Wisconsin River Total Maximum Daily Load
Response to Public Comments on the Technical Scope of Work
February 21, 2014

Overview

This document provides the Wisconsin Department of Natural Resources' (WDNR) response to public comments related to the proposed modeling approach outlined in the Wisconsin River Total Maximum Daily Load (TMDL) Technical Scope of Work (October 2013). Public comments that were received and focused on other aspects of the TMDL (e.g. baseline scenario, site specific criteria, allocations) will be addressed at a later time. The technical scope of work represents the current proposed technical approach that will be used in development of the TMDL and includes watershed response (Soil and Water Assessment Tool), urban response (Source Loading and Management Model for Windows), empirical reservoir (BATHTHUB), and mechanistic reservoir (CE-QUAL-W2) modeling. The public comments, provided primarily by partners participating in the Wisconsin River TMDL technical stakeholder group, were collected through an on-line questionnaire, during two technical stakeholder meetings (November 6th and 13th, 2013), and during an open comment period (November 13, 2013 – December 13, 2013). The Wisconsin River Total Maximum Daily Load Technical Scope of Work document and accompanying presentations can be found at http://dnr.wi.gov/water/tmdls/wisconsin/technical/documents.asp. Some questions submitted to the WDNR could not be answered with complete certainty at this time because the analysis or dataset has not yet been developed. As a result, additional technical memorandums will be provided for public review and comment as specific components of the model (point sources, land management, etc.) are developed.

TMDL Monitoring Comments

1. **How much monitoring will continue in and beyond 2014? Is there a monitoring strategy for the basin beyond 2013?**

   WDNR Response: The tributary, river, and reservoir monitoring that were completed specifically to support the development of the Wisconsin River TMDL began in 2009 and ended in December 2013. Other water quality monitoring efforts such as the WDNR's long term trend sites and the continued monitoring of Fenwood Creek (37 square mile watershed) will continue in the basin to answer specific questions related to water quality assessments at various scales. Monitoring along with other assessments will be an integral part of the TMDL implementation plan. A post-TMDL monitoring effort will determine the effectiveness of the implementation activities associated with the TMDL. WDNR will work in partnership with local interest groups to support monitoring efforts which often provide a wealth of data to supplement WDNR data. All other quality-assured available data in the basin will be considered when looking at the effectiveness of the implementation activities associated with the TMDL.

2. **The lack of monitoring data in the northern quarter of the Wisconsin River Basin is a major concern as the heavily forested portion of the state has the potential to contribute significant background phosphorus levels to the Wisconsin River Basin. How will this be accounted for?**

   WDNR Response: While the in-stream monitoring completed specifically to support the development of the Wisconsin River TMDL (2009 – 2013) did not include water quality monitoring sites above Tomahawk, WI there have been many other monitoring efforts (discharge and water chemistry) above Tomahawk such as WDNR watershed rotation water chemistry monitoring sites that can be used to assess phosphorus concentrations. In 2014 the WDNR will assess all previously collected water chemistry collected above Tomahawk to quantify the phosphorus contribution from the northern portion of the watershed which primarily consists of forested and wetland landcover. A preliminary evaluation of phosphorus data indicates that in addition to the TMDL-specific sampling, approximately 2,500 phosphorus samples were collected in the Wisconsin River watershed above Merrill from 2010 – 2013. In addition, there are nine active flow monitoring stations in this part of the basin which will provide useful information for model development.

