

Agreement No.: BT002
FC: 95706
Amount: \$50,000

Soil and Water Modeling and Monitoring Agreement
between
State of Wisconsin, Department of Natural Resources
and
Science Museum of Minnesota – St. Croix Watershed Research Station

- I. GENERAL INFORMATION:
Grantee/Project Sponsor: Science Museum of Minnesota-St. Croix Watershed Research Station
Project Title: State of the Lake Report
Period Covered by This Agreement: January 1, 2014 – December 31, 2015
- II. AGREEMENT RECIPIENT: Science Museum of Minnesota-St. Croix Watershed Research Station
- III. AUTHORITY: This agreement between the State of Wisconsin Department of Natural Resources (hereinafter referred to as WDNR) and Science Museum of Minnesota-St. Croix Watershed Research Station (hereinafter referred to as SMM) is hereby entered into pursuant to Wis. Stat. s. 29.037
- IV. PURPOSE: The purpose of this agreement is to enable the WDNR to make payments in accord with the St. Croix Crossing Mitigation Package, Soil and Water Modeling and Monitoring MOU.
- V. BACKGROUND: The St. Croix Crossing project involves the construction of a new bridge across the St. Croix River in St. Croix County, Wisconsin. The Supplemental Final EIS (SFEIS) prepared for the project includes a section on bridge mitigation items. Included in this mitigation package is \$400,000 designated for the St. Croix Basin water Resources Planning Team (Basin Team). The purpose of this \$400,000 is to study how the opening of a new bridge between Minnesota and Wisconsin may impact water quality in the St. Croix River. Once mitigation funds became available the Basin Team requested project proposals to decide how to allocate the \$400,000. One of the approved proposals was to secure funding for a State of the Lake Report. This is an agreement between the WDNR and the SMM on how the mitigation dollars will be spent on this project.
- VI. SCOPE: The WDNR will provide the SMM with \$50,000 to fund the costs of salary of a research scientist and printing over a period of two years.

Task 1: Update the flow record for inflows to and outflows from Lake St. Croix and Task 2: Update nutrient mass balance estimates; are to be completed for 2014. Task 3: Conduct comprehensive trends analyses, and Task 4: Assess progress toward the 2020 phosphorus reduction goal; are to be completed for 2015.

An interim report for tasks 1 and 2 will be provided by January 31, 2015. This report is required for the release of the 2015 payment.

In return the SMM and Suzanne Magdalene, Ph.D., or successor, shall complete the projects as described in the Basin Team Project Proposal Form and submit reports to WDNR upon completion of the projects.

Semiannual progress reports, describing completed Tasks 1-4, will be provided to the St. Croix Water Resources Planning Team by July 1 and December 31 of 2014 and 2015. The Final Project Report is to be completed and submitted to WDNR by December 31, 2015.

- VII. PERIOD OF PERFORMANCE: This agreement shall remain in effect until December 31, 2015. The WDNR and the SMM may jointly and periodically evaluate this agreement and, if mutually agreed, will amend the agreement as necessary. Any modifications to this agreement shall become effective upon approval by both parties.

PAYMENT: The Department agrees to provide funding to the Science Museum of MN up to a total \$50,000 for the project. WDNR will encumber \$25,000 on an annual basis over a two year project period in which SMM will be eligible for a \$12,500 advance payment and reimbursement of the remaining funding of \$12,500 upon satisfaction of the deliverables outlined in the Basin Team Project Proposal. Ten percent (\$2,500) of each year's payment will be withheld until State of the Lake Project tasks are completed in full, as specified in the Project Work Plan submitted by Suzanne Magdalene, Ph.D.

- VIII. PARTY REPRESENTATIVES: The representatives of the parties who shall serve as project coordinators and principal contacts for the purposes of this agreement are as follows:

SMM: Dr. Daniel R. Engstrom or his successor
St. Croix Watershed Research Station
16910 152nd Street North
Marine on St. Croix, MN 55047

WDNR: Dan Baumann, P.E., Regional Director
1300 West Clairemont Avenue
Eau Claire, WI 54701

- IX. SPECIAL PROVISIONS:

- A. The SMM agrees that information gathered as a result of the projects will be readily available, as needed, to other entities in St. Croix County operating within the context of the Soil and Water Modeling and Monitoring MOU associated within the St. Croix Crossing SFEIS.

