Minnesota Pollution Control Agency

Minnesota Nutrient Reduction Strategy Support

Assessment of Watershed Work (WRAPS & CWMP) to Address Nutrients

November 04, 2024

Objective 1 Report

TETRA TECH

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EXECUTIVE SUMMARY

To support the revision of Minnesota's 2014 Nutrient Reduction Strategy (NRS), the Minnesota Pollution Control Agency contracted with Tetra Tech to review published Watershed Restoration and Protection Strategy (WRAPS) reports and Comprehensive Watershed Management Plans (CWMP) for information related to nitrogen and phosphorus pollution in Minnesota waters. MPCA seeks to determine if and how the plans consider the NRS and how state-level nutrient reduction efforts could help support nutrient reduction at the local level.

This report summarizes the review of 79 WRAPS reports and 40 CWMPs.

Nutrient Sources

Both WRAPS reports and CWMPs typically identified and prioritized sources of nutrients. Throughout much of Minnesota, agricultural sources and pathways were the most common sources of impairment and were most frequently prioritized, with crop operations often more frequently prioritized than livestock operations. In the WRAPS reports, sources were typically quantified using the Hydrologic Simulation Program-FORTRAN (HSPF) model. Sources were not often quantified in CWMPs.

MPCA targets source pathways, which are the mechanisms by which a pollutant is released and migrates to and within a waterbody (also known as: fate and transport). An example of an agricultural pathways is the application of a fertilizer to a crop field that is followed by a rain event, where the rainwater transports excess nutrients into the subsurface tile drain system and the tile flow transports the nutrients to a surface stream. Most reports did not discuss source pathways in much detail. Less than one-quarter of WRAPS reports discussed sources and source pathways relative to low- or high-flow conditions and less than 10% of WRAPS reports discussed temporal trends with nutrient sources or pathways

Prioritized Waters

The WRAPS reports often prioritized specific waters, based on a host of factors including impairment status, threat to public health, biological significance, financial considerations, and public participation and involvement. The CWMPs typically prioritized issues and resources, which did not always translate to prioritizing a water for phosphorus and nitrogen sources.

The WRAPS reports generally did not address or prioritize downstream waterbodies, though many WRAPS reports acknowledge potential downstream impacts or the 2014 NRS. The CWMPs did not address downstream waterbodies explicitly, though some plans did base the nutrient goals on the NRS.

Water Quality Trends

Temporal trends in total phosphorus and total nitrogen monitoring data were discussed in a majority of WRAPS reports and only a few CWMPs. Several reports focused on other parameters (e.g., total suspended solids). Analysis of trends was challenging because individual WRAPS reports often presented trends with multiple monitoring sites but the trends were not consistent across monitoring sites.

Nutrient Goals

Most WRAPS reports and CWMPs identified nutrient goals but those goals were not consistent with the 2014 NRS. Goals were identified for phosphorus (88%) and nitrogen (65%) in most WRAPS reports but only 48% of phosphorus goals and 25% of nitrogen goals were consistent with the 2014 NRS. Many WRAPS reports identified goals that were designed to address local impairments that were consistent with TMDLs or river eutrophication standards. WRAPS reports' goals also target local waterbodies for protection (e.g., high quality waters, threatened waters).

All of the CWMPs identified phosphorus goals, while 90% identified nitrogen goals. For both nutrients, only about a third of the reports identified goals consistent with the 2014 NRS. Many CWMPs identified goals that were designed to address local impairments or protection of local waters that are not impaired

Recommended Actions

All of the WRAPS reports and CWMPs identified recommended actions and best management practices (BMPs); however, some reports targeted other pollutants and did not present BMPs to address phosphorus or nitrogen. WRAPS reports typically identified BMPs to target both impaired waters (i.e., those waters on Minnesota's 303(d) list) and threatened or degraded waters. WRAPS reports identified BMPs at varying scales, from a pollutant-waterbody combination to a group of waterbodies impacted by similar sources. The CWMPs typically identified BMPs (or recommended actions) along with measurable goals for both impaired waters and threatened or degraded waters and a timeline.

Tools and Models

Many models were cited in the WRAPS reports and CWMPs but seven tools were used most frequently (Table 1). Generally, HSPF models were built to support TMDL and WRAPS development. The CWMPs often cited HSPF results developed for TMDL and WRAPS reports.

Table 1. Summary of models and tools

Name	Type	WRAPS reports	CWMPs
ACPF	BMP siting tool (beta version with BMP load estimation)	16%	33%
BATHTUB	Reservoir eutrophication model	9%	8%
HSPF	Flow & water quality model	85%	70%
HSPF-SAM	BMP siting and load estimation tool	23%	38%
PTMApp	BMP siting and load estimation tool	18%	55%
SWAT	Flow & water quality model	14%	10%
ZCT	Priority area identification model	n/a	20%

ACPF = Agricultural Conservation Planning Framework; BMP = best management practice; CWMP = Comprehensive Watershed Management Plant; HSPF = Hydrologic Simulation Program – FORTRAN; n/a = not available; PTMApp = Prioritize, Target, and Measure Application; SAM = Scenario Application Manager; SWAT = Soil and Water Assessment Tool; WRAPS = Watershed Restoration and Protection Strategy; ZCT = Zonation Conservation Tool.

Forest and Peatland

Forests and peatlands are essential habitat for wildlife and can be nutrient-sinks. Both landscapes were historically used for resource extraction. Today, efforts are being made to restore, enhance, and protect forest and peatland. The WRAPS reports and CWMPs present limited information on the sources and pathways of nutrients from forest and peatlands but do provide general information on management strategies and BMPs.

Additional Study Needs

Many WRAPS reports and CWMPs recommended additional study or monitoring needs. WRAPS reports often recommended additional water quality monitoring and additional study to support source assessment, lake characterization, and identification and prioritization of lake management practices and other BMPs. CWMPs often recommended additional surface and groundwater quality monitoring and additional study to support source assessment and to support BMP siting, prioritizing, and efficiency.

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
BWSR	Board of Soil and Water Resources
CWMP	Comprehensive Watershed Management Plan
MPCA	Minnesota Pollution Control Agency
NRS	Nutrient Reduction Strategy
SSTS	subsurface treatment system
SWCD	soil and water conservation district
TMDL	total maximum daily load
WRAPS	Watershed Restoration and Protection Strategy
1W1P	One Watershed One Plan

Note: Acronyms/abbreviations for tools and models are defined in Section 7.0.

1.0 INTRODUCTION

In 2014, the state of Minnesota developed a Nutrient Reduction Strategy (NRS) to guide the reduction of nutrient-loading to Minnesota's waters and downstream waters. The statewide NRS framework established milestones and final load goals at Minnesota's state boundaries. The 2014 NRS recommended reductions for agriculture, wastewater, and other sources to achieve milestones and goals.[1]

Minnesota's state water agencies[2] developed *The Minnesota Water Management Framework* (Figure 1) in 2013 to clarify roles and enhance coordination. The *Framework* defines five categories of work in an adaptive management approach (plan-do-check-adapt). Through coordination and collaboration with each other and partners, agencies aim to improve the effectiveness and efficiency of water management while empowering local action for clean and sustainable water statewide. The *Minnesota Water Management Framework* describes five main steps:

- Monitoring, Assessment, and Characterization
- Problem Investigation and Applied Research
- Restoration and Protection Strategy Development
- Comprehensive Watershed Management Planning
- Implementation

Figure 1. Illustration of *The Minnesota Water Management Framework*.

[1] To collectively achieve the NRS goals and milestones, reductions needed to be estimated for major watershed (HUC8). Minnesota uses a collaborative, watershed-based approach to monitor, evaluate, protect, and restore water quality throughout the state. In 2022, the Minnesota Pollution Control Agency (MPCA) developed interim guidance to refine the necessary NRS reductions for each subbasin (MPCA 2022).

[2] Minnesota's state water agencies are the Metropolitan Council, Minnesota Board of Water and Soil Resources, Minnesota Department of Agriculture, Minnesota Department of Health, Minnesota Department of Natural Resources, Minnesota Pollution Control Agency, and Minnesota Public Facilities Authority.

The Minnesota Pollution Control Agency (MPCA) implements the Watershed Restoration and Protection Strategy (WRAPS) process at the scale of major watersheds (i.e., hydrologic units defined by an 8-digit code [HUC8]). WRAPS reports are based on monitoring and assessment, stressor identification, and watershed-scale models, which often support the development of total maximum daily loads (TMDLs) for certain waters impaired for their designated uses. TMDL reports determine the amount of pollutant that a water can assimilate while still maintaining water quality standards. WRAPS reports cover all waters within a major watershed. WRAPS have been developed for all major watersheds in Minnesota and will be updated systematically to address new monitoring data and impairments. MPCA guidance for WRAPS updates includes prompts for WRAPS to strengthen linkages to nutrient reduction goals and strategies included in the NRS.

Restoration and Protection Strategy Development

Watershed restoration and protection strategies (WRAPS) reports summarize water quality data, stressor identification results, and goals for protection and restoration

Groundwater restoration and protection strategies (GRAPS) reports summarize available state groundwater and drinking water information, identify groundwater and drinking water issues, and recommend strategies for implementation.

Landscape Stewardship Plans are written for watersheds with forested landscapes, make recommendations for land protection to maintain or protect water quality, and provide critical information for forest management and land protection goals in watershed plans.

Building on the WRAPS process, local governments[3] are developing comprehensive watershed management plans (CWMP) for all major watersheds in Minnesota through the Minnesota Board of Water and Soil Resources' (BWSR's) One Watershed, One Plan (1W1P) program. This program supports partnerships of local governments in developing prioritized, targeted, and measurable implementation plans. The objective of these plans is to create a systematic, watershed-wide, science-based approach to watershed management. These plans focus on implementation planning in a 10-year cycle. CWMP development is authorized by statute and requires specific items each plan must address, including "surface water and ground water quality protection, restoration, and improvement, including prevention of erosion and soil transport into surface water systems." BWSR has identified 60 planning boundaries that generally follow the HUC8 watershed scale, with some modifications to accommodate portions of watersheds that cross the state line or other minor boundary adjustments to facilitate local government participation in watershed planning. BWSR establishes policies for plan content requirements and plan development procedures.

MPCA has developed WRAPS reports for every major watershed in Minnesota and local governments have developed CWMPs for 48 of the major watershed in Minnesota. In many watersheds throughout Minnesota, anthropogenic activities have led to nutrient eutrophication that degrades water quality. Many WRAPS reports and CWMPs describe such nutrient pollution and identify best management practices (BMPs) to address such pollution.

To support the revision of the 2014 NRS, MPCA contracted with Tetra Tech to review published WRAPS reports and CWMPs for information related to nitrogen and phosphorus pollution in Minnesota waters. Both types of reports generally focus on the local scale. MPCA seeks to determine if and how the plans consider the NRS and how state-level nutrient reduction efforts could help support nutrient reduction at the local level.

[3] Tribal governments are invited to participate in planning and implementation partnerships. Plan development includes public participation from community members.

This report summarizes the review of 79 WRAPS reports and 40 CWMPs.

2.0 NUTRIENT SOURCES

Sources of nitrogen and phosphorus and the pathways that transport nutrients to waterways vary across the state. Both point and nonpoint sources can contribute nutrient loads, and the dominance of such sources can vary by flow condition.

As nutrient loading in many watersheds can be derived from multiple nonpoint sources and transport pathways, it can be difficult to prioritize and quantify sources, especially without intensive monitoring or a watershed model. Such challenges then complicate the determination of necessary reductions.

WRAPS reports and CWMPs identified and prioritized nutrient sources; however, a minority of WRAPS reports and all of the CWMPs did not quantify source loads. When sources were quantified in WRAPS reports, the quantification method used most often was the Hydrologic Simulation Program-FORTRAN (HSPF) model. Source pathways were not often discussed in detail. Results are summarized separately for the WRAPS reports (Section 2.1 and Table 10 and Table 11 in Appendix A) and CWMPs (Section 2.2 and Table 17 in Appendix B).

2.1 WATERSHED RESTORATION AND PROTECTION STRATEGIES

Throughout much of Minnesota, agricultural sources and pathways were the most common sources of impairment. Individual agricultural sources identified in the WRAPS report, along with other categories of sources, are summarized in Table 2. Source categories identified and prioritized by nutrient are summarized in Figure 2, identified source categories by major basin are summarized in Figure 3, and agricultural source categories identified and prioritized by nutrient and basin are summarized in Figure 4.

Few WRAPS reports discussed sources and source pathways relative to low- or high-flow conditions. Several WRAPS identified subsurface treatment systems (SSTSs), permitted point sources, and cattle access to streams (with direct deposition of waste) as primary sources during low-flow (or low-precipitation) conditions, while runoff (or tile flow) from crops or pastures is a primary source during high-flow conditions. A few WRAPS reports, notably in the Minnesota River Basin, also discussed how runoff from the predominant corn-soybean rotations can exacerbate higher flows in the spring and lower flows in the summer. Several WRAPS reports also discussed the impacts of higher flows on pollutant loading (at static concentrations) and bank/channel erosion. A few WRAPS reports discussed how nutrient-loading from spring runoff (and snowmelt) contributes disproportionately larger loads compared to the rest of the year (e.g., Root River WRAPS update). The Sauk River WRAPS update discussed how precipitation events can flush anoxic water in wetlands downstream, and when combined with nutrient eutrophication, exacerbates downstream low dissolved oxygen.

The WRAPS report for the Lower Minnesota River discussed the dichotomy of how many agricultural sources with runoff as the pathway contribute the most TP load during high-flow events, whereas river eutrophication typically occurs during summer low-flow conditions, when TP has a longer residence time in streams. Similarly, this WRAPS report discussed that lake-like conditions can occur in the Mississippi River at the locks and dams during low flow, which can result algal blooms from excess phosphorus loadings held in the pools.

The methods of source and pathway identification and prioritization varied across the WRAPS reports. Source identification and prioritization was most frequently based on stressor identification and TMDL reports. WRAPS reports also refer to modeling studies, other organizations' publications, and review of field-scale data. Many WRAPS reports discussed one or more groups of people involved with prioritization, including local teams (composed of local and state conservation staff), technical committees, and citizens. A few WRAPS reports discussed a weight-of-evidence approach used by local stakeholder teams or technical committees. Several WRAPS reports also mentioned best professional judgement or a ranking system for source and pathway

prioritization. Finally, Tetra Tech hypothesizes that a combination of prioritization methods may have been used for most WRAPS reports but that the WRAPS reports did not go into detail when describing the prioritizations.

Few WRAPS reports discussed trends with nutrient sources or pathways. Such trends were most frequently discussed for watersheds in the Minnesota River Basin. Generally, the source trends were a result of changing land uses (e.g., agricultural and urban development), changing farming practices, and increased population. These changes in source trends also affect hydrology (i.e., infiltration, evapotranspiration, soil water holding capacity).

Table 2. Summary of common sources and pathways identified in the WRAPS reports.

Source category	Source and pathway
Agriculture	▪ Application of commercial fertilizer, manure, and pesticide (via runoff or tile flow) ▪ Conversion of natural landscapes to agricultural production ▪ Bank or channel erosion (from altered hydrology due to channelization and tile flow; via hoof-shear from livestock access to streams) ▪ Legacy nitrogen (shallow, nitrate-enriched aquifers) and leaching to groundwater (including karst) ▪ Manure from feedlots and pasture (via runoff) or from livestock access to streams (direct deposition) ▪ Poor riparian vegetation cover and loss of riparian vegetation (e.g., livestock grazing, crops planted up to streambanks) ▪ Soil erosion and tillage/residue management in crop fields (via runoff or tile flow)
Point Sources (non-stormwater)	▪ Wastewater treatment facilities ▪ Domestic and industrial effluent
SSTS	▪ Noncompliant or failing SSTS ▪ Unsewered communities
Urban stormwater	▪ Deicing chemicals ▪ Regulated stormwater runoff (municipal, industrial, and construction) ▪ Unregulated stormwater runoff (e.g., manicured lawns)
Natural	▪ Atmospheric deposition ▪ Forests ▪ Peatland and wetlands ▪ Wildlife (via direct deposition or runoff) ▪ Wind erosion (phosphorus bound to soils)
Other	▪ Bluff erosion ▪ Dams and culverts ▪ Ditch erosion (including ditch instability and legacy ditches in peatland areas) ▪ Groundwater (surface-to-groundwater interaction) ▪ Legacy phosphorus (resuspension and internal loading) ▪ Rural residential runoff ▪ Shoreline development (erosion and wave-action) ▪ Timber harvest ▪ Upland runoff and upland waterbodies

Figure 2. Summary of sources of phosphorus and nitrogen identified and prioritized in the WRAPS reports.

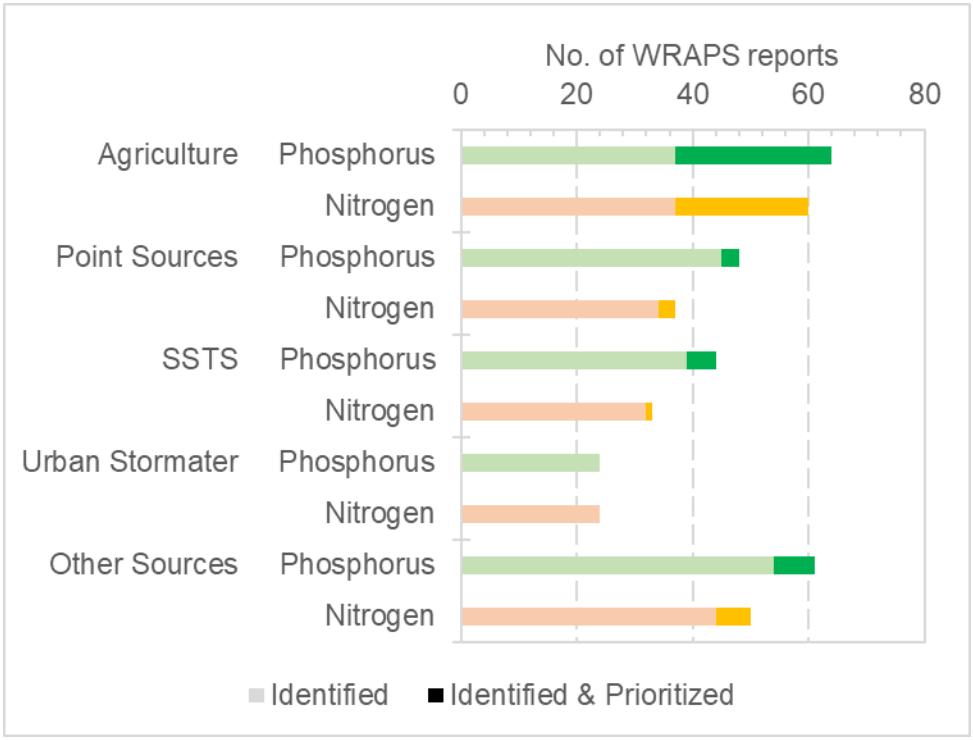


Figure 3. Summary of sources of phosphorus (left) and nitrogen (right) identified in the WRAPS reports, by major basin.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.

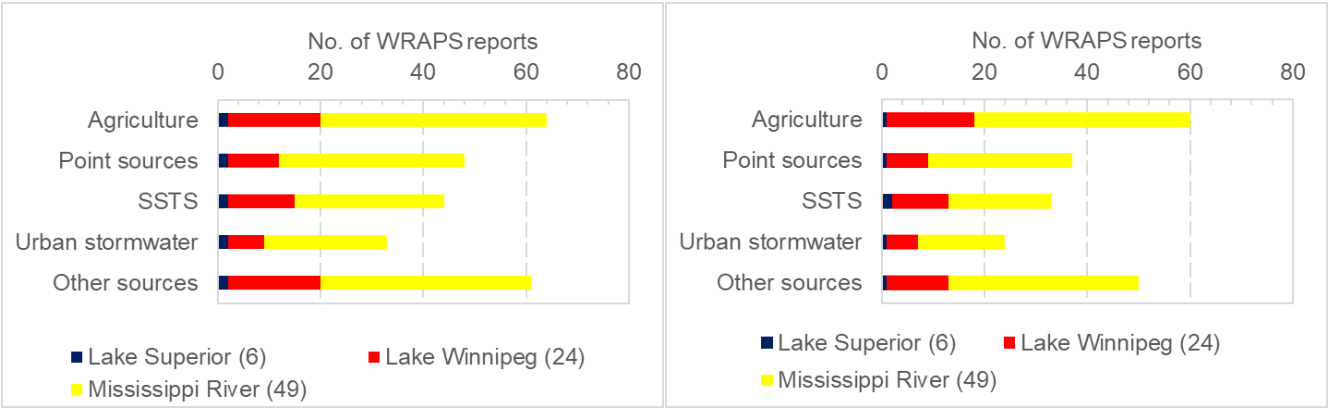
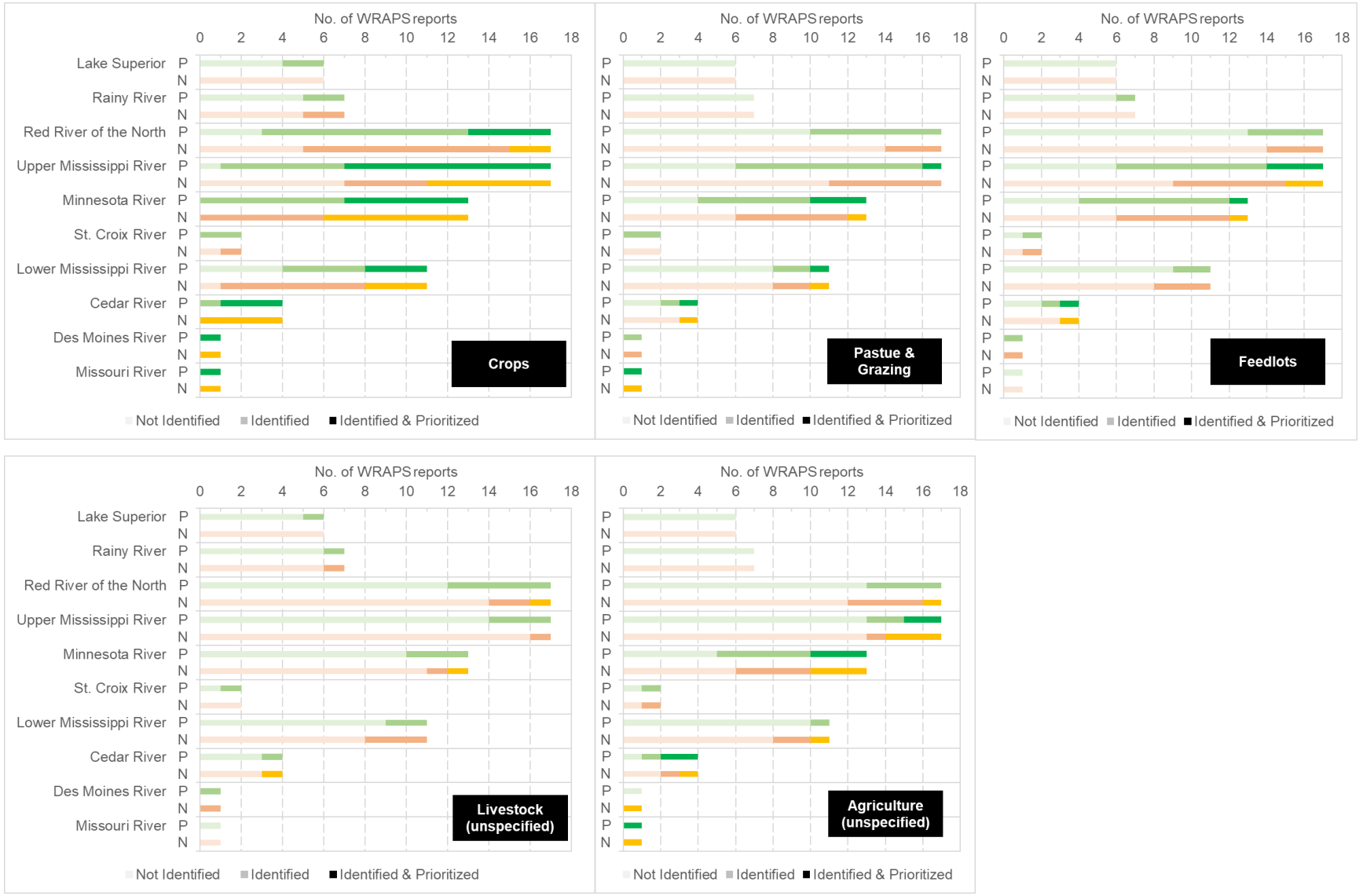


Figure 4. Summary of agricultural sources of phosphorus and nitrogen in the WRAPS reports, by basin.



