Minnesota Wastewater Nitrogen Reduction and Implementation Strategy – Summary

Excess nitrogen is harmful for Minnesota surface and groundwaters as well as for downstream waters in other jurisdictions. While Minnesota's wastewater sector is estimated to discharge less than 10% of total nitrogen (TN) to Minnesota surface waters statewide, wastewater plants can contribute significant quantities of nitrate and ammonia nitrogen to individual waterbodies, particularly where there are not many other sources or during low stream-flow conditions. This wastewater nitrogen reduction and implementation strategy (Strategy) was developed by the MPCA in consultation with stakeholders to accomplish the nitrogen reductions needed from the wastewater sector for the protection and restoration of Minnesota and downstream waterbodies. Wastewater nitrogen reductions are an integral part of Minnesota's nutrient reduction strategy (NRS) which also addresses nonpoint sources.

Existing nitrogen water quality standards

Narrative water quality standards

Minnesota Rules Chapter 7050.0221. Specific water quality standards for Class 1 waters of the state; domestic consumption.

Subpart 6. Additional standards. In addition to the standards in subparts 2 to 5, no sewage, industrial waste, or other wastes from point or nonpoint sources, treated or untreated, shall be discharged into or permitted by any person to gain access to any waters of the state classified for domestic consumption so as to cause any material undesirable increase in the taste, hardness, temperature, chronic toxicity, corrosiveness, or nutrient content, or in any other manner to impair the natural quality or value of the waters for use as a source of drinking water.

Minnesota Rules Chapter 7050.0222. Specific water quality standards for Class 2 waters of the state; aquatic life and recreation.

Subpart 7. Additional standards; Class 2 waters. The following additional standards and requirements apply to all Class 2 waters.

A. No sewage, industrial waste, or other wastes from point or nonpoint sources shall be discharged into any of the waters of this category so as to cause any material change in any other substances, characteristics, or pollutants which may impair the quality of the waters of the state or the aquatic biota of any of the classes in subparts 2 to 6 or in any manner render them unsuitable or objectionable for fishing, fish culture, or recreational uses. Additional selective limits or changes in the discharge bases may be imposed on the basis of local needs.

Numeric water quality standards

Minnesota Rules Chapter 7050.0221. Specific water quality standards for Class 1 waters of the state; domestic consumption.

Minnesota's water quality standards (WQS) for Class 1 waters incorporate by reference the Environmental Protection Agency (EPA) drinking water standards, which include a 10 mg/L Nitrate-Nitrogen (NO_3-N) criterion.

- Class 1 waters are protected as sources for domestic consumption, including all waters of the state that are or may be used as a source of supply for drinking, culinary or food processing use, or other domestic

purposes and for which quality control is or may be necessary to protect the public health, safety, or welfare.

Minnesota Rules Chapter 7050.0222. Specific water quality standards for Class 2 waters of the state; aquatic life and recreation.

Minnesota's WQS for Class 2 waters include the following un-ionized ammonia-nitrogen chronic aquatic life toxicity criteria:

- Class 2A waters – 16 µg/L
- Class 2Bd and Class 2B waters – 40 µg/L

Proposed water quality standards

The MPCA is proposing to update Minnesota's ammonia-nitrogen WQS based on EPA criteria to include a final acute value, maximum standard, and chronic standard in Minn. R. 7050. The MPCA's Ammonia water quality standard webpage provides details of the proposed update.

The MPCA has determined that excessive NO_3-N concentrations in surface waters are harmful to aquatic organisms and has developed draft water quality criteria for the protection of aquatic life in Class 2A and 2B waters. The MPCA's Aquatic Life Water Quality Standards Draft Technical Support Document for Nitrate defines the basis for the development of new nitrate water quality standards for the protection of aquatic organisms.

Nutrient reduction strategy

Minnesota's NRS calls for point source and nonpoint source TN reductions in watersheds draining to the Mississippi River and in the Red River Basin. TN goals for the Lake Superior and Rainy River Basins are under consideration for the NRS revision process that is currently underway.

