Summary of Concerns with the
Proposed Nutrient Concentration Objectives and Loading Targets for the
Red River at the US/Canada Boundary

Executive Summary

Hall & Associates has been contracted by the Minnesota cities of Breckenridge, Moorhead, Roseau and Warroad ("Cities") and the Minnesota Environmental Science and Economic Review Board to summarize our technical concerns with the International Red River Board's ("IRRB's") proposed nutrient concentration objectives and load targets currently under consideration by the International Joint Commission ("IJC"). The Cities are interested in this matter because they each own and operate wastewater treatment facilities that discharge within the Red River watershed and the Minnesota Pollution Control Agency ("MPCA") has a long-history of seeking to impose mandatory effluent limit requirements on the Cities based on IJC reports and recommendations.[1]

The regulation of nutrients is extremely complex and compliance with nutrient regulations is extremely expensive for wastewater treatment facilities. Thus, before setting nutrient objectives or targets, it is critical to complete a rigorous technical analysis to ensure that such nutrient objectives and targets are both *necessary to protect* and *sufficiently protective* of the environment before setting nutrient objectives or targets. In this case, we believe that IRRB has demonstrated that the phosphorus load target for the Red River, developed to protect Lake Winnipeg, is reasonable and appropriate for the protection of Lake Winnipeg and that the IJC should accept that recommendation.

However, based on our review of the information made available by the IJC, the IRRB has failed to demonstrate that nitrogen control is necessary to protect Lake Winnipeg. IRRB's recommendation that TN reduction is necessary to protect Lake Winnipeg conflicts with the finding of several recent peer-reviewed studies demonstrating that TN reduction is not necessary to protect the Great Lakes from excessive algal growth. Based on the information presented by the IRRB and IJC, it is not apparent why such reduction is required for Lake Winnipeg and no cite-specific information has been presented showing that nitrogen control, in addition to phosphorus control, is necessary to restore acceptable algal biomass and assemblages to the lake. Therefore, unless the public is presented with clear studies, based on conditions in Lake Winnipeg, confirming that TN reduction is required to ensure algal levels decrease, this part of the proposal should be withdrawn. In addition, the IRRB has failed to demonstrate that the proposed concentration objectives for total nitrogen and phosphorus in the Red River are

[1] *See* Memorandum, *The 1909 Boundary Waters Treaty and MPCA staff Recommendations For Total Phosphorus Effluent Limits For NPDES/SDS Dischargers in the Red River Basin" To: Lisa Thorvig et al., From: Steve Weiss and Denise Oakes* (December 4, 2012)*;* Memorandum, *A revised Approach for Implementing Total Phosphorus Effluent Limits in the Red River Basin, Minnesota*, p.2 (MPCA, March 27, 2014)

necessary. If the proposed concentration objectives for total nitrogen and phosphorus and the load target for total nitrogen are adopted and implemented, it will lead to unnecessarily costly regulatory requirements for the cities—especially with respect to total nitrogen.

Based on our review of the technical information made publicly available by the IJC we opine and recommend the following:

(1) The proposed total phosphorus load target for the Red River, developed to prevent and mitigate excessive algal biomass and harmful algal blooms in Lake Winnipeg, is reasonable and scientifically defensible. Further, it is our opinion that the total phosphorus load target is the only proposal under consideration by the IJC that is actually *necessary* to protect Lake Winnipeg. We recommend that the IJC accept this recommendation.

(2) The proposed concentration objective and load target for TN are not scientifically defensible, are inconsistent with and more restrictive than Minnesota's adopted and USEPA approved River Eutrophication Standards applicable to the Red River and are not necessary to protect Lake Winnipeg. Further, the proposed total nitrogen recommendations are inconsistent with recent peer-reviewed literature evaluating the Great Lakes. We recommend that the IJC withdraw these recommendations unless and until the critical scientific deficiencies identified by Hall & Associates and Dr. Steven Chapra are substantively addressed.

(3) The proposed total phosphorus concentration objective for the Red River is not scientifically defensible, is inconsistent with and more restrictive than Minnesota's adopted and USEPA approved River Eutrophication Standards and is not necessary to protect Lake Winnipeg. We recommend that the IJC withdraw this recommendation unless and until the critical scientific deficiencies identified by Hall & Associates and Dr. Steven Chapra are substantively addressed.

Background

The technical basis for the proposed nutrient concentration objectives at issue is a report entitled, The Development of a Stressor-Response Model for the Red River of the North, RESPEC, June 2016 (RESPEC Report).[2] The Cities were never formally notified about the completion of this report. However, via their independent inquiry, they became aware of the RESPEC Report and proposed concentration objectives in 2018. In July of 2018 the Cities submitted technical comments prepared by Hall & Associates evaluating the technical basis for the proposed concentration objectives to the IRRB.[3] The comments noted numerous deficiencies demonstrating that the proposed nutrient concentration targets were not scientifically defensible

[2] The Development of a Stressor-Response Model for the Red River of the North. TopicalReport.RSI-2611, RESPEC, June 2016.

[3] Review of: The Development of a Stressor-Response Model for the Red River of the North, RESPEC, by Hall & Associates, June 4, 2018 ("Hall & Associates Review of RESPEC Report").

and requested that they be peer reviewed via public process consistent with Minnesota Law or withdrawn by the IRRB.