2.2 COMPREHENSIVE WATERSHED MANAGEMENT PLANS

The CWMPs often presented limited information about sources and pathways of nutrient loading because much of the investigation into and reporting of nutrient sources and pathways occurred during the WRAPS process, prior to the 1W1P process. Nutrient source and pathway information is still important for the 1W1P process because appropriate BMPs must be selected to address the nutrient loading, but the 1W1P program policies do not require additional source identification and assessment beyond the TMDL and WRAPS processes.

In identifying sources and pathways, CWMPs typically relied on and cited the publications within the WRAPS process: monitoring and assessment reports, stressor identification reports, TMDL reports, and WRAPS reports. The CWMPs also cited water and resource planning documents published by state and tribal governments and non-governmental organizations; for example, several CWMPs cited the statewide *Minnesota Prairie Conservation Plan* (The Nature Conservancy 2018).

Typical sources of phosphorus and nitrogen identified in the CWMPs are summarized in Table 3 and summarized by source category in Table 18 in Appendix B. Additionally, the categories of sources identified and prioritized are summarized in Figure 5 and Figure 6.

Table 3. Summary of common sources and pathways identified in the CWMPs.

Source category	Source and pathway
Agriculture	▪ Application of commercial fertilizer or manure (runoff or tile drains) ▪ Conversion of natural landscapes to agricultural production ▪ Bank or channel erosion (altered hydrology due to channelization and tile drains) ▪ Feedlots and pasture (runoff), livestock access to streams (direct deposition) ▪ Tillage (runoff or tile drains)
Point Sources	▪ Wastewater treatment facilities ▪ Domestic and industrial effluent
SSTS	▪ Noncompliant or failing SSTS
Urban stormwater	▪ Conversion of natural landscapes to urban development ▪ Insufficient stormwater infrastructure
Other	▪ Atmospheric deposition ▪ Disturbance of forest soils ▪ Groundwater (surface-to-groundwater interaction) ▪ Groundwater wells that were abandoned or are unused ▪ Landfills and storage tanks ▪ Legacy phosphorus (resuspension and internal loading) ▪ Shoreline development (erosion and wave-action) ▪ Wildlife (direct deposition or runoff)

Figure 5. Summary of sources of phosphorus and nitrogen identified and prioritized in the CWMPs.

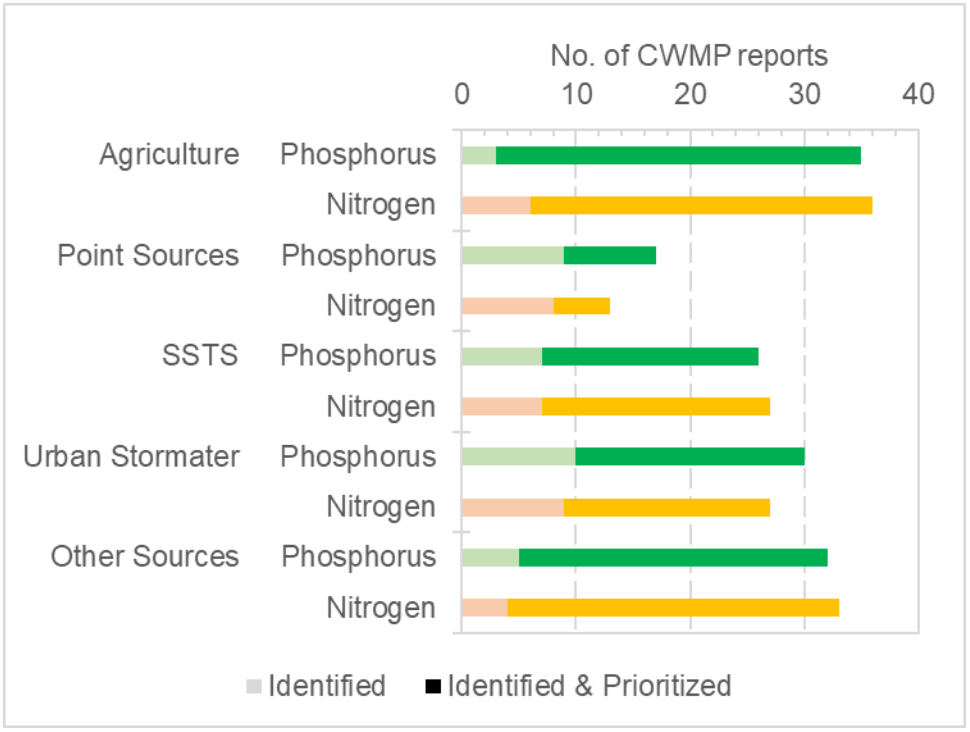
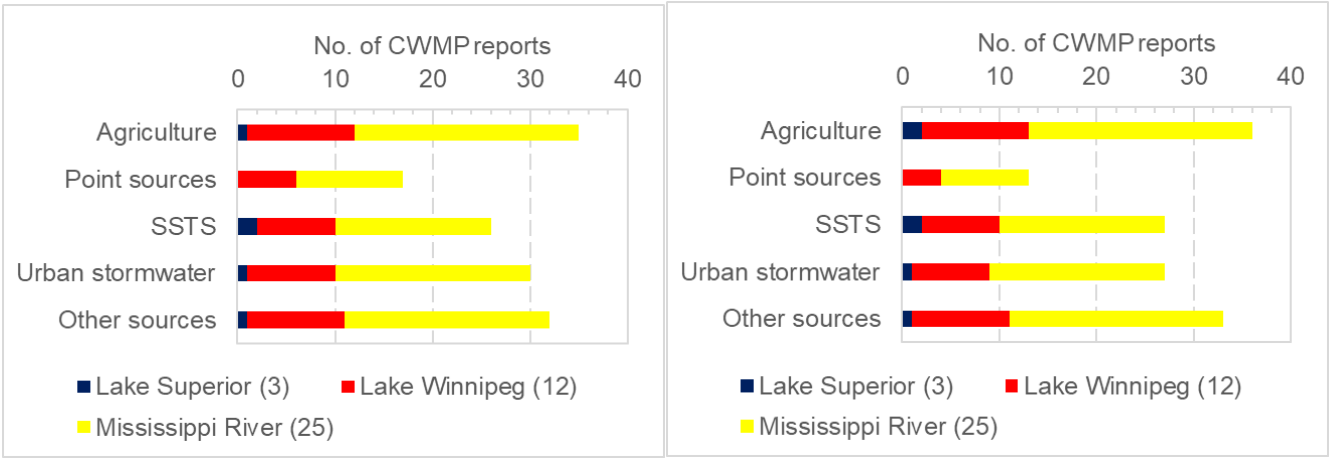


Figure 6. Summary of sources of phosphorus and nitrogen identified in the CWMPs, by major basin.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.



3.0 PRIORITIZED WATERS

The TMDL/WRAPS and 1W1P processes typically target specific waterbodies. MPCA fulfills Minnesota's requirements under the Clean Water Act by biennially reporting on the assessment of waters throughout the state and developing a prioritized list of waters that do not meet water quality standards, where a TMDL must be developed. Beyond the TMDL process, the WRAPs process prioritizes specific waters that may need restoration or protection, which are not listed as impaired. The WRAPS process examines surface water quality in terms of water quality (chemistry and biology), as well as connectivity, geomorphology and hydrology. This is done on a watershed-scale, for identifying necessary strategies beyond TMDL development. The 1W1P process is comprehensive planning for many aspects of natural resources (surface water and groundwater quality and quantity, habitat, recreation, etc.), on a watershed-scale. Through 1W1P, participating local and tribal governments partner to develop a watershed plan, which they adopted and implement. These plans contain measurable goals for a locally-defined set of issues and specific implementation actions to address those issues over a 10-year period. The water quality elements of CWMPs build on WRAPS data and strategy recommendations. This section presents a summary of the prioritization process and prioritized waters in the WRAPS reports (Section 3.1) and CWMPs (Section 3.2).

The WRAPS reports generally did not address or prioritize downstream waterbodies, though many WRAPS reports acknowledge potential downstream impacts or the 2014 NRS. The CWMPs did not prioritize or set goals for downstream waterbodies explicitly, though some plans did base nutrient goals on the NRS. The purpose of the 1W1P process is for local partnerships to plan local implementation over a 10-year period within a local watershed; as such, the 1W1P process does not directly target downstream waterbodies.

With regards to phosphorus, explanation as to why more planning efforts did not target downstream waters is that many WRAPS reports and CWMPs addressed small lakes that are threatened or impaired by phosphorus-loading, nutrient eutrophication, and hypoxia. Often the goals and strategies were lake-specific and would not apply to downstream lotic waters. Additionally, outflow from small lakes could have minimal impact on larger rivers and the entire watershed. As such, the planning efforts many have ignored or only minimally considered downstream waters.

3.1 WATERSHED RESTORATION AND PROTECTION STRATEGIES

The prioritization of specific waterbodies or subwatersheds varied considerably between the WRAPS reports. Generally, one or more of the following six categories of factors was considered when prioritizing waters (see list below). In many WRAPS reports, waters identified as impaired were prioritized (notably lakes impaired by phosphorus for their aquatic recreation use). The WRAPS reports did not specifically identify waters prioritized for the NRS, which may indicate that the NRS was not used as a reason to prioritize waters.

A majority of WRAPS reports prioritized specific lakes/reservoirs (56%) and specific streams/rivers (53%) for phosphorus (Figure 7). Less than half of the WRAPS reports prioritized specific waters for nitrogen. About a fifth of WRAPS reports did not prioritize any specific waters.

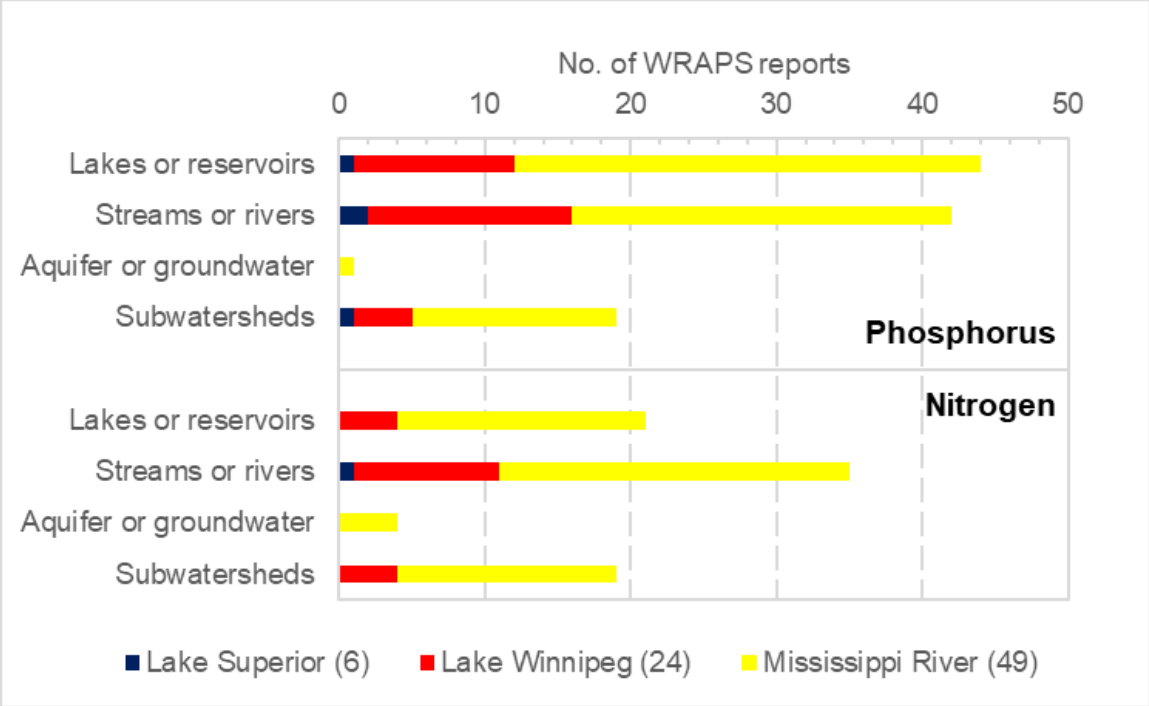
- Impairment status
  - A water is healthy and is to be protected to maintain its status as healthy.
  - A water is healthy but near the impairment threshold and is to be protected to prevent degradation.
  - A water is healthy but is declining in health.
  - A water is impaired and without a TMDL.
- Threat to public health
  - A water is upstream of a drinking water protection area

- A water is a public access point

- Biological significance
  - Cisco refuge lakes
  - Trout lakes
  - Wild rice lakes
- Financial considerations
  - Cost-benefit analysis indicates a return on investment
  - Restoration funds already targeted this area
  - BMPs are at or are approaching their lifespan
- Public participation and involvement
  - A water with an active watershed group or lake association
  - A water with willing partners or multiple partners to implement BMPs
  - A water with high-visibility to the public
- Miscellaneous
  - Size of water
  - Location of water (e.g., headwaters, small watershed)
  - Zonation Conservation Tool
  - Lake sensitivity to phosphorus

Figure 7. Summary of types of waters prioritized in the WRAPS reports, by major basin and nutrient.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.



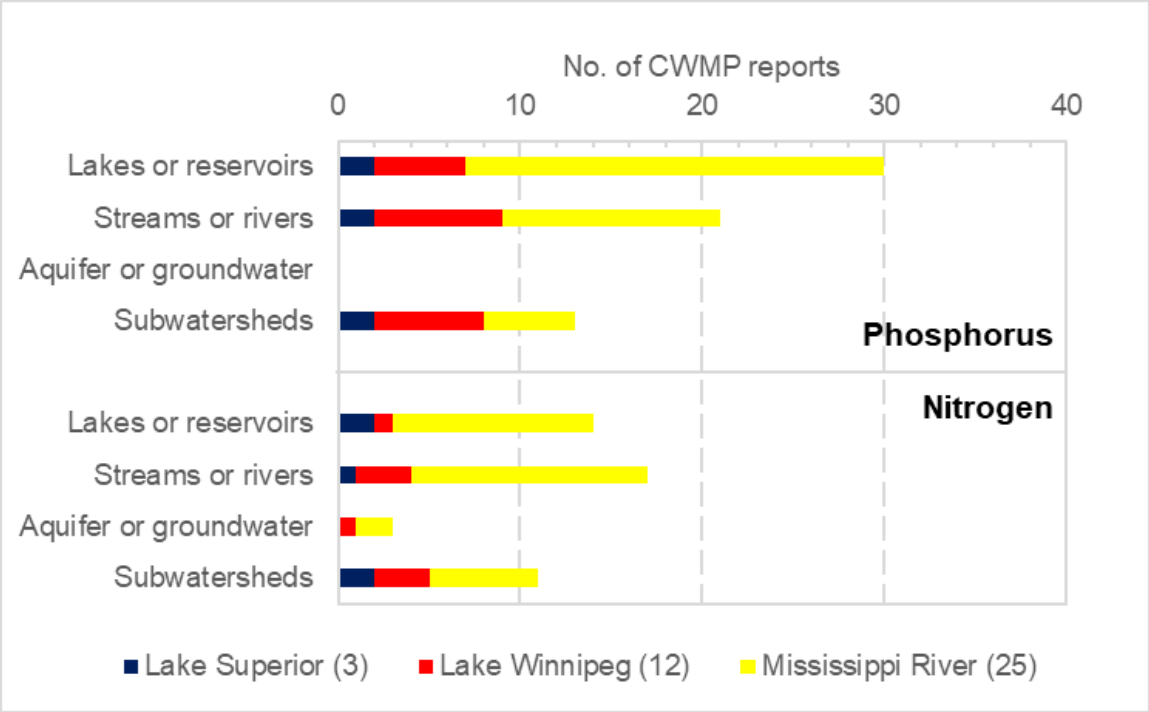
3.2 COMPREHENSIVE WATERSHED MANAGEMENT PLANS

The CWMPs used a variety of prioritization methods; most plans first identify a list of resource concerns and/or issues (e.g., erosion and sedimentation, drinking water, habitat, wetlands) and then further prioritize specific resources (e.g., “protection” or “restoration” lakes or streams, drinking water supply management areas, high quality habitats) where they intend to focus implementation. Because of the range of issues covered by plans, prioritization was not always specifically geared towards reducing phosphorus and nitrogen loading to Minnesota’s waters.

Generally, CWMPs more often prioritized waters to address phosphorus than to address nitrogen (Figure 8). Most CWMPs prioritized lakes or reservoirs (75%) and a majority prioritized streams or rives (53%) to address phosphorus, while only a minority of CWMPs prioritized lakes or reservoirs (35%) and streams or rivers (43%) to address nitrogen. No CMWPs prioritized aquifers or groundwater to address phosphorus, and only 3 plans prioritized aquifers and groundwater to address nitrogen.

Figure 8. Summary of types of waters prioritized in the CWMPs, by major basin and nutrient.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.



4.0 WATER QUALITY TRENDS

Water quality temporal trends for nutrients were reported in many WRAPS reports and some CWMPs. Several WRAPS reports focused on other parameters and such trends are not discussed herein. Many reports presented trends at multiple monitoring sites. Trends often varied between monitoring sites in one report, which made summarizing trends difficult.

About two-thirds of WRAPS reports (68%) discussed trends for total phosphorus monitoring data. The trends by report were (in order of frequency): decreasing (29%), varied by monitoring site (25%), nonsignificant (8%), and increasing (6%). A few WRAPS reports presented trends for orthophosphate. Trend summaries by WRAPS report are presented in Table 14 in Appendix A.

Less than two-thirds of WRAPS reports (63%) discussed trends for total nitrogen monitoring data. The trends by report were (in order of frequency): increasing (22%), varied by monitoring site (20%), nonsignificant (19%), and decreasing (3%). A few WRAPS reports presented trends for nitrate or total Kjeldahl nitrogen.

Very few CWMPs reported trends with total phosphorus (12%) or total nitrogen (5%). Trend summaries by CWMP are presented in Table 20 in Appendix B.

5.0 NUTRIENT GOALS

Most WRAPS reports and CWMPs identified nutrient goals but most identified goals were not consistent with the 2014 NRS. Results are summarized separately for the WRAPS reports (Section 5.1 and Table 13 in Appendix A) and CWMPs (Section 5.2 and Table 19 in Appendix B).

5.1 WATERSHED RESTORATION AND PROTECTION STRATEGIES

Most WRAPS reports identified nutrient goals: 88% identified phosphorus goals and 65% identified nitrogen goals (Table 4). Almost half (48%) of reports identified phosphorus goals consistent with the 2014 NRS, while a quarter (25%) identified nitrogen goals consistent with the NRS. In most cases, goals consistent with the NRS were set to achieve the NRS; however, in some cases, goals appeared to be set for local catchments that happen to also be consistent with the NRS. Many WRAPS reports identified goals that were designed to address local impairments or threatened/degraded waters that were consistent with TMDLs or river eutrophication standards.

Results by major basin and by basin are presented in Figure 9 and Figure 10, respectively. Only in the *Mississippi River* major basin did a majority of WRAPS reports identify phosphorus goals consistent with the 2014 NRS.

Table 4. Summary of nutrient goals identified in the WRAPS reports

Nutrient goals	Phosphorus	Nitrogen
No goal	10	28
Stated goal is not consisted with 2014 NRS	32	32
Stated goal is consistent with 2014 NRS	38	20

Figure 9. Summary of goals identified in the WRAPS reports by major basin.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.

