Environment and Natural Resources Trust Fund (ENRTF) M.L. 2014 Work Plan

Date of Report: 15 January 2014

Date of Next Status Update Report: 31 January 2015

Date of Work Plan Approval:

Project Completion Date: 30 June 2017

Does this submission include an amendment request? _No_

PROJECT TITLE: **Watershed-Scale Monitoring of Long-Term Best-Management Practice Effectiveness**

Project Manager: Daniel R. Engstrom

Organization: St. Croix Watershed Research Station
Science Museum of Minnesota

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Location: Statewide

Total ENRTF Project Budget:		
	ENRTF Appropriation:	**$ 900,000**
	Amount Spent:	**$ 0**
	Balance:	**$ 900,000**

Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 03g

Appropriation Language:
$900,000 the second year is from the trust fund to the Science Museum of Minnesota for the St. Croix Watershed Research Station to evaluate the effectiveness of best management practices in reducing sediment and nutrient loads at watershed scales over long time periods. This appropriation is available until June 30, 2017, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Watershed-Scale Monitoring of Long-Term Best-Management Practice Effectiveness

II. PROJECT STATEMENT:

Minnesota has widespread water-quality impairments due to nonpoint-source (NPS) pollution generated by agricultural, urban, and other human-altered lands. Mitigation of these impairments requires implementing best-management practices (BMPs) that are designed to limit soil erosion and nutrient transport from lands to receiving waters. Long-term data sets of water quality and land-use history are needed to tease apart the many factors that impact water quality. In particular, data sets that span periods before and after BMP implementation are needed to determine BMP effectiveness. However, such data sets are lacking, because water-quality monitoring of our lakes and rivers did not begin until well after humans altered the landscape. In this project, we will fill this data gap by constructing long-term water-quality records as preserved in lake sediments.

We will select five to ten lake basins in Minnesota for a detailed assessment of whole watershed loads of sediment and nutrients, as determined from multiple sediment cores collected from each lake. Our team of scientists will apply a comprehensive suite of proven analytical tools such as radioisotopic dating, sediment fingerprinting, algal analysis, and diatom reconstruction to determine the changes in pollutant loading over long periods of time, most critically before and after BMP implementation. In addition, our lab will bring a new capability to Minnesota by establishing the Center for Harmful Algal Research in Minnesota. The CHARM lab will use a specialized (inverted) microscope to identify algae in current noxious blooms and to develop novel techniques to document these blooms over time in the sediment record.

The chronology of these loads and blooms as determined from the sediment record will be compared against the history of land use and BMP implementation in each basin to search for statistical correlations. Finally, watershed computer models will be fit to these basins as constrained by the long-term data extracted from the sediment-core records, thereby both testing and improving the models. The benefits include development of critical long-term data sets, a test of BMP effectiveness at the watershed scale, and improvement of modeling tools to make results more realistic and predictive. These results will be transmitted to state and local resource managers in a series of workshops in the Twin Cities and in each study watershed. Fact sheets specific to each watershed will provide concise, easily understood results for local managers. The long-term data sets will greatly enhance the value of existing watershed monitoring in the state by providing temporal context, without which the current records are unanchored relative to natural, pre-industrial conditions.

III. PROJECT STATUS UPDATES:

Project Status as of 31 December 2014:

Project Status as of 30 June 2015:

Project Status as of 31 December 2015:

Project Status as of 30 June 2016:

Project Status as of 31 December 2016:

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Select new sites, characterize watersheds, & document BMP histories

Description: A careful selection of study sites will be critical to the success of this research effort. Each selected watershed will encompass a *principal* lake that receives runoff (and likely also groundwater and tile flow when present) that delivers loads of sediment and nutrients to the lake. The watershed may also contain *subsidiary* lakes or ponds where additional information may be gathered regarding effects of local practices or issues of scale. Our selection strategy will focus on sites representing a range of land-use change and BMP implementation, and those sites likely to possess high-quality sediment records. To help in this regard, we will sift through the SCWRS state-wide archive of over 100 radiometrically dated lake-sediment cores to identify trends in siliciclastic sediment accumulation rates, and thus erosion rates, over the last century. Watershed-scale erosion rates will be statistically summarized by ecoregion or other selected data subsets to provide a foundation for selecting representative sites for the detailed analyses to follow. We will also meet with state agency and university personnel involved with current monitoring, modeling, and benchmark-site programs (e.g., the sentinel lake and watershed projects) to consider sites where efforts may be synergistic. Armed with this background and depending on watershed size and complexity, we will select five to ten lake watersheds for detailed study.