In response to the comments contained in the Hall & Associates review of the RESPEC Report, the IJC requested that Dr. Walter Dodds and Dr. Helen Baulch conduct a peer review of the RESPEC Report with specific attention to the concerns raised by Hall & Associates. These authors reviewed the documents and prepared an evaluation titled "Consensus report for the International Joint Commission on RESPEC 2016 Report", March 8, 2019, ("Consensus Report"). The Cities were not given an opportunity to provide feedback on the charge questions or the selection of the peer reviewers. This peer review resulted in the Consensus Report, which fully supported the proposed nutrient endpoints after acknowledging numerous problems with the original report. [4]

The Cities received a copy of the Consensus Report on September 26, 2019 although it had been completed in March, 2019. However, it is our understanding the IRRB met in Gimli, Manitoba, on September 10-11, 2019, with no notice to the Cities and elected to forward the proposed nutrient targets to the IJC for consideration—before the Cities were given an opportunity to review and respond to the Consensus Report. The Cities submitted a request for a hearing to the IJC related to the proposed nutrient concentration objectives on October 16, 2019.

The Cities then asked Dr. Stephen Chapra, a nationally recognized expert in stressor-response modeling and a distinguished researcher who has assisted the IJC over the past 40 years, to review the RESPEC report and the analysis provided by Hall & Associates to provide his expert opinion about the scientific defensibility of the proposed concentration objectives. Dr. Chapra concluded that the proposed nutrient concentration targets for the Red River were not based on sound science.[5]

The Cities subsequently became aware of proposed nutrient concentration targets for Lake Winnipeg and corresponding nutrient loading targets for the Red River in January 2020, when the IJC granted and issued a public notice for the hearing requested by the Cities. The public notice included a report entitled Proposed Nutrient Concentration Objectives and Loading Targets for the Red River at the US/Canada Boundary, IRRB, September 2019 (IRRB Report). The IRRB Report was a summary proposal and did not contain specific information regarding how the Lake Winnipeg nutrient concentration objectives and loading targets were developed. We have been able to glean the basis for the proposed TP load reductions, based on the TP concentration objectives for Lake Winnipeg, from hyperlinks contained within the September 2019 report (revised November 25, 2019).

However, as noted above, additional information is necessary to understand the basis for the TN concentration objective and load targets. The existing information made available by the IJC does not indicate that TN reduction is required to ensure significant algal growth reduction in

[4] Consensus report for the International Joint Commission on RESPEC 2016 (Dodds & Baulch, March 2019).
[5] Letter from Dr. Chapra, Scientific opinion on proposed numeric nutrient targets for the Red River proposed by the International Red River Board, IJC Reference 81R (Dec. 6, 2019) ("Chapra Analysis").

Lake Winnipeg. The relevant studies all state that excessive TP loading is causing the problem and TN regulation is presented as an afterthought or speculation that such reduction might be needed (e.g., as a nutrient ratio based on the TP criteria identified).

The comments presented below summarize our significant concerns with the Red River nutrient concentration objectives, as previously submitted, and includes a more detailed response to the assessment presented in the Consensus Report. We are also providing comments on the IRRB Report, based on the various information presented in the report and the attached supporting information, outlining our concerns regarding the proposed TN load objectives proposed for Lake Winnipeg.

Comments on the Proposed Nutrient Concentration Objectives and Loading Targets for the Red River at the US/Canada Boundary

1. Summary of Scientific Concerns with Red River Objectives

Nutrient concentration objectives for the Red River of the North were originally developed in the June 2016 report by RESPEC (The Development of a Stressor-Response Model for the Red River of the North). This report was the subject of comments by Hall & Associates (July 11, 2018) and a peer-review style report by Dodds and Baulch (March 8, 2019) Finally, Dr. Steven Chapra reviewed all these documents and provided his own independent assessment. (December 6, 2019). Hall & Associates provided additional comments to the IJC, via a PowerPoint Presentation, during the Public Comment meeting on January 16, 2020.

a. Comments on RESPEC Report

Overall, the nutrient concentration objectives contained in the RESPEC Report should be withdrawn as not necessary to protect aquatic life uses in the Red River because the proposed TP and TN criteria are not based on accepted impairment thresholds. The primary technical deficiencies identified by Hall & Associates (July 11, 2018) were:

- The recommended nutrient targets were based on data that do not reflect the conditions in the river using metrics that are not related to designated use attainment. The periphyton data were obtained from glass slides floating near the surface of the river to maximize algal growth because the river is too turbid to allow such growth to occur naturally. These data were then evaluated using algal community metrics (i.e., saprobity, nutrient tolerance, nitrogen uptake metabolism) with no demonstrated relationship to aquatic life use attainment.
- Establishment of a TN target is inconsistent with Minnesota's River Eutrophication Standards and the proposed TN concentration target was developed using metrics that are not related to designated use attainment. The MPCA specifically adopted the RES noting that TN criteria were not necessary to protect designated uses. The specific metric used to characterize desirable periphyton communities, nitrogen uptake metabolism, is not associated with any assessment of use impairment and the RESPEC Report provides no information showing why such communities are "desirable" or what metric value constitutes a threshold for aquatic life use attainment based on "desirable communities".
- The primary assessment metric, periphyton growth, was based on surface mounted samplers that do not reflect the actual growth that occurs in the river. The results of this testing are artificial and cannot be used to predict periphyton growth in the river or the response to changes in nutrient concentration.
- The Report claimed to follow USEPA's stressor-response guidance for developing the proposed nutrient targets. In reality, a stressor-response relationship was not developed, and no impairment thresholds were identified. As a consequence, there is no confidence that the recommended nutrient concentrations will cause a shift to more desirable communities (assuming that is necessary to ensure attainment of aquatic life use).

- Adjacent land use characteristics may be responsible for the observed taxonomic effects. Such a relationship was identified in the RESPEC Report and it was shown to explain more of the variability in response than changes in nutrient concentration. Consequently, nutrient control may have no effect on shifting to more desirable communities.[6]

The proposed objectives merely represent the average concentration observed at three locations *assumed* to possess the most desirable algal communities.[7] However, the RESPEC Report was tasked with developing a stressor-response relationship along a nutrient concentration gradient, but, as noted by Hall & Associates, Dr, Chapra and confirmed by the Consensus Report, no such relationship was developed.[8] Consequently, it is apparent that the proposed TP and TN targets are not demonstrated to be necessary to protect the aquatic life uses of the Red River of the North. They certainly are not required to ensure excessive plant growth does not occur, as it is not occurring under existing ambient conditions.

