Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2015 Work Plan

Date of Report: October 15, 2014

Date of Next Status Update Report: January 2015

Date of Work Plan Approval:

Project Completion Date: June 2018

Does this submission include an amendment request? No

PROJECT TITLE: Hydrologic Effects of Contemporary Forest Practices in Minnesota

Project Manager: Dr. Diana Karwan

Organization: University of Minnesota – Twin Cities

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Location: Itasca County (field site) and Ramsey County (University of Minnesota Twin Cities, St. Paul campus)

Total ENRTF Project Budget: $150,000	**ENRTF Appropriation:**	**$150,000**
	Amount Spent:	**$0**
	Balance:	**$150,000**

Legal Citation: M.L. 2015, Chp. 76, Sec. 2, Subd. 03r

Appropriation Language:
$150,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to install hydrologic monitoring stations to collect water quantity and quality data from lands managed for timber production to better understand the relationship between harvest practices and water resources and related responses to changing climate and other disturbance factors in order to inform forest management practices. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Hydrologic Effects of Contemporary Forest Practices in Minnesota

II. PROJECT STATEMENT:

Lack of understanding exists in Minnesota and the Lake States region regarding the effects of contemporary forest harvest practices on water resources. In forested landscapes, runoff amount and timing and sediment concentration and load are the major water quality concerns[1]. Previous studies in the region were conducted decades ago[2] and their results have been widely applied beyond the conditions under which they were conducted. For example, the strong preference for winter timber harvest is based on these previous studies and assumes certain temperature, soil, and other hydrologic conditions will occur. Climate, as measured by temperature and precipitation, has shifted and will likely continue to shift in the region causing further changes in watershed response to vegetation change. Additionally, forest health is further affected by pests, such as the Emerald Ash Borer (EAB), and fire, such as the Pagami Creek Fire of 2011. In order to make effective, science-based forest management decisions, water quantity and quality information is needed. Such information is difficult to find on managed timberlands within the state outside of the Marcell Experimental Forest. In order to understand the effects of timber harvests as they are currently conducted, this project will establish water resource monitoring sites for stream flow and associated fine sediments on lands managed for timber.

A need exists to collect and analyze time-series hydrologic data in order to evaluate the relationship between forest harvesting and stream water quantity and quality. This project will fill that need by collecting stream discharge and water quality data associated with managed timberlands in upland-dominated watersheds. The paired-watershed study design allows for comparison of results to previous studies, such as those in the Marcell Experimental Forest, in order to evaluate differences with watershed characteristics and harvest practices. Furthermore, time-series data and individual stream water samples will be collected in such a way to develop a mechanistic understanding behind correlations between contemporary forest management practices and stream hydrology. Results of this study will be shared widely within the forest management and scientific hydrology communities.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of *January 2016***:**

Project Status as of *July 2016***:**

Project Status as of *January 2017***:**

Project Status as of *July 2017***:**

Project Status as of *January 2018***:**

Overall Project Outcomes and Results:

[1] Knife River-Turbidity TMDL Project, 2010. Deer Creek Turbidity TMDL Project, 2013. Nemadji River-Turbidity TMDL Project, ongoing. Poplar River –Turbidity TMDL Project, 2013. Information online: http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/tmdl-projects/lake-superior-basin-tmdl/lake-superior-basin-tmdls.html

[2] Summarized in Verry, E. S. (2004), Land Fragmentation and Impacts to Streams and Fish in the Central and Upper Midwest, in *A Century of Forest and Wildland Watershed Lessons*, edited by G. G. Ice and J. D. Stednick, pp. 129–154, Society of American Foresters, Bethesda, MD.

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Site Selection and Instrumentation
Description:

Site selection is critical to this field-based study. Activity 1 will result in the selection of 2 sites in watersheds near each other in which stream gaging/monitoring stations (described below) will be established. These two sites will be selected from land owned and managed by UPM Blandin in Itasca County, such as the creeks draining to Pokegama Lake, south of Grand Rapids (shown in Map attachment). Information from Pokegama Creek and other previous locations of water quality studies will be compiled during the first few months of this study in order to inform final site selection (Activity 1, Outcome 1).