- B. The SMM agrees that failure on its part to abide by the project contract and its stipulations could require a repayment of the mitigation funds.
- C. This agreement does not impose any obligation, financial or otherwise, upon the WDNR in regards to the subsequent operation and/or maintenance of any facilities developed in this project.

X. LIABILITY: The SMM recognizes and understands that it may be responsible for the consequences of its own acts, errors, or omissions and those of its employees, agents, boards, commissions, agencies, officers and representatives, including providing its own defense. To the extent authorized by law, the WDNR shall be responsible for the consequences of its own acts, errors, or omissions and those of its employees, agents, contractors, officers, and representatives and shall be responsible for any losses, claims and liabilities which are attributable to such acts, errors or omissions. It is not the intent of the parties to impose liability beyond that imposed by Wisconsin Statutes. This clause applies only to actions of each party pursuant to this agreement, and does not apply to actions or events that occur outside the scope of this agreement.

By signature the SMM and the WDNR hereby accept all terms and conditions of this agreement without exception, deletion or alteration.

IN WITNESS WHEREOF, the parties hereto have caused this agreement to be executed as of the date therein written.

SMM

WDNR

Eric J. Jolly / (SMM)
(Signature)

Eric J. Jolly, Ph.D., President

5/1/14
(Date)

W. Matt Murney
(Signature)

for Cathy Stepp, Secretary

4/10/14
(Date)

Project Work Plan Stillwater Bridge Mitigation Funding

Project Title: State of the Lake Report

Primary Contact Person: Suzanne Magdalene, Ph.D.

Lead Organization: St. Croix Watershed Research Station, Science Museum of MN

Address: 16910 N. 152nd Street **City, State, Zip:** Marine on St. Croix, MN 55047

Telephone: 651-433-5953 x25 **Email:** smagdalene@smm.org

Project Category:

Education and
Outreach

Modeling

Monitoring

Phosphorus
Reduction Activity

Project Costs:

Grant Request \$50,000

Matching Funds \$120,000

Project Total Cost \$170,000

Executive Summary (100 words or less)

The "State of the Lake Report—Assessing Lake St. Croix" will entail a comprehensive analysis of the ecological status and trends of the lake since 1999. This effort will build upon an existing database that integrates water quality data from several monitoring agencies, while extending seasonal trend analyses of physical, chemical, and biological variables to several tributary and lake sites. With the guidance of the Basin Team's Monitoring and Assessment Committee, the State of the Lake Report will develop and standardize an assessment protocol that will serve as a template for a State of the Basin report.

Excerpt from the Memorandum of Understanding (MOU)

Soil and Water Modeling and Monitoring. Mn/DOT shall pay \$400,000 to the WisDNR to assist the Basin Team in soil and water modeling and monitoring of Lake St. Croix to help develop and implement phosphorus reduction strategies.

Project Relevance to MOU

The proposed project will assess the current water quality conditions or "state" of Lake St. Croix and the progress toward a phosphorus reduction goal set by the St. Croix Basin Water Resources Planning Team (hereafter Basin Team), slated for completion in 2020. The construction design for the Stillwater bridge recognizes the importance of the 20% phosphorus reduction goal; the preliminary bridge design targeted a 19% reduction in phosphorus runoff (Eshenaur 2006), but was later amended to achieve a 23% phosphorus runoff reduction (Zeng 2012). The State of the Lake Report will document the baseline water quality conditions in Lake St. Croix prior to bridge construction, enabling follow-up assessments of the impact of the new bridge crossing on the Lake.

Background

Lake St. Croix (hereafter, the Lake) comprises the lower 25 miles (41 km) of the St. Croix River, forming part of the boundary between Minnesota and Wisconsin. Located at the confluence of the St. Croix River with the Mississippi River (Figure 1), Lake St. Croix serves as the integrator of a drainage area of 7,760 square miles (20,100 km²). Analysis of lake sediment cores (Triplett et al. 2003) indicated the current trend was toward eutrophication of Lake St. Croix unless action was taken to alter that trajectory (Davis 2004). In 2006, agency heads of Wisconsin Department of Natural Resources (WDNR) and Minnesota Pollution Control Agency (MPCA) signed an agreement to reduce phosphorus loading to Lake St. Croix by 100 metric tons per year (a 20% reduction) by 2020. Lake St. Croix was documented to exceed three site-specific water quality standards (clarity, phosphorus, and chlorophyll) and in 2009 was added to Minnesota's 303(d) list of impaired waters for eutrophication due to excess nutrients and chlorophyll. Subsequently, a Lake St. Croix Total Maximum Daily Load (TMDL) and Implementation Plan adopted the 100 tons phosphorus reduction goal (MPCA and WDNR 2012).