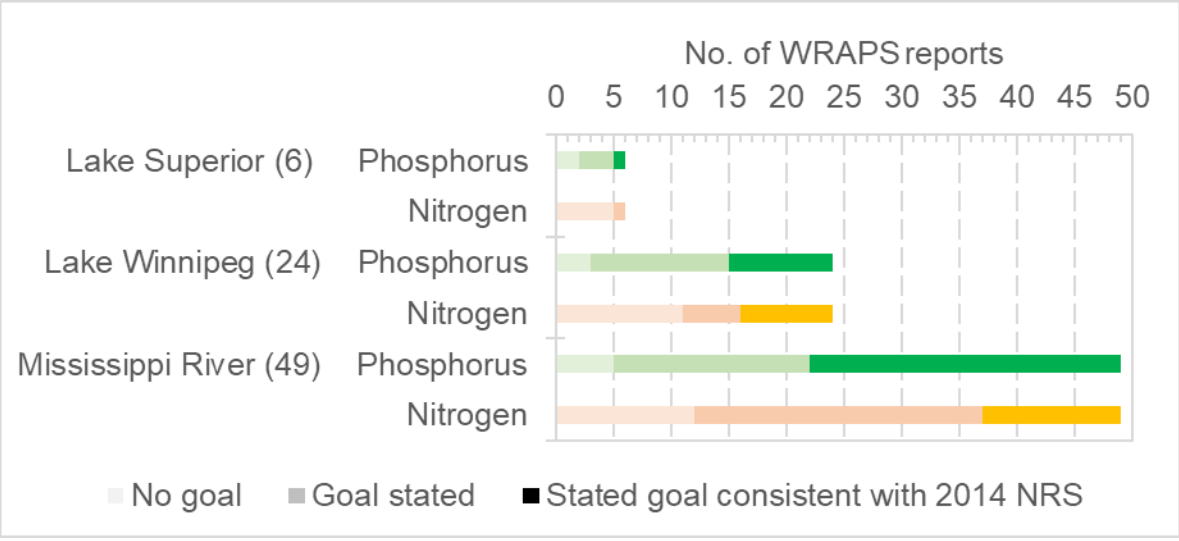
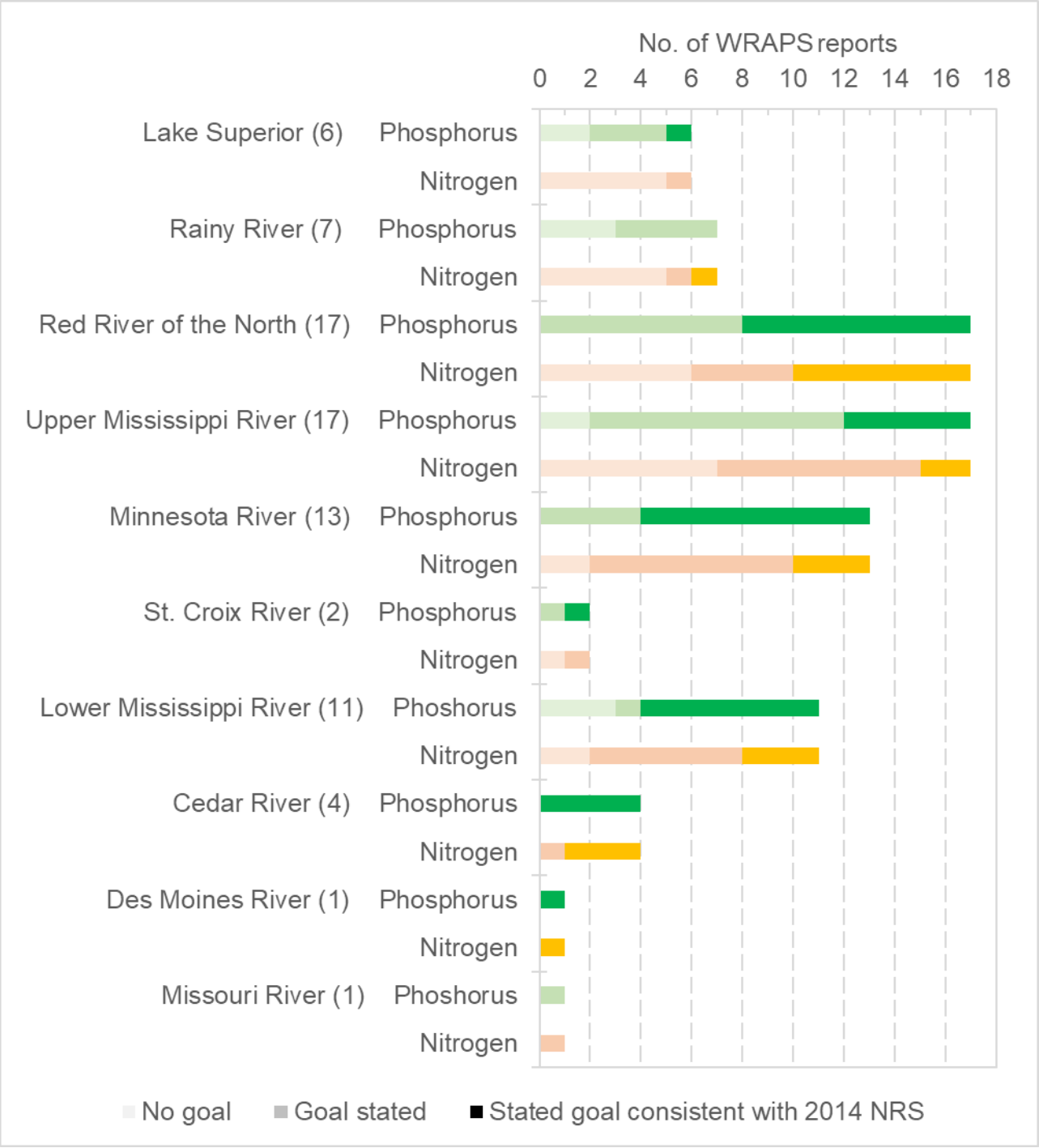


Figure 10. Summary of goals identified in the WRAPS reports by basin.

Note: The number or watersheds in each basin is provided in parentheses after the basin name.



5.2 COMPREHENSIVE WATERSHED MANAGEMENT PLANS

All the 40 CWMPs identified phosphorus goals, while 90% identified nitrogen goals (Table 5). For both nutrients, about a third of the reports identified goals consistent with the 2014 NRS. Most CWMPs identified goals that were designed to address specific waterbodies or subwatersheds (i.e., the NRS or downstream waterbodies were not a focus).

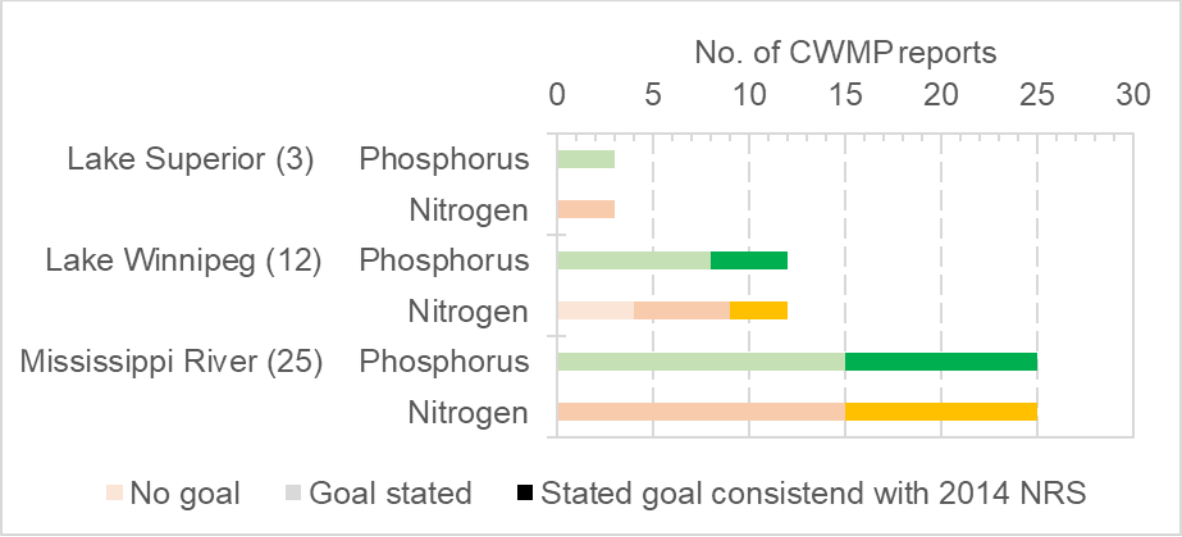
All the CWMPs in the *Lake Superior* major basin identified phosphorus and nitrogen goals but none of the goals were consistent with the 2014 NRS (Figure 11). All the CWMPs in the *Lake Winnipeg* major basin identified phosphorus goals but four reports did not identify nitrogen goals; most goals targeted local impairments. All of the CWMPs in the Mississippi River major basin identified phosphorus and nitrogen goals and 60% of the goals were consistent with the 2014 NRS.

Table 5. Summary of nutrient goals identified in the CWMPs

Nutrient goals	Phosphorus	Nitrogen
No goal	0	4
Stated goal is not consistent with the 2014 NRS	26	23
Stated goal is consistent with 2014 NRS	14	13

Figure 11. Summary of goals identified in the CWMPs by major basin.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.



6.0 RECOMMENDED ACTIONS

All of the WRAPS reports and CWMPs identified suites of BMPs to address impairments and improve water quality. Most reports included BMPs to address nitrogen and phosphorus sources; however, several reports focused on other pollutants and sources when nutrients were not the cause of impairments (e.g., total suspended solids in the Lake Superior North WRAPS report). Recommended actions that do not address nutrients are not presented herein (e.g., BMPs in the Nemadji River WRAPs to mitigate of the effects of sand and gravel mining),

WRAPS reports typically identified BMPs to target both impaired waters (i.e., those waters on Minnesota's 303(d) list) and threatened or degraded waters. WRAPS reports identified BMPs at varying scales, from a pollutant-waterbody combination to a group of waterbodies impacted by similar sources. The BMPs identified and selected in the WRAPS reports for addressing phosphorus or nitrogen are summarized in Table 6; this table groups BMPs into four categories (agricultural – crop, agricultural – livestock, urban, and other) and differentiates structural and non-structural BMPs. In a few WRAPS reports, a recommended action or strategy included developing site-specific standards.

The CWMPs typically identified BMPs (or recommended actions) along with measurable goals and a timeline; often in tabular format. As with the WRAPS reports, the CWMPs were not limited to nutrients and the CWMPs addressed other pollutants. The BMPs identified and selected in the CWMPs for addressing phosphorus or nitrogen are summarized in Table 7; like the table for the WRAPS report, this table groups BMPs into four categories and differentiates structural and non-structural BMPs.

Table 6. Recommended actions to address nutrients identified in the WRAPS reports and CWMPs

Agricultural – Crop	Agricultural – Livestock	Urban	Other
Structural Practices			
Buffer strips Conservation crop rotation Conservation cover Contour [strip] farming Controlled drainage (e.g., water control structures) Cover crops Crop rotation Drainage Ditch modification Filter strips and border filter strips Forage and biomass planting Grassed waterways Inlets (e.g., alternative tile inlets, rock inlets, side inlets) Perennial vegetation Reenrollment in current programs (e.g., CREP) Retention ponds Saturated buffer Terraces Treatment wetland (constructed or restored) Two-stage ditch Voluntary land restoration or retirement Water and sediment control basin Windbreaks and shelterbelt establishment or renovation Woodchip bioreactors	Alternative livestock water source Feedlot runoff control (e.g., clean water diversion) Heavy use area protection Livestock fencing Waste (manure) storage facility or composting facility	Biofiltration systems (e.g., vegetated filter strips, vegetated swales) Detention basins Disconnect impervious surfaces Eco-friendly landscaping Infiltration practices (e.g., catch basin, ditch, iron-enhanced sand filter) Permeable pavement Rain gardens Rain barrels Retrofit existing stormwater treatment Sanitary sewer expansion around lakes (eliminate SSTS) Sediment removal practices Sediment basins Stormwater treatment ponds and wetlands	Carp barrier Ditch stabilization Grade stabilization (e.g., ravine) Facility (treatment) upgrade and effluent load/volume reduction Floodplain reconnection In-channel or in-ditch storage Riparian buffer Sediment basins Shoreline bioengineering and restoration Shoreline buffers (natural) SSTS upgrade or replacement and eliminate straight pipes Stream restoration Well decommissioning and sealing (nitrogen) Wetland restoration

Agricultural – Crop	Agricultural – Livestock	Urban	Other
Nonstructural practices			
Agriculture Water Quality Certification Program Extended hay/alfalfa rotations Improve soil health Increase soil organic carbon Incorporate/inject fertilizer Integrated pest management Irrigation water management Manure fertilizer application management (e.g., set-backs, no winter spreading) Nitrification inhibitors Nitrogen fertilizer management (Groundwater Protection Rule) Nutrient management plans (e.g., crop diversity, gridded soil sampling, 4R) Open lot runoff management Reduce fertilizer application rates Tillage and residue management USDA Nitrogen Management Plan	Manure management Prescribed grazing & pasture management Silvopasturing	Construction site erosion control Drainage management planning and maintenance Drinking water source protection Enforce construction site erosion control plans Fertilizer management for lawns and golf courses Land use ordinances Pilot stormwater reuse projects Preserve aquatic buffer zone Progressive stormwater ordinances Proper storage of construction and maintenance material Roadway and trail chemical application management Roadway culvert management (sediment-bound phosphorus) Snow pile management Street sweeping Stormwater volume reduction Urban forestry management Urban stormwater management Use Minimum Impact Design Standards	Alum treatment (lakes) Biomanipulation (lakes) Conservation easements Dam operation Ditch cleanout management (i.e., generally reduce cleanouts) Dredging (lakes) Drought contingency planning Fish management Forestry management Lake drawdown Lake habitat and vegetation management planning (invasive species management) Landowner education/outreach Manage beaver dams NPDES/SDS permit compliance Shoreline protection (e.g., setbacks, buffers) SSTS tracking and education/outreach Water level management Water quality tests kits for the public and training/clinics Zoning and ordinances for vulnerable groundwater (nitrogen)

Note: CREP = Conservation Reserve Enhancement Program; NPDES = National Pollutant Discharge Elimination System; SDS = State Discharge System; SSTS = subsurface treatment system; USDA = U.S. Department of Agriculture.

7.0 TOOLS AND MODELS

Both WRAPS reports and CWMPs discuss models and results that were used to develop the respective plans. In some cases, models are constructed to support development of a plan (e.g., HSPF models constructed as part of the WRAPS process). In other cases, model results from a different effort are used to support development of a plan (e.g., CWMPs that cite HSPF models developed as part of the WRAPS process). Models can be used for one or more purposes (Table 7) and model results may be used for different purposes for different plans (e.g., HSPF model results used for source assessment in a WRAPS report and used to identify high loading areas to target in the CWMPs).Many tools and models were used to support development of the WRAPS reports and CWMPs (Table 8 on page 19) but seven tools and models were cited most frequently (Table 9). Results are summarized separately for the WRAPS reports (Section 7.1 and Table 15 in Appendix A) and CWMPs (Section 7.2 and Table 21 in Appendix B).

Table 7. Models and tools most often cited in the WRAPS reports and CWMPs

Task that the model or tool was used to support	ACPF	BATHTUB	HSPF	HSPF-SAM	PTMApp	SWAT	ZCT
Identify or prioritize waters or subwatersheds		✚	✚	✚	✚	✚	✚
Develop pollutant reduction goals			✚	✚	✚	✚	
Identify appropriate practices to achieve goals				✚	✚		
Site practices on the landscape	✚				✚		
Evaluate implementation progress (e.g., pollutant load reduction)				✚	✚		
Estimate and evaluate costs of implementation				✚	✚		

Table 8. Models and tools cited in the WRAPS reports and CWMPs

ID	Model or tool name	Waterbody model	Watershed model	Stormwater model	BMP siting tool	BMP loading tool
ACPF	Agricultural Conservation Planning Framework	--	--	--	✚	--
BATHTUB	BATHTUB	✚	--	--	--	--
CNET	CNET	✚	--	--	--	--
GHOST	Generic Hydrologic Overland-Subsurface Toolkit	--	✚	--	--	--
GSSHA	Gridded Surface Subsurface Hydrologic Analysis	--	✚	--	--	--

ID	Model or tool name	Waterbody model	Watershed model	Stormwater model	BMP siting tool	BMP loading tool
GWLF	Generalized Watershed Loading Function	--	✚	--	--	--
HSPF	Hydrologic Simulation Program – FORTRAN	--	✚	--	--	--
HSPF-SAM	HSPF – Scenario Application Manager	--	--	--	--	✚
MIDS BMP	Minimal Impact Design Standards BMP calculator	--	--	--	--	✚
NBMP	Watershed Nitrogen BMP Assessment Tools	--	--	--	--	✚
PBMP Tool	Watershed Phosphorus BMP Assessment Tools	--	--	--	--	✚
PONDNET	PONDNET	--	--	--	--	✚
PTMApp	Prioritize, Target, and Measure Application	--	--	--	✚	✚
P8	P8 Urban Catchment Model	--	--	✚	--	✚
RUSLE2	Revised Universal Soil Loss Equation	--	--	--	--	✚
SWAT	Soil and Watershed Assessment Tool	--	✚	--	--	✚
SWMM	Storm Water Management Model	--	--	✚	--	✚
WPLRCT	Watershed Pollutant Load Reduction Calculator Tool	--	--	--	--	✚
ZCT	Zonation Conservation Tool	--	--	--	--	--

7.1 WATERSHED RESTORATION AND PROTECTION STRATEGIES

Results from the HSPF model were most often used to support the WRAPS process; however, several other models were also cited in the WRAPS reports. Figure 12 (page 21) and Figure 13 (page 22) present the models and tools most often used to support the development of WRAPS reports, by major basin and basin (respectively). Figure 14 (page 23) presents other models and tools cited in the WRAPS reports. The following list briefly summarizes the models and tools used to support WRAPS development

- **Waterbody models**: BATHTUB and CNET are reservoir eutrophication models that were used to evaluate lakes in a few WRAPS projects.
- **Watershed models**: GHOST, GSSHA, GWLF, HSPF, and SWAT are watershed-scale flow and water quality models that were used to estimate nutrient loading. MPCA has developed HSPF models covering much of the state and 85% of WRAPS reports cited HSPF results. The SWAT model is often used to simulate agricultural watersheds and was cited in 14% of WRAPS reports. The GHOST, GSSHA, and GWLF models were only cited in a couple WRAPS reports.
- **Stormwater models**: P8 is a model for simulating stormwater systems, while PONDNET is a model for simulating a series of connected ponds. Both models were cited in only a couple of WRAPS reports.

- **BMP-siting tools**: ACPF and PTMApp are GIS-based tools for siting BMPs using landscape siting criteria and BMP design criteria. PTMApp also estimates BMP loading and a beta-version of the ACPF model can simulate BMP nitrogen loading. ACPF was cited in 16% of WRAPS reports, while PTMApp was cited in 18% of reports.
- **BMP loading tools**: NBMP and PBMP are spreadsheet-based tools, developed by ~~BWSR~~MPCA, to estimate nitrogen and phosphorus loading (respectively) from BMP installation based on published removal efficiencies. HSPF-SAM is a tool developed by RESPEC to use HSPF results to estimate load reductions from BMP installation. HSPF-SAM results were cited in 23% of WRAPS reports. WRLPCT was cited in a few WRAPS reports.

SPAtially Referenced Regression On Watershed attributes (SPARROW) simulated loads for Minnesota watersheds, published by USGS, were also cited in a few WRAPS reports. The Zonation Conservation Tool was cited in several WRAPS reports to support the identification of priority areas for restoration or protection.

In addition to mechanistic models (to simulate flow and water quality) and BMP tools (to site or to estimate loads), several additional applications were used to support development of one to several WRAPS (see the list below). These applications use geographic information systems, spatial data, and results from other models (e.g., HSPF) to support the strategy development and BMP selection.

- Enhanced Geospatial Water Quality Products (EGWQP)
- Water Quality Decision Support Application (WQDSA) (precursor to PTMApp)
- Watershed Health Assessment Framework (WHAF) tool

Figure 12. Models and tools often used to develop the WRAPS reports, by major basin.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.

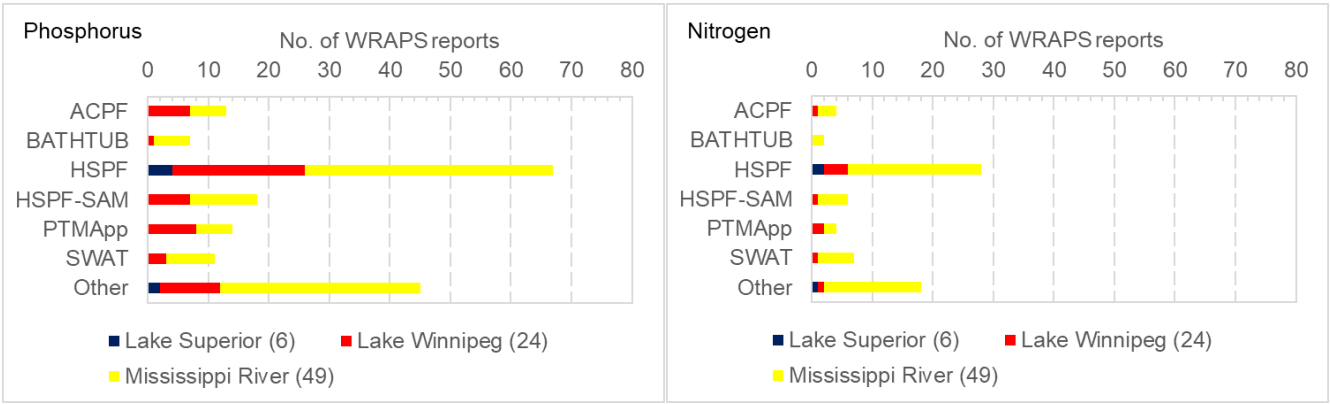
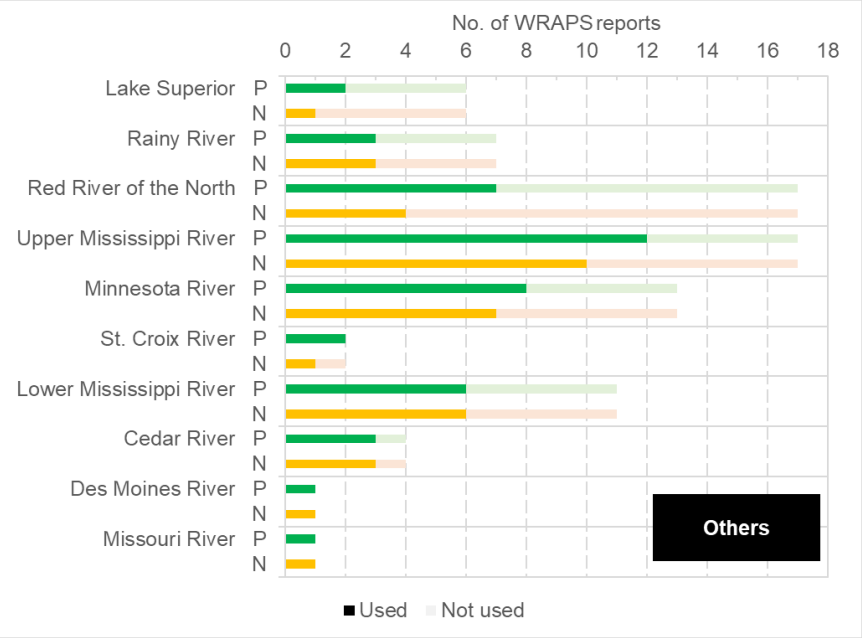


Figure 13. Models and tools often used to develop the WRAPS reports, by basin.

Figure 14. Other models and tools used to develop the WRAPS reports, by basin.

Note: The other models and tools exclude ACPF, BATHTUB, HSPF, HSPF-SAM, PTMApp, and SWAT.