Contrary to most nutrient criteria adopted by other states, the RESPEC Report did not identify a periphyton or phytoplankton chlorophyll-a endpoint for excessive algal growth.[9] However, all phytoplankton chlorophyll-a concentrations were less than the criterion established by the MPCA for the Red River, and the periphyton data used as the basis for selecting the proposed nutrient targets are associated with chlorophyll-a concentrations nearly an order of magnitude less than that used in states with such criteria. Moreover, the periphyton data were derived for artificial growing conditions that maximize growth. These data, considered collectively, show that the Red River is not suffering adverse effects from nutrients and does not need an independent set of nutrient objectives.[10]

Finally, the recommendation that nitrogen objectives are necessary to protect the Red River is contrary to the historical approach used by the IJC and has not been justified by any scientific analysis showing that such control, in addition to phosphorus control, is necessary.[11]

b. Comments on Consensus Report

The Consensus Report assessed five points: (1) review of the primary issues of concern raised in the Hall & Associates Report, (2) was the stressor-response model developed for the Red River appropriate to address the charge from the Statement of Work (SOW), (3) was the stressor-response model appropriately applied to address the charge from the SOW, (4) was the field study design and data collected appropriate to fill data gaps and address the SOW, and (5) were the statistical methods used applied correctly to address the SOW.[12]

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[6] *See Supra,* ("Hall & Associates Review of RESPEC Report").
[7] *See*, RESPEC Report at 63 (stating "the TP and TN averages for the three sites having the lowest biomass and most desirable communities was 0.15 mg/L and 1.15 mg/L, respectively").
[8] *See* Consensus Report at 8.
[9] *See* Chapra Analysis at 3-4.
[10] *Id.*
[11] TN is not regulated under the Great Lakes Water Quality Agreement. *See generally* Great Lakes Water Quality Agreement, *available at* https://binational.net//wp-content/uploads/2014/05/1094_Canada-USA-GLWQA-_e.pdf.
[12] *See* Consensus Report at 1, 8.

- Initial Concerns

In the October 16, 2019 letter from the Minnesota Cities to the IJC requesting a public hearing on the proposed numeric nutrient targets, several concerns were raised regarding the Consensus Report. These concerns included:

- The objective of the RESPEC Report was to identify biological use impairment thresholds and develop a stressor-response model to determine nutrient criteria necessary to protect those uses. The Consensus Report acknowledged that biological thresholds were not identified and then supported the proposed TP and TN targets because they reflect water quality from "higher quality" areas. This is not a defensible position;
- The Consensus Report supported the derivation of numeric targets for TN, claiming this position is supported in the literature. The assertion that TN control is necessary to protect designated uses is contrary to MPCA's River Eutrophication Standards and the long-standing approach used by the IJC in the Great Lakes which do not require TN control. The specific issue is whether TN reduction is necessary to ensure ecological protection and neither the RESPEC Report nor the Consensus Report made such a demonstration;
- The Consensus Report supported the use of floating periphytometers to characterize periphyton characteristics in the Red River while acknowledging known masking effects of turbidity and TSS on algal responses to nutrients. There was no attempt to demonstrate that the periphytometer results bear any relationship to existing or future potential conditions in the river. If anything, these results show that periphyton growth, as measured by chlorophyll-a concentration, does not cause use impairment even under the most favorable growing conditions.[13]

- Consensus Report Focus on Reference Conditions Inappropriate

The primary concern raised by Hall & Associates was that a threshold for impairment was not identified. Consequently, a stressor-response model relating the impairment metric to increasing nutrient concentration could not be used to identify the nutrient target because no response target was identified. In responding to this comment, the Consensus Report stated:

> Concern was noted by Hall & Associates regarding the use of measures such as saprobity metrics, nutrient tolerance, and nitrogen uptake metabolism group. These metrics are provided in the report, but the establishment of the criteria on page [sic] does not appear to rely on these metrics, instead, it relies on the partial redundancy analysis of taxonomic data averaging the three sites where the strongest and weakest relationships were found -- and using nutrient concentrations at these sites to estimate the nutrient concentrations associated with more desirable communities.[14]

[13] *See* Chapra Analysis at 5, 8.
[14] Consensus Report at 2.

The Statement of Work for the RESPEC Report intended to use a stressor-response relationship and a biological threshold along a stressor (nutrient) gradient to identify the nutrient target necessary to protect the Red River. As noted in the Consensus Report, the RESPEC Report "did not identify specific biological "thresholds" (point 6), rather they found conditions in least impacted areas and used those to recommend criteria."[15] However, as described in the SOW, the intent was to identify a response variable that represents a threshold above which the river is impaired and relate that response variable to a nutrient gradient. The nutrient concentration at which the response variable exceeds the threshold becomes the nutrient target.

The Consensus Report authors seem to be distinguishing between the specific metrics (saprobity, nutrient tolerance, nitrogen uptake metabolism) and "more desirable communities", as though this distinction makes a difference. It does not. If "more desirable communities" is used as the basis for setting the nutrient target, this term must be defined and a value representing a threshold for impairment must be identified if a stressor-response evaluation is used to develop the nutrient target. This was not done. Moreover, it is apparent that the Consensus Report has misinterpreted the intention of the IJC (i.e., use a stressor-response analysis to develop numeric nutrient concentration objectives).

