EPA
United States
Environmental Protection
Agency

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force

2023 Report to Congress

Acknowledgements

Special thanks go to the many governmental representatives, their staff, and their colleagues from fellow agencies who support the efforts of the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, also known as the Hypoxia Task Force (HTF). Their diverse knowledge and expertise contributed to the successful collaboration and consensus building needed to produce this Report to Congress. The U.S. Environmental Protection Agency appreciates the input provided by the HTF member agencies:

State Agencies

Arkansas Natural Resources Commission
Illinois Department of Agriculture and Environmental Protection Agency
Indiana State Department of Agriculture
Iowa Department of Agriculture and Land Stewardship, State Co-Chair
Kentucky Department for Environmental Protection
Louisiana Governor's Office of Coastal Activities
Minnesota Pollution Control Agency
Mississippi Department of Environmental Quality
Missouri Department of Natural Resources
Ohio Department of Agriculture
Tennessee Department of Agriculture
Wisconsin Department of Natural Resources

Federal Agencies

U.S. Army Corps of Engineers
U.S. Department of Agriculture: Farm Production and Conservation
U.S. Department of Agriculture: Research, Education and Economics
U.S. Department of Commerce: National Oceanic and Atmospheric Administration
U.S. Department of the Interior: U.S. Geological Survey
U.S. Environmental Protection Agency, Federal Co-Chair

Tribes

National Tribal Water Council

SAN 10305

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force
2023 Report to Congress

October 2023

Fourth Report

Contents

Executive Summary

The Harmful Algal Blooms and Hypoxia Research and Control Amendments Act of 2014 (HABHRCA) directs the U.S. Environmental Protection Agency (EPA) Administrator, through the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force or HTF), to submit a progress report to the appropriate congressional committees and the President beginning no later than 12 months after the law's enactment, and biennially thereafter.

This 2023 fourth *Report to Congress* describes progress made toward the goals of the *Gulf Hypoxia Action Plan 2008* (Action Plan; USEPA 2008) through activities directed by or coordinated with the HTF and carried out or funded by EPA and other HTF members. This report provides updates since the 2019/2021 Report to Congress, including federal and state actions and newly published science advancements.

This report is organized consistent with the structure of HABHRCA section 604(b):

- The HTF and an Assessment of Progress Made Toward Nutrient Load Reductions (Part 1)
- The Response of the Hypoxic Zone and Water Quality Throughout the Mississippi/Atchafalaya River Basin (MARB) (Part 2)
- The Economic and Social Effects of the Hypoxic Zone (Part 3)
- Lessons Learned (Part 4)
- Recommended Appropriate Actions to Continue to Implement or, if Necessary, Revise the Strategy Set Forth in the *Gulf Hypoxia Action Plan 2008* (Part 5)

The HTF, its partners, and the scientific community have advanced the understanding of the hypoxic zone and many of the upstream, land-based factors that contribute to its annual formation. This report includes a summary of the current scientific understanding of projected climate change impacts on the Gulf of Mexico (Gulf), the status of the hypoxic zone in the Northern Gulf, and the delivery of nutrients to the Gulf from the MARB. HTF members continue to advance the scientific understanding of key topics including nutrient load quantification; nutrient source, fate, and transport in the MARB and to the Gulf; the resource response of the hypoxic zone and water quality throughout the MARB; and the economic and social effects of excess nutrients.

The HTF remains committed to its 2035 goal of reducing the 5-year average areal extent of the hypoxic zone in the Gulf to less than 5,000 square kilometers by 2035, with an interim target for reducing total nitrogen (TN) and total phosphorus (TP) loads by 20 percent by the year 2025. The 2019/2021 Report to Congress noted that recent science confirms that strategies to reduce both nitrogen and phosphorus by 48 percent are needed to meet the HTF's 2035 goal; that finding is reiterated in Section 4.2 of this Report. Progress to date on reducing nitrogen loads has been strong: the Task Force has met is 2025 interim target to reduce total nitrogen loads by 20 percent. However, total phosphorus loads have increased. More work is needed to reduce nitrogen and phosphorus by 48 percent to meet the HTF's 2035 goal.

The Infrastructure Investment and Jobs Act (IIJA), Public Law 117-58, also referred to as the Bipartisan Infrastructure Law, provides a critical investment in strategies to improve water quality in the MARB and the Gulf and reduce the northern Gulf hypoxic zone. The IIJA includes $12 million per year during federal

Fiscal Years (FY) 22–26 ($60 million in total) for EPA to support implementation of the Action Plan. These funds provide equal support to the 12 HTF member states for development and implementation of their nutrient reduction strategies, with funding supporting the tribes with land in the 12 HTF state area of the MARB and other Action Plan partners. With the IIJA, all HTF states have the opportunity to upgrade their municipal wastewater treatment infrastructure with billions in additional investment through the CWA State Revolving Loan funds; some HTF states have also used support from EPA under the American Recovery and Reinvestment to upgrade municipal wastewater treatment plants. The Inflation Reduction Act (IRA), Public Law 117-169, provides for significant investment in nutrient reduction activities on private lands, with $19.5 billion nationally for U.S. Department of Agriculture (USDA) Natural Resources Conservation Service to support climate-smart agriculture, including improving nutrient management opportunities. With this funding, USDA will target lands in need of conservation treatment, increase program flexibilities, launch a new outreach campaign, and expand partnerships to develop and improve nutrient management plans; in the MARB these funds will support Action Plan goals.

Accelerated implementation of nutrient reduction strategies throughout the MARB continues to be the HTF's primary path forward. In addition to the IIJA and IRA funding noted above, the work of the HTF is supported by technical and financial support from federal HTF members, including support through Farm Bill Conservation Programs, the Clean Water Act, the Water Resources Development Act, and other authorities and programs, with active participation by private sector, nongovernmental, and other partners and stakeholders. The HTF engages a wide range of partners in the public and private sectors. As states and tribes implement their nutrient reduction strategies, they work with diverse groups including universities, agricultural associations, business councils, conservation organizations, municipalities, wastewater utilities, nonprofits, and private foundations.

The HTF continues to identify the highest priority nutrient source areas for conservation treatment using tools to target priority watersheds, inventory existing conservation practices, and estimate nutrient load reduction to help target scarce resources. The HTF is working to communicate successes to producers and their networks of trusted advisors to further build support for conservation investments. The HTF is sharing stories of success and acknowledging remaining challenges with the public. Better communication and engagement with the public is essential to sustaining and expanding the HTF's work.

This Report to Congress is one important tool for describing the HTF's progress toward reducing nutrient loads to the northern Gulf, amplifying state summaries of progress, sharing lessons learned in implementing nutrient reduction strategies, and adaptively managing strategies for improving water quality in the Gulf.

HABHRCA 2014: LANGUAGE REGARDING THE HTF[1]

PUBLIC LAW 113–124—JUNE 30, 2014

Public Law 113–124
113th Congress
An Act
To amend the Harmful Algal Blooms and Hypoxia Research and Control Act of 1998, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014."

SEC. 7. NORTHERN GULF OF MEXICO HYPOXIA.

Section 604 is amended to read as follows:

''SEC. 604. NORTHERN GULF OF MEXICO HYPOXIA.

''(a) INITIAL PROGRESS REPORTS.—Beginning not later than 12 months after the date of enactment of the Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2014, and biennially thereafter, the Administrator, through the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, shall submit a progress report to the appropriate congressional committees and the President that describes the progress made by activities directed by the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force and carried out or funded by the Environmental Protection Agency and other State and Federal partners toward attainment of the goals of the Gulf Hypoxia Action Plan 2008.

"(b) CONTENTS.—Each report required under this section shall—

"(1) assess the progress made toward nutrient load reductions, the response of the hypoxic zone and water quality throughout the Mississippi/Atchafalaya River Basin, and the economic and social effects;

"(2) evaluate lessons learned; and

"(3) recommend appropriate actions to continue to implement or, if necessary, revise thestrategy set forth in the Gulf Hypoxia Action Plan 2008."

[1] On Jan 7th, 2019, the HABHRCA 2014 was amended through the Harmful Algal Bloom and Hypoxia Research and Control Amendments Act of 2017 (Pub. L. 115-423, Section 9, Jan. 7, 2019, 132 Stat. 5462). Section 604, requiring the HTF reports to Congress, was unaffected by the 2017 amendments. 33 U.S.C. § 4004.

Part 1. The Hypoxia Task Force and an Assessment of Progress Made Toward Nutrient Load Reductions

Each year, the Mississippi/Atchafalaya River Basin (MARB) (796,800,000 acres spread across 31 states and two Canadian provinces) delivers enormous volumes of water containing nitrogen and phosphorus to the northern Gulf of Mexico (Gulf), creating hypoxic conditions that can be inhospitable to life. These excess nutrients come from the daily activities of citizens throughout America's heartland, including production agriculture on millions of acres of farmland, urban land use, and wastewater management. In 1997, federal, tribal, and state agencies formed a Mississippi River/Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force or HTF) to lead collaborative efforts to reduce Gulf hypoxia and to improve water quality throughout the MARB.[2] Despite strong efforts, reducing nutrient loads from this vast landscape—one where tens of millions of people live and work—is an extraordinary task. The enormity of this challenge drives collaboration between states, tribes, federal agencies, and stakeholders to scale up conservation and increase the use of innovative, market-based, and community-based approaches to supplement traditional governmental regulatory and incentive programs and make more progress.

1.1 HTF Structure and Public Engagement

The HTF is a federal, tribal, and state member partnership that works collaboratively and voluntarily on reducing excess nitrogen and phosphorus loads delivered from the MARB in order to reduce the size of the Gulf hypoxic zone. Major efforts undertaken by the HTF are summarized on the HTF history web page.

HTF members represent five federal agencies, 12 states bordering the Mississippi and Ohio rivers,[3] and the National Tribal Water Council represents interests of tribes. The HTF is led by a federal and a state co-chair. The U.S. Environmental Protection Agency (EPA) is the HTF federal co-chair, and four other federal departments/agencies are members; the state co-chair, established in 2010, rotates among the state members; Iowa is the current state co-chair. Each HTF member state is represented by an official from its agriculture, pollution control, or natural resources agency. The representative state agency works with all relevant agencies within the state to achieve HTF goals.

Senior staff of each member agency and the collaborating agencies meet as the Coordinating Committee and support HTF members. Sub-basin committee leaders from the Lower Mississippi River, the Ohio River (represented by the Ohio River Valley Water Sanitation Commission, ORSANCO), and the Upper Mississippi River (represented by the Upper Mississippi River Basin Association) are members of the Coordinating Committee. Southern Extension and Research Activities Committee Number 46 (SERA-46)[4],

[2] The HTF was convened as an Interstate Management Conference under CWA section 319(g)(1).
[3] Federal and state members: U.S. Environmental Protection Agency; U.S. Department of Agriculture (Farm Production and Conservation, and Research, Education and Extension); U.S. Department of Interior; U.S. Department of Commerce National Oceanic and Atmospheric Administration; and the U.S. Army Corps of Engineers; and Arkansas, Illinois, Indiana, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Ohio, Tennessee, and Wisconsin.
[4] USDA National Institute of Food and Agriculture (NIFA) provides funding through the Hatch Act Multi-State Committee SERA-46: Framework for Nutrient Reduction Strategy Collaboration.

with members who are researchers and extension specialists from land grant universities in each of the 12 HTF states, is a key partner participating on the Coordinating Committee.

The Coordinating Committee meets regularly to share information on the state of science and communication in the MARB and to inform each other on actions to implement nutrient reduction strategies. HTF workgroups, staffed by Coordinating Committee members and their colleagues, further advance the areas of metric development, policy advancement, funding opportunities, and communication coordination.

Partnerships are key to scaling up the needed nutrient reduction actions, and the HTF strongly values the actions and collaboration of partners described throughout this report. The HTF facilitates and members participate in partnerships that encourage a holistic approach to reducing hypoxia in the Gulf and improving water quality in the MARB. This approach includes addressing upstream sources as well as near-field and downstream impacts.

The HTF holds public meetings (concurrently webcasted) throughout the MARB and periodically in Washington, DC. EPA hosted a public meeting in Washington, DC in December 2022.

In addition to participating in HTF public meetings, the public can engage with the HTF and its members by participating in member efforts to implement nutrient reduction strategies, interacting with land grant universities in partnership with HTF and state efforts, engaging in local watershed efforts, and contacting HTF members or Coordinating Committee members at any time throughout the year.

1.2 HTF Goals

In 2001, the HTF first agreed to meet a coastal goal of reducing the size of the hypoxic zone in the northern Gulf to a 5-year annual average of less than 5,000 square kilometers by 2015, subject to the availability of resources. To achieve this goal, the HTF developed its first Action Plan (2001 Action Plan), which described nitrogen reduction activities that HTF member states agreed to implement with federal member support at the Upper Mississippi, Lower Mississippi, and Ohio river sub-basin scales across the MARB. In addition, the HTF agreed to restore and protect waters within the MARB and to improve MARB communities and economic conditions, particularly the agricultural, fishery, and recreational sectors, through improved public and private land management using a cooperative, incentive-based approach (USEPA 2001).

In 2007, EPA convened a Mississippi River Basin subcommittee of EPA's Science Advisory Board on behalf of the HTF, to provide an updated science assessment. The Mississippi River Basin subcommittee estimated that a 45 percent reduction in total nitrogen (TN) and a 45 percent reduction in total phosphorus (TP) would be needed to reach the coastal goal set by the HTF in 2001 (USEPA 2007).

With these updates, the HTF recognized state nutrient reduction strategies as the cornerstone for reducing nutrient loads to the Gulf and throughout the MARB, because states have the authority, with strong support from federal partners, to achieve the nutrient loss reductions needed. The HTF agreed to the updated 11-action Gulf Hypoxia Action Plan 2008 (2008 Action Plan). The first action called for member states to complete and implement comprehensive nitrogen and phosphorus reduction strategies. The eleventh action called for a reassessment of the Action Plan every five years. In the

Reassessment 2013: Assessing Progress Made Since 2008, the HTF recommended accelerating the implementation of nutrient reduction activities and identifying ways to track and measure progress at a variety of geographic scales. The Harmful Algal Blooms and Hypoxia Research and Control Amendments Act of 2014 (HABHRCA) requires this biennial *Report to Congress* which the HTF uses in place of Action Plan reassessments.

In 2015, recognizing the enormity of the task of reducing nutrient loads on a subcontinental scale, the HTF affirmed its coastal goal of reducing the areal extent of the hypoxic zone in the Gulf, but extended the time for reaching that goal from 2015 to 2035. As part of its *New Goal Framework*, the HTF agreed to an interim target for reducing TN and TP loads from the MARB to the Gulf by 20 percent by 2025 and committed to regularly track progress towards its 2025 interim target and 2035 goal (USEPA 2015). This Report to Congress presents the progress towards the goal and interim target.

1.3 Tracking Progress Toward the 2025 Interim Target and 2035 Goal

The HTF has worked in recent years to establish and report on specific Gulf and MARB water quality and nutrient reduction metrics at a variety of geographic scales. The HTF relies on states to report state-level water quality and state-level actions taken toward meeting the 2035 goal and 2025 interim target, and relies on federal partners for research, monitoring, and modeling support. The HTF's metrics, discussed in the 2019/21 Report to Congress, include:

- Regular tracking of loading trends from point and nonpoint sources (sections 1.4 and 1.5).
- Long-term monitoring and reporting of loading trends using the United States Geological Survey (USGS) Weighted Regressions on Time, Discharge and Season (WRTDS) model (section 1.6).
- Ongoing work by states to quantify progress towards the 2035 goal and 2025 interim target through implementing state nutrient reduction strategies (section 1.8).
- The 5-year average areal extent of the hypoxic zone, based on the National Oceanic and Atmospheric Administration's (NOAA) annual hypoxic zone cruise that measures the areal extent (section 2.1.1).
- Water quality and river flow data (section 1.6).
- MARB-scale modeling assessments of nutrient loading trends from agricultural sources using U.S. Department of Agriculture (USDA) Soil & Water Assessment Tool (SWAT) models and Conservation Effects Assessment Project (CEAP) assessments (section 2.2.2).

1.4 Point Source Load Reduction Progress

Point sources of nutrients in the MARB are primarily discharges from wastewater treatment plants (WWTPs), or major sewage treatment facilities, but can also include concentrated animal feeding operations and regulated urban stormwater runoff. The HTF is tracking point source load reduction progress by major sewage treatment facilities via a series of reports, the 2016 *Report on Point Source Progress in Hypoxia Task Force States*, the 2019 *Second Report on Point Source Progress in Hypoxia Task Force States*, and the third report is included in this section. See Appendix B for full list of facilities.

1.4.1 Point Source Progress Metrics and Methodology

Point source progress is tracked across major sewage treatment facilities using three metrics: (1) number of facilities issued National Pollutant Discharge Elimination System (NPDES) permits with monitoring requirements for nitrogen and/or phosphorus; (2) number of facilities issued NPDES permits with numeric discharge limits for nitrogen and/or phosphorus; and (3) nutrient loads from facilities discharging to the MARB.

1.4.1.1 Facility Universe

For all three reports, the facility data in each HTF state with Standard Industrial Classification (SIC) Code 4952, Sewerage Systems, as well as facilities with no SIC Code but labeled as a publicly owned treatment works (POTW) (Facility Type Indicator field) were downloaded from EPA's Integrated Compliance Information System (ICIS). EPA worked only with nutrient monitoring, limits, and loads at "major" POTWs—those with a design flow of 1.0 million gallons per day (MGD) or more to determine the universe of facilities (facilities) in each HTF state. Beginning with the second report, an additional geographic filter within state boundaries was used to include only the facilities which discharge to the MARB. Permitted facilities that discharge to waterbodies other than the MARB were excluded from the analysis. The remaining facilities compose the universe of major facilities discharging to the MARB from HTF states.

1.4.1.2. NPDES Permit Nutrient Monitoring Requirements and Limits

To document state progress on establishing nitrogen and phosphorus monitoring requirements and discharge limits at major sewage treatment plants, the HTF uses data in the ICIS database. ICIS retains NPDES permit data that facilities submit to states and EPA in their monthly Discharge Monitoring Reports (DMRs) (see EPA's Enforcement and Compliance History Online (ECHO), the public interface with ICIS). ICIS contains limit and monitoring requirement records associated with NPDES permits. For more information about states sharing data with EPA, see the NPDES eReporting web page.

For this report, EPA used data from ICIS for nutrient monitoring and permit limits through September 30, 2020, the target date for states to complete data entry to the ICIS database for that federal Fiscal Year (FY) ending on that date. From the universe of HTF state facilities discharging to the MARB, this report identifies the number of facilities with nutrient monitoring and limit requirements listed in their permits for various forms of nitrogen (excluding ammonia) and phosphorus. Appendix A documents the forms of nitrogen and phosphorus parameters included in counts of nutrient monitoring and limit requirements. This process mirrors the approach EPA and the Association of Clean Water Administrators (ACWA) apply to each state nationwide to document major POTWs with nutrient monitoring and limit requirements in ACWA's Nutrient Reduction Progress Tracker.

1.4.1.3. Nutrient Loading

The EPA ICIS data system also contains facility wastewater discharge flow data and monitored pollutant concentrations. EPA has developed a Water Pollutant Loading Tool that uses those flow and concentration data to calculate facilities' pollutant discharge loads or, for facilities that do not monitor nitrogen or phosphorus, calculates estimated nutrient loads using typical pollutant concentrations (TPCs) and facility discharge flows. Loading Tool information and the general methodology can be found on the Water Pollutant Loading Tool – Resources page. Data can be searched and filtered using the Nutrient Modeling webpage, and HTF member state-specific methodology information can be found on the ECHO Hypoxia Task Force Search Help webpage.

Since the first report, the number of facilities that monitor discharges has increased and now many states have the data to calculate nutrient loads for facilities. For this third report, states reported nutrient load calculations for facilities via one of three methods: (1) report loads for all facilities; (2) report loads for facilities when there is a discrepancy between Loading Tool calculations and state loads; and (3) using Loading Tool calculations. Loads and reporting methods for each facility can be found in Appendix B. Where appropriate, states used method two due to discrepancies between state and Loading Tool calculations, which can occur for several reasons, including data transfer issues between ICIS and the loading tool, data entry errors, and monitoring occurring more often than required in the permit.

In addition to loads from major sewage treatment plants, the HTF Point Source Workgroup has explored the possibility of tracking loads from other sources, including facilities in industries that use large volumes of cooling water, such as steam electric power generating stations or petroleum refineries. Reporting on loads from these sources is confounded by a lack of data on influent nutrient loads, making it difficult to distinguish loads that are added from loads that are simply passed through those plants. Once industries using high volumes of cooling water were excluded, analyses showed the remaining industries discharge, in aggregate, much lower loads than major sewage treatment plants. Similarly, minor (smaller) sewage treatment plants (those with a design flow of less than 1.0 MGD) contribute insignificant loads compared to major sewage treatment plants.

1.4.1.4 Data Reconciliation and Verification

Each HTF state reviewed the metrics for each facility and identified errors to be reconciled (facility numbers per HTF state range from 27 to 211). When verifying the nutrient load data, states either provided corrections for those facilities that had incorrect load values reported from the Loading Tool or sent EPA their calculations for all facilities for use in this report, as seen in Appendix B.

1.4.2 Status of HTF States in Reducing Point Source Loads

The 2016 first HTF point source report used data as of September 30, 2014, to document 1,410 major sewage treatment facilities (facilities) within HTF states. The 2019 report updated this universe to present 1,175 of the 2016 facilities in the MARB watershed of the HTF states; those facility numbers are provided in this third report, and document that:

- 56 percent of facilities monitored both nitrogen and phosphorus.
- 71 percent of the facilities monitored at least one of those nutrients.
- 27 percent of the facilities had a discharge permit limit for nitrogen and/or phosphorus.
- 4 percent of the facilities had permit limits for both nitrogen and phosphorus.

The 2019 second HTF point source report used data as of September 30, 2017, to document progress at a larger universe (1,199) of facilities within the MARB watershed of HTF and stated that:

- 70 percent of facilities monitored both nitrogen and phosphorus.
- 86 percent of the facilities monitored at least one of those nutrients.
- 32 percent of the facilities had a discharge permit limit for nitrogen and/or phosphorus.
- 4 percent of the facilities included permit limits for both nitrogen and phosphorus.

In 2018 after developing a common reporting methodology, the HTF adopted the reporting of nitrogen and phosphorus loads discharged by facilities as an additional common measure of progress. This new measure was based on 2017 calendar year data, documenting:

- Facilities contributed 287,708,571 pounds of nitrogen and 44,972,256 pounds of phosphorus to the MARB. For context, the USGS calculated, at the time the second report was published, that total MARB nutrient loads to the Gulf in 2017 were approximately 3,320,000,000 pounds of nitrogen and 314,000,000 pounds of phosphorus; these calculations have been updated and were approximately 2,760,000,000 pounds of nitrogen and 310,000,000 pounds of phosphorus (Lee 2022).
- Thus, 9 percent of all nitrogen loads and 14 percent of all phosphorus loads discharging to the Gulf were from major sewage treatment facilities.

The third report, included below, uses NPDES permit data as of September 30, 2020, and load discharge data as of December 31, 2020. When compared to the previous two reports, this third report shows the following progress (see Appendix B for facility-level data used to show progress) as of 2020:

- Across all 12 HTF states, 86 percent of facility permits discharging to the MARB included monitoring requirements for both nitrogen and phosphorus, an increase from 70 percent in 2017. Ninety-four percent of the facility permits included monitoring requirements for at least one nitrogen or phosphorus parameter, an increase from 86 percent in 2017 (see Table 1-1 and Figure 1-1).
- 41 percent of the facility permits in HTF states that discharge to the MARB have limits for nitrogen or phosphorus, an increase from 32 percent in 2017; most of those permits have phosphorus limits. Five percent of the facility permits include limits for both nitrogen and phosphorus, an increase from four percent in 2017 (see Table 1-2 and Figure 1-2).
- Based on the methodology and data described in section 1.4.1, the 1,232 facilities contributed 295,776,015 pounds of nitrogen and 39,996,983 pounds of phosphorus to nutrient loads in the MARB. This is a 2 percent reduction in N discharges from those calculated for 2017 and a 5 percent increase in P discharges from 2017 levels.
- For context, USGS (Lee 2022) calculates that total MARB nutrient loads to the Gulf in Water Year 2020 were approximately 3,700,000,000 pounds of nitrogen and 452,000,000 pounds of phosphorus (see Table 1-3 and Figure 1-3). This calculation shows that 8 percent of all nitrogen loads and 10 percent of all phosphorus loads discharging to the Gulf were from major sewage treatment facilities, compared to 9 percent of all nitrogen loads and 14 percent of all phosphorus loads in 2017.

Table 1-1. Number and percentage of facilities discharging to the MARB with nitrogen and/or phosphorus monitoring requirements for monitoring-only purposes or for compliance with a discharge limit.

State	# of Facilities in Universe 2020	Monitoring N and P		Monitoring N Only		Monitoring P Only		Monitoring N and/or P	
		# of Facilities	% of Facilities	# of Facilities	% of Facilities	# of Facilities	% of Facilities	# of Facilities	% of Facilities
Arkansas	79	53	67%	1	1%	8	10%	62	78%
Illinois	211	201	95%	0	0%	1	0.5%	202	96%
Indiana	119	42	35%	0	0%	76	64%	118	99%
Iowa	106	103	97%	1	1%	0	0%	104	98%
Kentucky	91	88	97%	0	0%	3	3%	91	100%
Louisiana	104	70	67%	1	1%	0	0%	71	68%
Minnesota	63	61	97%	0	0%	2	3%	63	100%
Mississippi	27	27	100%	0	0%	0	0%	27	100%
Missouri	125	116	93%	1	1%	0	0%	117	94%
Ohio	133	133	100%	0	0%	0	0%	133	100%
Tennessee	117	114	97%	1	1%	0	0%	115	98%
Wisconsin	57	54	95%	0	0%	3	5%	57	100%
2020 Total[a]	1,232	1062	86%	5	0.4%	93	8%	1160	94%
2017 Total[a]	1,199	843	70%	12	1%	172	14%	1,027	86%
2014 Total[b]	1,175	662	56%	10	1%	167	14%	839	71%

Notes: N = nitrogen; P = phosphorus.
[a] The difference in the universe of MARB-discharging facilities (1,175 using data as of September 30, 2014 for the 2016 report; 1,199 using data as of September 30, 2017 for the 2019 report; 1,232 using data as of September 30, 2020 for this 2023 report) primarily reflects increased electronic data reporting and more complete facility data in EPA's ICIS rather than an increased number of new facilities with permits.
[b] Due to limitations in geospatial data at the time, the 2016 report included all major sewage treatment plants in the 12 HTF states. Currently available geospatial data allow this report to show major sewage treatment plants that discharged to the MARB as of September 30, 2014, which reduced the universe of facilities reported.

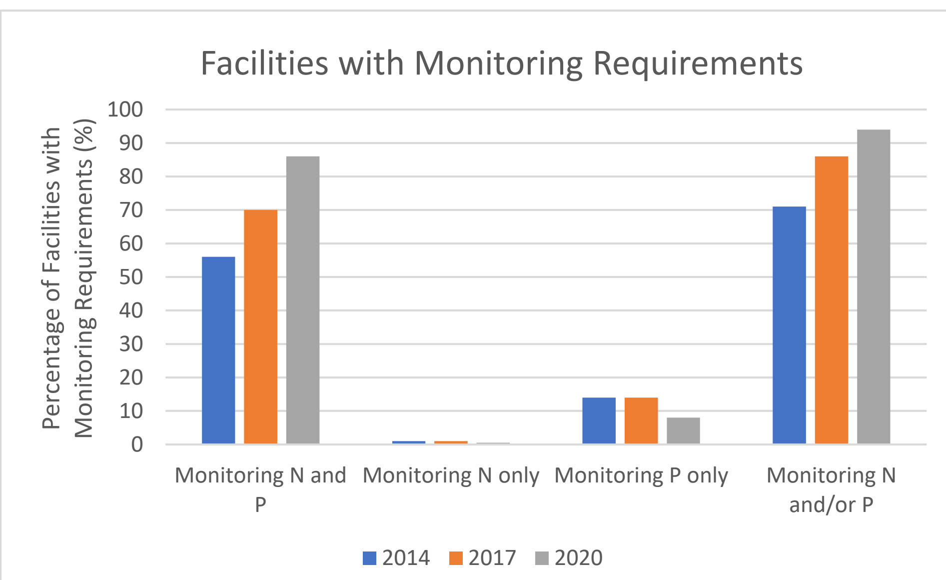


Figure 1-1. The percentage of facilities with nitrogen (N) and/or phosphorus (P) monitoring requirements, by reporting year.

Table 1-2. Number and percentage of facilities discharging to the MARB with numeric discharge limits for nitrogen and/or phosphorus.

State	# of Facilities in Universe 2020	Limiting N and P		Limiting N Only		Limiting P Only		Limiting N and/or P	
		# of Facilities	% of Facilities	# of Facilities	% of Facilities	# of Facilities	% of Facilities	# of Facilities	% of Facilities
Arkansas	79	6	8%	2	3%	12	15%	20	25%
Illinois	211	2	1%	0	0%	80	38%	82	39%
Indiana	119	0	0%	0	0%	117	98%	117	98%
Iowa	106	3	3%	33	31%	2	2%	38	36%
Kentucky	91	0	0%	1	1%	29	32%	30	33%
Louisiana	104	0	0%	1	1%	0	0%	1	1%
Minnesota	63	4	6%	0	0%	52	83%	56	89%
Mississippi	27	13	48%	0	0%	0	0%	13	48%
Missouri	125	0	0%	0	0%	7	6%	7	6%
Ohio	133	4	3%	1	1%	38	29%	43	32%
Tennessee	117	31	27%	0	0%	11	9%	42	36%
Wisconsin	57	0	0%	0	0%	57	100%	57	100%
2020 Total[a]	1,232	63	5%	38	3%	405	33%	506	41%
2017 Total[a]	1,199	42	4%	27	2%	316	26%	385	32%
2014 Total[b]	1,175	52	4%	10	1%	252	21%	314	27%

Notes: N = nitrogen; P = phosphorus.

[a] The difference in the universe of MARB-discharging facilities (1,175 using data as of September 30, 2014 for the 2016 report; 1,199 using data as of September 30, 2017 for the 2019 report; 1,232 using data as of September 30, 2020 for this 2023 report) primarily reflects increased electronic data reporting and more complete facility data in EPA's ICIS rather than an increased number of new facilities with permits.

[b] Due to limitations in geospatial data at the time, the 2016 report included all major sewage treatment plants in the 12 HTF states. Currently available geospatial data allow this report to show major sewage treatment plants that discharged to the MARB as of September 30, 2014, which reduced the universe of facilities reported.

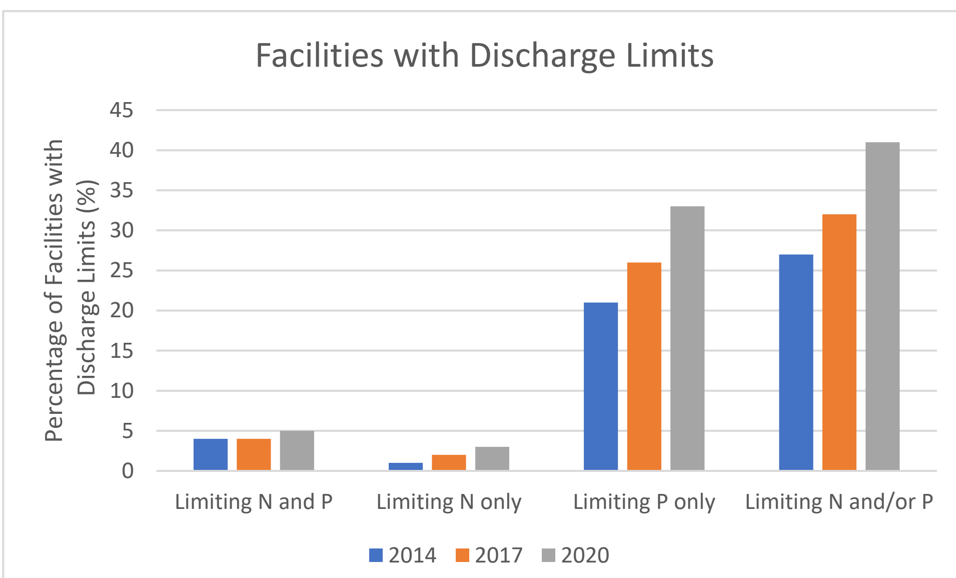


Figure 1-2. The percentage of facilities with nitrogen (N) and/or phosphorus (P) discharge limits, by reporting year.

Table 1-3. Total calculated and estimated annual load of nitrogen and phosphorus from facilities discharging to the MARB in 2020.

	2020 N (lbs/yr)[a]	2020 P (lbs/yr)[a]
Arkansas	11,819,508	2,165,827
Illinois	77,983,643	12,297,545
Indiana	26,192,308	1,512,571
Iowa	19,280,403	3,358,489
Kentucky	15,000,375	2,566,690
Louisiana	15,509,568	2,586,018
Minnesota	25,717,188	674,494
Mississippi	1,821,491	485,352
Missouri	35,501,281	5,222,903
Ohio	32,622,452	3,800,371
Tennessee	24,182,337	5,078,516
Wisconsin	10,145,461	248,207
2020 Total[b]	295,776,015	39,996,983
2017 Total[b]	287,708,571	44,972,256

Notes: N = nitrogen; P = phosphorus; (lbs/yr) = pounds per year
[a] See section 1.4.1 for the methods used to calculate or estimate N and P loads. See Appendix B for facility-level data and state-provided load calculation and estimation methodology.
[b] Values for % N and P Loads from DMR/Monitoring Data for the year 2017 considered DMR data only. Values for 2020 also include those reported from monitoring efforts but not reported in a DMR in ICIS to more accurately track all monitoring that is occurring.

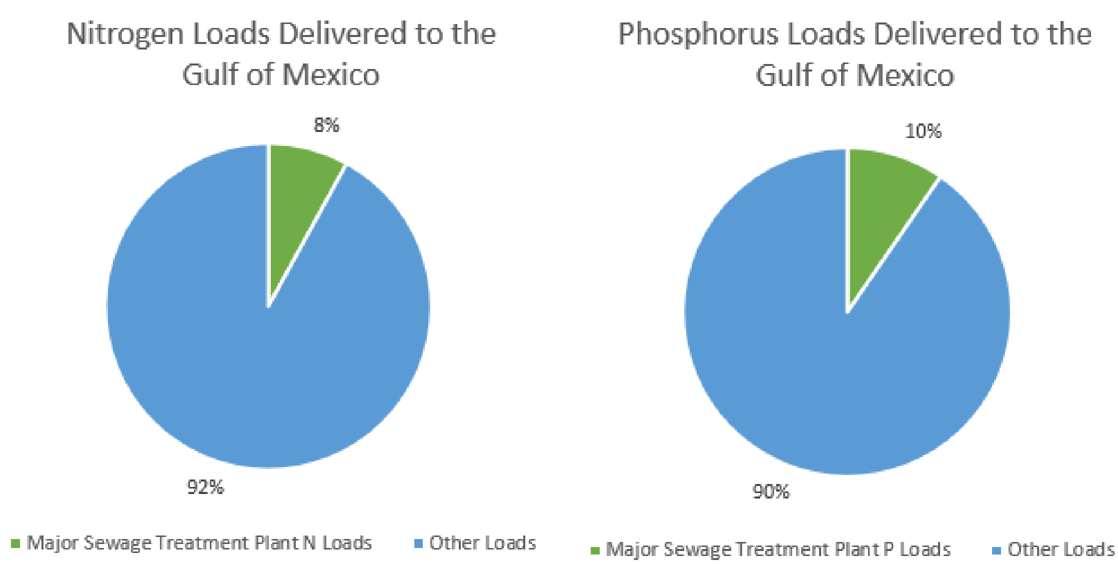


Figure 1-3. Calculated or estimated 2020 nutrient loads from facilities (green) discharging to the MARB vs. all other nutrient loads based on USGS-calculated total MARB nutrient loads in 2020 (blue).

In addition to reporting nutrient load estimates and the increasing number of NPDES permits with nutrient monitoring and limit requirements, states are making further progress to reduce point source loads to the MARB. As discussed in section 1.8, states are undertaking various projects and strategies to reduce nutrient loads from major sewage treatment plants. Common themes include implementing more stringent limits in NPDES permits, plant optimization programs, and nutrient trading programs. For example, in Illinois in 2020, 90 facilities had an annual average TP concentration of 1 mg/L or less, with 31 of those being 0.5 mg/L or less. Indiana plans to implement phosphorus limits of 1 mg/L for all major facilities. Iowa, Kentucky, and Tennessee are implementing plant optimization programs that will further help to reduce nutrient loads. Iowa, Louisiana, Minnesota, Missouri, and Wisconsin are all currently exploring or implementing nutrient trading programs to help meet nutrient limits on a faster timeline.

1.5 Nonpoint Source Load Reduction Progress

Since the 2019/2021 HTF Report to Congress, progress has been made on implementing a wide range of activities (e.g., those described in sections 1.7 and 1.8), to reach the HTF goal and interim target. The main driver of reductions in nonpoint sources of nutrients throughout the MARB are actions taken to implement federally-supported state nutrient reduction strategies. Each state is implementing an array of activities to reduce nutrient loads to the Gulf that are best suited to their unique conditions. Section 1.8 highlights the progress made by HTF states, including tracking progress and scaling up nonpoint source (NPS) load reduction actions. Common themes across the HTF states include leveraging funding and resources which identify priority areas for nutrient reduction, developing tools to better estimate the load reduction potential of different conservation practices, and conducting outreach and engagement within priority watersheds. As described in Section 1.7, federal agencies support states in making progress on reducing NPS loads and tracking that progress, for example through USGS's long-term monitoring and trend analysis in the river (section 1.6), EPA's Clean Water Act (CWA) section 319 Program (section 1.7.2) and USDA's CEAP national assessments (sections 1.7.3 and 2.2.2).

As discussed in the HTF's 2019/21 Report to Congress, many entities work to reduce NPS nutrient loads to the Gulf, including federal, tribal, state, and local agencies, individual landowners and producers, nongovernmental organizations and foundations, and corporate sustainability programs, among others. Because of the varied programs and entities implementing them, inventorying conservation practices and estimating load reductions across the MARB is complex. To support this challenge, the HTF has published and updated a compendium guide to describe the tools available to track progress in the MARB. Another tool available includes an assessment of approaches, methods, and tools to quantify environmental, social, and economic outcomes associated with farm conservation practices (Perez and Cole 2020).

1.6 MARB Nutrient Load Reduction Progress

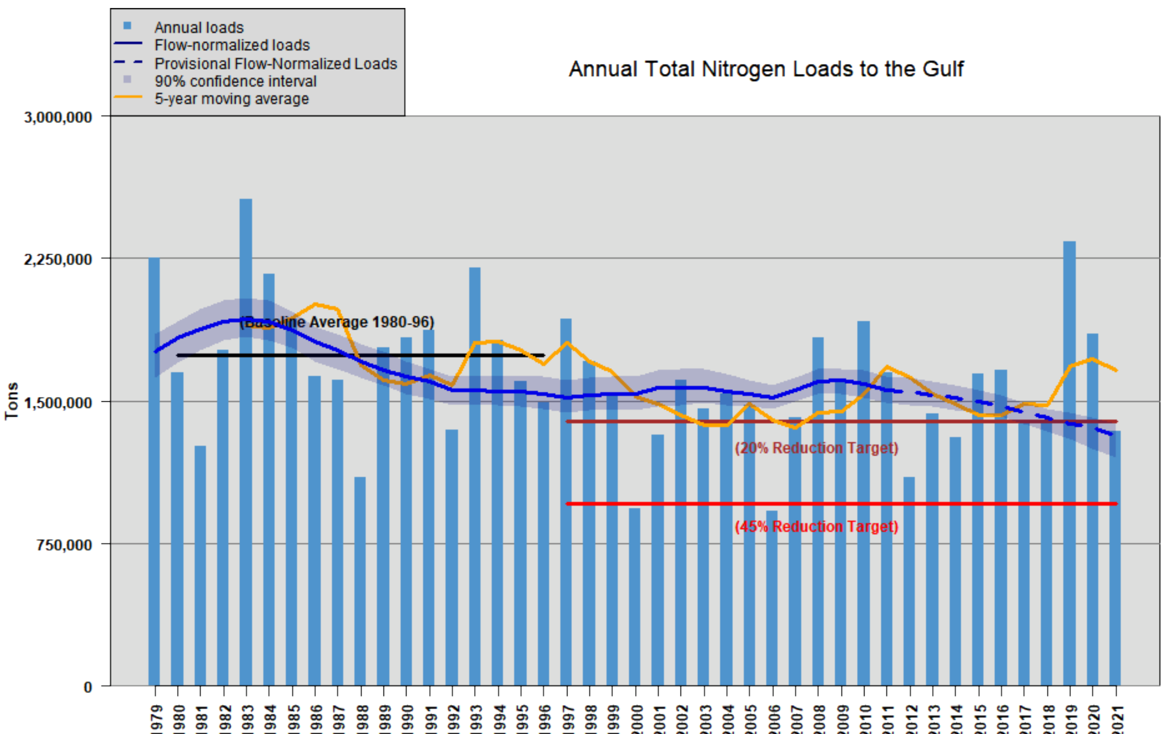
The HTF tracks reductions in nutrient loading from major MARB rivers as measured against the average TN and TP loads delivered to the Gulf during the baseline period from 1980 to 1996. Nutrient loading to the Gulf, and thus the hypoxic zone, is heavily influenced by the amount of water flowing from the MARB (i.e., higher streamflows carry more nutrients, contributing to a larger hypoxic zone). Thus, streamflow changes alone can increase or decrease nutrient loading to the Gulf each year, despite any point and NPS controls, land-use changes, population growth, or other challenges simultaneously occurring in the watershed. Therefore, to track nutrient loading changes to the Gulf due to human actions, the short-term variability in nutrient loading due to year-to-year changes in streamflow must be accounted for during analysis of long-term change.

The HTF has adopted two metrics for assessing the long-term changes in nutrient loading that minimize the variability due to year-to-year changes in streamflow. The first is the HTF's long-standing use of a 5-year moving average load, which is computed in any given year as the average of the load in the current year and the preceding four years. Often, a 5-year period will contain a mix of high, moderate, and low streamflow years, and the resulting average nutrient load over the 5-year period will reflect a balance of high and low streamflows. However, a 5-year period might contain more low or high streamflow years, such as during a multi-year drought or other prolonged climatic condition. While multiple years of low streamflow will likely result in multiple years of low nutrient loading—and thus multiple years of a smaller hypoxic zone, nutrient loading and the size of the hypoxic zone will eventually increase again as streamflows increase. Thus, a 5-year moving average during a period with multiple years of higher or lower than average streamflows will reflect these prolonged natural climatic conditions more than sustained human progress in reducing nutrient loading to the Gulf. For these reasons, a second, more robust metric that is less affected by these climatic situations was adopted in January 2018. This second metric is based on a method that "normalizes" loads to average streamflow conditions, using the USGS WRTDS model (Hirsch et al. 2010, 2015; Lee et al. 2017). Moving forward, the HTF will use the flow-normalized approach to assess MARB progress. This will minimize the effects of year-to-year flow variations. The HTF will continue to consider additional approaches that may help to better quantify results from state nutrient reduction efforts and track progress.

While the WRTDS method, like other load-estimation approaches, has strengths, it also has limitations. With WRTDS, estimates of flow-normalized loads in previous years might vary as new data are incorporated; therefore, it can take several years of new data to stabilize the estimates in previous years. For this reason, estimates from the model are considered provisional until 10 years of new data have been added. This feature illustrates the importance of the HTF using multiple metrics to track progress in any given year.

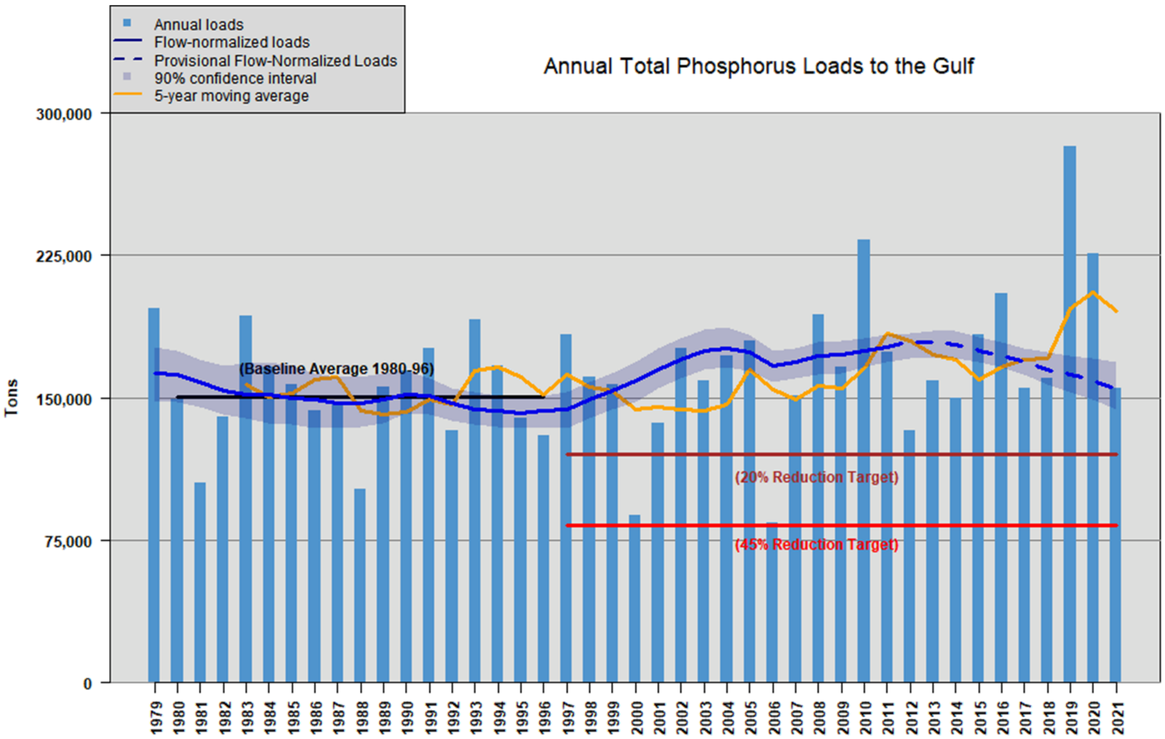
The 5-year moving average and the WRTDS flow-normalized loads from the Mississippi and Atchafalaya rivers during the period from 1980 to 2021 are shown in Figure 1-4 and Figure 1-5, as determined and reported by the USGS (Lee 2022). The two methods differed in their representation of progress toward the interim nutrient reduction goal. The flow-normalized results indicated that TN loads decreased below the 20 percent interim reduction target in 2020 and 2021 (see Figure 1-4). Overall, the change in flow-normalized TN loads between the baseline (1980–1996) and 2021 was estimated to be -23 percent (-26 percent of that was likely due to changes in upstream nitrogen sources and +3 percent from a long-term change in streamflow). The 5-year moving average, however, increased relative to the baseline period and did not show a reduction in nitrogen loads below the interim reduction goal. This was in part because of particularly high streamflow years in 2019 and 2020; both years were included in the 5-year period used to compute the 5-year moving average nitrogen loads for 2019, 2020, and 2021.

In contrast, TP loads have increased somewhat since the baseline period, and both the flow-normalized and 5-year moving average metrics were still above the interim reduction target in 2021 (see Figure 1-5). Overall, the change in flow-normalized TP loads between the baseline (1980–1996) and 2021 was estimated to be +3 percent (+1 percent of that was likely due to changes in upstream phosphorus sources and +2 percent from a long-term change in streamflow). As with TN, the particularly high streamflow years in 2019 and 2020 contributed to higher 5-year moving average phosphorus loads in 2019, 2020, and 2021.



Trend start period	Trend end year	Trend, in percent change	Lower 90% confidence interval	Upper 90% confidence interval	Trend attributed to changes in streamflow	Trend attributed to other changes in the watershed
1980-1996	2021	-23%	-32%	-19%	3%	-26%

Figure 1-4. TN loads to the Gulf from the Mississippi and Atchafalaya rivers between 1980 and 2021. Results from the two metrics used by the HTF to evaluate progress towards nutrient reduction targets—the 5-year moving average loads and the flow-normalized loads—are shown.



Trend start period	Trend end year	Trend, in percent change	Lower 90% confidence interval	Upper 90% confidence interval	Trend attributed to changes in streamflow	Trend attributed to other changes in the watershed
1980-1996	2021	3%	-7%	15%	2%	1%

Figure 1-5. TP loads to the Gulf from the Mississippi and Atchafalaya rivers between 1980 and 2021. Results from the two metrics used by the HTF to evaluate progress towards nutrient reduction targets—the 5-year moving average loads and the flow-normalized loads—are shown.

In addition to these metrics for tracking nutrient loading trends near the mouth of the Mississippi and Atchafalaya rivers, many of the HTF states have state-specific approaches for tracking water quality progress (section 1.8). The HTF is considering whether to adopt one or more consistent water quality metrics of progress within the MARB, at sub-basin scales. In May 2019, the HTF chartered a Trends Workgroup to compile current state water quality metrics and develop options for one or more common approaches for tracking sub-basin water quality trends. In January 2020, the HTF approved a plan for the Trends Workgroup to continue to engage with the National Great Rivers Research and Education Center (NGRREC) in a partnership to measure and display water quality trends across the 12 HTF states for the public. Through this collaboration, NGRREC has determined sites eligible for trend analysis through a detailed site screening and data harmonization approach. NGRREC and the Trends Workgroup will continue to collaborate on this effort with guidance from the Coordinating Committee and HTF throughout the process.

Federal HTF members further explored long-term trends in TN and TP flow-normalized loads from the MARB and found shifts in the river load response to watershed nutrient balances between 1975 and 2017 (Stackpoole et al. 2021). Nutrient balances in the landscape can be a key driver of river nutrient loads, representing inputs (fertilizer, manure, deposition, wastewater, nitrogen-fixation, and weathering) minus outputs (nutrient uptake and removal in harvest, and nitrogen emissions). Despite consistent surpluses in these annual nutrient balances during the study period, the rate of increase in nitrogen has slowed in recent decades and phosphorus declined. **This is a key finding, because it shows that improving the alignment of nutrient management with crop needs has slowed the rate of nutrient balance increases, indicating some success in controlling nutrients at the source.** Annual nutrient balances and river loads were positively correlated between 1975 and 1985, but afterwards a disconnect between both the nitrogen and phosphorus balances and river loads emerged, and the subsequent river load patterns were different for nitrogen versus phosphorus (Stackpoole et al. 2021). Nitrogen balances increased slightly while nitrogen loads decreased between 1985 and 1995 and then remained relatively stable through 2017. Phosphorus balances decreased between 1985 and 1995, remained relatively stable from 1996 to 2005, then increased through 2017, while river phosphorus loads were stable between 1985 and 1995, increased between 1995 and 2005, then were stable again through 2017. In the case of nitrogen, other factors such as best management practice (BMP) implementation, changes in watershed buffering capacity, the effects of tile drainage, or increased precipitation were potentially just as important in explaining changes in river nutrient loads over time as nitrogen balances, and in the case of phosphorus, they were even more important. The increase in nitrogen balances between 1975 and 2017 contributed to increased river loads during that period, but these increases were later offset by a reduction in the rate of increases in the nitrogen balances over time as well as other factors after the mid-1980s. If these other factors had not been in effect, TN loads from the MARB to the Gulf may have doubled since the mid-1980s. For phosphorus, factors other than changing phosphorus balances were leading to higher TP river loads over time; these factors influenced changing TP loads in the river, and the effect changed from decreasing TP load to increasing TP loads over the study period.