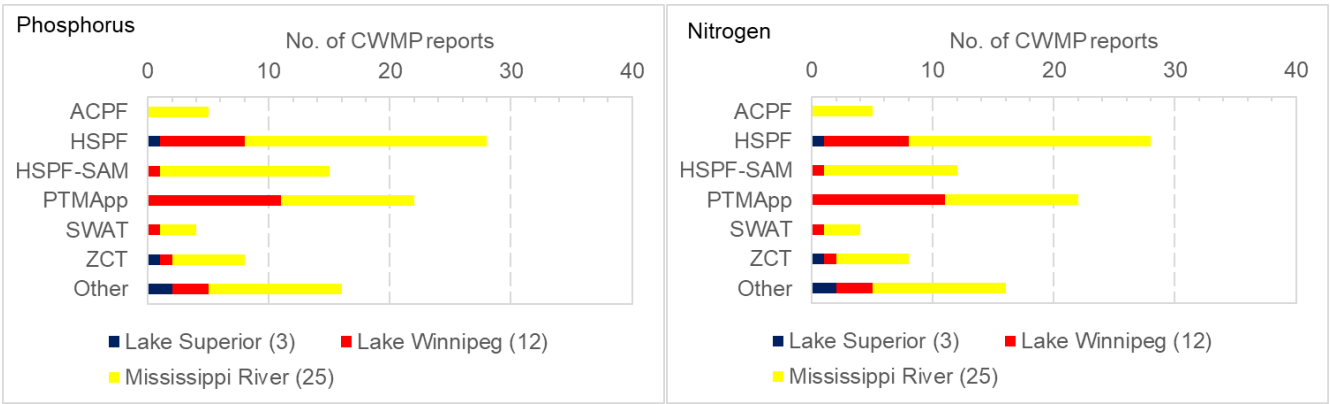


7.2 COMPREHENSIVE WATERSHED MANAGEMENT PLANS

Several models were used in the WRAPS or 1W1P processes and were discussed in the CWMPs. Figure 14 present the models and tools most often used to support the development of CWMPs. The CWMPs often cited the HSPF model results used to develop WRAPS reports; often the CWMPs referred to sources and load from the HSPF models. The Zonation Conservation Tool was cited in several CWMPs to support the identification of priority areas. The Minnesota Stream Quantification Tool and Debit Calculator (MNSQT) was cited in a few ss to support development of restoration strategies. A few CWMPs also documented additional models or tools to estimate pollutant load reductions: MIDS BMP calculator, RUSLE2, MPCA's Simple Method Estimator, NBMP, PBMP, SWMM, and WPLRC.

Figure 15. Models and tools often discussed in the CWMPs, by major basin.

Note: The number or watersheds in each major basin is provided in parentheses after the major basin name.



8.0 FOREST AND PEATLAND

Forest and peatland are important landscapes throughout northern Minnesota, especially in the *Lake Superior*, *Rainy River*, and *Upper Mississippi River* basins. Both landscapes provide essential habitat for wildlife. In addition to ecological importance, forest and peatlands are important for human society. Historically, these landscapes were used for resource extraction (e.g., timber, peat) and agriculture. Today, far less resource extraction occurs but both landscapes are still important. For example, about 75% of Minnesotans get their drinking water from forested parts of the state even though only 33% of the state is forested, most of which is in the northeastern part of the state (DNR n.d., Hilliard 2018).

Peatlands cover more than 10% of the state (DNR n.d.). In northern Minnesota, boreal peatlands dominate. Boreal peatlands are often divided into two plant community groups (DNR n.d.):

- **Bogs** develop where peat builds up over time and the peat surface becomes elevated, isolating it from mineral-rich runoff or groundwater. In these settings, all nutrient inputs come solely from precipitation and wind-blown dust.
- **Fens** have groundwater that has percolated through mineral soil, flowing continuously at or near the surface and in contact with plant roots.

This section presents a brief literature review (Section 8.1), discussion of forests and peatlands as sources of nutrient loading (Section 8.2), and a discussion of strategies to protect forest and peatlands (Section 8.3).

8.1 BRIEF LITERATURE REVIEW

This subsection presents a brief literature review of the state of the science on forest and peatland in Minnesota.[4]

8.1.1 Forest

In Minnesota, forests are mainly found in the northeastern portion of the state (Hilliard 2018). They play an important role in reducing nutrient runoff by capturing rainfall, trapping polluted runoff (such as nitrogen and phosphorus), and stabilizing soils that might otherwise wash into waterways. This process prevents contaminants from entering surface and groundwaters. Forest soils also have pore spaces that soak up and store rainwater and snowmelt. The average capture of rainfall by a forest canopy ranges from 10-40% (Hörmann et al. 1996). Other studies have shown that forest soils slow storm water infiltration rates more efficiently than suburban, agricultural, or impervious surfaces (Kays 1980, Bharati et al. 2002).

Realizing the positive effect forests have on helping to clear pollutants from surface waters, Minnesota was the first state to develop a robust, science-based approach for BMPs within the state stormwater regulations (U.S. Department of Agriculture 2020). Planting riparian buffers between agricultural land and surface waters has multiple environmental and practical benefits, including reduction of sediment, nutrients, pesticides, and other pollutants entering streams, lakes, ponds, wetlands, and other waterbodies, and provides habitat for wildlife and important pollinators (Zamora and Wyatt 2020). These are small scale examples of what the aspen forests in the northeastern part of the state accomplish naturally. According to the Huron River Watershed Council, one mature evergreen can intercept more than 4,000 gallons of rain per year, while deciduous trees can take in 500-760 gallons (Brown 2020). Extrapolated out to an entire forest or watershed scale, that could equal millions of gallons of water and tons of pollutants being filtered out. Studies of pre- and postharvest forests developed a “disturbance

[4] Tetra Tech searched Web of Science and Google Scholar for relevant publications.

severity index" that found that nutrient availability generally increased with disturbance severity in aspens (Roberts and Gilliam 1995, Kurth et al. 2020).

8.1.2 Peatland

Peat is composed of partially decayed organic matter, and it forms in a saturated, low oxygen environment. Peatland areas are those that have waterlogged substrates that have the capacity to accumulate organic matter, eventually forming soil that is at least 30cm thick called peat (Glaser 1987, Rochefort et al. 2012). In northern Minnesota, peat forms in poorly drained areas, where precipitation exceeds evaporation and the water table is near the surface (DNR n.d.). Peatlands also play an important part in ecosystem function through carbon storage, biodiversity, water retention, and water quality (Glaser 1987).

There have been many studies of nutrients in peatlands. Reiners and Reiners (1970) studied total accumulation and flux of nutrients between an upland oak forest, marginal fen, and cedar swamp in Minnesota. Turnover times of nitrogen and phosphorus were slower than that of calcium and magnesium, indicating a greater degree of retention by perennial vascular plants (which retain their nutrients rather than losing them during leaf fall) and soil microflora. Bogs have also been found to be sinks for nitrogen. In 1988, Urban and Eisenreich found that rates of nitrogen-fixation decreased rapidly below the surface of a bog in the Marcell watershed (Urban and Eisenreich 1988). They concluded that the bog was a large nitrogen-sink, retaining 65% of its inputs; the peatland was characterized by quick reuse of nitrogen in upper, aerobic peat and stable loading of large amounts of nitrogen in deeper anaerobic peat. Although peatlands may be nutrient sinks, those nutrients are not especially available for use (Laine et al. 2004, Gorham and Janssens 2005). Peatlands have developed various strategies to adapt to living with low nutrient levels, including conserving leaves over several seasons (Crawford 1993), asexual reproduction, use of mycorrhizae, or carnivory (Rochefort et al. 2012)

8.2 SOURCES AND PATHWAYS

Several WRAPS reports and CWMPs discuss forests and anthropogenic activities in forestland that can result in nutrient loading (e.g., runoff over logged ground, erosion along forest roads). However, most plans present very limited information about sources and pathways of nutrient loading.

Few plans discuss peatlands. Most WRAPS reports and CWMPs that discuss peatlands present limited information about the sources and pathways of nutrient loading. This is similar with the overall trend for all landforms and sources, where many reports identify sources of nutrients but do not provide many details on nutrient source pathways.

8.2.1 Watershed Restoration and Protection Strategies

In the early 20th Century, peatlands in northern Minnesota were believed to be suitable for farming if the peatlands could be drained; refer to the Mississippi River–Grand Rapids WRAPS report for a brief history. As a result of this belief, considerable effort was made to dig ditches through the peatlands in northern Minnesota. The scale of the alterations to the peatland landscape and hydrology was enormous. For example, the Lower Rainy River WRAPs found that 45% of the total stream length, which includes ditches, is composed of altered waterways. While the peatlands were ditched, the effort was largely a failure in many areas because the ditched peatland was unsuitable for farming. The ditched peatland remains today, and most of it is relatively undeveloped.

The ditching of the peatlands not only degraded the peatlands but also impacted, and still impacts, downstream waterbodies. The ditched peatlands are often in the headwaters of larger watersheds, where phosphorus derived from the organic peat soils migrates through the ditches to downstream waterbodies. Such phosphorus contributes to nutrient eutrophication in these downstream waterbodies. Additionally, peatlands and certain

wetlands may have low dissolved oxygen; natural or anthropogenic disturbance can result in water with low dissolved oxygen migrating downstream, which can further degrade downstream anoxic or hypoxic waters.

Several WRAPS reports discussed the rarity and sensitivity of calcareous fens and surrounding areas. These features are threatened by development and groundwater diversion or overuse.

8.2.2 Comprehensive Watershed Management Plans

Many CWMPs reports in northern Minnesota included little to no discussion of the sources and pathways related for forests, peatlands, and wetlands. For example, the Middle Snake-Tamarac Rivers CWMP identifies calcareous fens in the watershed (within the central beach ridges) but does not present information on the current conditions of the fens. Several CWMPs do provide some information on sources or pathways. The Lake of the Woods CWMP identifies shoreline dunes, peatlands, forests, and wetlands as sensitive areas and lands of concern, where building new subdivisions fragments native land covers and altered hydrology degrades peatlands. This CWMP also includes fens and bogs with seeps and other wetlands when discussing wetland degradation through the drainage and filling of wetlands.

Many CWMPs throughout the state did generally discuss the loss of habitat in native land covers from anthropogenic activities (e.g., the Lower Minnesota River West CWMP with agricultural development). Many CWMPs discuss the degradation or loss of wetlands and the need to enhance degraded wetlands and restore lost wetlands.

8.3 PROTECTION STRATEGIES

Most WRAPS reports and CWMPs discuss protection strategies and BMPs that target forested riparian corridors, in both rural and urban environments. Several WRAPS reports and CWMPs discuss protection strategies for urban forests and rural woodlots. While many WRAPS reports and CWMPs discuss protection strategies for wetlands, few reports discuss such strategies for peatlands. Strategies are summarized separately for the WRAPS reports (Section 8.3.1) and CWMPs (Section 8.3.2).

8.3.1 Watershed Restoration and Protection Strategies

Protection strategies and BMPs for forests (Section 8.3.1.1) and peatlands (Section 8.3.1.2) are discussed separately.

8.3.1.1 Forest

Forestry management strategies vary considerably depending on the composition and quality of the forest and how people use the forest. For example, management strategies for forests that are harvested for timber may target erosion from forest roads and culverts, while management strategies for forests in rural woodlots may target enhancing game-wildlife habitat.

Many WRAPS reports focus on enhancing and protecting forests in riparian corridors and forested wetlands. Strategies typically focus on preserving continuous riparian forests to prevent habitat fragmentation. Such WRAPS often recommend the development of forest stewardship plans or other planning documents. Many WRAPS reports also target stream crossings in forests with recommendations to properly design and maintain crossings and implement sediment control BMPs to too prevent erosion or trap eroded material from such crossings. The WRAPS reports also reference BMPs to maintain forest roads and limit equipment traffic, to reduce compaction and soil rutting.

WRAPS reports, notably in northern Minnesota, discuss protection strategies to prevent future development in forested areas. Strategies include conservation easements and mechanisms to acquire and protect forested land. Some WRAPS discuss improving regulations, ordinances, or enforcement to better protect forested land.

8.3.1.2 Peatland

With ditched peatlands, a multi-stage process is necessary to restore and preserve such peatlands. First, programs should identify any benefits to maintaining existing ditches. For example, the Mississippi River-Grand Rapids WRAPS report discussed a study where MPCA identified over 200 miles of ditches that provide little benefit to private landowners. Next, for ditches that do not provide benefits, programs are needed to restore natural hydrology. Most WRAPS reports that discussed management actions for peatland focused on restoring hydrology. Additional elements of the landscape may also need to be restored; for example, establishing perennial cover in areas with degraded vegetation. In the example with the Mississippi River-Grand Rapids WRAPS report, no restoration has begun. Finally, after restoration, programs are needed to protect the peatlands from future development.

As some ditched peatland is used in agricultural operations, many of the agricultural BMPs presented in Section 6.0 are applicable. Such practices should prevent nutrient-rich runoff, following precipitation, from migrating downstream. Given the high organic content of peat, manure should not be land-applied as a fertilizer; similarly, livestock should not graze on peatland to prevent direct deposition of waste on peatland. Additionally, livestock should not graze on peatland because livestock may dislodge peat (via trampling) that can migrate downstream following precipitation.

Where ditches are beneficial to landowners, ditch improvements could be implemented to prevent degradation of peatlands and downstream-loading. Two-stage ditches can allow a ditch to function more like a stream (i.e., natural channel development). Grade stabilization can also be used to maintain the integrity of the ditches.

The restoration and protection of wetlands could follow a process similar to that of the ditched peatlands. Wetland hydrology restoration should be followed by revegetation with native species and protections to prevent future dewatering.

The Lower Rainy River WRAPS report discussed how restoring and protecting peatland and wetland ecosystems can provide co-benefits, such as carbon and phosphorus storage. Development of peatlands or wetlands can release carbon to the atmosphere (carbon compounds contribute to the Greenhouse Effect) or release of dissolved organic carbon into surface waterways.

Of the several WRAPS reports that discussed calcareous fens and surrounding areas, the only recommended strategy was to protect these features from development. Such a protection strategy must focus on hydrology because groundwater diversions can drain calcareous fens.

8.3.2 Comprehensive Watershed Management Plans

Many CWMPs discussed the need to protect high-value resources, including native land covers, sensitive habitat, and groundwater. For example, the Des Moines River CWMP identifies oak savannas, calcareous fens, and trout streams and rare and declining habitats. Many reports focus and land and water resources planning that focus on protecting these high-value resources from development. A common means of protection identified in the CWMPs are conservation easements.

In addition to conservation easements, high-value forests can be protected (and enhanced) through the development of forest stewardship plans and the enrollment in tax incentive programs (e.g., Sustainable Forest Incentive Act).

Several CWMPs discussed maintaining and protecting groundwater quantity and quality because trout streams and calcareous fens are groundwater-dependent. As such, these waters can be very sensitive to anthropogenic disturbance. For example, the Hawk Creek-Middle Minnesota CWMP discusses how calcareous fens are susceptible to changing groundwater conditions. Due to their sensitivity to disturbance, several CWMPs categorized trout streams and calcareous fens and high-priority for protection.

A few CWMPs noted that calcareous fens are occasionally protected indirectly when management measures are implemented to protect other waters or features that are in the same area as a calcareous fen. For example, Middle Snake-Tamarac Rivers CWMP identifies calcareous fens within the central beach ridges with only one calcareous fen is protected because it is within the Florian Wildlife Management Area.

A few CWMPs recommended strategies to restore ditched peatlands, basically following the same approach as described in the WRAPS reports (see Section 8.3.1.2 for a summary of the multi-step process for restoring ditched peatlands). For example, the Lake of the Woods CWMP recommends restoration of altered hydrology and abandonment of ditches in the peatlands within the headwaters of this watershed.

Finally, a few CWMPs identify calcareous fens and sensitive habitat in need of protection but specific strategies for calcareous fens are not discussed in detail (e.g., Missouri River Watershed CWMP).

9.0 ADDITIONAL STUDY NEEDS

Many WRAPS reports and CWMPs recommended additional study or monitoring. Most recommendations targeted local data gaps (e.g., better delineating an impairment, quantifying the load from a specific source). BMP recommendations were split between targeting local data gaps (e.g., feasibility of plugging an unnecessary ditch) and fundamental data gaps (e.g., load reduction efficiency for a category of BMPs).

Additional study needs are summarized separately for the WRAPS reports (Section 9.1) and CWMP (Section 9.2) reports.

9.1 WATERSHED RESTORATION AND PROTECTION STRATEGIES

Many WRAPS reports recommended additional study needs, including monitoring, but the recommendations were often specific to an individual WRAPS report. In many cases, the additional monitoring or study was recommended for a specific waterbody, group of waterbodies (e.g., lakes), or subwatershed.

The additional monitoring and study needs were categorized into five groups:

- **Water quality monitoring** for specific waterbodies to better define impairments (e.g., lake eutrophication, low dissolved oxygen in streams, high-flow concentrations) or to collect data for waterbodies that were not recently monitored.
- **Source assessment** of certain candidate sources or source pathways (e.g., atmospheric deposition, groundwater transport, land use change and nitrate in groundwater response, ditch dredging), quantification of source loads, and source assessment for biological impairments.
- **Lakes characteristics** (e.g., hypolimnetic oxygen demand, sediment nutrient release assays to study internal loading and legacy phosphorus)
- **Lake management practices** (i.e., drawdown feasibility, chemical treatment options for internal loading) and lake management planning.
- **BMPs** feasibility (e.g., legacy ditch removal, peatland hydrology restoration), volume and load reduction effectiveness, operations and maintenance planning (including inspections), and retrofit assessment/feasibility.

9.2 COMPREHENSIVE WATERSHED MANAGEMENT PLANS

Many CWMPs also recommended additional study or monitoring and most recommendations were watershed-specific. The additional monitoring and study needs were categorized into four groups:

- **Surface water quality monitoring** for specific waterbodies to (1) evaluate temporal or spatial trends, (2) establish a baseline, or (3) better define impairments.
- **Groundwater quality monitoring** to (1) comprehensive study groundwater in specific watersheds or (2) better understand nitrate transport in groundwater and to surface water.
- **Source assessment** to (1) quantify low-priority sources or source pathways, (2) better understand threats to drinking water (e.g., identify vulnerable public water systems, identify threats to private wells), or (3) determine effects of zebra mussels on lake water quality.
- **BMPs** siting at a finer-scale, feasibility (e.g., cluster/community systems), prioritizing among several candidate BMPs, or volume and load reduction effectiveness.

A few CWMPs also identified a need for additional training for SWCD staff and for citizens or groups participating in volunteer monitoring programs. The Lake Superior North CWMP recommended expanding the volunteer monitoring program to include nitrogen and phosphorus; limited nutrient information was included in the Lake Superior North WRAPS report, as nutrients are not causing impairments.

10.0 SUMMARY OF KEY INFORMATION BY BASIN

Key information about goals, sources, and models and tools is presented for each of seven regions (roughly the size of HUC6 basins), which are grouped by the three major basins. Information about individual watersheds (i.e., HUC8 subbasins) are presented in Appendices and B.

Note that the percentages presented in this section are the percentages of WRAPS reports within a basin. For example, if a characteristic is cited as 65% of the Red River of the North basin, then that equates to 11 of the 17 watersheds in the basin.

10.1 MISSISSIPPI RIVER MAJOR BASIN

In the *Mississippi River* basin, planning efforts typically targeted agricultural sources of phosphorus and nitrogen. While many WRAPS reports identified nutrient goals, such goals were not always consistent with the 2014 NRS. Considerable portions of the phosphorus planning efforts in the WRAPS reports and CWMPs were focused on small lakes within individual watersheds. While the 2014 NRS was often cited in watershed-scale discussions, the numeric goals (e.g., loads, reductions) and strategies (e.g., shoreline restoration and protection) for phosphorus were typically focused at finer-scales: lakes and lake subwatersheds.

HSPF was frequently used to support planning efforts and several tools were used to assist with strategy development or site BMPs. BATHTUB was not frequently cited; however, BATHTUB has been frequently used to develop TMDLs for small lakes throughout the *Mississippi River* major basin. Strategies and BMPs typically targeted agricultural sources of phosphorus and nitrogen. Many plans also address other sources or issues as well. Point sources were often identified as sources of impairment or sources of high nutrient loading. The WRAPS reports and CWMPs do not typically discuss goals and strategies for point sources since point sources are regulated through MPCA. However, it is worth noting that these plans identify point sources and there may be a perception that point sources contribute significant nutrient loads.

10.1.1 Upper Mississippi River Basin

The Upper Mississippi River basin is composed of watersheds dominated by varying levels of urban development and agricultural operations, but the basin also includes several near-pristine watersheds with minimal development that typically meet water quality standards. WRAPS reports and CWMPs focused on a myriad of anthropogenic issues. Most WRAPS reports identified phosphorus (88%) and nitrogen (59%) goals but the goals were not frequently consistent with 2014 NRS goals for phosphorus (29%) and nitrogen (12%).

All of the WRAPS reports identified agriculture and other sources of phosphorus, while a majority of the reports also identified point sources (65%), SSTS (71%), and urban stormwater (65%). Most reports identified agriculture (82%) and other sources (71%) of nitrogen, but unlike phosphorus, fewer of the reports identified point sources (41%), SSTS (41%), and urban stormwater (35%) as sources of nitrogen. Many reports prioritized agriculture for phosphorus (59%) and nitrogen (47%). At the watershed-scale, few reports prioritized point sources (6%) and other sources (18%) and no reports prioritized SSTS or urban stormwater.

In the WRAPS reports, for phosphorus and nitrogen (respectively), crops were the most frequently identified (94%, 59%) and prioritized (59%, 35%) agricultural source. Pasture and grazing (65%, 35%) and feedlots (65%, 47%) were also frequently identified but were rarely prioritized at the watershed-scale.

The WRAPS reports cite results from several models and tools: HSPF (82%), ACPF (36%), BATHTUB (18%), SAM (18%), and SWAT (9%). Many reports (55%) cite several other models or tools.

10.1.2 Minnesota River Basin

The Minnesota River basin is dominated by agricultural operations, including tile-drain corn-soybean crop operations in the western (lower) half of the basin. The WRAPS reports frequently identified phosphorus (100%) and nitrogen (85%) goals; a majority of phosphorus goals (53%) were consistent with the 2014 NRS but few nitrogen goals (18%) were consistent with the 2014 NRS.

As expected, WRAPS reports and CWMPs focused on addressing nutrient-loading from agricultural operations. All of the WRAPS reports identified agriculture as a source of phosphorus and nitrogen. Similarly, a majority of reports identified point sources, SSTS, urban stormwater, and other sources as source of phosphorus and nitrogen but few to no reports prioritized these non-agricultural sources.