The evaluations presented in the Consensus Report repeatedly refer to "minimally impacted sites" and "reference sites" as the basis for establishing the nutrient targets. The Consensus Report concludes with a list of reference concentrations (See, Table 1) and comments that these reference concentration nutrient targets represent the range for protection of rivers in the region. This reference-site approach does not account for confounding factors and is unrelated to the adverse responses associated with eutrophication (therefore it fails to show that the proposed regulation is necessary).

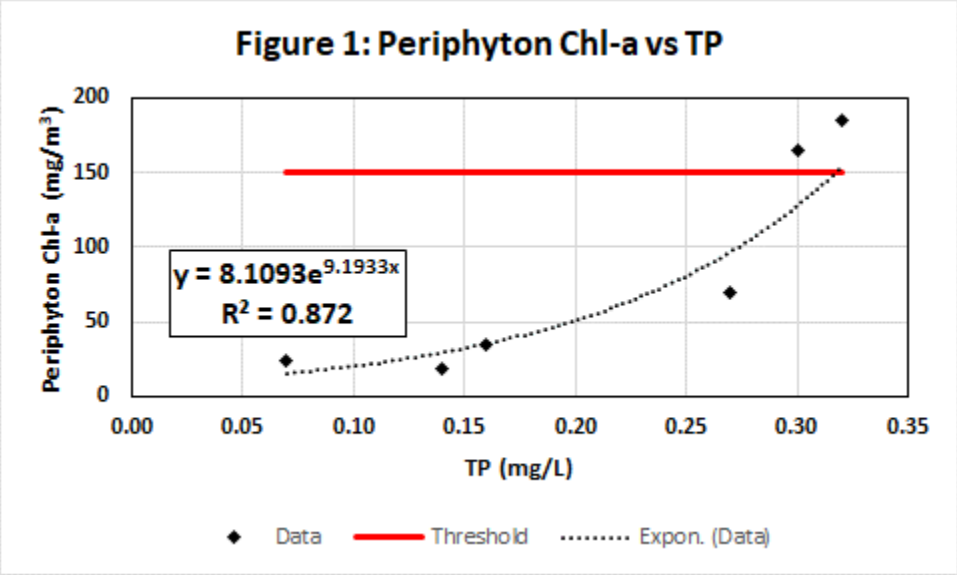
This error is illustrated in the Consensus Report recommendations regarding the use of simple correlations to justify the RESPEC nutrient targets.

> Given the potential statistical problems (or subjectivity) in the original report with determination of reference sites, we took an alternative approach to visually assess the validity of the results of the report. Using data presented on page E1 we explored simple relationships within the TP, TN, and periphyton chlorophyll data. …
>
> We note that interpretation of this plot is sensitive to the TSS threshold applied, with a lower threshold leading to greater linearity. Nonetheless, we conclude the proposed TP criteria (from page 64 of RESPEC) of 0.15 mg TP/L is representative of more desirable conditions based on the lower periphyton chlorophyll a.[16]

The authors of the Consensus Report took data from the surface periphytometers and plotted the data as a simple linear regression. The authors claim that this simple regression supports the proposed TP target because lower periphyton chlorophyll-a is a more desirable condition. This is clearly an erroneous conclusion. The authors equated lower periphyton chlorophyll-a with more

[15] *Id* at 8.
[16] *Id* at 3.

desirable conditions and assumed this represented a threshold of impairment. The more desirable periphyton chlorophyll-a concentration was less than 40 mg/m^2.[17] This is an exceedingly low level of periphyton biomass and is not recognized as a threshold of impairment elsewhere. For example, the State of Montana (Suplee et al. 2009) uses mean periphyton chlorophyll-a levels < 150 mg/m^2 as meeting designated uses. Earlier work in the literature suggests that chlorophyll-a concentrations of 100-150/m^2 represents a benthic algae nuisance threshold (Horner et al. 1983, Welch et al. 1988, etc.). The Minnesota Pollution Control Agency (MPCA) uses a growing season average periphyton chlorophyll-a concentration of 150 mg/m^2.[18] If an impairment threshold was used as the basis for assessing the nutrient target, a significantly higher TP concentration would be identified, assuming that TP concentration caused the observed periphyton chlorophyll-a concentration. (Figure 1). Information presented in the RESPEC Report, and discussed below, suggest that factors other than TP are controlling the observed algal growth.



- Periphyton Data Not Representative of Actual Growth in the Red River

The biological threshold necessary for this analysis is the periphyton chlorophyll-a concentration expected to occur in the Red River, not the concentration that can grow on a glass slide under ideal growing conditions. A review of the published methodologies used by multiple states shows that the use of surface periphytometers is not a method recommended for characterizing algal growth in streams.[19] Virtually all of the methods reviewed discuss the use of natural substrates as the basis for characterizing periphyton growth.

[17] *Id* at 3-5.

[18] Minn. R. 7020.0222, subp.2b. (C).

[19] For example, the procedures recommended by the USGS for periphyton sampling provides "Regardless of which sample types are collected in a particular study, all samples are collected from instream habitats that are present in the reach." USGS. 2002. Open File Report 02-150. Revised Protocols for Sampling Algal, Invertebrate, and Fish Communities as Part of the National Water-Quality Assessment Program at 15. (emphasis added)

In response to comments that the results from the floating periphytometers over-estimated the actual growth of periphyton in the river and cannot be used to assess impairment status, the authors of the Consensus Report provided several conflicting comments without agreeing or disagreeing with the concern. These include the following:

- "numerous shallow solid surfaces occur in the river upon which algae can grow";
- conditions on the slides "may be somewhat different than average conditions in the river";
- "[a]lgae that are in the river colonize the periphytometers, and they are subject to the same forms and concentrations of nutrient that occur throughout the river";
- [periphytometers] are an "excellent measure of the potential for algal growth in the river";
- smooth substrata (i.e., slides) in general "attain lower amounts of chlorophyll than rougher substrata as sloughing is greater and a complex surface gives more area to colonize"; and,
- "many may be more shaded than the periphytometers except in shallow portions."[20]

In contrast to the lack of a definitive statement in the Consensus Report, the RESPEC Report clearly noted "Surface-mounted samplers were expected to provide the greatest opportunity for periphyton growth (i.e., least light limitation), which was important given the general doubt of algal abundance in the river.[21]

- USEPA Stressor-Response Guidance Ignored

In response to the concern raised that the RESPEC Report did not follow USEPA's guidance on conducting stressor-response, The Consensus Report makes several claims.