Other studies further illuminate the multiple nutrient-influencing factors interacting throughout the MARB. In 2022, the USGS and the U.S. Army Corps of Engineers (USACE) Rock Island District, in partnership with others, released a report regarding the ecological status and trends of the Upper Mississippi and Illinois Rivers (Houser et al. 2022). The report is the third of its kind produced as part of the Upper Mississippi River Restoration (UMRR) program, and includes information on long-term changes in water quality, aquatic vegetation, and fish from six study areas spread across the Upper Mississippi and Illinois Rivers. Key findings from the report include:

- There is more water in the river more of the time, with high flows lasting longer and occurring more frequently throughout the system. Water flow is an important factor affecting the quality and quantity of habitat.
- Floodplain forest loss has occurred across most of the system. Healthy floodplain forests sequester nutrients, provide important habitat for wildlife, and support outdoor recreation opportunities and access to clean water for millions of people.
- In most of the river system, water in the main channel has become clearer. In parts of the river system, water has become clearer and aquatic plants more abundant, improving habitat for some fish and wildlife. Reduced sediment in the river allows sunlight to reach deeper into the water and promotes plant growth. Plants take up nutrients, slow the water, and anchor sediment, further improving water clarity and triggering additional plant growth.
- Concentrations of nutrients, notably nitrogen and phosphorus, remain high, exceeding EPA benchmarks. However, TP concentrations have declined in many of the studied river areas.

- The river system continues to support diverse and abundant fishes. Popular sport fishes have increased in parts of the river system. However, there have been substantial declines in forage fish which serve as important food for larger fishes and other animals. Invasive species of carp have substantially affected the river ecosystem where they have become common.

1.7 Federal Agency Collaboration and Assistance to HTF States and Tribes

1.7.1 National Leadership and Federal Programs Working Together

Through several initiatives, USDA and EPA have partnered to make progress towards accomplishing the goals of the HTF Action Plan. Through the National Water Quality Initiative (NWQI), USDA and EPA collaborate with states to improve water quality by implementing watershed-scale agricultural conservation practices, supporting enhanced conservation planning, and monitoring in a subset of NWQI watersheds. In 2019, USDA expanded the scope of NWQI to include source water protection (SWP) as an additional focus area, including both surface and ground water based public water systems. In FY22, 24 SWP projects were identified and 27 projects in FY23. The 2018 Agricultural Improvement Act (Farm Bill) emphasizes collaboration between agricultural producers and the drinking water community, with 10 percent of conservation dollars directed to partnerships to protect drinking water supplies. EPA is working with the Natural Resources Conservation Service (NRCS) to foster communication and partnerships among NRCS, states, and water utility leaders to capitalize on resources provided through USDA conservation programs that implement conservation and management practices which protect both surface and ground water drinking water sources from nutrients, sediment, and pathogens. Relying on monitoring during FY17-20, states reported that 36 percent of monitored NWQI waters showed improvement(s) for at least one of NWQI pollutant, with 73 percent of improvements attributed to agricultural conservation practices. An EPA analysis showed eighteen waterbodies in NWQI watersheds that previously did not meet water quality standards for nutrients, sediments or in 2017 were now meeting standards as of 2020.[5] EPA's CWA section 319 grant funding serves as an important compliment to dedicated Environmental Quality Incentives Program (EQIP) funding provided to landowners through the NWQI. Between FY17 and FY20, $20,344,093 in CWA section 319 funding was invested in NWQI watersheds, which was matched by $22,501,850 in nonfederal funding.[6]

NOAA and EPA co-chair the Interagency Working Group for the HABHRCA, which enhances communication and coordinates efforts among more than 20 federal members. The Working Group has made important progress assessing the causes of harmful algal blooms (HABs) and hypoxia and helping to monitor, prevent, control, and mitigate these events and their impacts. The HAB efforts are focused on causes and toxicity, monitoring and forecasting, toxin detection, readiness and response, prevention

[5] More improvements may be attributable to NWQI activities, however, reasons for restoration activities are not always noted in EPA's Assessment and Total Maximum Daily Load Tracking and Implementation System.
[6] Budget amounts applied across the entirety of the project regardless of the footprint of the project, which could include one or many HUC12 watersheds. Funds could have been applied in the HUC12 watershed from the NWQI listing or from an adjacent one if multiple watersheds were included in the project . Data are entered continuously in GRTS and additional projects/funds for open grants can be added daily. These dollar amounts/projects are from a data download completed on October 21, 2021.

and control, and assessing the economic and environmental impacts. In addition to publishing regular assessments, research strategies, and technical reports, the agencies support research and leverage resources and expertise from research universities and institutions. The agencies translate science into practical tools to help communities, resource managers, and other stakeholders respond to and minimize impacts of HAB and hypoxia events and better prepare for future events through monitoring, forecasting, and planning.

1.7.2 EPA Support for HTF States and Tribes

In April 2022, EPA released a policy memorandum, *Accelerating Nutrient Pollution Reductions in the Nation's Waters*, that reaffirmed the agency's commitment to "reenergizing partnerships with governments, Tribes, agriculture, community organizations, research institutions, and the public to make sustained progress." The memo identified three primary strategies EPA will use to continue reducing nutrient pollution in the Nation's waters: (1) deepen collaborative partnerships with agriculture, (2) redouble efforts to support states, tribes, and territories to achieve nutrient pollution reductions from all sources, and (3) utilize EPA's CWA authorities to drive progress, innovation, and collaboration.

The Infrastructure Investment and Jobs Act (IIJA), Public Law 117-58, provides an investment in critical strategies to improve water quality in the MARB and the Gulf and reduce the hypoxic zone in the northern Gulf. Specifically, the IIJA includes $12 million per year for each of FY22–26 ($60 million in total) to EPA to use for actions to support the Action Plan. Through EPA's new IIJA Gulf Hypoxia Program (GHP), initial funds were awarded to Task Force member states in 2022, and in 2023, EPA is working to award funds to tribes, sub-basin committees (Upper Mississippi, Lower Mississippi, and Ohio), and the Southern Extension and Research Activities Committee Number 46 (SERA-46). This investment will support the development and implementation of strategies to accelerate the reduction of nutrient loads in the MARB and Gulf. The 11 priorities of the GHP are:

- Support states as they scale up implementation of their nutrient reduction strategies.
- Support tribes in leveraging existing nutrient reduction strategies or developing new ones to advance HTF goals.
- Advance multi-state collaboration through support for multi-state organizations that will help to achieve the goals of the Gulf Hypoxia Action Plan.
- Document and communicate progress towards HTF goals at the MARB scale.
- Advance research in support of nutrient reduction strategies.
- Leverage resources and coordinate with other federal, foundation, state, and tribal programs.
- Ensure that GHP benefits are realized by disadvantaged communities.
- Advance water quality actions that have climate adaptation or mitigation co-benefits.
- Fully enforce civil rights.
- Support the American worker and build a strong conservation workforce.
- Support domestic manufacturing.

EPA is committed to ensuring that GHP funds are used to meet the needs of all communities, and in particular, disadvantaged communities that disproportionately experience the impacts of degraded water quality from nutrient pollution. The GHP operates consistent with the Justice40 Initiative, which aims to provide that 40 percent of the overall benefits from certain federal investments, such as in climate, clean energy, clean water, and other areas, flow to disadvantaged communities that are marginalized by underinvestment and overburdened by pollution.[7] EPA is also committed to taking actions to anticipate, prepare for, adapt to, and recover from the impacts of climate change while advancing the nation's climate resilience. Thus, recipients of GHP funding are asked to take actions that can have climate adaptation or mitigation co-benefits and that increase resiliency. Ultimately, the GHP will significantly expand and enhance the capacity of partners in the MARB to reach the goals of the HTF's Action Plan with benefits to communities across the MARB.

Through the IIJA and annual appropriations, billions in additional investment are available via the Clean Water State Revolving Fund and the Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) that tribes and HTF states can use to upgrade municipal wastewater treatment infrastructure. Some HTF states have also used support from EPA under the American Recovery and Reinvestment to upgrade municipal wastewater treatment plants. In December 2021, EPA published the *Clean Water State Revolving Fund Best Practices Guide for Financing Nonpoint Source Solutions*; this document highlights ways that states can use their State Revolving Funds for conservation investments that can cost effectively reduce nutrient loads.

As directed by Congress in House Report 116-448, EPA developed a *Mississippi River Restoration and Resiliency Strategy* (MRRRS) in coordination with the USACE, USDA, NOAA, the Department of the Interior, and the Federal Emergency Management Agency. The MRRRS inventories existing federal and state investments in the MARB, identifies gaps, and makes policy recommendations in the areas of improving water quality, restoring habitat and natural systems, improving navigation, eliminating aquatic invasive species, and building local resilience to natural disasters. Development of the strategy has facilitated enhanced communication between federal partners and stakeholders, promoted consideration of how climate change and equity and environmental justice concerns in the MARB could be addressed by federal programs, and serves as a point of departure for future coordinated actions to address a range of environmental, economic, and social concerns in the Mississippi River Basin.

EPA is supporting the Upper Mississippi River Basin Association, the Upper Mississippi River Sub-Basin Committee representative as it convenes stakeholders who are involved in implementing states' nutrient reduction strategies. UMRBA is facilitating collaboration, cooperative action, and information sharing related to conservation practices with stacked or multiple ecosystem benefits, such as water quality, flood resilience carbon capture and wildlife habitat. UMRBA hosted a Multi-Benefit Conservation Practice Workshop in November 2022 to enhance the collaborative nature of conservation practice implementation and accelerate nutrient reduction in the Upper Mississippi River Basin. A second workshop is planned for Fall 2023.

[7] For covered programs under the Justice40 Initiative and other federal programs where a statute directs resources to disadvantaged communities, the term "disadvantaged communities" includes those geographically defined communities identified as disadvantaged by the Climate and Economic Justice Screening Tool (established by the Council on Environmental Quality), and all Federally Recognized Tribes whether or not they have land. This term may also include other geographically dispersed disadvantaged communities (such as migrant workers). For more information, see: https://screeningtool.geoplatform.gov; and M-23-09, https://www.whitehouse.gov/wp-content/uploads/2023/01/M-23-09_Signed_CEQ_CPO.pdf.

Under CWA section 319, EPA works with states, tribes and territories to reduce nonpoint sources of pollution such as runoff and drainage from agricultural fields, as well as community stormwater runoff not covered by a discharge permit. In FY22, EPA provided $50,013,900 to HTF states under CWA section 319 grant program to help them manage nonpoint sources of pollution. In September 2022, EPA published a memo titled *Continued Actions in FY23 to Increase Equity and Environmental Justice in the Nonpoint Source Program*, summarizing work completed over the course of 2022 to integrate environmental justice into NPS programming and outlining efforts and engagement planned in support of NPS equity goals for FY23 and beyond. During the end of 2021 and beginning of 2022, EPA held listening sessions with state and tribal grantees and subgrantees to identify opportunities to address the barriers experienced by disadvantaged communities in the CWA section 319 grant program.

Under CWA section 106, EPA provides grants to states, interstates, and tribes to support their water pollution control programs, including their work to reduce nutrient pollution. In FY22, EPA provided $46,754,000 to the HTF States and $1,378,000 to ORSANCO (Ohio River Sub-basin Committee lead) to support their efforts to reduce water pollution. Under CWA section 604(b), which is a small set aside from the Clean Water Act State Revolving Fund, EPA provided $8,145,000 to the HTF states to support their water quality management planning activities.

Under CWA section 304(a), EPA has developed and from time to time revises recommendations for ambient water quality criteria to help states and authorized tribes protect public health and aquatic life from the adverse effects of pollution, including nutrient pollution. EPA stands ready to assist states and authorized tribes through the Nutrient Scientific Technical Exchange Partnership & Support (N-STEPS) program. In September 2022, EPA released updates to the models available on EPA's website that support the CWA section 304(a) recommended ambient water quality criteria to address nutrient pollution in lakes and reservoirs. EPA updated the models used to derive protective criteria by incorporating data collected during the 2017 National Lakes Assessment. These updates reflect the latest scientific knowledge regarding the concentrations of nitrogen and phosphorus that are protective of drinking water sources, recreational uses, and aquatic life in lakes and reservoirs. States and authorized tribes can use the updated national models—and even incorporate local data into them—to help develop numeric nutrient criteria that are consistent with national relationships while accounting for unique local conditions.

EPA continues to support co-regulatory partners' adoption of numeric nutrient criteria through technical briefings and direct, state-specific technical support. EPA is currently providing ongoing assistance supporting the use of the lake and reservoir models to seven HTF member states (Arkansas, Illinois, Indiana, Minnesota, Ohio, Tennessee, and Wisconsin). In addition, EPA is currently providing technical assistance to three HTF members states (Arkansas, Kentucky, and Tennessee), supporting their efforts to develop numeric nutrient criteria for rivers and streams.

EPA continues to advocate that states, territories, and authorized tribes adopt numeric nutrient criteria into their water quality standards to protect and restore their waters from the negative impacts of nutrient pollution. EPA regional offices are encouraged to negotiate commitments to establish numeric nutrient criteria in performance partnership agreements. EPA supports and strongly encourages states to rely on numeric targets for water quality assessment, CWA section 303(d) assessment and lists, total maximum daily load (TMDL) targets, and NPDES permitting. EPA expects that states will either adopt numeric nutrient criteria into their water quality standards or commit to use numeric targets to implement applicable narrative criteria statements. For lakes and reservoirs that have previously been assessed using a state's nutrient-related narrative criterion, EPA expects states to consider new criteria recommendations in their next triennial review (per 40 CFR 131.20(a)) to determine whether more can be done to ensure the protection and restoration of those waters.

Under CWA section 303(d), states and authorized tribes develop lists of waters that do not meet their water quality standards and do not yet have a restoration strategy, known as a "Total Maximum Daily Load" (TMDL), to identify which sources of pollution need to be reduced in order to meet standards. As of 2022, HTF states had developed more than 3,800 TMDLs for reducing nutrient pollution. In September 2021, EPA released a *2022 – 2032 Vision for the Clean Water Act Section 303(d) Program* ("2022 Vision") that identifies opportunities to manage effectively CWA section 303(d) program activities to achieve water quality goals for the Nation's aquatic resources. It encourages the use of flexible and innovative approaches to implement CWA section 303(d), as well as to identify ways to use limited resources to leverage partnerships, restore and protect water quality, and encourage development of solutions to emerging and difficult water quality challenges. As part of the 2022 Vision, states, territories, and tribes identify their long-term CWA section 303(d) program priorities in their own unique manner using any of a myriad of approaches, including, but not limited to specific geographic areas, pollutants, designated uses, or pollutant-use combinations. HTF states may consider reflecting broader programmatic priorities (e.g., to address nutrient pollution in the MARB) as part of their priorities for the CWA 303(d) program to leverage resources across programs and agencies.

Building public awareness on the nature and extent of HABs supports action to reduce the extent and severity of these blooms and protect public health and recreation opportunities. To aid in tracking the occurrence of HABs in the nation's freshwaters, EPA developed and maintains the CyanoHAB story map as a user-friendly, interactive resource. The story map compiles monthly updates on state-issued recreational waterbody and drinking water health advisories due to cyanobacterial harmful algal blooms (cyanoHABs) from across the country. EPA also provides basic information about the causes and effects of the most common cyanoHABs and cyanotoxins in U.S. waters, major cyanoHAB events in the United States, and national tallies of annual beach advisories and closures due to HABs. EPA also provides links on its website to HAB preparedness and response tools, as well as state and local HAB contacts, including laboratories that perform analysis of water samples for cyanotoxins. One tool is EPA's Cyanobacteria Assessment Network (CyAN) mobile application, a customizable app that provides access to cyanobacterial bloom satellite data for over 2,000 of the largest lakes and reservoirs across the nation. The app can help local and state water quality managers make faster and better-informed management decisions related to cyanobacterial blooms. CyAN data are o available to the public in real time via EPA's How's My Waterway web application (on the Community Page, in the Monitoring Tab, under current water conditions, CyAN Satellite Imagery).

In October 2022, EPA released a Lagoon Action Plan to improve public health and protect water quality in thousands of small, rural, and tribal communities that rely on lagoon wastewater treatment systems. Actions completed to date include: $2 million in grants to accelerate innovative and alternative technologies in lagoon systems that may require infrastructure improvements for nutrients and ammonia; selection of new Clean Water Rural, Small and Tribal Technical Assistance grantees including TA awards specifically for lagoon communities; selection of 29 new Environmental Finance Centers; and release of Compliance Tips for Small Wastewater Treatment Lagoons with Clean Water Act Discharge Permits, the Universe of Lagoons Report and the Lagoon Inventory Dataset.

1.7.3 USDA Support for HTF States and Tribes

USDA's NRCS offers financial and technical assistance to help landowners implement voluntary conservation practices through various Farm Bill programs, including but not limited to EQIP, Regional Conservation Partnership Program (RCPP), Conservation Stewardship Program, and Agricultural Conservation Easement Program (ACEP). From FY10 to FY21, NRCS invested $14.2 billion in voluntary conservation programs and conservation technical assistance in HTF states.

The Inflation Reduction Act will deliver $19.5 billion nationally in new conservation funding to support climate-smart agriculture, which could also provide significant opportunities for water quality co-benefits. Many of the climate smart cropland practices that are supported through IRA are incorporated in state nutrient reduction strategies, such as cover crops, nutrient management, and grassed waterways. IRA funding is also available for activities like wetland restoration and for conservation of grasslands and forests that have water quality benefits.

Beginning in the 2008 Farm Bill, NRCS developed several landscape conservation initiatives that target voluntary conservation program funding to areas with critical natural resource concerns. Design and delivery approaches for these initiatives have been informed by CEAP watershed studies "lessons learned" (Osmond et al. 2012) and CEAP-based assessment tools (see section 2.2.2). Water quality initiatives intersect with the MARB, cross geopolitical boundaries, take a science-based approach to addressing resource concerns on regional scales, and rely on strong planning and partnerships to enhance and accelerate conservation system implementation. A summary of key USDA initiatives supporting the HTF includes the following:

- For FY21-22, about 170 watersheds were designated as NWQI planning or implementation watersheds in the 12 HTF states. NRCS provided $91.6 million in HTF states through NWQI to address nutrient and sediment runoff from 2012 to 2021, supporting farmers in treating over 319,000 acres.
- The Mississippi River Basin Healthy Watersheds Initiative (MRBI) priorities are aligned with and support each state's nutrient reduction strategy (NRS). From 2010 to 2021, MRBI supported conservation on over 1.72 million acres, with EQIP obligations totaling $402 million.
- RCPP has awarded 42 projects in the 12 HTF states, totaling almost $246 million from 2017 to 2022, for water quality efforts that include partners such as watershed improvement districts, irrigation districts, soil and water conservation districts (SWCDs), The Conservation Fund, Ducks Unlimited, The Nature Conservancy, state agencies and state producer associations.
- USDA's Farm Service Agency (FSA) administers the Conservation Reserve Program (CRP), a voluntary program through which participating landowners are incentivized to convert highly erodible and environmentally sensitive cropland from intense cropping practices back to valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat. There were 6.2 million acres enrolled in CRP in the 12 HTF states as of August 2022. In addition, the 2018 Farm Bill created a new program option under CRP called CLEAR30, which will support long-term 30-year contracts to improve water quality through reducing sediment and nutrient runoff, helping to prevent hypoxia and algal blooms.
- NRCS provided the HTF NPS Workgroup with EQIP implementation data from 2009 to the present. NRCS will annually provide certified EQIP data for the 12 MARB states in the format requested by the NPS Workgroup.

USDA also supports the development and deployment of decision support tools to help producers implement nutrient reduction strategies. The USDA Office of Environmental Markets supports market development across the country, evaluates the economics of markets, and develops tools and resources such as the Nutrient Tracking Tool (NTT) to help landowners participate in markets and estimate environmental services of conservation efforts. NTT is a field-specific tool to estimate nutrient and sediment losses and estimate yield impacts, helping to inform conservation decisions on the farm. NRCS supports the development of environmental markets and conservation finance approaches through programs such as Conservation Innovation Grants (CIG) and RCPP.

In 2015, a USDA-led partnership released a watershed-scale precision conservation assessment tool, the Agricultural Conservation Planning Framework (ACPF), founded on CEAP concepts and techniques. This tool continues to be updated and provides technical support to states throughout the MARB. ACPF includes tools to process Light Detection and Ranging (LiDAR)-based digital elevation models for hydrologic analysis and to identify agricultural fields most prone to deliver runoff directly to streams; map and classify riparian zones to inform whole-watershed riparian corridor management; and estimate the extent of tile drainage in a watershed. The software maps out locations appropriate for installation of several types of conservation practices, including controlled drainage, grassed waterways, water and sediment control basins, and nutrient removal wetlands. This targeting tool is used by watershed planners for projects in several MARB states where appropriate data is available, including Illinois, Indiana, Iowa, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin, in conjunction with federal or state NRS projects (Tomer et al. 2013, 2015a,b, 2017). NRCS has an agreement with Iowa State University (ISU) to establish the ACPF Hub through FY24 to provide support and assistance to NRCS staff and conservation partners to use and adopt the ACPF, and to apply ACPF results in watershed planning and assessment to inform conservation practice implementation and outreach strategies for water quality efforts. ACPF tool enhancement and expansion into new geographies is supported by USDA CEAP Watersheds Component.

Nutrient management maximizes crop-nitrogen uptake and has a compelling and cost-effective role to play in mitigating greenhouse gas emissions from agriculture. USDA recently announced it is targeting funding, increasing program flexibilities, launching a new outreach campaign to promote nutrient management's economic benefits, and expanding partnerships to develop nutrient management plans. NRCS is highlighting why SMART Nutrient Management Planning (right Source, right Method, right Rate, and right Timing) is a win-win for farmers.

USDA is working to increase assistance and encourage SMART Nutrient Management Planning. SMART Nutrient Management Planning helps farmers save money on fertilizer costs—which have increased significantly in the past year—with the added benefit of healthier soils, fewer greenhouse gas emissions, and cleaner water. NRCS recently highlighted *SMART* nutrient management planning which includes the 4Rs of nutrient stewardship (right source, right method, right rate, and right timing) and emphasizes smart activities to reduce nutrient loss by adding assessment of comprehensive, site-specific conditions, recognizing that nutrient needs—as well as risks for nutrient losses—vary even within a field. Producers could save an average of nearly $30 per acre on fertilizer costs if they implemented a nutrient management plan. Nutrient management not only improves water quality but is also an important part of climate-smart agriculture. To share the science behind SMART nutrient management and the outcomes it can achieve, in October 2022, NRCS Conservation Outcomes Webinar Series focused on

*Addressing Water Quality Outcomes Through Nutrient and Water Management***,** and a webinar recording and additional resources are available online.

There are hundreds of case studies across USDA on how agency programs result in real-world actions to address nutrient reduction. For example, the USDA Agricultural Research Service (ARS) has engaged in numerous partnerships and research projects since 2015 that provide information and knowledge critical to advancing the understanding of nutrient dynamics and reductions in the Gulf. Below are descriptions of some of these projects.

- Through a partnership with the USGS Lower Mississippi-Gulf Water Science Center, ARS scientists developed the first stressor response relationships describing ecological responses to nutrient enrichment in the Mississippi Delta region of the Lower Mississippi River Basin. Published work includes using novel algal assemblage indicators to quantify ecological responses to nutrient enrichment in Delta streams (Hicks and Taylor 2019), while current work is identifying challenges and developing new indicators that incorporate novel assemblages (bacteria) and analysis techniques to meet the challenge of documenting ecological responses to changing nutrient status within highly modified agricultural streams (Taylor et al. *in review*; DeVilbiss et al. *in prep-a,* DeVilbiss et al. *in prep-b*).
- ARS scientists and university partners demonstrated that shallow water habitat management on harvested cornfields removed excess nitrogen through denitrification and decreased sediment loss during runoff events, provided critical mudflat habitat that attracted and maintained high populations of benthic macroinvertebrates, and supported threatened shorebird species during critical migration stopovers. In response to research results, USDA NRCS EQIP practice 644 was changed to create a separate shorebird migration period (September through November) eligible for cost-share during beginning in FY21 for the state of Mississippi (Taylor et al. *in prep.*). Successful implementation of this conservation practice could aid in reduction of nitrogen to the Gulf.
- ARS scientists and university partners are conducting a long-term replicated pond scale field experiment to study effects of stoichiometric imbalance between nitrogen and phosphorus inputs (higher nitrogen relative to phosphorus) on primary productivity, nutrient cycling (specifically denitrification and N_2 fixation), HAB development, hypoxia, and the probability of toxin production in agriculturally influenced lakes. Results from this work thus far show that lake primary production can be limited by imbalances between nitrogen and phosphorus in shallow eutrophic lakes, demonstrating that nutrient reduction efforts focused both on nitrogen and phosphorus are needed (Kelly et al. 2021).
- ARS scientists have conducted extensive research on agricultural ditch management practices designed to increase nutrient removal and storage within ditch networks. Controlled experiments demonstrated differential denitrification rates among two common wetland plant species, the role of season, nutrient inputs, and winter plant senescence in mitigation potential, and the potential for novel within-ditch bioreactors to contribute to nitrogen mitigation in agricultural ditches (Taylor et al. 2015; Speir et al. 2017; Nifong et al. 2019; Taylor et al. 2020; Nifong et al. 2021).
- ARS scientists have recently published works highlighting the availability of a long-term water quality database assessed as part of the USDA CEAP within the Lower Mississippi River Basin. The web-based application, Sustaining the Earth's Watersheds, Agricultural Research Data System (STEWARDS), includes a 25-year database from Beasley Lake in the Mississippi Delta, demonstrating effectiveness in agricultural BMPs in reducing lake nutrients and eutrophication (Lizotte et al. 2021a,b; Nifong et al. 2022).

The USDA National Institute of Food and Agriculture (NIFA) provides funding to land grant and other universities, organizations, and federal agencies to conduct research and extension programs related to Gulf hypoxia that result from agricultural practices in the MARB. NIFA funding is currently supporting research programs that are focused on:

- The effectiveness of BMPs on cropland that can reduce the runoff and transport of nitrogen, phosphorus and sediment and improve soil health;
- The socio-economic factors associated with farmer adoption of conservation practices;
- Cost-benefit analyses of performance-based conservation practices at the watershed scale;
- Increased understanding of nutrient enrichment and cycling in crop, livestock, and forest systems;
- Field studies and models that determine how water flow patterns transport nutrients over or through the land and to waterways by avoiding riparian buffers that sequester nutrients; the development of technologies to reduce these flows; and surveys on the willingness of farmers to adopt these technologies;
- Models to estimate performance of conservation practices on nitrate loading;
- The role of microbial transformation of nitrogenous fertilizers which lead to more effective methods for plant fertilization and minimize excessive nitrogen application; and
- The role of climate change and the effects of tillage management on nutrient cycling, water budget and crop productivity.

In addition to funding research programs that provide new information relevant to the MARB and Gulf hypoxia, NIFA provides funding to land grant universities to plan and carry out extension programs to interpret research findings and their relevance to farmers and their operations. Recent and current extension education programs focus on:

- Demonstrations of the water quality benefits of current and alternative conservation practices;
- Maximizing agricultural production for food, fiber, and fuel, while improving and protecting soil and water quality;
- Management practices that reduce nitrogen losses from land application of animal waste to subsurface drained fields;
- Use of cover crops to contribute nutrients and improve soil health; and
- Decision support tools to boost crop yields by taking into account agricultural drainage systems, tillage types, and fertilizer use in response to changing climate, economic and , environmental conditions.

1.7.4 USGS Support for HTF States and Tribes

In response to the Consolidated Appropriations Act of 2022 (H.R. 2471), USGS hosted a Mississippi River Science Forum in February 2023 with relevant federal agencies, including EPA, the U.S. Fish and Wildlife Service, the National Park Service, the U.S. Forest Service, NRCS, the Federal Emergency Management Agency, USACE, and NOAA, along with state, local and tribal governments located in states that border the Mississippi River, academia, and other interested stakeholders. The purpose of the virtual forum was to share current science, identify data gaps and areas of concern, prioritize next steps, and identify resources needed to advance the goals of improving water quality, restoring habitat and natural systems, improving navigation, eliminating aquatic invasive species, and building local resilience to natural disasters. USGS will incorporate lessons learned on stakeholder engagement from previous work on the Great Lakes science needs assessment, identify opportunities for stakeholders to provide USGS with thoughts and information that can be used in the report to congress that will follow the forum, and will make the findings publicly available in a report of the proceedings within 270 days of the conclusion of the forum.

1.7.5 NOAA Support for HTF States and Tribes

Working with state partners, NOAA's National Weather Service (NWS) has developed Runoff Risk Advisory Forecasts across the Great Lakes region with the help of the Great Lakes Restoration Initiative. These tools guide farmers and producers on how the timing of fertilizer and manure applications can minimize nutrient losses. The tools are currently available in Ohio, Michigan, Minnesota, and Wisconsin, and are operationalized in New York, with potential for expansion into Indiana when that state is ready. In 2022, the Runoff Risk Version 3 update, based on the NWS National Water Model, continues to be in development and could offer potential coverage to additional states, pending state interest and collaboration. If Runoff Risk tools are implemented across the MARB, HTF member states would be able to encourage their use to enhance farm-scale nutrient management planning and help minimize nutrient loss to local water bodies and ultimately to the Gulf.

1.8 State Implementation of Nutrient Reduction Strategies[8]

Presented below are summaries of how the twelve HTF states are working to implement their state nutrient reduction strategies to work towards reducing nutrient loss and the size of the hypoxic zone. Also included in these summaries are brief overviews of how each state plans to use the funds provided by the GHP to work towards the HTF's goal.

1.8.1 Arkansas

The 2022 Arkansas Nutrient Reduction Strategy (ANRS) update is based on scientific analysis with input from stakeholders and public agencies. The ANRS first originated as part of the 2014 Arkansas Water Plan and in conjunction with participation in the HTF. In 2018, Arkansas initiated a stakeholder process to update the ANRS, resulting in a new strategic HUC8 watershed prioritization methodology for evaluating nutrient trends. In 2021, with assistance from an HTF grant, the Arkansas Water Resource Center (AWRC) used nearly 30 years of available water quality monitoring data to analyze watershed and site-specific trends statewide and assign nutrient reduction priorities using a four-tiered framework (see Figure 1-6):

- Tier 1—Maximum focus on nutrient reduction; based on sufficient data.
- Tier 2—Focus on nutrient reduction activities; needs more monitoring.
- Tier 3—Less focus for nutrient reduction activities; needs more monitoring.
- Tier 4—Least focus for nutrient reduction activities; sufficient monitoring in place.

[8] These summaries were drafted by the HTF states and incorporated into this document with very little editing; the summaries reflect state actions as described by the states.

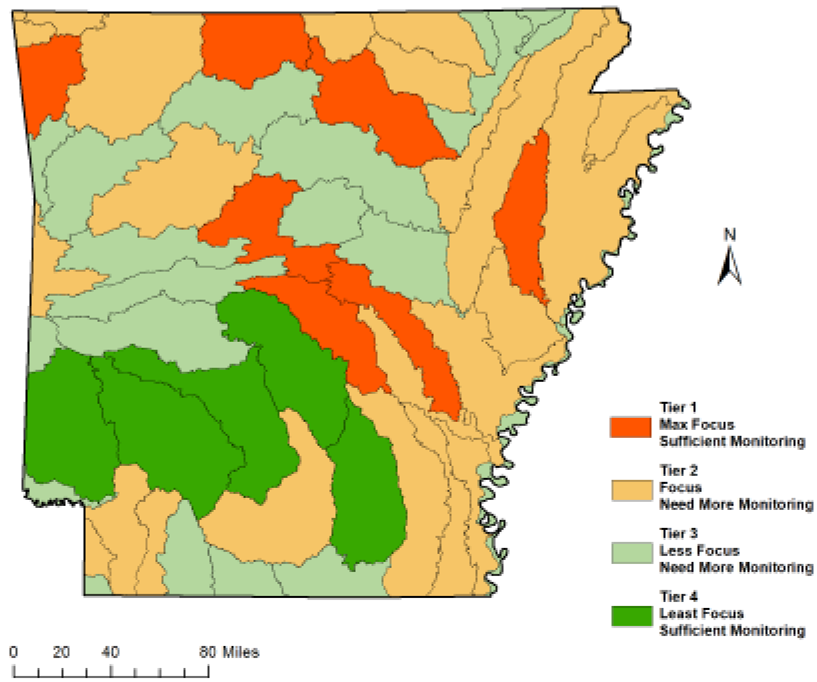


Figure 1-6. 2022 ANRS four tiers of HUC 8 watersheds.

The ANRS update was finalized in 2022. Every two years, the HUC8 watershed tier prioritization will be updated with new water quality monitoring data and reviewed by a team of technical and scientific experts. This adaptive management approach assumes that new knowledge will be gained as nutrient reduction strategies, projects, and programs are implemented and evaluated. Workgroups are in the process of being formed to ensure implementation of the 2022 ANRS update and to continue to improve the ANRS.

Arkansas's GHP Workplan

Arkansas's GHP workplan focuses on implementation of the goals of the ANRS. The three main goals of the ANRS are:

- Goal 1: Increase or maintain downward trends for Tier 1 watersheds.
- Goal 2: Enhance water quality monitoring to inform nutrient trends for Tier 2 watersheds.
- Goal 3: Continue efforts in all watersheds.

Arkansas's GHP projects focus on water quality monitoring and conservation practices of Tier 1 and Tier 2 watersheds. For example, the Upper Cache River watershed is a focus for nutrient reduction and increased monitoring. The watershed is highly channelized and is dominated by row crop agriculture. It has few remaining wetlands, which creates a challenge to control sediment and nutrients. During a previous monitoring project, sites were identified as 'hot spots' with consistently high nutrient and sediment concentrations. The first year of GHP funding will support water quality monitoring efforts in the Upper Cache River watershed by gathering preliminary data prior to two-stage ditch construction proposed for nutrient reduction. The second year of GHP funding will be used to support implementation of two-stage ditches in the Upper Cache River watershed. Two-stage ditches are drainage ditches that have been modified by adding benches that serve as floodplains within the overall channel. The benches function as wetlands during certain times of the year, which reduces ditch nutrient loads. Two-stage ditches have been documented to reduce nutrient and sediment loads upwards of 50 percent. The restoration of this beneficial natural process within Upper Cache River watershed will provide the drainage capacity necessary for agricultural production, as well as the water quality benefits in reducing nutrients and sediments.

Septic Remediation Pilot Program

In many rural areas throughout Arkansas, residential wastewater is treated using septic systems. Inadequate or poorly maintained septic systems are often ineffective and can leak nutrients such as nitrogen and phosphorus. Arkansas has a Septic Remediation Pilot Program to help homeowners replace old, failing septic systems. The program started in 2021 with two watersheds: the Beaver Reservoir Watershed and the Illinois River Watershed. In 2022, the Buffalo River Watershed was added. These watersheds in northwest Arkansas are a priority for the state. Illinois River and Beaver Reservoir are both in Arkansas's Nutrient Surplus Area, included as priority watersheds for 2018–2023 Nonpoint Source Pollution Management Plan, and are Tier 1 and Tier 2 nutrient reduction watersheds, respectively. The Buffalo River watershed is the nation's first National River.

The Septic Remediation Pilot Program offers financial assistance in the form of a grant and/or loan to qualifying homeowners in the targeted watersheds. Funding is only for repair or replacement of an existing septic system, as determined by the Arkansas Department of Health. Grant assistance is based on a sliding income scale of the homeowner. Grants are paired with a no interest loan up to a 10-year term. For instance, an income level less than $20,828 receives 90 percent grant funding and a 10 percent loan, and an income level between $62,486–$83,314 receives 10 percent grant funding and a 90 percent loan. There is also a 0 percent interest loan for all income levels above $83,315 that is available. Financial assistance to homeowners does not exceed $30,000 of grant and loan funding, with total funding usually between $5,000 and $10,000 per failing septic tank. Local watershed managing organizations oversee applicant eligibility, review applications, and ensure proper installation of septic systems. The Septic Remediation Pilot Program will run for two more years, after which time, it will be evaluated.

Tracking BMP Implementation

The Arkansas Nutrient Reduction Tracking Framework (Arkansas Framework) tracks reductions in nutrient losses from the implementation of BMPs on agricultural lands. The Arkansas Framework consists of three elements:

- Collecting information on BMP implementation on agricultural lands in Arkansas.
- Estimating nutrient loads from Arkansas HUC8 watersheds.
- Reporting BMP implementation and nutrient load changes for Arkansas HUC8 watersheds.

The Arkansas Framework is based on the Spreadsheet Tool for Estimation of Pollutant Load (STEPL) model. Current work creating a dashboard for the public is underway and is set to be finalized by February 2024.

Great Lakes to Gulf

Arkansas has been working with the Great Lakes to Gulf Virtual Observatory (GLTG) for an Arkansas Data Portal within the GLTG. The GLTG is an interactive application that provides user-friendly access to water quality information about the Mississippi River and its tributaries. GLTG helps people visualize and better understand nutrient pollution and its potential causes. The Arkansas Data Portal is based on water quality data compiled by the AWRC that was analyzed for the 2022 ANRS Update. The Arkansas Data Portal published in November 2022 and has three layers available:

- Site-Level Trends Analysis
- Aggregated HUC 8 Trend Analysis
- Water Quality Stations & Data Availability

1.8.2 Illinois

The Illinois Nutrient Loss Reduction Strategy (INLRS) released in 2015, uses the best available science and robust stakeholder engagement to implement practices to reduce nutrient loss from agriculture, point sources, and urban stormwater. INLRS goals include interim reduction goals of 15 percent for reduction of nitrate and a 25 percent reduction of TP, with a long-term goal of 45 percent reduction of both nutrients. Stakeholders have opportunities to remain engaged through the Policy Working Group and eight additional subcommittees focused on agriculture, urban stormwater, water quality monitoring, communications, and benchmarking. Biennial reports are released every two years to document the progress of implementation. Metrics reported include staffing and financial resources, education and outreach activities, land and facility improvements, and water quality. INLRS implementation efforts are led by the Illinois Environmental Protection Agency (IEPA), Illinois Department of Agriculture (IDOA), and University of Illinois Extension.

Implementation is executed through both regulatory and voluntary approaches. For agriculture, voluntary implementation of conservation practices occurs through traditional state and federal financial and technical assistance programs as well as collaborations among agriculture and conservation organizations. For point sources, nutrient reductions, particularly TP, are achieved through the issuance of NPDES permits. Urban stormwater implementation relies on voluntary implementation of green infrastructure practices and regulatory requirements for Municipal Separate Storm Sewer System (MS4) permits.

Agriculture and Nonpoint Sources

The INLRS recommends implementation of conservation BMPs backed by peer-reviewed science proven to reduce nitrogen and phosphorus losses from nonpoint and agriculture sources. These include in-field and edge-of-field practices, and land use changes. A process is established for adding additional conservation practices or updating practice performance, which is administered by an Ag Science Team at the University of Illinois.

State and Federal Financial Assistance programs

Tracking and reporting of conservation practices implemented occurs through a combination of state and federal financial assistance program data and survey information. State programs include the IEPA CWA section 319 grant program, IDOA Partners for Conservation program, and the Illinois Department of Natural Resources Conservation Reserve Enhancement Program (CREP). Federal programs include USDA's Natural Resource Conservation Service and FSA programs.

National Agriculture Statistics Service INLRS Survey

Since not all agriculture conservation practices are implemented using governmental financial assistance programs, a statistically significant farmer survey is conducted by the National Agriculture Statistics Service every two years to document farmer knowledge and implementation of conservation practices recommended in the INLRS. Questions contained in the survey address topics such as nitrogen and phosphorus fertilizer management, cover crops, and edge of field practices such as bioreactors and constructed wetlands.

Table 1-4, Table 1-5, and Table 1-6 represent a portion of the results from the survey conducted in 2020 for the 2019 crop year.

Table 1-4. Acres with a nitrogen management strategy.

	Acres in 2011	Acres in 2015	Acres in 2017	Acres in 2019
Acres of corn planted	12,600,000	11,700,000	11,200,000	10,500,000
Acres where an MRTN strategy was used to determine application rates	8,820,000 or 70% of planted acres	9,430,000 or 81% of planted acres	3,730,000 or 33% of planted acres	3,700,000 or 33% of planted acres
Acres where other industry-approved technique was used to determine application rates	Not asked	Not asked	7,750,000 or 69% of planted acres	7,390,000 or 70% of planted acres

Table 1-5. Cover crops planted on tiled and non-tiled acres.

	Acres
Corn/soybean acres planted to cover crops after the 2019 crop season on tiled ground	930,000
Corn/soybean acres planted to cover crops after the 2019 crop season on non-tiled ground	480,000
Corn/soybean acres planted to cover crops after the 2017 crop season on tiled ground	290,000
Corn/soybean acres planted to cover crops after the 2017 crop season on non-tiled ground	420,000
Corn/soybean acres planted to cover crops after the 2015 crop season on tiled ground	490,000
Corn/soybean acres planted to cover crops after the 2015 crop season on non-tiled ground	630,000
Corn/soybean acres planted to cover crops after the 2011 crop season on tiled ground	220,000
Corn/soybean acres planted to cover crops after the 2011 crop season on non-tiled ground	380,000

Table 1-6. General knowledge questions (percent reporting).

		Not at All Knowledgeable	Slightly Knowledgeable	Somewhat Knowledgeable	Knowledgeable	Very Knowledgeable
2020	Nutrient Loss Reduction Strategy	26.9%	29.9%	20.7%	10.7%	11.8%
	MRTN Strategy	30.2%	29.0%	17.6%	14.7%	8.5%
	Woodchip Bioreactors	54.7%	17.2%	14.4%	11.5%	2.2%
	Constructed Wetlands	42.1%	20.5%	16.5%	17.9%	3%
	Cover Crop Management	9.1%	24.7%	27.7%	26.1%	12.4%
2019	Nutrient Loss Reduction Strategy	21%	27%	38.4%	11.6%	2%
	MRTN Strategy	20.3%	33.5%	25.5%	14.1%	6.6%
	Woodchip Bioreactors	53.8%	23%	15%	5.5%	2.7%
	Constructed Wetlands	19.7%	29.6%	38%	10.2%	2.5%
	Cover Crop Management	15.2%	16.7%	35.5%	28.4%	4.2%

<u>Watershed Outreach Associates in Priority Watersheds</u>

Since 2018, IEPA has provided financial support to the University of Illinois Extension for two watershed outreach associate positions. The work conducted under this grant supports the INLRS through the development and delivery of education, outreach, and technical assistance centered in priority watersheds as identified in the INLRS. One watershed outreach associate works in two watersheds designated as priority watersheds for nitrogen loss, and one works in two watersheds designated as priority watersheds for phosphorus loss. Watershed outreach associates have focused part of their time assisting local SWCDs and watershed groups in the development and implementation of watershed-based plans.

Watershed outreach associates are also responsible for the creation of the Illinois Nutrient Loss Reduction Podcast series, in collaboration with the Illinois Extension Media Communications specialist. Each episode features a practice or topic relevant to reducing nutrient loss primarily from agriculture sources. At the end of 2020, 32 episodes had been produced and available for streaming.

Partner Programs

Effectively addressing nutrient loss from agriculture would not be possible without the support provided by the many nongovernmental organization programs and collaborations that have developed as a result of the INLRS. The 2021 Biennial Report identified over 30 such programs, some of which are listed below, along with program websites.

Keep it 4R Crop. The Illinois Fertilizer and Chemical Association's (IFCA's) Keep it 4R Crop program is based on the principles of 4R nutrient stewardship: right source, right rate, right time, and right place. IFCA works closely with its members, including fertilizer manufacturers, distributors, and agricultural retailers, to promote the 4Rs and uphold the IFCA 4R Code of Practice, which promotes education and adoption of specific fertilizer management practices designed to reduce nutrient losses and assure nutrient use by the crop. https://www.ifca.com/4R/Code

Nutrient Stewardship Grant Program. From 2015-2020, the Illinois Farm Bureau (IFB) Board of Directors committed over $700,000 to this program, funding 100 projects in 70 counties across Illinois. IFB committed $150,000 to the program in 2019, and once again in 2020. Through this program, IFB takes on an active role to support county farm bureaus and local partners to develop projects that address farmer needs for research, education and outreach, and implementation of conservation practices for nutrient loss reduction. https://www.ilfb.org/ifb-in-action/what-were-working-on/protecting-our-environment/nutrient-stewardship-grant-program/

Precision Conservation Management (PCM). PCM is a service program designed to help farmers understand and manage risks associated with adopting new conservation practices, with the objective of helping farmers make sound financial decisions. The program evaluates conservation practices on both their impact to the environment and their impact to family farmer profitability. Developed by the Illinois Corn Growers Association and through collaborations with more than 30 partners and the development of a farmer-friendly data collection platform, PCM offers one-on-one technical support to over 350 farmers in Illinois and Kentucky. https://www.precisionconservation.org/

STAR Conservation Evaluation Tool. Saving Tomorrow's Agriculture Resources (STAR) is a free and confidential evaluation tool that provides farm operators and landowners a means to evaluate, measure, and increase their use of conservation practices based on locally identified resource concerns. Using a simple evaluation system, it assigns points for various cropping activities, management decisions, and conservation practices of a field. The total points are used to assign a one to five STAR Rating. The higher the rating, the more on-farm activities are protecting soil and water resources. After the STAR evaluation, farmers receive field signs with their earned STARs, which can increase as they adopt additional practices. https://starfreetool.com/home

Illinois Nutrient Research and Education Council

The Nutrient Research & Education Council (NREC) was created in 2012 by the state of Illinois and is managed by representatives from farmer organizations, commercial fertilizer retailers, specialty fertilizer retailers, certified crop advisers, and IDOA. NREC is a public-private partnership that assures a sustainable source of funding for nutrient research and education programs. The partnership between NREC and IDOA ensures that an assessment of $0.75/ton on all bulk fertilizer sold in Illinois is allocated to research and educational programs focused on nutrient use and water quality. From 2012 to 2020, NREC invested $23 million in nutrient efficiency research and has produced over 60 peer-reviewed journal articles.

NREC works with industry stakeholders to identify needs and prioritize areas of research. Annually, NREC requests proposals for projects that examine, test, and measure the effectiveness and economic viability of farming practices that reduce nitrogen and phosphorus losses to water and are not detrimental to agricultural production or yield. For more information, visit https://www.illinoisnrec.org/.

Point Sources

Point source sector implementation of the INLRS focuses on reducing nutrient loads through wastewater treatment facility system upgrades and watershed approaches. Major municipal wastewater treatment facilities (facilities with a design average flow equal to or greater than 1.0 MGD) continue to reduce TP loads in their discharge through compliance with NPDES permit limits.

2020 Point Source Nutrient Loads

The 2020 estimated annual statewide TP load from point sources was 15.2 million pounds. Two hundred eleven major municipal facilities contributed 12.3 million pounds, while it is estimated that minor municipal facilities contributed 2.4 million pounds. Industrial facilities contributed approximately 0.5 million pounds. This results in a 16 percent reduction from the 2011 baseline load. The top ten major municipal facilities with the highest TP loads are responsible for 59 percent of the TP load from all point sources. The average annual TP concentration from all major municipal facilities in 2020 was 1.72 mg/L.

Significant TP load reductions are still anticipated in the long-term, due to large wastewater treatment facilities that are scheduled to be in compliance with NPDES permit requirements over the next several years. Improvements in the development and successful operation of technology that enhances nutrient removal is also key to achieving nutrient loss reduction goals.

The 2020 TN load from all point sources was estimated to be 83.2 million pounds, which is a 4.7 percent decrease from the 2011 baseline load. Like TP, most of the TN point source load is discharged by the major municipal facilities, followed by minor municipals, and major and minor industrials. See Table 1-7 for more information. The 2020 average annual TN concentration from all major municipal facilities was 13.07 mg/L. See Appendix B for a review of the methodology used to estimate annual state-wide loads.

Table 1-7. Point Source Nutrient Loads 2020.

Point Source Sector	TP Load (million lb/yr)	TN Load (million lb/yr)
2011 Baseline Load	**18.1**	**87.3**
2020 Nutrient Load	**15.2**	**83.2**
Major Municipals	12.3	78
Minor Municipals	2.4	3
Major and minor industrials	0.5	2.2
Reduction from 2011 Baseline	**2.9 (16%)**	**4.1 (4.7%)**

<u>NPDES Permits Issued with Nutrient Criteria</u>

By the end of 2020, IEPA had issued 77 permits that required each facility to meet a TP concentration limit of 1 mg/L, representing 36 percent of major municipal facility permits with this limit. Further, 16 facilities are on a compliance schedule to meet future TP limits of 1 mg/L. Approximately 200 major municipal facilities are now required to monitor for TP and TN. Additionally, IEPA has issued 20 NPDES permits with a goal of TN removal.

In 2020, there were 90 facilities with an annual average TP concentration of 1 mg/L or less, with 31 of those being 0.5 mg/L or less.

As a condition of an agreement between the Illinois Association of Wastewater Agencies and environmental groups, all NPDES permit renewals after January 25, 2018, for major municipal facilities are subject to the following:

- If the permittee has already installed chemical addition for phosphorus removal instead of Biological Phosphorus Removal (BPR), and has a 1 mg/L TP monthly average effluent limit in its permit, or the permittee is planning to install chemical addition with an IEPA construction permit that is issued on or before July 31, 2018, the 1 mg/L TP monthly average effluent limit (and associated compliance schedule) shall apply, and a 0.5 mg/L TP limit shall not be applicable.
- If the treatment method is chemical phosphorus removal, the facility must meet a twelve-month rolling geometric mean phosphorus limit of 0.5 mg/L by 2025.
- If the treatment method is BPR, the facility must meet a twelve-month rolling geometric mean phosphorus limit of 0.5 mg/L by 2030.
- If the treatment plant requires extensive modifications or if the treatment method is biological nutrient removal (both phosphorus and nitrogen), the facility must meet a twelve-month rolling geometric mean phosphorus limit of 0.5 mg/L by 2035.

In addition, major municipal wastewater treatment facilities continue to complete and submit optimization and feasibility studies. Feasibility studies are developed to meet TP concentrations of 0.5 mg/L and 0.1 mg/L. Through the end of 2020, 143 optimization and feasibility studies have been submitted out of the 211 major municipal treatment facilities.

Nutrient Assessment Reduction Plans

The requirement to develop a nutrient assessment reduction plan (NARP) is being incorporated into many Illinois NPDES permits for major municipal facilities that discharge into a receiving water body that has been determined impaired or at risk of eutrophication. The purpose of the NARP is to identify phosphorus input reductions and other measures that can be implemented by a major municipal facility or group of major municipal facilities via a watershed workgroup to help ensure that dissolved oxygen and offensive aquatic algae and aquatic plant criteria are met throughout a watershed. NARPs will be submitted to the IEPA by December 31, 2023, or 2024, depending on when a facility's permit was issued.

At the end of 2020, 53 individual major municipal facilities were developing NARPs. It has been determined that 42 facilities do not meet the criteria to develop one, while it is yet to be determined for another 30 facilities. Of the 53 facilities developing a NARP, 14 are required due to discharging to a waterway impaired for nutrients and 39 are required due to discharging to a waterway at risk of impairment due to nutrients. In addition to these facilities, there are 89 facilities developing NARPs as a part of a watershed group.

Watershed Approach

IEPA continues to encourage and work with local watershed groups to meet the nutrient loss reduction objectives in the INLRS, including NPS, urban stormwater, and point source nutrient loading. Where practical, as part of this effort, the agency is using permit conditions to require nutrient reduction feasibility reports, cost-effective implementation of control technologies using existing infrastructure, and improved nutrient removal technologies. Facilities will employ improvements to meet INLRS objectives. IEPA continues to work with the Fox River Study Group, DuPage River Salt Creek Workgroup, Lower Des Plaines Watershed Group, Lower DuPage River Watershed Coalition, North Branch Chicago River Watershed Workgroup, and Des Plaines Watershed Workgroup.

Urban Stormwater

Efforts to reduce nutrient runoff in urban stormwater is centered on education and outreach, implementation, and locally led programming, with an emphasis on promoting green infrastructure. IEPA administers the MS4 permit program, the Green Infrastructure Grant Opportunities (GIGO) program, and CWA section 319 NPS grant program. Many municipalities and stormwater management organizations implement projects and programs designed to reduce urban stormwater runoff.