3. **The financial limitations of the TMDL process have led to distinct decisions which may jeopardize the sanctity of the monitoring and modeling process. Because of the financial restrictions, the Wisconsin DNR was forced to establish fewer monitoring sites on the river and in reservoirs than would have been their preference. Frequency of sampling was also reduced due to financial restrictions, especially in the reservoirs. The number of monitored parameters also had to be limited due to cost. The lack of sufficient information can negatively impact the validity of the entire project.**

   WDNR Response: The tributary, river, and reservoir monitoring design for the TMDL (2009 – 2013) incorporated 53 daily mean flow sites, 13 water quality sites on the Wisconsin River, 19 water quality tributary sites, and 21 water quality sites within the reservoirs. All water quality sites were sampled semi-monthly. The design also considered the set-up and calibration requirements of the various models used to develop the TMDL. While further monitoring data is always preferred, the monitoring design provided the ability to complete a phosphorus mass balance and support the requirements of each water quality model. It should be noted that in addition to the primary TMDL monitoring design, there are also other sites that have been evaluated in the basin for other projects which may be incorporated into the WDNR's assessment.

Watershed Response Modeling (SWAT) Comments

4. **Will soil phosphorus concentration be evaluated on a smaller scale than county by county?**

   WDNR Response: The SWAT model can incorporate an initial soil phosphorus concentration for all lands throughout the watershed at the subwatershed scale. Soil test phosphorus information at the field, farm, or subwatershed scale is not available to the WDNR due to privacy constraints. The soil phosphorus information provide within nutrient management plans cannot be used for several reasons including availability and privacy concerns. In an effort to use the best available information for the entire watershed, the WDNR will obtain average current soil-test phosphorus data (from agriculturally managed land) from the University of Wisconsin – Madison Soil Testing Laboratories (http://uwlab.soils.wisc.edu/soilsummary/). The laboratory provides annual soil test

summaries per county. If information at a finer scale is available for the entire basin the WDNR will use it.

As recommended during the technical stakeholder meetings, the WDNR will investigate soil phosphorus concentration data from other land cover types such as forests as well as examine the sensitivity of soil phosphorus in the modeled phosphorus budget. If soil test phosphorus for other lands cannot be determined it will be left at the model default value of 5 ppm.

5. What guidelines or criteria will define if the model is producing acceptable results?

WDNR Response: Models are deemed acceptable when they can simulate a set of conditions while meeting a set of statistical criteria. With respect to the SWAT model, the first guideline for producing acceptable results is that the model input parameters are consistent with literature or field measured values. The second guideline is that the SWAT model accurately simulates conditions as defined by measured data including the annual water budget and crop yield, daily discharge, and monthly sediment and phosphorus loads. The accuracy of the calibrated model is measured using statistical metrics of fit. The two metrics used as objective functions will include the coefficient of determination (R^2) and Nash–Sutcliffe simulation efficiency (NSE). Ancillary statistics will be used to validate model calibration, including percent bias (PBIAS) and the ratio of the root mean square error to the standard deviation of the observations (RSR). This statistic evaluation is consistent with the recommendations of Moriasi et al. (2007).[1]

6. How does the SWAT model represent intermittent streams?

WDNR Response: Within the SWAT model the classification of a stream as ephemeral, intermittent, or perennial is a function of the amount of groundwater contribution received by the stream. The WDNR's 1:24,000 hydrography line work[2] (24K hydrography) will serve as the basis for the SWAT model's flow routing. If an intermittent stream reach is defined within the 24K hydrography it will be included in the SWAT model. While there may be other small-scale flow paths within a drainage area, the scale of this watershed assessment does not allow for inclusion of every grass waterway or intermittent streams. Small-scale watershed assessments (30 square miles or less) that will take place during TMDL implementation are likely to include a more detailed assessment of flow pathways.

7. Have the impacts of major rain events been accurately documented from the tributaries?

WDNR Response: An extensive network of 19 tributary monitoring sites that measured daily discharge and semi-monthly water chemistry were incorporated as part of the Wisconsin River TMDL monitoring strategy. The tributary monitoring sites evaluate drainages ranging in size from 26 to 608 square miles in size. The majority of stations actively collected data between 2009 and 2013 which provided sufficient variability in precipitation and subsequent flow regimes.