All of the WRAPS reports identified crops as the most frequent agricultural source. These reports also identified the following sources of phosphorus and nitrogen (respectively): pasture and grazing (82%, 64%), feedlots (82%, 64%), and unspecified agriculture (73%, 64%). These agricultural sources were not as frequently prioritized as a source at the watershed-scale as cropland.

The WRAPS reports cite results from several models and tools: HSPF (92%), SAM (46%), SWAT (38%), PTMApp (15%), and ACPF (8%). Many reports (62%) cite several other models or tools.

10.1.3 Lower Mississippi River Basin

The Lower Mississippi River basin receives upstream nutrient loads from the Upper Mississippi River basin, Minnesota River basin, and St. Croix River basin. These basins contribute considerable nutrient loads to the Mississippi River. Most WRAPS reports identified phosphorus (73%) and nitrogen (82%) goals; a majority of phosphorus goals (54%) were consistent with the 2014 NRS but few nitrogen goals (23%) were consistent with the 2014 NRS

The WRAPS reports frequently identified the following source categories for phosphorus and nitrogen (respectively): agriculture (64%, 73%), point sources (64%, 55%), and other sources (64%, 73%). Crops were the most frequently identified agricultural source of phosphorus (64%) and nitrogen (91%). Pasture and grazing were infrequently identified (27%) and prioritized (9%) for both nutrients. The other agriculture sources (often just described as “agriculture” in general) were identified in few reports (9% to 27%) but no other agricultural source was prioritized.

The WRAPS reports cite results from several models and tools: HSPF (82%), ACPF (36%), PTMApp (18%), SAM (18%), and SWAT (9%). Many reports (55%) cite several other models or tools.

10.1.4 Cedar, Des Moines, and Missouri Rivers Basins

Only small portions of the Cedar, Des Moines, and Missouri rivers watersheds are within Minnesota. These watersheds are along the Minnesota-Iowa or Minnesota-South Dakota state boundaries in heavily agricultural areas. The WRAPS reports always identified phosphorus and nitrogen goals and most goals were consistent with the 2014 NRS goals for phosphorus (83%) and nitrogen (67%).

Agriculture and point sources were frequently identified (83%) as sources of nutrients in the WRAPS reports. However, only agriculture was frequently prioritized (83%), while point sources were rarely prioritized for phosphorus (17%) and never prioritized for nitrogen. SSTS were often identified as sources of phosphorus (50%) and nitrogen (33%), but like point sources, SSTS were only rarely prioritized for phosphorus (17%) and never prioritized for nitrogen.

Crops were the most frequently identified (100%) and prioritized (83% phosphorus, 100% nitrogen) agricultural source. Pasture and grazing (67% phosphorus, 50% nitrogen) and unspecified agriculture (67% both nutrients) were also frequently identified but less frequently prioritized.

The WRAPS reports cite results from several models and tools: HSPF (67%), SAM (50%), SWAT (33%), and BATHTUB (17%). Many reports (67%) cite several other models or tools.

10.2 LAKE WINNIPEG MAJOR BASIN

The *Lake Winnipeg* major basin in Minnesota is composed of two independent basins: the Red River of the North basin and Rainy River basin. Unlike the other two major basins, much of the *Lake Winnipeg* major basin is not within Minnesota but is within in North Dakota, South Dakota, and Canada.

Planning efforts often targeted agricultural sources of phosphorus and nitrogen but not to the same degree as in the *Mississippi River* major basin. The use of models and tools is generally similar to the other two major basins except that PTMApp was more often cited in the Red River of the North basin and ACPF were more often cited in the Rainy River basin.

10.2.1 Red River of the North Basin

The Red River of the North is the western boundary of Minnesota and the much of the watershed is within North Dakota or South Dakota. Within Minnesota, agriculture is the predominant land use in many watersheds but not to the same degree as in the Minnesota River Basin. Nutrient-loading is an important issue for much of this basin. While all of the WRAPS reports identified phosphorus goals, only just over half (53%) identified phosphorus goals consisted with the 2014 NRS. For nitrogen, a majority (65%) identified nitrogen goals but less than half (41%) identified nitrogen goals consistent with the NRS.

The WRAPs reports frequently identified the following sources of phosphorus and nitrogen (respectively): agriculture (88%, 76%), SSTS (59%, 47%), and other sources (88%, 53%). Crops were the most frequently identified and prioritized (respectively) agricultural sources of phosphorus (82%, 24%) and nitrogen (71%, 12%). While other agricultural sources were infrequently identified (12% to 41% for phosphorus, 6% to 18% for nitrogen), these other agricultural source were not highly prioritized.

The WRAPS reports cite results from several models and tools: HSPF (94%), PTMApp (47%), SAM (35%), ACPF (18%), and SWAT (18% for phosphorus, 12% for nitrogen). Many reports (42% for phosphorus, 24% for nitrogen) cite several other models or tools.

10.2.2 Rainy River Basin

The Rainy River Basin is the northern boundary of Minnesota and a portion of the watershed is within Canada. Within Minnesota, much of the basin is covered in forest and wetlands. Agriculture is an important source of nutrient loading in certain watersheds. Over half (57%) of the WRAPS reports identify phosphorus goals but none of the goals are consistent with the 2014 NRS. As mentioned earlier, and applicable throughout the state, phosphorus goals in many watersheds target specific lakes. Nitrogen goals are infrequently identified (29%) and rarely consistent with the 2014 NRS (14%).

The WRAPS reports identified the following sources of phosphorus and nitrogen (respectively): agriculture (43%, 57%), point sources (43%, 29%), and SSTS (43%, 43%). The reports cite results from several models and tools: HSPF (86% for phosphorus, 71% for nitrogen), ACPF (57%), PTMApp (47%), SAM (29%), and BATHTUB (14% for phosphorus, 29% for nitrogen). Many reports (43%) cite several other models or tools.

10.3 LAKE SUPERIOR MAJOR BASIN

Nutrients were not a significant focus of the WRAPS reports and CWMPs in the *Lake Superior* major basin. When planning efforts focused on pollutants and degradation, the efforts focused on sediment and habitat. Generally, the *Lake Superior* major basin is composed of many high quality waters that meet water quality standards. Additionally, unlike the other two major basins, agricultural operations are not the predominant land use in the *Lake Superior* major basin. Many BMPs focused on fisheries and habitat (e.g., fisheries management, stream connectivity, invasive species control).

Only 25% of WRAPS reports identified phosphorus goals from the 2014 NRS and none identified nitrogen goals. One-half of WRAPS reports did not identify or prioritize any sources of phosphorus or nitrogen. One-third of WRAPS reports identified and prioritized agriculture as a source of phosphorus but only one report identified and prioritized agriculture as a source of nitrogen. Crops (33%) and unspecified livestock (17%) were identified as sources of phosphorus but were not prioritized. WRAPS reports often focused on sediment or total suspended solids as the pollutant-of-concern.

The majority of WRAPS reports (67%) cite results from HSPF. A couple other models are also cited in one or two reports.

11.0 NRS AND LOCAL PLANNING EFFORTS

Despite being developed at different spatial-scales, the NRS and local planning efforts can support each other to achieve nutrient reductions across Minnesota. Optimally, information compiled locally (i.e., the watershed-scale) during the WRAPS and 1W1P process could be combined to support the NRS, while statewide and major basin strategies, goals and reductions from the NRS can be disaggregated to the watershed-scale to support WRAPS updates and CWMP updates.

11.1 WATERSHED-SCALE GOALS

The 2014 NRS presented goals and necessary reductions at the scale of major basins and key basins. Several years later, MPCA (2022) developed interim guidance to apply the NRS goals to individual watersheds using a fair-share approach. The approach is based on HSPF modeling to estimate recent loads and quantification of reducible loads for various land covers/uses and non-land-based sources (e.g., point sources). This interim guidance is being updated and included in the 2025 NRS.

Future WRAPS updates and CWMP updates can incorporate the watershed-scale recent loads and remaining necessary reductions. MPCA and local governments can identify and promote strategies and BMPs to specifically address the quantified necessary reductions.

11.2 TRACKING PROGRESS TOWARD ACHIEVING NRS GOALS

As new WRAPS updates and CWMP updates are developed, MPCA and BWSR could consider using these local planning efforts to help track progress toward achieving watershed-scale NRS goals. The planning efforts could quantify newer recent loads using recent monitoring data or updated HSPF modeling results. These newer recent loads could then be compared with the watershed-scale NRS goals and remaining necessary reductions could be calculated. Then, as described in Section 11.1, the planning efforts can then identify strategies and specific BMPs to achieve the remaining necessary load reductions. Incorporation of watershed-scale goals, tracking progress, and adaptively managing strategies would all go hand-in-hand.

A key challenge with MPCA and BWSR potentially using local planning efforts to track progress toward achieving statewide NRS goals is that both the WRAPS and 1W1P processes typically focus on specific waterbodies (including restoration of impaired or threatened waters or conservation or protection of high quality waters) and finer scales. Additionally, these planning efforts do not typically focus on downstream waters. Finally, CWMPs typically use loading estimates developed during the TMDL and WRAPS processes; thus, using local planning efforts to track progress toward NRS goals would probably necessitate a scheme with the WRAPS updates first estimating new recent loads and quantifying remaining necessary reductions, followed by the CWMP updates developing strategies and identifying BMPs to achieve the new remaining necessary reductions.

11.3 TRACKING STRATEGY AND BMP IMPLEMENTATION

During TMDL development, MPCA inputs key data into a Tableau database to help with TMDL tracking. A similar effort could be used for WRAPS development. A Tableau database could be constructed to track non-TMDL goals and strategies for waters that are not on Minnesota's Section 303(d) list of impaired waters or for the entire watershed. Pertinent data like include waterbody identifier, strategy type (e.g., restoration, protection), pollutant, existing and goal loads or concentrations, and BMPs, These data could then be compiled and evaluated in Tableau when future iterations of the NRS are developed. A similar effort to track strategies and BMPs could be developed for CWMPs.

11.4 MODELS AND TOOLS

To support future WRAPS and CWMPs updates, MPCA could consider additional modeling efforts. About 60% of the HSPF models cover timeframes after the 2014 NRS (i.e., about 40% of HSPF models only cover years preceding the 2014 NRS). Updating and extending the HSPF models to more recent years will allow for better evaluation of recent loading and more accurate determination of necessary reductions. Additionally, MPCA could consider a developing a holistic, statewide approach to HSPF modeling that would more easily allow for the combination and evaluation of modeling results from separate models. HSPF models are developed for specific watersheds and are not typically designed to address regional or statewide evaluations. For example, land uses and sources are often categorized differently between HSPF models, which can be a challenge when trying to simultaneously evaluate results from multiple different HSPF models.

Certain basins in the *Mississippi River* major basin are predominantly agricultural but HSPF is not a crop-growth model. MPCA could consider encouraging the development of crop-growth models (e.g., SWAT and Agricultural Policy Environmental eXtender Model [APEX]). HSPF models could be used to identify key subwatersheds and fine-scale SWAT or APEX models could be developed for these key subwatersheds. Such models may help with identifying critical areas for upland nutrient loading and support BMP identification and siting efforts.

WRAPS reports do not often discuss BMP-siting using such models as ACPF and PTMApp. Future use of these models could be presented in WRAPS updates to help catalog restoration efforts and help track progress. Such modeling could also be used to support development of Nine Key Element Plans that are developed at finer scales. MPCA may wish to explore opportunities to better synergize Nine Key Element Plans with the WRAPS and 1W1P processes.

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APPENDIX A: SUMMARY TABLES FOR WRAPS REPORTS

Table 9. Watershed Restoration and Protection Strategy reports

Notes
a. These three watersheds are included in the Des Moines River Basin WRAPS (wq-ws4-52a).
b. These watersheds are both included in the Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a).
c. These three watersheds are included in the Missouri River Basin WRAPS (wq-ws4-40a).
d. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.
e. These WRAPS reports are update reports.

Watershed	Document	Approval
Big Fork River	wq-ws4-37a	9/8/2017
Blue Earth River	wq-ws4-95a	6/20/2023
Bois de Sioux River	wq-ws4-43a	4/8/2020
Buffalo River	wq-ws4-11a	8/9/2016
Cannon River	wq-ws4-23a	10/20/2016
Cedar River	wq-ws4-59a	5/24/2019
Chippewa River	wq-ws4-24a	3/16/2017
Clearwater River	wq-ws4-80a	1/8/2021
Cloquet River	wq-ws4-72a	10/27/2020
Cottonwood River	wq-ws4-93a	12/10/2022
Crow Wing River	wq-ws4-09a	2/2/2015
Des Moines River – Headwaters [a]	wq-ws4-52a	2/25/2021
Duluth Urban Area Watershed	wq-ws4-42a	10/13/2020
East Fork Des Moines River [a]	wq-ws4-52a	2/25/2021
Kettle River [b]	wq-ws4-73a	3/25/2021
Lac qui Parle River	wq-ws4-74a	7/22/2021
Lake of the Woods	wq-ws4-66a	2/6/2020
Lake Superior – North	wq-ws4-51a	8/9/2018
Lake Superior – South	wq-ws4-41a	8/2/2018
Le Sueur River	wq-ws4-10a	8/20/2015
Leech Lake River	wq-ws4-31a	5/10/2017
Little Fork River	wq-ws4-21a	11/28/2017
Little Sioux River [c]	wq-ws4-40a	1/18/2018
Long Prairie River	wq-ws4-19a	4/21/2017
Lower Big Sioux River [c]	wq-ws4-40a	1/18/2018
Lower Des Moines River [a]	wq-ws4-52a	2/25/2021
Lower Minnesota River	wq-ws4-58a	2/10/2020
Lower Rainy River	wq-ws4-91a	9/9/2022
Lower Red River – Tamarac River	wq-ws4-48a	3/21/2019

Watershed	Document	Approval
Lower St. Croix River	--	--
Minnesota River – Headwaters	wq-ws4-75a	3/9/2022
Minnesota River – Mankato	wq-ws4-63a	1/23/2020
Minnesota River – Yellow Medicine River/Hawk Creek	wq-ws4-13a wq-ws4-29a	11/9/2016 9/11/2017
Mississippi River – Brainerd	wq-ws4-65a	7/30/2020
Mississippi River – Grand Rapids	wq-ws4-61a	9/18/2019
Mississippi River – Headwaters	wq-ws4-50a	8/23/2018
Mississippi River – La Crescent	wq-ws4-71a	8/4/2020
Mississippi River – Lake Pepin	wq-iw9-15n wq-ws4-14a [d]	3/27/2015 --
Mississippi River – Reno	wq-ws4-68a	3/12/2020
Mississippi River – Sartell	wq-ws4-78a	11/20/2020
Mississippi River – St. Cloud	wq-ws4-07a wq-ws4-99a [e]	3/5/2015 6/20/2024
Mississippi River – Twin Cities	--	--
Mississippi River – Winona	wq-ws4-28a	11/1/2016
Mustinka River	wq-ws4-20a	9/26/2016
Nemadji River	wq-ws4-30a	6/14/2017
North Fork Crow River	wq-ws4-06a wq-ws4-92a [e]	1/5/2015 3/20/2023
Otter Tail River	wq-ws4-82a	9/14/2021
Pine River	wq-ws4-33a	10/3/2017
Pomme de Terre River	wq-ws4-01	3/15/2013
Rainy River – Headwaters	wq-ws4-87a	6/15/2022
Rainy River – Rainy Lake	wq-ws4-90a	7/26/2022
Rapid River	wq-ws4-88a	2/17/2022
Red Lake River	wq-ws4-60a	11/20/2019
Red River of the North – Grand Marais Creek	wq-ws4-56a	4/11/2019
Red River of the North – Marsh River	wq-ws4-83a	6/24/2021
Red River of the North – Sand Hill River	wq-ws4-26a	10/6/2017
Redeye River	wq-ws4-17a	10/26/2016
Redwood River	wq-ws4-94a	4/19/2023
Rock River [c]	wq-ws4-40a	1/18/2018
Root River	wq-ws4-18a wq-ws4-98a [e]	11/16/16 (draft)

Watershed	Document	Approval
Roseau River	wq-ws4-76a	12/3/2020
Rum River	wq-ws4-34a	7/10/2017
Sauk River	wq-ws4-08a wq-ws4-96a [e]	4/8/2015 7/17/2023
Shell Rock River	wq-ws4-70a	5/26/2021
Snake River – Red River Basin	wq-ws4-79a	12/3/2020
Snake River – St. Croix River Basin	wq-ws4-04	8/11/2014
South Fork Crow River	wq-ws4-47a	10/4/2018
St. Louis River	wq-ws4-46a	8/9/2018
Thief River	wq-ws4-49a	3/18/2019
Two Rivers	wq-ws4-57a	6/10/2019
Upper Big Sioux River [c]	wq-ws4-40a	1/18/2018
Upper Iowa River	wq-ws4-68a	3/12/2020
Upper Red River of the North	wq-ws4-36a	12/22/2017
Upper St. Croix River [b]	wq-ws4-73a	3/25/2021
Upper Wapsipinicon River	wq-ws4-67a	1/31/2020
Upper/Lower Red Lake	wq-ws4-81a	5/21/2021
Vermilion River	wq-ws4-86a	1/20/2022
Watonwan River	wq-ws4-62a	1/23/2020
Wild Rice River	wq-ws4-89a	5/16/2022
Winnebago River	wq-ws4-64a	6/15/2020
Zumbro River	wq-ws4-39a	11/8/2017

Table 10. Summary of nutrient sources in WRAPS reports

Notes
Listed source was identified for phosphorus (○) or nitrogen (□) or listed source was identified and prioritized for phosphorus (◉) or nitrogen (▣).
Sources were quantified for phosphorus (✚) or nitrogen (✱).
a. The Des Moines River Basin WRAPS (wq-ws4-52a) is for the *Des Moines River – Headwaters*, *East Fork Des Moines River*, and *Lower Des Moines River*.
b. The Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a) is for the *Kettle River* and *Upper St. Croix River*.
c. The Missouri River Basin WRAPS (wq-ws4-40a) is for the *Little Sioux River*, *Lower Big Sioux River*, *Rock River*, and *Upper Big Sioux River*.
d. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.
e. These WRAPS reports are update reports.

Watershed	Document	Agriculture	Point sources	SSTS	Urban stormwater	Other sources	Quantified
Big Fork River	wq-ws4-37a	○ | □	○ | --	○ | □	-- | --	○ | --	✚ | --
Blue Earth River	wq-ws4-95a	○ | □	○ | □	--	○ | □	○ | □	✚ | ✱
Bois de Sioux River	wq-ws4-43a	○ | □	○ | --	○ | --	○ | --	○ | --	✚ | --
Buffalo River	wq-ws4-11a	○ | □	◉ | ▣	◉ | ▣	-- | --	○ | □	✚ | ✱
Cannon River	wq-ws4-23a	◉ | ▣	○ | □	-- | --	-- | --	○ | □	✚ | ✱
Cedar River	wq-ws4-59a	◉ | ▣	○ | □	-- | --	-- | --	○ | □	-- | --
Chippewa River	wq-ws4-24a	◉ | ▣	○ | □	○ | □	-- | --	○ | □	✚ | ✱
Clearwater River	wq-ws4-80a	◉ | ▣	○ | □	○ | □	○ | □	○ | □	✚ | ✱
Cloquet River	wq-ws4-72a	-- | --	-- | --	○ | □	○ | □	-- | --	-- | --
Cottonwood River	wq-ws4-93a	○ | □	○ | □	○ | □	○ | □	○ | □	✚ | ✱
Crow Wing River	wq-ws4-09a	◉ | ▣	○ | □	○ | □	○ | □	○ | □	✚ | --
Des Moines River Basin [a]	wq-ws4-52a	◉ | ▣	○ | □	-- | --	-- | --	-- | --	✚ | ✱
Duluth Urban Area Watershed	wq-ws4-42a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Kettle River and Upper St. Croix River [b]	wq-ws4-73a	○ | □	-- | --	○ | □	○ | □	○ | □	✚ | --
Lac qui Parle River	wq-ws4-74a	○ | □	○ | □	○ | □	-- | --	○ | □	-- | --
Lake of the Woods	wq-ws4-66a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Lake Superior – North	wq-ws4-51a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Lake Superior – South	wq-ws4-41a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Le Sueur River	wq-ws4-10a	◉ | ▣	○ | □	◉ | □	○ | □	◉ | ▣	-- | --

Watershed	Document	Agriculture	Point sources	SSTS	Urban stormwater	Other sources	Quantified
Leech Lake River	wq-ws4-31a	○ | --	-- | --	○ | --	○ | --	○ | --	-- | --
Little Fork River	wq-ws4-21a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Long Prairie River	wq-ws4-19a	◉ | ▣	○ | □	○ | □	-- | --	○ | □	-- | --
Lower Minnesota River	wq-ws4-58a	○ | □	○ | □	○ | □	○ | □	○ | □	✚ | --
Lower Rainy River	wq-ws4-91a	○ | □	○ | □	○ | □	○ | □	○ | □	-- | --
Lower Red River – Tamarac River	wq-ws4-48a	○ | □	-- | --	-- | --	-- | --	○ | □	-- | --
Minnesota River – Headwaters	wq-ws4-75a	◉ | ▣	○ | □	○ | □	-- | --	○ | □	✚ | ✱
Minnesota River – Mankato	wq-ws4-63a	○ | □	○ | □	○ | □	○ | □	○ | □	✚ | ✱
Minnesota River – Yellow Medicine River/Hawk Creek	wq-ws4-13a wq-ws4-29a	◉ | ▣ ◉ | ▣	○ | -- ○ | □	○ | -- ○ | □	○ | □ ○ | □	○ | □ ○ | □	✚ | ✱ ✚ | ✱
Mississippi River – Brainerd	wq-ws4-65a	○ | □	○ | □	○ | □	○ | □	○ | □	-- | --
Mississippi River – Grand Rapids	wq-ws4-61a	○ | □	○ | --	○ | □	○ | --	○ | --	✚ | --
Mississippi River – Headwaters	wq-ws4-50a	○ | □	○ | --	○ | □	○ | □	○ | □	✚ | ✱
Mississippi River – La Crescent	wq-ws4-71a	○ | □	-- | --	○ | □	-- | --	-- | --	-- | --
Mississippi River – Lake Pepin	wq-iw9-15n wq-ws4-14a [d]	○ | □ -- | □	-- | -- ○ | □	-- | □ -- | --	-- | -- ○ | □	-- | -- ○ | □	-- | -- -- | --
Mississippi River – Reno	wq-ws4-68a	○ | □	○ | --	-- | --	-- | --	○ | □	✚ | ✱
Mississippi River – Sartell	wq-ws4-78a	◉ | ▣	○ | ▣	-- | --	-- | --	○ | □	✚ | ✱
Mississippi River – St. Cloud	wq-ws4-07a wq-ws4-99a [e]	◉ | -- ◉ | ▣	-- | -- -- | --	○ | -- -- | --	-- | -- -- | --	○ | -- ○ | □	-- | -- ✚ | ✱
Mississippi River – Winona	wq-ws4-28a	◉ | ▣	○ | ▣	-- | --	○ | --	○ | □	-- | ✱
Missouri River Basin [c]	wq-ws4-40a	◉ | ▣	○ | □	○ | □	-- | --	○ | □	✚ | ✱
Mustinka River	wq-ws4-20a	◉ | □	-- | --	○ | □	-- | --	○ | --	-- | --
Nemadji River	wq-ws4-30a	○ | --	○ | --	○ | --	-- | --	○ | --	-- | --
North Fork Crow River	wq-ws4-06a wq-ws4-92a [e]	◉ | □ ◉ | ▣	-- | -- ○ | --	○ | -- -- | --	○ | --	◉ | ▣	-- | -- ✚ | --