MS4 Report Analysis

IEPA manages approximately 380 active MS4 permits for communities around the state. As part of the NPDES stormwater program, permitted communities are required to follow six minimum control measures:

- Public education and outreach on stormwater impacts.
- Public involvement and participation.
- Illicit discharge detection and elimination.
- Construction site stormwater runoff control.
- Post-construction stormwater management in new developments and redevelopments.
- Pollution prevention/good housekeeping for municipal operations.

Starting in 2019, University of Illinois Extension began a comprehensive review of the Annual Facilities Inspection Reports from communities with MS4 permits to better quantify stormwater and green infrastructure practice implementation. This analysis, summarized in Table 1-8, allows a more comprehensive understanding of urban stormwater management practices around the state to better capture progress toward INLRS water quality goals by the urban stormwater sector.

Table 1-8. Number of MS4 communities reportings practices in 2018-2020.

	2018		2019		2020	
Number of Communities Reporting	287		214		314	
Practice	Number of Communities	%	Number of Communities	%	Number of Communities	%
Community outreach	278	97%	212	100%	308	99%
Erosion control programs	Not measured	-	204	96%	299	96%
Electronics recycling programs	40	14%	185	87%	259	83%
Street sweeping programs	114	39%	166	78%	239	77%
Household hazardous waste collections	92	32%	166	78%	227	73%
Litter cleanup events	51	18%	148	70%	213	68%
De-icer management programs	101	35%	132	62%	202	65%
Leaf collection programs	Not measured	-	134	63%	203	65%
Detention basin management/ inspection programs	89	31%	113	53%	154	49%
Green infrastructure grants	32	12%	97	46%	119	38%
Detention pond inventories	Not measured	-	77	36%	102	33%
Green infrastructure requirements in new development and redevelopment	Not measured	-	65	31%	79	25%
Stormwater master plans	27	9%	65	31%	71	23%
Green infrastructure inventories	Not measured	-	49	23%	48	15%
Rain barrel programs	80	27%	25	12%	41	13%
Homeowner rain garden incentives	23	8%	3	1%	41	13%
Stormwater utility fees	24	8%	10	5%	22	7%
Community rain gardens	30	10%	12	7%	12	4%

Green Infrastructure Grant Opportunities Program

IEPA administers the $25 million GIGO program, which provides grants for projects to construct green infrastructure BMPs that prevent, eliminate, or reduce water quality impairments by decreasing stormwater runoff into Illinois rivers, streams, and lakes. Projects may be located on public or private land. For the purposes of GIGO, green infrastructure means any stormwater management technique or practice employed with the primary goal to preserve, restore, mimic, or enhance natural hydrology. Green infrastructure includes, but is not limited to, methods of using soil and vegetation to promote soil percolation, evapotranspiration, and filtering or the harvesting and reuse of precipitation.

In 2020, eleven GIGO grants totaling $9 million were awarded, including local match. These eleven projects are expected to achieve the following annual estimates:

- 4,973 pounds of nitrogen reduced.
- 1,423 pounds of phosphorus reduced.
- 1,063 tons of sediment reduced.
- 31,414,497 gallons of stormwater retained.

Illinois-Indiana Sea Grant Programs

Lawn to Lakes

Based on feedback from a citizen survey and focus groups, three brochures and three watershed factsheets on natural lawn care were developed and disseminated statewide to county Extension offices and partners in Illinois and Indiana. Presentations were also given at conferences, community events, and via a podcast episode focused on natural lawn care. https://lawntolakemidwest.org/

Rainscaping

Illinois-Indiana Sea Grant provides training to communities interested in building rain gardens, using a curriculum developed by Purdue Extension. Rain gardens lead to reduced stormwater runoff and improved water quality. Through workshops, Master Gardeners and other community members learn about rain gardens and other residential-scale green infrastructure techniques. In 2019, University of Illinois Extension piloted a Rainscaping training event at the Jackson County Extension Office in cooperation with the Greater Egypt Regional Planning Commission. The event proved successful, educating eight attendees and building a demonstration rain garden. In 2020, the Purdue Rainscaping Education Program was officially adopted by University of Illinois Extension through a memorandum of agreement to expand it throughout Illinois.

1.8.3 Indiana

Indiana's State Nutrient Reduction Strategy (SNRS) is the product of an inclusive effort of the Indiana Conservation Partnership (ICP) under the leadership of the Indiana State Department of Agriculture (ISDA) and the Indiana Department of Environmental Management (IDEM). The SNRS aims to capture present and future endeavors in Indiana that positively impact the state's waters, as well as to gage the progress of conservation, water quality improvement, and soil health practice adoption. It represents Indiana's commitment to reduce nutrient discharges and runoff into waters from nonpoint and point sources alike. The main objectives and importance of Indiana's strategy are included in the executive summary of the SNRS.

An update to the Indiana SNRS was released in February 2021 and can be found on the ISDA SNRS website.

Key Developments and Updates on SNRS Implementation

- The GIS Story Map of the major river and lake basins in Indiana, developed by ISDA, has been updated and can be found at the SNRS website. The basin story maps can now all be found in one interactive web application highlighting each of Indiana's 10 major river and lake basins to help tell the story of conservation and showcase Indiana's efforts to enhance water quality within those basins. This story map makes Indiana's SNRS more interactive. Learn more.
- As mentioned in the last Report to Congress, the ICP measures and tracks sediment, nitrogen, and phosphorus load reductions from individual BMPs implemented on the ground to determine the impact of assisted conservation efforts statewide by using EPA's Region 5 Sediment and Nutrient Load Reduction model. Collected data from the ICP partners is run through the model to analyze the sediment, nitrogen, and phosphorus load reductions for specific practices. And while this model is project-specific, it provides a valuable perspective on a larger scale when showing the collective reductions of practices across several programs. To see annual accomplishments reports and watershed maps of these reductions, visit ISDA's SNRS web page.
- The Indiana Science Assessment was started in 2019 to strengthen and improve the existing method that the ICP uses to capture sediment and nutrient load reductions from conservation practices so that dissolved nutrients and other practices not tied to sediment can be captured. However, quantifying the nutrient load reductions and water quality improvement from individual practices is scientifically challenging, and the current Indiana method for determining nutrient load reductions will benefit from using the most recent research. This will allow for more accurate reductions to be tracked and better assessment of the progress being made on improving water quality. In addition, knowing the historic and ongoing trends of nutrients loads in the watersheds of the state is important in order to know where more conservation work is needed. The Indiana Science Assessment addresses two components to move the SNRS forward.
- Component 1 of the Indiana Science Assessment determines water quality trends statewide and by major watershed basins by inputting water quality data from USGS and IDEM monitoring stations into the USGS model known as the WRTDS model. A trends report was released in June of 2022 on the results of this analysis and can be viewed on the Science Assessment website. Analyzing water quality monitoring information to determine loads and concentrations within each of the basins in the state will further help in prioritizing watersheds for more targeted conservation efforts in the future. The next steps for component 1 include determining a baseline of reductions needed, and development of an online tool to display results and make them more accessible to partners and the public. This information will also be used to draw comparisons of the basins in the state to determine the watersheds with the highest trends in nutrient loads and concentrations.

- Component 2 of the Indiana Science Assessment focuses on strengthening and improving the method to calculate sediment and nutrient load reductions from implemented conservation practices. Research conducted around the Midwest and in Indiana provides new understanding of the effectiveness of in-field and edge-of-field practices in reducing nitrogen and phosphorus loads from agricultural fields. A research associate is working at Purdue University to compile, review, and analyze research data to identify and/or develop a standardized tool and procedures for estimating nutrient load reductions from conservation practices, and to be used in determining the percent efficiency of certain conservation practices on reducing nutrient loads. Component 2 is led by a core team from six conservation agencies and organizations, with scientific input from a Science Committee of 18 scientists at five academic institutions in Indiana and two federal research agencies (USDA-ARS and USGS). To view the Progress Reports for years 1 and 2 of the Assessment, visit https://www.in.gov/isda/divisions/soil-conservation/indiana-state-nutrient-reduction-strategy/indiana-science-assessment/.
- Component 2 also includes a collective list and consistent definitions of conservation practices. The Core Team developed a document providing the definitions of the initial ten conservation practices and criteria assessed in phase 1 of the Science Assessment. This definitions document can be found on the Indiana Science Assessment website. Definitions of other conservation practices will be available in future editions of this guide as practices are added to the Indiana Science Assessment process.
- The Cover Crop Premium Discount Program was launched in 2020 through a partnership between ISDA, The Nature Conservancy, and the USDA Risk Management Agency. The goal of the program is to expand cover crop use among farmers in several counties in the state. The focus is to target first-time cover crop users, but other are eligible as well. Eligible growers can receive a $5.00/acre premium discount on the following year's crop insurance invoice for verified acres. The program achieved an enrollment of over 7,000 acres in its first year with that number doubling to 15,000 acres enrolled the second year. In 2023, the goal was to enroll 35,000 acres which was met. It should be noted interest exceeded available funding with producers applying for 48,155 acres.

GHP Workplan Summary

Funding provided through the GHP will initially be focused in three areas: staff capacity, soil sampling, and the Science Assessment. ISDA is hiring a staff person to help manage the new GHP dollars and to provide support with the SNRS efforts. The staff person will manage and coordinate the statewide soil sampling program that will be developed under this workplan that aims to increase the frequency in which landowners sample soil as well as improve nutrient use efficiency.

The Indiana Nutrient Research & Education Program will also be created to focus on the work of the Indiana Science Assessment. This program will allow for continued management and research analysis under Indiana's Science Assessment to determine efficiency of conservation practices on improving water quality.

NPS Efforts and Programs

Targeted Implementation Efforts

CREP

One of the initiatives that is part of Indiana's SNRS is the CREP. It is a component of the USDA FSA's CRP and is a voluntary program involving an agreement between the federal government and state (and other) partners that aims to improve water quality and address wildlife issues by reducing erosion, sedimentation, and excess nutrients, and enhancing wildlife habitats within specified watersheds in the Wabash River system.

The CREP agreement in Indiana covers 11 HUC 8 priority watersheds, covering all or part of 65 Indiana counties. Indiana's CREP enrollment goal is 26,250 acres and, according to the state's tracking system, as of October 2022, approximately 22,000 acres had been enrolled in the program and 1,058 linear miles of waterways have been protected. The ISDA and its partners have invested over $10.4 million in state funds to implement these conservation practices and, for every state dollar that is invested, $4–$13 federal dollars are matched through payments made by the USDA FSA.

Clean Water Indiana Program

The Clean Water Indiana Program (CWI) supports the implementation of conservation practices that reduce NPS water pollution through education, technical assistance, training, and cost sharing programs. The CWI fund is administered by the ISDA, Division of Soil Conservation under the direction of the State Soil Conservation Board.

The CWI Program is responsible for providing local matching funds as well as grants for sediment and nutrient reduction projects for Indiana's SWCDs. For state fiscal year 2022, 13 applications submitted by SWCDs were funded, totaling $789,825 and impacting 18 SWCDs. Funded projects include cost-share programs, staffing for technical assistance and project coordination, equipment, educational displays, field days, and marketing and outreach programs. Non-SWCD led projects were also awarded funding totaling $60,000 to the Southern Indiana Cooperative Invasives Management for regional specialists to help all counties address invasive species concerns. For state fiscal year 2023, 13 applications were approved totaling $616,115 and impacting 18 SWCDS. Information on all the approved grants is available on the CWI Program website. CWI also contributes critical state matching funds for Indiana's CREP and supports other statewide initiatives such as the Indiana Conservation Cropping Systems Initiative.

Infield Advantage Program

Infield Advantage (INFA) is a proactive, collaborative opportunity for farmers to collect and understand personalized, on-farm, field-specific data to optimize their management practices to improve their bottom line and benefit the environment. The program began in Indiana in 2010 and, in 2018, the impact had grown to include over 1,000 fields in more than 60 counties.

In 2019, the program received a CIG from USDA NRCS which has been utilized to offer more practical and flexible trials for growers. The program is working with numerous private, public, and nonprofit groups throughout Indiana to promote soil health management practices to broad audiences and provide insights to participants. The program itself is comprised of split-field trials surrounding cover crop impacts, nitrogen management, and tillage practice impacts. Participating farmers use precision agriculture tools, protocols, and technologies such as soil testing, biomass testing, and agronomic benching software to track changes at the field scale. Participating growers receive free in-field data and analysis giving them the tools to make environmentally and economically sound management decisions. Participants receive soil sampling and soil health assessments for the field(s) they enroll into the program, which with results from the trials, will be used to analyze overall impact of the program.

INFA is funded through the Indiana Corn Marketing Council and the Indiana Soybean Alliance with checkoff funds and is being offered at no additional charge to producers.

Point Source Efforts and Projects

NPDES Measures

To significantly reduce the discharge of nutrients to surface waters of the state and to protect downstream water uses, IDEM set a practical state treatment standard of 1.0 mg/L TP for municipal wastewater dischargers with design flows of 1 MGD or greater. This policy became effective January 1, 2015. Applying the 1 mg/L TP limit will amount to a nearly 45–50 percent reduction of TP loads from major wastewater dischargers over the next few permit cycles.

Additionally, IDEM will implement TMDL load reductions approved for TP upon the renewal of any affected permit and will continue to implement phosphorus removal as required by Title 327 Indiana Administrative Code (IAC) Article 5-Rule 10-Section 2.

For nitrogen, effective January 1, 2019, IDEM requires all major municipal wastewater permits with an average design flow rating of 1.0 MGD or greater to monitor for TN. It requires TN be reported and sampled at a minimum of one time monthly for both effluent mass (loading) and concentration via 24-hour composite sampling.

For all major dischargers, TN must be determined by testing total Kjeldahl nitrogen (TKN) and nitrate + nitrite and reporting the sum of the TKN and nitrate + nitrite results (reported as nitrogen). Nitrate + nitrite can be analyzed together or separately. Monitoring for TN is required in the effluent only.

The data collected will be used to garner a better understanding of nitrogen loadings in Indiana waters and aid the state with future updates of its nutrient reduction efforts.

1.8.4 Iowa

The Iowa NRS (or strategy) is a research and technology-based approach to assess and reduce excess nutrients delivered to Iowa waterways and the Gulf. The strategy outlines opportunities for efforts to reduce excess nutrients in surface water from both point sources such as municipal WWTPs and industrial facilities and nonpoint sources, including agricultural operations and urban areas, in a scientific, reasonable, and cost-effective manner.

The Iowa NRS, including the reporting of progress, is a collaborative effort supported by representatives of the ISU College of Agriculture and Life Sciences, Iowa Department of Natural Resources (IDNR), and Iowa Department of Agriculture and Land Stewardship (IDALS). The Water Resources Coordinating

Council, a body of governmental agencies that coordinate around water-related issues in Iowa, is presented with the *Annual Progress Report* each year. The NRS related documents can be accessed on ISU's NRS webpage.

In recent years, the NRS reporting structure has evolved from an extensive written report to an interactive dashboard format. The current dashboard website can be found here.

Recent Highlights

Recent NRS highlights can be accessed on the Strategy Documents web page for ISU's NRS.

Recent Funding or Program Announcements

New Efforts to Scale-Up Edge-of-Field Practices

In 2021, IDALS in partnership with Polk County, Polk and Dallas SWCDs, and several other partners, completed a first-of-its-kind "Batch and Build" of 54 bioreactors and saturated buffers in Central Iowa watersheds. Phase 2 of the project plans to install another 48 practices in 2022. These practices are estimated to remove over 47,000 lbs. of nitrogen annually. This initial partnership is growing to add additional phases in Central Iowa watershed. It is also expanding into other key watersheds in Iowa and with a host of new partners. This project concept was a recommendation developed through the Conservation Infrastructure Initiative, a collaboration of leaders within and outside of the agriculture industry that came together to help identify barriers and opportunities associated with advancing the Iowa NRS.

New Partnership to Advance Measurement of Farmer Practice Adoption

In 2020, after establishing a formal process and demonstration phase, the Iowa Nutrient Research and Education Council (INREC) formally expanded their efforts to track and report farmer conservation practice adoption. This effort is conducted in consultation with IDALS, ISU, and IDNR and supports the overall tracking and reporting system developed to track progress of the INRS. The INREC survey tracks primarily in-field nutrient and tillage management systems of Iowa farmers annually. The data has been challenging to quantify and has historically depended on response surveys to estimate statewide usage. The INREC survey leverages partnerships with the Iowa agricultural retailer network to survey "as applied" data for randomly selected fields and aggregated via statistically valid methods in partnership with the ISU Statistical Laboratory. For more information on the project, go to: https://www.iowanrec.org/programs-resources. Including the initial pilot phase, the survey covers crop years 2017–2021 with data collection for crop year 2022 beginning in 2023.

Iowa Point Source Updates

The INRS currently identifies 161 industrial and municipal wastewater treatment point source facilities that need to evaluate the amounts of nutrients in their discharges in order to meet the goals of the strategy. Upon receiving an NPDES permit under the INRS, each facility works to develop a feasibility study, which outlines the resources required to achieve nutrient reduction goals. The permits also incorporate requirements for measuring nutrient concentrations in influent and effluent to determine current nutrient removals and provide an empirical basis for feasibility studies.

Point source facilities listed in the strategy are required to monitor raw waste inflows and final treated effluent for TN and TP. This extensive monitoring effort has generated one of the country's most complete sets of point source nutrient data, and the extent of this data collection will continue to increase as the remaining permits are issued. The data has enabled the facilities and the IDNR to determine current TN and TP loads associated with these point sources, even before additional nutrient reduction technologies are installed.

A facility uses the data collected during the 2-year period after permit issuance to evaluate the feasibility and reasonableness of reducing the amounts of nutrients discharged into surface water. The INRS establishes a target of reducing TN and TP from point sources by 66 percent and 75 percent, respectively. A facility's feasibility study must include an evaluation of operational changes that could be implemented to reduce the amounts of TN and TP discharged. If the implementation of operational changes alone cannot achieve the targets, the facility must evaluate new or additional treatment technologies that could achieve reductions in the nutrient amounts discharged. (See Figure 1-7 and Figure 1-8, which summarize the progress over recent years.)

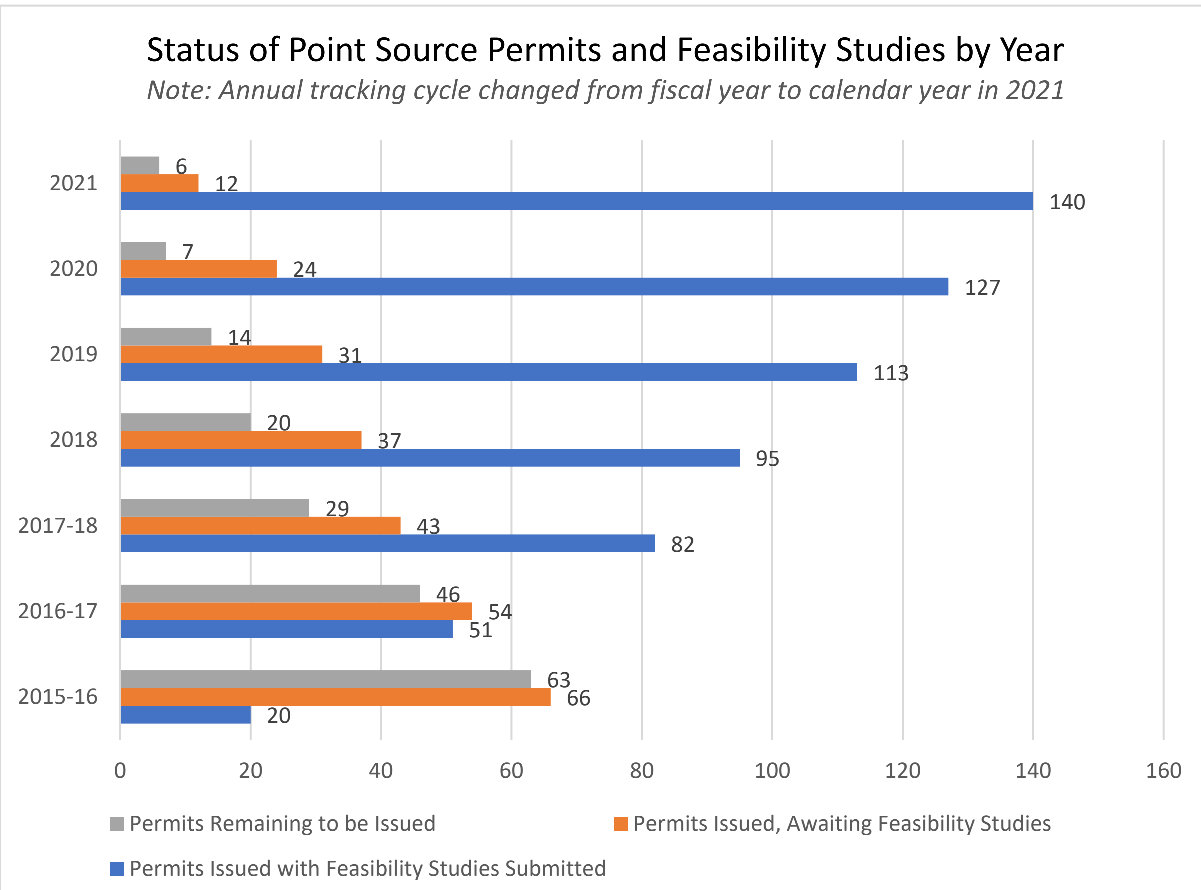


Figure 1-7. Status of point source permits and feasibility studies by year.

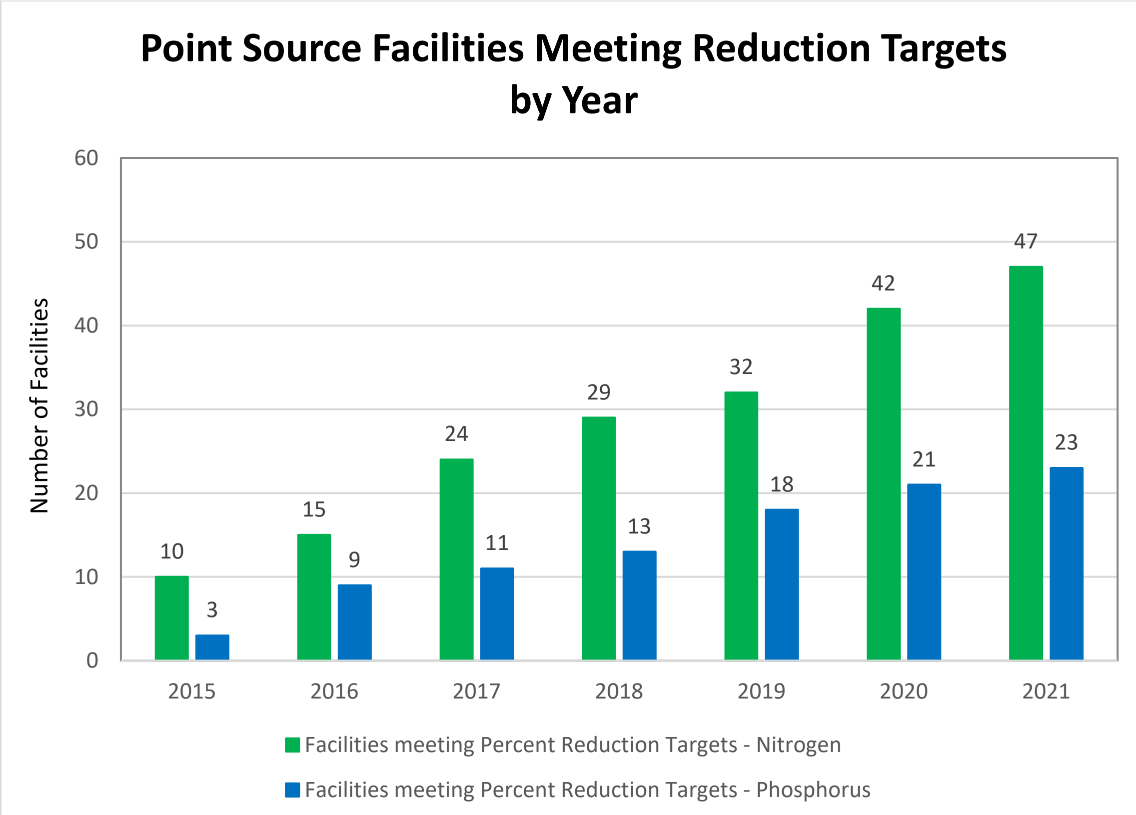


Figure 1-8. Point source facilities meeting reduction targets by year.

As these feasibility studies are reviewed and approved by the IDNR, the schedules contained in the studies for installing nutrient reduction technologies or optimizing existing treatment are added to the facilities' NPDES permits by amendment. Once the construction or optimization outlined by the schedules is complete and treatment processes are optimized, facilities will submit twelve months of effluent TN and TP sampling results. Effluent limits based on those sampling results will then be added to facilities' permits and become enforceable.

Iowa Nutrient Reduction Exchange

Agricultural and urban partnerships are a critical component to meet the goals of Iowa's NRS. The Nutrient Reduction Exchange (NRE) was developed to help establish these partnerships. The NRE incentivizes regulated municipalities and industries across the state to partner with farmers to implement nutrient-reducing BMPs. Participation in this tracking system is voluntary and non-regulatory. Iowa DNR may recognize those entities generating and registering nutrient reductions for: (1) meeting INRS goals, (2) offsetting new loads associated with growth, and (3) future regulatory compliance relief through water quality trading.

Several cities have signed memorandums of understanding (MOUs) with Iowa DNR that provide the regulatory certainty needed by the cities to demonstrate that their efforts will be recognized, and lays out the process for doing so. The cities of Cedar Rapids, Ames, Dubuque, Muscatine, and Storm Lake all have signed MOUs and more are on the way. Several communities in Iowa, especially Cedar Rapids and

Ames, have made significant investment in their respective watersheds that will be recognized in the NRE.

Iowa Nutrient Research Center

The Iowa Nutrient Research Center (INRC) was established in 2013 to help manage NPS nitrogen and phosphorus pollution. The INRC was established by the Iowa Board of Regents in response to legislation passed by the Iowa Legislature. The INRC pursues science-based approaches to nutrient cycling that include evaluating the performance of current and emerging nutrient management practices and providing recommendations on implementing existing practices and developing new practices.

Since 2013, the INRC has awarded more than 127 grants among Iowa's three Regent Schools (University of Iowa, University of Northern Iowa, and ISU). The awards total slightly over $15.1 million, with approximately 24 percent of the funds going to nutrient management research, 11 percent to land management research, 17 percent to edge-of-field research, and 48 percent to multi-objective research.

Addition of New Practices in the NRS

As research on NPS conservation practices is conducted, new insights are developed regarding the effectiveness of practices in reducing nitrogen and phosphorus loss. These data can be submitted to the NRS Science Team to review the effectiveness of conservation practices in the same manner in which the original NRS Science Assessment was conducted.

In the 2016 reporting period, saturated buffers were approved as an NRS practice. In the 2017 reporting period, blind tile inlets were approved. Multi-purpose oxbows were added to the practice list in 2019. A science team has been working to update nutrient reduction practice performance information using procedures consistent with the original Iowa NRS Science Assessment. This work is updating practice performance information with more recent literature and adding new practices where literature is available. It is anticipated this information will be released in 2023.

1.8.5 Kentucky

In 2022 the Kentucky Division of Water (KDOW) updated Kentucky's NRS (eec.ky.gov/nutrientreduction) to prioritize investments and enhance cooperative efforts that will help decrease excess nutrients that fuel HABs and contribute to Gulf hypoxia. The Nutrient Reduction Strategy Update represents a significant reconsideration of the state's approach to nutrient prioritization, and a reinvestment in Kentucky's Agriculture Water Quality Act (AWQA). The update also provides a holistic framework tailored to Kentucky's unique geologic, agricultural, and hydrologic landscape, and improves on progress made since the 2014 Strategy.

To prioritize available resources, KDOW used over 40 years of water monitoring data to create Kentucky's Nutrient Priority Areas (see Figure 1-9) that balance the needs of drinking water sources, open water recreation, and areas with greater nutrient concentrations (i.e., high yield watersheds). The high nutrient yield watersheds represent areas that ranked highest in KDOW's 2019 and 2021 Nutrient Loads and Yields Studies. Prioritizing nutrient-focused SWP areas reflects an interagency focus by KDOW and NRCS to invest in community drinking water sources (see Hypoxia Task Force Success Stories).

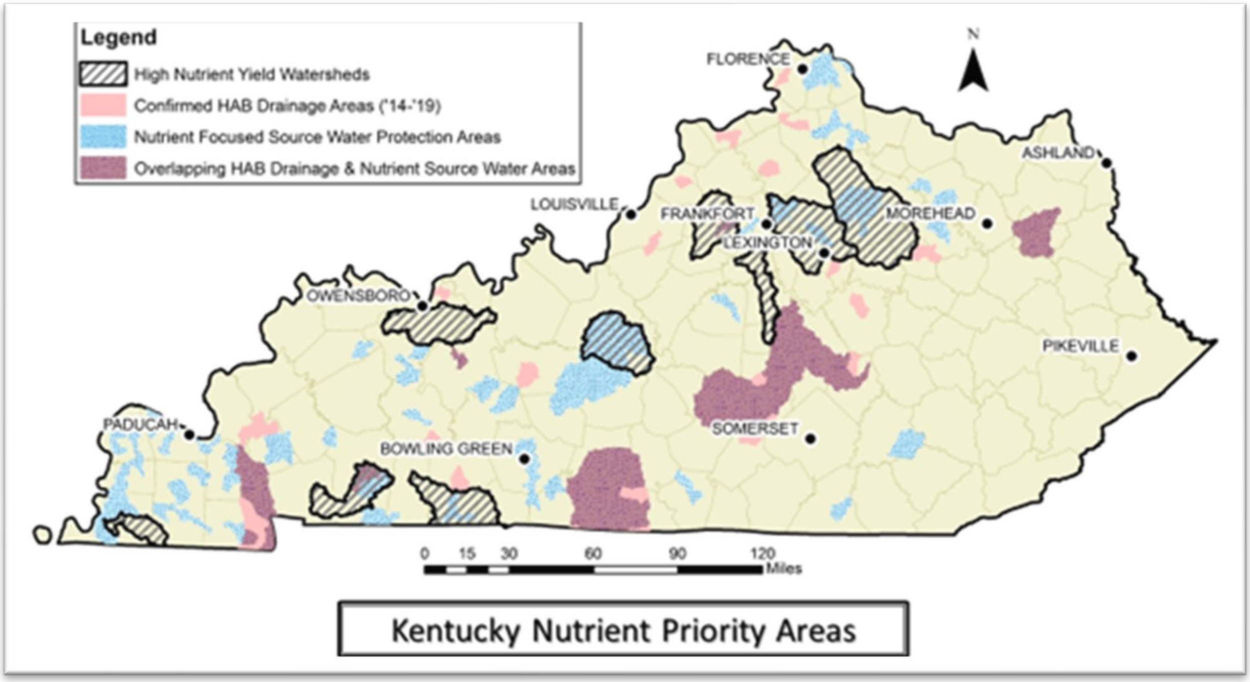


Figure 1-9. Kentucky nutrient priority areas.

Combined with confirmed HAB watersheds, these Nutrient Priority Areas allow KDOW to prioritize investments from the Gulf Hypoxia Program, 319 Grant Program, Clean Water State Revolving Fund Program, and the Kentucky Division of Conservation's (KDOC) State Cost Share Program. Applicants located in Nutrient Priority Areas are ranked higher, which increases their likelihood of being funded. Agriculture producers in source water portions of Nutrient Priority Areas are also eligible for a higher federal cost sharing rate from NRCS, which has already benefitted approximately 432,000 acres in Kentucky.

Kentucky is also reinvesting in AWQA planning tools to help farmers and foresters develop plans for protecting water quality using BMPs. KDOW used EPA grant funding to build an interactive AWQA Planning Tool that streamlines conservation planning, while improving access to funding, technical, and water quality information. Additionally, KDOW invested in a statewide AWQA outreach campaign consisting of radio, video, and print media (see Figure 1-10). KDOW is also working with the KDOC, the University of Kentucky Cooperative Extension, and others to distribute AWQA-branded grazing sticks and fencepost signs at livestock and commodity training events to promote completing and implementing AWQA plans.

Figure 1-10. Example of print media outreach product for the AWQA planning tool.

To improve understanding of statewide BMP implementation, KDOW and KDOC published initial results of their collaborative load reduction project, in which KDOW applied STEPL load modeling to KDOC-funded BMPs (see Figure 1-11). This partnership helps Kentucky quantify the benefits derived from state administered programs. Additional partnerships and data collection will help identify cumulative impacts and determine trends of nutrient loading, loss, and prevention across Kentucky.

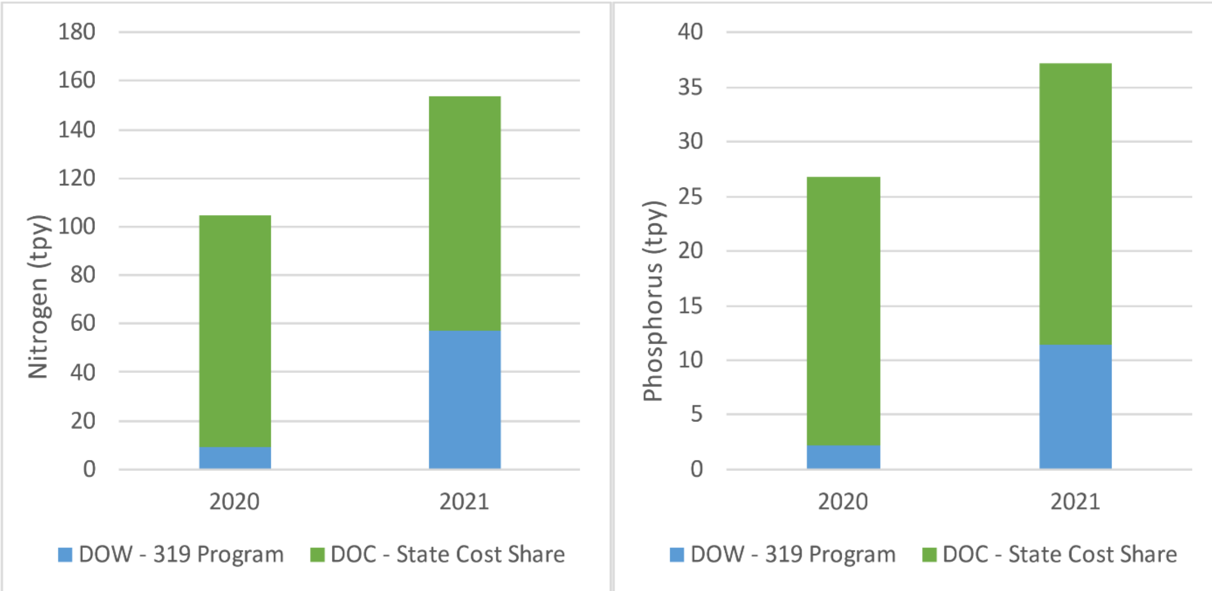


Figure 1-11. Nitrogen and phosphorus load reductions supported by Kentucky state agencies.

KDOW also engages with wastewater operators through the Nutrient Subcommittee of the Kentucky Drinking Water and Clean Water Advisory Council, which facilitates dialogue on nutrient optimization, permitting, and other relevant topics. KDOW is working to expand the nutrient optimization pilot program to major publicly owned treatment works. The ongoing dialogue will help guide and encourage nutrient training programs for wastewater operators and MS4 managers using the GHP.

1.8.6 Louisiana

The collaborative of Louisiana's Coastal Protection and Restoration Authority (CPRA), Department of Agriculture and Forestry (LDAF), Department of Environmental Quality (LDEQ), Department of Natural Resources, USDA NRCS Louisiana, and Louisiana State University Agricultural Center released an updated Louisiana Nutrient Reduction and Management Strategy in 2019. The strategy provides a framework of strategic components with underlying actions that guide implementation of nutrient reduction and management across the state to protect, improve, and restore water quality in Louisiana's inland and coastal waters. Implementation of the strategy has focused on six key areas: (1) river diversions, (2) NPS management, (3) point source management, (4) incentives, (5) leveraging opportunities, and (6) new science-based technologies/applications.

Nutrient Management Strategy Implementation

The interagency collaborative that developed the Louisiana Nutrient Reduction and Management Strategy team continues to jointly implement and monitor the progress of the strategy in Louisiana. In addition to EPA, other collaborative partners include: LDAF Soil and Water Conservation, Louisiana Master Farmer Partners, Barataria-Terrebonne National Estuary Program, and the Lake Pontchartrain Basin Foundation (among others). The Louisiana Nutrient Reduction and Management Strategy Interagency Team compiles annual reports that document the nutrient reduction and management implementation activities in the state. The strategy, annual reports, and pertinent nutrient management information can be accessed on Louisiana's Nutrient Reduction and Management Strategy web page.

Funding in Support of HTF States

EPA Funds to States in 2019 and 2020 ($200,000 Total)

Two projects were supported through this effort and were completed on September 30, 2022: (1) *Nutrient Reduction Strategies Supporting Section 319 CWA: Louisiana NPS Water Quality Analysis*. Monthly monitoring in four priority watersheds provided critical data that established current water quality conditions, identified highest concentrations of nutrients, determined geographical or temporal component to impairments, and quantified water quality improvements. (2) *Pilot Expansion of Water Quality Monitoring from Inshore to Offshore.* Seasonal monitoring over a 2-year period filled a critical monitoring gap in the nearshore to offshore environment, providing baseline status data and supporting efforts on the improvement of nutrient uptake modeling to evaluate nutrient dynamics in response to a river diversion. Data are currently in use.

IIJA Funds in 2021 to GHP (~4.1 million Over 5 Years)

Two projects have been approved for the first two years of this GHP effort: (1) The *Lake St. Joseph, Louisiana, Nutrient Loading Reduction* project aims to reduce the concentrations of nitrogen and phosphorus in the Lake St. Joseph and Cypress Bayou watersheds within the Tensas River Basin. Agriculture is the suspected source for nutrients, and offsite impacts of nutrient loading into Lake St. Joseph resulting from agricultural processes will be significantly reduced or eliminated through BMPs and conservation efforts. (2) *Pilot Transition to Autonomous Monitoring from Inshore to Offshore in Coastal Louisiana* is a continuation of Project 2 described above, with the addition of new technologies to allow more sampling locations in the dynamic coastal environment. Both projects are anticipated to continue through the 5-year funding cycle.

Nutrient Monitoring

LDEQ routinely monitors surface waters for nitrogen and phosphorus in their Ambient Water Quality Monitoring Program. Regarding water permitting, LDEQ's goals are to incorporate nutrient monitoring into all individual sanitary permits and landfills, industrial permits that are a source of excess nutrients, and general permits for which nutrient monitoring is required by a TMDL. Nutrient monitoring has been included in 1,658 facility permits to date (1,062 general permits and 596 individual permits). This information is based on permits that are coded into EPA's ICIS.

Alternatives to TMDLs/New Vision for 303(d) Program

Under EPA's Vision for the Clean Water Act Section 303(d) Program (see section 1.7.2), LDEQ began implementation of alternative restoration strategies for monitoring and reduction of nutrient loads in Yellow Water River (subsegment 040504) and Natalbany River (subsegment 040503). LDEQ also began activities as part of alternative restoration strategies to address excess nutrients in in New River (subsegment 040404) and Blind River (subsegments 040401 & 040403).

Water Quality Credit Trading

Louisiana developed a Water Quality Trading program to address excess nutrients and other appropriate parameters. Program objectives include providing a cost-effective method for achieving compliance with water quality standards that achieves equal or greater reduction of pollution, reducing cumulative pollutant loading, improving water quality, preventing future environmental degradation, and providing ancillary environmental benefits such as carbon sinks, flood retention, riparian improvement, and habitat. LDEQ made available a draft guidance document in December 2017, held six stakeholder meetings in 2018, and proposed and finalized rulemaking in 2019. The rule was amended in 2021 to allow eligibility to generate credits with public conservation funds unless otherwise prohibited by the terms and conditions of the public funded project.

Nonpoint Source

NPS pollution management activities are conducted in accordance with the EPA's *Nonpoint Source Program and Grants Guidelines for States and Territories* issued April 12, 2013. The CWA section 319 funds allocated to the State of Louisiana are divided equally between LDEQ and LDAF's Office of Soil and Water Conservation. Projects align with goals and objectives set in the EPA-approved state's NPS Pollution Program Management Plan to partially or fully restore impaired waters identified in the Louisiana Water Quality Integrated Report (CWA sections 305(b)/303(d)). LDEQ is working in collaboration with the state's agricultural partners at LDAF to refine techniques for calculating load reduction in implementation project areas. The goal of this collaborative effort is to compare estimated load reductions from implementation with loads calculated at sampling sites in priority watersheds through monitoring during the duration of implementation and one year following completion of implementation projects.

Statewide agricultural programs institutionalize NPS goals and objectives into all of the state's agencies' programs. For example, LDEQ and USDA have coordinated their watershed programs and used water quality data to identify water bodies that are eligible for implementation of federal cost-share programs. EQIP, the Wetlands Reserve Program (WRP), CREP, and CRP have been implemented in watersheds identified as impaired by agricultural nonpoint sources in the state's integrated report. The USDA and LDEQ partnered on USDA's MRBI to target practices that reduce excess nutrients such as nitrogen and phosphorus entering the Gulf. MRBI allowed states that border the Mississippi River to implement these types of NPS controls that could be expanded to adjacent watersheds to reduce the size of hypoxia in the Gulf.

Federal agencies participate in the Nonpoint Source Interagency Committee to coordinate their programs to meet CWA water quality goals. Two examples of this federal/state partnership are NRCS and U.S. Forest Service. Both of these agencies have partnered with LDEQ on coordination of projects to reduce the concentration and/or loading of sediment, excess nutrients, and other pollutants associated with agricultural and forestry activities, respectively.

Federal and state agricultural agencies in Louisiana have taken leadership roles in addressing agricultural NPS pollution. Through Farm Bill programs that USDA administers each year, thousands of acres of BMPs are implemented across the state to reduce the amount of sediment and excess nutrients entering the state's water bodies. LDEQ participates in the USDA State Technical Advisory Committee (STAC) to ensure water quality improvements continue to be a top priority for USDA's Farm Bill Conservation Programs. Through USDA's ranking criteria, which are provided to local stakeholders and field offices, water quality and habitat protection remain key factors in selecting which lands are included in Farm Bill programs. Members of the STAC are provided an opportunity to vote on the list of resource concerns addressed by Farm Bill Conservation Programs in the same manner as members of local stakeholder groups. This process keeps water quality priorities at the top of the list of issues that need to be addressed through Farm Bill programs. Each of the following statewide programs has a nutrient management component: Agricultural Statewide Program, Forestry Statewide Program, Urban Runoff Statewide Program, Hydromodification Statewide Education Program, and Coastal Nonpoint Pollution Control Program.

Source Water Protection

Louisiana DEQ's Source Water Protection Program (SWPP) staff assist Louisiana's communities in protecting aquifers and surface waters (e.g., rivers, lakes) that are sources of drinking water. The staff also works on environmental water quality issues that might arise related to drinking water sources. In addition, Louisiana SWPP staff assist Louisiana NPS staff in watershed areas where watershed implementation plans are completed as part of the watershed coordination team effort.

Numerous areas of Louisiana have experienced rapid growth and development; therefore, emphasis has been placed on working with parishes to establish a drinking water protection ordinance that protects their source water from NPS pollutants. SWPP has collaborated with the NPS Management Program to educate the public on the importance of preventing NPS pollution and maintaining onsite sewage disposal systems.

Coastal Protection and Restoration

The CPRA continues to work with universities, federal agencies (USACE, USGS, and NOAA), nongovernmental organizations, and private industry to improve the science surrounding river diversions and nutrient assimilation. To improve understanding of water quality dynamics, a numerical investigation of salinity variations in the Barataria Estuary and a project investigating the dynamics of nitrogen and phosphorus cycling across Barataria Basin were funded through Louisiana's RESTORE Center of Excellence Research Grants Program. Additionally, a Coastal Science Assistantship was funded to determine the impact of fresher conditions on the microbial processes of denitrification.

Louisiana's Comprehensive Master Plan for a Sustainable Coast (Coastal Master Plan) advances a comprehensive and integrated approach to restoration and protection. The 2023 Coastal Master Plan is currently being developed and includes the construction of additional river diversions with the intent to deliver high sediment loads and river water into more areas of deltaic wetlands. Sediment diversion projects will result in the flow of Mississippi and Atchafalaya river nutrients, freshwater, and sediment to bays, marshes, and estuaries. Louisiana's coastal wetlands have the value-added benefit of assimilating and removing nutrients from the Mississippi River. Intercepting excess nutrients via river diversions by filtering them through coastal basins before they exit the mouth of the Mississippi River might ultimately reduce the concentrations of nutrients that reach the Gulf.

To assess potential changes in water quality dynamics and spatial and temporal patterns in nutrient transformation, higher resolution project-specific numerical water quality models have been developed (e.g., for the Barataria, Breton, and Maurepas diversions) with a focus on nitrogen uptake to evaluate the potential fate of nitrogen in different types of wetlands and open water bodies. The Mid-Barataria and Mid-Breton Sediment Diversions are designed to reconnect the Mississippi River to wetlands and open water bodies by mimicking natural land building processes using an "engineering with nature" approach. The Delft3D water quality model, D-WAQ, is being used to simulate dissolved nutrient dynamics in the Barataria and Breton receiving basins. The Mid-Barataria Sediment Diversion Draft Environmental Impact Statement was released in March 2021, and public comments were received. The Final Environmental Impact Statement was officially published by USACE on September 23, 2022, representing a major milestone in the project's permitting process. The document details the benefits and potential impacts of the project on numerous factors including water quality, socioeconomics, fisheries, and storm surge/flooding, and includes the Louisiana CPRA's updated mitigation plan with significant increased funding for these measures. The Mid-Breton Sediment Diversion project is in the early stages of the federal permitting process. The River Reintroduction into Maurepas Swamp project, which is projected to benefit approximately 45,000 acres of wetlands by reconnecting one of the largest forested wetland complexes in the nation to the Mississippi River, is projected to receive the majority of funding from BP oil spill fines. The project goal is to introduce river water into the swamp, designed to ensure water retention long enough to benefit woody vegetation from fresh flowing water, nutrients, and fine sediments. During early project design, hydrodynamic modeling was used to ensure that these objectives can be met. The project is estimated to be ready for construction in 2023.

To determine baseline conditions, support the development and calibration/validation of models, and increase understanding of how Louisiana's coastal basins might respond to the influx of nutrients from a future Mississippi River diversion, CPRA is implementing the System-Wide Assessment and Monitoring Program (SWAMP). The development of SWAMP ensures that relevant water quality data are collected both prior to and following the construction and operation of new river diversion projects. SWAMP water quality monitoring and nutrient sampling has been implemented coast-wide. The SWAMP water quality network leverages existing long-term water quality programs (LDEQ, LDWF, and USGS), combined with the implementation of new water quality stations for a total of 120 water quality stations. Water quality parameters measured include nitrogen (TKN, nitrate+nitrite nitrogen, and ammonia), phosphorus (TP, orthophosphate), silica, chlorophyll a, total suspended solids, turbidity, dissolved oxygen, dissolved oxygen percent saturation, temperature, salinity, and pH. CPRA also worked with USGS to install three additional real-time monitoring stations within Barataria Basin to improve the availability of spatial and temporal water quality data. Implementation in the western basins started in 2020, and water quality data coastwide can be accessed at: https://cims.coastal.la.gov/monitoring-data/.

1.8.7 Minnesota

From 2020 to 2022, Minnesota advanced its NRS implementation in multiple ways. Progress made before the 2019/2021 Report to Congress was thoroughly documented in a comprehensive 5-year Minnesota NRS progress report. Minnesota has continued to make strides in each program described in the previous Report to Congress. Highlighted below are select progress updates and descriptions of new endeavors and products from the past two years. The Minnesota NRS and the 5-year progress report can be found on Minnesota's NRS website.

NPS Programs

CWA Section 319 NPS Pollution Program: The federal CWA section 319 NPS pollution program was recently restructured in Minnesota to provide 16 years of stable local funding for small watersheds. The program focuses on relatively small watersheds to make it more manageable to get the detailed assessment needed for goal setting, source identification, critical area identification, implementation targeting, and performance evaluation monitoring. Of the 35 watersheds selected, 21 have a direct focus on nutrients, 6 others have a secondary focus on nutrients, and the rest have an indirect interest in nutrients. More information is available on the Section 319 Small Watershed program here.

State Funding Assistance for BMP Implementation: Over the State FY20–21 biennium, Minnesota's 25-year Clean Water Legacy funding provided approximately $163 million for protection and restoration implementation activities. See Figure 1-12. A considerable portion of these funds is directed toward nutrient-reduction practices and efforts. More information about these funds can be found in the 2022 Clean Water Fund Performance Report. The Clean Water Legacy funding, when combined with other state program assistance, was $262 million for the FY20–21 biennium (with over 90 percent used for NPS pollution). Federal programs for BMP adoption contributed an additional $158 million over the biennium. More information can be found at Minnesota's Healthier Watersheds Tracking System.

Minnesota Agricultural Water Quality Certification: Minnesota has continued its certification program that provides regulatory certainty and prioritized cost-share for farms certified to meet BMP standards for water quality protection. Private industry has partnered with agencies to promote and use this program. Recent progress (October 2022) shows 1,273 producers that are certified, representing 922,574 acres. Certified farmers have added 2,550 new practices resulting in over 54,000 pounds of phosphorus loss reduced. Access more information about the Minnesota Department of Agriculture's program here.

Point Source Programs

Wastewater Nutrient Discharge Reduction: Between 2005 and 2021, wastewater point source phosphorus discharges were reduced 59 percent in areas ultimately draining to the Mississippi River. During this same period, nitrogen increased by 7 percent. See Figure 1-13. More information is available at Minnesota's wastewater phosphorus loads interactive map and the 2022 Pollution Report to the Legislature.

Wastewater Nitrogen Reduction Strategy: Minnesota recently began engaging with stakeholders to discuss plans to develop a detailed Wastewater Nitrogen Reduction Strategy. The strategy will move Minnesota toward facility-specific nitrogen management plans to ensure nitrogen is being reduced to the extent possible, while optimizing for both nitrogen and phosphorus treatment. The state is exploring water quality trading to support cost effective solutions, along with permit controls and/or state discharge restrictions to ensure that local aquatic life is protected and commitments to downstream waters are met.