Pokegama Creek has a history of research, including point-in-time characterizations of stream channel substrate and sediment [*Merten et al.*, 2010] and stream habitat for fish communities [*Hemstad et al.*, 2008]. As a part of previous studies, stream discharge was measured at individual times during the summer and fall of 2006. Historical data provides valuable information on the range of hydrologic conditions to expect and will be used to select stream monitoring locations (Activity 1, Outcome 2) and tailor the precise instrumentation for each site. For example, instruments with different calibrations will be selected based on the range of stream flows and turbidity expected at the two individual sites.

Installation of the two stream gaging stations will take place, one gage at each of the two selected sites, to allow for the most possible data to be collected during the project time. Stream gaging will consist of establishing a stable channel cross section at each of the two chosen research sites, either through the installation of a pre-calibrated control structure, such as a weir or flume, or through the selection of a stream cross section with stable bed/banks not prone to erosion or deposition under extreme flooding events. Final selection of the stream cross-section infrastructure will occur during site selection (Activity 1, Outcome 2) and will be informed by existing and historical measurements as well as the individual characteristics of each site.

Two stream gaging stations will be instrumented in order to continuously measure stream volumetric discharge and turbidity and to withdraw water samples for chemical analysis (for example biweekly during hydrologic baseflow and more frequently during rainfall and snowmelt events). Necessary instrumentation for each of the two sites includes a water depth sensor (e.g Teledyne Isco 720 flow module or similar pressure transducer), optical turbidity meter (e.g. Campbell Scientific Obs 3+ turbidity meter or similar optical sensor with data logging module), and automatic water sampler (e.g. Teledyne Isco Model 6712). This suite of sensors will allow for the continuous measurement of water level, which will be converted to stream discharge through a rating equation, continuous turbidity measurements, and systematic sampling of 1-liter stream water samples. Continuous water depth measurements will be converted to stream volumetric discharge through a site-specific rating equation. One-liter stream water samples will be withdrawn by the automatic sampler and subsequently analyzed for total suspended solids and basic water chemistry (under Activities 2-3 below). This sampler was selected because, when connected to the pressure transducer (e.g. ISCO Model 6712 with 729 flow module), it collects streamwater based on changes in water depth and allows for sampling throughout rainfall or snowmelt events. The emplacement of water monitoring and sampling equipment comprises Activity 1, Outcome 3.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 70,646
Amount Spent: $ 0
Balance: $ 70,646

Outcome	Completion Date
1. Compiled list of managed timberlands in Itasca County with previous stream hydrologic research. This list will include the measurements taken, range of stream discharge values, and associated scientific papers or reports.	*November 30, 2015*
2. Selection of 2 sites on nearby watersheds	*November 30, 2015*
3. Instrumentation of 2 gaging stations, one station on each of two watersheds, (identified	*May 31, 2016*

in Task 2) to measure water depth and turbidity, and to collect samples for suspended sediment, and water chemistry	

Activity Status as of *January 2016***:**

Activity Status as of *July 2016***:**

Activity Status as of *January 2017***:**

Activity Status as of *July 2017***:**

Activity Status as of *January 2018***:**

Final Report Summary:

ACTIVITY 2: Pre-treatment Monitoring
Description:

Water stage and quality will be monitored in the research site for a minimum of 1-2 years prior to timber harvest, beginning at the time of site instrumentation (Outcome 3 of Activity 1) through the winter of 2017 - 2018, when a harvest will take place based on the land owners business-as-usual operations. During Activity 2, water quantity and quality data will be collected in order to quantify the pre-harvest condition of the watershed.

Stage (water depth) measurements will be recorded continuously by the pressure transducer and converted to stream discharge by a site-specific rating equation. Turbidity measurement will also be recorded continuously with the optical turbidity sensor. One-liter stream water samples will be withdrawn by the automatic sampler on an approximately biweekly basis during baseflow conditions but more frequently during storm events or time of rapid change in stream condition. Once collected, water samples will be analyzed for Total Suspended Solids (TSS) and stream anions and cations at the University of Minnesota – Twin Cities based on standard methods. TSS data will be used to calibrate turbidity sensors and provide site-specific relationships between turbidity and TSS, thus enabling a continuous time-series record of TSS for the project duration that includes monitoring during rainfall and snowmelt events.