For selected watersheds, geographic data will be compiled and summarized. These data sets will be key for Activity 3 where they will be used for correlation to long-term sediment-core data and for input to the watershed models. Hydrographic and topographic data sets are readily available. Hydrologically conditioned DEMs (based on 10-m grids or LiDAR if available) will be used to generate flow-length grids (distance between the grid cell and receiving water), thereby providing a measure of hydrologic proximity useful for weighting BMP impact. Soils data will be obtained from the SSURGO database. The more difficult data to compile will be land-use and BMP histories. Recent land cover is available as spatially referenced data sets (i.e., GIS layers) based on satellite imagery, namely the National Land Cover Dataset (NLCD) and U.S. Department of Agriculture Crop Data Layer (CDL) dataset. Because these spatial data sets are not entirely comparable to each other and because they begin in about 1992, we will use tabular data from the USDA to enforce consistency for cropland areas and to extend the data back to the early 1900s. Land-use practices on agricultural lands will be assessed from a variety of sources, including tillage transect data and local information from county soil and water conservation district (SWCD) offices, statewide databases tracking BMP implementation (e.g., BWSR e-link conservation database), and federal data on conservation practices and land retirement. Data generated for the Conservation Effects Assessment Project (CEAP) will be queried to the degree available. We already possess snapshots of land polygons in the Conservation Reserve Program (CRP) in Minnesota for the 1990s and 2000s. Land-cover, land-use, and BMP histories will be aggregated into time slices corresponding to those available in the sediment core records, probably decadal resolution back to about 1930 and multi-decadal prior to that.

Summary Budget Information for Activity 1: **ENRTF Budget: $ 140,000**
Amount Spent: $ 0
Balance: $ 140,000

Activity Completion Date:

Outcome	**Completion Date**	**Budget**
1. Analyze existing data for 100+ lakes in SCWRS database; select 5-10 lake watersheds for complete analyses during this project	Jun 2015	$ 38,500
2. Compile geographic, climatic, land-use, and BMP data for selected watersheds	Dec 2015	$ 101,500

Activity Status as of 31 December 2014:

Activity Status as of 30 June 2015:

Activity Status as of 31 December 2015:

Activity Status as of 30 June 2016:

Activity Status as of 31 December 2016:

Final Report Summary:

ACTIVITY 2: Collect and analyze lake-sediment cores

Description: A main objective of lake-sediment collection and analysis is to measure the total amount of fine-grained sediment and nutrients trapped by each principal lake and to determine the timing (chronology) of when this occurred. Only by knowing the total amounts (and not just relative changes over time) can the loads be quantitatively related to whole-watershed erosion and nutrient loss rates from the surrounding landscape. Multiple sediment cores from different points in each lake are the most reliable method to measure whole-lake accumulation, so we will collect three to eight cores from each principal lake, depending on the complexity of the lake morphometry. In addition, should subsidiary lakes or ponds be present elsewhere within the watershed of a principal lake, sediment cores will be collected from a subset of these lakes to help resolve issues of transport and scale.

Not all cores will receive equal treatment. Central, primary cores from each principal lake will be analyzed for all the analyses listed below. Secondary cores from more peripheral parts of each principal lake will be analyzed for a reduced set (major sediment components and nutrients) and dated as necessary to achieve a correlative chronology with the primary core. Tertiary cores will be taken and interpreted in the field to identify the depositional area within each lake, with lab analysis limited to simple sediment content at most. Cores from subsidiary lakes will be treated as secondary cores with a subset of analyses selected specific to that watershed, depending on the question they are helping to answer. Considering all primary, secondary, and tertiary cores from both principal and subsidiary lakes, we expect to collect a total of 50-60 cores.

To obtain the sediment chronology, cores will be radiometrically dated by ^{210}Pb methods, supplemented as needed by identifying the 1963 ^{137}Cs peak that is remnant from the atmospheric testing of nuclear bombs. Based on typical sediment accumulation rates in Minnesota lakes, it should be possible to obtain reliable dates back to the mid to early 1800s in all lakes. Dating resolution will be roughly decadal. Older material in selected lakes will be dated by ^{14}C to assess natural background sediment accumulation rates.