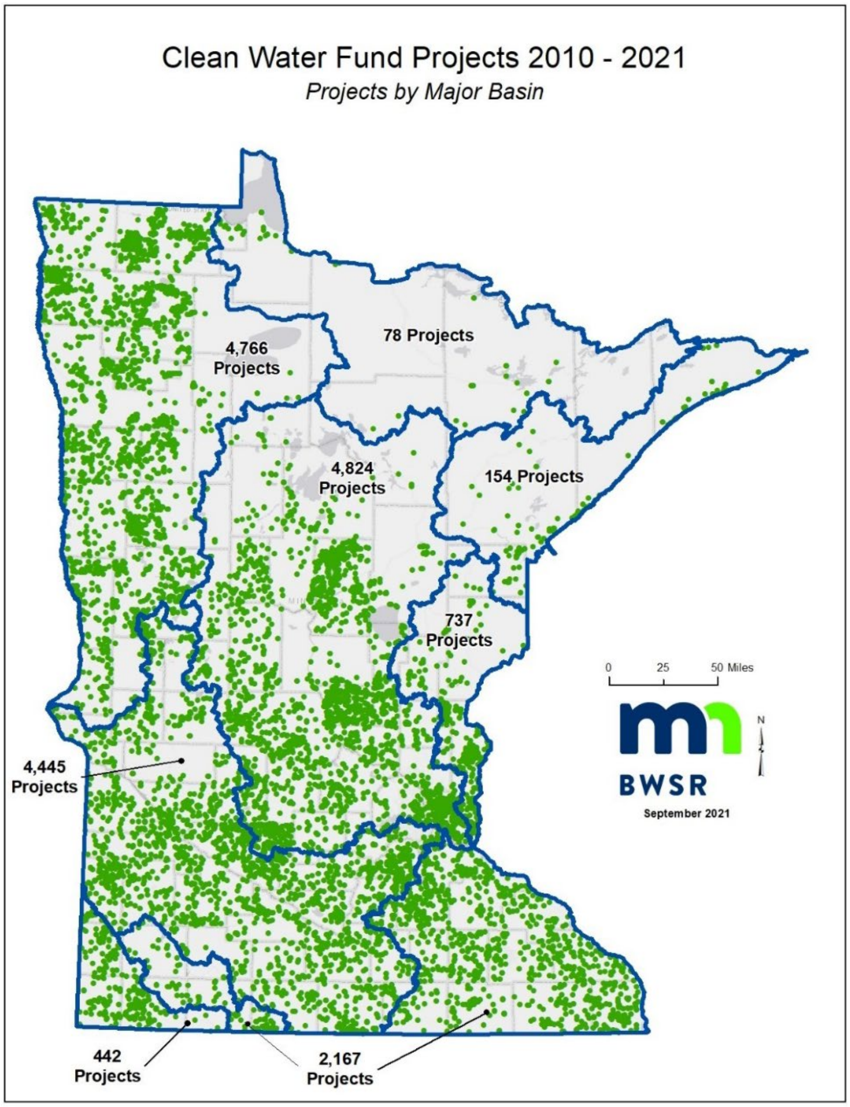


Figure 1-12. State funded projects between 2010 and 2021 (from the Minnesota Board of Water and Soil Resources)

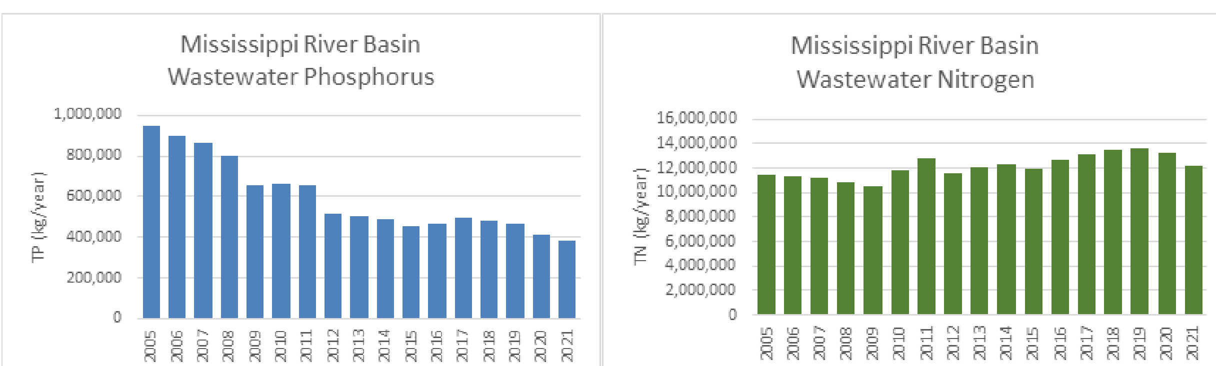


Figure 1-13. Point source wastewater phosphorus and nitrogen discharge trends into the Mississippi River Basin (from MPCA).

Watershed Approach

Watershed Strategies and Planning: Minnesota uses watershed monitoring, modeling, and other assessments to develop problem-solving strategies for local and downstream waters. Water quality conditions have been intensively monitored in all 80 watersheds, and watershed restoration and protection strategies have been completed for 79 of the 80 watersheds, with the remaining watersheds nearing completion. The technical reports and strategies are being used by partnerships of local governments to develop prioritized, targeted, and measurable implementation plans within the watersheds (known as one watershed, one plan). See Figure 1-14.

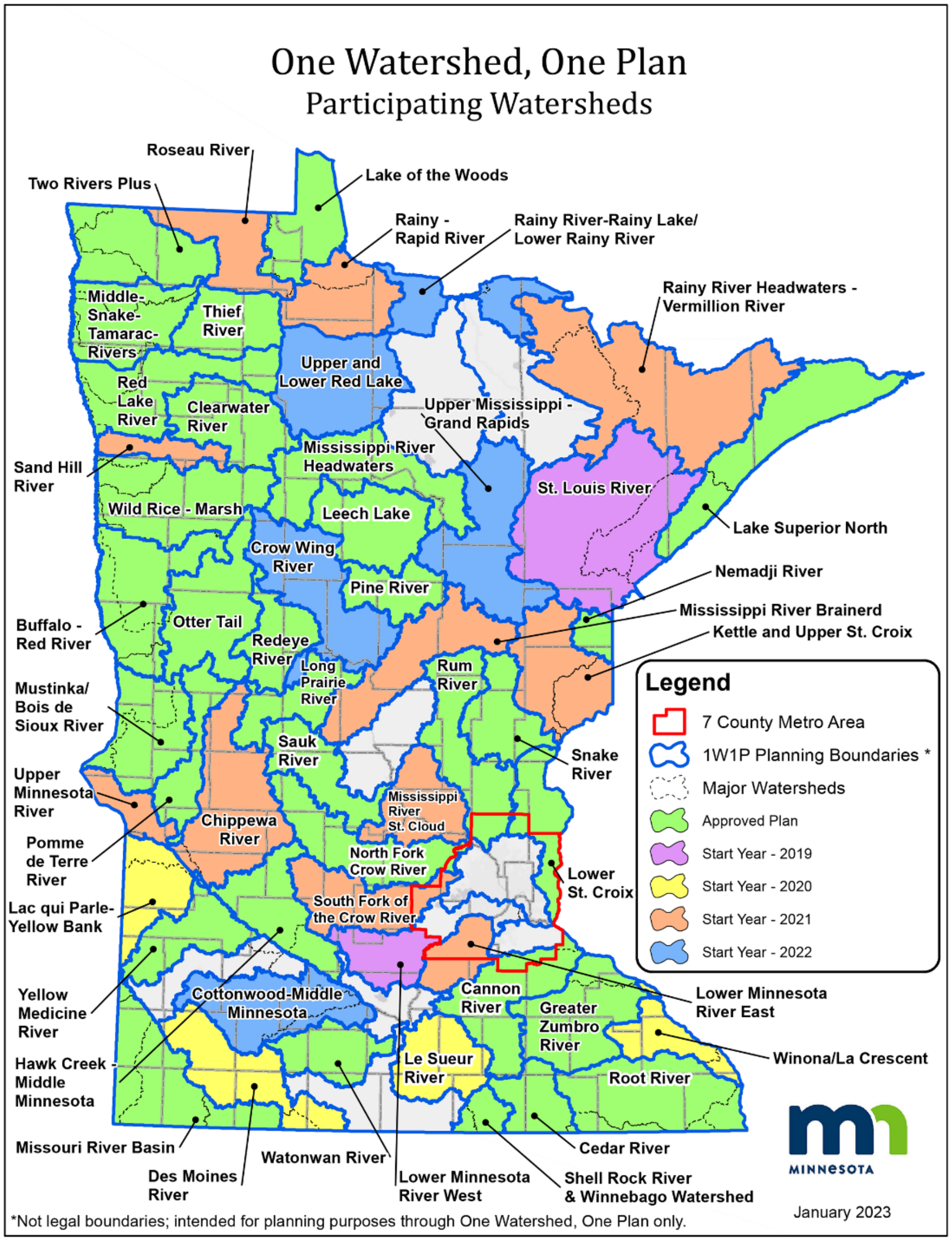


Figure 1-14. Status of comprehensive local water planning through the One Watershed, One Plan program (from Minnesota Board of Water and Soil Resources).

More information can be found on results of watershed monitoring and strategies at Minnesota Watersheds.

Watershed Outlet Load Reductions to Meet State Line Nutrient Goals: New guidance was developed to show nutrient load reductions from anthropogenic sources needed from each watershed to collectively achieve Minnesota's part of the Gulf nutrient reduction goals. The guidance also includes information on how to estimate BMP combinations and levels of adoption that will achieve specific watershed nutrient load reductions. A user-friendly watershed nutrient reduction planning tool called Watershed Pollutant Load Reduction Calculator was recently developed.

Watershed Based Implementation Funding (WBIF) Program: As part of the Clean Water Legacy funding previously noted, the Minnesota Board of Soil and Water Resources has now fully implemented the WBIF Program ($39.8 million in state FY22–23). Watershed-based funding is an alternative to the traditional project by-project competitive grant processes often used to fund water quality improvement projects. This funding allows collaborating local governments to pursue timely solutions based on a watershed's highest priority needs. The approach depends on comprehensive watershed management plans developed by local partnerships to provide assurance that actions are prioritized, targeted, and measurable.

TMDLs for Nutrient Impaired Waters

TMDLs have been approved for more than 570 of the approximate 744 nutrient-impaired waters in the state. More TMDL progress info can be found here.

River Nutrient Trends

Phosphorus concentration trends continue to show mostly decreases in the Mississippi River Basin; whereas nitrate trends show increases or no trends. For more information see page 27 of the 2022 Clean Water Fund Performance Report. Precipitation has been increasing, driving river load trends upward for both phosphorus and nitrogen.

Workplan for GHP funds

Minnesota's workplan for the first two years of GHP allocations focus on eight areas important for Minnesota's nutrient reduction work into the next decade and beyond, as follows:

1. BMP needs, effects, and priorities—From existing research, identify the most promising agricultural BMPs, associated nutrient reduction efficiencies, and new adoption acreage needs to reach our nutrient strategy goals.
2. Scaling up BMP adoption—Develop specific options and recommendations for how Minnesota can best scale-up and accelerate adoption of the most promising agricultural practices.
3. Remaining loads and geographic priorities—Update Minnesota's river nutrient load estimates for each source sector and identify remaining river nutrient load reduction needs at the state line and watershed outlets. Priority watersheds for nutrient reduction efforts will also be re-evaluated.
4. Tools for watershed planning—Support and increase use of watershed decision support tools for local nutrient reduction planning and strategic implementation of effective practices at the local watershed scale.

5. Point source wastewater nitrogen reduction—Identify facilities with high nitrate loads and those potentially harming local river aquatic life, and work with those facilities to provide assistance with planning and piloting nitrogen reduction.
6. Tracking system—Design a progress-tracking system for displaying ongoing and cumulative nutrient reduction efforts and results.
7. Strategy revision—Update and revise Minnesota's NRS to more effectively achieve point source and NPS nutrient load reductions to waters through 2035.
8. Manage and coordinate the above—Manage and coordinate subcontracting, reporting, financial, multi-state collaboration, and other project management work to accomplish parts 1-7.

Advancing Climate-Related Goals

Minnesota recently developed a comprehensive Minnesota Climate Action Framework which emphasizes the importance of how we manage our working lands. The agricultural practices needed for reducing greenhouse gasses, storing carbon, and adapting to climate change are largely the same practices that are needed for nutrient reduction to waters. Minnesota will be aiming to prioritize nutrient reduction practices that accomplish multiple benefits, including addressing climate change.

1.8.8 Mississippi

Mississippi uses both a statewide strategy and regionally specific strategies to address nutrient concerns on state lands and in state waters. These strategies focus on land use practices and characteristics that are unique to each region: the Mississippi River Delta (alluvial plain), upland areas, and coastal areas of the state. As individual watershed projects are developed, the nutrient reduction strategies are used to guide the development and implementation of watershed restoration and protection plans to ensure all plans include activities necessary to mitigate nutrient contributions to state waters and the Gulf. Taking a data driven approach, the agency and partners collect water quality data in watersheds where nutrient reduction practices are implemented.

Nutrient Monitoring

Mississippi Department of Environmental Quality (MDEQ) collects water samples at 37 bridge sites under the Fixed Station Monitoring Program each year within the state as part of status and trends monitoring. The network of statewide ambient primary fixed stations provides systematic water quality sampling at regular intervals and for uniform parametric coverage to monitor water quality status and trends over a long-term period. These locations are sampled monthly for routine water chemistry, including nutrient parameters.

Mississippi uses a calibrated index of biotic integrity to assess the health of benthic macroinvertebrate communities in wadeable streams outside of the Mississippi Alluvial Plain. As part of this monitoring program, MDEQ collects biological community data along with habitat measures and water quality on approximately 100 streams annually.

Annually, MDEQ collects samples from 20 publicly accessible lakes (greater than 100 acres in size). Depending on the size of the lake/reservoir, one to five monitoring locations are sampled. Lakes are monitored for traditional physical, chemical, and biological water quality parameters during the summer index period (May-November). Lakes/reservoirs are sampled on a rotating cycle until all water bodies greater than 100 acres have been monitored.

As part of the Mississippi Coastal Assessment program, MDEQ collects samples at 25 randomly selected sites annually along with 12 static sites. Coastal assessment monitoring is conducted during the late summer index period (July-September). Sample sites are selected using a probabilistic site selection methodology. At the end of the 5-year reporting period, a total of 125 monitoring locations have data that can be used to assess water quality in the coastal and estuarine waters in the state.

In addition to localized monitoring in watersheds, Mississippi is taking steps to evaluate nutrient conditions at a larger statewide scale. These efforts include partnering with USGS to perform nutrient trends analysis at long-term monitoring stations statewide as well as developing a Spatially Referenced Regression on Watershed Attributes (SPARROW) Model that is calibrated with Mississippi specific data and provides nutrient loading information for watersheds in the state. Nutrient trends analyses were developed at more than 20 locations across the state using a 10-year dataset. As a result of the analyses, flow weighted concentrations and loads were calculated at each site as well as evaluated by region and major land use type. This information can be used to measure change in condition from implementing nutrient reduction actions through time. The SPARROW model will estimate Mississippi's nutrient and sediment loading into the state's surface waters and will serve as a key mechanism for determining background nutrient loads. Outputs from this model can also be used to help target areas in the state where implementation activities can have the most impact on water quality. Model development is currently underway with the final model output expected to be complete mid-to-late 2023.

Mississippi has been diligently implementing nutrient reduction activities across the state for years. However, these conservation efforts have not been aggregated into a consolidated data set that can be used to determine progress over time. Mississippi is actively gathering long term implementation data (2008–present) that can be used to estimate load reductions achieved through implementation of conservation practices. The final estimated load reductions achieved through the implementation of these practices is schedule to be completed by the end of 2023. These data will show outcomes achieved at individual watersheds and can be aggregated to provide load reduction estimates at regional and statewide scales.

Nonpoint Sources

The state's strategy for the management and abatement of NPS pollution relies on statewide and targeted watershed approaches. These approaches are implemented through both regulatory and non-regulatory programs on the federal, state, and local levels. The implementation of program activities or categories that are not regulated rely primarily on the voluntary cooperation of stakeholders and are supported financially through federal assistance programs such as CWA section 319(h) and available state resources. The strategy for addressing NPS pollution on a statewide level includes education/outreach, monitoring and assessment, watershed planning activities, BMP demonstrations, BMP compliance, technology transfer, consensus building, and partnering. Implementation of the NPS Program is done in cooperation with numerous agencies, organizations, and groups at all levels of government and in the private sector. Priority is given to activities that promote consensus building and resource leveraging opportunities to increase the overall effectiveness of the Mississippi's NPS Program.

The NPS Basin Management Program implements strategies that target priority watersheds throughout the state. Prioritization of these watersheds is an evolving process identified in coordination with resource agency partners as part of the Basinwide Approach to Water Quality Management. Mississippi's collaborative leveraged approach to reduce excessive nutrients and their impacts focuses on the development and implementation of appropriate nutrient reduction strategies. The target audience for the strategic planning and implementation includes local agencies and organizations with a mission for environmental and water quality restoration and protection, and local, state, and federal agencies with the authority to develop and implement nutrient reduction plans and practices. CWA section 319 NPS funding has been used increasingly to support nutrient reductions in large watersheds. The strategy behind this approach is to use the committed CWA section 319 resources to attract additional leveraging opportunities, that together, create a greater potential to achieve quantifiable reductions in nutrient concentrations/loadings.

Point Sources

Through the NPDES Permitting Program, Mississippi has been implementing nutrient monitoring and/or limits for TN and/or TP to ensure effluent monitoring is required for all municipal NPDES permits that have a discharge of greater than 1.0 MGD. Monitoring on wastewater coming into facilities, or influent monitoring, is included in all NPDES permits for municipal facilities with a discharge greater than 1.0 MGD. In addition, as part of the MS4 process, Mississippi is requiring entities to incorporate nutrient reduction strategies as part of stormwater management plans.

Nutrient permit limits are included for TP and TN for all facilities that have permits that discharge into receiving waters that have nutrient TMDLs. Mississippi has over 190 water bodies with TMDLs for TN and/or TP statewide. Whenever a discharge is located in a watershed with a nutrient TMDL, the facility, at a minimum, is required to monitor their discharge for nutrients. Based on the TMDL loading requirements calculated for the watershed, those facilities may also be required to have nutrient limits. Additionally, as intensive water quality models are developed on state waters, where data of sufficient quality and quantity exist, and models are calibrated and verified; model outputs are used to provide nutrient limits for new or expanding dischargers.

Water Quality Criteria

MDEQ's goal is to develop scientifically defensible water quality criteria that are appropriate and protective of Mississippi's surface waters. MDEQ continues working towards the development of numeric nutrient criteria for each of Mississippi's various water body types: lakes/reservoirs, rivers/streams, coastal waters, and waters of the Mississippi Alluvial Plain. The criteria developed for each water body type will be coordinated with the water quality criteria for other water body types to ensure consistency across the state and protection from negative impacts to downstream waters.

Highlights of MDEQ's numeric nutrient criteria development efforts include the following:

- MDEQ continues nutrient criteria development efforts across all waterbody types with the intention of establishing criteria in a sequenced approach in the following order: (1) Lakes and Reservoirs (outside the Mississippi Alluvial Plain), (2) Coastal Waters, (3) Wadeable Streams (outside the Mississippi Alluvial Plain, and (4) Delta Waters (waters within the Mississippi Alluvial Plain).

- MDEQ plans to develop numeric nutrient criteria for Mississippi's large rivers (non-wadeable rivers and streams) based on site-specific information. The scheduling of this work will be determined based upon prioritization and available resources.
- MDEQ continues to collect data, conduct studies, and develop water quality models to support numeric nutrient criteria development for water bodies across the state.
- MDEQ is currently reviewing the updated guidance released by EPA regarding nutrient criteria development for lakes and reservoirs (EPA-822-R-21-005) and evaluating ways to incorporate the new information into ongoing criteria development work.
- MDEQ remains committed to providing updates to stakeholders regarding the progress and status of nutrient criteria development. These updates promote open communication between MDEQ staff and stakeholders.
- MDEQ continues to develop the plan for numeric nutrient criteria implementation evaluating concerns and questions raised by both MDEQ staff and stakeholders pertaining to implementation details surrounding numeric nutrient criteria. MDEQ will continue to work concurrently on both criteria development and implementation planning.

Mississippi's Plan for GHP Grant Funds

Mississippi applied for two years of funding (FY22 and FY23) made available to HTF states through the IIJA under the new GHP. Working with partners to identify the highest priorities for this new funding opportunity, the first set of project recommendations focus heavily on filling data gaps and building tools that can help Mississippi establish a strong foundation for making management decisions. Specifically, the funding will be used to characterize delivered nitrogen loads to the Mississippi River (background nutrient contribution), estimate load reductions achieved through BMP implementation 2008–present (load reductions achieved), and build a new biological response metric that can help measure water quality impacts from nutrient reduction activities (success measure).

The HTF has prioritized the expansion of in-flow monitoring networks in the MARB to better estimate and track nutrient and sediment loads from states into the river. In support of this priority recommendation, Mississippi plans to use GHP funds to partner with the USGS to install real time nitrate sensors at six major tributaries to the Mississippi River. Data collected at these locations will be used to develop more accurate, scientifically defensible, estimates of Mississippi's nutrient contributions to the river and the hypoxic zone.

As work is ongoing to better characterize nutrient loading from Mississippi waters, funding from the grant will also be used to develop a process and tool to estimate load reductions achieved through reductions activities. Mississippi's Nonpoint Source Reduction Estimation Tool will build on existing frameworks for calculating load reductions achieved from implementation of BMPs to capture and report on TP, TN, and sediment reductions achieved over time. Implementation data from NRCS funded activities as well as those funded from CWA section 319 grant efforts and, where possible, private investments will be incorporated into a model framework to estimate reductions achieved at the watershed scale. These results can then be aggregated to report on outcomes at larger regional or statewide levels.

As more and more efforts are focused on reducing nutrient loading in the environment, it is important to enhance the process by which these changes can be monitored and measured in the environment. Biological organisms that live in stream environments, such as plants and fish, can be used to document and assess the health of streams. Non-vascular plants, such as algae and diatoms are commonly used as an indicator of water quality conditions. Algae and diatoms directly respond to nutrient availability in water bodies. Studies have established that algae or diatom-based community traits are sensitive response measures to nutrient pollution in streams. These organisms serve as a long-term indicator of nutrient loading and overall stream health. Although Mississippi has a vast network of monitoring capabilities, including the use of biological metrics, a portion of the GHP funds will be used to develop a diatom index that will be used to monitor and track changes in nutrient loading as well as target areas that need focused nutrient reduction efforts.

Mississippi's NRS was last updated in 2012. Using GHP Funds, Mississippi will work with partners, organizations, and stakeholders statewide to re-evaluate the existing strategies and identify any areas that may need updates. This process will allow Mississippi, along with our partners, to review applicability of nutrient reduction strategies over time; provide updates from lessons learned over the last 15 years; and communicate outcomes achieved from nutrient reduction actions to partners and the public.

Figure 1-15 below illustrates MDEQ's approach to modeling, implementation, measuring, and monitoring nutrient management actions. It leverages efforts that are currently underway (SPARROW Model, Nutrient Trends Analysis, and Nutrient Reduction Estimates) with those that have been proposed in MDEQ's first GHP grant application (Nutrient Response Estimation Tool, Continuous Nitrate Monitoring, Diatom Index, and NRS Update).

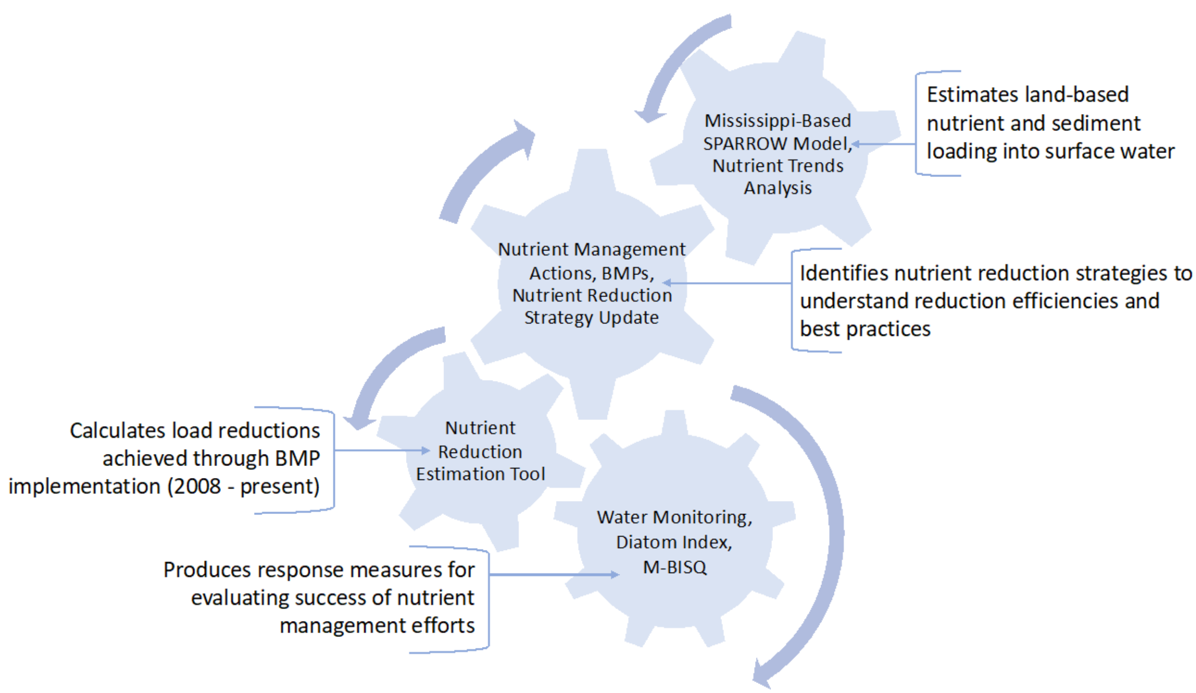


Figure 1-15. Mississippi Department of Environmental Quality's approach to nutrient management.

1.8.9 Missouri

Missouri is continuing to make progress in efforts to reduce nutrient loss and implement the actions identified in the Missouri Nutrient Loss Reduction Strategy. Several of these recent Department of Natural Resources efforts are highlighted below.

In continuing to **Implement Numeric Nutrient Criteria for Lakes** in 2021 and 2022, the department conducted 19 watershed models, 13 lake BATHTUB models, 72 antidegradation reviews, and listed a total of 100 separate lakes as impaired due to nutrients or chlorophyll-a. The Department has also conducted a total of 55 watershed-scale Reasonable Potential Analyses on lakes subject to the rule to support NPDES permit decisions. **4R Nutrient Stewardship:** To date, SWCP has entered into five contracts with two separate cooperators in Randolph County with *the potential* to reduce nutrients from 617 acres.

Implement Statewide Soil Moisture Network: The department successfully installed soil moisture and temperature sensors at 15 sites across Missouri that will help understand and respond to weather conditions affecting nutrient infiltration and runoff.

Thanks to the **Missouri Parks, Soils, and Water Sales Tax** (1/10th of 1 percent), over $101 million in tax revenue went to fund agricultural conservation practices on the ground from 2021 and 2022. Included in that was a combined total of 266,601 acres (over 416 square miles) of cover crops.

Nutrient Trading: In April 2022, Missouri Department of Natural Resources' Water Protection Program publicly unveiled a draft Missouri Nutrient Trading Program to serve as the next natural step from Missouri's 2016 Water Quality Trading Framework to deliver one of Missouri's nutrient strategy goals of implementing water quality trading across the state. The program incorporates the most up to date policy guidance to date supplied by the EPA with regards to water quality trading and refines many of the policy positions initially explored in the 2016 Framework. This Program sets the guidelines for nutrient trading in the state and will be implemented through individual permits. Missouri could see credit banking as early as 2024 and trades as early as 2029.

TP Point Source Target Reduction Rule: In April 2022, Missouri Department of Natural Resources' Water Protection Program announced a formal rulemaking process to establish TP requirements of 1 mg/L or 75 percent reduction for all domestic point sources with design flows equal to or greater than 1 MGD and all industrial facilities categorized as major that typically discharge phosphorus in their industrial wastewater. The scope of these actions captures approximately 92 percent of Missouri's point source flow and results in an estimated 61.6 percent reduction of phosphorus load from point sources in the state. This would translate to an estimated reduction of 5.5 percent of the total aggregate statewide phosphorus load when fully implemented. If this rulemaking process is completed pursuant to its current schedule, this rule would become effective November 2023 with final permitted compliance dates implemented between 2029 and 2034.

1.8.10 Ohio

Ohio continues to make significant investments in research, nutrient reduction, and monitoring to reduce the severe nutrient issues that drive both far-field hypoxia and local HABs through the H2Ohio Program, the Harmful Algal Bloom Research Initiative (HABRI) and investment in watershed-based planning. The provision of additional federal resources to support GHP work by states in FY20 and FY22–27 has been welcomed and has expanded strategic efforts to increase implementation of nutrient reducing practices in Ohio. Concern for Ohio River, Mississippi River, and Gulf water quality directly corresponds with Ohio's regional and local concern as impacts on drinking water sources and recreational contact remain a continuing problem in Ohio.

The HABRI program has provided $12.5 million since 2015 to Ohio universities to conduct research and answer important questions regarding HABs. These dollars are matched by the universities and focus on the following four areas: tracking blooms from their source; producing safe drinking water; protecting public health; and engaging stakeholders. While much of this research has focused on the Lake Erie watershed, it is a statewide program that is benefiting Ohio and elsewhere. See the 2021 Summary of HABRI Research for more information.

Three Ohio agencies are administering the H2Ohio program, each with state funded resources with slightly differing water quality applications. The program is intended to develop long-term, sustainable, science-based and cost-effective strategies to address Ohio water quality problems. The largest funding provided through the Ohio Department of Agriculture (ODA) H2Ohio program is available only to a small set of Ohio River Basin counties that also drain to Lake Erie. The ODA H2Ohio programming is currently focused primarily on the Western Lake Erie Basin, but where it is available, it is focused on a set of nutrient management or reduction practices. The program enrolls acres of farmland for the following implementation incentives: voluntary nutrient management plans, variable-rate phosphorus fertilization, subsurface nutrient placement, manure incorporation, conservation crop rotation, and drainage water management structures. As Ohio's legislature continues to fund the program, the ODA H2Ohio incentives will expand further across the state.

Since 2020, the Ohio Environmental Protection Agency (Ohio EPA) has applied wastewater improvement in its application of H2Ohio programming. Funding has focused on assisting with sanitary sewer extensions to address failing home septic treatment systems, improving wastewater treatment in small villages, and providing home sewage treatment system (HSTS) replacements in disadvantaged communities. Since 2020, over $6.4 million has been applied to these types of problematic wastewater situations in the Ohio River Basin by Ohio EPA.

Lastly, the Ohio Department of Natural Resources has utilized the H2Ohio program to significantly increase wetland development across the Ohio River Basin. This program focuses on slowing, capturing, storing, and treating runoff in riparian and floodplain areas as well as in restored and enhanced wetlands. Since 2020, the Ohio Department of Natural Resources has provided $18 million in the Ohio River Basin. These funds have created new and restored existing wetlands and provided monitoring of these wetland sites. The map below (Figure 1-16) shows wetland projects built or in-progress with the areas South of the yellow watershed divide representing those in the Ohio River Basin.

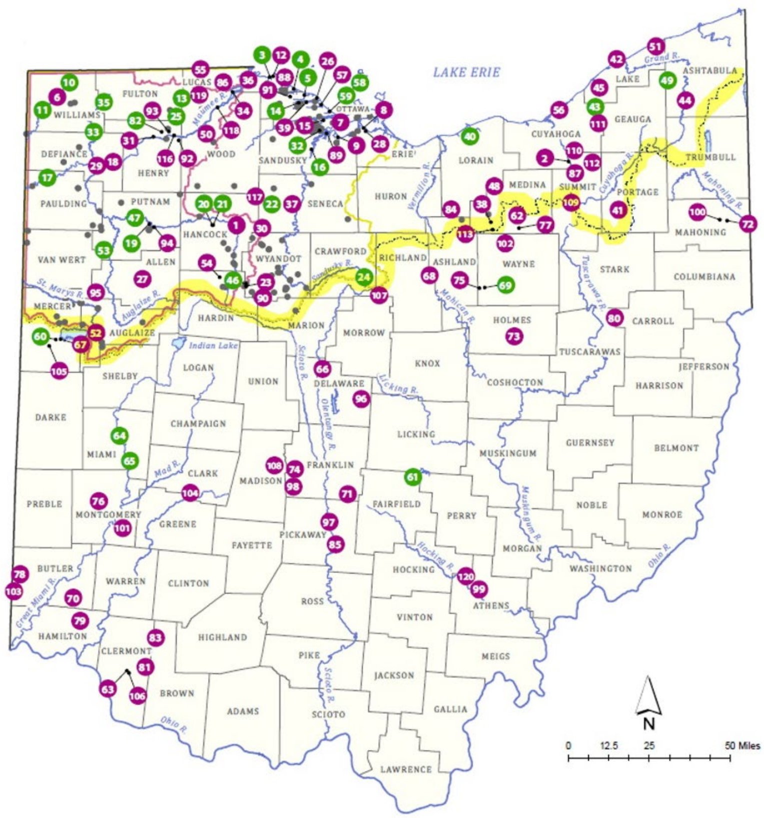


Figure 1-16. Wetland creation, restoration, and project monitoring in Ohio; the yellow line designates the Ohio River Basin/Lake Erie watershed divide; green circles represent completed projects; purple are projects underway.

Monitoring

In 2020, Ohio produced its third biennial report on the mass loading of nutrients delivered to Lake Erie and the Ohio River from Ohio's nonpoint and point sources. The 2020 Nutrient Mass Balance Study for Ohio's Major Rivers provides estimated nutrient loading (TN and TP) based on continuous sampling at pour points at gages in nine watersheds in Ohio, as estimated by the National Center for Water Quality Research using the relative proportion of land uses. Ohio's Mass Balance Study recognizes several factors that influence watershed loading such as watershed size, annual water yield, NPS yield, land use, per capita yield, and population density.

Recently, three watersheds were added to the list of monitored watersheds (Little Miami River, East Fork Little Miami River, and the Hocking River) which will bring Ohio's Mass Balance Study coverage from 66 percent to 72.6 percent of the area of the state. As evident in most watersheds, and in the three major Ohio River watersheds (Great Miami River, Scioto River, and Muskingum River) with over five years of monitoring history, nonpoint sources contribute the highest loads of nitrogen and phosphorus. And the NPS loads increase relative to permitted sources (WWTPs) and HSTS as annual rainfalls increase. From these and similar Mississippi River and Gulf data, it is evident that annual weather patterns and precipitation are main drivers in nutrient and algal bloom peaks and valleys, and that nutrient reduction in nonpoint sources may take substantial time to detect. The following shows the relative amounts of nitrogen and phosphorus from different sources for each watershed.

Nutrient Mass Balance—The Great Miami River Watershed

Agricultural land use dominates this watershed at 68 percent. NPS is the largest proportion of the TP and TN load as is reflected in the relative proportions shown below (Figure 1-17).

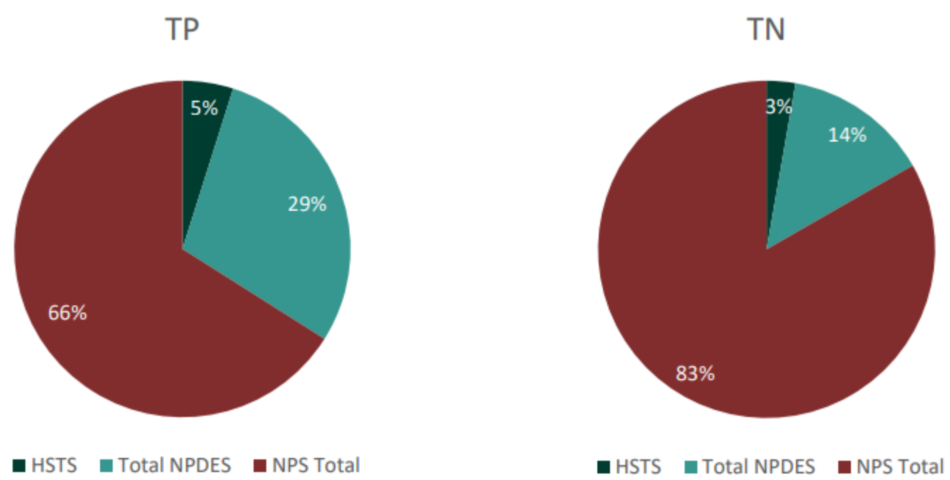


Figure 1-17. Proportion of TP and TN load from different sources for the Great Miami watershed, average of five years (wy15-wy19). (Source: State of Ohio Nutrient Mass Balance Report, page 66.)

Nutrient Mass Balance—The Scioto River Watershed

The Scioto River is the second largest watershed in Ohio that drains to the Ohio River. Agricultural land use dominates the Scioto watershed at 58 percent. The relative proportion of TP and TN are shown below Figure 1-18.

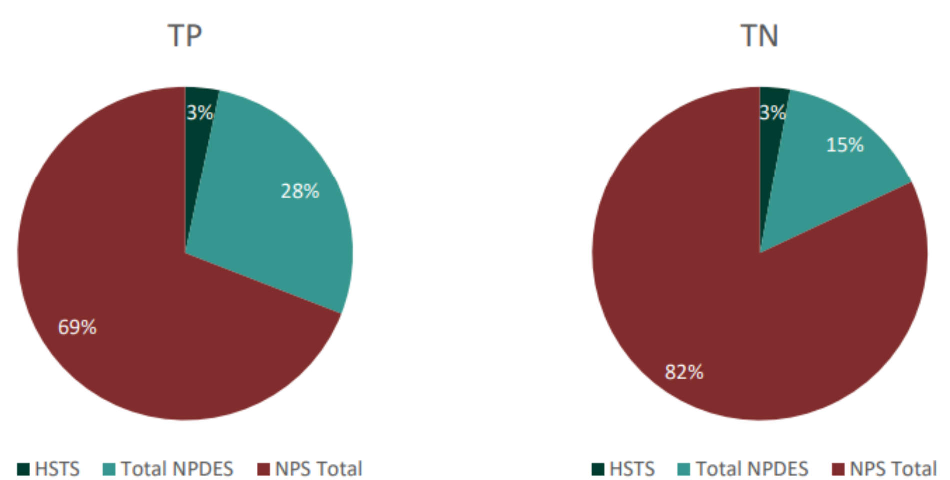


Figure 1-18. Proportion of TP and TN load from different sources for the Scioto watershed, average of five years (wy15-wy19). (Source: State of Ohio Nutrient Mass Balance Report, page 72.)

Nutrient Mass Balance—Muskingum River Watershed

Natural and agricultural land use dominates the Muskingum River watershed at 48 percent and 40 percent respectively. The relative proportion of TP and TN are shown below (Figure 1-19).

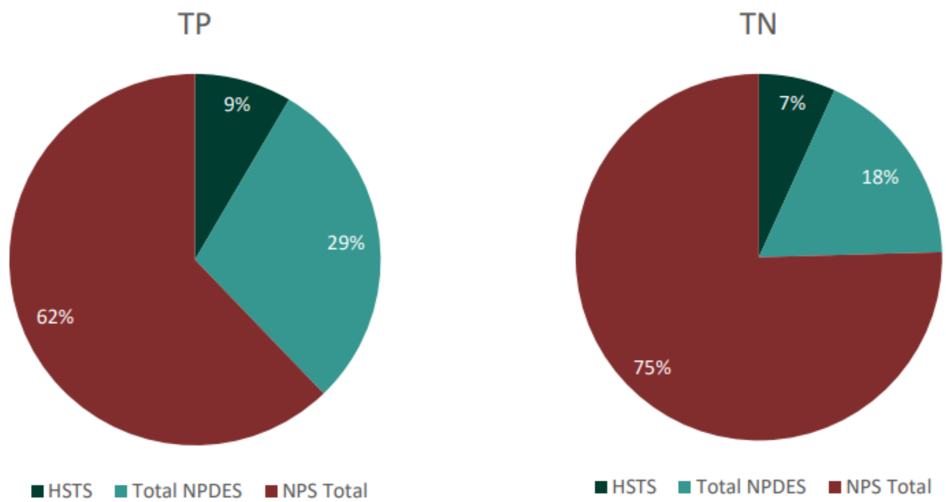


Figure 1-19. Proportion of TP and TN load from different sources for the Muskingum watershed, average of five years (wy15-wy19). (Source: State of Ohio Nutrient Mass Balance Report, page 77.)

Monitoring of Public Drinking Water Systems

Ohio requires that public drinking water systems monitor for toxins related to HABs with results posted for public drinking water systems. Additionally, the Public Water System Harmful Algal Bloom Response Strategy was recently updated in 2022 and a separate Harmful Algal Bloom Response Strategy for Recreational Waters was created in 2020. Impairments due to HABs remain a significant problem.

Legislation and Other Efforts

A law signed in January 2021 established seven new watershed coordinators statewide, employed by ODA. The coordinators will aggregate water quality data and impairments for each large watershed area, provide a baseline assessment of BMP use and their fit for the region, and provide potential funding options for BMPs. While NPS implementation strategies (NPS-IS) provide watershed-based planning at the small HUC12 watershed scale, this program will be working at much larger scale, having seven areas across the state, and supporting greater implementation through SWCDs.

NPS Efforts Including Watershed Planning and Implementation Projects

Ohio utilizes the development of approved NPS-IS as a way to engage stakeholders in a locally led process of tying water resource impairments to ready-to-apply actions and projects that will assist in reducing nutrients and other sources of impairment. Ohio EPA's Division of Surface Water and ODA's Division of Soil and Water Conservation (DSWC) provide financial and technical assistance for the development of NPS-IS. Approved strategies are data driven characterization of causes and sources of issues within the watershed, development of measurable goals, and objectives that conclude with attainable projects. Since 2020, Ohio NPS-IS have also contained far-field pollution reduction goals. Additionally, the project summaries that NPS-IS contain are typically eligible for CWA section 319(h) funding should a public entity or nonprofit apply.

In response to the 2020 EPA $200,000 HTF EPA assistance grant, Ohio EPA used these funds to provide subgrants to 13 local entities to facilitate development of 26 new NPS-IS in the Ohio River Basin with priority placed on areas with significant cropland acreages. As a result, in submitted 2022 CWA section 319(h) applications for funding of NPS projects, 4 of 11 applications were projects that came from recently developed NPS-IS. Additionally, as siting tools such as ACPF are utilized that help stakeholders consider feasible projects on their property, more ready-to-implement projects can be incorporated that can help meet the hypoxia reduction goal.

Scioto CREP

The Scioto CREP began in 2005 as a partnership between USDA and ODA-DSWC to provide increased incentives for priority agricultural CRP projects. This program had previously provided 15-year conservation reserve contracts on almost 70,000 acres of farmland prior to renewal. The program has recently been renewed with new incentives for enrolling or re-enrolling cropland into the program. While most previous gains were made with riparian setbacks, this renewal offers incentives on many older successful practices such as wetlands, plus an additional practice with cost-share that will allow treatment of subsurface drainage through saturated buffers. In the right circumstances, this increases the treatment area from tens of feet of surface drainage to hundreds of feet of subsurface that normally bypass a grassed filter strip. Ohio has committed to incentive payments to increase CRP enrollment.

Muskingum Watershed Program

Since 2012, the Muskingum Watershed Conservancy District and ODA-DSWC have administered $2,700,000 in project dollars to private landowners and local SWCDs within the watershed boundary. The program provides cost-share dollars to agricultural producers in the watershed to reduce runoff, sedimentation, and loss of nutrients from crop and pasture fields. BMPs supported under this program include cover crops, livestock exclusion fencing, education and outreach opportunities, critical area seedings, field buffers, and nutrient management planning. In 2021, 33,539 acres of cover crops were planted on 305 individual properties.

319 NPS Implementation Grants

Table 1-9 shows 319 NPS implementation grants which have been finished in the Ohio River Basin since the last HTF Report along with estimated load reductions.

Table 1-9. CWA Section 319 NPS Implementation Grants in the Ohio River Basin since 2020.

Project Sponsor	Project Title	Watershed	Project Total	N lbs/yr	P lbs/yr	Sed tons/yr
Preservation Parks of Delaware 18(h)-EPA-30	Stream Restoration	050600011601	$451,220	230	115	100
Clermont SWCD 18(h)-EPA-26	Shor Park Restoration	0509025021305	$218,776	2820	755	328
Fairlawn 19(h)-EPA-24	Smith Ditch Restoration	050400010102	$325,532	34.4	12.7	15.7
Holmes Co. Eng 20(h)EPA-17	Rush Run Restoration	050400030607	$289,830	137.0	52.0	84.0
Belmont SWCD 20(h)EPA-20	Crabapple Ck Crossing	050301060904	$40,000	-	-	0.6
Grand Lake St. Marys LFA 20(h)EPA-05	Gilliland NP Wetland Natural Area Dev.	051201010204	$75,944	60.0	19.0	13.5
City of Sharonville 20(h)EPA-26	Twin Creek Wetland Enhancement	050902030101	$56,821	25	33	36
ABC W&SW Dist 20(h)EPA-22	Cranberry Run Stream Restoration	050301030803	$300,000	227.0	57.0	11.7
Mill Ck Alliance 20(h)EPA-31	Low head dam mitigation	050902030103	$229,459	52	22	18
Mill Creek Alliance 21(h)EPA-05	Sharon Cr Restoration	050902030103	$298,238	87	869	1739
Clermont SWCD 21(h)EPA-11	Williamsburg Wetland	050902021102	$199,690	3628	974	100
Perry SWCD 21(h)EPA-13	Grosse Treatment Wetland	050400060403	$57,052	6939	108	0
Franklin SWCD 21(h)EPA-22	Fieldstone Stream / Wetland Restoration	050600011503	$252,980	1631	374	156
City of Delaware 22(h)EPA-07	Stream Restoration	50600011007	$230,036	402	142	190
Mill Ck Alliance 22(h)EPA-09	Low Head Dam	50902030103	$298,740	130	62	54
GLSM Facilities 22(h)EPA-11	Little Chickasaw Stream Restoration	05120101 02 04	$300,000	1040	283	132
Warren SWCD 22(h)EPA-26	Cascading Waterway	050902020406	$51,865	130	62	54
Boardman Twp 22(h)EPA-27	Stream Daylighting	50301030803	$165,000	142	55	89

Ohio's Workplan for FY22–23 GHP Funding

Ohio submitted a 2-year workplan to increase GHP support activities using funding provided by the IIJA. An additional workplan will be submitted for the balance of the five years. Under this workplan, Ohio plans to increase support for nutrient reduction in Ohio's contributing area to the Mississippi River and Gulf through the following objectives:

1. **Update Ohio's Nutrient Reduction Strategy**
   Ohio's Nutrient Reduction Strategy (ONRS) has not been updated since 2016 and will be updated with strategies, measures, and progress that can be tracked using the research and experience gained since the previous 2016 update. This update will be supported by a staff member as described in objective four below.
2. **Increase Nutrient Management Technical Assistance**
   ODA will be adding a fulltime Nutrient Management Specialist that will provide training and support to county SWCD personnel, farm and crop advisors, and farm producers. Their focus area will be on development of Voluntary Nutrient Management Plans that have been a required prerequisite to some H2Ohio programs as H2Ohio spreads to Ohio River Basin watersheds.
3. **Increase Conservation Practice Design Technical Assistance**
   The Department of Agriculture will add a fulltime Conservation Engineer to provide Professional Engineering Assistance to support approval and design of structural nutrient reduction practices such as two-stage ditches, wetlands, drainage water management, saturated buffers. This initiative will increase access to plan approval and design services and will precede expansion of Ohio's H2Ohio program to fund practices in areas beyond the Western Lake Erie Basin. The position will also focus on priority agricultural areas contributing higher amounts of nutrients.
4. **Increase Ohio EPA Staff Support for Nutrient Reduction Activities and Evaluation to Support HTF Goals**
   Ohio EPA is in the process of adding a fulltime environmental specialist to support nutrient reduction activities in the Ohio River Basin that advance goals of the HTF. This staff will assist the ONRS update and develop evaluation measures in coordination with Objective 1. They will also evaluate potential nonpoint and point source measures for addition to the ONRS and evaluate ONRS progress, as well as evaluate the need for extra outreach, information, or accommodation to increase access or involvement of disadvantaged communities and support development of NPS-IS that include Gulf Hypoxia far-field targets.
5. **Support Development of Additional HUC12 NPS-IS**
   This objective subgrant development of small watershed NPS-IS using the tools that conceptualize potential nutrient reducing practices and/or reduce peak nutrient in spring flows through drainage water management, sediment reduction, water retention or reuse. It will support 12 to 17 new NPS-IS with stakeholder processes to develop implementation projects that will be eligible for funding through the nonpoint source program or other resources. Efforts will be made to include outreach to disadvantaged communities.

6. **Develop a Program That Reduces Nutrients from Home Septic Treatment Systems or Septage from Disadvantaged Communities in Southeast or Southern Ohio**
   Discharges from failing septic systems are significant source of nutrients, especially where poor installation, undersized leach fields, limited soil areas, poor maintenance, and limited income to perform maintenance reduce treatment capability. This objective evaluates homeowner maintenance of systems and their access to affordable septic cleanout. Land application is allowed, and Ohio Administrative Code application to the agronomic need of the vegetation over-application has been a problem. This may be due to the great distance that haulers must go for a WWTP that will receive septage. After evaluation, this project will evaluate whether more local access can be provided to increase affordability and reduce land application and over application. Other methods of treatment for septage may be considered such as waste to isolated nutrients to produce fertilizer products. Additionally, use of Clean Water State Revolving Fund money may be sought based upon need for HSTS repair or better maintenance solutions. These activities are being focused in disadvantaged areas near Athens, Ohio.
7. **Measure the Effectiveness of New Innovative Practices**
   This project evaluates effectiveness of cascading waterways and other innovative nutrient reducing practices. Some experimental practices have been built (e.g., cascading waterways), but without monitoring to show effectiveness. This project implements monitoring of this practice to establish whether it is a suitable candidate for an interim and eventually established NRCS standard practice.
8. **Support the Continued Maintenance of USGS Gage Water Quality Monitoring at Three Monitoring Points in the Ohio River Basin**
   Ohio recently established water quality monitoring at three USGS gages[9] on the Hocking River, the East Fork of the Little Miami, and the Little Miami at Milford. This objective supports maintenance of these gages to continue to collect water quality data (specifically nutrient load, concentrations, and flow) indefinitely. Results are used in Ohio's Mass Balance Report. This is the main means of measuring and communicating nutrient loads on the larger watersheds in Ohio and is critical to monitoring and communicating progress towards Gulf HTF goals.

1.8.11 Tennessee

Overall Strategy in Action

Multidisciplinary Nutrient Strategy Task Force

In 2019, the Tennessee Department of Environment and Conservation (TDEC) and Tennessee Department of Agriculture (TDA) convened the Tennessee Nutrient Strategy Taskforce, drawing representation from academia, state and local government, WWTP operators, stormwater professionals, agriculture, the private sector, and nongovernmental organizations. The taskforce was, in part, a response to the 2011 EPA "Stoner Memo," which emphasizes collaboration between state

[9] For the Little Miami River Milford and East Fork Little Miami River Perintown sites, the stage and discharge portion is supported by the Army Corps of Engineers and USGS's Federal Priority Streamgages (FPS). For the Hocking River at Athens, the stage and discharge portion is supported though the Army Corps of Engineers and FPS. The nutrient work at all three sites is supported by the USGS Cooperative Matching Funds, National Water Quality Program, and Ohio Department of Natural Resources.

agencies, conservation districts, industry, private landowners, agriculture, utility districts, and other stakeholders for developing a comprehensive state framework for nutrient reductions and builds upon TDEC's and TDA's Nutrient Reduction Framework as part of comprehensive efforts to accomplish long-term nutrient reduction in Tennessee.

In 2020, progress was slowed due to the pandemic. TDEC convened the Nutrient Strategy Taskforce a total of four times that year. These meetings served as check-ins with stakeholders and provided opportunity to share tools and resources available to support nutrient-related strategies, engage in training opportunities, learn from peer environmental agencies and taskforces in other states, and exchange information related to nutrient activities supported by participating stakeholder agencies. The partners created content for a series of webpages (Nutrient Strategy Taskforce) intended to house information about nutrient management in Tennessee. In 2021, The Tennessee Nutrient Strategy Taskforce working groups worked on their respective goals and produced the Inaugural report.

Point Sources

Point Sources Permitting and Wastewater Treatment Optimization

Tennessee continues to address the discharge of nutrients from municipal and domestic sources through upholding of the antidegradation provision in Tennessee's state water quality standards and through education. The antidegradation activity presents differently for new, expanding, and existing sources. For proposed new sources and expanding discharges, Tennessee requires applicants to evaluate treatment technologies with biological nutrient removal capability. For existing discharges, Tennessee is imposing "hold the line" limits on discharges into waterbodies which Tennessee assesses as having unavailable conditions for nutrients. Also, in support of antidegradation, Tennessee applies these nutrient limits as annual rolling loads to encourage biological removal, versus chemical addition, and to encourage reuse alternatives. Tennessee imposes monitoring and reporting of effluent TN and TP at a quarterly frequency minimum in NPDES permits for POTWs regardless of size. This provides Tennessee with data for watershed modeling, elevates the visibility of nutrients to the dischargers, and provides the basis for capped limits when a facility needs to expand or when Tennessee assesses an impairment. For all POTWs and additionally the small domestic dischargers such as schools and businesses, Tennessee is including narrative in the permit fact sheets on Tennessee's state-wide nutrient reduction program and encouraging voluntary participation in an optimization program for biological nutrient removal.