In addition to TSS, water samples will be analyzed for dissolved chemical species, such as cations and anions, which can be used with nearby precipitation data to evaluate contributions of surface and subsurface waters to the stream (e.g. [*Hooper*, 2003; *Klaus and McDonnell*, 2013]). These samples provide the necessary data to evaluate the relative importance of different hydrologic pathways linking the forested watershed to the stream. Ultimately, these water flow pathways will be important to understand and predict hydrologic response to forest management. The data collected under Activity 2 will be used in conjunction with that collected in Activity 3 for an analysis of change in hydrologic condition with forest harvest.

Hydrologic output (stream discharge and turbidity/suspended sediment) from each of the two instrumented sites will be related to each other through a linear model, as is typical in paired watershed studies [*United States Environmental Protection Agency*, 1993]. This model will be reported as Activity 2, Outcome 4 and used to allow for comparison of sites during and after timber harvest (Activity 3).

Because the duration of this study includes approximately 18 months of monitoring pre-timber harvest, rainfall-runoff models may be used to evaluate a larger range of hydrologic conditions than we experience between the spring of 2016 and the winter of 2018 (e.g. if the study years are anomalously wet or dry, rainfall or snowmelt events that are larger or smaller than what the site experiences during this project will be evaluated using a model). In this manner, a model can be used robustly evaluate the hydrologic effects of timber harvest over a broader range of conditions [*Zégre et al.*, 2010]. During the time the project team is gathering the calibration data, a review of the scientific literature will be conducted to determine the successful application of rainfall-runoff modeling in upland-dominated watersheds of the Great Lakes region (Activity 2, Outcome 3).

Summary Budget Information for Activity 2:

ENRTF Budget: $ 57,029
Amount Spent: $ 0
Balance: $ 57,029

Outcome	Completion Date
1. Data set of stream discharge at each of the two instrumented gaging sites (one site to receive a harvest, the other to serve as its unharvested control)	*February 2018*
2. Data set of turbidity and suspended sediment at each of the two instrumented gaging sites (one site to receive a harvest, the other to serve as its unharvested control)	*February 2018*
3. Report containing the review of scientific literature on application of rainfall-runoff models in Great Lakes watersheds	*February 2018*
4. Comparison of the stream discharge data at each of the two instrumented gaging sites to each other. A relationship will be developed to relate the stream discharge at the gage in the watershed to remain unharvested to the gage in the watershed to receive a harvest.	*March 2018*

Activity Status as of *January 2016***:**

Activity Status as of *July 2016***:**

Activity Status as of *January 2017***:**

Activity Status as of *July 2017***:**

Activity Status as of *January 2018***:**

Final Report Summary:

ACTIVITY 3: Timber Harvest Treatment Monitoring
Description:

This project will monitor stream discharge and sediment export responses to timber harvest, conducted by the landowner according to the contemporary practices during the late winter months (January – February 2018) (Activity 3, Outcome 1). During site selection (Activity 1), communication with the landowner/manager will begin regarding their plans for forest management over the coming years and this information will be considered when selecting a site. The current study is designed to provide hydrologic monitoring around planned, business-as-usual forest management activities. Because the harvest activity is not funded by this study and presumably would be conducted in the absence of this study, it is not listed as a study-specific outcome. Hydrologic monitoring, as described above under Activity 2, will continue during and after the harvest in order to evaluate hydrologic changes during and after timber harvest. This monitoring data comprises Activity 3, Outcome 1. There will be two stream gaging stations – one of these two watersheds will receive a harvest treatment while the other will not and will be considered a control. In order to compare stream hydrology with and without timber harvest, the watershed containing harvest units will be compared to the second instrumented watershed, which does not experience a harvest (Activity 3, Outcome 2). Results of these comparisons will be subsequently presented at one state or regional conference, such as the Minnesota Water Resources Conference or Northern Regional Meeting of the National Council for Air and Stream Improvement and will contribute to scientific peer reviewed publications on forest hydrology in the region.