Sediment cores will be analyzed for a suite of components to assess the loads of sediment and nutrients, as a reflection of the water quality of the runoff (and other hydrologic components) reaching the lake. Loss on ignition analysis will determine organic, carbonate, and siliciclastic (eroded soil) components. Surface-fallout radioisotopes (^{210}Pb, ^{137}Cs, and ^{10}Be) will be used to fingerprint the sediment according to its origin, namely, a mixture of field and non-field sources. Phosphorus content (both total and extractable fractions) of the sediment will determine apparent loads of this essential nutrient. In concert with sediment phosphorus, lake-water phosphorus content over time will be estimated by analysis of the remains of diatoms, a group of algae with certain species that are diagnostic of phosphorus content the water in which they live. General algal productivity will be assessed by the accumulation of biogenic silica, which is largely composed of the glass cell walls of these diatoms. Fossil pigments will also be analyzed, which can diagnose presence of blue-green algae, generally considered indicative of noxious conditions.

A new addition to our toolbox will be the analysis of soft-body subfossil algal remains in sediment. This analysis requires a distinctive type of microscope, an “inverted” microscope, to allow identification of algal parts that have settled in a shallow well in specialized slides. The same equipment and procedure can also be used on fresh samples of algae as well, giving our lab the capability of providing community analysis of existing algal blooms.

With the acquisition of this new microscope, we expect our lab to become a resource for agencies and other institutions needing to identify the species composition of noxious algal blooms. We have named this resource the CHARM lab—the Center for Harmful Algae Research in Minnesota.

Summary Budget Information for Activity 2: **ENRTF Budget: $ 411,000**
Amount Spent: $ 0
Balance: $ 411,000

Activity Completion Date:

Outcome	**Completion Date**	**Budget**
1. Collect and analyze 3-8 sediment cores per lake	Sep 2016	$ 363,000
2. Establish Center for Harmful Algae Research in Minnesota (CHARM lab)	Jun 2015	$ 48,000

Activity Status as of 31 December 2014:

Activity Status as of 30 June 2015:

Activity Status as of 31 December 2015:

Activity Status as of 30 June 2016:

Activity Status as of 31 December 2016:

Final Report Summary:

ACTIVITY 3: Quantify BMP effectiveness by linking land to water with statistical analyses and modeling
Description: The first step in statistical data analysis will be to search for trends in the water-quality records as inferred from lake-sediment analysis. In particular, we seek to test the working hypothesis that the peak in water-quality degradation occurred in the mid- to late-20th century as a consequence of poor farming practices, and that water quality has improved as farming practices have become more conservation-minded. What pattern is evident in the lake-sediment core records of water quality? Differences among time periods will be assessed by common non-parametric tests (Mann-Whitney or Kruskal-Wallace tests). Or, where appropriate, trends tests will be applied to assess change over time and rate of change. The second data analysis step will seek correlations between changes in water quality and changes in land use and BMP implementation. Do changes in water quality occur at the same time as those on the land, or are there lags in the response? Are there compensating factors that mutually mask the effect of the other? Distinguishing among the multiple possible factors will require careful analysis of (a) chemical or radioisotopic signatures that bear fingerprints of their sources, and (b) timing and magnitude of changes.

Because correlation is not causation, we will model watershed processes in order to assess whether purported correlations are mechanistically realistic. In this project, we plan to constrain the model to not only present-day data, but to past data as well as reconstructed from the sediment cores. We will use the Soil and Water Assessment Tool (SWAT), a watershed modeling program developed by the Agricultural Research Service (ARS) of the U.S. Department of Agriculture (USDA). Model construction requires inputs of hydrography, topography, soils, land cover, and agricultural management practices, all of which will be compiled during Activity 1 above. For each study watershed, a SWAT model will be calibrated to the recent land-use and climate conditions, probably a 2000-2010 average condition. In particular, the model will be constrained to match the sediment and phosphorus loads inferred from the sediment core data for this recent time period. Then, the model will be tested by its ability to simulate loads of sediment and phosphorus for selected periods in the past. Model parameters will be adjusted to past conditions first by altering land cover, then management practices, to allow assessment of model sensitivity to these factors independently. Finally, the model will be run with a land cover of native vegetation to match pre-euroamerican loads inferred from the sediment core, which will provide a bracketing end member of model results that should help constrain certain model parameters to account for inherent landscape features (i.e., topographic complexities) whose effects might otherwise be confounded by human impacts. These models, constrained to past conditions by the sediment-core data, will help explain relative differences in apparent BMP effectiveness driven by differences in soils, topography, and climate among the study watersheds.