TDEC – Division of Water Resources has been championing plant optimization as an effective approach with environmental and economic benefits since 2011. Case studies from Tennessee cities and utilities are posted on the Tennessee Plan Optimization Program website. The Tennessee Plan Optimization Program partners include Tennessee Association of Utility Districts, Municipal Technical Advisory Services, and Tennessee Industrial Assessment Center. With TDEC, the partners support the participating facilities and their operators through site visits, training, development of optimization strategy, and technical assistance during the optimization process, all free of charge.

Nonpoint Sources

Grant Programs Provide Source of Funds for Conservation Practices

319 Grant Program

TDA continues to partner with qualifying entities to fund projects under the CWA section 319 program to lessen impacts to Tennessee waters from nonpoint sources, including excess nutrients. Tennessee normally receives around $2.7 million each year through this fund. With this money, TDA funds primarily watershed restoration projects that aim to install BMPs, but also education/outreach projects that aim to educate and inform various audiences about NPS pollution. As required by EPA, staff are modeling load reductions on CWA section 319-funded watershed restoration projects and have chosen to use EPA's STEPL model.

Success stories are documented on EPA's Tennessee Nonpoint Source Success Stories web page. Tennessee ranks second in the nation in the number of *Success Stories* as defined by EPA with **43** total *Success Stories* (reflecting a total of 61 total water quality improvements). The most recent *Success Story* was written for McCutcheon Creek and just received approval by EPA in October of 2022. Plans are set to submit at least two new *Success Stories* each year.

The Agricultural Resources Conservation Fund

State funds are provided through the Agricultural Resources Conservation Fund Incentive Program to provide financial support for Tennessee farmers to install conservation practices that lessen soil erosion, reduce livestock impacts to state waters, and improve land management on Tennessee farms. This fund is generated by a state real estate transfer tax. In recent years of a strong real estate market in Tennessee, the fund has grown from providing $3,000,000 per year a few years ago to producing almost $15,000,000 in 2021. There has been a significant increase in the requests for funding for the planting of cover crops, due to the promotional work by USDA NRCS across Tennessee. The Land and Water Stewardship section is also estimating load reductions using the STEPL model on all these practices.

Almost all of this money goes on-the-ground on farmland through all 95 SWCDs across the state. A small portion of the money is provided to universities in the state to do applied research that aims to answer specific questions that would better inform our grant programs and other agencies interested in increasing the quantity and quality of conservation activities in Tennessee.

Partnerships with NGOs and Land Grant Universities

The Nature Conservancy

TDA is negotiating with The Nature Conservancy and the Soil Health Partnership to fund several full partner and associate partner sites for in-depth soil health applied research and analysis. University of Tennessee Agricultural Research is collaborating with the Soil Health Partnership on this effort, and also on a companion research project through the University.

Tennessee Valley Authority

The Tennessee Valley Authority (TVA) has partnered with TDA to establish the Tennessee Riparian Incentive Program (TRIP) in the state of Tennessee to improve water quality, protect aquatic biodiversity and sequester carbon. The program will initially prioritize the Elk, Duck, and Clinch/Powell Rivers watersheds. These rivers are home to numerous species of fish, freshwater mussels, and other living organisms that occur nowhere else in the world. Partners in addition to TVA and TDA include USDA FSA and NRCS. TVA provided $500K for the 10-year project. Project participation will require landowners to enroll land in CRP and install riparian forest buffers. As an additional incentive for CRP participants, the TRIP will provide an additional bonus payment of $3,000 per acre to landowners for completed CRP riparian forest buffer projects in the priority watersheds.

USDA NRCS / The Nature Conservancy: Tennessee Technological University

USDA NRCS and The Nature Conservancy have funded Tennessee Technological University to conduct a 5-year study (2019–2023) assessing nutrient retention dynamics in 35 NRCS WRP easements along major rivers in western Tennessee and Kentucky. The goals of this study are to assess the effectiveness of the WRP in enhancing wetland nutrient retention and identify wetland attributes that promote nitrogen and phosphorus removal, with a focus on vegetation and hydrology restoration practices. Data from this research will be used to prioritize land purchased for enrollment in the USDA ACEP, and better design wetland restorations to maximize nutrient retention capacity. Additional information about this project can be found at https://sites.tntech.edu/jnmurdock/wetland-nutrient-retention/.

USDA NRCS

USDA NRCS provides financial assistance to landowners to implement agricultural conservation practices that improve and protect natural resources. Watershed plans are developed in the first year and financial funding for the implementation of practices identified to improve water quality are funded for the next four years. A vulnerability index was formulated by Tennessee NRCS GIS specialists to identify areas that are most likely to contribute to water pollution. Specifically, the NWQI and MRBI watershed selection includes coordination with multiple state agencies and nutrient impacts are one of the prioritization considerations.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service gives money to TDA through their *Partners for Fish and Wildlife* program for the implementation of conservation practices in specific watersheds that are of particular interest to their management of certain aquatic species. The funding is passed through TDA straight to local SWCDs to coordinate and oversee the installation of conservation practices on private lands.

1.8.12 Wisconsin

In addition to Wisconsin's ongoing efforts described in the 2019/2021 Report to Congress, implementation actions continue to reduce phosphorus loads through existing state regulations, discharge permits, watershed plans, and producer-led watershed groups. *Wisconsin's Nutrient Reduction Strategy* (2013) and 2017–2019 Implementation Progress Report can be viewed on Wisconsin's nutrient reduction website.

Point Source Phosphorus Reduction Options

Since December 2010, the Wisconsin Department of Natural Resources (WDNR) has been including water quality based effluent limits (WQBELs) in Wisconsin Pollutant Discharge Elimination System (WPDES) permits to comply with Wisconsin's water quality standards for phosphorus. Wisconsin's Phosphorus Implementation Guidance provides a detailed discussion of the phosphorus standards and implementation procedures for those standards in WPDES permits.

Many point sources are developing and/or implementing trading or adaptive management projects to seek phosphorus compliance in lieu of installing treatment technologies (see Figure 1-20). Information about these and other projects is available. As of late 2022, approximately 50 WPDES permitted facilities have achieved compliance with stringent phosphorus WQBELs through water quality trading. Approximately 20 permittees are engaged in adaptive management. It is anticipated that adaptive management and trading projects will continue to be developed over the next 5–10 years as point sources make compliance decisions.

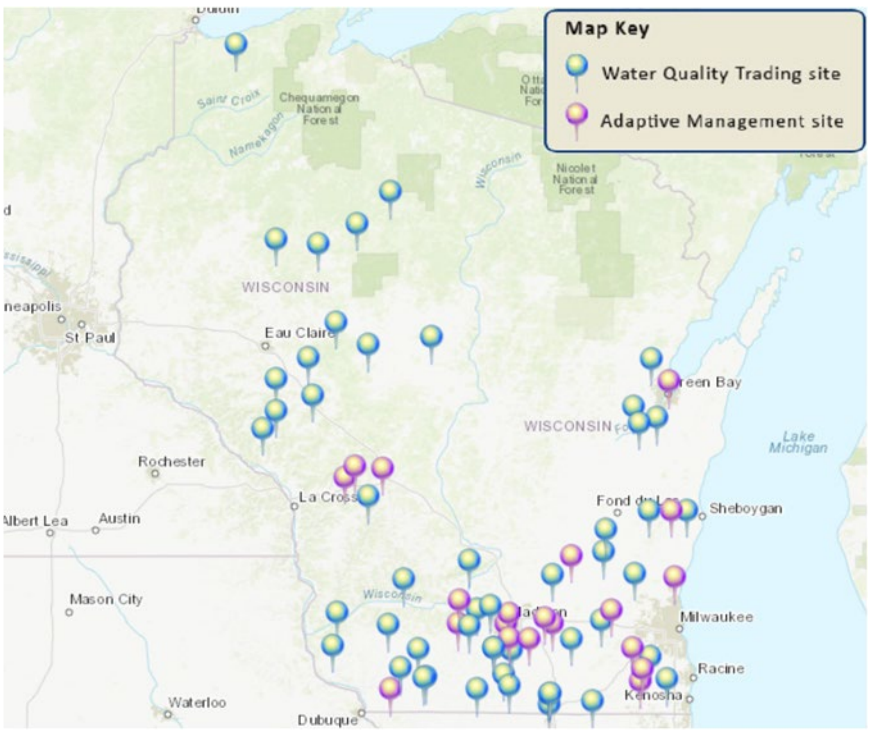


Figure 1-20. Adaptive management/water quality trading participants as of October 2022.

In 2019, WDNR convened a water quality trading advisory committee as a means to engage stakeholders in advance of a water quality trading policy update. As an outcome of the advisory committee meetings, several flexibilities were incorporated into a 2020 water quality trading guidance update to help encourage trading, particularly in TMDL areas that have stringent baseline requirements. Those updates include:

- Alignment of interim credit duration with TMDL implementation timeframes, which extended interim credit durations from 5–10 years from date of practice establishment.

- Introduction of an "interim floor" concept, which is a more readily achievable minimum level of pollution control required to generate interim credits in a TMDL area. Interim floor values are reach-specific and reflect achievable levels of pollution control using typical agricultural BMPs (reduced tillage and cover crops) that represent a base level conservation effort.
- Acknowledging that pollutant sources that are not included in the assumptions of a TMDL may qualify for a site-specific baseline when calculating the credit threshold.
- Authorizing the use of rotational averaging when calculating credits generated from agricultural fields.
- Better defining the applicable hydrologic area over which credits can be traded as the largest geographic area possible while still achieving water quality standards.

In some cases, point sources might seek an individual phosphorus variance based on substantial and widespread social and economic impacts. Facilities with an approved variance may not be immediately required to undertake large capital expenses as part of a facility upgrade, but also commit to making strides towards reducing effluent phosphorus and achieving eventual compliance with the final limit.

In anticipation of the expected increase in phosphorus variances associated with the 2010 rule change and the opportunities for watershed-based offsets, a multi-discharger variance (MDV) for phosphorus was established in 2017 to help streamline and improve the variance process. The MDV allows a discharger 5–20 years to comply with restrictive phosphorus limits, while making meaningful contributions to local water quality. During the variance term, point sources are required to optimize their treatment processes for phosphorus, make stepwise reductions in effluent phosphorus concentrations, and implement a watershed project through an MDV watershed plan.

Point sources can select one of three types of watershed projects eligible for the MDV: payments to county land and water conservation departments, an implementation agreement with WDNR for phosphorus reduction projects, or implementation with a third party for phosphorus reduction projects.

As of late 2022, 150 point sources had been approved for coverage under the MDV. The vast majority of all MDV watershed plans use the county payment option. Because of this, funding levels now exceed $1,000,000 for county land and water conservation departments statewide (Table 1-10).

Table 1-10. Phosphorus MDV coverage and associated funding levels.

Calendar Year	Number of Facilities Covered	Total County Funding	Counties Participating
2017	2	$2,606.02	1
2018	34	$619,363.60	25
2019	73	$938,116.95	34
2020	98	$937,241.50	35
2021	119	$1,144,247.72	26

In 2022, the WDNR completed a review of the first 5-year implementation period of the MDV, as required under s. 283.16(3m), Wisconsin Statutes. The purpose of the review was to evaluate pollution reductions achieved by the MDV and determine whether they are consistent with highest attainable condition requirements found in federal code at 40 CFR 131.14. The evaluation includes a summary of all facilities covered under the MDV, interim effluent limitations assigned to those facilities, and NPS phosphorus reductions funded by the MDV. Point source reductions under the MDV were estimated at 127,000 lbs/year while NPS reductions totaled 18,965 lbs/year. More information about the multi-discharger phosphorus variance is available.

Nine Key Element Watershed Plans

Wisconsin continues to support watershed-based plans consistent with EPA's nine key elements as a strategy to focus local, state, and federal resources on reducing agricultural nutrient loading and increasing farm profitability. As of 2022 there are 45 active nine key element watershed plans across the state, which include more than 6.5 million acres (Figure 1-21). The vast majority of the plans have a 10-year schedule and lifespan. A preliminary assessment conducted by WDNR in 2021 and 2022 estimated the amount of plan implementation ranged from recently started to approximately 25 percent complete. The extent of plan implementation depends on multiple factors, such as time since plan implementation activities began, access to staffing and funding resources at the county level, and education, outreach and landowner and producer interest.

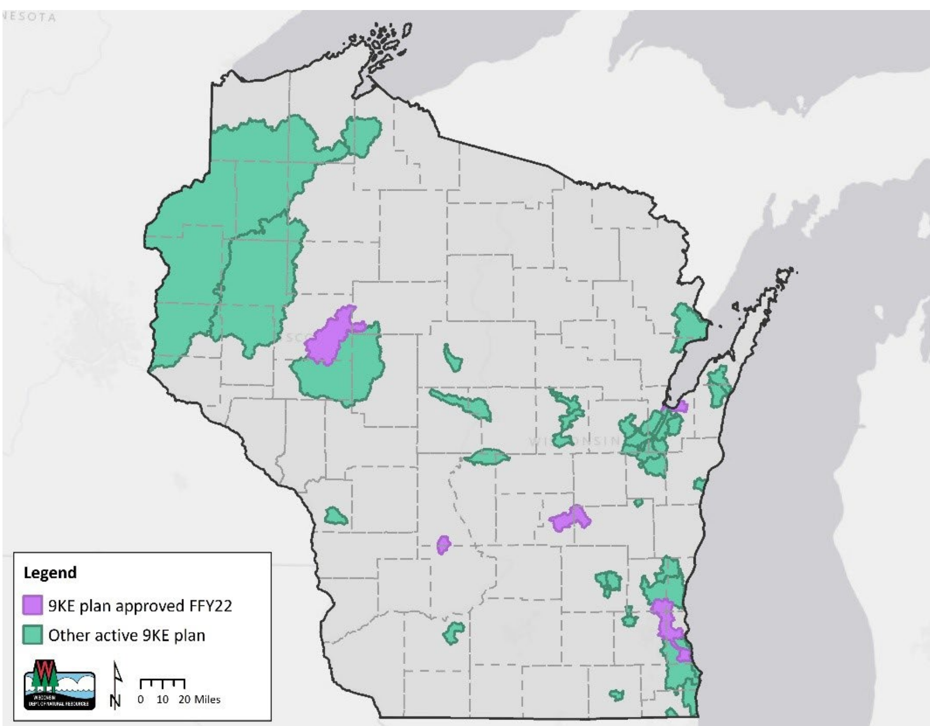


Figure 1-21. Wisconsin nine key element watershed plan coverage as of October 2022.

Producer-Led Watershed Protection

Wisconsin's Producer-Led Watershed Protection Grant program continues to grow as does the popularity of this important approach to nutrient loss reduction at the watershed scale. In 2020 and 2021, $750,000 in grants were awarded by the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) each state fiscal year to projects that focus on ways to improve soil and water quality impacts on farming operations and that work to increase farm participation in these voluntary efforts (see DATCP Producer Led Project Summaries and Figure 1-22). The program funds groups of farmers that work to lead and advance conservation solutions by increasing on-the-ground practices and farmer participation in these efforts. Grant funds can be used for incentive payments to try conservation practices, education and outreach efforts, in-field demonstrations, and administrative costs to coordinate the group. DATCP's Producer-Led Conservation Progress summary shows that in 2021 these producer-led groups implemented conservation practices that reduced estimated phosphorus losses by over 120,000 pounds and soil erosion by over 180,000 tons.

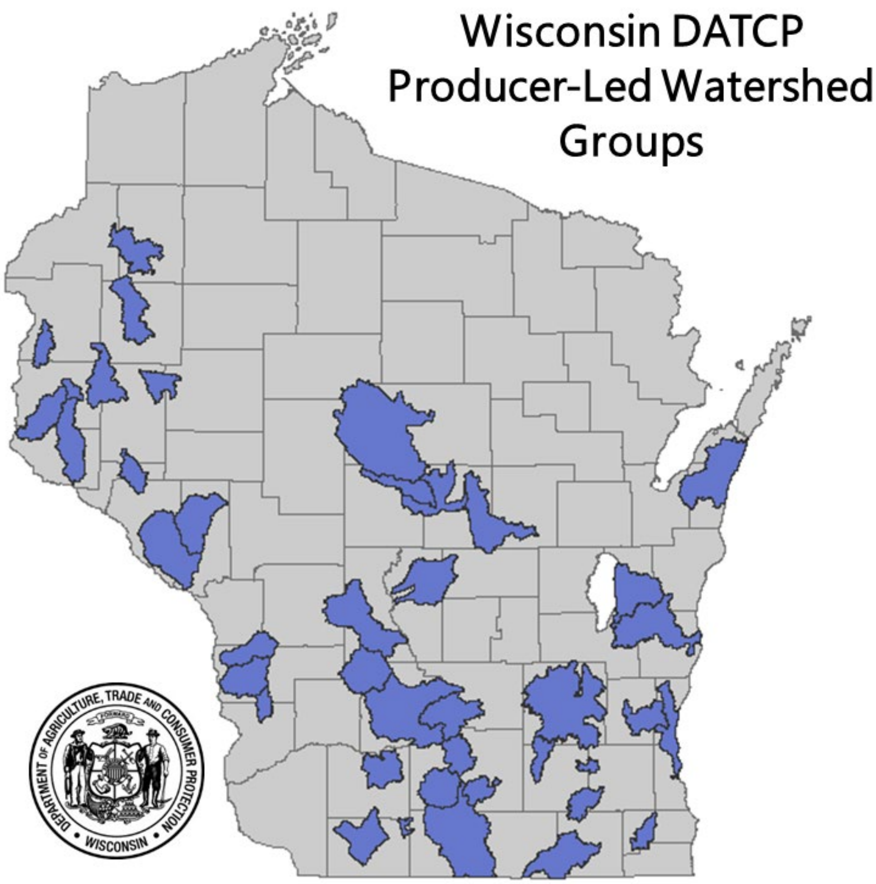


Figure 1-22. Wisconsin producer-led watershed group locations as of 2022.

GHP Workplan

During 2022 WDNR and DATCP collaborated to develop a workplan for the new GHP. The first two years of funding will be used to implement *Wisconsin's Nutrient Reduction Strategy*. Wisconsin proposes to use GHP funds to support implementation, coordination, and reporting of the state NRS. Tasks in the workplan include NRS support, watershed project implementation, and visualizing nutrient reduction achievements (Figure 1-23). Wisconsin intends to fund innovative practices and pilot projects to reduce agricultural NPS nutrient losses, expand support for key initiatives related to agriculture and water quality, and improve state capability to track, report, and demonstrate progress. Major environmental results anticipated from this project include reductions in nitrogen and phosphorus loads to Wisconsin waters and the Mississippi River, particularly from agricultural nonpoint sources. Disadvantaged communities will be given priority consideration.

Figure 1-23. Summary of Wisconsin Nutrient Reduction Strategy Implementation project to be funded by the new GHP.

Part 2. The Response of the Hypoxic Zone and Water Quality Throughout the MARB

2.1 The Response of the Hypoxic Zone to Excess Nutrients from the MARB

Since the 2019/2021 Report to Congress, a better understanding has emerged about the extent and nature of the hypoxic zone, its impact on marine resources, and the specific tools for assessing progress in reducing the hypoxic zone size. In support of hypoxic zone management, NOAA has invested more than $50 million in enhanced research, forecasting, and monitoring capabilities since 1990. Activities involving many NOAA programs include the Nutrient Enhanced Coastal Ocean Productivity Program (1990–1999), the HABHRCA-mandated Northern Gulf Ecosystems and Hypoxia Assessment Program (2000–2022), the Coastal Hypoxia Research Program (2005–present), the Gulf of Mexico Hypoxia Watch collaborative project (2001–present), the Coastal and Ocean Modeling Testbed Program (2010–2017), and the Ocean Technology Transition Program (2020–present). Practical, site-level project examples from NOAA include an experimental model to better understand where shrimp can be found relative to the hypoxic zone and improved understanding of fish exposure to low dissolved oxygen concentrations (LaBone et al. 2021), an improved understanding of production and application of manure fertilizers in the MARB under extreme weather conditions (Bian et al. 2021), and development of a model to simulate daily hypoxia conditions in the Gulf (Katin et al. 2022).

These and other investments by federal and state agencies enable the HTF and its partners to make informed, proactive, and science-based decisions for mitigating the impact of hypoxia on the Gulf ecosystem and for assessing progress toward reaching the Action Plan goals.

2.1.1 Current Status of the Hypoxic Zone

For the past several years, the Northern Gulf Institute has hosted a media teleconference with speakers from NOAA, the HTF, and partners to discuss the results of the annual hypoxic zone assessment cruise and factors affecting the measured zone size and ongoing federal and state efforts in the MARB to reduce nutrient loads to the Gulf. Since the 2019/2021 Report to Congress, there have been two annual measurements of the hypoxic zone. In 2021, the midsummer areal extent was calculated to be 16,400 square kilometers. River discharge measured above normal for the three weeks prior to the research cruise in 2021, resulting in a larger than forecasted size (NOAA 2021). The 2022 midsummer areal extent was 8,480 square kilometers, resulting in the eighth smallest hypoxic zone measured, a major factor being the below average Mississippi River discharge over the summer (NOAA 2022a). See Figure 2-1.

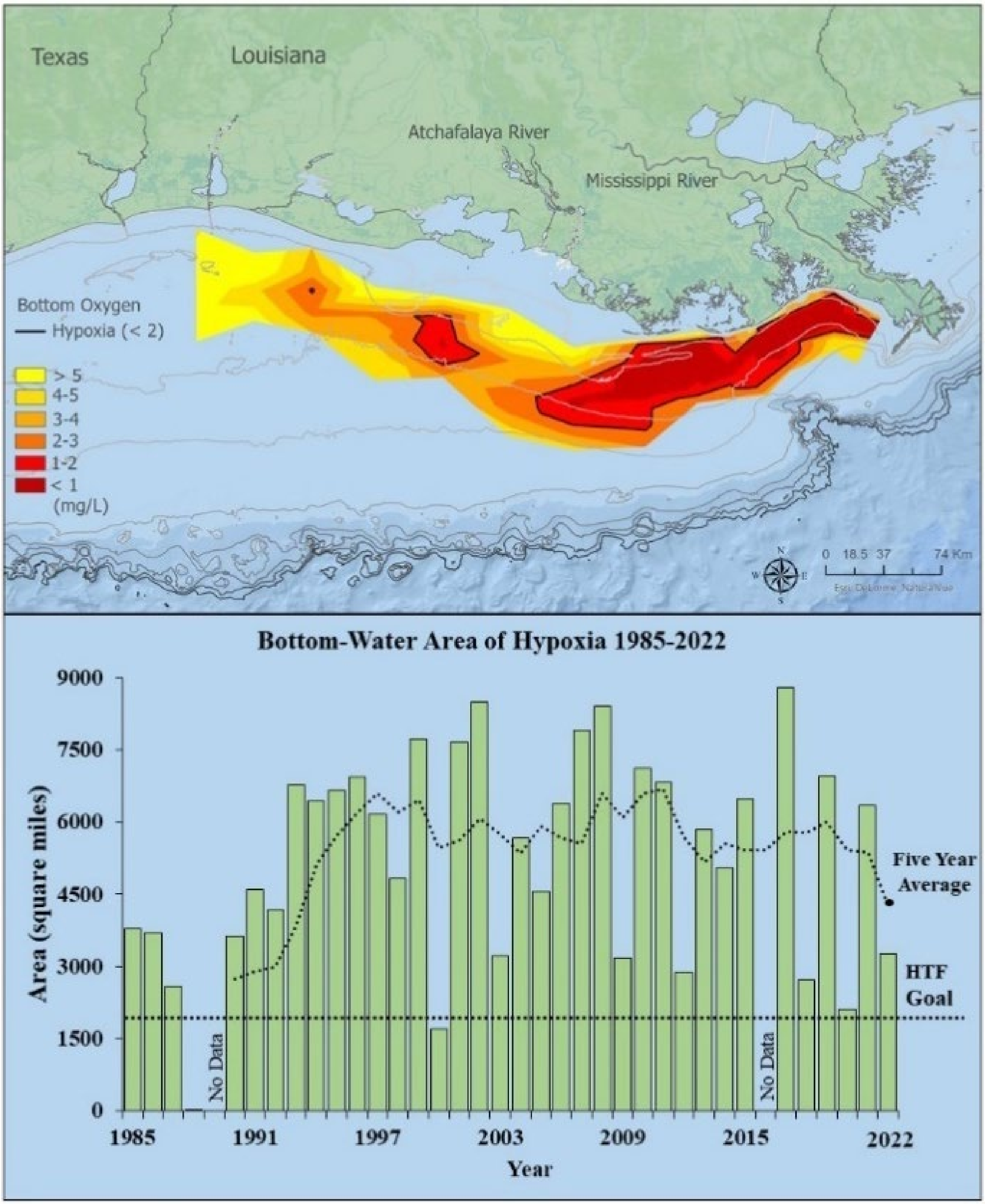


Figure 2-1. (Top) Map of measured Gulf hypoxia zone, July 25–31, 2022. Red area denotes 2 mg/L of oxygen or lower, the level below which is considered hypoxic, at the bottom of the seafloor. (Bottom) Long-term measured size of the hypoxic zone (green bars) measured during the ship surveys since 1985, including the target goal established by the HTF and the 5-year average measured size (black dashed lines). (LUMCON/LSU/NOAA)

2.2 New Science and Information on Water Quality in the MARB and Gulf

2.2.1 Response of the Hypoxic Zone to Climate Change

The formation and duration of the northern Gulf hypoxic zone (i.e., where dissolved oxygen concentrations are less than 2-3 mg/L) are driven by a complex chain of key factors such as nutrient loads, stratification, algal blooms, and oxygen solubility (Rabalais and Turner 2019; Rabalais 2014). Climate drivers, such as rainfall, wind, and air temperatures have a strong influence on these key factors that control the hypoxic zone. Trends in climate change impacts across the United States, including the MARB, are expected to continue. How climate changes will affect the key factors that drive the hypoxic zone is difficult to understand due to the inherent spatial and temporal variability of hypoxia, interactions with land use and water management, legacy nutrient dynamics, and dependence on uncertain changes in hydrology in response to future climate—modeling studies project both increases and decreases in precipitation and runoff (Coffey et al. 2019; Sinha et al. 2019).

An increasing body of published literature documents how observed historical and projected future changes in both global and regional climates influence the hypoxic zone and the factors that contribute to its formation (e.g., nutrient loads, stratification, algal blooms, and oxygen solubility). Altered precipitation patterns—such as more intense precipitation, shifts in the seasonal distribution of precipitation, warmer air and water temperatures, and increased atmospheric carbon dioxide (CO_2) associated with climate change—are expected to cause cascading effects on the factors that drive the hypoxic zone, such as nutrient loading, water column stratification, algal bloom formation, and oxygen solubility (Hayhoe et al. 2018; NOAA 2022b; Lehrter et al. 2017; see Figure 2-2). The current literature indicates that climate change effects on key factors driving hypoxia have the potential to worsen the extent and duration of the hypoxic zone (Altieri and Gedan 2015; Lehrter et al. 2017).

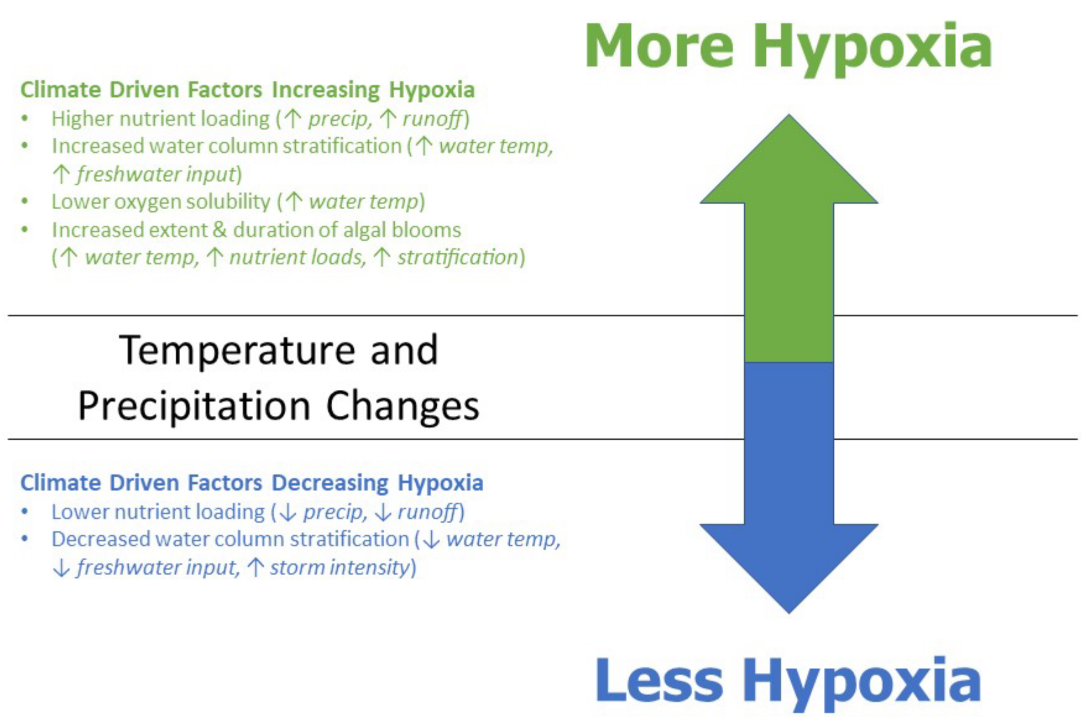


Figure 2-2. Climate driven factors affecting hypoxia in the Gulf.

Climate Change Effects on Key Factors Affecting Hypoxia

Climate change effects on key factors affecting hypoxia are explored in more detail below in individual sections and an overview summary, along with projected impacts to the hypoxic zone. Appendix C contains relevant selected findings from recent studies.

Nutrient Loads

The temporal dynamics of nutrient loading (due to contemporary[10] and/or legacy sources[11]) via runoff from land surfaces and infiltration to groundwater are closely related to the amount and timing of precipitation (Donner and Scavia 2007; Zhang et al. 2022). Over the next century, increased precipitation in the MARB is anticipated to result in more water, sediment, and nutrients reaching the coastal zone of the northern Gulf (Justić and Wang 2014; Rabalais 2014; Sinha et al. 2017). Greater nutrient losses from the land, driven by heavy precipitation events (i.e., those with a high rainfall intensity where rainfall rates exceed normal levels[12]), would augment eutrophication through nutrient-enhanced algal production and eventual decomposition, which in turn would increase hypoxia.

In the Upper Mississippi River Basin, modeling by Sinha et al. (2017) indicated that potential increases in TN loads of 28 percent to 38 percent could occur in the near future in response to projected climate scenarios (2031–2060; low to high greenhouse gas emissions scenarios), with increases of 50 percent to 81 percent in the far future (2071–2100; low to high greenhouse gas emissions scenarios). For the Lower Mississippi River Basin, the same study projects TN load increases of 19 percent to 24 percent in the near future and 25 percent to 33 percent for the far future period (Sinha et al. 2017). Another study projected increases in nitrogen loads of up to 30 percent by the end of the 21st century for the MARB, with the spring season alone contributing up to 41–50 percent of the additional nutrient loading per year (Zhang et al. 2022; see Figure 2-3[13]). Changes in phosphorus loading are not as well documented, but similar precipitation driven changes in loads are likely (Coffey et al. 2019).

[10] Contemporary nutrients are nutrients which leave a system within a short period of time after initial introduction to the landscape.
[11] Legacy nutrients are surplus nutrient inputs from previous years that are stored within the watershed and accumulate and/or are retained in soils, groundwater, and in the bottom sediments of lakes and streams for a period of time beyond initial introduction to the landscape (Van Meter et al. 2018; Chen et al. 2018).
[12] EPA Climate Change Indicators: https://www.epa.gov/climate-indicators/climate-change-indicators-heavy-precipitation.
[13] In Figure 2-3, Representative Concentration Pathway (RCP) 8.5 represents more warming and a high greenhouse gas emissions scenario. RCP 4.5 represents moderate warming and a moderate greenhouse gas emissions scenario. The current nitrogen load reduction goal is shown by the green dashed line.

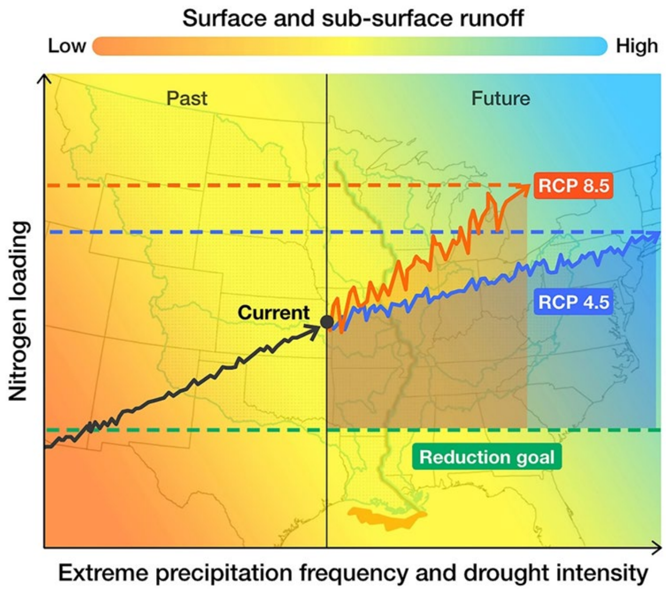


Figure 2-3. Conceptual illustration of possible trajectories of nitrogen loading changes induced by heavy rainfall intensity and frequency under future climate and management scenarios (Zhang et al. 2022).

A greater amount of annual precipitation volume in the MARB is expected to occur during heavy events (NOAA 2022b), flushing accumulated nutrients from land to waterbodies after projected drier or drought periods (Zhang et al. 2022; Lu et al. 2020; Sinha and Michalak 2016; Sinha et al. 2017). In the MARB, precipitation patterns have been suggested to be the controlling factor of nitrogen loading from land and transport through the river system as land use and cover has remained relatively constant in recent times (Donner and Scavia 2007). Over 60 percent of the MARB (an area which yields over 80 percent of nitrogen loading to the Gulf) has already experienced increasing heavy precipitation since 2000, with the annual nitrogen yield estimated to have increased from 28 percent to 35 percent due to extreme precipitation across the region (Lu et al. 2020). Modeling and USGS monitoring estimates demonstrate an approximately 30 percent higher annual nitrogen load in the years with higher river flow than the long-term median (Lu et al. 2020). A higher frequency of heavy precipitation is anticipated to drive a large portion of the projected future nutrient load increases (Zhang et al. 2022).

Some studies suggest that decreases in nitrogen loads could also occur in response to certain climate change scenarios (Alam et al. 2017; Sinha et al. 2019). Similar decreases could also occur for phosphorus loads. The direction of change in nutrient loads will ultimately be driven by the precipitation and temperature trends that are realized over different temporal and spatial scales and land use/management changes within the MARB (Zhang et al. 2022; Coffey et al. 2019; Sinha et al. 2017, 2019). Conflicting projections in future nutrient loads are likely to reflect the different climate scenarios and nutrient loading models applied in individual studies.

<u>Stratification</u>

Stratification of the water column is a precondition for the development of the hypoxic zone. The strong pycnocline (layer with the greatest density gradient) in the northern Gulf typically results in less diffusion (movement) of oxygen from the surface water column to the bottom water column, leading to less oxygen in bottom waters (Rabalais 2014; Rabalais and Turner 2019). Warming of surface waters, in combination with increased freshwater discharge from the Mississippi River due to increased precipitation in the MARB and future sea level rise, is projected to promote the development and strengthening of stratification in the northern Gulf (Laurent et al. 2018). These changes would increase the strength and persistence of surface and bottom water column separation and may also increase phytoplankton[14] biomass, thus resulting in a physical environment more conducive for establishment and maintenance of hypoxia.

Increased riverine freshwater discharge is also expected to decrease salinity gradients, which increases stratification and increases the extent or intensity of hypoxia (Rabalais 2014). Water temperatures in the Gulf are also projected to increase concurrently with rising air temperatures (Laurent et al. 2018). Modeling by Lehrter et al. (2017) showed an increase in average hypoxic zone duration due to an average increase in water temperature of 1.1°C and a decrease in salinity of 0.09[15] for the region where hypoxia typically occurs (<50 m depth).

Algal Blooms

Algal blooms, which are overgrowths of algae in the water, typically precede hypoxic conditions. Following a bloom, algal decomposition can consume oxygen, leading to hypoxia in the lower water column. Eutrophication[16] caused by increased nutrient loading and warmer waters are key factors that promote the formation of algal blooms in the Gulf. Climate change is expected to extend the seasonal window for blooms to occur by enhancing conditions favorable for bloom formation (see Figure 2-4). Increased carbon production resulting from higher water temperatures, increased nutrient loading, and enhanced ecosystem metabolism[17] may exacerbate the spatial distribution and persistence of hypoxia across the northern Gulf.

Furthermore, bloom forming algae, such as cyanobacteria, are known to thrive under higher temperatures due to both physiological (for example more rapid growth) and physical factors (such as enhanced stratification) (O'Neil et al. 2012). During conditions that promote stratification (e.g., warm, dry and calm periods; decreased surface salinity/increased freshwater), bloom forming algal species can form intracellular gas vesicles to control their buoyancy (e.g., Microcystis, Anabaena), floating upward to optimize photosynthetic production and sinking downward to optimize nutrient acquisition. This provides these algae with a competitive advantage that allows them to thrive (Reynolds 1987).

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[14] Phytoplankton are free-floating, microscopic algae. Since phytoplankton require the sun's energy to turn carbon dioxide and water into food and energy via photosynthesis, they inhabit the sunlit upper layers of freshwater and marine environments. Common types of phytoplankton include diatoms, green algae, cyanobacteria (blue-green algae), and flagellates (USEPA 2022a).

[15] Salinity is a measure of the amount of salts dissolved in water. It is usually expressed in parts per thousand (ppt) or 0 /00 (USEPA 2006).

[16] Eutrophication occurs when excessive nutrients cause a dense growth of algal blooms. As algae ultimately die off and decompose, oxygen is consumed resulting in low levels of oxygen in the water (USEPA 2022b).

[17] Ecosystem metabolism is the total energy processed by all the individual organisms that make up an ecosystem. For simplification, the numerous metabolic processes that transform energy in organisms or ecosystems can be lumped into two categories: production and respiration (Fairbridge and Alexander 1999).

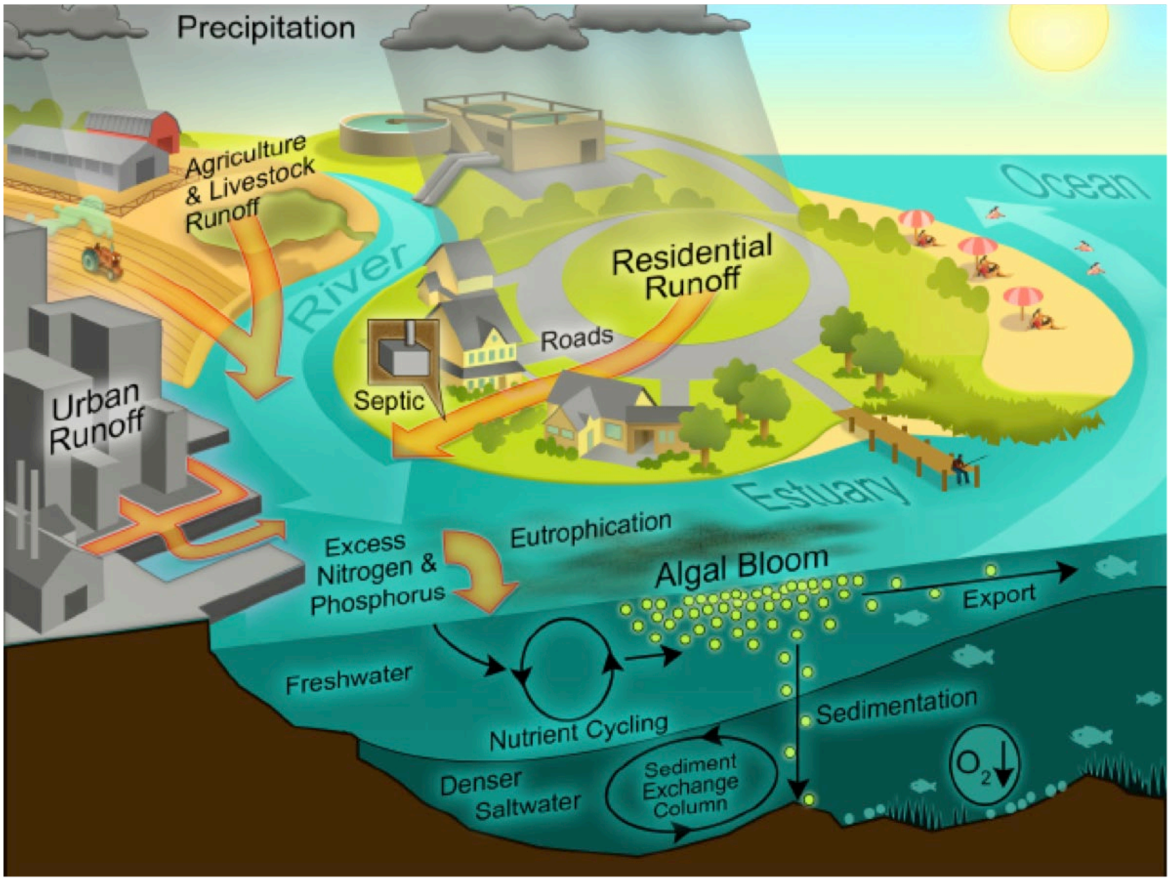

Figure 2-4. Changes in Precipitation and Temperature Affect Loadings from the Land, Nutrient Cycling, and the Formation of Algal Blooms (Paerl 2008)

In addition to its role as a greenhouse gas that affects climate change, increased atmospheric CO_2 can also directly affect algae by lowering the pH and favoring algae communities (like cyanobacteria) that can grow faster in such conditions (Coffey et al. 2019; Glibert 2020). Increased organic matter produced during algal blooms is decomposed in the lower water column, depleting oxygen, generating CO_2, and contributing to the decline in pH (Rabalais and Turner 2019).

Oxygen Solubility

Warmer waters hold less dissolved oxygen than cooler waters (Rabalais and Turner 2019). In the northern Gulf, summer bottom water column temperatures have increased over the past decades at a rate 1.9 times faster than the rise in local summer air temperatures (Turner et al. 2017). Between 1963 and 2015, it is estimated that bottom water column temperatures have increased by an average of ~0.05°C per year (Turner et al. 2017). The increase in bottom water column temperatures, particularly in summer, have contributed to the development and persistence of the hypoxic zone (Laurent et al. 2018).

Modeling by Laurent et al. (2018) in the northern Gulf indicates that surface and bottom water temperatures in summer could increase by 2.2°C and 2.7°C, respectively, by 2100. These increases in water temperature and associated effects on oxygen solubility were estimated to account for 60 percent to 74 percent of the total change in bottom water oxygen for the future scenarios simulated in the study (stratification was indicated to account for the remaining change) (Laurent et al. 2018). Overall, these changes would contribute to increases in hypoxic area and volume if realized (specific details in next section).

Projected Hypoxic Zone Area Changes

The preceding subsections explain how climate change is anticipated to exacerbate the factors that adversely influence the hypoxic zone. Specifically, current seasonal hypoxic conditions and eutrophication-driven acidification in bottom waters are expected to be aggravated by warming air temperatures and altered precipitation patterns. Increased surface ocean temperatures, freshwater and nutrient inputs, and atmospheric CO_2 will further exacerbate hypoxic conditions (Laurent et al. 2018).

Modeling by Del Giudice et al. (2020) indicates that a 2°C increase in mean water temperature should cause a 26 percent increase in hypoxic area as a result of reduced oxygen solubility and enhanced lower water column respiration (Del Giudice et al. 2020). Justić et al. (2003) suggests that a 20 percent increase in the volume of Mississippi River discharge, which may occur under some climate change scenarios, would increase the frequency of hypoxia by the same magnitude.

Another modeling study applied a coastal ocean ecosystem model to assess the effect of a future climate scenario of + 3°C air temperature and + 10 percent river discharge on the hypoxic zone. Simulations suggested a mean increase of 9.5 days (10 percent increase) for the duration of severe hypoxic zones (defined as more than 60 days per year), and a 1,130 km^2 increase (~8 percent increase) in the hypoxic zone area (Lehrter et al. 2017).

Laurent et al. (2018) suggests that the hypoxic area will increase by 26 percent and hypoxic volume by 39 percent on average by late century (2100), with significant year-to-year variations. Results indicate a modest expansion of the hypoxic zone, but more severe hypoxia and greater exposure to prolonged hypoxic conditions. Bottom waters are generally forecasted to be hypoxic for a longer time (Laurent et al. 2018). The main drivers underlying these changes are a reduction in oxygen solubility (accounting for 60–74 percent of the change) and increased stratification (accounting for less than 40 percent). Additionally, simulations showed that years of upwelling (driven by favorable winds) in combination with elevated freshwater discharge would drive the largest future effects (Laurent et al. 2018).

Summary

In summary, there is a consensus in published literature that hypoxic conditions are likely to worsen if projected climate changes are realized. Table 2-1 summarizes the anticipated changes in the hypoxic zone and associated key contributing factors.

Table 2-1. Summary of climate change effects on hypoxia and associated contributing factors.

Contributing Factor	Anticipated Change	Scientific Understanding*
Nutrient Loading	• The majority of literature suggests that an increase in nutrient loading is likely to occur, due largely to altered hydro-patterns, especially increased heavy precipitation and runoff. • Confidence in projected changes in hydrology together with land use and management is, however, uncertain and may vary by year and location.	Low
Stratification	• Literature suggests a strengthening of stratification due to increased freshwater inflow, reduced salinity gradients and warmer water temperatures.	Medium
Algal Blooms	• Literature suggests an increase in the extent and duration of algal blooms due to enhancement of conditions that support bloom development (nutrient loading/eutrophication, warmer water, stratification etc.)	Medium
Oxygen Solubility	• Literature suggests that warmer waters will cause a decrease in oxygen solubility, worsening hypoxic conditions.	High
Hypoxic Zone	• Literature suggests an increase in the extent and duration of the hypoxic zone if projected climate changes are realized.	Medium

*Scientific understanding categories assigned are subjective based on best professional judgement of Tetra Tech scientists (EPA contractor) about amount of literature available and the strength of the evidence.

Future Needs

Many studies suggest that the collective impacts from climate change on the hypoxic zone and nutrient loads (from contemporary and legacy sources) from the MARB may make the achievement of reduction goals for nutrient loading and the size of the hypoxic zone more complex, and that current management actions may need to be adapted (Donner and Scavia 2007; Zhang et al. 2022). More information about the extent and scale of management actions to offset the effects of climate change is needed to support the decision-making process. Management responses for reducing risks should consider strategies and practices robust to a range of potential future conditions (Paul et al. 2019).

Further research can provide a better understanding of climate change effects on the hypoxic zone and inform management responses. For example, the development of models that incorporate climate change together with other cascading factors (e.g., land use/management changes, legacy nutrients) would improve knowledge about potential vulnerabilities and impacts. Models, such as those discussed in section 2.2.3, need to consider dynamics beyond temperature and freshwater discharge effects, including altered hydrodynamic circulation patterns and variable nutrient loads (e.g., nutrient recycling and retention), to comprehensively assess the cumulative impacts to the hypoxic zone. Watershed scale legacy nutrients are expected to further contribute to nutrient loading, but the effects under future climate conditions are yet to be fully explored in the scientific literature.

2.2.2 Advancements in Monitoring and Modeling Water Quality and Load Reductions throughout the MARB

EPA's National Aquatic Resource Surveys monitor the nation's waters on a rotating basis in which the program samples rivers and streams, lakes, wetlands, coastal estuaries, and Great Lakes nearshore waters once every 5 years. EPA uses a statistical survey design to monitor at sites with the purpose of assessing the condition of all waters nationally over time. In addition to assessing waters nationally, the National Rivers and Streams Assessment (NRSA) data can be used to assess condition in the MARB and in its sub-basins (Upper Mississippi, Lower Mississippi, Upper Missouri, Lower Missouri, Ohio, and Arkansas/White/Red basins). NRSA reports on the condition of nutrients, as well as biology and habitat.

Results from NRSA 2018-19 report the percentage of river and stream miles in good, fair, or poor condition for both TN and TP as compared to regionally relevant least distributed reference condition. For the MARB, the percentage of river and stream miles in good condition was 21.6 percent and 31.5 percent for TN and TP, respectively (Figure 2-5). When comparing 2018-19 results to previous NRSA surveys, TP showed a 15.1 percentage point increase in the number of river and stream miles in good condition from 2013-14 to 2018-19, but there was no significant trend cross all three NRSA surveys (2008-09 through 2018-19). TN showed no significant change or trends across the various NRSA surveys. The individual subbasins showed statistically significant improvements in the percentage of river and stream miles in good condition for TP, except for the Lower Missouri subbasin which showed no change (Figure 2-6). The increased change in TP ranged from 2.4 percentage points in the Upper Missouri to 21.1 percentage points in the Arkansas/White/Red River subbasin. As with the MARB, there was no significant trends in TP across all three NRSA surveys. The percentage of rivers and stream miles in good condition for TN showed no significant change or trends across the various subbasins and the MARB.

The 2019/2021 Report to Congress provided a detailed overview of MARB-scale modeling assessments using a mechanistic model, SWAT, and a hybrid regression-based model, SPARROW, led respectively by USDA and USGS. While no new MARB scale SPARROW or SWAT model results have been updated since the 2019/2021 Report to Congress, at the national scale, USDA developed and released an enhanced SWAT+ model, an enhanced Agricultural Policy/Environmental eXtender (APEX) model, and published an updated CEAP report. In March of 2022, USDA published *Conservation Practices on Cultivated Cropland: A Comparison of CEAP I and CEAP II Survey Data and Modeling*, a national report utilizing the APEX field-scale biophysical model to provide estimates of edge-of-field losses and conservation practice benefits. USDA has continued developing the input data sets from the second national CEAP survey, updating the SWAT+ model, and anticipates publishing updated MARB results by late 2024. When results are published at the MARB, regional, or state scales, the HTF can better understand sources of and decadal trends in nutrient loads to the Gulf.

USDA quantifies the effectiveness of conservation practices through CEAP assessments, which are based on input data collected by USDA via two national farmer surveys completed in 2003-2006 and 2013-2016. CEAP findings help to determine current impacts, remaining conservation needs, and strategies for increasing effectiveness to achieve benefits from additional conservation. Nationally, the March 2022 report shows use of no-till, crop rotations, more efficient irrigation methods and advanced technologies have climbed in recent years. These surveys, when data is presented at the MARB scale, will provide the HTF with a method to track progress over a decade of conservation adoption and highlight areas where additional conservation will have the largest nutrient reduction impact.

