than a purely local backup, would allow neighboring groundwater-dependent systems to draw on it during periods of constrained availability, improving regional resilience at comparatively low incremental cost.

Enhanced water conservation and use efficiency generally requires and benefits from sustained public education and outreach, as well as ongoing coordination among the Region’s water providers, county agencies, and the IDNR and IFA at the state level.

5.2 Conservation Recommendations

Based on the water demand, availability, and risk findings presented in this study, the following conservation-related actions are recommended for the Northeast Indiana Region:

- Encourage full participation in, and expansion upon, existing Indiana water loss audit requirements among the Region’s 76 public water utilities, prioritizing state funding and technical assistance toward the smaller, more resource-limited systems.
- Target irrigation efficiency incentives and drought-contingency programs toward Elkhart, LaGrange, Kosciusko, and St. Joseph counties, where irrigation withdrawals coincide with the Summer critical season and negative cumulative excess water availability in sub-basins.
- Adopt local ordinances or incentive programs addressing discretionary Summer outdoor water use, consistent with the pronounced seasonal peak observed in public supply demand across all nine counties.
- Continue to support industrial water recycling and process efficiency improvements to sustain the long-term declining trend in industrial withdrawals observed since the late 1980s.

- Ensure that any future proposal for new or increased withdrawals within the Great Lakes Basin portion of the Region documents sound and economically feasible conservation and efficiency measures, consistent with Compact review requirements under IC 14-25-15 and 312 IAC 6.2.

6.0 Findings and Recommendations

This section synthesizes the demand, availability, and risk analyses presented in **Sections 2.0** through **4.0** into a set of overall findings for the Northeast Indiana Region, followed by a consolidated set of recommendations intended to guide state agencies, regional utilities, and local decision-makers in planning for reliable and sustainable water supplies through 2070.

6.1 Water Demand

Total water demand across all use sectors in the Region is projected to rise from approximately 197 MGD in 2020 to approximately 291 MGD by 2070, an increase of 94 MGD. This growth is driven almost entirely by agricultural irrigation, projected to increase from about 49 MGD to about 121 MGD as the number of irrigated acres increase to accommodate the warmer, drier growing season and crop water needs. Irrigation is both the largest source of projected regional growth and the most climate-sensitive and uncertain sector in the forecast, and it is heavily concentrated in the glacial outwash aquifers of Elkhart, LaGrange, and Kosciusko counties in the St. Joseph River Basin.

By contrast, public water supply demand is projected to ease slightly, from about 75 MGD to about 74 MGD, as ongoing per-capita efficiency gains outpace modest population growth, driven almost entirely by reductions in groundwater use, whereas the surface-water withdrawals in Fort Wayne have been historically consistent. Self-supplied residential, power generation, and commercial/industrial demand are each projected to remain essentially flat over the planning horizon.

6.2 Water Availability

Historical water availability (2007–2023) is positive across most of the Region's sub-basins on an annual and seasonal basis, indicating that current withdrawals are generally supported by naturally occurring streamflow after accounting for minimum instream flow requirements. However, several St. Joseph River Basin sub-basins where irrigation withdrawals are concentrated already fall below minimum instream flow thresholds during Summer months in the driest years of record.

Looking forward, the two basins diverge sharply. In the St. Joseph River Basin, rising irrigation demand is projected to coincide with declining seasonal water availability, particularly in Summer and Winter, producing increasingly frequent periods of negative cumulative excess water availability—meaning that streamflow is projected to fall below minimum instream flow targets more often by 2070. In the Maumee River Basin, where irrigation is minimal, future consumptive use is projected to remain near historical levels; annual availability declines only slightly, Winter and Spring availability decline moderately, and Fall availability is projected to improve in most sub-basins.

6.3 Risks to Water Supply

Section 4.0 identified four categories of risk to the Region's water supply that operate independently of the demand and availability balance: climate, water quality, infrastructure condition, and rapidly emerging demand from data center development. The findings below summarize each, along with the asymmetry between the Maumee and St. Joseph River Basins in how those risks present.

- **Climate:** The Region's historical hazard of rapid, damaging snowmelt flooding on the Maumee, St. Joseph, and St. Marys Rivers (notably 1978 and 1982) is increasingly compounded by flash drought, which struck the state in June 2022 and again in 2023. Projected increases in precipitation falling on a shrinking snowpack are expected to raise runoff and flood risk, while warming Great Lakes water is reinforcing harmful algal bloom frequency in Lake Erie.
- **Water quality:** Agricultural land use and legacy industrial contamination are the two dominant drivers. Groundwater risks include VOC/industrial solvent contamination clustered in the South Bend–Elkhart corridor (including several Superfund sites) and emerging PFAS contamination now subject to new federal drinking-water limits. Surface water risks include nitrate from agricultural drainage, Maumee River phosphorus loading that drives Lake Erie's algal blooms, CAFO waste management, combined sewer overflows, nitrate, and bacterial (fecal coliform/E. coli) impairment.
- **Infrastructure:** A review of Preliminary Engineering Reports for 28 public water utilities across the Region confirms that aging infrastructure is a present-day, not merely theoretical, risk. Smaller utilities face capital costs per connection that are substantially higher than those of larger systems, increasing the risk of reactive rather than planned infrastructure replacement.
- **Data centers and emerging demand:** Allen and St. Joseph counties are experiencing rapid hyperscale data center development, adding a fast-emerging water demand and land-use pressure to both basins (including Google's Project Zodiac and Microsoft's Granger project). Existing and planned projects have already been linked to wetland loss. No single agency currently evaluates the cumulative water budget of site withdrawals, associated power-generation cooling demand, wastewater discharge, and wetland impacts together, despite several projects sitting within or adjacent to contamination-sensitive outwash aquifers.