Watershed	Document	Agriculture	Point sources	SSTS	Urban stormwater	Other sources	Quantified
Otter Tail River	wq-ws4-82a	○ | □	○ | □	○ | □	○ | □	○ | --	-- | --
Pine River	wq-ws4-33a	◉ | ▣	-- | --	-- | --	-- | --	◉ | ▣	-- | --
Pomme de Terre River	wq-ws4-01	◉ | ▣	○ | □	○ | --	-- | --	○ | □	-- | --
Rainy River – Headwaters	wq-ws4-87a	-- | --	○ | □	○ | □	-- | --	◉ | ▣	-- | --
Rainy River – Rainy Lake	wq-ws4-90a	-- | □	-- | --	-- | --	-- | --	◉ | --	✚ | --
Rapid River	wq-ws4-88a	○ | □	-- | --	-- | --	-- | --	○ | □	✚ | ✱
Red Lake River	wq-ws4-60a	◉ | ▣	○ | □	-- | □	-- | □	○ | □	✚ | ✱
Red River of the North – Grand Marais Creek	wq-ws4-56a	○ | □	-- | --	○ | □	-- | --	○ | □	-- | --
Red River of the North – Marsh River	wq-ws4-83a	○ | □	-- | --	○ | --	-- | --	○ | □	-- | --
Red River of the North – Sand Hill River	wq-ws4-26a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Redeye River	wq-ws4-17a	◉ | ▣	-- | --	-- | --	-- | --	○ | □	-- | --
Redwood River	wq-ws4-94a	◉ | ▣	○ | □	-- | --	-- | --	○ | □	✚ | ✱
Root River	wq-ws4-18a	-- | □	-- | □	-- | --	-- | --	-- | □	-- | --
	wq-ws4-98a [e]	-- | □	-- | --	-- | --	-- | --	-- | □	-- | --
Roseau River	wq-ws4-76a	○ | □	○ | □	○ | □	-- | --	○ | □	-- | --
Rum River	wq-ws4-34a	○ | □	○ | □	○ | □	○ | □	○ | □	-- | --
Sauk River	wq-ws4-08a	○ | --	○ | --	○ | --	○ | --	○ | --	○ | --
	wq-ws4-96a [e]	○ | □	○ | □	○ | □	○ | □	○ | □	✚ | ✱
Shell Rock River	wq-ws4-70a	○ | ▣	○ | □	○ | □	○ | □	○ | □	✚ | ✱
Snake River – Red River Basin	wq-ws4-79a	○ | □	○ | □	○ | □	○ | □	○ | □	✚ | ✱
Snake River – St. Croix River Basin	wq-ws4-04	○ | --	○ | --	◉ | --	○ | --	◉ | --	✚ | --
South Fork Crow River	wq-ws4-47a	◉ | ▣	◉ | □	○ | --	○ | □	○ | --	✚ | --
St. Louis River	wq-ws4-46a	○ | --	○ | □	-- | □	○ | --	○ | □	✚ | ✱
Thief River	wq-ws4-49a	○ | □	-- | --	-- | --	○ | --	-- | --	-- | --
Two Rivers	wq-ws4-57a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --

Watershed	Document	Agriculture	Point sources	SSTS	Urban stormwater	Other sources	Quantified
Upper Iowa River	wq-ws4-68a	◉ | ▣	○ | □	-- | --	-- | --	○ | □	✚ | ✱
Upper Red River of the North	wq-ws4-36a	◉ | ▣	-- | --	-- | --	-- | --	○ | □	✚ | ✱
Upper Wapsipinicon River	wq-ws4-67a	◉ | ▣	-- | --	-- | --	-- | --	-- | --	-- | ✱
Upper/Lower Red Lake	wq-ws4-81a	○ | --	-- | --	○ | --	-- | --	○ | --	○ | --
Vermilion River	wq-ws4-86a	-- | --	○ | □	◉ | --	○ | □	○ | --	✚ | ✱
Watonwan River	wq-ws4-62a	○ | □	-- | --	-- | --	-- | --	-- | --	-- | --
Wild Rice River	wq-ws4-89a	○ | □	-- | --	-- | --	○ | □	-- | --	-- | --
Winnebago River	wq-ws4-64a	◉ | ▣	◉ | --	◉ | --	-- | --	-- | ▣	✚ | --
Zumbro River	wq-ws4-39a	○ | □	○ | --	-- | --	-- | --	○ | □	-- | --

Table 11. Summary of agricultural sources in WRAPS reports

Notes

Listed source was identified for phosphorus (○) or nitrogen (□) or listed source was identified and prioritized for phosphorus (◉) or nitrogen (▣).

a. Crops includes surface runoff and tile drainage that can contain nutrients derived from the application of commercial fertilizer, manure, or pesticides.

b. Feedlots include unregistered feedlots, registered feedlots, permitted feedlots, and concentrated animal feeding operations.

c. The Des Moines River Basin WRAPS (wq-ws4-52a) is for the *Des Moines River – Headwaters*, *East Fork Des Moines River*, and *Lower Des Moines River*.

d. The Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a) is for the *Kettle River* and *Upper St. Croix River*.

e. The Missouri River Basin WRAPS (wq-ws4-40a) is for the *Little Sioux River*, *Lower Big Sioux River*, *Rock River*, and *Upper Big Sioux River*.

f. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.

g. These WRAPS reports are update reports.

Watershed	Document	Crops [a]	Pasture & Grazing	Feedlots [b]	Livestock (unspecified)	Agriculture (unspecified)
Big Fork River	wq-ws4-37a	○ | --	-- | --	○ | --	-- | --	-- | --
Blue Earth River	wq-ws4-95a	○ | □	-- | --	○ | --	○ | --	○ | --
Bois de Sioux River	wq-ws4-43a	○ | □	-- | --	○ | □	-- | --	-- | --
Buffalo River	wq-ws4-11a	○ | □	-- | --	-- | --	○ | □	-- | --
Cannon River	wq-ws4-23a	◉ | ▣	-- | --	-- | --	○ | □	○ | ▣
Cedar River	wq-ws4-59a	◉ | ▣	◉ | ▣	◉ | ▣	◉ | ▣	◉ | ▣
Chippewa River	wq-ws4-24a	◉ | ▣	◉ | ▣	◉ | ▣	◉ | ▣	◉ | ▣
Clearwater River	wq-ws4-80a	◉ | ▣	○ | □	○ | □	-- | --	-- | --
Cloquet River	wq-ws4-72a	-- | --	-- | --	-- | --	-- | --	-- | --
Cottonwood River	wq-ws4-93a	○ | □	○ | □	○ | □	-- | --	-- | --
Crow Wing River	wq-ws4-09a	○ | □	○ | □	○ | □	○ | □	-- | --
Des Moines River Basin [c]	wq-ws4-52a	◉ | ▣	○ | □	○ | □	○ | □	-- | ▣
Duluth Urban Area Watershed	wq-ws4-42a	-- | --	-- | --	-- | --	-- | --	-- | --
Kettle River and Upper St. Croix River [d]	wq-ws4-73a	○ | □	○ | --	○ | □	○ | --	○ | □
Lac qui Parle River	wq-ws4-74a	○ | □	○ | □	○ | □	-- | --	-- | --
Lake of the Woods	wq-ws4-66a	-- | --	-- | --	-- | --	-- | --	-- | --
Lake Superior – North	wq-ws4-51a	-- | --	-- | --	-- | --	-- | --	-- | --
Lake Superior – South	wq-ws4-41a	-- | --	-- | --	-- | --	-- | --	-- | --

Watershed	Document	Crops [a]	Pasture & Grazing	Feedlots [b]	Livestock (unspecified)	Agriculture (unspecified)
Le Sueur River	wq-ws4-10a	◉ | ▣	-- | --	○ | --	-- | --	○ | □
Leech Lake River	wq-ws4-31a	○ | --	○ | --	○ | □	-- | --	○ | □
Little Fork River	wq-ws4-21a	-- | --	-- | --	-- | --	-- | --	-- | --
Long Prairie River	wq-ws4-19a	◉ | ▣	-- | --	-- | --	-- | --	◉ | ▣
Lower Minnesota River	wq-ws4-58a	○ | □	-- | --	○ | □	-- | --	○ | □
Lower Rainy River	wq-ws4-91a	-- | --	-- | --	-- | --	○ | □	-- | --
Lower Red River – Tamarac River	wq-ws4-48a	○ | □	○ | --	○ | --	○ | --	○ | □
Minnesota River – Headwaters	wq-ws4-75a	○ | □	○ | □	○ | □	○ | □	-- | --
Minnesota River – Mankato	wq-ws4-63a	○ | □	○ | □	○ | □	-- | --	○ | □
Minnesota River – Yellow Medicine River/Hawk Creek	wq-ws4-13a wq-ws4-29a	◉ | ▣ ◉ | ▣	◉ | -- ◉ | --	-- | -- -- | --	-- | -- -- | --	◉ | ▣ ◉ | ▣
Mississippi River – Brainerd	wq-ws4-65a	○ | □	○ | □	○ | □	-- | --	-- | --
Mississippi River – Grand Rapids	wq-ws4-61a	◉ | --	◉ | --	○ | □	-- | --	-- | --
Mississippi River – Headwaters	wq-ws4-50a	◉ | ▣	○ | --	○ | □	-- | --	-- | --
Mississippi River – La Crescent	wq-ws4-71a	○ | □	○ | □	○ | □	○ | □	-- | --
Mississippi River – Lake Pepin	wq-iw9-15n wq-ws4-14a [f]	○ | □ -- | □	○ | □ -- | --	○ | □ -- | --	-- | -- -- | --	-- | -- -- | □
Mississippi River – Reno	wq-ws4-68a	○ | □	-- | --	-- | --	-- | □	-- | --
Mississippi River – Sartell	wq-ws4-78a	◉ | ▣	○ | □	-- | --	-- | --	-- | --
Mississippi River – St. Cloud	wq-ws4-07a wq-ws4-99a [g]	◉ | -- ◉ | ▣	-- | -- ○ | □	◉ | -- ○ | --	◉ | -- -- | --	-- | --
Mississippi River – Winona	wq-ws4-28a	◉ | ▣	-- | --	-- | --	-- | --	-- | --
Missouri River Basin [e]	wq-ws4-40a	◉ | ▣	◉ | ▣	-- | --	-- | --	◉ | ▣
Mustinka River	wq-ws4-20a	◉ | □	-- | --	-- | --	-- | --	-- | --
Nemadji River	wq-ws4-30a	○ | --	-- | --	-- | --	○ | --	-- | --

Watershed	Document	Crops [a]	Pasture & Grazing	Feedlots [b]	Livestock (unspecified)	Agriculture (unspecified)
North Fork Crow River	wq-ws4-06a wq-ws4-92a [g]	◉ | -- ◉ | --	-- | -- ○ | --	-- | -- ○ | --	-- | --	-- | -- -- | ▣
Otter Tail River	wq-ws4-82a	○ | □	○ | --	-- | --	-- | --	○ | □
Pine River	wq-ws4-33a	-- | --	-- | --	◉ | ▣	-- | --	◉ | ▣
Pomme de Terre River	wq-ws4-01	◉ | ▣	○ | □	○ | □	-- | --	○ | □
Rainy River – Headwaters	wq-ws4-87a	-- | --	-- | --	-- | --	-- | --	-- | --
Rainy River – Rainy Lake	wq-ws4-90a	-- | □	-- | --	-- | --	-- | --	-- | --
Rapid River	wq-ws4-88a	○ | □	-- | --	-- | --	-- | --	-- | --
Red Lake River	wq-ws4-60a	◉ | --	-- | --	-- | --	-- | --	-- | ▣
Red River of the North – Grand Marais Creek	wq-ws4-56a	○ | □	-- | --	-- | --	○ | --	-- | --
Red River of the North – Marsh River	wq-ws4-83a	○ | □	○ | --	-- | --	-- | --	-- | --
Red River of the North – Sand Hill River	wq-ws4-26a	-- | --	-- | --	-- | --	-- | --	-- | --
Redeye River	wq-ws4-17a	◉ | ▣	-- | --	◉ | ▣	○ | --	-- | --
Redwood River	wq-ws4-94a	◉ | ▣	○ | □	-- | --	-- | --	-- | --
Root River	wq-ws4-18a wq-ws4-98a [g]	-- | □ -- | □	-- | -- -- | --	-- | □ -- | --	-- | -- -- | --	-- | □
Roseau River	wq-ws4-76a	○ | □	○ | □	-- | --	○ | □	-- | --
Rum River	wq-ws4-34a	○ | □	-- | --	○ | □	-- | --	-- | --
Sauk River	wq-ws4-08a wq-ws4-96a [g]	○ | -- ○ | □	○ | □	-- | --	-- | --	-- | --
Shell Rock River	wq-ws4-70a	○ | ▣	○ | --	○ | --	-- | --	-- | --
Snake River – Red River Basin	wq-ws4-79a	○ | □	○ | □	○ | □	-- | --	-- | --
Snake River – St. Croix River Basin	wq-ws4-04	○ | --	○ | --	-- | --	-- | --	-- | --
South Fork Crow River	wq-ws4-47a	◉ | ▣	○ | --	-- | --	-- | --	○ | --
St. Louis River	wq-ws4-46a	○ | --	-- | --	-- | --	-- | --	-- | --

Watershed	Document	Crops [a]	Pasture & Grazing	Feedlots [b]	Livestock (unspecified)	Agriculture (unspecified)
Thief River	wq-ws4-49a	-- | --	-- | --	-- | --	-- | --	○ | □
Two Rivers	wq-ws4-57a	-- | --	-- | --	-- | --	-- | --	-- | --
Upper Iowa River	wq-ws4-68a	◉ | ▣	◉ | ▣	-- | --	-- | --	-- | --
Upper Red River of the North	wq-ws4-36a	◉ | ▣	-- | --	-- | --	◉ | ▣	○ | □
Upper Wapsipinicon River	wq-ws4-67a	◉ | ▣	-- | --	-- | --	-- | --	○ | □
Upper/Lower Red Lake	wq-ws4-81a	○ | --	○ | --	-- | --	-- | --	-- | --
Vermilion River	wq-ws4-86a	-- | --	-- | --	-- | --	-- | --	-- | --
Watonwan River	wq-ws4-62a	○ | ▣	-- | --	-- | --	-- | --	-- | --
Wild Rice River	wq-ws4-89a	○ | □	-- | --	-- | --	-- | --	-- | --
Winnebago River	wq-ws4-64a	◉ | ▣	-- | --	-- | --	-- | --	◉ | --
Zumbro River	wq-ws4-39a	○ | □	-- | --	-- | --	-- | --	-- | --

Table 12. Summary of prioritized waters in WRAPS reports

Notes
Number of waters prioritized for phosphorus (1, 2, 3, etc.) or nitrogen (1, 2, 3, etc.).
Whether or not downstream waters were prioritized for phosphorus (✚) or nitrogen (✱).
a. The Des Moines River Basin WRAPS (wq-ws4-52a) is for the *Des Moines River – Headwaters*, *East Fork Des Moines River*, and *Lower Des Moines River*.
b. The Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a) is for the *Kettle River* and *Upper St. Croix River*.
c. The Missouri River Basin WRAPS (wq-ws4-40a) is for the *Little Sioux River*, *Lower Big Sioux River*, *Rock River*, and *Upper Big Sioux River*.
d. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.
e. These WRAPS reports are update reports.
f. Exact number of streams and lakes difficult to determine since some portions of the same waterbody are listed multiple times in different categories.

Watershed	Document	Lakes or reservoirs	Streams or rivers	Aquifer or groundwater	Sub-watersheds	Downstream waters
Big Fork River	wq-ws4-37a	16 | --	-- | --	-- | --	-- | --	-- | --
Blue Earth River	wq-ws4-95a	13 | --	18 | 26	-- | --	-- | --	-- | --
Bois de Sioux River	wq-ws4-43a	4 | 4	4 | 4	-- | --	-- | --	-- | --
Buffalo River	wq-ws4-11a	15 | 15	23 | 23	-- | --	7 | 7	-- | --
Cannon River	wq-ws4-23a	27 | 27	5 | 5	-- | --	-- | --	-- | --
Cedar River	wq-ws4-59a	-- | --	2 | 2	-- | --	3 | 3	-- | --
Chippewa River	wq-ws4-24a	10 | --	9 | 1	-- | --	-- | --	-- | --
Clearwater River	wq-ws4-80a	3 | 3	1 | 1	-- | --	-- | --	-- | --
Cloquet River	wq-ws4-72a	-- | --	-- | --	-- | --	-- | --	-- | --
Cottonwood River	wq-ws4-93a	14 | 14	19 | 19	-- | --	7 | 7	-- | --
Crow Wing River	wq-ws4-09a	8 | --	1 | 1	-- | 1	-- | --	-- | --
Des Moines River Basin [a]	wq-ws4-52a	14 | --	1 | 1	-- | --	4 | 5	-- | --
Duluth Urban Area Watershed	wq-ws4-42a	-- | --	-- | --	-- | --	-- | --	-- | --
Kettle River and Upper St. Croix River [b]	wq-ws4-73a	-- | --	-- | --	-- | --	-- | --	-- | --
Lac qui Parle River	wq-ws4-74a	7 | --	16 | --	-- | 1	-- | --	-- | --
Lake of the Woods	wq-ws4-66a	-- | --	-- | --	-- | --	-- | --	-- | --
Lake Superior – North	wq-ws4-51a	-- | --	-- | --	-- | --	-- | --	-- | --

Watershed	Document	Lakes or reservoirs	Streams or rivers	Aquifer or groundwater	Sub-watersheds	Downstream waters
Lake Superior – South	wq-ws4-41a	-- | --	-- | --	-- | --	-- | --	-- | --
Le Sueur River	wq-ws4-10a	11 | --	6 | 6	-- | 1	-- | --	-- | --
Leech Lake River	wq-ws4-31a	1 | --	-- | --	-- | --	-- | --	-- | --
Little Fork River	wq-ws4-21a	-- | --	-- | --	-- | --	-- | --	-- | --
Long Prairie River	wq-ws4-19a	7 | 7	-- | --	-- | --	11 | 11	-- | --
Lower Minnesota River	wq-ws4-58a	13 | 13	7 | 7	-- | --	-- | --	-- | --
Lower Rainy River	wq-ws4-91a	-- | --	6 | 6	-- | --	12 | 12	-- | --
Lower Red River – Tamarac River	wq-ws4-48a	1 | --	-- | --	-- | --	2 | 2	-- | --
Minnesota River – Headwaters	wq-ws4-75a	-- | --	-- | --	-- | --	8 | 8	-- | --
Minnesota River – Mankato	wq-ws4-63a	# | # [f]	# | # [f]	-- | --	-- | --	-- | --
Minnesota River – Yellow Medicine River/Hawk Creek	wq-ws4-13a wq-ws4-29a	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --
Mississippi River – Brainerd	wq-ws4-65a	48 | 48	47 | 47	-- | --	-- | --	-- | --
Mississippi River – Grand Rapids	wq-ws4-61a	26 | 26	44 | 44	-- | --	7 | 7	-- | --
Mississippi River – Headwaters	wq-ws4-50a	28 | 28	26 | 26	-- | --	-- | --	-- | --
Mississippi River – La Crescent	wq-ws4-71a	-- | --	3 | 3	-- | --	-- | --	-- | --
Mississippi River – Lake Pepin	wq-iw9-15n wq-ws4-14a [d]	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --
Mississippi River – Reno	wq-ws4-68a	-- | --	4 | 4	-- | --	-- | --	-- | --
Mississippi River – Sartell	wq-ws4-78a	16 | 16	16 | 16	-- | --	-- | --	-- | --
Mississippi River – St. Cloud	wq-ws4-07a wq-ws4-99a [e]	36 | -- 32 | 32	8 | -- 5 | 6	-- | -- -- | --	-- | -- 2 | 6	-- | -- -- | --
Mississippi River – Winona	wq-ws4-28a	-- | --	-- | --	-- | --	15 | 15	-- | --
Missouri River Basin [c]	wq-ws4-40a	9 | --	1 | 1	-- | --	-- | --	-- | --
Mustinka River	wq-ws4-20a	-- | --	6 | --	-- | --	-- | --	-- | --
Nemadji River	wq-ws4-30a	3 | --	4 | --	-- | --	3 | --	-- | --

Watershed	Document	Lakes or reservoirs	Streams or rivers	Aquifer or groundwater	Sub-watersheds	Downstream waters
North Fork Crow River	wq-ws4-06a wq-ws4-92a [e]	56 | 56 5 | 5	-- | --	-- | --	7 | 5 5 | 5	-- | --
Otter Tail River	wq-ws4-82a	61 | 61	10 | 10	-- | --	-- | --	-- | --
Pine River	wq-ws4-33a	56 | 56	-- | --	-- | --	-- | --	-- | --
Pomme de Terre River	wq-ws4-01	4 | 4	6 | 3	-- | --	5 | 5	-- | --
Rainy River – Headwaters	wq-ws4-87a	14 | --	1 | --	-- | --	-- | --	-- | --
Rainy River – Rainy Lake	wq-ws4-90a	12 | --	-- | --	-- | --	-- | --	-- | --
Rapid River	wq-ws4-88a	-- | --	5 | 5	-- | --	-- | --	-- | --
Red Lake River	wq-ws4-60a	-- | --	-- | --	-- | --	-- | --	-- | --
Red River of the North – Grand Marais Creek	wq-ws4-56a	-- | --	6 | 6	-- | --	-- | --	-- | --
Red River of the North – Marsh River	wq-ws4-83a	-- | --	1 | --	-- | --	2 | 3	-- | --
Red River of the North – Sand Hill River	wq-ws4-26a	4 | --	-- | --	-- | --	-- | --	-- | --
Redeye River	wq-ws4-17a	-- | --	-- | --	-- | --	-- | --	-- | --
Redwood River	wq-ws4-94a	1 | 1	3 | 3	-- | --	-- | --	-- | --
Root River	wq-ws4-18a wq-ws4-98a [e]	-- | -- -- | --	-- | 13 -- | --	-- | -- -- | --	-- | 2 -- | --	-- | -- -- | --
Roseau River	wq-ws4-76a	-- | --	30 | 30	-- | --	-- | --	-- | --
Rum River	wq-ws4-34a	17 | 17	-- | --	-- | --	-- | --	-- | --
Sauk River	wq-ws4-08a wq-ws4-96a [e]	5 | -- 27 | 27	-- | -- 9 | 9	-- | -- 1 | 1	-- | -- 1 | 1	-- | -- -- | --
Shell Rock River	wq-ws4-70a	-- | --	4 | 2	-- | --	10 | 6	-- | --
Snake River – Red River Basin	wq-ws4-79a	-- | --	7 | 7	-- | --	-- | --	-- | --
Snake River – St. Croix River Basin	wq-ws4-04	6 | --	-- | --	-- | --	-- | --	-- | --
South Fork Crow River	wq-ws4-47a	13 | --	-- | --	-- | --	-- | --	-- | --
St. Louis River	wq-ws4-46a	2 | --	1 | 1	-- | --	-- | --	-- | --

Watershed	Document	Lakes or reservoirs	Streams or rivers	Aquifer or groundwater	Sub-watersheds	Downstream waters
Thief River	wq-ws4-49a	-- | --	6 | --	-- | --	-- | --	-- | --
Two Rivers	wq-ws4-57a	1 | --	6 | 6	-- | --	-- | --	-- | --
Upper Iowa River	wq-ws4-68a	-- | --	3 | 3	-- | --	-- | --	-- | --
Upper Red River of the North	wq-ws4-36a	-- | --	-- | --	-- | --	-- | --	-- | --
Upper Wapsipinicon River	wq-ws4-67a	-- | --	-- | 1	-- | --	-- | --	-- | 1
Upper/Lower Red Lake	wq-ws4-81a	5 | --	-- | --	-- | --	-- | --	-- | --
Vermilion River	wq-ws4-86a	1 | --	-- | --	-- | --	-- | --	-- | --
Watonwan River	wq-ws4-62a	1 | --	-- | --	-- | --	3 | 3	-- | --
Wild Rice River	wq-ws4-89a	-- | --	-- | --	-- | --	-- | --	-- | --
Winnebago River	wq-ws4-64a	-- | --	-- | --	-- | --	-- | --	-- | --
Zumbro River	wq-ws4-39a	2 | --	1 | --	-- | --	-- | --	-- | --

Table 13. Summary of nutrient goals in WRAPS reports

Notes
Nutrient goals (load, concentration, or reduction) were identified for phosphorus (✚) or nitrogen (✱),
Nutrient goals were either (1) only focused on the local catchment for phosphorus (○) or nitrogen (□) and (2) were consistent with Minnesota's Nutrient Reduction Strategy for phosphorus (◉) or nitrogen (▣).
a. The Des Moines River Basin WRAPS (wq-ws4-52a) is for the *Des Moines River – Headwaters*, *East Fork Des Moines River*, and *Lower Des Moines River*.
b. The Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a) is for the *Kettle River* and *Upper St. Croix River*.
c. The Missouri River Basin WRAPS (wq-ws4-40a) is for the *Little Sioux River*, *Lower Big Sioux River*, *Rock River*, and *Upper Big Sioux River*.
d. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.
e. These WRAPS reports are update reports.
f. Goals stated were specific to the target catchment and consistent with the Minnesota NRS goals.