- "The stressor-response approach is not extremely prescriptive by the EPA, and the approach was followed in general."
- The work did use several response variables that would be reasonable. These include phytoplankton and periphyton biomass and community structure."
- "The low r^2 associated with model fits (0.15 and 0.16) is a concern. However, a simple plotting of the data in appendix E -- (Figure 1 & 2 here) shows the proposed TP and TN criteria from the RESPEC report is a reasonable one."[22]

We note that USEPA's Stressor-Response Guidance is based on a presumption that the stressor-response evaluation is based on a response metric that is directly linked to designated uses and there is a threshold, above which, uses are impaired. [23] As noted earlier, the metric used to develop the proposed nutrient concentration objectives, "more desirable communities", is

[20] Consensus Report at 6-7.
[21] RESPEC Report at 23.
[22] Consensus Report at 7.
[23] Using Stressor-response Relationships to Derive Numeric Nutrient Criteria. USEPA. November 2010. "Variables are selected during this step that represent different concepts shown on the conceptual model, including variables that represent N and P concentrations, variables that represent responses that can be directly linked with designated uses, and variables that can potentially confound estimates of stressor-response relationships, at ix.

undefined, no threshold level was identified, and no stressor-response relationship was developed. The suggestion that simple data plotting, as illustrated above in Figure 1, shows the proposed nutrient criteria are reasonable is overly simplistic and seriously flawed as previously discussed.

- Effects of Adjacent Land Use Characteristics Ignored

In response to a concern that adjacent land use characteristics exert a significant influence on the periphyton metrics and explain the greatest amount of variance in the data, the Consensus Report commented that the authors did not see strong evidence for adjacent land use characteristics driving algal biomass at specific sites.[24] This comment is directly at odds with the findings in the RESPEC Report:

> To increase our understanding of all stressors in the Red River, an additional assessment to discern the effect of land use on the algal community was performed. Constrained ordinations with measures of land-use attributes from the SPARROW model and from subsequent GIS manipulations of the summarized data (Figure 7-13 and Figure 7-18) were included in an attempt to quantify the persistent influence of stressors based on general knowledge of the effect of anthropogenic disturbance drivers in subwatersheds on aquatic communities. Efforts were made to view these stressors in light of potential nutrient sources. Although phytoplankton's explained variance with the land-use ordination was higher than the chemistry analysis (23 percent versus 16 percent), the explained variance in the periphyton communities was appreciatively higher (35 percent versus 15 percent) and both analyses revealed ecologically meaningful correlations. Shown in Figure 7-13 (phytoplankton/land-use RDA diagram), the strong association of the percentage of riparian wetlands with the *x*-axis indicates that the variance in the phytoplankton data between sites was very strongly correlated with this land-use parameter.[25]

The implications of the strong correlation reported in the RESPEC Report goes to the proper application of stressor-response evaluations to developing scientifically defensible numeric criteria for nutrients. USEPA's guidance on the use of stressor-response relationships discusses the need to properly define and account for confounding factors when using this technique.[26] However, because the authors of the Consensus Report characterized the Guidance as "not extremely prescriptive", they dismissed the significance of this requirement. However, without properly accounting for confounding factors that are strongly correlated with the algal metrics, there is limited confidence that controlling for nutrients will achieve the goal of restoring more desirable communities.[27]

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[24] Consensus Report at 7.
[25] RESPEC Report at 61 (emphasis added).
[26] See, USEPA. November 2010, Chapter 5 – Evaluate and Document Analysis.
[27] *See*, SAB Review of Empirical Approaches for Nutrient Criteria Derivation. EPA-SAB-10-006. "[M]ore careful consideration of confounding variables is necessary to maximize the potential for stressor-response relationships to reflect cause and effect between nutrient concentrations and ecological responses." (at xix)

c. Comments Provided by Steven Chapra

The Minnesota Red River cities obtained an opinion from Dr. Steven Chapra on the efficacy of the RESPEC Report, the review prepared by Hall & Associates, and the Consensus Report. Dr. Chapra is an internationally respected researcher who has provided approximately 40 years of consulting services to the International Joint Commission. His December 6, 2019 letter identified the same deficiencies reported by Hall & Associates and concluded that the TP and TN concentration objectives identified for the Red River were not scientifically defensible. He provided the following general observations regarding these reports:

- "No evaluation is presented to identify a threshold for aquatic life use impairment associated with any plant growth metric. . .This is not a scientifically defensible method for deriving numeric nutrient criteria to protect aquatic life uses."[28]
- "The proposed endpoints are not justified because they are not grounded in any demonstrable significant adverse impact from eutrophication or, for that matter, even the existence of a eutrophic condition."[29]
- "These data [periphyton and phytoplankton chlorophyll-a concentrations] suggest that nuisance algal growth is not occurring in this river, even under artificially ideal growing conditions."[30]
- "The RESPEC Report does not contain any demonstration [showing TN control alone is necessary to reduced algal growth] and, therefore cannot serve as a scientifically defensible basis for the recommended TN endpoint."[31]
- "While the use of floating periphytometers may be useful in identifying the forms of periphytic algae that are present in the river and possible maximum growth levels when growing conditions are optimized, these data are not representative of the relative biomass of these species occurring under existing conditions or reasonably expected to occur in the future."[32]

Dr. Chapra also noted that the simplified regression analysis presented in the Consensus Report shows periphyton chlorophyll-a levels are greatly reduced at TP concentrations below 0.15 mg/L and greatly increased at TP concentrations above 0.27 mg/L.[33] Numerous scientific studies have shown that periphyton growth should be unlimited at TP concentrations greater than 0.05 mg/L.[34] The fact that chlorophyll-a levels were very low at TP concentrations up to 0.15 mg/L confirms that other factors are controlling the growth of periphyton on the surface-mounted slides, as observed in the RESPEC Report.