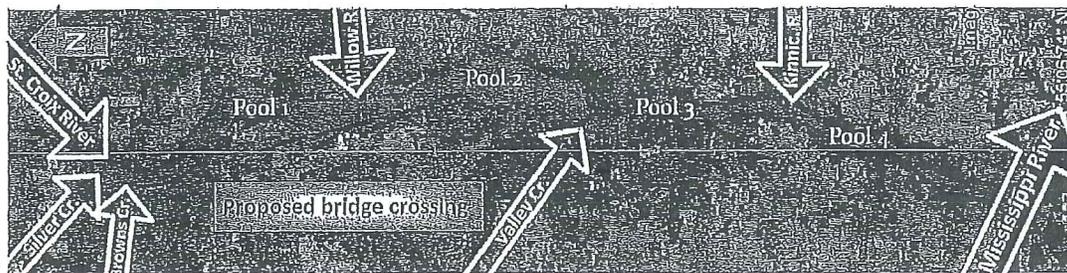


Figure 1. Location of proposed bridge and major surface inflows (white arrows) to Lake St. Croix.

Problem Statement

In the history of water-resources management of the St. Croix Basin, there has been only one assessment project that synthesized data from several major and complementary monitoring efforts; this synthesis was the basis for the 100 metric tons phosphorus reduction goal (Davis 2004). The reduction goal was determined by comparing historical conditions (Triplett et al. 2003) with 1998-1999 monitoring data (Lenz et al. 2003) and future projections from a BATHTUB lake model (Robertson and Lenz 2002). Fifteen years have passed since collection of the data that generated the reduction goal, which is set for 2020, just seven years from now. In addition, nearly ten years have passed since the most recent seasonal Kendall trends were calculated using 1976-2004 water quality data for the St. Croix River at Stillwater and Prescott (Lafrancois et al. 2009).

In addition to the need for a timely follow-up assessment, this project will address issues of improved data quality and increased data availability. Firstly, among the data that were available at the time of the 1999 analyses, key variables have benefitted from improved measurement and

analytical methods; 1) St. Croix River flow at Stillwater and Prescott, and 2) internal nutrient loading to the overlying lake from anoxic bottom waters and sediments. Secondly, at the time of the 1999 analyses many variables had only a single year of data available. Many variables have since been measured over a much longer time frame representing a wider range of hydrologic conditions, notably, 1) the seasonal trends in lake water quality, and 2) annual loads from tributary streams. Direct measurement of variables across a greater range of climate conditions has enabled, not just an understanding of the absolute range of a given variable (a data quality issue), but also of the degree that interactions among variables change depending on hydrologic conditions. Much more data are now available to make an assessment of the interannual range of contributing loading sources and spatial variability of loads within Lake St. Croix. A persistent problem for Lake St. Croix monitoring is that volumes of high quality data are being collected, but without assessment or synthesis across monitoring agencies.

The members of the Basin Team's Monitoring & Assessment (M&A) Committee have placed a high priority on the pursuit of assessment projects, especially those that integrate data across agencies, and they rated a State of the Lake Report among the highest priority proposals for bridge mitigation funding. The relatively small area of Lake St. Croix was chosen by the M&A Committee as an assessment pilot project area, as a precursor for a future goal of basin-wide assessment. During this State of the Lake project, M&A will guide the development of an assessment protocol, such that the selection of water quality variables (e.g., sediments, nutrients, algae) and analytical methods (e.g., loading, trends) will also be applicable to the entire St. Croix Basin.

A relational database that integrates monitoring data from multiple agencies has already been constructed as part of a previous related project (Magdalene et al. 2013). The database, dubbed the St. Croix River Basin Information System (SCRIBIS), contains locational and descriptive site information, and flow and water quality data from 1990 onward. Although the database now contains information on about two dozen sites near and within Lake St. Croix, only two sites have ever had trend analysis conducted on part of their record. This project will conduct trend tests on the complete database, incorporating the trends of multiple variables into an assessment of whether the reduction goal will be achieved by 2020, and if not, when it can be expected to be achieved.