Watershed	Document	Phosphorus	Nitrogen
Big Fork River	wq-ws4-37a	✚ | ○	-- | --
Blue Earth River	wq-ws4-95a	✚ | ◉ [f]	✱ | □ [f]
Bois de Sioux River	wq-ws4-43a	✚ | ◉ [f]	-- | --
Buffalo River	wq-ws4-11a	✚ | ◉ [f]	-- | --
Cannon River	wq-ws4-23a	✚ | ◉ [f]	✱ | □ [f]
Cedar River	wq-ws4-59a	✚ | ◉ [f]	✱ | □ [f]
Chippewa River	wq-ws4-24a	✚ | ◉ [f]	✱ | □ [f]
Clearwater River	wq-ws4-80a	✚ | ○	-- | --
Cloquet River	wq-ws4-72a	✚ | ◉ [f]	✱ | □ [f]
Cottonwood River	wq-ws4-93a	✚ | ◉ [f]	-- | --
Crow Wing River	wq-ws4-09a	✚ | ◉ [f]	□
Des Moines River Basin [a]	wq-ws4-52a	✚ | ◉	✱ | ▣
Duluth Urban Area Watershed	wq-ws4-42a	✚ | ○	-- | --
Kettle River and Upper St. Croix River [b]	wq-ws4-73a	✚ | ◉ [f]	✱ | □
Lac qui Parle River	wq-ws4-74a	✚ | ○	✱ | ▣
Lake of the Woods	wq-ws4-66a	-- | --	✱ | ▣
Lake Superior – North	wq-ws4-51a	-- | --	-- | --
Lake Superior – South	wq-ws4-41a	-- | --	-- | --
Le Sueur River	wq-ws4-10a	✚ | ○	✱ | ▣
Leech Lake River	wq-ws4-31a	✚ | ○	-- | --
Little Fork River	wq-ws4-21a	-- | --	-- | --
Long Prairie River	wq-ws4-19a	✚ | ○	-- | --
Lower Minnesota River	wq-ws4-58a	✚ | ◉ [f]	✱ | □ [f]
Lower Rainy River	wq-ws4-91a	✚ | ○	-- | --
Lower Red River – Tamarac River	wq-ws4-48a	✚ | ○	✱ | ▣
Minnesota River – Headwaters	wq-ws4-75a	✚ | ◉ [f]	✱ | □ [f]

Watershed	Document	Phosphorus	Nitrogen
Minnesota River – Mankato	wq-ws4-63a	✚ | ◉ [f]	✱ | □ [f]
Minnesota River – Yellow Medicine River/Hawk Creek	wq-ws4-13a wq-ws4-29a	✚ | ◉ [f]	✱ | □ [f]
Mississippi River – Brainerd	wq-ws4-65a	✚ | ○	✱ | □
Mississippi River – Grand Rapids	wq-ws4-61a	✚ | ○	✱ | □
Mississippi River – Headwaters	wq-ws4-50a	✚ | ◉	✱ | ▣
Mississippi River – La Crescent	wq-ws4-71a	✚ | ◉	✱ | ▣
Mississippi River – Lake Pepin	wq-iw9-15n wq-ws4-14a [d]	✚ | ◉ ✚ | ◉ [f]	✱ | ▣ ✱ | □ [f]
Mississippi River – Reno	wq-ws4-68a	✚ | ◉ [f]	✱ | □ [f]
Mississippi River – Sartell	wq-ws4-78a	✚ | ○	✱ | □
Mississippi River – St. Cloud	wq-ws4-07a wq-ws4-99a [e]	✚ | ○ -- | --	-- | -- -- | --
Mississippi River – Winona	wq-ws4-28a	-- | --	-- | --
Missouri River Basin [c]	wq-ws4-40a	✚ | ○	✱ | □
Mustinka River	wq-ws4-20a	✚ | ◉ [f]	✱ | □ [f]
Nemadji River	wq-ws4-30a	✚ | ○	-- | --
North Fork Crow River	wq-ws4-06a wq-ws4-92a [e]	✚ | ◉ ✚ | ◉ [f]	✱ | ▣ ✱ | □ [f]
Otter Tail River	wq-ws4-82a	✚ | ◉	✱ | ▣
Pine River	wq-ws4-33a	✚ | ○	✱ | □
Pomme de Terre River	wq-ws4-01	✚ | ◉	✱ | ▣
Rainy River – Headwaters	wq-ws4-87a	✚ | ○	✱ | □
Rainy River – Rainy Lake	wq-ws4-90a	✚ | ○	-- | --
Rapid River	wq-ws4-88a	-- | --	-- | --
Red Lake River	wq-ws4-60a	✚ | ◉	✱ | ▣
Red River of the North – Grand Marais Creek	wq-ws4-56a	✚ | ◉	✱ | ▣
Red River of the North – Marsh River	wq-ws4-83a	✚ | ○	-- | --
Red River of the North – Sand Hill River	wq-ws4-26a	✚ | ○	✱ | □
Redeye River	wq-ws4-17a	✚ | ○	✱ | □
Redwood River	wq-ws4-94a	✚ | ○	-- | --
Root River	wq-ws4-18a wq-ws4-98a [e]	✚ | ◉ [f] -- | --	✱ | □ [f] -- | --
Roseau River	wq-ws4-76a	✚ | ◉ [f]	✱ | □ [f]
Rum River	wq-ws4-34a	✚ | ○	-- | --

Watershed	Document	Phosphorus	Nitrogen
Sauk River	wq-ws4-08a wq-ws4-96a [e]	✚ | ○ -- | --	-- | -- -- | --
Shell Rock River	wq-ws4-70a	✚ | ◉ [f]	✱ | ▣
Snake River – Red River Basin	wq-ws4-79a	✚ | ◉	✱ | ▣
Snake River – St. Croix River Basin	wq-ws4-04	✚ | ○	-- | --
South Fork Crow River	wq-ws4-47a	✚ | ◉ [f]	✱ | □ [f]
St. Louis River	wq-ws4-46a	✚ | ○	-- | --
Thief River	wq-ws4-49a	✚ | ○	-- | --
Two Rivers	wq-ws4-57a	✚ | ○	✱ | ▣
Upper Iowa River	wq-ws4-68a	✚ | ◉	✱ | ▣
Upper Red River of the North	wq-ws4-36a	✚ | ◉	✱ | ▣
Upper Wapsipinicon River	wq-ws4-67a	✚ | ◉	✱ | ▣
Upper/Lower Red Lake	wq-ws4-81a	✚ | ○	-- | --
Vermilion River	wq-ws4-86a	-- | --	-- | --
Watonwan River	wq-ws4-62a	✚ | ○	✱ | □
Wild Rice River	wq-ws4-89a	✚ | ○	✱ | □
Winnebago River	wq-ws4-64a	✚ | ◉	✱ | ▣
Zumbro River	wq-ws4-39a	✚ | ○	✱ | □

Table 14. Summary of monitoring result trends

Notes
Nutrient trends were reported as increasing (↑), decreasing (↓), varying by monitoring site (╬), or not significant or not observed (◊). In some cases, no trend analysis was reported (--).
a. The Des Moines River Basin WRAPS (wq-ws4-52a) is for the *Des Moines River – Headwaters*, *East Fork Des Moines River*, and *Lower Des Moines River*.
b. The Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a) is for the *Kettle River* and *Upper St. Croix River*.
c. The Missouri River Basin WRAPS (wq-ws4-40a) is for the *Little Sioux River*, *Lower Big Sioux River*, *Rock River*, and *Upper Big Sioux River*.
d. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.
e. These WRAPS reports are update reports.

Watershed	Document	Phosphorus	Nitrogen
Big Fork River	wq-ws4-37a	╬	╬
Blue Earth River	wq-ws4-95a	↑	↑
Bois de Sioux River	wq-ws4-43a	↓	--
Buffalo River	wq-ws4-11a	--	--
Cannon River	wq-ws4-23a	↓	╬
Cedar River	wq-ws4-59a	↓	↑
Chippewa River	wq-ws4-24a	--	--
Clearwater River	wq-ws4-80a	╬	↑
Cloquet River	wq-ws4-72a	--	--
Cottonwood River	wq-ws4-93a	↓	◊
Crow Wing River	wq-ws4-09a	↓	↑
Des Moines River Basin [a]	wq-ws4-52a	↓	↑
Duluth Urban Area Watershed	wq-ws4-42a	╬	◊
Kettle River and Upper St. Croix River [b]	wq-ws4-73a	╬	╬
Lac qui Parle River	wq-ws4-74a	◊	◊
Lake of the Woods	wq-ws4-66a	--	--
Lake Superior – North	wq-ws4-51a	╬	◊
Lake Superior – South	wq-ws4-41a	╬	╬
Le Sueur River	wq-ws4-10a	↓	↓
Leech Lake River	wq-ws4-31a	↓	◊
Little Fork River	wq-ws4-21a	↓	╬
Long Prairie River	wq-ws4-19a	↑	╬
Lower Minnesota River	wq-ws4-58a	--	--
Lower Rainy River	wq-ws4-91a	↓	↑
Lower Red River – Tamarac River	wq-ws4-48a	↓	◊
Minnesota River – Headwaters	wq-ws4-75a	╬	╬
Minnesota River – Mankato	wq-ws4-63a	╬	╬

Watershed	Document	Phosphorus	Nitrogen
Minnesota River – Yellow Medicine River/Hawk Creek	wq-ws4-13a wq-ws4-29a	-- ↑	-- ↑
Mississippi River – Brainerd	wq-ws4-65a	╬	╬
Mississippi River – Grand Rapids	wq-ws4-61a	--	--
Mississippi River – Headwaters	wq-ws4-50a	╬	--
Mississippi River – La Crescent	wq-ws4-71a	↓	↑
Mississippi River – Lake Pepin	wq-iw9-15n wq-ws4-14a [d]	-- --	-- ↑
Mississippi River – Reno	wq-ws4-68a	--	--
Mississippi River – Sartell	wq-ws4-78a	╬	↓
Mississippi River – St. Cloud	wq-ws4-07a wq-ws4-99a [e]	╬ ↓	↑ ↑
Mississippi River – Winona	wq-ws4-28a	↓	↑
Missouri River Basin [c]	wq-ws4-40a	╬	╬
Mustinka River	wq-ws4-20a	--	--
Nemadji River	wq-ws4-30a	--	--
North Fork Crow River	wq-ws4-06a wq-ws4-92a [e]	◊ ↓	↑ ◊
Otter Tail River	wq-ws4-82a	╬	╬
Pine River	wq-ws4-33a	◊	◊
Pomme de Terre River	wq-ws4-01	↓	↑
Rainy River – Headwaters	wq-ws4-87a	↑	--
Rainy River – Rainy Lake	wq-ws4-90a	--	--
Rapid River	wq-ws4-88a	--	--
Red Lake River	wq-ws4-60a	↑	--
Red River of the North – Grand Marais Creek	wq-ws4-56a	↓	--
Red River of the North – Marsh River	wq-ws4-83a	--	--
Red River of the North – Sand Hill River	wq-ws4-26a	--	--
Redeye River	wq-ws4-17a	◊	◊
Redwood River	wq-ws4-94a	--	--
Root River	wq-ws4-18a wq-ws4-98a [e]	╬ ↓	↑ ╬
Roseau River	wq-ws4-76a	◊	◊
Rum River	wq-ws4-34a	↓	↑
Sauk River	wq-ws4-08a wq-ws4-96a [e]	╬ ╬	╬ ↑

Watershed	Document	Phosphorus	Nitrogen
Shell Rock River	wq-ws4-70a	⇊	⇊
Snake River – Red River Basin	wq-ws4-79a	🡻	◊
Snake River – St. Croix River Basin	wq-ws4-04	◊	◊
South Fork Crow River	wq-ws4-47a	⇊	⇊
St. Louis River	wq-ws4-46a	🡻	◊
Thief River	wq-ws4-49a	🡻	◊
Two Rivers	wq-ws4-57a	--	--
Upper Iowa River	wq-ws4-68a	--	--
Upper Red River of the North	wq-ws4-36a	--	--
Upper Wapsipinicon River	wq-ws4-67a	--	--
Upper/Lower Red Lake	wq-ws4-81a	--	--
Vermilion River	wq-ws4-86a	--	--
Watonwan River	wq-ws4-62a	🡻	◊
Wild Rice River	wq-ws4-89a	--	--
Winnebago River	wq-ws4-64a	--	--
Zumbro River	wq-ws4-39a	⇊	⇊

Table 15. Summary of tools in WRAPS reports

Notes
ACPF = Agricultural Conservation Planning Framework; HSPF = Hydrologic Simulation Program – FORTRAN; PTMApp = Prioritize, Target, and Measure Application.
Tools were used for phosphorus (✚) or nitrogen (✱).
a. The Des Moines River Basin WRAPS (wq-ws4-52a) is for the *Des Moines River – Headwaters*, *East Fork Des Moines River*, and *Lower Des Moines River*.
b. The Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a) is for the *Kettle River* and *Upper St. Croix River*.
c. The Missouri River Basin WRAPS (wq-ws4-40a) is for the *Little Sioux River*, *Lower Big Sioux River*, *Rock River*, and *Upper Big Sioux River*.
d. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.
e. These WRAPS reports are update reports.

Watershed	Document	ACPF	HSPF	HSPF-SAM	PTMApp	BATHTUB	SWAT	Other
Big Fork River	wq-ws4-37a	-- | --	✚ | --	-- | --	-- | --	✚ | --	-- | --	-- | --
Blue Earth River	wq-ws4-95a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	✚ | ✱
Bois de Sioux River	wq-ws4-43a	✚ | --	✚ | --	-- | --	-- | --	-- | --	-- | --	✚ | --
Buffalo River	wq-ws4-11a	-- | --	✚ | --	-- | --	-- | --	-- | --	✚ | --	✚ | --
Cannon River	wq-ws4-23a	-- | --	✚ | ✱	-- | --	-- | --	✚ | ✱	-- | --	✚ | ✱
Cedar River	wq-ws4-59a	-- | --	-- | --	-- | --	-- | --	-- | --	✚ | ✱	✚ | ✱
Chippewa River	wq-ws4-24a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	✚ | ✱
Clearwater River	wq-ws4-80a	-- | --	✚ | ✱	✚ | ✱	✚ | ✱	-- | --	✚ | ✱	✚ | ✱
Cloquet River	wq-ws4-72a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	✚ | ✱
Cottonwood River	wq-ws4-93a	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	✚ | --
Crow Wing River	wq-ws4-09a	-- | --	✚ | --	-- | --	✚ | --	-- | --	-- | --	✚ | --
Des Moines River Basin [a]	wq-ws4-52a	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	✚ | ✱
Duluth Urban Area Watershed	wq-ws4-42a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Kettle River and Upper St. Croix River [b]	wq-ws4-73a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	✚ | --
Lac qui Parle River	wq-ws4-74a	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	✚ | ✱	✚ | ✱
Lake of the Woods	wq-ws4-66a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Lake Superior – North	wq-ws4-51a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Lake Superior – South	wq-ws4-41a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --

Watershed	Document	ACPF	HSPF	HSPF-SAM	PTMApp	BATHTUB	SWAT	Other
Le Sueur River	wq-ws4-10a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	✚ | ✱	✚ | ✱
Leech Lake River	wq-ws4-31a	-- | --	✚ | --	-- | --	-- | --	-- | --	-- | --	✚ | --
Little Fork River	wq-ws4-21a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Long Prairie River	wq-ws4-19a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Lower Minnesota River	wq-ws4-58a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Lower Rainy River	wq-ws4-91a	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Lower Red River – Tamarac River	wq-ws4-48a	-- | --	✚ | ✱	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Minnesota River – Headwaters	wq-ws4-75a	-- | --	✚ | ✱	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --
Minnesota River – Mankato	wq-ws4-63a	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	✚ | ✱	-- | --
Minnesota River – Yellow Medicine River/Hawk Creek	wq-ws4-13a wq-ws4-29a	-- | -- -- | --	✚ | ✱ ✚ | ✱	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --	✚ | ✱ ✚ | ✱	✚ | ✱ ✚ | ✱
Mississippi River – Brainerd	wq-ws4-65a	-- | --	✚ | ✱	-- | --	-- | --	✚ | ✱	-- | --	-- | --
Mississippi River – Grand Rapids	wq-ws4-61a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	✚ | ✱
Mississippi River – Headwaters	wq-ws4-50a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	✚ | ✱
Mississippi River – La Crescent	wq-ws4-71a	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --	✚ | ✱
Mississippi River – Lake Pepin	wq-iw9-15n wq-ws4-14a [d]	-- | -- ✚ | ✱	✚ | ✱ -- | --	-- | -- -- | --	-- | -- ✚ | ✱	-- | -- -- | --	-- | -- -- | --	✚ | ✱ ✚ | ✱
Mississippi River – Reno	wq-ws4-68a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Mississippi River – Sartell	wq-ws4-78a	-- | --	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Mississippi River – St. Cloud	wq-ws4-07a wq-ws4-99a [e]	-- | -- -- | --	-- | -- ✚ | ✱	-- | --	-- | -- -- | --	-- | -- -- | --	-- | -- -- | --	✚ | ✱ ✚ | ✱
Mississippi River – Winona	wq-ws4-28a	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --
Missouri River Basin [c]	wq-ws4-40a	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	✚ | ✱
Mustinka River	wq-ws4-20a	✚ | ✱	✚ | ✱	-- | --	✚ | ✱	-- | --	-- | --	-- | --

Watershed	Document	ACPF	HSPF	HSPF-SAM	PTMApp	BATHTUB	SWAT	Other
Nemadji River	wq-ws4-30a	-- | --	+ | --	-- | --	-- | --	-- | --	-- | --	+ | --
North Fork Crow River	wq-ws4-06a	-- | --	+ | *	-- | --	-- | --	+ | *	-- | --	+ | *
	wq-ws4-92a [e]	-- | --	+ | *	-- | --	+ | *	-- | --	-- | --	+ | *
Otter Tail River	wq-ws4-82a	-- | --	+ | *	-- | --	+ | *	-- | --	-- | --	+ | *
Pine River	wq-ws4-33a	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	+ | *
Pomme de Terre River	wq-ws4-01	-- | --	+ | *	-- | --	+ | *	-- | --	-- | --	-- | --
Rainy River – Headwaters	wq-ws4-87a	+ | *	+ | *	+ | *	-- | --	-- | --	-- | --	+ | *
Rainy River – Rainy Lake	wq-ws4-90a	+ | *	+ | *	-- | --	-- | --	-- | --	-- | --	+ | *
Rapid River	wq-ws4-88a	+ | *	+ | *	+ | *	-- | --	-- | --	-- | --	+ | *
Red Lake River	wq-ws4-60a	-- | --	+ | *	+ | *	+ | *	-- | --	+ | *	-- | --
Red River of the North – Grand Marais Creek	wq-ws4-56a	-- | --	+ | *	-- | --	+ | *	-- | --	-- | --	-- | --
Red River of the North – Marsh River	wq-ws4-83a	-- | --	+ | *	+ | *	-- | --	-- | --	-- | --	-- | --
Red River of the North – Sand Hill River	wq-ws4-26a	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	+ | *
Redeye River	wq-ws4-17a	+ | *	-- | --	-- | --	-- | --	-- | --	-- | --	+ | *
Redwood River	wq-ws4-94a	+ | *	-- | --	+ | *	-- | --	-- | --	-- | --	+ | *
Root River	wq-ws4-18a	-- | --	+ | *	-- | --	-- | --	-- | --	+ | *	+ | *
	wq-ws4-98a [e]	+ | *	+ | *	+ | *	+ | *	-- | --	-- | --	+ | *
Roseau River	wq-ws4-76a	-- | --	+ | *	+ | *	-- | --	-- | --	-- | --	-- | --
Rum River	wq-ws4-34a	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	+ | *
Sauk River	wq-ws4-08a	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	-- | --
	wq-ws4-96a [e]	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	-- | --
Shell Rock River	wq-ws4-70a	-- | --	+ | *	-- | --	-- | --	+ | *	+ | *	+ | *
Snake River – Red River Basin	wq-ws4-79a	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	-- | --