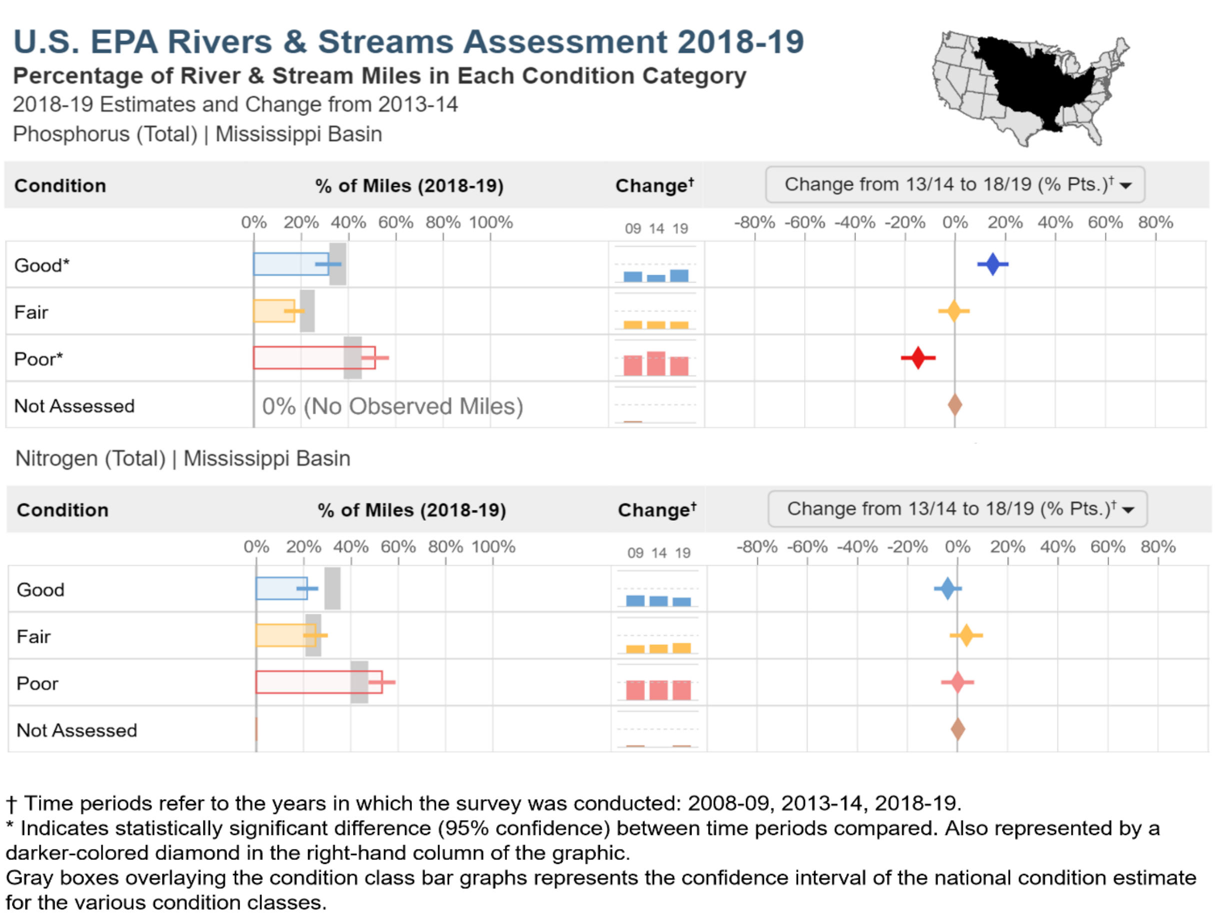

Figure 2-5. MARB TP and TN condition categories.

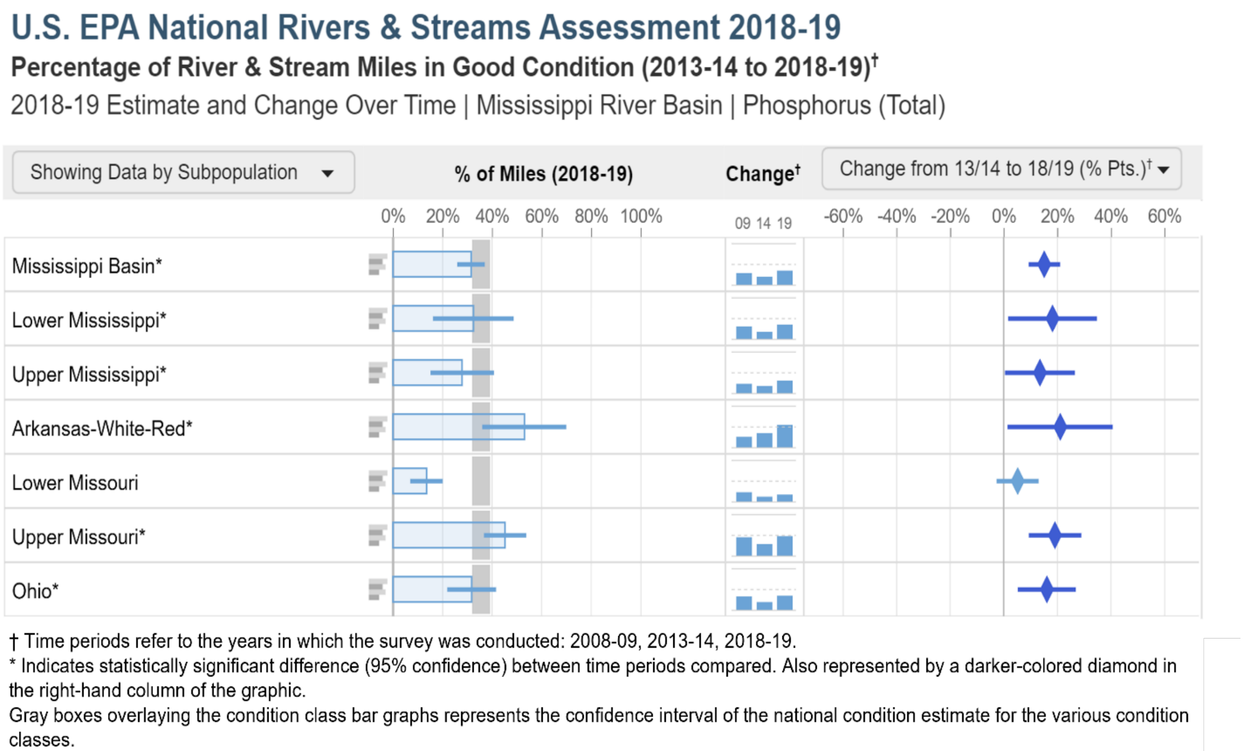

Figure 2-6. Extent of river and stream with TP in good condition at the MARB and sub-basin level.

APEX is used to model data collected from farmer surveys at the field level and provides estimates of conservation practice impacts on edge-of-field sediment, nutrient, and pesticide losses, wind and water erosion estimates, and carbon sequestration.

USDA's CEAP assessments estimate progress in reducing losses in the decade between the two surveys and provide trends in conservation.

Key national scale findings in the March 2022 report include:

- Farmers increasingly adopted advanced technology, including enhanced-efficiency fertilizers and variable rate fertilization to improve efficiency, assist agricultural economies, and benefit the environment.
- More efficient conservation tillage systems, particularly no-till, became the dominant form of tillage, improving soil health and reducing fuel use.
- Use of structural practices increased, largely in combination with conservation tillage, as farmers increasingly integrated conservation treatments to gain efficiencies. Structural practices include terraces, filter and buffer strips, grassed waterways, and field borders.
- Irrigation expanded in more humid areas, and as irrigators shifted to more efficient systems and improved water management strategies, per-acre water application rates decreased by 19 percent and withdrawals by 7 million-acre-feet.
- Nearly 70 percent of cultivated cropland had conservation crop rotations, and 28 percent had high-biomass conservation crop rotations.

Because of this increased conservation, the report estimates nationally:

- Average annual water (sheet and rill) and wind erosion dropped by 70 million and 94 million tons, respectively, and edge-of-field sediment loss declined by 74 million tons.
- Nearly 26 million additional acres of cultivated cropland were gaining soil carbon, and carbon gains on all cultivated cropland increased by over 8.8 million tons per year.
- Nitrogen and phosphorus losses through surface runoff declined by 3 percent and 6 percent, respectively.
- Average annual fuel use dropped by 110 million gallons of diesel fuel equivalents, avoiding associated greenhouse gas emissions of nearly 1.2 million tons of carbon dioxide equivalents.

In addition, CEAP Watershed Assessment Studies provide insight into the tools necessary to improve water quality at the watershed scale. Current CEAP watershed studies are underway as a complement to the broader scale CEAP cropland assessments to measure and model effects of conservation at edge-of-field and small watershed scales. In May 2020, a Special Issue of the Journal of Soil and Water Conservation reviewed and synthesized more than 15 years of science documenting conservation outcomes to add to several key prior publications, webinars, and blogs summarizing lessons learned to enhance conservation outcomes on water quality (Moriasi et al. 2020). A recent USDA webinar presents the science behind nutrient management for improved water quality, *Addressing Water Quality Outcomes Through Nutrient and Water Management*. These projects will also help quantify lag time in nutrient reduction and conservation effects at multiple watershed scales. A new assessment of legacy phosphorus sources, processes, and management options was funded in 2021 and two projects assessing nitrate sources/lag time and legacy sediment sources were initiated in 2022.

EPA is collaborating with states and other stakeholders to further develop water quality modeling frameworks throughout the MARB (Evenson et al. 2021). These projects intend to inform regional and state level management decisions to reduce the size of the hypoxic zone and mitigate its impacts, using data inputs such as those described in the National Nutrient Inventories (Sabo et al. 2021a; Sabo et al. 2021b; Sabo et al. 2019).

Various modeling studies, conducted to improve understanding of factors and sources contributing to increased nitrogen export from the MARB, have focused on interactions of air, land, and water. To address changes in climate factors (section 2.2.1) EPA is developing an Integrated Multi-Media Modeling System (IMMMS) linking air, land, and water processes to target the nitrogen cycle and evaluate nitrogen sources, fate, and transport comprehensively (Yuan et al. 2018). The framework of the IMMMS is undergoing thorough evaluation and testing. The system will be used to simulate the impact of land use/land management and climate change on nutrient loadings to the Gulf.

2.2.3 Advancements in Monitoring and Modeling the Hypoxic Zone

Federal HTF members are also active on the applied monitoring, modeling, assessment, and research front.

NOAA, in conjunction with academic partners and USGS, continues to issue the annual hypoxic zone forecasts in early June of each year. In 2017 NOAA transitioned to a suite of hypoxia forecast models, integrating the results of multiple models into a separate ensemble forecast that is released in coordination with other external modeling efforts. With 2022 being the fifth year of the NOAA ensemble forecast, this capability is available for future HTF assessments of nutrient management reduction scenarios necessary to achieve the nutrient reduction goals of the HTF. At the end of each hypoxia season, NOAA supports a retrospective analysis with two coupled hydrodynamic-biogeochemical models to simulate the temporal and spatial evolution of hypoxia. This capability is important to understanding the factors, such as mixing events, affecting the measured size for a particular year and how the hypoxic zone changes outside of the mid-summer cruise survey measurement timeframe.

Figure 2-7 compares model results to data collected during the peak of the hypoxic season, which typically begins in May and continues through the end of October. The grey dot is the NOAA ensemble forecasted size and the black dot is the ship survey measurement. For the year shown (2020), the models were in good agreement with the mid-summer survey and captured the mixing and disruption of the hypoxic zone caused by the passage of three major storms that year (Cristobal, Hanna, and Laura).

NOAA continues to explore other methodologies to improve modeling efficiency and accuracy. In 2020 and 2021, NOAA funded projects to test cost-effective technologies to gather water quality data autonomously, throughout the water column. These projects use autonomous (i.e., unmanned) underwater and surface vehicles to provide necessary near-bottom oxygen and other water quality observations at a wide variety of depths. Field trials of these technologies occurred during the summer of 2022 and will continue during the summer of 2023 to test their abilities alongside the annual ship survey cruise. These new capabilities, once operationalized, may augment the annual monitoring cruise and the generation of the metric used by the HTF. Benefits of this effort will go beyond the one-time annual measurement, as these technologies can be mobilized quickly and used to monitor wherever hypoxic conditions persist, especially in shallow waters.

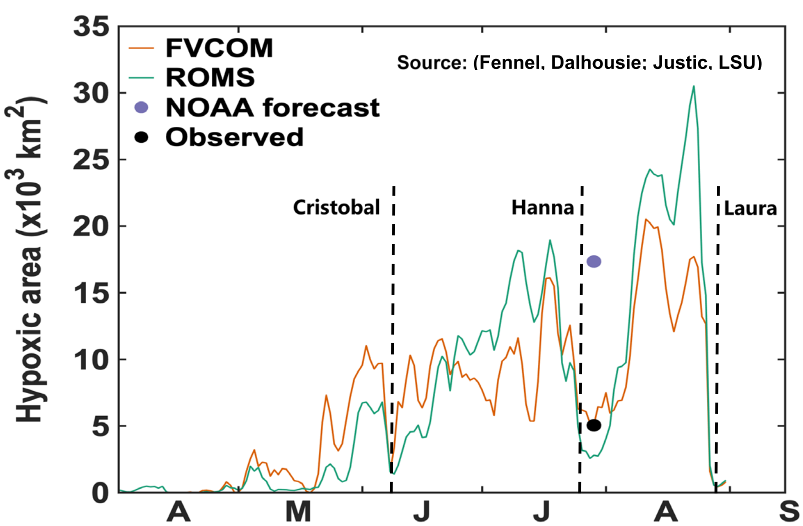

Figure 2-7. Graphs of model-derived (Finite-Volume Coastal Ocean Model [FVCOM] and Regional Ocean Modeling System [ROMS]) hypoxic area size estimates vs observed data through the hypoxic season in 2020.

To better understand the dynamics of the hypoxic zone and to better track progress made on reducing its size, the HTF and several agencies are working to advance research in modeling and monitoring the hypoxic zone. EPA investigated how offshore hypoxia impacts nearshore water quality in coastal state waters. The impact of offshore hypoxia on localized nearshore dissolved oxygen conditions is less understood and challenging to assess over the timeframe during which hypoxia occurs. To address this issue, EPA combined an analysis of 30 years of hydrographic data with simulations from a hydrodynamic-biogeochemical model to determine how offshore hypoxia impacts nearshore water quality. Results identified contiguous hypoxia between state waters and the offshore hypoxic zone nearly every year in the 30+ year dataset. These results suggest that MARB nutrient management strategies aimed at reducing nutrient inputs and hypoxia remain essential to improving the nearshore coastal water quality across the northern Gulf.

EPA is also investigating the spatial dynamics of carbon production controlling hypoxia, which has thus far been largely attributed to east-west transport of nutrients and carbon from the MARB plumes. Recent field studies suggest nearshore carbon production helps to maintain hypoxia in middle area of the nearshore part of the zone. EPA employed a three-dimensional hydrodynamic-biogeochemical model to examine factors driving spatial variations in carbon production, oxygen consumption, and hypoxia. Simulation results identified highly productive nearshore waters as important carbon sources for hypoxia formation, with seasonal bottom currents capable of transporting carbon to intermediate depths where hypoxia is most common. These results highlight the value of complex simulation models as tools to inform complex ecological processes and demonstrate a new paradigm in carbon production dynamics fueling offshore hypoxia (Jarvis et al. 2020).

Complex simulation models are a valuable tool to inform nutrient management decisions aimed at reducing hypoxia in the northern Gulf, yet simulated hypoxia response to reduced nutrients varies greatly between models. To better understand this, EPA recently compared two biogeochemical models driven by the same hydrodynamics: the Coastal Generalized Ecosystem Model (CGEM) and Gulf of Mexico Dissolved Oxygen Model (GoMDOM), to investigate how these models differ in simulating hypoxia and the response to reduced nutrients (Jarvis et al. 2021). Results show that different complex model formulations significantly altered outcomes of hypoxia simulations and that the hypoxic area and volume varied spatially across the zone between two models. In addition, results found that hypoxia responded differently to reduced nutrient load scenarios between models, with hypoxic area reductions varying as much as 23 percent between models. Findings show that the models must be evaluated in context with multiple models to effectively inform decision making (Mann 2021).

Part 3. The Economic and Social Effects of the Hypoxic Zone

Recent and ongoing research has expanded the knowledge base of the effects of hypoxia on fish and fisheries, and on local and regional economies. Advancements in studies of the economic and social effects are providing support for management decisions with new tools and forecasting abilities, generating greater understanding of hypoxia, and furthering the body of knowledge surrounding hypoxia.

Hypoxia affects valuable fisheries and disrupts sensitive ecosystems by reducing the extent and quality of habitat for a variety of organisms (Diaz and Rosenberg, 2008; Breitburg et al., 2009). Hypoxia also has many lethal and sublethal effects on ecosystems, such as increased mortality, reduced growth, shifts in fish diet, changes in migration patterns, barriers to spawning pathways, changes to species reproductive success, and sex ratios, all of which may have economic impacts on local industry (Glaspie et al. 2019; LaBone et al. 2019; Rahman and Thomas 2017, 2018; Rose et al. 2017a, 2017b, Langseth et al. 2014; Thomas et al. 2015; Rahman and Thomas 2012; Craig 2012).

Ecosystem impacts, in both the MARB and the Gulf, are complex and interwoven alongside socioeconomic effects. The edge of the northern Gulf ecosystem contains almost half of the nation's coastal wetlands and supports economically important commercial and recreational fisheries. While additional research is needed to further quantify the economic losses due to hypoxia alone, it has been estimated that the excess nitrogen that washes into the Mississippi and Atchafalaya rivers leading to the formation of the hypoxic zone has "contributed up to $2.4 billion in damages to ecosystem services generated by fisheries and marine habitat every year since 1980" (Boehm 2020). Therefore, reducing excess nitrogen to the MARB will not only reduce the hypoxic zone size, but will also reduce those extensive regional economic losses.

Commercial fishing industries are an important economic driver in the Gulf region and are essential for the livelihoods of local communities. In 2020, commercial fishery landings in the Gulf generated $5.5 billion in income and supported approximately 150,000 jobs (NMFS 2023). Recreational fishing generated $1.6 billion in income and approximately 44,000 jobs (NMFS 2023). In 2012, coastal ocean-related tourism added $37 billion to the Gulf region's GDP and supported approximately 579,000 jobs (Kosaka and Steinback 2018). In particular, the shrimp fishery is economically important, bringing in half of the revenue of the top ten commercial fisheries in 2016 and particularly vulnerable to hypoxia (NMFS 2018; Boehm 2020). Analysis of monthly trends in the price of Gulf brown shrimp from 1990 to 2010 showed that hypoxia resulted in short-run price increases for large shrimp compared to the price of small ones (Smith et al. 2017). When the hypoxic zone is present, fishermen catch more small shrimp and fewer large ones, making small shrimp cheaper and larger ones more expensive. While the total quantity of shrimp caught could remain the same during hypoxic periods, a reduction in the highly valued large shrimp would lead to a net economic loss for fishermen. Study results also demonstrate that hypoxia alters the spatial dynamics of the Gulf shrimp fishery, and this has potential negative consequences for shrimp harvesting and the economic condition of the fishery, such as increased time spent finding the shrimp and increased travel time to the shrimp (Purcell et al. 2017). Other fisheries affected by hypoxia likely undergo similar spatial fluctuations, and further studies are needed to understand how lethal and sub-lethal hypoxia effects, along with human decisions, can have an economic impact on affected fisheries.

3.1 Advancements in Modeling the Economic and Ecological Impacts of Hypoxia

Three ongoing NOAA-supported projects (2016–2022) are evaluating the impacts of hypoxia on fish and fisheries in the Gulf as well as considering what can be expected from the Gulf fisheries when the 2035 goal is met. The overall objective of these projects is to quantify, through multidisciplinary ecosystem models or other methods, the ecological and socioeconomic impacts of hypoxia, including an evaluation of the effects of alternative management strategies on ecosystem function and living resource populations. Projects include the following:

- *Synthesis of long-term data sets and modeling of data to support fisheries and hypoxia management in the northern Gulf*. This project is focused on exploring the consequences of hypoxia for regional fisheries and for fish community ecological indicators. Specific outcomes from this project will include:
    - Estimates of hypoxic area and volume over the entire hypoxic season for the period of record (1985–present) based on the dissolved oxygen sampling data available from the monitoring cruise programs.
    - A probabilistic biophysical hypoxia model capable of simulating and forecasting dissolved oxygen over the entire hypoxic season and entire period of record. Results will have a strong empirical basis and quantified uncertainty.
    - A new set of hypoxia metrics (area, volume, and duration, using multiple hypoxic thresholds: 1 mg/L, 2 mg/L, 3 mg/L) across the extent of the zone, based on the results of the geostatistical and biophysical modeling.
    - Evaluation of hypoxia effects on catch and effort from the region's two major commercial fisheries (Gulf menhaden, penaeid shrimp) that incorporates the new hypoxia estimates.
    - Evaluation of hypoxia effects within the context of other environmental and anthropogenic stressors on ecological indicators of upper-trophic-level fish community currently in use to monitor the status of the Gulf ecosystem. (Project page).

  Progress to date: Scientists from NOAA's Southeast Fisheries Science Center and North Carolina State University have developed species distribution models for brown and white shrimp. The models were based on historic shrimp catch rates, shrimping effort, dissolved oxygen levels, and other environmental data collected from fishery surveys and other sources in the region. When integrated with the hypoxia forecast, the spatial distribution of dissolved oxygen was simulated to predict where shrimp are likely to be in early summer. As a result, the first experimental hypoxia-responsive shrimp distribution forecast was produced in 2022.

- *Using Linked Models to Predict Impacts of Hypoxia on Gulf Coast Fisheries Under Scenarios of Watershed and River Management.* This project intends to provide managers with new quantitative information about how nutrient reductions will affect fish populations, and how the combination of river diversions and hypoxia will affect fish and shrimp populations. A second outcome will be a tool that provides consistent and defensible predictions, from the watershed to the living resources. In the longer term, results will contribute to management decisions about watersheds and diversions that reduce the extent and severity of the hypoxic zone, based least partially on fishery population-level responses. (Project page).

Progress to date: By linking the Dynamic Land Ecosystem Model (DLEM) for the watershed, Delft3D model for diversions, the Finite-Volume Coastal Ocean Model-Water Quality Analysis Simulation Program [FVCOM-WASP] for hydrodynamics and water quality, and fish and shrimp population models, results are beginning to provide NOAA with quantitative predictions of how hypoxia and nutrient reductions will affect fisheries at the population-level. The results are informing managers on options for weighing the costs of nutrient reduction vs the effect of reduced primary production on fisheries.

- *User-driven tools to predict and assess effects of reduced nutrients and hypoxia on living resources in the Gulf.* These tools will predict how hypoxia could affect species-specific fish growth rate potential as a metric of essential fish habitat and biomass and catch of ecologically and economically important living resources. The project will lead to an improved capability to assess the effects of alternative management strategies on ecosystem function, living resources, and fisheries revenue. (Project page).

  Progress to date: A final draft version of the decision support tool was presented to the project's final advisory panel meeting in November 2022. The decision support tool visualizes the biomass and distribution of select fishery species in response to Mississippi River nutrient load reductions that reflect the goals of the HTF. All three projects will be contributing to a special issue in *Marine and Coastal Fisheries* that will synthesize project outcomes through project-specific and collaborative papers from program leads.

Part 4. Lessons Learned

4.1 Benefits of the IIJA and Inflation Reduction Act

The IIJA's investment in clean water is nothing short of transformational and includes approximately $50 billion for EPA to invest in water infrastructure and support programs across the nation, the single largest investment in clean water that the federal government has ever made. Specifically, the IIJA includes an unprecedented $12 million per year for five years ($60 million in total) that EPA is investing in state and tribal strategies to meet the goals of the Action Plan and build their capacity to scale up conservation implementation. EPA is posting all relevant materials on the GHP webpage. The Inflation Reduction Act (IRA) will deliver $19.5 billion nationally in new conservation funding to support climate-smart agriculture, including for NRCS to improve opportunities for nutrient management.

4.2 The Critical Role of Partnerships

Since the HTF adopted its first Action Plan in 2001, the HTF has engaged a full range of public and private sector partners. States are implementing their nutrient reduction strategies by working with universities, agricultural associations, business councils, conservation organizations, municipalities, wastewater utilities, nonprofits, private companies, and private foundations. The scope of the HTF's 2035 goal and 2025 interim target requires this wide array of partners; as noted in Part 1 of this report, reducing the nutrient load delivered to the northern Gulf every year is an extraordinary challenge, requiring conservation on millions of acres across nearly half the United States. Recent science confirms that meeting the HTF's 2035 goal for reducing the size of the Gulf hypoxic zone will require nitrogen and phosphorus reductions of about 48 percent (Fennel and Laurent 2018). The scope and scale of this challenge is driving new collaboration among states, tribes, federal partners, and stakeholders to widen the circle of engagement, accelerate innovation, and amplify efforts to achieve the results needed. Further expansion of partnerships is necessary to support the many needs to meet the HTF's goal.

Implementation requires partners that can provide planning, engineering, technical assistance, funding, and on-the ground services. Partners are needed who can help scale up soil and water conservation efforts, by fully integrating needed water quality results into activities across urban, suburban, industrial, and rural landscapes. Examples of these key partnerships and partner organizations include:

- Illinois Department of Agriculture–NRCS partnership: This partnership delivers over $13.3 million in new funding to support conservation planning and Illinois Nutrient Loss Reduction Strategy staffing and programming.
- Ohio–USDA partnership: ODA and Department of Natural Resources and USDA support a Scioto River Watershed as part of the Conservation Reserve Enhancement Program to reduce sediment and nutrient loads and improve water quality and wildlife habitat.
- USDA and EPA continue to partner on watershed-scale implementation of agricultural conservation practices for nutrient reduction and enhanced conservation planning in all NWQI watersheds.

- The USGS and the USACE Rock Island District, in partnership with the Upper Mississippi River Basin Association and others, released a report regarding the ecological status and trends of the Upper Mississippi and Illinois Rivers (Houser et al. 2022). The report is the third of its kind produced as part of the UMRR program and includes information on long-term changes in water quality, aquatic vegetation, and fish from six study areas across the Upper Mississippi and Illinois Rivers.
- In 2021, the Agricultural Nutrient Policy Council released a document, *American Agriculture's State, Regional, and National Initiatives to Reduce Nutrient Losses in the Mississippi River Basin*, that describes how farmers and agribusinesses have helped states implement their nutrient loss reduction strategies.
- Nongovernmental organizations continue to make key investments in conservation. As just one example among many, in Iowa the Nature Conservancy and a broad coalition of partners are implementing the Iowa “4R Plus” program.

4.3 The Importance of Incorporating Scientific Advancements and New Findings into Nutrient Strategies

The HTF, its partners, and the scientific community have made tremendous strides in characterizing the hypoxic zone and many of the upstream, land-based factors that contribute to its annual formation. Research on the scope and scale of efforts for achieving the necessary nutrient reductions has been impressive, and the findings provide insight into expanding conservation implementation (Sharpley et al. 2019; Fennel and Laurent 2018; CAST 2019).

Because much of the nutrient load in the northern Gulf originates on agricultural land, research into the application, fate, and transport of fertilizer applied to Midwestern lands is critical. Researchers have found that “managing agricultural nutrients to achieve water quality goals involves complexities best organized around source and transport processes,” because once nutrients are applied, “management outcomes are influenced by several factors across many scales, most uncontrollable, which must be considered when transferring science into policy” (Sharpley et al. 2019). Attempts to intercept, treat, or otherwise address nutrients after they are mobilized on the landscape are complex, difficult, and often costly. More effectively planning and calibrating nutrient applications provides the opportunity to improve both a producer’s return on investment and water quality. For example, the Fertilizer Institute, The Nature Conservancy, and state partners promote optimized on-farm nutrient management using the 4Rs (NIMSS 2023).

This educational approach highlights the key decision points in crop nutrient application, from selecting crop-specific blends of nitrogen and phosphorus to ensuring efficient uptake by plants. It also guards against practices that might lead to excessive fertilizer runoff, like applying fertilizer on frozen or wet ground before a storm. Illinois’ Keep it 4R Crop program is a partnership with the Illinois Fertilizer and Chemical Association’ who works closely with stakeholders and promote education and adoption of fertilizer management processes. Nutrient management is challenging to scale up (Osmond et al. 2012), and this communication strategy is reaching many nutrient application decision makers.

Other states are also utilizing the best available science in updating and implementing their nutrient reduction strategies and identifying and prioritizing key areas for BMP implementation. For example, Indiana is using the latest science to improve the accuracy of nutrient load and concentration estimates and reductions from BMPs. This improved accuracy helps to direct their efforts for further nutrient reductions. Arkansas and Kentucky both have an updated NRS that incorporates 30 years of data to identify priority areas for targeted nutrient reduction, which will allow for optimized resource use. Many states are also using models such as STEPL and the Pollutant Load Estimation Tool (PLET) to estimate the impacts of BMPs on nutrient reduction, helping to increase understanding of the effects that BMPs have on overall nutrient reduction goals.

To better address the complexities of nutrient management, NRCS recently highlighted *SMART* nutrient management planning which includes the 4Rs of nutrient stewardship (right source, right method, right rate, and right timing) *and* emphasizes smart activities to reduce nutrient loss by adding *assessment* of comprehensive, site-specific conditions, recognizing that nutrient needs—as well as risks for nutrient losses—vary even within a field. Additionally, as part of its effort to increase use of nutrient management practices, NRCS has also recently signed two Memorandums of Understanding (MOUs) that further its conservation efforts targeted at improving nutrient management through the NRCS Technical Service Provider Program. These MOUs with American Society of Agronomy (ASA) and its International Certified Crop Adviser (ICCA) Program and with ag-retailer Truterra LLC, a Land O'Lakes company, will enable NRCS to leverage partnerships to expand capacity and reach new producers with technical and financial assistance.

Data collection and application at the local level is a critical component of integrating new science into nutrient strategies. For example, Indiana is utilizing field-specific data in its Infield Advantage program to optimize management practices. This ensures that the best possible practices are being utilized in each field within the program, optimizing nutrient reductions. Kentucky's updated NRS has been tailored to the state's unique geologic, agricultural, and hydrologic landscape to optimize load reductions.

The HTF NPS Workgroup developed a list of key conservation practices, by working with SERA-46 and the Walton Family Foundation. The HTF NPS Workgroup is identifying, inventorying, and analyzing these practices to derive nutrient loss estimates using a Conservation Tracking Framework (Christianson 2019). The framework can be used across HTF states to ensure centralized, consistent, and accessible data sources for assessing progress. This framework can also be used to support each state as it implements its individual nutrient strategies and help ensure agricultural conservation practices adopted across the MARB are accurately and consistently reported.

Finally, as noted previously in this report, the collective impacts from climate change on the hypoxic zone and nutrient loads (from contemporary and legacy sources) from the MARB may make the achievement of HTF goals more complex. Many studies suggest that current management actions need to be adapted to meet reduction goals for nutrient loading and the size of the hypoxic zone (Donner and Scavia 2007; Zhang et al. 2022) climate considerations in nutrient loss reduction strategies. However, more information about the extent and scale of management actions required to offset the effects of climate change is needed to support the decision-making process. Management responses for reducing risks should consider robust strategies and practices capable of addressing a range of potential future conditions to ensure that HTF goals can be met (Paul et al. 2019).

4.4 The Significance of Place-Based Nutrient Reduction Strategies

While many sources contribute to excess nutrients in the MARB, much of the nutrient load in MARB waterways and the Gulf come from nonpoint sources, a majority of which are from agricultural losses (Robertson and Saad 2019, 2021; White et al. 2014). During the 20-plus year history of the HTF, the federal policy and legal and regulatory framework for managing NPS pollution has remained largely unchanged, relying on state strategies and programs; federal financial and technical assistance and investments in science; and some efforts to encourage market-based approaches, including trading between regulated point sources and unregulated nonpoint sources. This framework, which encompasses more than two decades of research, multiple conservation developments and implementation, wastewater treatment improvements, nutrient management innovation, and partnership building by the HTF and many others, shows that there is no one-size-fits-all approach to reducing excess nutrients. State nutrient reduction strategies—with each state using a combination of regulatory programs, financial and technical assistance, and community-based and innovative approaches that works best for that state, its partners, and its stakeholders, and supported by federal partners—continue to be the cornerstone of the HTF's strategic work. Still, while recognizing the need for flexibility and adaptability, there are common themes that emerge from these state-led efforts and inform the HTF's future directions. These include:

- Identifying and targeting the highest priority nutrient source areas for conservation treatment are necessary to make the most progress. Data-driven tools (e.g., remote sensing and analysis, modeling) that identify priority nutrient source areas, inventory existing conservation practices, and estimate the relative potential for nutrient load reduction can help target scarce resources.
- Nutrient management—controlling nitrogen and phosphorus at the source—can provide a strong return on conservation investments and reduce costs for producers, providing an economic incentive for progress. Yet, in many areas achieving nutrient reduction at the scale needed to meet the HTF's 2035 goal and local water quality objectives will require the use of additional elements of a comprehensive conservation system to also control and trap excess nutrients.
- Given the work needed, the HTF should more fully consider opportunities to expand the use of innovative financing approaches, including market-based and "pay for performance" approaches to broaden the circle of partners who invest in reducing excess nutrients in the MARB.
- Communicating examples of success to producers and their networks of trusted advisors is critical for progress. Highlighting stories of success and of remaining challenges to the public at large is also essential to sustaining and expanding the HTF's work.

Part 5. Recommended Appropriate Actions to Continue to Implement or, if Necessary, Revise the Strategy Set Forth in the Gulf Hypoxia Action Plan 2008

5.1 Continue to Implement the Action Plan

Much has been accomplished since the HTF adopted its Action Plan over a decade ago, and much more work remains to be done. State-of-the-art scientific and social knowledge (esp., conservation promotion) has advanced significantly. The Action Plan set in motion scientific, technical, educational, and public policy activities to assess the problem and advance the adoption of solutions more thoroughly. The groundwork laid over the intervening years provides a clear path forward. No significant changes are needed in the specific actions in the plan; rather, those actions need to be scaled up considerably, especially in priority areas.

State and federal members and their many partners and stakeholders should continue monitoring, assessing progress, taking action, and adaptively managing their work. This will include testing new approaches that can enlist additional partners and resources to help the HTF achieve its goals. Activities set in motion by the Action Plan—supporting state nutrient reduction strategies, accelerating nutrient loss reduction, advancing the science, tracking progress, and raising awareness—remain relevant. Leveraging existing conservation and water management programs, promoting efficient and effective nutrient reduction practices, and scaling up successful watershed planning approaches are foundational to success (Rao and Power 2019). Harnessing the power of “big data” to assess nutrient impacts, quantify pollutant loads, prioritize management actions, track conservation practices, and evaluate programs and progress is essential.

Advancements in the scientific understanding of nutrient transport, transformation, and fate over the past 20 years have reduced some uncertainties regarding the dynamic processes associated with the challenges and solutions needed to advance implementation, but much work remains to be done (Sharpley et al. 2019), such as addressing potential climate impacts. The HTF must continue to rely upon sound science and evidence-based solutions to advance towards its goals.

Finally, the HTF is focused on communicating results to increase awareness of Gulf hypoxia and build a broader understanding of the wide array of work being accomplished by the HTF, the challenges, and the need for greater support and engagement by partners and stakeholders to make more progress.

5.2 Accelerate Actions to Reduce Excess Nutrients

Accelerated implementation of state nutrient reduction strategies—supported by federal HTF members and with active participation by private sector, nongovernmental, other partners, and stakeholders—continues to be the path forward. IIJA and IRA investments are providing vitally needed, additional federal support for water infrastructure and scaling up conservation treatments on the landscape. New and continued state-led conservation investments are pivotal as well. Examples of recent state actions that the HTF can build on to accelerate progress include leveraging funding and resources to better identify priority watersheds for nutrient conservation, conducting outreach and engaging in partnerships in priority watersheds and with associated organizations, and conducting further research to better estimate and track nutrient load reductions from conservation practices.

Even with additional federal and state investments, innovative financing approaches are needed to further scale up implementation. Several states have or are in the process of implementing innovative approaches, including using their Clean Water State Revolving Fund programs to support nonpoint source projects, testing out "pay for performance" models, and using water quality trading programs to facilitate collaboration among point and nonpoint sources. A common theme across the states within the MARB is utilization of new science and tools to accelerate actions that reduce nutrient loads. New science is being incorporated into decision-making to prioritize and optimize resource use within nutrient reduction strategies. Tools are being developed and advanced to assist in planning and prioritization, particularly with the implementation and understanding of BMPs (see section 2.2.2). The HTF can further support and build upon these prioritization and optimization efforts. We have learned that improving the alignment of nutrient management with crop needs has slowed the rate of nutrient balance increases, indicating some success in controlling nutrients at the source (see section 1.6).

5.3 Research Needs

The HTF recognizes that more research is needed for effective implementation of nutrient reduction strategies. In response, the HTF chartered the Research Needs workgroup to identify key research needs that effectively support state implementation of nutrient reduction strategies. This group has identified 14 needs or data gaps and conducted a survey among HTF members to identify the top seven research priorities. Research needs that have been identified range from the social sciences (e.g., how to successfully promote the implementation of conservation practice systems) to the physical sciences (e.g., nutrient transport, transformation, and fate). A Health and Environmental Research Online (HERO) database has been created to house the literature findings. A literature review for the impacts of legacy nutrients on water quality has been completed and a literature review for BMPs is in progress. The workgroup is planning to work with the states to further identify research gaps that need to be filled to support implementation of state nutrient reduction strategies.

In accordance with the GHP priorities and given the findings that climate change can impact the effects of nutrient loading on the hypoxic zone, climate considerations should be incorporated into the state nutrient reduction strategies to accelerate progress toward reaching the HTF 2025 interim target and 2035 goal. Further research is needed to provide a better understanding of climate change effects on the hypoxic zone and inform management responses. For example, the development of models that incorporate climate change together with other cascading factors (e.g., land use/management changes, legacy nutrients) would improve knowledge about potential vulnerabilities and impacts. Models need to consider dynamics beyond temperature and freshwater discharge effects, including altered hydrodynamic circulation patterns and variable nutrient loads, to comprehensively assess the cumulative impacts the hypoxic zone. Watershed scale legacy nutrients are expected to further contribute to nutrient loading, but the effects under future climate conditions are yet to be fully explored in the scientific literature. Undertaking this research would provide a clearer path forward on actions to prioritize to efficiently reduce excess nutrients.

5.4 Better Communicate Results to the Public

Many HTF states and federal members regularly communicate to their constituencies about work they do to reduce excess nutrients in waterways, their scientific studies on Gulf hypoxia, and causes of hypoxia. To amplify and support these efforts, the HTF is implementing a communication strategy to highlight topics such as successful projects and programs that have the potential for replication in other states; case studies that result in demonstrable progress or measurable environmental results; opportunities to support markets to fund watershed improvements and establish nutrient trading programs; and innovative partnerships created by supply chain and other market-based entities. The HTF is also increasing engagement with state outreach and media affairs personnel to communicate progress, publishing the HTF Newsletter that amplifies relevant information from across the MARB, and publishing a success stories story map to highlight where states have reduced nutrients.

5.5 Conclusion

This fourth report to Congress, required by the 2014 HABHRCA Amendments, describes the progress made by the HTF toward attainment of its goals since the 2019/2021 Report to Congress. The members of the HTF continue to work collaboratively to implement the 2008 Action Plan, which has advanced through support provided by the new Gulf Hypoxia Program under the IIJA.

All HTF states are implementing strategies to reduce excess nutrients in the MARB that contribute to the hypoxic zone in the Gulf, with unprecedented levels of federal support. The HTF is committed to making strong progress on implementing these strategies and other actions outlined in the 2008 Action Plan. Federal agencies are providing coordination support and technical and financial assistance and engaging in scientific investigations to support state and tribal efforts to reduce excess nutrients. The HTF will continue to incorporate the latest science in implementing nutrient reduction strategies and will aggregate climate co-benefits, where known, to provide the foundation for future progress and scientific advancement. The HTF continues to forge action-focused partnerships, employ innovative approaches, and invest in tracking progress. The HTF remains committed to meeting its 2025 interim target and its 2035 goal for reducing Gulf hypoxia.

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Appendix A. Nutrient Parameters Included in the NPDES Permit Counts

From the universe of major sewage treatment plants, EPA tallied facilities with effluent monitoring and limits for various forms of nitrogen (excluding ammonia) and phosphorus. This appendix documents the parameters included in counts of nutrient monitoring and limit requirements.

Parameter code	Parameter description	Pollutant code	Chemical Abstracts Service Registry number
00600	Nitrogen, total [as N]	2817	7727-37-9
00602	Nitrogen, Dissolved	99999	
00605	Nitrogen, organic total [as N]	2817	7727-37-9
00607	Nitrogen, organic, dissolved [as N]	2817	7727-37-9
00613	Nitrite nitrogen, dissolved [as N]	2806	14797-65-0
00615	Nitrogen, nitrite total [as N]	2806	14797-65-0
00618	Nitrogen, nitrate dissolved	5713	14797-55-8
00620	Nitrogen, nitrate total [as N]	5713	14797-55-8
00621	Nitrate nitrogen, dry weight	5713	14797-55-8
00623	Nitrogen, Kjeldahl, dissolved [as N]	2817	7727-37-9
00625	Nitrogen, Kjeldahl, total [as N]	2817	7727-37-9
0625D	Nitrogen, Kjeldahl, total [as N] [per discharge]	2817	7727-37-9
00630	Nitrite + Nitrate total [as N]	10354	
00631	Nitrite plus nitrate dissolved 1 det.	10354	
00640	Nitrogen, inorganic total	2817	7727-37-9
00650	Phosphate, total [as PO4]	5878	14265-44-2
00653	Phosphate total soluble	5878	14265-44-2
00655	Phosphate, poly [as PO4]	5878	14265-44-2
00660	Phosphate, ortho [as PO4]	5878	14265-44-2
00662	Phosphorus, total recoverable	5889	7723-14-0
00664	Dock discharge of phosphorus	5889	7723-14-0
00665	Phosphorus, total [as P]	5889	7723-14-0
0665S	Phosphorus, total [as P] [per season]	5889	7723-14-0
00666	Phosphorus, dissolved	5889	7723-14-0
00667	Phosphorus, dissolved reactive [drp as P]	5889	7723-14-0
00670	Phosphorus, total organic [as P]	5889	7723-14-0
00671	Phosphate, ortho, dissolved [as P]	5878	14265-44-2
01299	Nitrogen-nitrate in water [pct]	5713	14797-55-8
04157	Phosphorus [reactive as P]	5889	7723-14-0
04175	Phosphate, ortho [as P]	5878	14265-44-2
49579	Nitrogen, total Kjeldahl	2817	7727-37-9
50785	Phosphorus, ortho	5889	7723-14-0
51084	Nitrogen, total available [water]	2817	7727-37-9
51086	Nitrogen, nitrate [NO_3] [water]	5713	14797-55-8
51087	Nitrogen, Kjeldahl, total [TKN] [water]	2817	7727-37-9
51092	Phosphate, total [P2O5], water	11195	17101-36-9
51100	Nitrogen, total, as NO_3 [water]	5713	14797-55-8
51425	Nitrogen, Total as N	99999	N/A

Parameter code	Parameter description	Pollutant code	Chemical Abstracts Service Registry number
51426	Phosphorus, Total as P	99999	N/A
51445	Nitrogen, Total	2817	7727-37-9
51447	Nitrogen, Nitrite Total	2806	14797-65-0
51448	Nitrogen, Nitrate Total	5713	14797-55-8
51449	Nitrogen, Kjeldahl Total	2817	7727-37-9
51450	Nitrite Plus Nitrate Total	10354	N/A
51451	Phosphorus, Total	5889	7723-14-0
51489	Nitrogen, Total as NO_3 + NH_3	12586	N/A
51622	Limiting Nutrient [Nitrogen or Phosphorus]	99999	N/A
51662	Nitrogen, Kjeldahl, Total [TKN], insoluble	2817	7727-37-9
51663	Phosphorus, insoluble	5889	7723-14-0
51675	Annual Nitrate Nitrogen Discharged	5713	14797-55-8
51699	Phosphorus, Total [Avg Seasonal Load Cap]	5889	7723-14-0
51764	Phosphorus Adsorption	5889	7723-14-0
70505	Phosphate, total, color method [as P]	5889	7723-14-0
70506	Phosphate, dissolved color method [as P]	5878	14265-44-2
70507	Phosphorus, in total orthophosphate	5889	7723-14-0
71850	Nitrogen, nitrate total [as NO_3]	5713	14797-55-8
71888	Phosphorus, total soluble [as PO4]	5878	14265-44-2
81393	Nitrogen, total Kjeldahl, % removal	2817	7727-37-9
81639	Nitrogen Kjeldahl, total [TKN]	2817	7727-37-9
82386	Nitrogen, oxidized	2817	7727-37-9
82539	Nitrogen, Kjeldahl	2817	7727-37-9

Appendix B. State-Specific Facility Level Data and Methods

This appendix contains facility level data for each of the three measures, monitoring, limits, and loads, for each HTF state. Each state uses methods described in section 1.4.1.2; the load notations are described in the table footnotes, as each state may use a combination of options.

B-1 Arkansas

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
AR0020010	Fayetteville, City of	✓	✓		✓	250,193*	2,843
AR0020087	Forrest City, City of	✓	✓			71,125*	9,739
AR0020273	Siloam Springs, City of	✓	✓		✓	123,064*	5,246
AR0020303	North Little Rock WW Utility – Faulkner Lake	✓	✓			262,107*	28,133
AR0020320	North Little Rock WW Utility – Five Mile Creek WWTP					250,487*	41,144*
AR0020605	Arkadelphia, City of					93,043*	18,966*
AR0020702	Batesville Water Utilities – Batesville Wastewater Treatment Plant	✓	✓			249,768*	94,633
AR0021211	Mountain Home, City of – WWTP	✓	✓	✓		115,764*	24,053
AR0021466	Alma, City of	✓	✓			56,520*	13,886
AR0021482	Van Buren, City of – Main Plant	✓	✓			115,934*	97,756
AR0021580	Osceola, City of					44,217*	8,738*
AR0021601	Searcy Board of Public Utilities	✓	✓			187,557*	**
AR0021661	Cabot Water & Wastewater Commission	✓	✓			104,820*	3,577
AR0021733	Dequeen, City of	✓	✓	✓	✓	107,652*	3,328
AR0021741	Green Forest, City of-WWTP	✓	✓	✓	✓	95,957*	1,456
AR0021750	Fort Smith, City of-Massard WWTP	✓	✓			383,806*	42,543
AR0021768	Russellville Water & Sewer System, City Corporation	✓		✓		256,947*	42,507*
AR0021776	Nashville, City of	✓	✓			25129†	1995†
AR0021792	Berryville, City of-Berryville Wastewater Treatment Plant		✓		✓	56,629*	2,169

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
AR0021806	Little Rock Water Reclamation Authority-Adams Field Water Reclamation Facility	✓	✓			881,810*	20,901
AR0021822	Monticello, City of-West Plant	✓	✓			96,546*	618
AR0021831	Monticello, City of – East Plant	✓	✓			21,119*	5
AR0021903	Wynne, City of	✓	✓			43,736*	6,354
AR0021971	Marion, City of					497,405*	78,422*
AR0022004	Huntsville, City of	✓	✓	✓	✓	55,577*	2,964
AR0022021	West Helena, City of – Water Utilities	✓	✓			67,848*	4,423
AR0022039	West Memphis, City of – Utilities	✓	✓			226,798*	196,971
AR0022063	Springdale Water & Sewer Commission		✓		✓	592,326*	13,342
AR0022101	Beebe Water and Sewer Commission	✓	✓			65,785*	9,962
AR0022187	Clarksville Light & Water	✓	✓			81,328*	17,133
AR0022250	Dermott, City of-South Pond					12,103*	2,287
AR0022292	Decatur, City of	✓	✓	✓	✓	119,728*	3,175
AR0022365	Camden Water Utilities	✓	✓			151,204*	471
AR0022381	Heber Springs Water and Sewer Commission D/B/A Heber Springs Water Department	✓	✓		✓	57,631*	42,776
AR0022403	Bentonville, City of	✓	✓	✓	✓	35,308†	699,380†
AR0022454	Greenwood, City of	✓	✓			46,699*	5,219
AR0022560	Blytheville, City of-West WWTF	✓	✓			27,273*	5,265
AR0022578	Blytheville, City of-South WWTF	✓	✓			38,197*	4,353
AR0033278	Fort Smith, City of – "P" Street WWTP					470,117*	70,556
AR0033316	Pine Bluff Wastewater Utility	✓	✓			**	**
AR0033626	North Little Rock Wastewater Utility-Maumelle Water Management					83,438*	17,008*
AR0033723	El Dorado Water Utilities – South Plant	✓	✓			111,777*	1,819
AR0033766	Paragould Light, Water and Cable WWTP	✓	✓			164,812*	23,562

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
AR0033880	Hot Springs, City of	✓	✓		✓	519,133*	27,718
AR0033936	El Dorado Water Utilities – North Plant	✓	✓			96,280*	1,249
AR0033987	Dumas, City of					20,419*	3,426*
AR0034002	Bryant, City of	✓	✓			89,041*	13,932
AR0034126	Malvern, City of	✓	✓			117,907*	**
AR0034291	Hot Springs Village Poa-Mill Creek WWTP	✓	✓		✓	33,488*	1,127
AR0034321	Harrison, City of		✓			94,671*	14,223
AR0034380	Stuttgart, City of	✓	✓			57,042*	46,775
AR0035602	Trumann, City of		✓			19,558*	6,099
AR0036498	Benton, City of	✓	✓			240,773*	24,444
AR0036692	Mena, City of					207,869*	35,324*
AR0037044	Newport, City of					56,615*	11,541*
AR0037176	Sherwood, City of – North Facility					23,951*	4,018*
AR0037907	Jonesboro, City of-City Water & Light (CWL)-Westside WWTP					92,021*	18,758*
AR0038288	North Little Rock WW Utility-White Oak Bayou					149,224*	27,349*
AR0038466	Hope, City of – Bois D'Arc WWTP	✓	✓			36,878*	6,292
AR0039284	Hot Springs Village Poa-Cedar Creek WWTP	✓	✓		✓	54,266†	418
AR0040177	Little Rock Water Reclamation Authority	✓	✓			412,465*	38,066
AR0040967	Van Buren Municipal Utilities Commission-Van Buren North Treatment Plant	✓	✓			65,535*	7,081
AR0041335	Jacksonville Wastewater Utility – J. Albert Johnson Regional Treatment Facility		✓			214,913*	26,351
AR0042951	Ashdown, City of	✓	✓			19,038*	852
AR0043389	Helena Municipal Water and Sewer System					55,090*	11,041*
AR0043397	Rogers, City of		✓		✓	397,473*	4,182
AR0043401	Jonesboro, City Water & Light Plant of The City of – Eastside WWTP					337,476*	50,649*
AR0043427	Warren Water & Sewer, City of	✓	✓			36,597*	1,752

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
AR0043613	Magnolia, City of-Big Creek WWTP	✓	✓			75,598*	4,814
AR0046566	Walnut Ridge, City of-WWTP	✓	✓			25,780*	9,486
AR0047279	Conway Corporation – Tucker Creek WWTP					169,439*	31,537*
AR0048747	Clinton, City of-West WWTF	✓	✓	✓	✓	0	0
AR0048801	Barling, City of	✓	✓			83,094*	20,059
AR0048836	Clinton, City of-East WWTF	✓	✓			20,046*	**
AR0050024	Northwest AR Conservation Authority	✓	✓		✓	139,255*	877
AR0050288	Fayetteville/West Side WWTP		✓		✓	369,080*	4,604
AR0050849	Little Rock Water Reclamation Authority	✓	✓			94,818*	2,115
AR0051951	Conway Corporation – Tupelo Bayou WWTP	✓	✓			227,067*	30,235
AR0050296	El Dorado, City of – Ouachita Joint Pipeline		✓		✓	368,321*	9,754*
Totals	79 facilities	55	62	8	18	11,819,508	2,165,827

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with * are EPA loading tool estimates.
Loads marked with † are state provided from DMR data. DMR data in ICIS was cross-checked with state DMR records and corrected load estimates were provided, calculated with methods consistent with the EPA loading tool.
** indicates no/insufficient data to make an estimate, due to monitoring/reporting not being required and further data transfer issues between DMR inputs and loading tool outputs.