[1] Moriasi, DN; Arnold, JG; Van Liew, MW; Binger, RL; Harmel, RD and Veith, TL (2007) Model Evaluation Guidelines for Systematic Quantification of Accuracy in Watershed Simulations. Transactions of the ASABE. 50(3): 885-900.
[2] Wisconsin Department of Natural Resources 1:24.000-scale hydrography line work

8. **How are waste water treatment plant effluent streams going to be included in the model?**

   WDNR Response: The simulation of each surface water effluent discharge under current conditions will be defined in the SWAT model as a point source with a specified daily phosphorus load based on the water quality monitoring data submitted as part of the permit. The effluent stream is incorporated directly into the tributary or river flow that the outfall discharges to. The complete description of the how point sources were inventoried and their respective pollutant loads will be provided by the WDNR in a technical memorandum released in 2014.

9. **The use of personal observations to define agricultural land management can be generalized and inaccurate. The use of this data puts the accuracy of the entire model in question.**

   WDNR Response: The methodology used to temporally define agricultural land management in the Wisconsin River Basin is based on an annual spatial variability analysis using the National Agricultural Statistics Service (NASS) cropland data layer, approximately 2,617 county transect survey data points that confirm crop sequence and tillage, dairy producer locations, and other county wide information provided by NASS. The use of professional knowledge from county conservationist, independent agronomists, and agricultural extension agents is one component of the methodology. It should be noted that some agricultural management information such as manure and fertilizer application rates could only come from professional knowledge or county wide estimates. Information provided by individual county land and water conservation staff was corroborated by neighboring counties and other agricultural professionals.

10. **The SWAT model is input data intensive, requiring modelers to make assumptions for categories that are unknown. These assumptions and the potentially inaccurate data may raise the implications on non-point source contributors.**

    WDNR Response: Numeric computer models such as SWAT are inherently simplified versions of the systems they represent; however, when properly developed the models have been shown to represent water quality conditions and support regulatory decision making processes such as TMDLs. Proper development of a model incorporates an accurate conceptualization of the system through data collection, analysis, and calibration of the model output to the measured data improves the model's portrayal of the system. The sensitivity of model output to assumptions will be assessed, and variables to which the model is sensitive will be refined through further research.

11. **The proposed scope of work does not define what values of background phosphorus will be used in developing the model.**

    WDNR Response: Background phosphorus can refer to the phosphorus export from sources such as forests and wetlands as well as contributions such as groundwater. With respect to contributions from wetlands and forested areas, monitoring data within less developed watersheds (those comprised with primarily wetland and forested land cover) can provide an estimate of background phosphorus. In addition, model calibration of mixed land use watersheds will also help quantify the export from forested and wetland land cover.

    The SWAT model incorporates the impact that groundwater inputs have on resultant stream phosphorus concentrations. The WDNR will assess the in-stream phosphorus data collected during base flow periods to estimate the groundwater phosphorus concentrations. Groundwater phosphorus concentrations vary by locality and this heterogeneity will be integrated into the model.

A technical memorandum outlining the analysis will likely be released sometime in 2014. It is proposed that in-stream phosphorus data be examined rather than water supply well data because well data may not be representative of groundwater contributions to stream flow unless the wells are drawing water from aquifers that are contributing to stream flow. Further, the concentration discharged into streams may be less than the concentration in adjacent ground water due to the possibility of biological uptake in stream sediment or other process that may impact phosphorus transport in groundwater.

12. Will the SWAT model include the impact of wetlands as a potential source of phosphorus?

WDNR Response: Yes, wetlands, as spatially defined by the Wisconsin Wetland Inventory, will be modeled within the SWAT model and can be considered both a sink and source of phosphorus. Subbasins with dominant wetland land cover will be compared to measured in-stream water quality to better understand the function of phosphorus export to hydrologic condition. That information will be incorporated into the SWAT model.