Watershed	Document	ACPF	HSPF	HSPF-SAM	PTMApp	BATHTUB	SWAT	Other
Snake River – St. Croix River Basin	wq-ws4-04	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --	+ | *
South Fork Crow River	wq-ws4-47a	-- | --	+ | *	-- | --	-- | --	+ | *	-- | --	+ | *
St. Louis River	wq-ws4-46a	-- | --	+ | --	-- | --	-- | --	-- | --	-- | --	-- | --
Thief River	wq-ws4-49a	+ | --	+ | --	-- | --	-- | --	-- | --	-- | --	+ | --
Two Rivers	wq-ws4-57a	-- | --	+ | *	-- | --	+ | *	-- | --	-- | --	-- | --
Upper Iowa River	wq-ws4-68a	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	-- | --
Upper Red River of the North	wq-ws4-36a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --	+ | *
Upper Wapsipinicon River	wq-ws4-67a	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --	-- | *
Upper/Lower Red Lake	wq-ws4-81a	-- | --	+ | --	-- | --	-- | --	-- | --	-- | --	-- | --
Vermilion River	wq-ws4-86a	-- | --	+ | *	+ | *	-- | --	+ | --	-- | --	-- | --
Watonwan River	wq-ws4-62a	-- | --	+ | *	+ | *	-- | --	-- | --	-- | --	-- | --
Wild Rice River	wq-ws4-89a	-- | --	+ | *	+ | *	+ | *	-- | --	-- | --	-- | --
Winnebago River	wq-ws4-64a	-- | --	+ | *	+ | *	-- | --	-- | --	-- | --	+ | --
Zumbro River	wq-ws4-39a	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	-- | --

APPENDIX B: SUMMARY TABLES FOR CWMPS

Table 16. Comprehensive Watershed Management Plans

Watershed	Date
Bois de Sioux – Mustinka	1/27/21
Buffalo-Red River	10/28/2020
Canon River	6/24/2020
Cedar-Wapsipinicon	December 2019
Clearwater River	--
Des Moines River	--
Lac Qui Parle-Yellow Bank	January 2023
Lake of the Woods	August 2019
Lake Superior North	5/23/2017
Leech Lake River	February 2019
Le Sueur River	
Long Prairie River	--
Lower St. Croix River	10/28/2020
Lower Minnesota River	February 2023
Middle-Snake-Tamarac Rivers	--
Mississippi River Headwaters	--
Missouri River	June 2019
Nemadji River	2022
North Fork Crow River	April 2018
Otter Tail River	--
Pine River	--
Pomme de Terre River	June 2020
Rainy-Rapid	--
Red Lake River	January 2017
Leaf-Wing-Redeye Rivers	--
Root River	December 2016
Roseau River	--
Rum River	4/19/2022
Sauk River	March 2021
Shell Rock River + Winnebago River	February 2022
Snake River	1/25/2023
St. Louis River	--
Thief River	February 2020

Watershed	Date
Two Rivers Plus	April 2021
Watonwan	10/23/2020
Wild Rice-Marsh	--
Mississippi River Winona-La Crescent	--
Yellow Medicine River	September 2016
Zumbro River	November 2021

Table 17. Summary of nutrient sources in CWMPs

Notes
Listed source was identified for phosphorus (○) or nitrogen (□) or listed source was identified and prioritized for phosphorus (◉) or nitrogen (▣).
Sources were quantified for phosphorus (✚) or nitrogen (✱).
SSTS = subsurface treatment system (e.g., septic system with drain-field).

Comprehensive Watershed Management Plan	Agriculture	Point sources	SSTS	Urban stormwater	Other sources	Quantified
Bois de Sioux – Mustinka	◉ | □	◉ | □	◉ | □	◉ | □	◉ | ▣	-- | --
Buffalo-Red River	○ | □	-- | --	-- | --	○ | □	○ | □	-- | --
Canon River	◉ | ▣	◉ | --	○ | □	○ | □	◉ | ▣	-- | --
Cedar-Wapsipinicon	◉ | ▣	◉ | ▣	◉ | ▣	○ | □	◉ | ▣	-- | --
Clearwater River	◉ | □	◉ | --	○ | □	○ | □	◉ | ▣	-- | --
Des Moines River	◉ | ▣	○ | □	-- | ▣	◉ | ▣	◉ | ▣	-- | --
Hawk Creek- Middle Minnesota	◉ | ▣	○ | □	◉ | ▣	◉ | ▣	◉ | ▣	-- | --
Lac Qui Parle-Yellow Bank	◉ | ▣	○ | □	◉ | ▣	◉ | ▣	◉ | ▣	-- | --
Lake of the Woods	-- | --	○ | □	○ | □	-- | --	◉ | ▣	-- | --
Lake Superior North	-- | --	-- | --	◉ | ▣	-- | --	-- | --	-- | --
Leech Lake River	◉ | ▣	-- | --	-- | --	◉ | ▣	◉ | ▣	-- | --
Le Sueur River	-- | ▣	-- | --	-- | --	-- | --	-- | ▣	-- | --
Long Prairie River	◉ | ▣	○ | □	-- | --	◉ | ▣	○ | ▣	-- | --
Lower St. Croix River	◉ | ▣	-- | --	◉ | ▣	-- | --	◉ | ▣	-- | --
Lower Minnesota River	◉ | ▣	◉ | --	◉ | ▣	◉ | --	◉ | ▣	-- | --
Middle-Snake-Tamarac Rivers	◉ | ▣	-- | --	-- | --	-- | --	-- | --	-- | --
Mississippi River Headwaters	◉ | ▣	-- | --	◉ | ▣	-- | --	◉ | ▣	-- | --
Missouri River	-- | --	-- | --	-- | --	-- | --	◉ | ▣	-- | --
Nemadji River	○ | □	-- | --	-- | --	-- | --	○ | □	-- | --
North Fork Crow River	◉ | ▣	◉ | ▣	◉ | ▣	◉ | ▣	◉ | ▣	-- | --

Comprehensive Watershed Management Plan	Agriculture	Point sources	SSTS	Urban stormwater	Other sources	Quantified
Otter Tail River	◉ | ▣	-- | --	-- | ▣	◉ | ▣	◉ | ▣	-- | --
Pine River	◉ | ▣	-- | --	-- | ▣	◉ | ▣	-- | --	-- | --
Pomme de Terre River	◉ | ▣	○ | --	◉ | ▣	○ | --	◉ | ▣	-- | --
Rainy-Rapid	◉ | ▣	○ | □	◉ | ▣	◉ | ▣	◉ | ▣	-- | --
Red Lake River	◉ | ▣	-- | --	◉ | ▣	◉ | ▣	◉ | ▣	-- | --
Leaf-Wing-Redeye Rivers	◉ | ▣	-- | --	-- | --	◉ | ▣	-- | --	-- | --
Root River	◉ | ▣	-- | --	-- | --	-- | --	◉ | ▣	-- | --
Roseau River	○ | □	-- | --	○ | □	○ | □	○ | □	-- | --
Rum River	◉ | ▣	-- | --	○ | □	○ | □	◉ | ▣	-- | --
Sauk River	◉ | --	-- | --	◉ | ▣	◉ | ▣	-- | ▣	-- | --
Shell Rock River + Winnebago River	◉ | ▣	-- | --	◉ | ▣	○ | □	○ | □	-- | --
Snake River	◉ | ▣	-- | --	○ | □	◉ | ▣	◉ | ▣	-- | --
St. Louis River	◉ | ▣	-- | --	◉ | ▣	◉ | ▣	-- | --	-- | --
Thief River	◉ | ▣	◉ | ▣	◉ | ▣	○ | □	◉ | ▣	-- | --
Two Rivers Plus	◉ | ▣	-- | --	-- | --	-- | --	◉ | ▣	-- | --
Watonwan	◉ | ▣	-- | --	◉ | ▣	◉ | ▣	◉ | ▣	-- | --
Wild Rice-Marsh	○ | □	○ | --	○ | --	○ | --	-- | --	-- | --
Mississippi River Winona-La Crescent	◉ | ▣	-- | ▣	-- | --	◉ | ▣	◉ | ▣	-- | --
Yellow Medicine River	◉ | ▣	○ | □	◉ | ▣	◉ | ▣	◉ | ▣	-- | --
Zumbro River	◉ | ▣	◉ | ▣	◉ | --	◉ | ▣	◉ | --	-- | --

Table 18. Summary of prioritized waters in CWMPs

Notes
Number of waters prioritized for phosphorus (1, 2, 3, etc.) or nitrogen (1, 2, 3, etc.).
Whether or not downstream waters were prioritized for phosphorus (✚) or nitrogen (✱).

Comprehensive Watershed Management Plan	Lakes or reservoirs	Streams or rivers	Aquifer or groundwater	Sub-watersheds	Downstream waters
Bois de Sioux – Mustinka	5 | --	7 | --	-- | 1	-- | --	-- | --
Buffalo-Red River	10 | --	7 | --	-- | --	6 | --	-- | --
Canon River	8 | --	6 | 6	-- | --	2 | 2	-- | --
Cedar-Wapsipinicon	1 | --	8 | 11	-- | --	-- | --	-- | --
Clearwater River	5 | --	7 | --	-- | --	1 | --	-- | --
Des Moines River	6 | 6	8 | 8	-- | 4	5 | 5	-- | --
Hawk Creek- Middle Minnesota	7 | 7	4 | 4	-- | --	-- | --	-- | --
Lac Qui Parle-Yellow Bank	2 | --	4 | --	-- | --	4 | 2	-- | --
Lake of the Woods	-- | --	-- | --	-- | --	5 | 5	-- | --
Lake Superior North	3 | 1	5 | 1	-- | --	4 | 1	-- | --
Leech Lake River	-- | --	-- | --	-- | --	11 | 11	-- | --
Le Sueur River	35 | 35	3 | 3	-- | --	-- | --	-- | --
Long Prairie River	7 | --	1 | --	-- | --	-- | --	-- | --
Lower St. Croix River	52 | 52	8 | --	-- | --	-- | --	-- | --
Lower Minnesota River	8 | --	7 | 7	-- | --	-- | --	-- | --
Middle-Snake-Tamarac Rivers	-- | --	-- | --	-- | --	4 | --	-- | --
Mississippi River Headwaters	8 | 8	-- | --	-- | --	-- | --	-- | --
Missouri River	-- | --	4 | 4	-- | --	-- | --	-- | --
Nemadji River	-- | --	-- | --	-- | --	-- | --	-- | --
North Fork Crow River	15 | 15	-- | --	-- | --	-- | --	-- | --
Otter Tail River	24 | 24	9 | 9	-- | --	-- | --	-- | --
Pine River	5 | 5	-- | --	-- | --	-- | --	-- | --

Comprehensive Watershed Management Plan	Lakes or reservoirs	Streams or rivers	Aquifer or groundwater	Sub-watersheds	Downstream waters
Pomme de Terre River	6 | 6	-- | --	-- | --	-- | --	-- | --
Rainy-Rapid	-- | --	-- | --	-- | --	-- | --	-- | --
Red Lake River	-- | --	23 | 23	-- | --	-- | --	-- | --
Leaf-Wing-Redeye Rivers	70 | --	-- | --	-- | --	-- | 3	-- | --
Root River	3 | 3	6 | 6	-- | --	-- | --	-- | --
Roseau River	-- | --	-- | --	-- | --	1 | 1	-- | --
Rum River	13 | --	-- | --	-- | 18	-- | --	-- | --
Sauk River	13 | --	-- | --	-- | --	-- | --	-- | --
Shell Rock River + Winnebago River	13 | 13	4 | 4	-- | --	-- | --	-- | --
Snake River	11 | 11	9 | 9	-- | --	-- | --	-- | --
St. Louis River	3 | 3	20 | 20	-- | --	2 | 2	-- | --
Thief River	-- | --	10 | 4	-- | --	-- | --	-- | --
Two Rivers Plus	-- | --	-- | --	-- | --	5 | 5	-- | --
Watonwan	7 | --	-- | 2	-- | --	-- | --	-- | --
Wild Rice-Marsh	1 | --	5 | --	-- | --	-- | --	-- | --
Mississippi River Winona-La Crescent	1 | --	-- | 4	-- | --	-- | --	-- | --
Yellow Medicine River	8 | --	6 | 3	-- | --	7 | 7	-- | --
Zumbro River	2 | --	-- | --	-- | --	-- | --	-- | --

Table 19. Summary of nutrient goals in CWMPs

Notes
Nutrient goals (load, concentration, or reduction) were identified for phosphorus (✚) or nitrogen (✱),
Nutrient goals were either (1) only focused on the local catchment for phosphorus (○) or nitrogen (□) or (2) were consistent with Minnesota's Nutrient Reduction Strategy for phosphorus (◉) or nitrogen (▣).
a. Goals stated were specific to the target catchment and consistent with the Minnesota NRS goals.

Comprehensive Watershed Management Plan	Phosphorus	Nitrogen
Bois de Sioux – Mustinka	✚ | ○	-- | --
Buffalo-Red River	✚ | ◉	-- | --
Canon River	✚ | ◉[a]	✱ | ▣[a]
Cedar-Wapsipinicon	✚ | ◉[a]	✱ | ▣
Clearwater River	✚ | ○	-- | --
Des Moines River	✚ | ○	✱ | □
Hawk Creek- Middle Minnesota	✚ | ○	✱ | □
Lac Qui Parle-Yellow Bank	✚ | ○	✱ | □
Lake of the Woods	✚ | ○	✱ | □
Lake Superior North	✚ | ○	✱ | □
Leech Lake River	✚ | ○	✱ | □
Le Sueur River	✚ | ○	✱ | □
Long Prairie River	✚ | ○	✱ | □
Lower St. Croix River	✚ | ○	✱ | □
Lower Minnesota River	✚ | ◉[a]	✱ | ▣[a]
Middle-Snake-Tamarac Rivers	✚ | ◉[a]	✱ | ▣[a]
Mississippi River Headwaters	✚ | ○	✱ | □
Missouri River	✚ | ○	✱ | □
Nemadji River	✚ | ○	✱ | □
North Fork Crow River	✚ | ◉[a]	✱ | ▣[a]
Otter Tail River	✚ | ◉[a]	✱ | ▣[a]
Pine River	✚ | ○	✱ | □
Pomme de Terre River	✚ | ◉[a]	✱ | ▣[a]
Rainy-Rapid	✚ | ○	✱ | □
Red Lake River	✚ | ○	-- | --
Leaf-Wing-Redeye Rivers	✚ | ○	✱ | □
Root River	✚ | ◉	✱ | ▣
Roseau River	✚ | ○	✱ | □
Rum River	✚ | ○	✱ | □
Sauk River	✚ | ◉[a]	✱ | ▣[a]

Comprehensive Watershed Management Plan	Phosphorus	Nitrogen
Shell Rock River + Winnebago River	✚ | ○	✱ | □
Snake River	✚ | ○	✱ | □
St. Louis River	✚ | ○	✱ | □
Thief River	✚ | ◉[a]	✱ | ▣[a]
Two Rivers Plus	✚ | ○	✱ | □
Watonwan	✚ | ○	✱ | □
Wild Rice-Marsh	✚ | ○	✱ | □
Mississippi River Winona-La Crescent	✚ | ◉[a]	✱ | ▣[a]
Yellow Medicine River	✚ | ◉[a]	✱ | ▣[a]
Zumbro River	✚ | ◉[a]	✱ | ▣[a]

Table 20. Summary of monitoring result trends

Notes
Nutrient trends were reported as increasing (🡅), decreasing (🡇), varying by monitoring site (╬), or not significant or not observed (◊). In some cases, no trend analysis was reported (--).
a. The Des Moines River Basin WRAPS (wq-ws4-52a) is for the *Des Moines River – Headwaters*, *East Fork Des Moines River*, and *Lower Des Moines River*.
b. The Kettle River and Upper St. Croix River Watershed WRAPS (wq-ws4-73a) is for the *Kettle River* and *Upper St. Croix River*.
c. The Missouri River Basin WRAPS (wq-ws4-40a) is for the *Little Sioux River* and *Lower Big Sioux River*.
d. This WRAPS report (wq-ws4-14a) is for the Vermilion River that is tributary to Lake Pepin.
e. These WRAPS reports are update reports

Watershed Restoration and Protection Strategy report	Phosphorus	Nitrogen
Bois de Sioux – Mustinka	--	--
Buffalo-Red River	--	--
Canon River	--	--
Cedar-Wapsipinicon	╬	╬
Clearwater River	--	--
Des Moines River	--	--
Hawk Creek- Middle Minnesota	--	--
Lac Qui Parle-Yellow Bank	--	--
Lake of the Woods	--	--
Lake Superior North	--	--
Leech Lake River	--	--
Le Sueur River	🡅	🡅
Long Prairie River	╬	--
Lower St. Croix River	🡅	--
Lower Minnesota River	--	--
Middle-Snake-Tamarac Rivers	--	--
Mississippi River Headwaters	╬	--
Missouri River	--	--
Nemadji River	--	--
North Fork Crow River	--	--
Otter Tail River	--	--
Pine River	--	--
Pomme de Terre River	--	--
Rainy-Rapid	--	--
Red Lake River	--	--
Leaf-Wing-Redeye Rivers	--	--
Root River	--	--
Roseau River	--	--

Watershed Restoration and Protection Strategy report	Phosphorus	Nitrogen
Rum River	--	--
Sauk River	--	--
Shell Rock River + Winnebago River	--	--
Snake River	--	--
St. Louis River	--	--
Thief River	--	--
Two Rivers Plus	--	--
Watonwan	--	--
Wild Rice-Marsh	--	--
Mississippi River Winona-La Crescent	--	--
Yellow Medicine River	--	--
Zumbro River	--	--

Table 21. Summary of tools in CWMPs

Notes
ACPF = Agricultural Conservation Planning Framework; HSPF = Hydrologic Simulation Program – FORTRAN; PTMApp = Prioritize, Target, and Measure Application; SWAT = Soil and Water Assessment Tool
Tools were used for phosphorus (✚) or nitrogen (✱).

Comprehensive Watershed Management Plan	ACPF	HSPF	HSPF-SAM	PTMApp	Zonation Cons. Tool	SWAT	Other
Bois de Sioux – Mustinka	-- | --	✚ | ✱	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Buffalo-Red River	-- | --	-- | --	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Canon River	✚ | ✱	✚ | ✱	✚ | ✱	✚ | ✱	✚ | ✱	-- | --	-- | --
Cedar-Wapsipinicon	-- | --	✚ | ✱	✚ | ✱	-- | --	✚ | ✱	✚ | ✱	✚ | --
Clearwater River	-- | --	✚ | ✱	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Des Moines River	-- | --	✚ | ✱	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Hawk Creek- Middle Minnesota	-- | --	-- | --	✚ | ✱	-- | --	-- | --	-- | --	✚ | ✱
Lac Qui Parle-Yellow Bank	-- | --	-- | --	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Lake of the Woods	-- | --	-- | --	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --
Lake Superior North	-- | --	-- | --	-- | --	-- | --	✚ | ✱	-- | --	-- | --
Leech Lake River	-- | --	✚ | --	-- | --	-- | --	-- | --	-- | --	-- | --
Le Sueur River	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	-- | --
Long Prairie River	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	-- | --
Lower St. Croix River	✚ | ✱	-- | --	-- | --	✚ | ✱	-- | --	✚ | ✱	✚ | ✱
Lower Minnesota River	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	✚ | ✱
Middle-Snake-Tamarac Rivers	-- | --	-- | --	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Mississippi River Headwaters	-- | --	✚ | ✱	✚ | ✱	-- | --	-- | --	-- | --	✚ | ✱
Missouri River	-- | --	-- | --	-- | --	✚ | ✱	-- | --	-- | --	-- | --
Nemadji River	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --	✚ | ✱
North Fork Crow River	✚ | ✱	-- | --	-- | --	-- | --	-- | --	-- | --	-- | --
Otter Tail River	-- | --	-- | --	-- | --	✚ | ✱	-- | --	-- | --	✚ | ✱

Comprehensive Watershed Management Plan	ACPF	HSPF	HSPF-SAM	PTMApp	Zonation Cons. Tool	SWAT	Other
Pine River	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	-- | --
Pomme de Terre River	-- | --	+ | --	+ | --	+ | *	+ | *	-- | --	+ | *
Rainy-Rapid	-- | --	-- | --	+ | *	-- | --	-- | --	-- | --	+ | *
Red Lake River	-- | --	-- | --	-- | --	+ | *	-- | --	+ | *	-- | --
Leaf-Wing-Redeye Rivers	-- | --	-- | --	-- | --	+ | *	-- | --	-- | --	-- | --
Root River	-- | --	+ | *	-- | --	+ | *	+ | *	-- | --	-- | --
Roseau River	-- | --	-- | --	-- | --	+ | *	-- | --	-- | --	-- | --
Rum River	-- | --	+ | *	+ | --	+ | *	-- | --	-- | --	-- | --
Sauk River	+ | *	+ | *	+ | *	+ | *	-- | --	-- | --	+ | *
Shell Rock River + Winnebago River	-- | --	+ | *	+ | *	-- | --	-- | --	-- | --	+ | *
Snake River	-- | --	+ | *	+ | --	-- | --	+ | *	-- | --	+ | *
St. Louis River	-- | --	+ | *	-- | --	-- | --	-- | --	-- | --	+ | *
Thief River	-- | --	+ | --	-- | --	+ | *	-- | --	-- | --	-- | --
Two Rivers Plus	-- | --	-- | --	-- | --	+ | *	-- | --	-- | --	+ | *
Watonwan	-- | --	-- | --	-- | --	+ | *	-- | --	-- | --	-- | --
Wild Rice-Marsh	-- | --	-- | --	-- | --	+ | *	-- | --	-- | --	-- | --
Mississippi River Winona-La Crescent	-- | --	-- | --	-- | --	+ | *	-- | --	+ | *	-- | --
Yellow Medicine River	+ | *	+ | *	+ | *	-- | --	-- | --	-- | --	+ | *
Zumbro River	-- | --	+ | *	+ | *	-- | --	+ | *	-- | --	+ | *