6.4 Recommendations

The following recommendations (**Table 27**) are organized by focus area and are intended to be actionable by the state agencies, regional utilities, and counties best positioned to lead each effort.

Table 28. Summary of recommendations by focus area and lead entities.

Focus Area	Recommended Action	Lead / Partners
Irrigation & St. Joseph River Basin availability	Target irrigation efficiency incentives, soil-moisture-based scheduling, and drought-contingency planning in Elkhart, LaGrange, Kosciusko, and St. Joseph counties, where Summer cumulative excess water availability is projected to drop below the instream flow.	IDNR, Indiana Farm Bureau, county Soil & Water Conservation Districts, St. Joseph River Basin Commission, Maumee River Basin Commission, county drainage boards
Public water supply infrastructure	Continue the Region-wide capital needs and condition-rating inventory for the 76 public water utilities, prioritizing state-revolving fund/IFA funding toward smaller systems with high per-connection project costs.	IFA State Revolving Fund Loan program, utilities
Peak-day demand management	Adopt local ordinances or incentive programs addressing discretionary Summer outdoor water use (watering schedules, turf reduction, increasing-block rates) to reduce peak-day demand and associated infrastructure sizing costs.	Municipalities, utilities
Water quality protection	Expand nitrate monitoring in the St. Joseph River Basin outwash aquifers and Maumee River Basin agricultural streams; continue PFAS compliance support for utilities ahead of federal deadlines; support continued CSO separation planning.	IDEM, IDNR, utilities, St. Joseph River Basin Commission, Maumee River Basin Commission, county drainage boards
Data center & emerging demand	Establish a coordinated review of cumulative water withdrawals, associated power-generation cooling water, wastewater discharge, and wetland impacts from data center development in Allen and St. Joseph counties (and others as they arise).	IDNR, IDEM, IFA
Regional monitoring & data	Continue and expand SWWF reporting compliance and biennial water loss audits; track peaking factors and demand data across utilities to refine future planning updates to this study.	IFA, IDNR, utilities, St. Joseph River Basin Commission, Maumee River Basin Commission

7.0 Glossary

7Q10: The lowest 7-day average flow that occurs (on average) once every 10 years. In this study, the 7Q10 low flow was used as a minimum instream flow requirement in the Summer and Fall seasons.

A

alluvium: A general term for clay, silt, sand, gravel or similar unconsolidated detrital material, deposited during comparatively recent geologic time by a stream or other body of running water, as a sorted or semi sorted sediment in the bed of the stream or on its floodplain or delta, as a cone or fan at the base of a mountain slope.

anthropogenic: Man-made, or influenced by man, such as water withdrawals from aquifers and streams, wastewater returns, land use, land-cover modifications, and sources of contamination.

aquifer: A body of rock or sediment that is sufficiently porous and permeable to store, transmit, and yield significant or economic quantities of groundwater to wells and springs.

B

basin: The contributing land area that drains water, such as rainfall or snowmelt, to a basin outlet, or pour point. Also called a drainage basin, watershed, or catchment.

baseflow: The portion of streamflow derived from groundwater discharged to the stream.

bedrock: Any lithified geologic material that remains intact and in place where it was deposited.

C

cumulative excess water availability: A measure of the water remaining in a watershed or the collection of upstream sub-basins that could be used for expansion of public supplies, industry, or agriculture without jeopardizing instream flows.

D

dewatering: The removal of surface waters or groundwater by pumping to facilitate excavations for construction or mining.

discharge: The volume of water that passes a given location within a given period of time.

drawdown: The vertical distance the water elevation is lowered or the reduction of the pressure head due to the removal of water.

E

evapotranspiration: The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants.

excess water availability: A measure of the water remaining in a sub-basin that could be used for expansion of public supplies, industry, or agriculture without jeopardizing instream flows.

extraction well: An extraction well uses a pump to pull water from a vertical (or occasionally from a horizontal) interval screened in the saturated zone, moving the water to the surface for further disposition (e.g., treatment, beneficial use, etc.).