Summary Budget Information for Activity 3: **ENRTF Budget: $ 297,000**
Amount Spent: $ 0
Balance: $ 297,000

Activity Completion Date:

Outcome	**Completion Date**	**Budget**
1. Correlate sediment records to land-use and BMP histories	Mar 2017	$ 86,000
2. Construct computer watershed models	Mar 2017	$ 211,000

Activity Status as of 31 December 2014:

Activity Status as of 30 June 2015:

Activity Status as of 31 December 2015:

Activity Status as of 30 June 2016:

Activity Status as of 31 December 2016:

Final Report Summary:

ACTIVITY 4: Transfer knowledge to resource managers

Description: To inform resource managers, we will host a half-day workshop in the Twin Cities to present project results to state, local, and federal agency personnel. For broader dissemination, the workshop content will be tailored to each study watershed and presented to local officials at out-state venues. In addition, we will produce a series of fact sheets (2-4 p. each), for each of the detailed-study watersheds for use by local resource managers. These fact sheets will be targeted for the educated lay reader, to assist local managers in making and justifying BMP implementation decisions. A final project report will document all findings for reference by state personnel, and publications in peer-reviewed journals will inform the wider academic research community.

Summary Budget Information for Activity 4: **ENRTF Budget: $ 52,000**
Amount Spent: $ 0
Balance: $ 52,000

Activity Completion Date:

Outcome	**Completion Date**	**Budget**
1. Hold workshops & write fact sheets: Twin Cities & study watersheds	Jun 2017	$ 52,000

Activity Status as of 31 December 2014:

Activity Status as of 30 June 2015:

Activity Status as of 31 December 2015:

Activity Status as of 30 June 2016:

Activity Status as of 31 December 2016:

Final Report Summary:

V. DISSEMINATION:

Description: Activity 4 of this project (see above) focuses on knowledge transfer to watershed resource managers through a series of half-day workshops. These will include the following:

- One half-day workshop in the Twin Cities to present results to state and federal resource managers and interested university scholars
- One half-day workshop for each study watershed to present results to local resource managers at out-state venues.

In addition, we will produce a series of fact sheets (2-4 p. each), for each of the detailed-study watersheds for use by local resource managers. These fact sheets will be targeted for the educated lay reader, to assist local managers in making and justifying BMP implementation decisions. A final project report will document all findings for reference by state personnel, and publications in peer-reviewed journals will inform the wider academic research community.

Status as of 31 December 2014:

Status as of 30 June 2015:

Status as of 31 December 2015:

Status as of 30 June 2016:

Status as of 31 December 2016:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Explanation
Personnel:	$ 621,000	1 sediment geochemist at 8% FTE for 3 years; 1 sediment radioisotope analyst/geochemist at 75% FTE for 3 years; 1 diatom analyst at 75% FTE for 3 years; 1 hydrologist/watershed modeler at 75% FTE for 3 years
Professional/Technical/Service Contracts	$48,000	Analyses by external labs (Be-10, C-14, pigments)
Equipment/Tools/Supplies:	$ 35,000	$5K field supplies (tubing, tape, vials, misc.); $22K lab supplies (reagents, glassware; replacement parts); $8K data analysis supplies (data acquisition; software)
Capital Expenditures over $5,000:	$ 30,000	Inverted microscope
Travel Expenses in MN:	$ 19,000	$4K for BMP assessment trips; $11K for coring fieldwork; $4K for results dissemination workshops
Other -- Analytical Services:	$ 147,000	Lab analysis of sediment cores: sediment components (organic, carbonate, inorganic fractions); radiometric dating and sediment fingerprinting (Lead-210, Cesium-137); biogenic silica (algal productivity); sediment phosphorus content; diatom community; blue-green algal fossils.
TOTAL ENRTF BUDGET:	**$ 900,000**	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000: An inverted microscope (with the objective below the stage) is required for identifying and counting algal parts isolated from water or sediment samples. With proper maintenance, this microscope has an indefinite lifetime and is expected to be in service for many years.