13. Will the SWAT model include the impact of cranberry operations?

WDNR Response: The spatial extent of cranberry bogs have been digitized from aerial photography (approximately 21,000 acres and 1.4% of agricultural categorized as agricultural within the watershed) and defined in the SWAT model through the land cover input. Quantifying phosphorus export is difficult as it is tied to which bogs are in production at any given time, the drainage management (closed vs. flow-through) of the bogs and fertilizer application rates. The WDNR is in the process reviewing previous research to assess the impact of cranberry operations on phosphorus export throughout the basin.

14. Will the SWAT model include the impact of tile drainage?

WDNR Response: Yes, the SWAT model is able to account for tile drainage. The spatial extent of drain tiles will be based on several factors including areas where agricultural land intersect poorly drained soils and have a relatively low slope (< 2%). If it is available and does not bias the model, we will also rely on areas of tile drainage identified by county land and water conservation offices.

Urban Response Modeling (WinSLAMM) Comments

15. Please address why models already developed by Municipal Separate Storm Sewer Systems (MS4) urbanized areas are not going to be used or at least reviewed to verify potential difference between the new model developed with this study?

WDNR Response: The models previously developed by MS4s within the Wisconsin River TMDL study area to show compliance with the developed urban area performance standards in NR 151.13(2)(b)(1) have been reviewed by the Wisconsin River TMDL modeling team. These models do not provide the data needed for TMDL development because they do not provide data over the period of record or at the time step needed for the TMDL. Furthermore, the models developed by MS4s only includes areas within their municipal boundaries regulated by NR 151.13(2)(b)(1), whereas the TMDL will include all areas within municipal boundaries. Table 1 below summarizes some of major differences between the models developed by MS4 to show compliance with developed urban area performance standards, and the data needed for TMDL development.

Table 1: MS4 and TMDL Urban Modeling Differences

	MS4 Developed Urban Area Performance Standards Modeling	**TMDL Modeling**
Area Modeled	Areas regulated by NR 151.13(2)(b)(1)	Entire City/Village
Urban Land Use/ Development Conditions	2004	Current
Model Timeframe	1- or 5- years	12-years
Winter Season Loading	No	Yes
Needed Output	Average Annual Load (1981)	Monthly loads (2002-2013)

16. What year was used to determine the boundaries for the urban model areas?

WDNR Response: The TMDL urban model area is comprised of cities and villages, excluding any large, non-urbanized undeveloped areas within city/village limits, and urbanized areas within permitted MS4 townships. WDNR TMDL development team has requested the most recent municipal boundaries from cities and villages that are permitted MS4s. For cities and villages that are permitted MS4s and provide the requested data, the municipal data will be used. For cities and villages that are not permitted MS4s, and for permitted MS4s that do not provide the requested data, the statewide municipal and civil division (MCD) data layer will be used to spatially define municipal limits. According to metadata for the statewide MCD layer, this data was most recently updated in 2013 however this does not mean that data for all municipalities is current as of 2013.

'Urbanized areas' are areas classified as an "urbanized area" by the 2010 Decennial Census. Note that for the purpose of this document, "urbanized area" and "urban model area" are not the same.

17. **I am concerned about the level of detail, or lack thereof, for urbanized areas using the WinSLAMM model. Mostly this pertains to the blanket use of MDRNA land use. Maybe modeling the actual landuses is not going to have much impact, but if there is potential for urbanized areas to be largely the responsible parties (at least financially) it is only fair to model their contributions as accurately as possible.**

    WDNR Response: When the DNR evaluated municipalities for compliance with NR 151 requirements, on a municipal-wide basis during the development of previous TMDLs, the resulting unit load only varied by about 10%., and was consistent with the average annual load predicted in SLAMM by the standard land use file medium density residential no alleys. A similar evaluation was conducted using data reported by permitted MS4s within the Wisconsin TMDL study area. Results of this evaluation are summarized in the Wisconsin River TMDL urban modeling technical presentation (http://dnr.wi.gov/water/tmdls/wisconsin/technical/Presentations/Technical_Stakeholder_Meetings/04_TechMtg_1106_Urban_Modeling.pdf).