Current wastewater nitrogen permit limits in Minnesota

Minnesota wastewater permits have historically included NO_3-N or TN limits to protect groundwater as a source of drinking water. More recently, surface water TN effluent limits have also been developed for consistency with total maximum daily load (TMDL) wasteload allocations and to address whole effluent toxicity. Currently, 126 Minnesota wastewater permits contain TN or nitrate limits.

Total nitrogen loads

Wastewater effluent nitrogen concentrations and load reductions are needed to meet local and downstream water quality goals. Statewide TN loads discharged by Minnesota wastewater treatment facilities (WWTFs) have increased gradually from an average annual load of 13,832 metric tons per year (MT/yr) (2010-2012) to 14,074 MT/yr (2020-2022). A substantial majority of the annual effluent TN load is discharged by major municipal WWTFs.

Water quality-based effluent limits (WQBELs) would meet goals to protect aquatic life locally in streams and rivers. However, based on the draft NO_3-N aquatic life toxicity criteria, available discharge monitoring data and wastewater discharge location data, future reductions expected from attainment of WQBELs alone will be insufficient to achieve reductions necessary to meet the Minnesota NRS's goals for the Mississippi and Red River Basins.

After full attainment of the WQBELs, an additional 2,208 MT/year TN reduction (28%) would be needed in the Mississippi River Basin and an additional 118.6 MT/year TN reduction (45%) would be needed in the Red River Basin to meet statewide NRS goals. Wastewater TN load goals have not been determined for the Lake Superior and Rainy River Basins but are anticipated with the NRS revision in 2025.

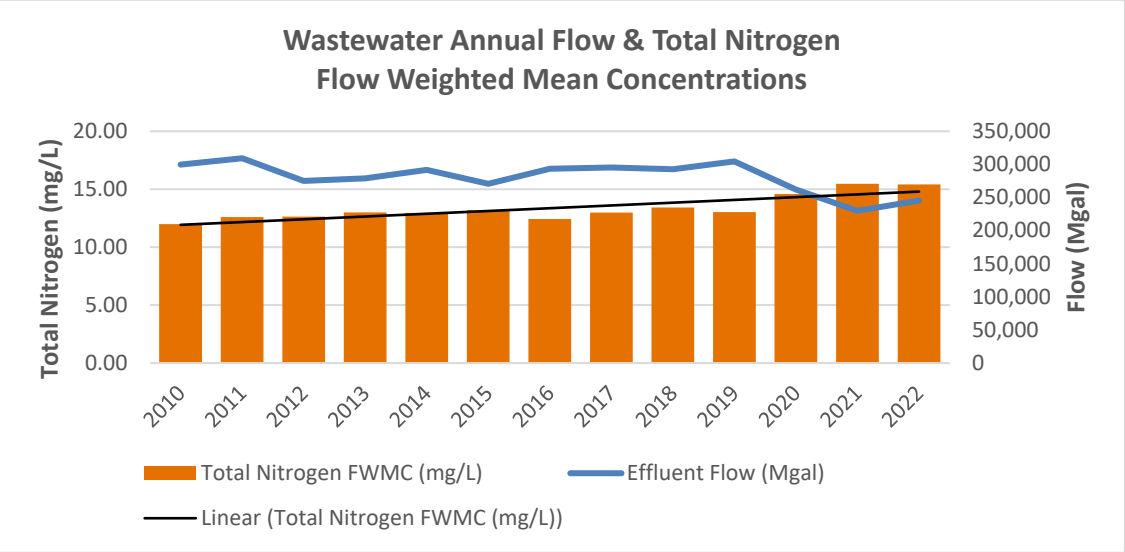
Table 1. Annual wastewater TN loads and load reductions expected from NO_3-N WQBELs – delivered to the State borders

	Annual end-of-pipe wastewater TN load (MT/year)	Annual wastewater TN load delivered to the state line (MT/year)	Estimated annual TN load reduction needed to meet NO_3-N WQBELs (MT/year)	Estimated NO_3-N WQBELs percent reduction at the state border (%)	Nutrient reduction strategy percent reduction goal from baseline (%)
Mississippi River	13,656	10,163	2,365	23%	45%
Red River	307	294	28.4	10%	50%
Lake Superior	785	785	94.3	12%	TBD
Rainy River	191	179	0.12	01%	TBD

Total nitrogen concentrations

Statewide flow weighted mean TN concentrations have increased steadily from 12.4 mg/L (2010-2012 average) to 15.2 mg/L (2020-2022 average).