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 7 FTEs

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: N/A

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
Science Museum of Minnesota	$ 387,000	$	Unrecovered support services (lab & equipment maintenance, infrastructure, project administration), 43% of direct costs
TOTAL OTHER FUNDS:	**$ 387,000**	**$**	

VII. PROJECT STRATEGY:

A. Project Partners: None.

B. Project Impact and Long-term Strategy: Undoubtedly, Minnesota waters have been impacted by human activities since the time of euroamerican settlement, which began in earnest in the mid-19th century. No data exist to docment the pristine, natural state of water quality prior to this settlement. After more than a century of agricultural and urban growth, regulations to protect and improve water quality were finally established, principally by the 1972 Clean Water Act. Water-quality monitoring began to be more common but the degree of pollution was difficult to assess because of the lack of baseline data. After spending billions of dollars nationally to clean up point sources of polluton with good success, we are now spending billions of dollars on best management practices (BMPs) to address nonpoint-source pollution. Unfortunately, the effectiveness of BMPs is difficult to assess at the watershed scale because the potential benefits of BMPs become mixed with and overwhelmed by continuing changes in land use, especially agricultural practices driven by policy decisions. Many Minnesota water bodies remain impaired. Fortunately, the Minnesota Clean Water, Land, and Legacy Amendment has provided critical funds to reinvigorate our efforts, both for water-quality monitoring and for BMP implementation. Still, without long-term data sets to documenting baseline water quality, we cannot easily quantify the net effects of BMPs in the context of other watershed influences. In summary, because of the lack of long-term water-quality data, we don't know where we started from, how far we've been blown off course, and whether we're making progress against stiff headwinds.

The importace of this project lies in filling this data gap: we will reconstruct long-term records reflective of water quality from clues preserved in lake sediments. Each year, a lake lays down a layer of sediment, the composition of which can be used to infer watershed-scale loads of sediment and nutrients. As noted earlier, this approach has been used with success for very large basins: Lake Pepin sediments document the nonpoint-source pollution history of the upper Mississippi River basin, as do Lake St. Croix sediments for its basin. We will build on these successes by selecting another five to ten lake basins within Minnesota for a similarly detailed assessment of whole watershed loads of sediment and nutrients. The chronology of these loads will be compared with the histories of land use and BMP implementation in each basin to help tease apart the multiple possible pollutant sources. Finally, watershed models will be fit to these basins as constrained by the long-term data extracted from the sediment-core records, thereby both testing and improving the models while providing another method of distinguishing among possible pollution sources. The benefits include development of critical long-term data sets, a test of BMP effectiveness at the scale at which our waters are deemed impaired, and improvement of modeling tools to make results more realistic and predictive. The long-term data sets will greatly enhance the value of existing watershed monitoring in the state by providing temporal context, without which the current records are unanchored relative to natural, pre-industrial conditions.

C. Spending History:

Part 1: Funding Source	**M.L. 1995 or FY96**	**M.L. 1999 or FY00**	**M.L. 2002 or FY03**	**M.L. 2007 or FY08**	**M.L. 2008 or FY09**
Met Council (for mass balance of sediment and phosphorus to Lake Pepin)	$ 150,000				
ENRTF (ML 1999, Chap. 2331, Sec. 16, Subd. 6b; for sediment fingerprinting of sediment sources in agricultural watersheds)		$ 350,000			
Met Council & MPCA (for mass balance of sediment and phosphorus to Lake St. Croix)			$ 250,000		
ENRTF (ML 2007, Chap. 30, HF293, Sec. 2, Subd. 5d; for demonstrating benefits of conservation grasslands)				$ 374,00	
MPCA (for construction and application of a computer model of the Sunrise River watershed to address nonpoint-source pollution loads)					$ 137,000
Part 2: Funding Source	**M.L. 2008 or FY09**	**M.L. 2009 or FY10**	**M.L. 2011 or FY12**	**M.L. 2012 or FY13**	**Total, Parts 1 & 2**
Nat'l Park Service (for construction of a computer model of the St. Croix River watershed to address nonpoint-source pollution loads)	$ 200,000				
ENRTF (ML 2009, Chap. 143, Sec. 2, Subd. 5d; for effect of tile drainage on river flow and erosion)		$ 300,000			
MPCA (matching 319 funds for above project)		$ 300,000			
MPCA (for Lake of the Woods phosphorus loading and sediment interaction problems)			$ 150,000, +$ 150,000 for FY14		
MPCA (for continued sediment fingerprinting work)				$ 250,000	
Plus numerous small projects documenting watershed-scale, long-term histories of atmospheric and other nonpoint-source pollution loads					
TOTAL					$ 2,611,000

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. VISUAL ELEMENT or MAP(S): See attached figure.