18. **WinSLAMM assumptions include that non-permitted municipalities have swale drainage and permitted MS4's are curb/gutter. What is this based on?**

    WDNR Response: Non-permitted municipalities are not classified as "urbanized area", so they are less likely to have curb and gutter, and more likely to have swale drainage. Furthermore, non-urbanized areas are more likely to have lower intensity land use types and thus the lower per acre loading rates predicted by running SLAMM with swale drainage system.

19. **How will the large areas of non-urban within cities and villages be handled in the model?**

    WDNR Response: Large, contiguous areas of non-urbanized undeveloped lands within the city/village limits of permitted MS4s will be removed from the urban model area and added in the SWAT model area. Mapping of areas added to the SWAT model will be made available for public review for a limited period of time prior to the commencement of final SLAMM modeling.

20. **Soils that are X/D should be classified in WinSLAMM as /D, not as X, unless they are drain tiled. Have you contacted municipalities with X/D soils to ask if the soils are drain tiled?**

    WDNR Response: Unless aerial photos show areas of X/D soils that are undeveloped, we presume there is either draintile or fill present, otherwise the land would not be buildable. Therefore, the soil texture assigned to the X/D soil in SLAMM (sand, silt clay) will be is based on the "X" rather than the "D" portion of the hydrologic soil classification. Municipalities concerned that this approach is not accurate within their city/village/town limits may provide the WDNR with a spatially referenced shapefile defining soil texture in areas mapped as X/D. WDNR will review any such submitted maps prior to use in TMDL modeling.

21. **The scope of work referenced the WinSLAMM, version 9 parameter files, but the document also said the WinSLAMM, version 10 model will be used to model the urban areas. It is recommended that the version 10 parameter files be used in conjunction with the WinSLAMM, version 10 model.**

    WDNR Response: Version 10 parameter files will be used in conjunction with the WinSLAMM, version 10.

22. How will snowmelt be simulated in WinSLAMM?

WDNR Response: Snowmelt is not simulated in SLAMM. Rather SLAMM simulates all precipitation as rainfall. Snowmelt is not simulated in most runoff models, and those that do simulate snowmelt are often inaccurate. For this reason, SLAMM modeling done to show compliance MS4 developed urban area performance standards excludes winter season months. However, by law TMDLs cannot ignore winter months, as these months can and do have runoff events from streets and parking. Therefore precipitation in the form of snow will be simulated as rainfall. Since TMDL modeling and allocations are done on a monthly basis and winter will not be the critical loading capacity period driving reductions this is not expected to have a significant impact on the outcome of the TMDL process.

Empirical Response Modeling (BATHTUB) Comments

23. How will the idea of a site specific standard for certain reservoirs be used in the modeling? Is it based on the usability of the water body instead of a water quality standard?

WDNR Response: The current draft site-specific criteria framework for lakes and reservoirs is based in part on the concept of algal response. A site-specific criterion may be appropriate as long as the reservoir maintains the expected biological endpoints. For example, the phosphorus criterion for shallow reservoirs is 40 µg/L. A reservoir could be eligible for a less stringent phosphorus criterion if it was demonstrated that this less stringent value would assure that chlorophyll-a would not exceed 20 µg/L ("nuisance algal bloom") for more than 30% of days during the summer.

24. How will you decide if a particular model is the proper model to be applied? Is this a subjective decision or are objective criteria used?

WDNR Response: Model selection will be based on which models provide the best fit prior to calibration and best professional judgment based on reviews of past application of BATHTUB in the upper Midwest.

25. How will the BATHTUB modeling work with the modeling from the MS4 (stormwater) permittees using WinSLAMM.

WDNR Response: There is one MS4, the city of Mosinee, directly draining into a reservoir where BATHTUB is being applied and that information will be included as part of the external load to the reservoir being simulated (Lake DuBay). Loads from other MS4s will be incorporated into the SWAT model as point sources.