Additionally, comparisons may be made between the during- and post-harvest data and the results of a rainfall-runoff model (selected from the review conducted under Activity 2, Outcome 3). This model will be used in the case the range of rainfall/snowmelt conditions experienced following harvest are outside of the range of

those observed during the calibration period (the duration of Activity 2). For example, if the project years are unusually wet or dry a rainfall-runoff model (e.g. as in [*Zégre et al.*, 2010]), calibrated using historical and ancillary information, can be used to simulate how the watersheds would respond to a precipitation event larger or smaller than what is experienced during the study. Such a model would not be a substitute for colleting data during the project period but can be used as a way to test watershed response to a precipitation event size not experienced during the timeframe of this study. If deemed necessary, such a model will be calibrated during Activity 3. The selection of a particular existing model will take place based on review of successful modeling efforts in the region, which was performed under Activity 2.

The main outcome of Activity 3 will be a comparison of the water quantity and quality in watersheds with and without harvest during the harvest and immediate post-harvest time intervals (Activity 3 Outcome 2). This study will provide valuable information on the water quantity and quality differences between a watershed receiving a timber harvest and a nearby unharvested, or control, watershed. After the three-year duration of this project, rather than retire the study sites, the project team intends to continue collecting data and seek additional funds to extend the study and monitor the two watersheds as the forest regrows in the harvest area.

Summary Budget Information for Activity 3:

ENRTF Budget: $ 22,325
Amount Spent: $ 0
Balance: $ 22,325

Outcome	Completion Date
1. Data on stream discharge, suspended sediment, and turbidity data during and immediately following harvest in treatment and control sites assembled	*June 2018*
2. Comparison of hydrologic data between harvested and unharvested watershed	*June 2018*

Activity Status as of *January 2016***:**

Activity Status as of *July 2016***:**

Activity Status as of *January 2017***:**

Activity Status as of *July 2017***:**

Activity Status as of *January 2018***:**

Final Report Summary:

V. DISSEMINATION:

Description:

The findings of this project and future projects based on this monitoring network will contribute to the knowledge of the hydrologic effects of forest management activities in the region.

The data generated by this project will be used to generate one graduate dissertation, peer-reviewed scientific publications, and presentations at state and national water resource conferences. In particular, we will target conferences for forest and water resource managers in the region, such as Minnesota Water Resources Conference and Northern Regional Meeting of the National Council for Air and Stream Improvement.

Status as of *January 2016***:**

Status as of *July 2016***:**

Status as of *January 2017:*

Status as of *July 2017***:**

Status as of *January 2018***:**

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 113,150	(1) Salary for 3 weeks per year (0.1 FTE) and fringe (19.83%) for Dr. Karwan during each year of the project. Dr. Karwan will manage all aspects of the project. (2) Salary and fringe (98.1%) for 1 PhD student for 2.0 years (0.5 FTE per year of funding). Fringe rate includes graduate student tuition. (3) Hourly salary for 1 undergraduate student 10 hours per week (0.25 FTE) without fringe during the academic year and with fringe (7.34%) during summer in years 2 and 3 of project. Undergraduate will assist with field collection and analysis of water samples and hydrologic data.
Equipment/Tools/Supplies:	$ 26,850	Funds are requested to instrument two stream gaging/sampling sites for continuous water depth, discharge, and turbidity measurement as well as automatic water samples for chemical analysis. Quotes have been obtained for the necessary pressure transducer, turbidity meter, data loggers, and water samplers. Each of these pieces could be used individually and range in price from approximately $1000 - $3300. The exact structure or cross section modification necessary for measuring discharge will be suited to the site chosen, but will cost approximately $2000 to install. The remaining $1000 will be used for laboratory analysis of water samples for total suspended solids and dissolved anions and cations in university facilities.
Travel Expenses in MN:	$10,000	Funds are requested for travel between the University campus in St. Paul and research area in Itasca County. This includes money for mileage and vehicle rental from the University's fleet services as well as for over-night stays in Grand Rapids, near the study sites, for multiple-

		day periods of field work.
TOTAL ENRTF BUDGET:	**$150,000**	

Explanation of Use of Classified Staff:

N/A

Explanation of Capital Expenditures Greater Than $5,000:

N/A

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

In year one, 0.6 FTE will be funded by this appropriation (0.1 for the project manager and 0.5 for the graduate student). In years two and three, 0.6 FTE will be directly funded by this appropriation (0.1 – project manager, 0.25 – graduate student, 0.25 – undergraduate research assistant).