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[28] Chapra Analysis at 3.
[29] *Id* at 4.
[30] *Id.*
[31] *Id* at 5.
[32] *Id* at 6.
[33] Chapra Analysis at 8.
[34] Dodds, one of the authors of the Consensus Report, reported that periphyton can achieve impressive biomass in nutrient poor waters. Dodds. 2006. Limnol. Oceanogr., 51(1, part 2), 2006, 671–680 (at 677).

> The location of the periphytometers at the water surface should have ensured adequate surface light, although the possibility of limited light appeared to remain because no other explanations were apparent to describe the limited algal growth in the presence of abundant nutrients.[35]

This factor was not identified. Without identifying and accounting for these confounding factors, the proposed nutrient targets are unreliable. (See, EPA-SAB-10-006 at 24 - The statistical methods in the Guidance require careful consideration of confounding variables before being used as predictive tools.)

2. Review of International Red River Board – Water Quality Committee Report: Proposed Nutrient Concentration Objectives and Loading Targets for the Red River at the US/Canada Boundary (revised November 25, 2019)

The Proposed Nutrient Concentration Objectives and Loading Targets for the Red River at the US/Canada Boundary (IRRB, September 16, 2019; revised November 25, 2019) included loading targets to protect Lake Winnipeg in addition to the concentration targets specified in the RESPEC Report for the Red River. The Minnesota Red River Cities were not aware of these Lake Winnipeg targets prior to the release of the IRRB proposal. Based on the information presented in the IRRB proposal (at 3), two independent approaches were used to develop the recommendations contained in the report:

- A stressor-response modeling approach to develop recommendations for nutrient concentration objectives for the Red River.
- A "downstream" approach based on the nutrient targets for Lake Winnipeg to develop recommendations for nutrient loading targets.

As discussed in Part 1 of these comments, the TP and TN concentration objectives (developed using stressor-response modeling) have not been shown to be necessary to protect the Red River. Moreover, the concentration targets are inconsistent with the water quality objectives established by the MPCA for limiting algal growth. The downstream TP load approach to protect Lake Winnipeg is appropriate, but some aspects of the recommended approach should be reconsidered, particularly the requirement to control TN.

a. Review of Proposed Nutrient Concentration Objectives and Loading Targets for the Red River.

Our primary concerns with the nutrient concentration objectives have been presented above. Additional concerns are presented below.

[35] RESPEC Report at 50.

- Conclusions Contrary to Minnesota Pollution Control Authority Determinations

  - Water Quality Standards Development

    When the MPCA developed the River Eutrophication Standards (RES), it specifically determined that nitrogen control was not necessary.[36]

  - Determination on Impairment Status for the Red River

    The MPCA has repeatedly determined that, although the Red River exceeded the TP criteria for southern rivers, it is not impaired because the response metrics necessary to confirm impairment (phytoplankton chlorophyll-a concentration, dissolved oxygen swing, BOD_5 concentration) are not exceeded.[37] The proposed nutrient concentration objectives are based on the assumption that the river is impaired for aquatic life uses.

  - Proposed standards more restrictive than existing Minnesota criteria

    The RES are expressed as long term, growing season (June – September) average concentrations for TP, phytoplankton chlorophyll-a, dissolved oxygen swing, and BOD_5 concentration.[38] In developing the stressor-response evaluation presented in the RESPEC Report, only single-point-in-time measurements were made to characterize TP and phytoplankton characteristics. These measurements were taken under conditions expected to maximize the observed conditions and the proposed objectives are specified as seasonal averages for each year.

- Comments on Concentration Objectives versus Loading Targets for the Red River

The Proposed Nutrient Concentration Objectives and Loading Targets for the Red River at the US/Canada Boundary (IRRB, September 16, 2019; revised November 25, 2019) included a TP load target based on TP concentration objectives designed to protect Lake Winnipeg as identified by the paleolimnology studies referenced below. This TP concentration objective for Lake Winnipeg was converted to an annual load and separate allocations were provided for the Red River at the US/Canada border and the other sources entering the Lake. Information presented in the IRRB proposal demonstrates that the TP concentration targets for the Red River based on RESPEC's stressor-response modeling are significantly more restrictive than the TP loading targets proposed to protect the lake. (See IRRB Report, Figure 3 at 10, reproduced below, showing that the hypothetical nutrient loads based on meeting the proposed concentration objectives are significantly lower than the proposed loading target to protect Lake Winnipeg). Thus, the proposed TP concentration objective for the Red River is not necessary to protect Lake Winnipeg (i.e. achieve the proposed TP loading target that was specifically developed to protect Lake Winnipeg).

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[36] Statement of Need and Reasonableness, Eutrophication Standards for Streams, Rivers, Lake Pepin, and Navigational Pools, Book 2, Minnesota Pollution Control Agency, 103, *available at* https://www.pca.state.mn.us/sites/default/files/sonar-book2.pdf.

[37] Minnesota Impaired Waters List, Minnesota Pollution Control Agency, (2020), *available at* https://www.pca.state.mn.us/water/minnesotas-impaired-waters-list.

[38] *See* Minn. R. 7050.0222.