26. Will lake property landowner contributions be evaluated as a source?

WDNR Response: The direct drainage areas around each lake will be assessed with the SWAT model. With respect to contributions from near-shore septic systems, a preliminary examination of the potential loadings from septic systems on the major reservoirs in the system indicates that it is highly unlikely that they are a significant source of phosphorus inputs to those water bodies. This may not be the case for lakes in the system with smaller watersheds, particularly natural lakes in the northern part of the basin. Some of these lakes may require more detailed evaluations and may require site-specific remedies as part of implementation plan development.

27. How will legacy phosphorus in the lakes be accounted for in the model?

WDNR Response: As an empirical model some level of internal loading is implicitly included in BATHTUB. In addition sediment core data is being collected on several of the reservoirs which will allow for the development of independent estimates of the impacts of legacy phosphorus.

28. Will the BATHTUB models be validated if the whole data set is being used for calibration?

WDNR Response: Validation of water quality simulation models is recommended to assess a model's performance. The WDNR will review previously collected reservoir water chemistry data to determine if a sufficient validation dataset exists. If sufficient data are available for a waterbody, some data will be held out for validation. Model calibration is an iterative process and is recommended that the calibrated model be assessed against a separate measured (validation) dataset. For example; the model could be calibrated with 2-3 years of data, and validated with the remainder. If the model did not fit the validation years well when assessed to statistical model evaluation criteria, the model would need to be recalibrated.

29. Please explain why a separate model was chosen for the Big Eau Pleine versus Petenwell. Both are long, narrow sediment sinks.

WDNR Response: Historic monitoring and modeling efforts indicated that BATHTUB would be able to adequately describe phosphorus transport and algal response in the Big Eau Pleine. The additional costs associated with monitoring and modeling needed to implement a more elaborate modeling approach did not appear to be justified.

Mechanistic Response Modeling (CE-QUAL-W2) Comments

30. Has the spatial variability of the cross-sections been accounted?

WDNR Response: Determining the number of layers (vertical) and segments (horizontal) in CE-QUAL-W2 to best represent the spatial variability of Lake Petenwell and Castle Rock will be determined based on local conditions (water depth, current patterns, uniformity of chemistry, etc.) and then modified as part of an iterative model development process. The target resolution of the model's computational matrix will be defined as the resolution where additional nodes will not significantly change model outputs. At this ideal resolution, computational efficiency will be maximized.

31. Will the influence of re-suspension from carp be considered in the model?

WDNR Response: No, CE-QUAL-W2 does not currently have an algorithm for carp-induced mixing of the water column.

32. How confident are we of the Fishing Hot Spots map that was used to develop the model's bathymetry? Has it been field checked?

WDNR Response: The use of the bathymetry provided in the Fishing Hot Spots map has not been validated at this time. The WDNR is currently in the process of obtaining other bathymetry data for comparison to the Fishing Hot Spots map. A technical memorandum outlining the analysis will likely be released sometime in 2014.

33. Is there a possibility that nitrogen may be the limiting factor in the Petenwell / Castle Rock system?

WDNR Response: An initial assessment of the dissolved inorganic phosphate (DIP) and dissolved inorganic nitrogen (DIN) indicate that there are certain occasions when nitrogen may be the limiting factor for certain algal species, particularly in late summer. However, this is likely more a symptom of excessive phosphorus loading to Petenwell and Castle Rock. Although nitrogen may well be limiting growth in these systems during the latter part of the summer, phosphorus enrichment is still almost certainly primarily responsible for the elevated productivity.

34. How will legacy phosphorus in the lakes be accounted for in the model?

WDNR Response: There is a newly coded sediment diagenesis sub-module for CE-QUAL-W2 that can be used if the legacy phosphorus is significant. In addition sediment core data was collected which will allow for the development of independent estimates of the impacts of legacy phosphorus.

35. Is SOD a problem?

WDNR Response: SOD is a process that definitely needs to be considered in the model, but at this time it is not considered a problem. Between the calibration process and having observed SOD data, a reasonable estimate of SOD for the system can be made.