B-2. Illinois

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IL0020052	Plano, City of	✓	✓		✓	38,640	1,293
IL0020061	Wood Dale, City of	✓	✓			70,069	13,157
IL0020087	Geneva, City of	✓	✓			77,280	4,170
IL0020109	Wauconda, Village of	✓	✓			122,348	2,050
IL0020117	Harvard, City of	✓	✓		✓	7,242	3,294
IL0020214	Milan, Village of	✓	✓			55,645	8,371
IL0020222	Manhattan, Village of	✓	✓		✓	26,609	981
IL0020273	Flora, City of	✓	✓			29,619	4,437
IL0020281	Hampshire, Village of	✓	✓		✓	26,299	707
IL0020354	Antioch, Village of	✓	✓		✓	67,762	1,970
IL0020516	Cary, Village of	✓	✓		✓	65,008	1,363

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IL0020559	New Lenox, Village of	✓	✓		✓	121,541	4,450
IL0020575	Princeton, City of	✓	✓			28,769	8,042
IL0020583	Fox River Grove, Village of	✓	✓		✓	40,983	2,846
IL0020621	Litchfield, City of	✓	✓		✓	72,245	5,813
IL0020729	Marengo, City of	✓	✓	✓	✓	19,508	1,539
IL0020788	Danville Sanitary District	✓	✓			346,016	18,149
IL0020796	Lindenhurst Sanitary District	✓	✓		✓	28,987	801
IL0020818	Fox Metro Water Reclamation District	✓	✓			2,018,442	69,175
IL0020958	Fox Lake, Village of	✓	✓		✓	479,679	17,843
IL0021059	Marseilles, City of	✓	✓			42,280	5,952
IL0021083	Caseyville Township	✓	✓		✓	139,139	5,418
IL0021113	Morris, City of	✓	✓			73,480	7,817
IL0021121	Crest Hill, City of	✓	✓			41,144	9,970
IL0021130	Bloomingdale, Village of	✓	✓			158,465	29,370
IL0021156	South Beloit, City of	✓	✓			127,625	17,684
IL0021181	Swansea, Village of	✓	✓		✓	48,282	8,907
IL0021237	Creve Coeur, Village of	✓	✓			41,871	6,309
IL0021261	Lockport, City of	✓	✓			47,613	4,780
IL0021288	Greater Peoria Sanitary and Sewage District	✓	✓			318,507	61,694
IL0021377	Paris, City of	✓	✓			65,287	21,860
IL0021547	Glenbard Wastewater Authority	✓	✓			658,960	69,487
IL0021598	Barrington, Village of	✓	✓			110,449	6,160
IL0021636	O'Fallon, City of	✓	✓			60,526	13,141
IL0021644	Charleston, City of	✓	✓			152,229	16,617
IL0021661	Jacksonville, City of					437,471†	51,363†
IL0021733	Lake in the Hills Sanitary District	✓	✓		✓	63,697	6,144
IL0021784	Kankakee River Metropolitan Agency	✓	✓			2,246,110	52,632
IL0021814	Geneseo, City of	✓	✓			61,172	19,981
IL0021849	Bensenville, Village of	✓	✓		✓	100,081	4,647
IL0021873	Belleville, City of	✓	✓		✓	237,461	16,882
IL0021971	Springfield Metro Sanitary District	✓	✓		✓	214,225	15,341
IL0021989	Sangamon County Water Rec District	✓	✓		✓	773,172	38,146
IL0022004	Streator. City of	✓	✓	✓	✓	57,245	7,011
IL0022055	Lake County Public Works Department	✓	✓		✓	261,534	18,653

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IL0022071	Lake County Public Works Department	✓	✓		✓	64,373	4,170
IL0022128	Rantoul, Village of	✓	✓		✓	117,227	17,792
IL0022161	Watseka, City of	✓	✓			2,354	6,240
IL0022179	Momence, City of	✓	✓			44,590	10,271
IL0022314	Pana, City of	✓	✓		✓	46,393	6,918
IL0022365	Benton, City of	✓	✓		✓	13,394	3,881
IL0022501	Mundelein, Village of	✓	✓			227,095	10,051
IL0022519	Joliet, City of	✓	✓			496,436	80,371
IL0022543	Batavia, City of	✓	✓		✓	185,881	7,081
IL0022586	Flagg Creek Water Reclamation District	✓	✓		✓	625,017	31,040
IL0022675	Carlinville, City of	✓	✓			38,175	11,282
IL0022705	St Charles. City of	✓	✓		✓	119,710	11,340
IL0023027	Kishwaukee Water Reclamation District	✓	✓		✓	398,028	24,887
IL0023141	Galesburg Sanitary District	✓	✓			233,759	52,255
IL0023221	Mendota, City of	✓	✓			69,787	8,823
IL0023248	Murphysboro, City of	✓	✓		✓	8,892	3,231
IL0023264	Salem, City of	✓	✓		✓	26,518	2,513
IL0023329	Algonquin, Village of	✓	✓		✓	88,489	8,159
IL0023469	West Chicago, City of	✓	✓			244,656	31,996
IL0023574	Vandalia, City of	✓	✓		✓	43,131	3,973
IL0023591	Freeport, City of	✓	✓			209,241	19,571
IL0023612	Clinton Sanitary District	✓	✓			35,880	6,814
IL0023825	Cairo, City of					25,891†	4,459†
IL0024201	Mokena, Village of	✓	✓		✓	112,060	22,634
IL0024465	Jerseyville, City of	✓	✓		✓	37,084	2,635
IL0024473	Aqua Illinois, Inc.	✓	✓		✓	68,964	3,040
IL0024830	Hoopeston, City of	✓	✓			4,357	1,671
IL0025089	Aqua Illinois	✓	✓			76,279	11,061
IL0025135	Beardstown Sanitary District	✓	✓			46,761	7,472
IL0025143	Columbia, City of	✓	✓			89,024	13,742
IL0025232	Stookey Township	✓	✓		✓	34,648	4,334
IL0026085	Wilmington, City of	✓	✓		✓	22,176	1,969
IL0026298	Greenville, City of	✓	✓			23,080	4,797
IL0026310	Edwardsville, City of	✓	✓			161,431	25,231
IL0026352	Carol Stream, Village of	✓	✓			232,544	32,648
IL0026450	Dixon, City of	✓	✓			131,136	43,765
IL0026808	St Charles, City of		✓			26,907†	5,373

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IL0027201	Rock River Water Reclamation District	✓	✓			2,141,766	223,527
IL0027341	Mt Vernon, City of	✓	✓		✓	86,620	1,450
IL0027367	Addison, Village of	✓	✓			132,058	20,794
IL0027464	Alton, City of	✓	✓			258,926	33,783
IL0027618	Bartlett, Village of	✓	✓			136,474	18,890
IL0027685	Belvidere, City of	✓	✓			92,883	21,264
IL0027723	Thorn Creek Basin Sd STP	✓	✓			672,779	96,844
IL0027731	Bloomington/Normal Water Reclamation District	✓	✓			844,771	124,924
IL0027839	Canton, City of	✓	✓			45,096	10,713
IL0027871	Carbondale, City of	✓	✓			36,242	25,820
IL0027898	Carbondale, City of	✓	✓			46,760	724
IL0027910	Carmi, City of	✓	✓		✓	38,338	4,857
IL0027944	Carpentersville, Village of	✓	✓			90,976	3,804
IL0027979	Centralia, City of	✓	✓			51,999	33,025
IL0028053	Metro Water Reclamation District of Greater Chicago	✓	✓			20,067,125	2,435,218
IL0028061	Metro Water Reclamation District of Greater Chicago	✓	✓			7,942,720	2,569,259
IL0028070	Metro Water Reclamation District of Greater Chicago					142,852†	17,940†
IL0028088	Metro Water Reclamation District of Greater Chicago	✓	✓			7,154,543	978,314
IL0028215	Collinsville, City of	✓	✓		✓	209,720	8,029
IL0028282	Crystal Lake, City of	✓	✓			200,740	4,004
IL0028321	Decatur Sd Main STP					1,066,611†	1,897,809†
IL0028347	Deerfield, Village of	✓	✓		✓	111,154	17,814
IL0028380	Downers Grove Sanitary District	✓	✓			562,103	110,224
IL0028517	Duquoin, City of	✓	✓		✓	9,103	2,431
IL0028541	East Dundee, Village of	✓	✓		✓	31,755	4,692
IL0028550	East Moline, City of	✓	✓			55,503	33,291
IL0028576	East Peoria, City of	✓	✓			157,914	25,429
IL0028622	Effingham, City of	✓	✓			99,029	34,318
IL0028657	Fox River Water Reclamation District	✓	✓			1,484,430	173,032
IL0028665	Fox River Water Reclamation District	✓	✓		✓	221,966	27,615
IL0028746	Elmhurst, City of	✓	✓			247,549	63,878
IL0028967	Glendale Heights, Village of	✓	✓			169,179	27,565
IL0029149	Harrisburg, City of	✓	✓		✓	49,677	5,275

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IL0029165	Herrin, City of	✓	✓			105,273	16,363
IL0029173	Highland, City of	✓	✓			36,589	5,103
IL0029203	Hillsboro, City of	✓	✓		✓	64,636	10,339
IL0029238	Huntley, Village of	✓	✓		✓	28,250	938
IL0029343	Kewanee, City of	✓	✓			77,570	11,072
IL0029424	Lasalle, City of	✓	✓			76,484	7,352
IL0029467	Lawrenceville, City of	✓	✓			22,596	25,090
IL0029530	Libertyville, Village of	✓	✓			233,205	9,482
IL0029564	Lincoln, City of	✓	✓			118,700	15,991
IL0029611	Lockport, City of	✓	✓			171,037	7,475
IL0029688	Macomb. City of	✓	✓			111,456	20,666
IL0029734	Marion, City of	✓	✓		✓	89,313	6,736
IL0029831	Mattoon, City of	✓	✓			237,300	33,726
IL0029874	Metropolis, City of	✓	✓			68,684	8,234
IL0029939	Moline, City of	✓	✓			254,511	29,330
IL0029947	Moline, City of	✓	✓			203,550	10,228
IL0029980	Monticello, City of	✓	✓		✓	17,348	793
IL0030015	Morton, Village of	✓	✓			98,320	18,526
IL0030023	Mount Carmel, City of	✓	✓			76,715	20,733
IL0030171	North Shore Water Reclamation District	✓	✓		✓	710,000	39,700
IL0030244	North Shore Sanitary District	✓	✓		✓	1,055,000	65,200
IL0030384	Ottawa, City of	✓	✓			190,953	21,968
IL0030457	Pontiac, City of	✓	✓			229,023	17,881
IL0030503	Quincy, City of	✓	✓			200,201	106,291
IL0030660	Peru, City of	✓	✓			65,444	11,985
IL0030686	Pittsfield, City of	✓	✓			30,764	7,695
IL0030732	Robinson, City of	✓	✓		✓	17,075	1,240
IL0030741	Rochelle, City of	✓	✓			44,474	21,424
IL0030783	Rock Island, City of	✓	✓			232,791	22,505
IL0030813	Roselle, Village of	✓	✓			49,826	13,410
IL0030953	Salt Creek Sanitary District	✓	✓			218,278	25,709
IL0030970	Sandwich, City of	✓	✓		✓	11,992	4,773
IL0031216	Spring Valley, City of	✓	✓			21,004	4,799
IL0031291	Sycamore, City of	✓	✓			164,054	17,791
IL0031356	Taylorville Sanitary District	✓	✓			105,212	14,945
IL0031488	Troy, City of	✓	✓			36,747	13,525
IL0031500	Urbana & Champaign Sanitary District	✓	✓			656,401	59,348

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IL0031526	Urbana-Champaign Sanitary District	✓	✓		✓	253,165	8,099
IL0031704	West Frankfort, City of	✓	✓			23,682	5,158
IL0031739	Wheaton Sanitary District	✓	✓			369,529	51,914
IL0031844	Dupage County Department of Public Works	✓	✓			529,972	69,017
IL0031852	Wood River, City of	✓	✓			137,463	11,645
IL0031861	Woodstock, City of	✓	✓		✓	52,334	2,460
IL0031933	Northern Moraine WW Reclamation Dist.	✓	✓		✓	60,502	2,859
IL0032689	Bolingbrook, Village of	✓	✓			100,014	16,652
IL0032735	Bolingbrook, Village of	✓	✓			168,971	22,621
IL0032760	Illinois-American Water Company	✓	✓		✓	13,173	1,150
IL0033481	Granite City, City of	✓	✓			459,984	180,081
IL0033553	Joliet, City of	✓	✓		✓	531,726	20,116
IL0033812	Addison, Village of	✓	✓			199,100	28,549
IL0034061	Naperville, City of	✓	✓			852,901	162,805
IL0034274	Wood Dale, City of	✓	✓			27,025	2,547
IL0034282	Woodstock, City of	✓	✓			44,080	8,780
IL0034479	Hanover Park, Village of	✓	✓			52,106	8,728
IL0034495	Pekin, City of	✓	✓		✓	166,013	25,788
IL0035092	North Shore Sanitary District	✓	✓		✓	876,000	39,700
IL0035891	Fox River Water Reclamation District	✓	✓		✓	153,209	4,321
IL0036137	Metro Water Reclamation District of Greater Chicago					420,794†	58,396†
IL0036218	Monmouth, City of	✓	✓		✓	159,176	8,086
IL0036340	Metro Water Reclamation District of Greater Chicago					1,266,155†	210,437†
IL0036382	Rock Island SW STP					9,071†	1,522†
IL0036412	Yorkville-Bristol Sanitary District	✓	✓		✓	76,689	6,157
IL0036421	Illinois American Water-Godfrey Wastewater	✓	✓			51,560	7,234
IL0042412	Washington, City of	✓	✓		✓	90,248	5,262
IL0046213	East Peoria, City of	✓	✓			20,009	2,312
IL0047741	Metro Water Reclamation District of Greater Chicago					905,099†	51,584†
IL0048232	St. Clair Township	✓	✓			147	5,360
IL0048526	Romeoville, Village of	✓	✓		✓	236,361	14,609
IL0048721	Roselle, Village of	✓	✓			72,816	8,778
IL0048755	Olney, City of	✓	✓		✓	41,390	2,797

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IL0053457	Crystal Lake, City of	✓	✓		✓	28,820	503
IL0054992	Braidwood, City of	✓	✓		✓	24,623	976
IL0055913	Minooka, Village of	✓	✓		✓	22,125	1,738
IL0055981	Illinois American Water Company	✓	✓			21,935	811
IL0059757	Colona, City of	✓	✓			13,747	4,185
IL0060569	Sterling, City of	✓	✓			217,869	44,217
IL0062260	Elburn, Village of	✓	✓		✓	4,606	5,075
IL0064998	Crest Hill, City of	✓	✓		✓	45,947	14,484
IL0065145	Sauget, Village of					2,267,380†	16,754†
IL0065188	Dupage County Public Works	✓	✓			222,335	6,881
IL0066257	McHenry, City of	✓	✓		✓	76,204	4,096
IL0068764	Gilberts, Village of	✓	✓		✓	48,027	1,117
IL0069744	Bolingbrook, Village of	✓	✓			91,359	29,955
IL0070688	Huntley, Village of	✓	✓		✓	14,317	944
IL0071366	Lake County Department of Public Works	✓	✓		✓	30,316	236
IL0071447	Poplar Grove, Village of	✓	✓		✓	11,096	462
IL0072192	Frankfort, Village of – Regional WWTP	✓	✓		✓	206,684	9,023
IL0072931	Chester, City of	✓	✓			12,661	1,727
IL0073504	Bloomington-Normal Water Reclamation District	✓	✓			229,462	41,131
IL0074373	Plainfield, Village of	✓	✓		✓	209,077	9,734
IL0075191	Galena, City of	✓	✓			7,750	3,224
IL0075507	Peru, City of	✓	✓			30,219	11,387
IL0076414	Joliet, City of	✓	✓		✓	140,085	8,526
IL0077551	City of Waterloo	✓	✓		✓	16,201	2,744
IL0078301	Rock Falls, City of	✓	✓		✓	27,418	200
IL0079073	Village of Itasca	✓	✓			40,695	3,062
Totals	211 facilities	201	202	2	82	77,983,643	12,297,545

Nutrient Load Notes:
Unmarked loads are from state DMR data, calculated as described in the methods below.
Loads marked with † are from facilities without required monitoring in their permits and were provided by the facility through voluntarily submitted information.

Illinois Nutrient Load Calculation Methodology:

Illinois used DMR data to calculate 2020 TP and TN loads for major municipal wastewater facilities. Point sources are categorized as major municipal sewage treatment facilities (defined as having with a design average flow of 1.0 MGD or more) and major and minor non-public operated treatment works, which represent discharges from industrial wastewater facilities. Load estimates for minor municipal sewage treatment facilities were also used.

In 2020, there were 211 major municipal wastewater treatment facilities, with 198 required to monitor for TN and 199 for TP. Nutrient loads for these facilities were calculated using monthly DMR data retrieved from ICIS using ICIS Reports on the SAP Business Objects Business Intelligence Platform.

Monthly nutrient loads for each facility were calculated using monthly average flow values (MGD) and monthly average TP and TN concentrations from the main treatment outfall(s). Facilities that are not required by their permit to submit TN or TP DMR data were contacted and voluntarily submitted internal data.

All DMR data was manually screened for outlier values. Facilities were contacted and asked to verify or correct suspicious data. While more laborious, this method allows for better quality control checks of the DMR data, ensures the correct outfalls are used, and provides more transparency of how loads were calculated for each individual facility.

To calculate monthly loads for the major municipal facilities, the following formula was used:

Monthly Average Flow Value (MGD) *Monthly Average Nutrient Concentration (mg/L) *8.34 (conversion factor) *30.417 (average days in a month)

Monthly loads were added to calculate annual TP and TN loads for each major municipal facility.

The EPA Water Pollutant Loading Tool was used to calculate the 2020 annual loads for non-POTW industrial facilities. There were 18 majors and 300 minors with TN loads and 13 majors and 49 minors with TP loads. Monthly DMR data was used to serve as a check on some of the higher loading facilities for accuracy. Large fluctuations in loads for a facility from previous years were also investigated. It should be noted that loads from power plants were not included, as it is difficult to differentiate between nutrients added to process wastewater and nutrient already present in the source water influent.

The annual nutrient loads for minor municipal facilities are continued to be based on the estimates used in the original Nutrient Loss Reduction Strategy Science Assessment. These load estimates will continue to be used until additional resources are available to provide more accurate loads.

B-3. Indiana

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IN0020044	Alexandria WWTP		✓		✓	63,099*	4,538
IN0020079	Danville WWTP		✓		✓	52,724*	2,770
IN0020095	Portland WWTP		✓		✓	55,210*	5,387
IN0020109	Greenfield WWTP	✓	✓		✓	173,308	28,989
IN0020133	Greensburg WWTP	✓	✓		✓	120,131	10,321
IN0020150	Yorkton WWTP, Town Of					46,192*	2,799
IN0020168	Noblesville WWTP, City Of		✓		✓	262,722*	15,789

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IN0020176	Monticello WWTP	✓	✓		✓	8,277	552
IN0020184	Edinburgh WWTP	✓	✓		✓	10,721	4,124
IN0020303	Martinsville WWTP		✓		✓	47,373*	21,157
IN0020362	North Manchester WWTP	✓	✓		✓	19,767	4,657
IN0020397	Scottsburg WWTP		✓		✓	55,860*	2,236
IN0020419	Sellersburg Municipal WWTP	✓	✓		✓	11,532	3,555
IN0020427	Bremen WWTP		✓		✓	28,850*	1,947
IN0020435	Chandler WWTP	✓	✓		✓	25,699	6,263
IN0020451	North Vernon WWTP	✓	✓		✓	19,356	5,821
IN0020508	Charlestown Wastewater Treatment Plant	✓	✓		✓	17,405	3,158
IN0020575	Linton WWTP, City Of		✓		✓	54,527*	6,594
IN0020605	Santa Claus WWTP, Town Of		✓		✓	26,686*	1,403
IN0020818	Lebanon WWTP	✓	✓		✓	78,815	11,842
IN0020834	Jasper Municipal WWTP		✓		✓	280,997*	11,351
IN0020893	Corydon WWTP		✓		✓	31,964*	9,256
IN0020982	Union City WWTP		✓		✓	35,755*	4,097
IN0020991	Plymouth WWTP	✓	✓		✓	130,162	159,473
IN0021016	Tell City Municipal WWTP	✓	✓		✓	61,688	5,118
IN0021024	Winchester WWTP		✓		✓	31,084	1,592
IN0021032	Greencastle Wastewater Treatment Plant		✓		✓	68,951*	7,874
IN0021083	Ellettsville Municipal WWTP		✓		✓	49,686*	2,493
IN0021181	Franklin WWTP, City Of		✓		✓	163,902*	20,135
IN0021202	Plainfield Water Pollution Control		✓		✓	105,325*	10,900
IN0021211	Brazil WWTP, City Of	✓	✓		✓	16,682	8,297
IN0021245	Brownsburg WWTP		✓		✓	117,396	5,331
IN0021270	Rushville WWTP		✓		✓	61,468*	1,819
IN0021300	Cumberland WWTP		✓		✓	43,980*	1,812
IN0021377	Delphi WWTP		✓		✓	44,601*	1,512
IN0021474	Tipton WWTP		✓		✓	65,378*	808
IN0021628	Hartford City WWTP	✓	✓		✓	49,349	3,384
IN0021644	Salem WWTP	✓	✓		✓	40,525	1,390
IN0021661	Rochester Wastewater Treatment Plant	✓	✓		✓	66,977	3,720
IN0022314	Bargersville WWTP	✓	✓		✓	35,584*	8,359
IN0022411	Bluffton WWTP, City Of		✓		✓	89,150	3,291

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IN0022420	Boonville Municipal WWTP		✓		✓	469,727*	8,862
IN0022497	Carmel WWTP		✓		✓	410,294*	71,074
IN0022535	Centerville WWTP		✓		✓	16,852*	2,902
IN0022608	Clinton Municipal WWTP		✓		✓	22,187*	969
IN0022624	Columbia City WWTP		✓		✓	61,625*	8,530
IN0022934	Frankfort WWTP, City Of	✓	✓		✓	246,421	4,798
IN0022951	French Lick Municipal WWTP		✓		✓	29,949*	735
IN0022985	Gas City WWTP		✓		✓	32,924*	947
IN0023060	Hammond Sanitary District WWTP		✓		✓	1,673,969*	58,834
IN0023124	Huntingburg WWTP		✓		✓	46,163*	1,838
IN0023132	Huntington WWTP		✓		✓	201,615*	8,999
IN0023183	Indianapolis Belmont & Southport Awtp		✓		✓	8,087,796*	169,979
IN0023302	Jeffersonville Downtown WWTP		✓		✓	212,388*	12,161
IN0023604	Logansport Wastewater Treatment Plant		✓		✓	262,969*	10,253
IN0023621	Lowell Wastewater Treatment Plant		✓		✓	135,729*	4,295
IN0023825	Mooresville WWTP, Town Of		✓		✓	72,511*	8,268
IN0023884	New Albany WWTP	✓	✓		✓	467,916	40,358
IN0023892	Newburgh Municipal WWTP	✓	✓		✓	56,292	2,632
IN0023914	New Castle WWTP		✓		✓	222,462*	7,267
IN0023965	Oak Park Conservancy District	✓	✓		✓	32,258	1,028
IN0024392	Princeton Wastewater Treatment Plant		✓		✓	86,486*	2,288
IN0024414	Rensselaer WWTP, City Of	✓	✓		✓	80,897	16,359
IN0024449	Rockville Municipal WWTP		✓		✓	39,678*	1,073
IN0024457	Schererville Wastewater Treatment Plant		✓		✓	239,350*	28,687
IN0024473	Seymour WWTP, City Of		✓		✓	186,559*	10,400
IN0024538	South Dearborn R.S.D.	✓	✓		✓	87,336	5,870
IN0024554	Sullivan Municipal WWTP		✓		✓	65,106*	3,361
IN0024741	Wabash WWTP		✓		✓	77,794*	3,789
IN0024821	West Lafayette WWTP		✓		✓	302,293*	13,303
IN0024902	Peru Utilities-Grissom Division WWTP	✓	✓			6,701	4,711

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IN0025135	Austin WWTP	✓	✓		✓	17,096	883
IN0025577	Laporte WWTP	✓	✓		✓	192,150†	22,539
IN0025585	Marion WWTP, City Of		✓		✓	311,232*	8,590
IN0025607	Terre Haute WWTP, City Of		✓		✓	432,495*	21,910
IN0025615	Richmond WWTP		✓		✓	308,227*	14,375
IN0025623	Bedford Wastewater Treatment Plant		✓		✓	84,235*	4,803
IN0025631	Muncie Water Pollution Control Facility		✓		✓	882,485*	51,579
IN0025658	Washington WWTP		✓		✓	220,169*	52,430
IN0025666	Madison WWTP	✓	✓		✓	59,273	5,408
IN0031020	Vincennes WWTP, City Of	✓	✓		✓	162,649	4,168
IN0032328	Peru Utilities WWTP		✓		✓	88,488	10,200
IN0032336	Connersville WWTP	✓	✓		✓	80,431	12,225
IN0032468	Lafayette WWTP	✓	✓		✓	1,520,038	34,421
IN0032476	Anderson WWTP	✓	✓		✓	74,993	29,622
IN0032573	Columbus WWTP, City Of	✓	✓		✓	134,053	7,379
IN0032719	Elwood WWTP, City Of		✓		✓	126,071*	5,574
IN0032867	Shelbyville Water Resource Recovery Facility		✓		✓	200,520*	13,135
IN0032875	Kokomo WWTP, City Of		✓		✓	440,982*	6,802
IN0032956	Evansville West WWTP	✓	✓		✓	601,386	28,929
IN0032964	Crawfordsville WWTP, City Of	✓	✓		✓	147,017	19,891
IN0032972	Speedway WWTP		✓		✓	145,899*	23,574
IN0033073	Evansville East WWTP	✓	✓		✓	747,223	30,769
IN0035378	Aqua Indiana Main Aboite		✓		✓	90,048*	5,322
IN0035696	Mount Vernon Municipal WWTP	✓	✓		✓	147,397	5,840
IN0035718	Bloomington S (Dillman Road)	✓	✓		✓	413,839	13,411
IN0035726	Bloomington N (Blucher Poole)	✓	✓		✓	148,944	21,109
IN0036951	Zionsville WWTP		✓		✓	44,624*	1,742
IN0037176	Community Utilities Of Indiana Inc WWTP		✓		✓	37,427*	5,047
IN0039241	Loogootee Wastewater Treatment Plant		✓		✓	21,833*	4,067
IN0039268	Batesville WWTP, City Of		✓		✓	32,322*	1,343
IN0039331	Dyer Wastewater Treatment Plant		✓		✓	72,775*	5,402
IN0042366	Prince’s Lakes WWTP	✓	✓		✓	1,939	2,401

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
IN0042391	Aqua Indiana Inc Midwest WWTP		✓		✓	126,879*	7,054
IN0043273	Carriage Estates Iii WWTP		✓		✓	90,697*	3,817
IN0047058	Clarksville WWTP		✓		✓	112,207*	851
IN0049026	Fall Creek Regional Waste District		✓		✓	86,929*	3,344
IN0051632	West Central Conservancy District		✓		✓	104,864*	6,762
IN0055484	Fishers Cheeney Creek WWTP		✓		✓	289,901*	19,279
IN0055760	Trico Water Resource Recovery Facility		✓		✓	111,481*	3,736
IN0057614	Hendricks County RSD	✓	✓		✓	135,997	21,342
IN0059544	Citizens Of Westfield LLC WWTP		✓		✓	117,496*	3,475
IN0060917	Warsaw WWTP		✓		✓	127,605*	16,464
IN0062456	Plainfield South WWTP, Town Of		✓		✓	34,894	4,771
IN0062863	Corydon #2 Satellite		✓		✓	11,042*	481
IN0063673	Jeffersonville North Water Reclamation Facility		✓		✓	75,025*	10,700
IN0063983	Chesterfield WWTP		✓		✓	22,825*	3,098
IN0064211	Whitestown South WWTP	✓	✓		✓	25,539	1,499
IN0064289	Huntertown WWTP	✓	✓		✓	27,562	523
Totals	119 Facilities	42	118	0	117	26,192,308	1,512,571

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with * are EPA loading tool estimates.
The nitrogen load marked with † for facility IN0025577 was initially calculated by the loading tool, but flagged as an outlier for being a magnitude of order larger than the previous report. The sample that was reported in ICIS in December was preserved incorrectly, resulting in a much higher than usual average daily nitrogen load (lbs/day) for the month of December. This resulted in the yearly TN load being substantially higher than usual. January and February had no nitrogen values entered in the DMR. This was corrected for using the same methodology that the Loading Tool uses when there is missing monthly data. The load for the 9 months of usable data was calculated using the DMR data entered into ICIS for March-November. The yearly load was then calculated by multiplying the 9 month load by 12/(12 - # of missing months), or (12/9).

B-4. Iowa

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
IA0020788	City of Coralville	✓	✓			107,118	15,483
IA0021059	City of Spencer	✓	✓			94,476†	17,158†
IA0021300	City of Jefferson	✓	✓	✓		43,409†	4,359†
IA0021334	City of Cresco	✓	✓			34,860	6,241
IA0021342	City of Harlan	✓	✓			29,461	6,513

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
IA0021369	City of Greenfield	✓	✓			4,532†	833†
IA0021377	City of Carroll	✓	✓	✓		43,880	1,584†
IA0021563	City of Forest City	✓	✓	✓		26,266	3,165
IA0021580	City of Emmetsburg	✓	✓	✓		20,330†	3,924
IA0021946	Glenwood Municipal Utilities	✓	✓			41,524	8,286
IA0021997	City of Mitchellville	✓	✓			14,776	2,203
IA0022004	City of Evansdale	✓	✓	✓		26,526†	4,023†
IA0022012	City of Leclaire	✓	✓			34,036	5,030
IA0022039	City of Charles City	✓	✓	✓		60,583†	11,325†
IA0022055	City of Algona	✓	✓	✓		46,868	14,464
IA0023302	Denison Municipal Utilities	✓	✓			66,092‡	12,920‡
IA0023345	City of Dyersville	✓	✓			9,150	3,606†
IA0023434	City of Muscatine	✓	✓			130,973†	33,770
IA0023442	City of Iowa Falls	✓	✓			45,621	8,200†
IA0023582	City of Britt	✓	✓			17,491	1,546
IA0023710	City of Mount Vernon	✓	✓		✓	23,976†	2,515†
IA0023744	City of Estherville	✓	✓	✓		115,528†	9,539†
IA0024481	City of Maquoketa	✓	✓			88,160	28,915
IA0024511	City of Grundy Center	✓	✓	✓	✓	7,231	418
IA0024554	City of Carlisle	✓	✓			11,870†	1,594
IA0025895	City of Anamosa	✓	✓	✓		8,196†	4,447
IA0025933	City of Eldora	✓	✓			10,611	3,272
IA0026034	City of Monticello	✓	✓			35,423	7,629
IA0027219	City of Fort Madison	✓	✓			82,301	11,267
IA0027472	City of Centerville	✓	✓			27,876	3,943
IA0027669	City of Indianola	✓	✓			90,763	9,155
IA0027723	City of Newton	✓	✓			119,542†	16,465
IA0027740	City of Cascade	✓	✓	✓		5,244	1,410
IA0028525	City of New Hampton	✓	✓			49,468	14,341
IA0028924	City of Chariton	✓	✓			36,571	4,122
IA0029025	City of Atlantic	✓	✓	✓		3,331	1,253
IA0031186	City of Grinnell	✓	✓			29,249	9,495
IA0031691	City of West Liberty	✓	✓	✓	✓	32,628	3,882
IA0031704	City of Nevada	✓	✓			73,273†	24,333†
IA0032328	City of Shenandoah	✓	✓			35,353†	5,698†
IA0032344	City of Oelwein	✓	✓			13,890†	5,628†
IA0032379	City of Perry					63,527‡	12,456‡
IA0032433	City of Washington	✓	✓	✓		21,876†	20,716†

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
IA0032484	City of Storm Lake	✓	✓	✓		234,499	41,216
IA0032662	City of Sheldon	✓	✓			9,965	3,556
IA0032727	City of Tipton (West)	✓	✓			11,554†	2,200†
IA0032751	City of Orange City	✓				33,258‡	6,712‡
IA0032905	City of North Liberty	✓	✓			72,593‡	14,191‡
IA0032956	City of Osage	✓	✓	✓		97,059†	3,170†
IA0033081	City of Waukon	✓	✓			42,199†	8,448
IA0033103	City of Toledo	✓	✓	✓		9,321†	778†
IA0033138	City of Rockwell City	✓	✓	✓		16,588	2,465
IA0033197	City of Waverly	✓	✓	✓		84,026	10,994
IA0033669	City of West Burlington	✓	✓			13,433†	2,838†
IA0033731	City of Sioux Center	✓	✓	✓		53,045†	17,283†
IA0034291	City of Winterset	✓	✓			32,843	4,879
IA0034380	City of Eagle Grove	✓	✓	✓		206,821	4,081
IA0035076	City of Fairfield					54,342‡	10,751‡
IA0035190	City of Clarinda	✓	✓			46,409†	8,531†
IA0035220	City of Decorah	✓	✓			45,984	14,408
IA0035238	City of Creston	✓	✓			57,277†	8,413†
IA0035271	City of Dewitt	✓	✓			15,377†	8,023†
IA0035866	City of Knoxville	✓	✓			53,859†	12,306
IA0035891	City of Vinton	✓	✓	✓		46,617†	6,788†
IA0035939	City of Grimes	✓	✓	✓		55,468†	15,574†
IA0035947	City of Clinton	✓	✓	✓		149,907†	17,498†
IA0035955	City of Ames	✓	✓			366,566‡	47,930‡
IA0036471	City of Hampton	✓	✓			19,230	1,351
IA0036510	City of Independence	✓	✓			56,844	34,831
IA0036536	City of Lemars	✓	✓			106,924†	44,101†
IA0036625	City of Webster City	✓	✓	✓		58,783	33,815
IA0036633	City of Cedar Falls	✓	✓	✓		378,723	46,436
IA0036641	City of Council Bluffs	✓	✓			464,400†	156,709†
IA0036935	City of Montezuma	✓	✓			11,811†	1,478†
IA0038521	City of Oskaloosa	✓	✓			44,858†	6,724†
IA0038539	City of Oskaloosa	✓	✓			70,143†	10,336†
IA0038610	City of Marshalltown	✓	✓			925,818†	116,965†
IA0040266	City of Red Oak	✓	✓			46,467	5,092
IA0041815	City of Osceola	✓	✓			51,296†	13,704†
IA0041904	City of Ogden	✓	✓	✓		4,163	530
IA0041921	City of Adel	✓	✓	✓		31,372	5,081†
IA0042609	City of Keokuk	✓	✓			266,008	39,035

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
IA0042641	City of Cedar Rapids	✓	✓			2,289,712†	792,622†
IA0042650	City of Waterloo	✓	✓	✓		1,681,885†	387,474†
IA0043052	City of Davenport	✓	✓			1,687,368†	65,419†
IA0043079	City of Burlington	✓	✓			224,198	24,592
IA0043095	City of Sioux City	✓	✓			666,114	51,180
IA0043681	City of Tama	✓	✓			42,394	5,160
IA0043869	City of Pella	✓	✓			97,379†	26,504†
IA0044130	Des Moines Metropolitan WRA	✓	✓			3,552,881	490,969
IA0044458	City of Dubuque	✓	✓			1,258,363	112,309
IA0044849	City of Fort Dodge	✓	✓	✓		375,569†	55,506†
IA0047783	City of Melcher-Dallas	✓	✓			7,213	935
IA0047791	City of Humboldt	✓	✓	✓		46,928†	4,898†
IA0047961	City of Wapello	✓	✓	✓		1,972†	1,206†
IA0047970	City of Mount Pleasant	✓	✓			28,301	9,749
IA0057169	City of Mason City	✓	✓			244,698	46,219
IA0058076	City of Boone	✓	✓	✓		84,174	14,214
IA0058441	Clear Lake Sanitary District	✓	✓			17,088†	5,947
IA0058611	City of Ottumwa	✓	✓			234,627†	23,757†
IA0059005	City of Cherokee	✓	✓	✓		36,094†	6,303†
IA0059765	Iowa Great Lakes Sanitary District	✓	✓		✓	144,387†	16,928†
IA0061891	City of Walcott	✓	✓			6,849	8,591
IA0063231	City of Eldridge	✓	✓			22,597†	3,634
IA0070866	City of Iowa City	✓	✓	✓	✓	287,724†	45,955
IA0075302	City of Jesup	✓	✓	✓		12,179†	2,070†
Totals	106 facilities	104	103	36	5	19,280,403	3,358,489

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with † are queried from the database of Iowa Department of Natural Resources (IDNR). A previous compatibility issue between the two systems prevented accurate flow of information from IDNR to EPA. Nutrient loads were calculated by IDNR using publicly available data from DMRs or IDNR records following the methods used by EPA's Loading Tool. Data for those facilities can be found at https://www.iowadnr.gov/Environmental-Protection/Water-Quality/Nutrient-Reduction-Strategy.
Loads marked with ‡ are estimates provided by the state, calculated in a manner consistent with the EPA loading tool.

B-5 Kentucky

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
KY0020001	La Grange STP	✓	✓		✓	48,488	1,383
KY0020010	Greenville STP	✓	✓			47,171	5,079
KY0020079	Hazard, City of	✓	✓			52,054	2,698
KY0020095	RWRA Max Rhoads WWTP	✓	✓			144,564	41,886
KY0020133	Corbin STP	✓	✓			29,048	10,185
KY0020150	Georgetown STP #1	✓	✓			124,971	14,162
KY0020257	Maysville STP	✓	✓			63,889†	15,770†
KY0020427	Shelbyville STP	✓	✓		✓	26,031	2,105
KY0020621	Versailles STP	✓	✓			43,702	8,607
KY0020711	Henderson STP (North)	✓	✓			122,928	5,989
KY0020877	Russellville STP	✓	✓			55,184	7,046
KY0020974	Lancaster WWTP	✓	✓			8,994	396
KY0021067	Lawrenceburg STP	✓	✓		✓	41,754	4,184
KY0021164	Glasgow STP	✓	✓			119,089	34,569
KY0021172	Benton STP	✓	✓			7,091	4,203
KY0021211	Mayfield STP	✓	✓			77,430	6,211
KY0021229	Flemingsburg STP	✓	✓		✓	8,526	1,188
KY0021237	Bardstown STP	✓	✓			75,735	12,705
KY0021270	London STP	✓	✓		✓	45,196	7,215
KY0021440	Morganfield WWTP	✓	✓			59,790	7,095
KY0021466	Northern KY Sanitation District 1- Dry Creek	✓	✓			1,279,640	99,263
KY0021491	Lexington Town Branch STP		✓			851,831*	164,612
KY0021504	Lexington West Hickman STP		✓		✓	802,520*	63,777
KY0022039	Elizabethtown Valley Creek WWTP	✓	✓			345,602	53,218
KY0022373	Ashland STP	✓	✓			1,079,195	16,781
KY0022390	Radcliff STP	✓	✓			167,666	17,506
KY0022403	Bowling Green Municipal Utilities	✓	✓			166,318	12,408
KY0022411	Morris Forman WQTC MSD		✓			1,653,772*	1,012,711†
KY0022420	Hite Creek WQTC MSD	✓	✓		✓	187,402	6,898
KY0022799	Paducah/McCracken County JSA – Paducah	✓	✓			334,447	44,260
KY0022861	Frankfort Municipal STP	✓	✓		✓	69,653	26,320
KY0022934	Leitchfield STP	✓	✓			58,044	38,036
KY0023540	Central City STP	✓	✓			35,987	6,573
KY0024082	Barbourville STP	✓	✓			30,884	1,373†

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
KY0024317	Columbia/Adair County STP	✓	✓		✓	31,299	811
KY0024619	Stanford STP	✓	✓			43,027	5,681
KY0024783	Scottsville STP	✓	✓			38,450	5,236
KY0025291	Pikeville WWTP	✓	✓			28,160	9,770
KY0025810	Paducah/McCracken County JSA – Reidland	✓	✓			20,372	3,183
KY0026093	Harlan STP	✓	✓			53,382	5,581
KY0026549	Lebanon STP	✓	✓		✓	63,587	2,414
KY0026611	Somerset STP	✓	✓			251,842	29,170
KY0027359	Shepherdsville STP	✓	✓			51,524	13,802
KY0027421	Harrodsburg STP	✓	✓		✓	39,037	11,166
KY0027456	Franklin STP	✓	✓			73,944	10,866
KY0027979	Eddyville STP	✓	✓			11,242	2,057
KY0028347	Williamsburg STP	✓	✓			51,095	6,133
KY0028401	Princeton STP	✓	✓		✓	44,457	4,744
KY0028428	Wilmore STP	✓	✓			26,570	4,633
KY0029122	Manchester STP	✓	✓			41,069	4,726
KY0033553	Greenup Joint Sewer Agency	✓	✓			17,673	2,079
KY0033804	Mount Washington STP	✓	✓			81,620	14,465
KY0033847	Monticello STP	✓	✓			51,862	9,134
KY0037991	Strodes Creek STP	✓	✓		✓	56,016	8,947
KY0048348	Greenup County Environmental Commission Wastewater Treatment Plant	✓	✓			101,499	19,251
KY0052752	Morehead STP	✓	✓			106,921	14,807
KY0054437	Campbellsville STP	✓	✓		✓	110,097	5,521
KY0057193	Danville STP	✓	✓		✓	218,548	10,134
KY0062995	Russell County Regional STP	✓	✓			31,695	6,510
KY0066532	Hopkinsville Hammond Wood STP	✓	✓			96,805	26,838
KY0072761	Bee Creek WWTP	✓	✓		✓	78,923	2,571
KY0072885	Middlesboro STP	✓	✓			91,184	22,782
KY0073377	Owensboro East STP	✓	✓			128,970	33,847
KY0078956	Derek R Guthrie WQTC MSD	✓	✓			1,830,287	234,753
KY0079898	Berea Municipal Utilities WWTP	✓	✓		✓	99,246	8,834
KY0082007	Georgetown STP #2	✓	✓		✓	141,275	4,825
KY0090654	Paris STP	✓	✓			9,206	3,984
KY0098043	Madisonville STP West Side	✓	✓			182,922	12,333

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
KY0098540	Cedar Creek WQTC MSD	✓	✓		✓	171,067	6,234
KY0100293	Henderson South STP #2	✓	✓			705,252	85,556
KY0100404	Jessamine Creek Environmental Control #1	✓	✓			107,920	34,991
KY0102784	Floyds Fork WQTC MSD	✓	✓		✓	122,833	3,279
KY0103357	Richmond Silver Creek STP	✓	✓			8,308	843
KY0103578	Honey Branch Regional STP	✓	✓			26,156	3,575
KY0104027	Jerry L Riley STP	✓	✓		✓	89,581	6,732
KY0104400	Mount Sterling Hinkston Creek STP	✓	✓		✓	65,732	4,375
KY0104931	Carrollton Regional WWTP	✓	✓		✓	67,178	4,137
KY0105031	Eastern Regional STP-Eastern Regional	✓	✓		✓	53,135	1,566
KY0105376	Northern Madison County Sanitation District	✓	✓		✓	10,264	2,104
KY0105791	Ohio County Regional STP	✓	✓		✓	31,621	1,670
KY0105856	Cynthiana STP New	✓	✓		✓	39,319	1,815
KY0106143	Louisville and Jefferson County MSD	✓	✓			50,814	7,615
KY0107107	Richmond Otter Creek STP	✓	✓		✓	107,028	9,014
KY0107239	Western Regional Water Reclamation Facility	✓	✓			553,949	43,695
KY0108740	Winchester Municipal Utilities	✓	✓			41,618	6,069
KY0109991	Williamstown Regional WRF	✓	✓			8,850	5,053
KY0111716	Louisville and Jefferson County MSD	✓	✓		✓	3,495	250
KY0034428	Red River WWTP	✓	✓	✓		25,097	3,555
KY0091561	Caveland EA	✓	✓			28,027	6,251
KY0112721	Fort Knox	✓	✓			88,212	8,485
KY0025909	Irvine	✓	✓			26,517	1,826
Totals	91 facilities	88	91	1	29	15,000,375	2,566,690

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with * are EPA loading tool estimates.
Loads marked with † are state provided from DMR data. DMR data in ICIS was cross-checked with state DMR records and corrected load estimates were provided, calculated with methods consistent with the EPA loading tool.

B-6. Louisiana

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
LA0006289	City of Franklin					29,440	2,944
LA0020109	Bastrop, City of (West Pond)					60,428*	11,895*
LA0020257	Town of Bunkie	✓	✓			18,025	3,409
LA0020443	Bastrop, City of (Main Plant)					37,714*	6,966*
LA0020541	City of Port Allen- Port Allen Wastewater Treatment Plant	✓	✓			30,266	4,239
LA0020559	Rayville, Town of					46,164*	9,108*
LA0020613	City of Broussard-Cote Gelee Wetland Wastewater Assimilation Proj.	✓	✓			17,136	12,953
LA0020630	Town of Ferriday- Wastewater Treatment Facility	✓	✓			8,942	5,189
LA0020648	City of Plaquemine- South Wastewater Treatment Plant	✓	✓			959	1,535†
LA0032131	St. Charles Parish Council – Luling Oxidation Pond	✓	✓			59,848	9,703
LA0032221	American Water Operations and Maintenance, LLC. – South Fort Polk WWTP					45,605*	9,296*
LA0032239	American Water Operations and Maintenance, LLC. – North Fort Polk WWTP					13,288*	2,229*
LA0032328	City of Hammond- South Slough Wetland Wastewater Assimilation Project	✓	✓			205,866	42,908
LA0032794	Vidalia, City of- Wastewater Treatment Plant	✓	✓			21,934	4,886
LA0032948	City of Thibodaux- Wastewater Treatment Facility	✓	✓			167,632	19,449
LA0033014	City of Breaux Bridge	✓	✓			15,261	4,738
LA0033227	City of Springhill	✓	✓			67,698	2,361
LA0033260	Town of Jena					26,163*	4,390*
LA0033430	Oakdale, City of	✓	✓			43,498	6,873

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
LA0033464	City of Pineville-Wastewater Treatment Plant	✓	✓			130,272	18,768
LA0036323	City of Ruston- Northside Wastewater Treatment Plant	✓	✓			162,942	24,949
LA0036340	Lake Charles Sewage Treatment Plant A					123,382*	23,267*
LA0036366	City of Lake Charles-WWTP B,C					209,088*	33,833*
LA0036374	Lafayette Consolidated Government – South WWTP	✓	✓			100,012	55,561
LA0036382	Lafayette Consolidated Government – East WWTP	✓	✓			145,290	34,059
LA0036391	Lafayette Consolidated Government – Northeast WWTP					107,824	10,856
LA0036404	City of Opelousas – Candy Street WWTP	✓	✓			62,008	10,488
LA0036412	E Baton Rouge City-Par (South)	✓	✓			2,020,874	307,799
LA0036439	E Baton Rouge City-Par (North)	✓	✓			697,058	118,360
LA0038059	City of Westwego-Wastewater Treatment Plant	✓	✓			40,613	2,741
LA0038091	Sewerage And Water Board of New Orleans-East Bank STP	✓	✓			2,434,184	213,598
LA0038105	Sewerage And Water Board of New Orleans-West Bank STP	✓	✓			572,499	76,152
LA0038130	City of Minden	✓	✓			41,812	7,858
LA0038288	City of Mandeville	✓	✓			161,786	31,906
LA0038407	City of Deridder-Wastewater Treatment Plant	✓	✓			15,764	17,540
LA0038431	Town of Amite City- Amite City STP					44,655*	8,338*
LA0038521	Town of Homer-Wastewater Treatment Plant					**	**
LA0038555	City of New Roads-Wastewater Treatment Plant	✓	✓			2,110	594
LA0038709	City of Dequincy					8,427	1,358

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
LA0038741	City of Monroe					381,653*	57,279*
LA0038814	City of Ville Platte					50,560*	10,306*
LA0038822	City of Grambling	✓	✓			4,569	646
LA0039055	Rayne, City of					16,560	10,525
LA0039748	City of Abbeville					75,144*	15,318*
LA0039802	Town of Delhi	✓	✓			54,069	36,182
LA0040177	St. Bernard Parish – Munster WWTP					1,995	60,809†
LA0040193	City of Jeanerette					2,576	1,006†
LA0040207	Terrebonne Ph Govt-Houma North	✓	✓			314,948	32,474
LA0040274	Terrebonne Ph-Houma-South	✓	✓			78,328	42,620
LA0040941	City of St. Martinville	✓	✓			27,049	6,384
LA0041009	City of Alexandria	✓	✓			92,518	57,091
LA0041254	City of Crowley	✓	✓			18,615	8,293
LA0041262	City of Gretna-Wastewater Treatment Plant	✓	✓			132,055	5,110
LA0041394	City of Shreveport- Lucas WWTP					952,601*	142,967*
LA0041751	City of Eunice- Wastewater Treatment Facility					52,343*	10,670*
LA0041769	City of Jennings WWTP					47,693	5,042
LA0042048	Jefferson Parish Department of Sewerage-Marrero WWTP					404,719*	60,741*
LA0042064	Jefferson Parish Department of Sewerage-Bridge City WWTP	✓	✓			141,082	14,816
LA0042081	Jefferson Parish Department of Sewerage-Harvey WWTP	✓	✓			458,173	56,603
LA0042188	City of Shreveport- North Regional WWTP					403,002*	65,043*
LA0042561	Lafayette Consolidated Government – Ambassador Caffery STP	✓	✓			116,943	74,215
LA0043915	City of Winnfield-Wastewater Treatment Plant	✓	✓			30,285	2,751
LA0043931	Donaldsonville, City of – Wastewater Treatment Facility	✓	✓			67,002	5,161
LA0043940	Harahan, City of					103,022	8,567

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
LA0043982	City of West Monroe-Wastewater Treatment Facility	✓	✓			71,456	31,514†
LA0044032	Plaquemines Parish Government- Belle Chasse WWTP	✓	✓			109,600	12,504
LA0044041	Plaquemines Parish Government- Buras WWTP	✓	✓			21,700	4,715
LA0044059	Plaquemines Parish Government- Port Sulphur WWTP	✓	✓			11,699	2,185
LA0044695	City of Ponchatoula – Ponchatoula Wastewater Treatment Facility	✓	✓			34,062	9,591
LA0045144	City of Marksville	✓	✓			28,981	8,644
LA0045446	Magnolia Water Utility Operating Co., LLC	✓	✓			31,495	2,308
LA0045730	City of Denham Springs	✓	✓			19,652	15,516
LA0047180	City of Slidell	✓	✓			132,116	37,026
LA0053716	Bossier City	✓	✓			203,566	11,795
LA0055328	City of Youngsville					42,131*	8,342*
LA0059951	Town of Walker	✓	✓			44,416	7,129
LA0064092	St. John The Baptist Parish – Woodland WWTP	✓	✓			13,954	1,176
LA0065251	Sewerage District #1 of Iberia Parish & City of New Iberia- Tete Bayou WWTP	✓	✓			33,680	4,523
LA0065978	Bossier City Dept of Pub Utility					170,566*	30,671*
LA0065986	City of Morgan City-Wastewater Treatment Facility	✓	✓			91,352	12,529
LA0066559	Utilities, Inc. of La-Arrowwood Regional WWTP					45,925*	9,241*
LA0066621	Town of Vinton-Treatment Plant					20,243*	3,396*
LA0066630	Jefferson Parish Department of Sewerage-East Bank WWTP	✓	✓			478,706	135,953
LA0066800	City of Kenner	✓	✓			669,335	42,626
LA0067083	City of Sulphur- WWTP	✓	✓			89,168	43,527
LA0067784	Livingston Parish Sewer District No. 2					44,059*	8,981*
LA0068381	St. Mary Parish Wards 5 And 8 Joint Sewer Commission	✓	✓			120,096	21,287

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
LA0068730	Magnolia Water Utility Operating Co., LLC	✓	✓			10,321	4,094
LA0069868	St. John The Baptist Parish – River Road Treatment Plant	✓	✓			82,335	7,031
LA0073521	St. Charles Parish Council – Hahnville STP	✓	✓			80,539	10,345
LA0073539	St. Charles Parish Wastewater Dept– Destrehan WWTP	✓	✓			196,230	16,231
LA0079596	St. John The Baptist Parish – Garyville WWTP	✓	✓			38,711	4,528
LA0084336	City of Covington- Sewerage Treatment Facility					90,160	16,082
LA0086576	City of Tallulah- Wastewater Treatment Plant	✓	✓			30,549	6,390
LA0095222	City of Natchitoches	✓	✓			4,948	17,630†
LA0109576	City of Gonzales – Wastewater Treatment Facility					67,546*	13,769*
LA0118770	Lake Charles, City of- STP					99,162*	20,213*
LA0120154	St. Tammany Parish Government – Castine Regional Sewage Treatment Plant	✓	✓			31,540	4,916
LA0120201	New Iberia, City of	✓	✓			31,541	21,404
LA0120243	Guste Island Utility Corp.	✓	✓			17,493	3,130
LA0126152	Consolidated Waterworks/Sewerage District No 1	✓	✓			70,155	12,859
LA0127097	St John The Baptist Parish	✓	✓			93,191	5,175
LA0127208	City of Thibodaux- North Thibodaux WWTP	✓	✓			**	**
LA0041386	Town of Haughton	✓		✓		13,219	3,330
Totals	104 facilities	71	70	1	0	15,509,568	2,586,018

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with * are EPA loading tool estimates.
Loads marked with † are state provided from DMR data. DMR data in ICIS was cross-checked with state DMR records and corrected load estimates were provided, calculated with methods consistent with the EPA loading tool.
** indicates no/insufficient data to make an estimate, due to monitoring/reporting not being required or no reporting during 2020 and further data transfer issues between DMR inputs and loading tool outputs.