Figure 1. Annual wastewater effluent total nitrogen concentrations



Typical TN effluent concentrations by facility class

Typical effluent TN concentrations vary by facility type and size. All municipal and a few industrial WWTFs are ranked as Class A through D based on factors such as operational complexity, restrictiveness of effluent limits and influent wastewater variability characteristics. Most industrial permits authorize wastewater discharges that do not require biological wastewater treatment and are not assigned a facility classification. However, six unclassified industrial wastewater discharges contain significant TN concentrations.

The summary statistics in Table 2 show substantial variability in calendar month average TN concentrations reported by municipal and industrial WWTFs in all classes. However, mean and median concentrations reported by facilities in Class A, B and C (generally mechanical, continuously discharging WWTFs) are substantially similar. Class D (generally stabilization pond, controlled discharge WWTFs) and unclassified industrial discharges report low TN calendar month average effluent concentrations. High concentration industrial discharges reported very high effluent TN concentrations.

Table 2. 2018 – 2022 Total nitrogen effluent concentrations (mg/L)

	Class A	Class B	Class C	Class D	High concentration industrial	Low concentration industrial
Mean	19.8	19.0	20.5	4.4	44.0	2.3
Median	19.0	17.2	18.0	3.6	35.6	1.5
Max	54.0	53.0	73.0	14.0	160.0	8.1
Min	1.6	0.5	0.1	0.0	1.3	0.0
Standard dev.	10.5	10.5	14.8	3.1	33.0	1.9
Mean + Standard dev.	**30.3**	**29.5**	**35.4**	**7.5**	**77.0**	**4.2**

For the purposes of this strategy, the threshold for distinguishing between high and low concentration discharges is the facility classification mean TN concentration plus one standard deviation, rounded to the nearest integer. The two exceptions are high concentration industrial facilities which are assigned the same concentration threshold as Class A and B facilities, and low concentration industrial facilities which are adjusted up to the draft NO_3-N criterion for cold water streams.

Table 3. High vs. low concentration discharge threshold

	Class A	Class B	Class C	Class D	High concentration industrial	Low concentration industrial
High/low TN concentration threshold	30 mg/L	30 mg/L	35 mg/L	8 mg/L	30 mg/L	5 mg/L

Municipal and industrial WWTFs exceeding the class-based thresholds shown in table three are considered high concentration discharges.

Wastewater nitrogen reduction and implementation strategy

The MPCA has developed a wastewater reduction strategy designed to achieve effluent NO_3-N and TN reductions consistent with local and downstream water quality goals. The strategy includes three phases to be implemented over multiple 5-year NPDES/SDS permit cycles:

Phase 1 (first permit cycle beginning on or after April 1, 2024)

- Implement MPCA guidance for new, expanding, and significantly upgraded[1] WWTFs:
  - For discharges which will cause or have a reasonable potential to cause or contribute to exceedances of:
    - NO_3-N drinking water standard in downstream waterbodies utilized as drinking water sources; or
    - NO_3-N causing biological stress to aquatic organisms.

The MPCA will develop nitrogen effluent limits that ensure that downstream uses are protected. Effluent limits will be included in the WWTF's NPDES/SDS permit, and construction of all necessary treatment units will be required to achieve effluent denitrification to levels sufficient to protect downstream uses.