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			
University of Minnesota	$6,872	$0	**In-kind Services To Be Applied To Project During Project Period:** 2% (0.02 FTE) of Karwan's salary during project years provided by the University of Minnesota
State			
	$	$	
TOTAL OTHER FUNDS:	**$**	**$**	

VII. PROJECT STRATEGY:

A. Project Partners:

The project will be led by Dr. Diana Karwan (University of Minnesota Department of Forest Resources), who receives funds from this request. Mr. Tim O'Hara (Minnesota Forest Industries), who does not receive funds from this project, will assist Dr. Karwan in identifying candidate research sites and with landowner introductions and communications. Partners will be sought among the private and state forest owners within Minnesota. For example, UPM-Blandin Paper Company (Grand Rapids, MN) manages approximately 190,000 acres in northern Minnesota for forest products, subject to conservation easement. UPM-Blandin has participated in past research projects and has shown interest in cooperating with additional research on their lands (see Map). An initial set of candidate sites has been identified on Blandin lands and Dr. Karwan has conducted preliminary site visits with scientists from UPM-Blandin. The National Council for Air and Stream Improvement (NCASI) is an independent, non-profit research organization whose mission involves scientific research to enhance the technical, environmental, and sustainability understanding of forest management. They are interested in monitoring the hydrologic effects of forest management in the Lake States and have stated they see this project as a pilot on which to base a network of sites.

B. Project Impact and Long-term Strategy:

The findings of this project based on this monitoring network will contribute to the knowledge of the hydrologic effects of forest management activities in the region. Gathering time-series on-the-ground data is essential to understanding how watersheds respond to vegetation changes within them. The current project will allow on-the-ground quantification of the surface water hydrologic effects of a business-as-usual timber harvest. Currently our only source of such time-series information is from the Marcell Experimental Forest (MEF). This study will provide data from a watershed of different condition (e.g. upland dominated) that will facilitate

comparisons with the wetland-dominated watersheds of the MEF. It is important for land managers to have hydrologic information from these different types of watersheds (with and without large wetland systems near their outlets) in order to make appropriate decisions and predictions for how land and vegetation management activities will affect water resources. By conducting this study in a nearby but different set of two watersheds (compared to previous studies at MEF), the scientific and land management communities will have more data to draw from as there will be this additional study on a different case with different dominant landform and current vegetation management practices.

The data generated by this project will be used to generate one graduate dissertation, at least one peer-reviewed scientific publications, and at least one presentation at state and national water resource conferences. In particular, we will target conferences for forest and water resource managers in the region, such as Minnesota Water Resources Conference and Northern Regional Meeting of the National Council for Air and Stream Improvement.

Other groups, in particular forest management and non-profit groups, have expressed interest in this project as a pilot on which to expand. Future funds will be sought from a variety of sources to continue and expand upon this work in order to quantify the long-term hydrologic processes which link current forest management practices to surface water quantity and quality. Currently, one proposal is in review with the National Council for Air and Stream Improvement.

C. Funding History:

While previous studies exist in the area, such as the long-term research funded by the USDA Forest Service at the Marcell Experimental Forest, this study is new and has received no prior funing.

Funding Source and Use of Funds	Funding Timeframe	$ Amount
		$
		$
		$

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List:

N/A

B. Acquisition/Restoration Information:

N/A

IX. VISUAL COMPONENT or MAP(S):

See attached graphic.

X. RESEARCH ADDENDUM:

See attached Research Addendum.

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than January 31, 2016, July 31, 2016, January 31, 2017, July 31, 2017, January 31, 2018. A final report and associated products will be submitted between June 30 and August 15, 2018.

References:

Hemstad, N. a., E. C. Merten, and R. M. Newman (2008), Effects of riparian forest thinning by two types of mechanical harvest on stream fish and habitat in northern Minnesota, *Canadian Journal of Forest Research*, *38*(2), 247–256, doi:10.1139/X07-157.