Project Benefits

We anticipate the following benefits from this project:

- This project will track progress toward the phosphorus reduction goal, and assess the likelihood of achieving that goal under a range of low- and high-flow conditions.
- This project will complement on-going monitoring/modeling efforts, including flow monitoring by USGS and Washington Conservation District, lake water quality monitoring by Metropolitan Council Environmental Services (MCES) and National Park

Service, three years loading from Wisconsin tributaries by USGS, and longitudinal modeling of Lake St. Croix ecological functioning by USGS.

- This project will provide an assessment of Lake St. Croix water-quality conditions prior to construction of the new Stillwater bridge, and will better enable a future assessment of development-growth impacts of the bridge.
- The Basin Team and associated partners have initiated several management strategies, including project prioritization (e.g., Top 50 P implementation projects, subwatershed modeling), funding initiatives (e.g., MN legislative appropriation), and community engagement (TMDL civic engagement plan and Basin Team civic governance training). Given the approaching endpoint for the reduction goal, this project will provide guidance for the management question: how intensively do the planned strategies need to be implemented?

Project Goals, Tasks, and Objectives

The goal of this project is to determine the current status and trends of water quality in Lake St. Croix. The project will be divided into four tasks:

Task 1: Update the flow record for inflows to and outflows from Lake St. Croix.

In contrast to flow estimations made for the 1999 assessment, St. Croix River flows are now measured by new United States Geological Survey (USGS) gages at Prescott, WI and Stillwater, MN. The outflow from Lake St. Croix has been measured at the Prescott narrows since 2007, and the inflow to Lake St. Croix has been measured at the Stillwater bridge since 2011. In addition, the flow records at these two sites can now be extended backward in time, with more accurate flow estimations derived from regression relationships between the actual measurements and upstream flow records (St. Croix River at St. Croix Falls, Apple River at Somerset, Willow River at Willow River State Park, and Kinnickinnic River at River Falls). Initial analysis of the Stillwater record resulted in an improved flow estimation method that increased accuracy from 92% to 98% (Pearson's correlation coefficient R^2). Moreover, the old estimation method appears to have been underestimating the volume of base flows and overestimating the volume of peak flows in the St. Croix River at Stillwater (Magdalene et al. 2013). These updates to the official flow record will be published by Ziegeweid and Magdalene (expected 2014). Such systematic errors in historical flow estimates may have propagated into errors in nutrient loading calculations performed on historical water quality data, especially during drier and wetter climate periods. Now that improved flow data are available, the magnitude of errors in historical loading estimates should be reassessed. This task will include the following objectives:

- Apply the updated historical flow estimates to FLUX 32 loading calculations conducted on water quality data.
- Compare previous and updated loading scenarios over a range of flow conditions.
- Determine whether any systematic errors occurred in previous loading calculations.

Task 2: Update nutrient mass balance estimates.

At the time of the 1999 analyses of Lake St. Croix (Robertson and Lenz 2002) only one year of data was available for many variables. Thus there was no way to assess how the ecologic response in the 1999 water year compared to other years, and there was little sense of the ranges in seasonal variability throughout the year. Many variables have since been measured over a much longer time frame representing a wider range of hydrologic conditions. Another outcome of the ongoing monitoring efforts is the emerging evidence of the importance of nitrogen in seasonal algal growth dynamics (Magdalene et al. 2013); In addition, we are beginning to understand the interactions among variables that depend on hydrologic conditions--that is, how the constellation of ecological variables change as the overall flow conditions increase or decrease. This project will move the assessment of sediment and nutrient mass balance in Lake St. Croix, from a single summer season (Robertson and Lenz 2002) to a range of annual mass balances, and toward the range of seasonal (monthly) mass balances. The aim is to predict the Lake's ecological response to low- or high-flow conditions, for any month of the year. This task will include the following objectives:

- Identify annual periods of mass balance data (e.g, expect 2005-2013).
- Calculate the range of annual loads for low- and high-flow conditions.
- Calculate the range of monthly loads for low- and high-flow conditions.

Task 3: Conduct comprehensive trends analyses.