F

Fall: Season defined in this report as the 3-month period September-October-November.

flash drought: A sudden and rapid intensification of drought conditions, usually developing over a period of just a few days to a few weeks, driven by a combination of below-average precipitation and high evaporative demand.

G

glacial till: Unsorted sediment deposited directly by glacial ice and showing no stratification.

groundwater: Water that occurs beneath the land surface and fills the pore spaces of the alluvium, soil, or rock formation in which it is situated. It excludes soil moisture, which refers to water held by capillary action in the upper unsaturated zones of soil or rock.

H

headwaters: The most up-gradient, or first-order, tributary watersheds contributing water and sediment downstream to the stream network.

hydrograph: A graph showing stream discharge (y-axis) over time (x-axis), reflecting the total runoff from the area upstream of the measurement point.

I

Indiana Finance Authority: Funding agency for this study.

indirect water reuse: The blending of treated or reclaimed water into a natural water source, such as a river or stream, and the subsequent use of that water as a potable supply.

infiltration: The flow of water downward from the land surface into and through the upper soil layers.

instream flow: A minimum flow that is retained in a stream to protect ecological health, recreational use, and water quality.

intake: A structure facilitating surface-water withdrawals.

irrigation: The controlled application of water for agricultural purposes through man-made systems to supply water requirements not satisfied by rainfall.

L

lithology: The description of rocks, especially in-hand and in-outcrop specimens, based on such characteristics as color, mineralogic composition and grain size.

M

Mann-Kendall trend test: A statistical test used to assess temporal datasets for increasing or decreasing trends as well as statistical significance of the trend.

monitoring well: A well designed for measuring water levels and/or testing ground-water quality.

N

natural baseflow: The portion of natural streamflow derived from groundwater discharged to the stream.

natural streamflow: The streamflow that would be measured if anthropogenic effects of surface-water and groundwater withdrawals and return flows were eliminated.

O

outfall: The place where a sewer, drain, or stream discharges; the outlet or structure through which reclaimed water or treated effluent is finally discharged to a receiving water body.

outwash: Deposit of sand and gravel carried by running water from the melting ice of a glacier and laid down in stratified layers.

P

parts per billion: The number of "parts" by weight of a substance per billion parts of water.

Used to measure extremely small concentrations.

parts per million: The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations.

peaking factor: Ratio of maximum water demand to the average demand, such as peak daily demand to average daily demand.

Public Water System (PWS): Water utilities that distribute water from either surface-water or groundwater sources. A PWS can be a community system that serves a large population, or a non-community non-transient (NCNT) system such as a school that has their own water well(s).

Q

Q90: The average daily streamflow that is exceeded 90% of the time. In this report, the Q90 is used as the instream flow requirement in the Winter and Spring seasons.

R

recharge: Water added to an aquifer or the process of adding water to an aquifer. Ground water recharge occurs either naturally as the net gains from precipitation, or artificially as the result of human influence.

return flow: Discharges to surface waters from facilities permitted by the NPDES program, such as wastewater treatment plants.

S

Sen slope: Theil–Sen estimator of slope used along with the Mann-Kendall trend test to calculate the magnitude of trends in the long-term temporal data.

Spring : Season defined in this study as the 3-month period March-April-May.

stormflow: The portion of streamflow derived from surface runoff, and excluding baseflow.

stratigraphy: The science of rocks: it is concerned with the original succession and age relations of rock strata and their form, distribution, lithologic composition, fossil content, geophysical and geochemical properties.

stream gage: A location where streamflow measurements of the streamflow is made.

streamflow: The flow of water in a stream or river, commonly measured at a USGS station, and reported in units of cubic feet per second, cubic meters per second, or millions of gallons per day.

sub-basin: A portion of a watershed defined by the drainage region between a downstream USGS station and one or more upstream USGS stations.

Summer: Season defined in this report as the 3-month period June-July-August.

surface runoff: Precipitation that is unable to infiltrate into a groundwater aquifer and instead flows along the earth's surface.

surface water: Water supply obtained from streams, lakes, and reservoirs.

T

till: Unsorted sediment deposited directly by glacial ice and showing no stratification.

U

unconsolidated: A sediment that is loosely arranged or unstratified, or whose particles are not cemented together.

unconfined aquifer: An aquifer that does not flow beneath an impermeable geologic layer and is free to flow in accordance with gravity. Sometimes called “water table aquifer.”

W

water availability: The portion of the natural baseflow remaining in a stream after instream flow requirements and reservoir releases are accounted for.

water budget: An accounting of water moving into, out of, and accumulating within a given region.

water demand: The amount of water required for different purposes and in different water-use sectors, such as for residential, institutional, industrial, and public water supplies.

watershed: A land area that channels rainfall and snowmelt to creeks, streams and rivers, and eventually to an outlet point, such as a USGS station. Also called a drainage basin, or catchment.

Winter: Season defined in this study as the 3-month period December-January-February.

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