Hooper, R. P. (2003), Diagnostic tools for mixing models of stream water chemistry, *Water Resources Research*, *39*(3), n/a–n/a, doi:10.1029/2002WR001528.

Klaus, J., and J. J. McDonnell (2013), Hydrograph separation using stable isotopes: Review and evaluation, *Journal of Hydrology*, *505*, 47–64, doi:10.1016/j.jhydrol.2013.09.006.

Merten, E. C., N. a. Hemstad, R. K. Kolka, R. M. Newman, E. S. Verry, and B. Vondracek (2010), Recovery of Sediment Characteristics in Moraine, Headwater Streams of Northern Minnesota After Forest Harvest, *Journal of the American Water Resources Association*, *46*(4), 733–743, doi:10.1111/j.1752-1688.2010.00445.x.

United States Environmental Protection Agency (1993), *Paired Watershed Study Design*, Washington D.C.

Zégre, N., A. E. Skaugset, N. a. Som, J. J. McDonnell, and L. M. Ganio (2010), In lieu of the paired catchment approach: Hydrologic model change detection at the catchment scale, *Water Resources Research*, *46*(11), n/a–n/a, doi:10.1029/2009WR008601.

Environment and Natural Resources Trust Fund
5/19/2015

Project Title: *Hydrologic Effects of Contemporary Forest Practices in Minnesota*
Legal Citation: *M.L. 2015, Chp. 76, Sec. 2, Subd. 03r*
Project Manager: *Diana Karwan*
Organization: *University of Minnesota - Twin Cities*
M.L. 2015 ENRTF Appropriation: $ *150,000*
Project Length and Completion Date: 3 *Years, June 30, 2018*
Date of Report: *October 15, 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	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Site Selection and Instrumentation***			***Pre-treatment Monitoring***			***Timber Harvest Treatment Monitoring***				
Personnel (Wages and Benefits) OVERALL	$41,587	$0	$41,587	$51,348	$0	$51,348	$19,945	$0	$19,945	$112,880	$112,880
Project Manager: Salary for 3 weeks per year (0.1 FTE) and fringe (19.83%) for D. Karwan during each year of the project. Karwan will manage all aspects of the project.											
Graduate Student: Salary and fringe (98.1%) for 1 PhD student for 2.5 years. Fringe rate includes graduate student tuition.											
Undergraduate Student: Hourly salary for 1 undergraduate student 10 hours per week (0.25 FTE) without fringe during the academic year and with fringe (7.34%) during summer in years 2 and 3 of project. Undergraduate will assist with field collection and analysis of water samples and hydrologic data.											
Equipment/Tools/Supplies	$25,850	$0	$25,850	$500	$0	$500	$500	$0	$500	$26,850	$26,850
Funds are requested to instrument one stream gaging/sampling site for continuous water depth, discharge, and turbidity measurement as well as automatic water samples for chemical analysis. Quotes have been obtained for the necessary pressure transducer, turbidity meter, data loggers, and water samplers (approx. $12,000 in total). The exact structure or cross section modification necessary for measuring discharge will be suited to the site chosen, but will cost approximately $2000 to install. The remaining $1000 will be used for laboratory analysis of water samples for total suspended solids and dissolved anions and cations in facilities at the University of Minnesota. This includes a portion of the reduction in funding recommendation amount from the original proposed budget.											
Travel expenses in Minnesota	$3,400	$0	$3,400	$4,950	$0	$4,950	$1,650	$0	$1,650	$10,000	$10,000
Funds are requested for travel between the University campus in St. Paul and research area in Itasca County. This includes money for mileage and vehicle rental from the University's fleet services as well as for over-night stays in Grand Rapids near the study sites under consideration, for longer periods of field work											
COLUMN TOTAL	**$29,250**	**$0**	**$29,250**	**$5,450**	**$0**	**$5,450**	**$2,150**	**$0**	**$2,150**	**$36,850**	**$36,850**