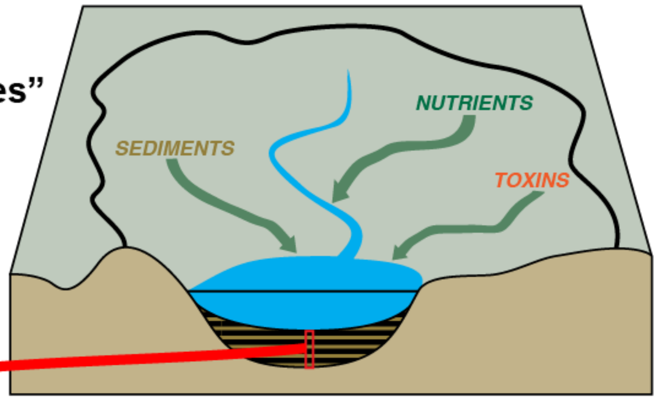
X. ACQUISITION/RESTORATION REQUIREMENTS WORKSHEET: N/A

XI. RESEARCH ADDENDUM: See attached Research Addendum.

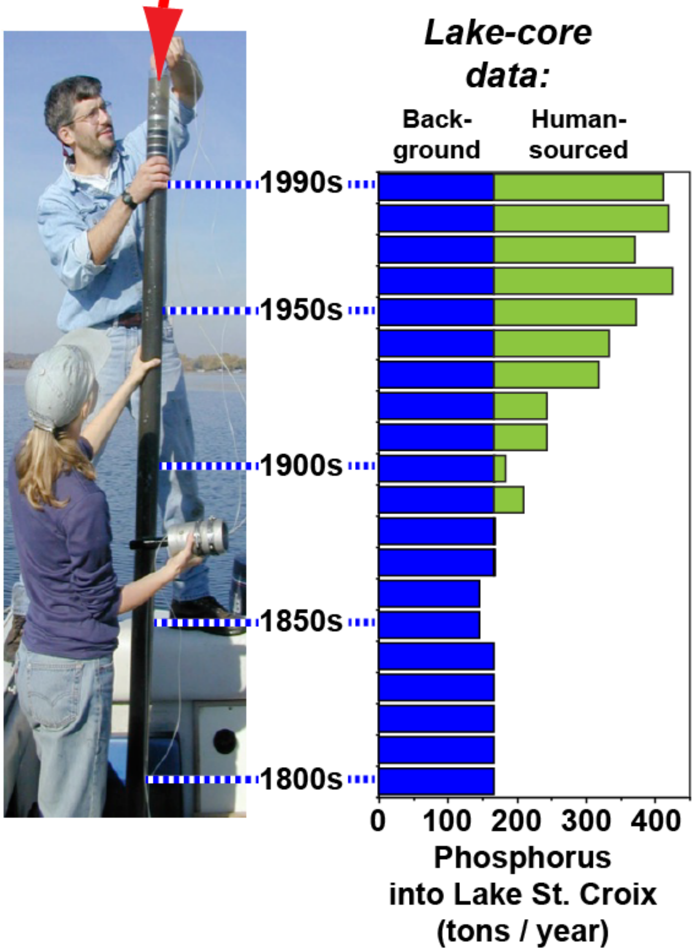
XII. REPORTING REQUIREMENTS:
Periodic work plan status update reports will be submitted no later than the end of the months of January 2015, July 2015, January 2016, July 2016, and January 2017. A final report and associated products will be submitted between June 30 and August 15, 2017.

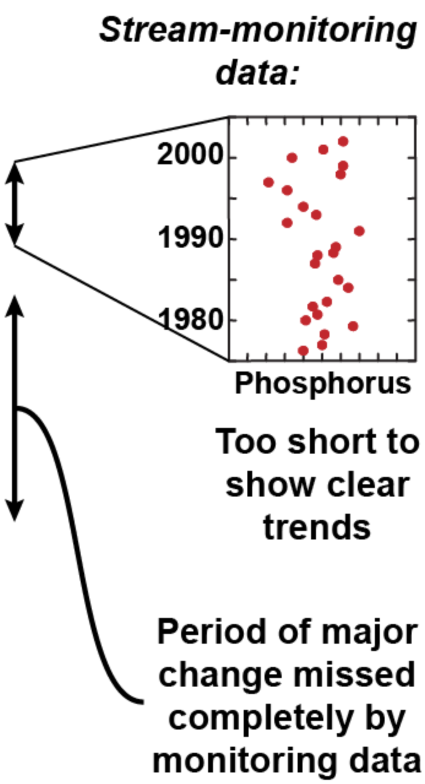
- ***Have BMPs* been effective?*** *Virtually no data exist at the watershed scale to answer this question.*
- ***Lake sediments offer a way of going back farther in time to see a more complete picture.***

Lakes collect long-term, watershed-scale "samples" *before and after* BMP implementation.