B-7. Minnesota

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
MN0020133	Montevideo WWTP	✓	✓		✓	38,879	4,093
MN0020141	Luverne WWTP	✓	✓		✓	66,895	5,486
MN0020150	New Prague WWTP	✓	✓		✓	50,333	1,154
MN0020222	Saint Michael WWTP	✓	✓		✓	32,460	2,524
MN0020290	Melrose WWTP	✓	✓		✓	211,478	6,034
MN0020362	Cambridge WWTP	✓	✓		✓	66,983	1,044
MN0020401	Redwood Falls WWTP	✓	✓		✓	79,402	3,759
MN0020567	Monticello WWTP	✓	✓		✓	31,342	2,801
MN0020664	Lake City WWTP	✓	✓		✓	40,373	596
MN0020681	Stewartville WWTP	✓	✓			55,424	6,510
MN0020761	Little Falls WWTP	✓	✓	✓	✓	58,556	5,858
MN0020788	Elk River WWTP	✓	✓	✓	✓	228,120	2,563
MN0020796	Waseca WWTP	✓	✓		✓	64,679	3,690
MN0022080	Grand Rapids WWTP	✓	✓			73,147	32,580
MN0022179	Marshall WWTP	✓	✓		✓	265,961	8,439
MN0022217	Windom WWTP	✓	✓	✓	✓	143,442	8,571
MN0022233	Glencoe WWTP	✓	✓	✓	✓	38,248	3,322
MN0022462	Bemidji WWTP	✓	✓		✓	77,921	307
MN0022535	Saint Peter WWTP	✓	✓		✓	103,945	3,139
MN0022683	Austin WWTP	✓	✓			1,088,529	69,930
MN0023094	Cold Spring WWTP	✓	✓		✓	26,157	1,089
MN0023973	Litchfield WWTP	✓	✓		✓	81,068	2,371
MN0024040	Madelia WWTP	✓	✓		✓	142,257	1,974
MN0024368	Northfield WWTP	✓	✓		✓	145,213	3,578
MN0024538	Princeton WWTP	✓	✓		✓	11,339	165
MN0024571	Red Wing WWTP	✓	✓		✓	121,432	2,482
MN0024619	Rochester WWTP/Water Reclamation Plant	✓	✓		✓	1,022,345	25,017
MN0024759	Saint James WWTP	✓	✓		✓	18,729	1,125
MN0025259	Willmar WWTF	✓	✓		✓	201,498	5,191
MN0025267	Winnebago WWTP	✓	✓		✓	16,992	715
MN0025330	Zumbrota WWTP	✓	✓			21,678	2,209
MN0025666	Becker WWTP	✓	✓		✓	25,535	508
MN0029629	Metropolitan Council – Rogers WWTP	✓	✓		✓	76,573	1,350
MN0029815	Metropolitan Council – Metropolitan WWTP	✓	✓		✓	12,103,952	168,317
MN0029882	Metropolitan Council – Blue Lake WWTP		✓		✓	2,251,562*	49,767

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
MN0029904	Metropolitan Council – Eagles Point WWTP	✓	✓		✓	480,007	4,304
MN0029955	Metropolitan Council – Hastings WWTP	✓	✓		✓	147,140	2,727
MN0029998	Metropolitan Council – St Croix Valley WWTP	✓	✓		✓	197,638	3,928
MN0030007	Metropolitan Council – Seneca WWTP		✓		✓	1,441,006*	24,459
MN0030066	New Ulm WWTP	✓	✓		✓	93,248	5,851
MN0030112	Fairmont WWTP	✓	✓		✓	79,961	2,632
MN0030121	Faribault WWTP	✓	✓		✓	294,409	9,171
MN0030147	Winona WWTP	✓	✓			229,646	55,188
MN0030171	Mankato Water Resource Recovery Facility	✓	✓		✓	498,019	6,412
MN0031178	Worthington Industrial WWTP	✓	✓		✓	114,446	3,632
MN0031186	Worthington WWTP	✓	✓		✓	132,190	3,846
MN0040649	Buffalo WWTP	✓	✓		✓	78,416	2,408
MN0040738	Alexandria Lake Area SD	✓	✓		✓	163,057	938
MN0040878	Saint Cloud WWTP	✓	✓		✓	417,521	8,009
MN0041092	Albert Lea WWTP	✓	✓			172,200	56,248
MN0045845	Metropolitan Council – Empire WWTP	✓	✓		✓	1,174,149	10,782
MN0046868	Whitewater River Regional WWTP	✓	✓			58,830	7,988
MN0049328	Brainerd WWTP	✓	✓		✓	59,872	3,069
MN0050725	Kasson WWTP	✓	✓		✓	31,337	1,094
MN0051250	Delano WWTP	✓	✓		✓	6,678	865
MN0051284	Owatonna WWTP	✓	✓		✓	287,396	8,232
MN0055361	Plainview Elgin Sanitary District	✓	✓		✓	16,157	1,059
MN0055808	Chisago Lakes Joint STC	✓	✓		✓	34,836	3,295
MN0055832	Hutchinson WWTP	✓	✓		✓	131,604	4,590
MN0064190	Otsego East WWTP	✓	✓		✓	14,576	412
MN0066079	Long Prairie WWTP – Municipal	✓	✓		✓	141,479	2,134
MN0066966	Annandale/Maple Lake/Howard Lake WWTP	✓	✓		✓	29,169	507
MN0068195	Le Sueur WWTP	✓	✓		✓	109,753	2,459
Totals	63 facilities	61	63	4	56	25,717,188	674,494

Nutrient Load Notes:
Unmarked loads are from state DMR data, calculated as described in the methods below.
Nitrogen Loads marked with * are estimated by the state based on 21 mg/L TPC for Class A mechanical WWTPs.

Minnesota Load Calculation Methodology:

1. Pair calendar month total flow to calendar month average concentration at each facility. There may be multiple reporting stations at each facility.
2. Sum nitrate, nitrite, and TKN for facilities not reporting TN.
3. Exclude or replace likely reporting errors.
    a. Flow greater than (daily design flow * 200) or 10,000 mgd. Minnesota has many lagoon systems so the 200 multiplier represents an upper bound for days of pond storage. The 10k mgd value is intended to screen missing decimal points in flow.
    b. Phosphorus greater than 50 mg/L.
    c. Nitrogen greater than 500 mg/L.
4. Populate values for months with no concentration data.
    a. Each facility is assigned a category based on size and type. We average observed nutrient concentrations by category to improve our estimates for months with no concentration data.
    b. Most facilities monitor nitrogen quarterly. We apply the annual average of the quarterly monitoring by facility to the 8 months without nitrogen monitoring.
    c. Facilities that are not monitoring nitrogen use the average categorical concentration from step 4a.
    d. Phosphorus data are available at most facilities for the current reporting period. Missing months are populated with the average concentration for the facility type.
5. Calculate pollutant loads.
    a. Multiply total flow * average concentration * 3.785.
    b. Categorize loads as:
        i. Observed: Concentration value was collected at the facility that month.
        ii. Estimated from sample: Nitrogen only, months where we applied the facility quarterly data to non-sampling quarters.
        iii. Estimated: No concentration data available, estimated from a categorical concentration.

B-8. Mississippi

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
MS0020044	New Albany POTW	✓	✓			91,550	8,940
MS0020184	Greenville POTW	✓	✓			314,693	67,931
MS0020311	Clarksdale POTW	✓	✓	✓	✓	52,601	7,808
MS0020371	Belzoni POTW	✓	✓	✓	✓	8,571	2,796
MS0020389	Yazoo City POTW	✓	✓	✓	✓	79,460	14,268
MS0020397	Grenada POTW	✓	✓	✓	✓	63,543	16,854
MS0020567	Cleveland POTW	✓	✓	✓	✓	10,370	2,936
MS0021024	Winona POTW	✓	✓			5,995	2,670
MS0022331	Water Valley POTW	✓	✓			28,456	4,475
MS0022381	Vicksburg POTW	✓	✓			96,020	13,816
MS0023833	Greenwood POTW	✓	✓	✓	✓	40,025	21,277
MS0024252	Natchez POTW	✓	✓			102,199	17,983

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
MS0024619	Indianola POTW	✓	✓	✓	✓	26,382	7,214
MS0024627	Batesville POTW	✓	✓			52,754	12,353
MS0029017	Oxford POTW	✓	✓			104,217	30,720
MS0029513	DCRUA, Olive Branch POTW Ross Road	✓	✓	✓	✓	42,680	5,519
MS0042030	Booneville POTW	✓	✓	✓	✓	23,189	6,094
MS0042455	Canton Municipal Utilities, Hydrograph Controlled Release POTW	✓	✓	✓	✓	4,159	997
MS0048691	Tunica County Utility District	✓	✓			77,705	5,740
MS0052221	Senatobia POTW	✓	✓			27,863	6,170
MS0054992	Clinton POTW, Southside	✓	✓	✓	✓	51,463	21,747
MS0057517	Canton Municipal Utilities, Beatties Bluff Wastewater Treatment Facility	✓	✓			128,369	118,259
MS0058581	Pontotoc, City of, Activated Sludge Facility	✓	✓			29,350	2,999
MS0061077	Mccomb POTW	✓	✓			32,133	16,928
MS0061328	Corinth POTW	✓	✓	✓	✓	101,009	16,874
MS0061271	Johnson Creek WWTP	✓	✓	✓	✓	24,461	3,204
MS0062227	Short Fork Creek POTW	✓	✓			202,272	48,781
Totals	27 facilities	27	27	13	13	1,821,491	485,352

Nutrient load notes:
All loads are reported from DMR data entered into ICIS and calculated by the loading tool.

B-9. Missouri

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/yr)
MO0004391	Metropolitan St Louis Sewer District	✓	✓			1,425,210	154,482
MO0021440	City of Monett	✓	✓			165,997	68,578
MO0022098	City of Republic	✓	✓			71,171†	17,016†
MO0022373	Bolivar, City of					92,612	16,464
MO0022381	City of Mount Vernon	✓	✓			26,686†	4,835†
MO0022853	City of Jackson	✓	✓			90,379	17,234
MO0023019	City of Sedalia	✓	✓			43,285	27,878
MO0023027	City of Sedalia	✓	✓			48,570	6,941
MO0023043	City of St. Joseph	✓				2,240,434	394,930
MO0023213	City of Dexter	✓	✓			83,022	12,809

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/yr)
MO0023221	City of Macon	✓	✓			73,068	20,031
MO0023256	City of Joplin	✓	✓			270,821*	123,936
MO0023272	City of California	✓	✓			93,640	18,931
MO0024911	City of Kansas City					3,494,702†	469,003†
MO0024929	City of Kansas City	✓	✓			702,701*	105,462*
MO0024961	KC Todd Creek WWTP					93,349*	19,029*
MO0025151	Metropolitan St. Louis Sewer District	✓	✓			3,013,930	978,604
MO0025160	Metropolitan St Louis Sewer District	✓	✓			896,499	87,194
MO0025178	Metropolitan St Louis Sewer District	✓	✓			4,735,231	601,868
MO0025186	City of Carl Junction	✓	✓			90,429	10,071
MO0025241	City of Branson	✓	✓			89,552	892
MO0025283	Union, City of	✓	✓			16,154	4,266
MO0025810	City of Washington	✓	✓			46,115	28,927
MO0026298	City of Platte City	✓	✓			8,549	3,575
MO0026301	City of Cabool	✓	✓			9,898	7,951
MO0026310	City of Mountain View	✓	✓			9,052	949
MO0026336	City of Savannah	✓	✓			23,626	3,140
MO0026387	City of Odessa	✓	✓			36,546	3,778
MO0026662	City of DeSoto	✓	✓			60,291	6,760
MO0027111	City of Herculaneum	✓	✓			21,362†	3,511†
MO0028037	City of Nixa	✓	✓		✓	41,604	842
MO0028070	City of Harrisonville	✓	✓			73,708	9,238
MO0028568	Kennett Board of Public Works	✓	✓			99,339	10,474
MO0028720	City of O'Fallon	✓	✓			1,081,054	44,498
MO0028789	City of Centralia	✓	✓			0	0
MO0028843	City of Excelsior Springs	✓	✓			61,092	7,274
MO0028860	City of Farmington	✓	✓			116,984	14,559
MO0028886	City of Blue Springs					96,529*	17,645*
MO0029742	American Water Military Services, LLC	✓	✓			88,630	24,784
MO0030970	City of St Peters	✓	✓			867,784	47,526
MO0032883	Marshall Municipal Utilities	✓	✓			25,354	20,862
MO0033286	City of Maryville	✓	✓			56,508	8,929
MO0035009	Sikeston Board of Municipal Utilities	✓	✓			102,856	12,412
MO0036242	City of Mexico	✓	✓			122,475	20,665
MO0036757	City of Aurora	✓	✓			58,793	20,380
MO0039136	City of Carthage	✓	✓			167,709	17,082

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/yr)
MO0039659	City of Eureka	✓	✓			34,793	14,703
MO0039748	Trenton Municipal Utilities	✓	✓			44,578	5,609
MO0040142	City of Pevely	✓	✓			33,782	8,314
MO0040185	Center Creek Wastewater Treatment Board	✓	✓			106,976	14,425
MO0040312	City of Farmington	✓	✓			88,392	12,970
MO0040738	City of Boonville	✓	✓			148,182	9,405
MO0040843	City of Marshfield	✓	✓			261,805	49,639
MO0041131	City of Pacific	✓	✓			50,684	8,219
MO0042579	City of Cassville	✓	✓		✓	15,135	149
MO0043648	City of Poplar Bluff	✓	✓			369,072	17,408
MO0047023	City of Rolla	✓	✓			5,720	1,250
MO0047031	City of Rolla	✓	✓			14,798	921
MO0048305	City of Kansas City - WSD					53,967*	10,593*
MO0048313	City of Kansas City					41,766*	7,565*
MO0049506	City of Kirksville					318,937*	49,072*
MO0049522	City of Springfield	✓	✓		✓	3,260,493	32,733
MO0049531	KCMO Water Services	✓	✓			480,275*	72,080*
MO0050652	City of Rolla	✓	✓			114,364	13,480
MO0051144	City of Perryville	✓	✓			208,463	15,306
MO0054623	City of Troy	✓	✓			39,860	8,735
MO0055204	Smithville WWTF	✓	✓			38,494†	6,005†
MO0055905	City of Warrensburg	✓	✓			15,227	8,182
MO0056162	Glaize Creek Sewer District	✓	✓			12,096	4,828
MO0058343	City of St. Charles	✓	✓			293,262	26,933
MO0058351	City of St. Charles	✓	✓			164,349	21,027
MO0080632	Festus Crystal City Sewage Commission	✓	✓			100,753†	5,419
MO0084158	City of Montgomery	✓	✓			6,762	1,313
MO0085472	DCSD Treatment Plant 1	✓	✓			81,763	35,716
MO0086126	Metropolitan Saint Louis Sewer District	✓	✓			257,064	24,775
MO0087912	City of Warrenton	✓	✓			81,074	9,022
MO0089010	City of Lebanon	✓	✓			59,427	15,021
MO0089109	City of Nevada	✓	✓			76,809	12,160
MO0089681	City of Independence	✓	✓			387,597	66,164
MO0093513	Hannibal Board of Public Works	✓	✓			137,915†	21,439†
MO0093564	City of St. James	✓	✓			2,552	3,824
MO0093599	City of Wentzville	✓	✓			247,043	63,740
MO0094161	City of Waynseville	✓	✓			70,892	8,299

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/yr)
MO0094579	City of Warrensburg	✓	✓			39,360	10,263
MO0094846	City of Jefferson City	✓	✓			486,480	50,284
MO0094854	City of Buffalo	✓	✓			50,232	7,922
MO0094919	City of Cuba	✓	✓			49,435	6,413
MO0095028	City of Caruthersville	✓	✓			65,981†	5,878
MO0096229	City of Butler					22,698*	3,962*
MO0096318	City of Carrollton	✓	✓			20,910	2,446
MO0096610	City of West Plains	✓	✓			75,413	5,067
MO0097390	City of Clinton	✓	✓			53,891*	1,612
MO0097837	City of Columbia	✓	✓			210,746	133,389
MO0099163	City of Ozark	✓	✓		✓	63,726	1,721
MO0099465	City of St Clair	✓	✓			48,379	3,044
MO0100676	City of Eldon	✓	✓			156,173	8,331
MO0101087	Little Blue Valley Sewer District	✓	✓			1,801,980	312,587
MO0101362	Metropolitan St Louis Sewer District	✓	✓			717,272	76,975
MO0101567	City of Sedalia	✓	✓			86,945	10,872
MO0103039	City of Springfield	✓	✓			224,497	10,676
MO0103241	Lake Ozark and Osage Beach Joint Board	✓	✓			123,120	21,876
MO0103331	City of Fulton	✓	✓			96,675	11,368
MO0103349	City of Joplin	✓	✓			420,359	40,838
MO0103560	City of Park Hills	✓	✓			94,707	16,052
MO0104299	City of Cameron	✓	✓			65,327	9,972
MO0104736	City of Sullivan	✓	✓			58,608	8,442†
MO0104906	City of Neosho	✓	✓			91,055	9,570
MO0107883	City of Kearney	✓	✓			16,705	2,823
MO0108227	City of Chillicothe	✓	✓			70,338	8,118
MO0111716	Pulaski County Sewer District No. 1	✓	✓			9,470	15,757
MO0112925	City of St Robert	✓	✓			39,154†	3,935†
MO0116041	City of Hollister	✓	✓		✓	13,926	1,784
MO0116572	Duckett Creek Sanitary District	✓	✓			164,687	72,968
MO0116599	City of Branson	✓	✓		✓	51,105	573
MO0117412	City of Belton	✓	✓			117,568	11,724
MO0117960	City of Moberly	✓	✓			48,990	1,945
MO0119474	Platte County Regional Sewer District	✓	✓			46,458	13,588
MO0120081	City of Charleston	✓	✓			27,954	8,822
MO0127949	Metropolitan St Louis Sewer District	✓	✓			585,251	64,961

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/yr)
MO0128490	Northeast Public Sewer District	✓	✓			28,502	13,675
MO0130371	City of Oak Grove	✓	✓			104,736	10,956
MO0131296	City of Troy	✓	✓			15,285	2,335
MO0133671	City of Ozark	✓	✓		✓	10,914†	167†
MO0136328	Cape Girardeau Municipal WWTF	✓	✓			135,216	27,109
MO0137111	City of Liberty	✓	✓			32,627	9,446
Totals	125 facilities	117	116	0	7	35,501,281	5,222,903

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with * are EPA loading tool estimates.
Loads marked with † are state provided from DMR data and calculated as described below.

Missouri Nutrient Load Calculation Methodology:

The Missouri Department of Natural Resources (the Department) utilized 2020 DMR data from Missouri's major domestic wastewater treatment facilities (WWTFs) for flow (parameter code 50050), TN (parameter code 00600) and TP (parameter code 00665). The Department calculated loads for each outfall as flow in MGD multiplied by the number of days per month and the nutrient concentration (mg/L) for each monitoring period. The Department then converted loads to pounds per month and summed monthly loads to obtain the annual load for each facility.

The Department excluded land application, no discharge, and stormwater outfalls. For any missing flow data, the Department used actual average facility flow, followed by design flow. The Department matched monthly flow with reported nutrient concentrations for that month. For any missing nutrient concentrations, the Department calculated TPCs using 2020 DMR data from 76 Missouri domestic WWTFs for TN and 105 for TP. TPCs were median nutrient concentrations for facilities subset by flow class 1–5 MGD or ≥ 5 MGD. Due to current TP effluent limits for facilities located in HUC 8 watersheds 11010001, 11010002, and 11010003, the Department excluded these facilities from TPC calculations for TP.

B-10. Ohio

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
OH0020079	Twin City Water & SD	✓	✓			130,382	4,896
OH0020133	City of West Carrollton	✓	✓			71,748	9,180
OH0020257	Village of Lexington	✓	✓			27,523*	1,306
OH0020320	City of Celina	✓	✓		✓	70,746	2,643
OH0020371	City of Orrville Municipal Utilities	✓	✓		✓	101,331	3,982
OH0020389	Hillsboro, City of	✓	✓		✓	21,303	888
OH0020419	Hamilton Co Brd of Comm Metropolitan SD	✓	✓			212,542	17,120
OH0020451	City of Milford	✓	✓			37,295	7,002

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
OH0020478	Gallipolis, City of	✓	✓			37,835	10,369
OH0020494	City of Mason	✓	✓		✓	103,706	22,162
OH0020516	City of Massillon	✓	✓		✓	477,012	18,699
OH0020605	Brookville, City of	✓	✓			22,400	4,678
OH0020621	City of Belpre	✓	✓			46,659	7,674
OH0020834	City of Jackson	✓	✓		✓	97,696	5,743
OH0020907	Eaton, City of	✓	✓			85,534	6,706
OH0021059	Lebanon City of	✓	✓			137,760	20,409
OH0021083	City of Greenfield	✓	✓		✓	42,761	1,389
OH0021300	Georgetown, Village of	✓	✓		✓	10,374	1,010
OH0021440	City of Harrison	✓	✓			1,234	17,520
OH0021644	Union, City of	✓	✓			39,118	4,840
OH0021776	Village of Columbiana	✓	✓			31,511	4,085
OH0021784	East Palestine, City of	✓	✓		✓	29,225*	874
OH0021814	Village of South Point	✓	✓			54,949	11,564
OH0021857	Village of West Milton	✓	✓			35,247	5,201
OH0022110	City of Newton Falls	✓	✓			23,222	2,618
OH0023388	City of Logan	✓	✓			47,637*	2,023
OH0023507	Wellston, City of	✓	✓			71,796	3,569
OH0023540	Shelby, City Of	✓	✓			484,291	48,489
OH0023779	City of London	✓	✓			99,194*	20,393
OH0023868	City of Alliance	✓	✓		✓	661,060	4,429
OH0023906	Ashland, City of	✓	✓		✓	195,104	30,735
OH0023931	City of Athens	✓	✓			110,701	16,683
OH0024007	Barberton WPCF	✓	✓		✓	200,539	7,103
OH0024015	Barnesville, Village of	✓	✓			26,841*	1,109
OH0024066	Bellefontaine, City of	✓	✓			82,127	9,967
OH0024309	Cambridge City of	✓	✓			41,134	3,487
OH0024325	Mahoning County Commissioners	✓	✓			59,229	3,435
OH0024333	Village of Canal Winchester	✓	✓			56,273*	12,379
OH0024350	Canton City Of	✓	✓		✓	836,163	58,354
OH0024406	City of Chillicothe	✓	✓			106,088	24,190
OH0024465	City of Circleville	✓	✓			51,188	16,360
OH0024732	City of Columbus, Sewerage & Drainage	✓	✓			1,818,805	534,055
OH0024741	City of Columbus, Sewerage & Drainage	✓	✓			3,749,245	414,245
OH0024775	Coshocton, City of	✓	✓			63,687*	73,291
OH0024881	Dayton, City of	✓	✓			2,079,327	287,886

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
OH0024911	Delaware, City of	✓	✓	✓	✓	100,228	10,461
OH0024945	City of Dover	✓	✓			48,750*	10,126
OH0024970	City of East Liverpool	✓	✓			90,533	7,941
OH0025011	Englewood, City of	✓	✓			33,414†	3,922†
OH0025062	Fairborn, City of	✓	✓			144,512	19,287
OH0025071	Fairfield, City of	✓	✓			268,850	35,246
OH0025275	Veolia Water N America Oper Serv	✓	✓			99,717	21,934
OH0025313	Galion, City of	✓	✓		✓	92,081	6,368
OH0025364	Girard, City of	✓	✓			104,617	22,295
OH0025381	Greene Co San Eng Dept	✓	✓		✓	184,950	13,171
OH0025429	City of Greenville	✓	✓		✓	29,735	2,627
OH0025445	City of Hamilton	✓	✓			297,667	66,844
OH0025453	Cincinnati Metropolitan SD	✓	✓			2,167,222†	150,110†
OH0025461	Hamilton Co Bd of Comm	✓	✓			1,418,650†	77,119†
OH0025470	Cincinnati Metropolitan SD	✓	✓			377,613	53,970
OH0025488	Hamilton Co Brd of Comm Metropolitan SD	✓	✓		✓	99,653†	2,138†
OH0025763	Heath, City of	✓	✓			58,714*	8,334
OH0025810	Hubbard City of	✓	✓			64,856	14,008
OH0025852	City of Ironton	✓	✓			89,660	7,410
OH0025925	Kenton, City of	✓	✓			99,657	13,022
OH0026026	Lancaster, City of Municipal Bldg	✓	✓			386,676	21,036
OH0026182	Louisville City of	✓	✓		✓	61,165	3,029
OH0026328	City of Mansfield	✓	✓		✓	505,793	59,637
OH0026344	Marietta, City of	✓	✓			81,900	18,101
OH0026352	Marion, City of	✓	✓			326,181	45,580
OH0026492	City of Miamisburg	✓	✓			145,500	20,704
OH0026522	City of Middletown	✓	✓			313,326	24,690
OH0026573	Minster, Village of	✓	✓		✓	48,321†	1,313†
OH0026590	Montgomery Co Brd of Comm	✓	✓		✓	313,370	32,110
OH0026638	Montgomery Co Brd of Comm	✓	✓			269,373	44,306
OH0026662	Mount Vernon, City of	✓	✓			182,387	20,699
OH0026671	Newark, City of	✓	✓			470,437	180,899
OH0026689	Village of Newcomerstown	✓	✓			23,278*	3,475
OH0026727	New Philadelphia, City of	✓	✓			122,626*	7,389
OH0026743	Niles, City of	✓	✓		✓	96,063	10,229
OH0026930	City of Oxford	✓	✓			71,412	12,851

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
OH0027049	Piqua, City Of	✓	✓			73,433	17,852
OH0027197	Portsmouth City of	✓	✓			137,599	16,149
OH0027324	Salem, City of	✓	✓		✓	213,113	2,562
OH0027421	Sidney, City of	✓	✓			200,044	49,418
OH0027472	City of Springboro	✓	✓			55,159	6,181
OH0027481	Springfield, City of	✓	✓			587,732	90,062
OH0027511	Steubenville, City of	✓	✓			140,267	7,550
OH0027600	Struthers, City	✓	✓			172,278	47,484
OH0027758	Troy, City of	✓	✓			215,848	31,320
OH0027880	Urbana, City of	✓	✓			124,870	8,254
OH0027936	City of Wadsworth	✓	✓		✓	123,541†	5,905†
OH0027987	City of Warren	✓	✓			391,225	22,396
OH0028002	Washington Court House SD	✓	✓			91,938	37,280
OH0028134	Wilmington City of	✓	✓		✓	102,083	10,884
OH0028185	Wooster, City of	✓	✓			171,866	7,314
OH0028193	Xenia, City of	✓	✓		✓	60,979	2,804
OH0028207	Xenia, City of	✓	✓		✓	1,710,063	54,319
OH0028223	Youngstown, City of	✓	✓			1,044,230	133,504
OH0031119	Pickerington, City of	✓	✓			79,515	13,366
OH0036021	Aqua Ohio Water Co Inc	✓	✓		✓	33,135	782
OH0036285	Trumbull Co Brookfield SD 1 & 2 STP	✓	✓			42,177	3,468
OH0036641	Logan County Commissioners	✓	✓			95,973	1,696
OH0037249	Mahoning County Commissioners	✓	✓		✓	267,624	6,690
OH0039098	Licking Co Brd of Comm	✓	✓			47,433*	17,443
OH0040592	Greene Co San Eng Dept	✓	✓		✓	47,114	10,932
OH0040983	Hamilton Co Brd of Comm Metropolitan SD	✓	✓			68,221	21,825
OH0043401	Trumbull County Sanitary Engineer	✓	✓			199,678	16,614
OH0045721	Mahoning County Commissioners	✓	✓		✓	705,962	5,739
OH0048089	Clermont Co Water Resources Dept	✓	✓			159,981	22,963
OH0049361	Clermont Co Water Resources Dept	✓	✓			44,376	12,186
OH0049379	Clermont Co Water Resources Dept	✓	✓			253,895	51,849
OH0049387	Clermont Co Water Resources Dept	✓	✓			315,414	40,872

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
OH0049417	Butler County Board of Commissioners	✓	✓			236,900	4,094
OH0049646	Tri Cities North Regional WW Authority	✓	✓			421,357	91,004
OH0049794	Clark Co Brd of Comm	✓	✓			40,931	4,782
OH0049999	Eastern Ohio Regional Wastewater Auth	✓	✓			310,688	5,281
OH0050016	Scioto County Commissioners	✓	✓			13,830	3,526
OH0054224	Dept. of Rehabilitation and Corrections	✓	✓		✓	30,555*	1,454
OH0054305	FAIRFIELD CO COMMISSIONERS	✓	✓		✓	80,290	1,621
OH0054399	Delaware County Regional Sewer District	✓	✓	✓	✓	66,972	2,892
OH0058157	Marion Co Sanitary Eng	✓	✓		✓	13,604	2,365
OH0064017	Summit County Environmental Services	✓	✓		✓	162,243	10,756
OH0071692	Warren Co Brd of Comm	✓	✓		✓	169,977	13,310
OH0072087	Butler County Water and Sewer Department	✓	✓	✓	✓	40,4042*	23,175
OH0076490	Chillicothe Correctional Institution	✓	✓			36,328	4,952
OH0094684	Lawrence Co Brd of Comm	✓	✓			28,284	5,294
OH0102857	Rittman, City of	✓	✓		✓	48,015	2,400
OH0113964	Southwest Licking Env Control Facility	✓	✓			86,965*	9,532
OH0121380	Delaware County Sanitary Engineer	✓	✓			226,982*	5,534
OH0136247	Delaware Co Brd of Comm	✓	✓	✓	✓	1,379	163
OH0136271	City of Marysville	✓	✓		✓	167,454*	7,115
OH0136603	City of Lancaster WPC Dept	✓	✓			20,460	6,338
Totals	133 facilities	133	133	4	42	32,622,452	3,800,371

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with * are EPA loading tool estimates.
Loads marked with † are state provided from DMR data. DMR data in ICIS was cross-checked with state DMR records and corrected load estimates were provided, calculated with methods consistent with the EPA loading tool.

B-11. Tennessee

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
TN0020052	Sweetwater STP	✓	✓	✓	✓	10,342	9,512*
TN0020079	City of Maryville	✓	✓			288,646	31,300
TN0020095	City of Kingsport	✓	✓			411,975	64,337
TN0020117	City of Gatlinburg	✓	✓		✓	78,622	4,830
TN0020141	Gallatin Public Utilities	✓	✓			41,410	5,789
TN0020478	Dayton STP	✓	✓			105,069	6,418
TN0020494	City of Lenoir City	✓	✓			40,613	16,057
TN0020508	City of Decherd	✓	✓	✓	✓	11,640	2,163
TN0020541	Town of Smyrna	✓	✓	✓	✓	15,191	2,435
TN0020575	Metro Water Services - Nashville Central STP	✓	✓			1,039,399	75,061
TN0020613	McKenzie STP	✓	✓	✓	✓	20,471	6,375
TN0020648	Nashville Dry Creek STP	✓	✓			286,974	25,105
TN0020656	City of Clarksville	✓	✓			324,124	19,496
TN0020672	Town of Rogersville	✓	✓			154	14
TN0020702	City of Newport	✓	✓			34,195	3,773
TN0020711	City of Memphis	✓	✓			5,266,763	1,769,693
TN0020729	City of Memphis	✓	✓			7,163,267	1,614,042
TN0020877	City of Lafayette	✓	✓	✓	✓	8,159	1,161
TN0020982	City of Covington	✓	✓			8,424	3,652
TN0021067	City of Millington	✓	✓	✓	✓	143,056	13,343
TN0021199	Jefferson City	✓	✓			99,054	8,160
TN0021229	City of Greeneville	✓	✓			16,502	4,843
TN0021237	Pigeon Forge STP	✓	✓		✓	38,720	2,059
TN0021253	City of Church Hill	✓	✓			1,177	1,909
TN0021261	Town of Spring City	✓				5,060	5253*
TN0021296	CH2M HILL Constructors, Inc.	✓	✓	✓	✓	91,274	2,724
TN0021580	Union City STP (A.L. Strub WWTP)	✓	✓			90,393	16,339
TN0021687	City of Pulaski	✓	✓			16,702	1,952
TN0021814	Fayetteville Public Utilities (FPU)	✓	✓			1,458	2,561
TN0021822	Knoxville Utilities Board (KUB)	✓	✓			91,853	5,983
TN0021857	Winchester Utilities	✓	✓			2,818	1,951
TN0021865	City of Portland	✓	✓	✓	✓	23,083	11,989
TN0021873	Town of Livingston	✓	✓	✓	✓	13,158	3,853
TN0022551	Lawrenceburg Utility Systems	✓	✓	✓	✓	6,899	3,098

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
TN0022586	City of Murfreesboro	✓	✓	✓	✓	106,369	48,425
TN0022888	Lewisburg STP	✓	✓	✓	✓	24,200	6,778
TN0023001	Erwin Utilities Authority	✓	✓			25,781	6,827
TN0023353	First Utility District of Knox County - Turkey Creek STP	✓	✓			211,368	24,737
TN0023469	Tullahoma Utilities Authority	✓	✓	✓	✓	43,142	5,907
TN0023477	City of Dyersburg	✓	✓		✓	128,581	27,986
TN0023507	Morristown Utilities Commission	✓	✓			160,650	25,380
TN0023515	Elizabethton STP	✓	✓			207,800	16,724
TN0023531	City of Bristol	✓	✓			**	**
TN0023574	Knoxville Utilities Board (KUB)	✓	✓			140,374	11,476
TN0023582	Kub-Kuwahee STP	✓	✓			519,049	24,488
TN0023591	City of McMinnville	✓	✓			29,978	997
TN0024121	Cleveland Utilities	✓	✓			116,715	15,345
TN0024155	City of Oak Ridge	✓	✓	✓	✓	179,636	28,856
TN0024180	Shelbyville Power, Water & Sewerage System	✓	✓			28,171	14,984
TN0024198	City of Cookeville	✓	✓	✓	✓	98,018	26,064
TN0024201	Athens Utilities Board	✓	✓	✓	✓	17,117	8,045
TN0024210	City of Chattanooga	✓	✓			3,140,645	349,843
TN0024236	Johnson City Knob Creek STP	✓	✓			90,137	10,465
TN0024244	Johnson City Brush Cr. STP	✓	✓			402,176	12,234
TN0024295	City of South Pittsburg	✓	✓			18,209	1,613
TN0024341	City of Lexington, Utilities Division STP	✓	✓			25,466	6,621
TN0024473	Roane Co. STP	✓	✓			28,673	3,496
TN0024813	Jackson Energy Authority	✓	✓		✓	207,106	44,991
TN0024945	Mountain City STP	✓	✓			24,337	3,060
TN0024961	City of Springfield	✓	✓	✓	✓	75,197	25,251
TN0024970	Nashville Whites Creek STP	✓	✓			403,321	74,784
TN0024996	Crossville STP	✓	✓			50,750	2,203
TN0025038	City of Manchester	✓	✓	✓	✓	64,458	14,434
TN0025437	Harriman Utility Board	✓	✓			2,446	1,120
TN0026158	Rockwood STP	✓	✓	✓	✓	15,292	2,970
TN0026247	Bells Lagoon	✓	✓		✓	53,246	13,357
TN0026506	Clinton STP #1	✓	✓			36,985	5,816

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
TN0026590	Town of Whiteville	✓	✓			15,397	6,249
TN0028754	City of Lebanon	✓	✓			138,641	24,461
TN0028789	Johnson City Regional STP	✓	✓			38,440	4,903
TN0028827	Franklin Water Reclamation Facility	✓	✓	✓	✓	70,108	28,642
TN0056103	City of Columbia	✓	✓		✓	80,288	28,575
TN0057291	Halls Lagoon	✓	✓			10,407	1,021
TN0057461	Town of Collierville	✓	✓			11,000	2,959
TN0058181	Loudon STP	✓	✓			403,553	133,684
TN0058238	Tellico Area Services System	✓	✓			11,147	3,708
TN0059404	City of White House	✓	✓	✓	✓	27,010	6,124
TN0061166	Sparta STP	✓	✓			10,797	1,937
TN0061271	Paris STP	✓	✓			32,751	1,495
TN0061565	City of Savannah	✓	✓			683	136
TN0061701	City of Kingston	✓	✓			26,784	6,716
TN0061743	Knoxville Utilities Board (KUB)	✓	✓			12,958	1,426
TN0062111	Town of Newbern	✓	✓			18,844	5,055
TN0062308	Town of Selmer	✓	✓			7,867	2,654
TN0062367	Brownsville Energy Authority	✓	✓			5,422	1,207
TN0062375	Milan Public Utilities	✓	✓	✓	✓	8,575	1,597
TN0062499	Munford Lagoon	✓	✓			31,556	4,389
TN0062545	City of Martin	✓	✓	✓	✓	31,078	10,212
TN0062588	Humboldt Board of Public Utilities	✓	✓			30,535	8,532
TN0062634	City of Jamestown	✓	✓	✓	✓	538	146
TN0063771	Etowah STP	✓	✓			77,435	4,262
TN0063959	City of Sevierville	✓	✓			**	**
TN0064092	Town of Rossville	✓	✓			793	579
TN0064688	Town of Monterey	✓	✓			3,578	2,201
TN0065358	Smithville STP	✓	✓	✓	✓	12,209	4,223
TN0066800	Bartlett STP	✓	✓		✓	20,157	11,726
TN0066958	Water Authority of Dickson County - Jones Creek	✓	✓	✓	✓	14,475	7,691
TN0067539	Athens Ub-No Mouse Creek STP	✓	✓		✓	2,719	1,376
TN0074748	Harpeth Valley Utility District	✓	✓			69,813	17,394

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/year)	2020 P Load (lbs/year)
TN0075078	Brownsville Energy Authority	✓	✓		✓	20,901	3,682
TN0075868	City of Spring Hill	✓	✓	✓	✓	30,009	4,008
TN0075876	Jackson Energy Auth-Middle Fk	✓	✓		✓	55,757	16,842
TN0077836	City of Oakland	✓	✓			8,679	4,528
TN0077917	City of Bolivar	✓	✓	✓	✓	37,787	2,702
TN0078191	Ripley Wastewater Lagoon	✓	✓			3,690	256
TN0078255	City of Lakeland STP	✓	✓		✓	5,540	3,879
TN0078271	City of Trenton					38919*	7137*
TN0078603	Town of Arlington (11150 Highway 70)	✓	✓			3,001	1,728
TN0078808	City of Waverly	✓	✓			13,327	2,657
TN0078841	Collierville Northwest STP	✓	✓			17,883	14,462
TN0078905	Hallsdale Powell Utility District	✓	✓	✓	✓	190,411	50,137
TN0080021	Lafollette Utilities Board	✓	✓	✓	✓	7,915	3,443
TN0080721	West Knox Utility District (WKUD)	✓	✓			23,502	9,881
TN0080764	City of Piperton	✓	✓	✓	✓	0	0
TN0081132	City of Pigeon Forge					0	0
TN0081175	Town of Jonesborough	✓	✓			27,419	5,386
TN0081906	State of Tennessee, Dept. of General Services, Memphis Megasite WWTP	✓	✓			0	0
Totals	117 facilities	115	114	31	42	24,182,337	5,078,516

Nutrient Load Notes:
Unmarked loads are from DMR data entered into ICIS and calculated by the loading tool.
Loads marked with * are EPA loading tool estimates.
** indicates no/insufficient data to make an estimate, due to no reporting during 2020 and further data transfer issues between DMR inputs and loading tool outputs.

B-12. Wisconsin

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
WI0020001	Whitewater Wastewater Treatment Facility	✓	✓		✓	57,407	790
WI0020044	Rhinelander, City of	✓	✓		✓	54,062	1,837
WI0020109	Richland Center Wastewater Treatment Facility	✓	✓		✓	24,933	3,091
WI0020150	Merrill, City of	✓	✓		✓	99,884	2,702

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
WI0020192	Hartford Water Pollution Control Facility	✓	✓		✓	67,376	319
WI0020257	Prairie Du Chien Wastewater Treatment Facility	✓	✓		✓	22,579	853
WI0020265	Mukwonago Wastewater Treatment Plant		✓		✓	53,889*	1,028
WI0020338	Stoughton Wastewater Treatment Facility	✓	✓		✓	54,558	1,187
WI0020362	Monroe Wastewater Treatment Facility	✓	✓		✓	49,216	837
WI0020371	Reedsburg Wastewater Treatment Facility	✓	✓		✓	52,446	5,324
WI0020435	Platteville Wastewater Treatment Facility	✓	✓		✓	94,431	1,436
WI0020478	Sun Prairie Wastewater Treatment Facility	✓	✓		✓	185,888	7,141
WI0020559	Sussex Wastewater Treatment Facility	✓	✓		✓	19,252	949
WI0020605	Baraboo Wastewater Treatment Facility		✓		✓	90,090*	703
WI0020681	Oregon Wastewater Treatment Facility	✓	✓		✓	51,435	3,714
WI0020737	Sparta Wastewater Treatment Facility	✓	✓		✓	45,099	3,178
WI0021008	Columbus Wastewater Treatment Facility	✓	✓		✓	57,119	1,420
WI0021024	Marshfield Wastewater Treatment Facility	✓	✓		✓	60,903	1,908
WI0021181	Oconomowoc Wastewater Treatment Plant	✓	✓		✓	182,056	5,264
WI0021318	Tomah Wastewater Treatment Facility	✓	✓		✓	23,093	1,136
WI0021695	Twin Lakes Wastewater Treatment Fac	✓	✓		✓	29,715	943
WI0021865	Rice Lake Utilities, City of	✓	✓		✓	301,907	4,770
WI0022144	Antigo, City of	✓	✓		✓	55,445	1,450
WI0022489	Fort Atkinson Wastewater Treatment Facility	✓	✓		✓	91,281	5,658
WI0022772	Waupun Wastewater Treatment Facility	✓	✓		✓	74,425	3,052
WI0022926	Burlington Water Pollution Control	✓	✓		✓	122,835	6,483
WI0023230	Arcadia Wastewater Treatment Facility	✓	✓		✓	87,423	3,415
WI0023345	Beaver Dam Wastewater Treatment Facility	✓	✓		✓	290,931	10,069

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
WI0023370	Beloit Wastewater Treatment Facility	✓	✓		✓	306,932	8,128
WI0023469	Brookfield, City of	✓	✓		✓	344,169	20,180
WI0023604	Chippewa Falls WWTF	✓	✓		✓	86,531	2,572
WI0023850	Eau Claire Wastewater Treatment Facility	✓	✓		✓	451,928	6,088
WI0024279	Hudson Wastewater Treatment Facility	✓	✓		✓	147,764	3,010
WI0024333	Jefferson Wastewater Treatment Facility	✓	✓		✓	70,438	964
WI0024597	Madison Metropolitan Sewerage District WWTF	✓	✓		✓	2,455,068	32,915
WI0024643	Mayville Wastewater Treatment Facility	✓	✓		✓	49,043	1,217
WI0024708	Menomonie Wastewater Treatment Facility	✓	✓		✓	141,031	2,283
WI0025739	Wausau Water Works WW Treatment Facility	✓	✓		✓	353,736	13,039
WI0025844	Wisconsin Rapids WWTF	✓	✓		✓	225,244	6,710
WI0027995	Plover Wastewater Treatment Facility	✓	✓		✓	75,050	1,931
WI0028291	Village of Union Grove	✓	✓		✓	3,956	1,073
WI0028541	Watertown Wastewater Treatment Facility	✓	✓		✓	220,427	5,840
WI0028754	Western Racine County Sewerage District	✓	✓		✓	21,508	1,841
WI0029394	River Falls Municipal Utility WWTF	✓	✓		✓	62,535	950
WI0029572	Stevens Point Wastewater Treatment Facility	✓	✓		✓	211,316	3,798
WI0029581	La Crosse, City of	✓	✓		✓	411,074	16,954
WI0029971	Waukesha City	✓	✓		✓	692,989	2,101
WI0030031	Plymouth Utilities WWTF		✓		✓	105,182*	524
WI0030350	Janesville Wastewater Utility	✓	✓		✓	215,558	8,750
WI0031194	Lake Mills Wastewater Treatment Facility	✓	✓		✓	44,193	1,345
WI0031402	Wi Dells Lk Delton Sewerage Commission WWTF	✓	✓		✓	55,062	373
WI0031461	Walworth County Metro	✓	✓		✓	296,952	9,460
WI0031470	Norway Tn Sanitary District 1 WWTF	✓	✓		✓	50,820	310
WI0031496	Salem Lakes, Village	✓	✓		✓	69,779	2,760
WI0032026	Delafield Hartland Water Pollution Control Commission	✓	✓		✓	106,278	4,590

NPDES ID	Permit Name	Monitoring N	Monitoring P	Limits N	Limits P	2020 N Load (lbs/yr)	2020 P Load (lbs/yr)
WI0035581	Rib Mountain Metro Sewage District WWTF	✓	✓		✓	331,268	6,011
WI0036021	Fontana Walworth Water Pollution Control Commission	✓	✓		✓	139,954	1,833
Totals	57 facilities	54	57	0	57	10,145,461	248,207

Nutrient Load Notes:
Unmarked loads are from state DMR data, calculated as described in the methods below.
Nitrogen Loads marked with * are estimated by the state based on the statewide average nitrogen concentration of 18 mg/L.

Wisconsin Nutrient Load Calculation Methodology:

- **Phosphorus**: All 57 facilities currently sample for TP at least monthly, so these loadings were calculated by first averaging the phosphorus concentrations (mg/L) for each month and then multiplying that number by the average flow for that month (MGD*8.34). The monthly average (lbs/day) was then multiplied by the number of days in that month to get the total mass loadings for each month (lbs/month). These numbers were then added together to get the total mass loading for the year (lbs/year).
- **Nitrogen**: 54 out of the 57 facilities had 2020 nitrogen data, but most of these facilities sample at a frequency of quarterly or less. To estimate annual loadings, all nitrogen samples for a facility taken in 2020 were averaged (mg/L) and then multiplied by the average flow for each month (MGD*8.34). The monthly average (lbs/day) was then multiplied by the number of days in that month to get the total mass loadings for each month (lbs/month). These numbers were then added together to get the total mass loading for the year (lbs/year).
    - NOTE: To estimate loadings from the 3 facilities which do not have sampling results for TN, the statewide average concentration was used (18 mg/L).

Appendix C: Key Findings from Research on Climate Change Effects of Hypoxia in the Gulf of Mexico

The following table provides relevant key findings from select papers used in this summary.

Key Findings	Authors
Evidence suggests that numerous climate variables including temperature, ocean acidification, sea-level rise, precipitation, wind, and storm patterns will affect dead zones, and that each of those factors has the potential to act through multiple pathways on both oxygen availability and ecological responses to hypoxia.	Altieri and Gedan 2015
Increased heavy precipitation events are likely to drive more episodic pollutant loading to water bodies. The risk of algal blooms could increase due to an expanded seasonal window of warm water temperatures and the potential for episodic increases in nutrient loading.	Coffey et al. 2019
A +2°C change in water temperature will cause a 26% hypoxic area increase due to enhanced sediment respiration and reduced oxygen solubility.	Del Giudice at al. 2020
A hypoxia model shows that the year-to-year variability in central U.S. climate must be considered in developing nutrient management policy. During a wet year, a nitrogen reduction of 50-60%—close to twice the recommended target—is required to meet the goal of reducing the hypoxic zone to less than 5,000 km^2 in size.	Donner and Scavia 2007
A 20% increase the Mississippi River discharge, which may occur under some climate change scenarios, would produce an increase in the frequency of hypoxia of the same magnitude.	Justić et al. 2003
Results indicated more severe and prolonged periods of hypoxia in the future due to reduced oxygen solubility in warmer waters and increased stratification.	Laurent et al. 2018
Results confirmed that a warmer and wetter future climate will, on average, worsen the extent and duration of hypoxia in this system.	Lehrter et al. 2017
Despite occurring in approximately 9 days $year^{-1}$, extreme precipitation events contribute approximately 1/3 of annual precipitation, and approximately 1/3 of total nitrogen yield on average. Both USGS monitoring and modeling estimates demonstrate an approximately 30% higher annual nitrogen load in the years with extreme river flow than the long-term median.	Lu et al. 2020
Cyanobacteria dominate phytoplankton assemblages under higher temperatures due to both physiological (e.g., more rapid growth) and physical factors (e.g., enhanced stratification), with individual species showing different temperature optima.	O'Neil et al. 2012
The combination of increased nutrient loads (from human activities) and increased freshwater discharge (from climate change) will aggravate the already high loads of nutrients from the Mississippi River to the northern Gulf, strengthen stratification (all other factors remaining the same), and worsen the hypoxia situation.	Rabalais 2014
Predicted higher stream flows for the upper Mississippi River watershed or increasing coastal water temperatures will result in increased nutrient runoff and stronger stratification gradients, respectively, and increase biological rates offshore and perhaps have other confounding consequences. These scenarios, among others, could aggravate hypoxia in the northern Gulf, and other eutrophied coastal waters worldwide.	Rabalais and Turner 2019

Key Findings	Authors
Results reveal high spatial and temporal variability in loading, with spatial variability primarily driven by nitrogen inputs, but with interannual variability and the occurrence of extremes dominated by precipitation across over three-quarters of the CONUS.	Sinha and Michalak 2016
Shows that climate change–induced precipitation changes alone will substantially increase (19 ± 14%) riverine TN loading within the continental United States by the end of the century for the "business-as-usual" scenario.	Sinha et al. 2017
The bottom water column warming in summer for all stations was 1.9 times faster compared to the rise in local summer air temperatures, and 6.4 times faster than the concurrent increase in annual global ocean sea surface temperatures. These recent changes in the heat storage on the northern Gulf continental shelf will affect oxygen and carbon cycling, spatial distribution of fish and shrimp, and overall species diversity.	Turner et al. 2017
Nitrogen loading is projected to increase by 30% under two climate scenarios (RCP4.5 and RCP8.5) by the end of the 21st century, half of which is likely driven by heavy precipitation. Future increases in spring heavy precipitation likely result in higher nitrogen leaching loss and enhance nitrogen loading.	Zhang et al. 2022