Most ecological variables change gradually in response to large-scale drivers such as land use or climate, such that a minimum of ten years of monitoring is needed to determine a trend with statistical significance. Thus far, the only assessment of trend data in Lake St. Croix was conducted on 1976-2004 water quality data for river monitoring sites at Stillwater, MN and Prescott, WI. Many ecological variables have since been measured at many more sites in Lake St. Croix over a much longer time frame representing a wider range of hydrologic conditions. Far more data are now available to make an assessment of the interannual range of variables, and to identify long-term trends via trend-testing methods. This task will include the following objectives:

- Calculate 1999-2013 seasonal Kendall trends on nutrient concentrations and loads contributing to the Lake.
- Conduct trend analysis using QWTrends, which can account for trends in flow and seasonality, on concentrations and loads of waters contributing to Lake St. Croix.
- Compare short-term (1999-2013) trends with long-term (1976-2004) trends (Lafrancois et al. 2009).

Task 4: Assess progress toward the 2020 phosphorus reduction goal.

The phosphorus reduction goal is set for just seven years from now. This project will assess whether achieving the goal is feasible. This task will include the following objectives:

- Compare annual phosphorus mass balances for dry/wet years with the 360 metric tons annual loading goal.

- Using the trend analyses, estimate the probable year that the phosphorus reduction goal will be achieved.

Project Deliverables and Products

This project will include the following deliverables and products:

- **Executive Summary and Fact Sheet**
These documents will be written in a style so as to be accessible by decision-makers and the interested public.
- **Detailed Report**
The “State of the Lake Report—Assessing Lake St. Croix” will entail a comprehensive analysis of the ecological status and trends of the lake since 1999.
- **Relational Database**
This resource will eventually be accessible online via a central web portal that provides access to land and water information for the entire St. Croix Basin. The St. Croix River Association is currently in the planning stages for hosting such a portal.

Project Timeline

Project Task	2014				2015			
Task 1: Flow Record (25%)	■	■						
Task 2: Mass Balances (25%)			■	■				
Task 3: Trend Analyses (25%)					■	■		
Task 4: Assess Progress (25%)							■	■

Project Billables

The Science Museum of Minnesota is requesting \$50,000 over two years to cover the costs of salary of a research scientist and printing.

Source of matching funds: \$60,000 from MCES (cost of Lake St. Croix monitoring starting May 2013) and \$60,000 from NPS (cost of Lake St. Croix monitoring starting May 2007).

References

- Davis 2004. St. Croix Basin phosphorus-based water quality goals. St. Croix Basin Water Resource Planning Team, 33pp. <http://www.pca.state.mn.us/index.php/view-document.html?gid=9978>
- Eshenaur, WC. 2006. St. Croix River Crossing water resources preliminary design. SRF Consulting Group, Inc. 51 pp. <http://bit.ly/1aiekVP>
- Lafrancois, BM, Magdalene, S, and Johnson, DK. 2009. Recent water quality trends and a comparison to sediment-core records for two riverine lakes of the Upper Mississippi River basin: Lake St. Croix and Lake Pepin. *Journal of Paleolimnology* 41: 603-622.
- Lenz, BN, Robertson, DM, Fallon, JD, Ferrin, R. 2003. Nutrient and suspended-sediment concentrations and loads, and benthic invertebrate data for tributaries to the St. Croix River, Wisconsin and Minnesota, 1997-1999. U.S. Geological Survey Water-Resources Investigations Report 01-4162, 63 pp.
- Magdalene, S, Ziegeweid, JR, Kiesling, R, Johnson, DK, Engstrom, DR, Hansen, DS. 2013. Final Project Report: Lake St. Croix nutrient loading and ecological health assessment. <http://bit.ly/1iASWjK>
- MPCA and WDNR 2012. Lake St. Croix nutrient total maximum daily load. TMDL report, 101 pp. <http://www.pca.state.mn.us/index.php/view-document.html?gid=18417>
- Robertson, DM, and Lenz, BN. 2002. Response of the St. Croix River pools, Wisconsin and Minnesota, to various phosphorus-loading scenarios. U.S. Geological Survey Water-Resources Investigations Report 02-4181, 36 pp.
- Triplett, L, Edlund, M, and Engstrom, DR. 2003. A whole-basin reconstruction of sediment and phosphorus loading to Lake St. Croix. Final Report to Metropolitan Council Environmental Services. 49 pp.
- Zeng 2012. Amendment to the 2006 St. Croix River Crossing water resources preliminary design, Minnesota Department of Transportation and Wisconsin Department of Transportation. 114 pp. <http://bit.ly/1hA5SsE>