Each slice of a lake-sediment core is a slice of watershed history.





**BMPs are best management practices, such as buffer strips, conservation tillage, and detention ponds, designed to keep our rivers and lakes clean.*

Environment and Natural Resources Trust Fund
M.L. 2014 Project Budget

Project Title: Watershed-Scale Monitoring of Long-Term Best-Management Practice Effectiveness
Legal Citation: M.L. 2014, Chp. 226, Sec. 2, Subd. 03g
Project Manager: Daniel R. Engstrom
Organization: St. Croix Watershed Research Station, Science Museum of Minnesota
M.L. 2014 ENRTF Appropriation: $ 900,000
Project Length and Completion Date: 3 Years, 30 June 2017
Date of Report: 15 January 2014

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	Activity 4 Budget	Amount Spent	Activity 4 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	**Select new sites, characterize watersheds, & document BMP histories**			**Collect and analyze lake-sediment cores**			**Quantify BMP effectiveness by linking land to water with statistical analyses and**			**Transfer knowledge to resource managers**				
Personnel (Wages and Benefits)	$133,000	$0	$133,000	$148,000	$0	$148,000	$294,000	$0	$294,000	$46,000	$0	$46,000	$621,000	$621,000
Engstrom, Research Director: Sediment dating; ~8% FTE charged for 3 yr; Salary=77%, Benefits=23% (~$24K)														
Almendinger, Senior Scientist (1 of 3); Watershed analysis, modeling; ~75% FTE for 3 yr; Salary=77%, Benefits=23% (~$199K)														
Edlund, Senior Scientist (1 of 3); Diatom & BG algae analyses; ~75% FTE for 3 yr; Salary=77%, Benefits=23% (~$199K)														
Schottler, Senior Scientist (1 of 3); BMP summary, dating, correlations; ~75% FTE for 3 yr; Salary=77%, Benefits=23% (~$199K)														
Professional/Technical/Service Contracts														
Utah State Univ. (for Be-10 measurements)				$30,000	$0	$30,000							$30,000	$30,000
Univ. of Regina (for algal pigments & toxins)				$12,000	$0	$12,000							$12,000	$12,000
Univ. of Minnesota (for C-14 dating, magnetics, particle size)				$6,000	$0	$6,000							$6,000	$6,000
Equipment/Tools/Supplies														
Field supplies (tubing, tape, sample containers, misc. field gear)				$5,000	$0	$5,000							$5,000	$5,000
Lab supplies (reagents, glassware, misc. lab supplies)				$22,000	$0	$22,000							$22,000	$22,000
Data analysis supplies (data acquisition, software)	$3,000	$0	$3,000				$3,000	$0	$3,000	$2,000	$0	$2,000	$8,000	$8,000
Capital Expenditures Over $5,000														
Equipment: Inverted microscope for algal analysis				$30,000	$0	$30,000							$30,000	$30,000
Travel expenses in Minnesota	$4,000	$0	$4,000	$11,000	$0	$11,000				$4,000	$0	$4,000	$19,000	$19,000
5-10 BMP assessment trips, meet with local resource managers														
5-10 field trips to collect lake-sediment cores														
5-10 trips to present results to local resource managers														
Other -- Analytical Services				$147,000	$0	$147,000							$147,000	$147,000
Lab analysis of sediment cores: sediment components (organic, carbonate, inorganic fractions); radiometric dating and sediment fingerprinting (Lead-210, Cesium-137); biogenic silica (algal productivity); sediment phosphorus content; particle size; diatom community; blue-green algal fossils.														
COLUMN TOTAL	**$140,000**	**$0**	**$140,000**	**$411,000**	**$0**	**$411,000**	**$297,000**	**$0**	**$297,000**	**$52,000**	**$0**	**$52,000**	**$900,000**	**$900,000**