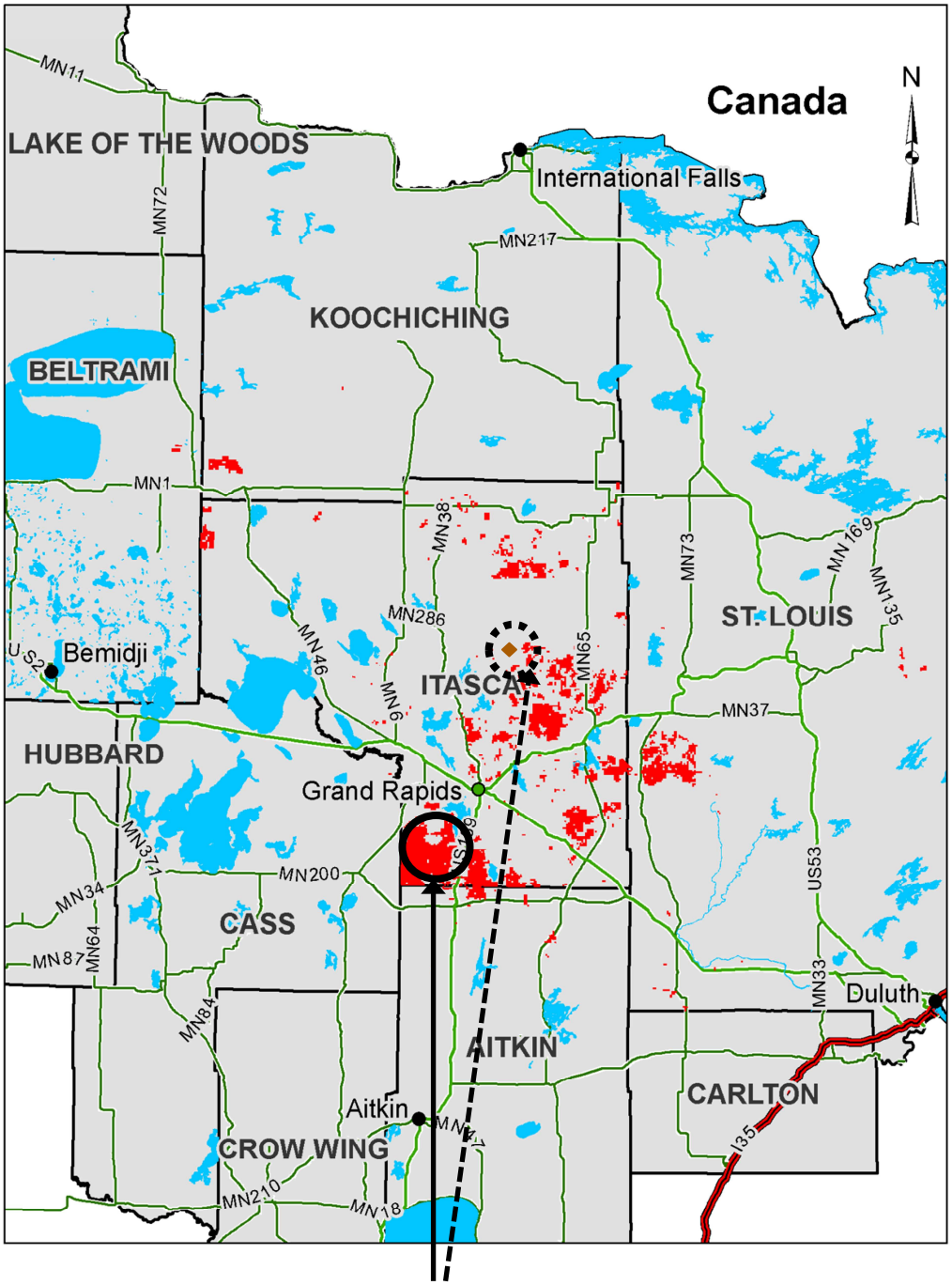

Figure 1 – UPM-Blandin lands are shown in red. These are candidate lands for this study, in particular Pokegama Creek area (circled - solid) has a history of previous riparian and stream ecology studies. The location of the Marcel Experimental Forest (MEF) is shown by the brown diamond in central Itasca County (circled – dashed).