- For all other discharges, facility plans, and other planning or design documents submitted by project proposers will be required to include design considerations for denitrification to levels sufficient to protect downstream uses and to achieve the future projected nitrogen.
- Begin administrative process to adopt NO_3-N aquatic life toxicity WQS and a 10 mg/L 12-month moving average TN state discharge restriction (SDR) for major municipal WWTFs and high concentration minor municipal WWTFs and industrial discharges.
- SDR will include an optimization incentive – facilities that optimize operations to achieve 15 mg/L TN effluent concentrations as a 12-month moving average during Phase 1 will have the 10 mg/L SDR limit

[1] Facilities are considered significantly upgraded when biological treatment units are replaced or substantially rebuilt.

deferred to the facility's second permit cycle following SDR adoption (i.e. Phase 3). Permittees will be made aware of this SDR optimization opportunity in Phase 1.

- High concentration municipal and industrial dischargers – reissued permits will include requirements to develop and implement nitrogen management plans (NMPs). See Table 3 above.
- All NPDES/SDS permitted facilities discharging upstream of a known index of biotic integrity (IBI) impaired water with NO_3-N as a stressor – reissued permits will include requirements to develop and implement enhanced NMPs.
- MPCA will continue to develop WQBELs for discharges that cause or have a reasonable potential (RP) to cause or contribute to impairments based on existing nitrogen standards.

Phase 2 (first permit cycle following adoption of NO_3-N aquatic life toxicity WQS and adoption of a 10 mg/l SDR)

- All Phase 1 implementation steps will remain in effect except as modified by the implementation of Phase 2.
- Low concentration municipal and industrial dischargers will develop and implement NMPs if effluent concentrations exceed the concentration thresholds shown in Table 3 above.
- Permit limits:
  - Nitrogen WQBELs will be developed for NPDES/SDS permits found to have RP in accordance with the NO_3-N aquatic life toxicity WQS.
  - 10 mg/L TN, 12-month moving average SDR limits will be included in NPDES/SDS permits in accordance with the criteria of the SDR.
  - Optimization incentive – 10 mg/L TN effluent limits will be deferred to phase 3 for facilities that have successfully optimized operation to achieve a 15 mg/L TN 12-month moving average concentration during Phase 1 of this strategy.

Phase 3 (second permit cycle following adoption of NO_3-N aquatic life toxicity WQS and adoption of a 10 mg/l SDR)

- All Phase 1 and 2 implementation steps will remain in effect except as modified by implementation of Phase 3.
- 10 mg/L TN SDR 12-month moving average effluent limits will be included in NPDES/SDS permits for major municipal wastewater facilities and high concentration minor municipal WWTFs and industrial dischargers that had successfully optimized operations per incentive.