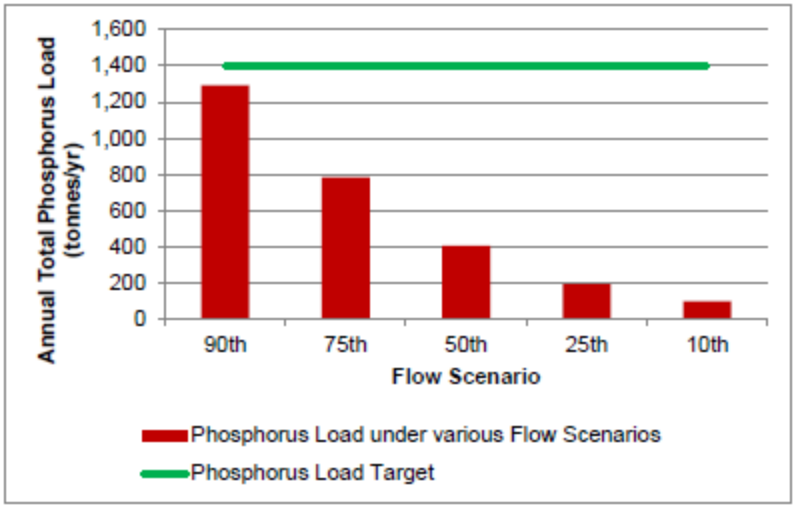

Figure 3. Hypothetical nutrient loads based on meeting the proposed concentration objectives under five flow scenarios at the US/Canada border. Green bar represents loading target necessary to protect Lake Winnipeg.

Moreover, the proposed nutrient loading targets are five-year running average loads while the proposed concentration objectives are expressed as seasonal averages for each year.[39] Taking variability into account, compliance with the proposed concentration objectives on an annual basis will require the five-year running average concentration to be approximately half the proposed load target. Thus, the proposed concentration objective for TP is far in excess of the proposed loading target and is not necessary to protect Lake Winnipeg.

Summary

As discussed above, nutrient concentration objectives for the Red River are not linked to a use impairment threshold in a scientifically defensible manner, they are contrary to the MPCA's determination that the Red River is not impaired by nutrients, and will result in limitations that are much more restrictive than that determined necessary to protect Lake Winnipeg. Therefore, these nutrient concentration objectives should be removed from the IRRB's proposal to protect these waters.

b. Concerns with TN Concentration Objectives and Load Targets for Lake Winnipeg

The IRRB Report indicated that the loading targets for Lake Winnipeg were derived from paleolimnology studies evaluating phytoplankton communities and TP levels observed in the Lake. Based on these studies, it was recommended "that total phosphorus concentrations [in Lake Winnipeg] be reduced back to 1990s levels of 0.05 mg/L to reduce the frequency and severity of cyanobacteria blooms."[40] This approach seems reasonable. However, the report then recommended TN objectives without a determination that TN control was necessary to achieve

[39] *See* IRRB Report at 11-12 – Application.
[40] IRRB Report at 7.

the stated objective. This TN objective is not based on any demonstration of need and is contrary to the long-standing and successful approach for addressing nutrient issues in the Great Lakes.[41]

- Minnesota Does Not Regulate TN

The State of Minnesota's adopted and USEPA approved Lake Eutrophication Standards (LES) establish TP criteria and response criteria for Minnesota lakes.[42] The LES do not establish nitrogen criteria for lakes because the MPCA has independently determined that TN is not a routine stressor that controls algal growth in Minnesota lakes.[43]

- The IJC Does Not Regulate TN in the Great Lakes

Eutrophication control in the Great Lakes has focused on the control of phosphorus loads to these lakes. This program has been very successful in reducing phytoplankton chlorophyll-a concentrations and is proof that TN control is not necessary as an independent requirement in these systems. See, for example, the assessment of long-term trends of nutrients and trophic response variables in the Great Lakes.[44] This study presented data showing that TP control was sufficient to control algal growth, even as TN (primarily as nitrate) concentrations increased.

> It has become clear in hindsight that the management of nitrogen at that time would have been largely futile and wastefully expensive, as the system was clearly phosphorus limited and has become increasingly so as P loadings were reduced (Schelske 2009).
>
> This result has implications beyond the Great Lakes. In recent years, there has been a push to control eutrophication of freshwater systems by simultaneously regulating both phosphorus and nitrogen (e.g., Lewis and Wurtsbaugh 2008; Lewis et al. 2011). As eloquently argued by several experts (e.g., Schindler et al. 2008; Schelske 2009; Schindler and Hecky 2009; Schindler 2012) and supported by our study of the Great Lakes, universally adopting such a strategy for all freshwater systems would be an ineffective and costly strategy for mitigating eutrophication.
>
> (Dove and Chapra 2015 at 717)

- Independent Review by Dr. Chapra States TN Control Not Routinely Necessary

The independent review provided by Dr. Chapra commented on this issue and concluded that "there is no consensus that TN control is necessary in fresh waters, and, if anything, the consensus is that it is not generally a good idea (Schindler et al. 2015). Moreover, while TP control has been shown to effectively limit algal growth in freshwater systems, I am not aware of any demonstration showing TN control is similarly effective or routinely necessary to preclude

[41] *See* Chapra Analysis at 4.
[42] *See* Minn. R. 7050.0222.
[43] Statement of Need and Reasonableness, Eutrophication Standards for Streams, Rivers, Lake Pepin, and Navigational Pools, Book 2, Minnesota Pollution Control Agency, 103, *available at* https://www.pca.state.mn.us/sites/default/files/sonar-book2.pdf.
[44] Dove, Alice and Steven C. Chapra. 2015. Long-term trends of nutrients and trophic response variable for the Great Lakes. Limnol. Oceanogr. 60, 2015: 696 – 721.

excessive algal growth." (Chapra Analysis at 5). Please note that Dove and Chapra 2015 presents data from the Great Lakes showing algal levels have decrease in response to TP control while the TN:TP ratio has increased to levels significantly higher than that recommended in the IRRB Report.