Table 4. Wastewater nitrogen reduction strategy implementation summary		Major municipal WWTP Low concentration[1]	Major municipal WWTP High concentration[1]	Minor municipal WWTP Low concentration[1]	Minor municipal WWTP High concentration[1]	Industrial discharger Low concentration[1]	Industrial discharger High concentration[1]
Phase 1 – First permit cycle starting April 1, 2024	MPCA	Begin administrative process to adopt 10 mg/l TN State Discharge Restriction (SDR) and NO_3-N WQS. Notify permittees of eligibility for deferred implementation of 10 mg/l SDR TN limits to Phase 3 if facilities have successfully optimized operations to a 15 mg/l annual average concentration during Phase 1.					
	All NPDES wastewater facilities		Develop & implement NMP		Develop & implement NMP		Develop & implement NMP
	New, expanded, and significantly upgraded facilities[3] with RP for drinking water and IBI impaired waters with NO_3-N stressors	Designed and built to meet N WQBELS	Designed and built to meet N WQBELS	Designed and built to meet N WQBELS	Designed and built to meet N WQBELS	Designed and built to meet N WQBELS	Designed and built to meet N WQBELS
	All other new, expanded, and significantly upgraded facilities[3]	Designed for denitrification	Designed for denitrification	Designed for denitrification	Designed for denitrification	Designed for denitrification	Designed for denitrification
	RP for exceedance of existing class 1 waters 10 mg/L NO_3-N WQS	TN WQBEL[2]	TN WQBEL[2]	TN WQBEL[2]	TN WQBEL[2]	TN WQBEL[2]	TN WQBEL[2]
	Facilities discharging upstream of IBI impaired waters with NO_3-N stressors	Develop & implement enhanced NMP[4]	Develop & implement enhanced NMP[4]	Develop & implement enhanced NMP[4]	Develop & implement enhanced NMP[4]	Develop & implement enhanced NMP[4_5]	Develop & implement enhanced NMP[4]
	TMDL wasteload allocation	TN WQBEL if discharge has RP[2]	TN WQBEL if discharge has RP[2]	TN WQBEL if discharge has RP[2]	TN WQBEL if discharge has RP[2]	TN WQBEL if discharge has RP[2]	TN WQBEL if discharge has RP[2]
Phase 2 – First permit cycle following adoption of 10 mg/l TN SDR and NO_3-N WQS [all Phase 1 requirements remain in effect except as modified by implementation of Phase 2]	MPCA	Begin implementation of 10 mg/L TN SDR & NO_3-N WQBELS					
	All NPDES wastewater facilities	Develop & implement NMP	Update & implement NMP	Develop & implement NMP	Update & implement NMP	Develop & implement NMP[5]	Update & implement NMP
	All NPDES wastewater facilities	10 mg/L SDR TN limit[7_8]	10 mg/L SDR TN limit[7_8]		10 mg/L SDR TN limit[7_8]		10 mg/L TN SDR limit[7_8]
	RP for exceedance of AQL NO_3-N WQS or IBI impairments with NO_3-N stressors	TN or NO_3-N WQBEL[6]	TN or NO_3-n WQBEL[6]	TN or NO_3-N WQBEL[6]	TN or NO_3-N WQBEL[6]	TN or NO_3-N WQBEL[6]	Tn or no_3-n wqbel[6]
Phase 3 – Second permit cycle following adoption of 10 mg/l SDR & NO_3-N WQS [all Phase 1 and 2 requirements remain in effect except as modified by implementation of Phase 3]	All NPDES wastewater facilities	Update & implement NMP	Update & implement NMP	Update & implement NMP	Update & implement NMP	Update & implement NMP[5]	Update & implement NMP
	All NPDES wastewater facilities	10 mg/L TN limit for facilities that have successfully optimized operations during Phase 1[8]	10 mg/L TN limit for facilities that have successfully optimized operations during Phase 1[8]		10 mg/L TN limit for facilities that have successfully optimized operations during Phase 1[8]		10 mg/L TN limit for facilities that have successfully optimized operations during Phase 1[8]

Table 4 Footnotes

[1]High vs. low concentration determined based on facility class mean concentration + standard deviation (see Table 3).

[2]TN limit and limit type to be determined at permit issuance.

[3]Facilities considered to be significantly upgraded when biological treatment units are replaced or substantially rebuilt.

[4]Enhanced NMP is a goal-oriented optimization plan designed to achieve a specific effluent concentration target.

[5]Low concentration industrial dischargers to develop NMPs if effluent concentrations exceed threshold TN concentration (Table 3)

[6]Limit parameter and limit type to be determined at permit issuance.

[7]Attainment of 10 mg/l SDR TN limit deferred one permit cycle if the facility has successfully optimized operations to a 15 mg/l annual average concentration during Phase 1.

[8]10 mg/l SDR TN limits implemented as 12-month moving average limit types.

Meeting nutrient reduction strategy goals

Estimated TN load reductions based on this proposed strategy is expected to achieve Minnesota's NRS goals at the State's borders for the Mississippi River Basin based on current flows. The updated and revised NRS may describe how to reconcile potential increases into the future.

Table 5. Wastewater nitrogen reduction strategy estimated wastewater loads and reductions

	Updated NRS wastewater baseline TN load at state line (MT/yr)	NRS reduction goal (%)	NRS WW TN load goal at state line (MT/yr)	Current WW TN load at state line (MT/yr)	Proposed TN load at state line with this strategy (MT/yr)	Proposed WW TN reduction from baseline (%)	Proposed WW TN reduction from current load (%)
Mississippi River	8,721	45%	4,795	10,163	4,069	53%	60%
Red River	326	50%	163	294	127	61%	57%
Lake Superior	1,212	Maintain	TBD	785	664	45%	15%
Rainy River	218	TBD	TBD	179	137	37%	23%