Another report by Schindler [45] reviews the evidence for and against the need for both nitrogen and phosphorus control in lakes to reverse cultural eutrophication. This report cites to the success of "phosphorus-only" control in numerous lakes and identifies three types of errors in scientific recommendations that call for dual control of nitrogen. These errors include (i) the assumption that short experiments where nutrients are added to small bottles or mesocosm cannot be extrapolated to whole ecosystems over long time periods, (ii) conclusions about reversing eutrophication by adding nutrient to water rather than decreasing nutrients, and (iii) flawed assumptions and logic about ecosystem-scale nutrient cycling. Before nitrogen control is recommended by the IJC, the Commission needs to review the basis for this recommendation in light of these specific concerns with the literature supporting the need for nitrogen control.

- Technical Supporting Document Does Not Show TN Control Necessary

The paleolimnology study used as the basis for establishing the TP target in Lake Winnipeg (Bunting et al. 2016) made explicit recommendations concerning the need to reduce TP.

> By assuming Lake Winnipeg has been regulated mainly by the influx of P prior to regime shift ca. 1990, we propose that modern TP content in the south basin (~100 μg P L^{-1}) must be reduced ~five-fold to return the basin to mesotrophic conditions characteristic of the preagricultural era (~15-20 μg P L^{-1}). These targets are consistent with the P optimum of the predominant (60-80% of valves) diatom taxon, *Aulacoseira islandica* (~15.4 μg P L^{-1}), determined using a survey of >100 regional lakes, although we caution that factors other than nutrient influx (e.g., physical mixing, Si, light, etc.) appear to be regulating diatom species composition in the south basin (Fig. 6). Similarly, we recommend that modern TP concentrations be reduced to ~50 μg P L^{-1} (50% decrease) to suppress current outbreaks of diazotrophic cyanobacteria and reduce the present surplus of water column SRP (~50% of TP), yet allow for the high interannual variability in river discharge which regulates nutrient influx to the lake. (at 36-37) (Emphasis added)
>
> Finally, we caution that failure to immediately reduce P influx may initiate a final transition in lake state from buoyant N_2-fixing *Aphanizomenon* and *Anabaena* to potentially toxic, but low-light adapted cyanobacteria (*Planktothrix*, *Microcystis*, *Cylindrospermopsis*) due to continued pollution with N, as has occurred in the Canadian Prairies (Patoine et al. 2006; Leavitt et al. 2007), Europe (Scheffer et al. 1990; Bunting et al. 2007), China (Paerl and Scott 2010; Xu et al. 2010), and elsewhere. (at 37) (Emphasis added)

[45] Schindler, D. 2012. The dilemma of controlling cultural eutrophication of lakes. Proc. R. Soc. B (2012) 279, 4322-4333.

Similar recommendations were not made for nitrogen because the determination of water quality targets for nitrogen were outside the scope of the paleolimnoligical studies [46]. While this study noted highly significant correlations between total algal biomass and nitrogen influx for turbid polymictic lakes with > 50 µg P/L as bioavailable SRP and there may be substantial benefits to reducing both nitrogen and phosphorus, we note that the selected TP target will reduce the SRP well below the threshold upon which the nitrogen reduction recommendation was based.

The total nitrogen objective of 0.75 mg/L was derived to preserve a 15:1 nitrogen to phosphorus ratio. (Environment and Climate Change Canada. 2018). The need to preserve this ratio is contradicted by the specific data collected by Dove and Chapra (2015) for the Great Lakes and the review by Schindler (2012). Moreover, if the conditions prevalent in the 1990s serve as the basis for nutrient regulation in Lake Winnipeg, as recommended in the IRRB Report, the N:P ratio at that time should also be preserved if shown to be necessary. The Modeling Report noted that from 1992 to 1994, annual mean N:P for the south basin and north basin ranged from 22:1 to 35:1 and 34:1 to 55:1 respectively. (Modeling Report at 17) These N:P ratios are significantly higher than the proposed ratio.

Summary

As discussed above, TP concentration objectives for Lake Winnipeg were developed to reflect conditions previously seen in the Lake and the proposed load targets were developed consistent with the TP concentration objective for Lake Winnipeg as identified by the paleolimnological studies. This approach seems reasonable. The corresponding concentration and load limits for TN were developed without consideration for actual need and are contrary to Minnesota's approach to addressing eutrophication in lakes and the IJC's approach to addressing eutrophication in the Great Lakes. Moreover, TN control is contrary to specific comments by a recognized expert (Steven Chapra) and is not supported by the underlying science used to support the TP concentration target. Without a specific assessment showing that TN control, in addition to TP control, is necessary to achieve the targets identified for Lake Winnipeg, this IRRB proposal to include a TN concentration objective or load target should be withdrawn.

3. Additional Considerations

The phosphorus load target for the Red River developed to protect Lake Winnipeg suggests that significant load reductions will be necessary to achieve the target concentration in the lake. This will require reductions from both point and non-point sources. We have not seen information showing the relative contributions from these sources, but it would appear from the loading charts presented in the IRRB Report (Figure 7), that point sources represent a small percentage of the overall load. Presuming that this is true, it is not reasonable to impose restrictive concentration or loading limits on these facilities because the cost of treatment is not reasonable for the small overall reduction in load that would be achieved. A primary focus of the Lake Winnipeg restoration project should be a focus on non-point sources. The IRRB should advocate

[46] Manitoba Conservation and Water Stewardship. September 2015. Application of a Water Quality Model to Develop Nutrient Targets for Lake Winnipeg Tributaries at 16. (hereafter, "Modeling Study").

an adaptive management strategy whereby point source dischargers can work with non-point sources to make cost-effective TP load reductions in the system.