Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2017 LCCMR Work Plan

Date of Submission: September 06 2016

Date of Next Status Update Report: Dec 31 2017

Date of Work Plan Approval: 06/07/2017

Project Completion Date: June 30 2020

Does this submission include an amendment request?

PROJECT TITLE: Reassessing Toxicity of Petrochemical Spills on Groundwater and Surface Waters

Project Manager: Dalma Martinovic-Weigelt

Organization: University of St. Thomas

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Location: Bemidji, MN

Total ENRTF Project Budget:	**ENRTF Appropriation:**	**$300,000**
	Amount Spent:	**$0**
	Balance:	**$300,000**

Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 04e

Appropriation Language:
$300,000 the first year is from the trust fund to the commissioner of natural resources for an agreement with the University of St. Thomas to reassess long-term effects of oil spills through the analysis of chemical parameters related to oil degradation and evaluate the impacts on aquatic species, groundwater, and surface waters. This appropriation is available until June 30, 2021, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: Reassessing Toxicity of Petrochemical Spills on Groundwater and Surface Waters

II. PROJECT STATEMENT:

Threat: Minnesota's water resources (and wildlife and fish that use those) are threatened by petroleum spills from leaking underground storage tanks, oil refineries, and spills from the transnational pipeline that crosses our state. For example, at this time MN Pollution Control Agency-Petroleum Remediation Program (MPCA-PRP) is monitoring more than 19,000 leaking tank sites. Many of the known chemical constituents of petroleum are very toxic to the fish and wildlife, and the toxicity of many of these constituents has not been evaluated.

Major Knowledge Gaps:

We do not know the chemical identity, quantity and toxicity of many chemicals present in petroleum-impacted groundwater and surface water, particularly the chemicals that result as the petroleum degrades over time (i.e., degradation products). **Past toxicity assessments of petroleum-impacted surface and groundwater are: 1. Incomplete** – because only a small subset of known chemicals have been assessed for toxicity, and **2. Inadequate** for identification of many sublethal effects (including those on endocrine, immune and nervous systems) – which are important determinants of organism's survival and population health.

Below we frame our contribution in a well-known risk assessment framework that relies on identification of knowns and unknowns**:**

1. *There are known knowns (these are things we know that we know)* - **this is what we already regulate for and what we monitor in MN.**
2. *There are known unknowns (there are things that we know we don't know)* – **we know that past toxicity assessment omitted analyses of many biologically important effects and propose to evaluate those** (e.g., endocrine, immune, neurotoxic effects).
3. *But there are also unknown unknowns (there are things we don't know we don't know)* – **new technologies allow us to look for unknown toxic chemicals and to detect toxicity in the whole samples that we could not have predicted based on our past knowledge.**

Opportunity: Over the past two years exciting new technologies emerged that will allow us to investigate the toxicity of petroleum-impacted waters **faster, cheaper, and far more completely.** We now have access to new technologies that allow us to analyze whole-water samples (waters containing both original petroleum compounds and degradation products) for over 90 toxicity indicators in a time- and cost-effective manner. Extensive toxicity data can be integrated with existing and new and cutting-edge water chemistry analyses to help us identify unknown pollutants of concern. Furthermore, integration of toxicity and chemistry data with indicators of natural attenuation processes can lead to **better understanding of effectiveness of natural attenuation.**

The work proposed here would improve our understanding of the lasting effects of oil spills on groundwater and associated surface water, and would allow regulators to better prioritize clean-up efforts to mitigate risk to ecological health given limited funds.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of *[Dec 31 2017]***:**

Project Status as of *[June 30 2018]***:**

Project Status as of *[Dec 31 2018]***:**

Project Status as of *[June 30 2019]***:**

Project Status as of *[December 31 2019]***:**

Project Status as of *[June 30 2020]***:**

Overall Project Outcomes and Results:
To be inserted at the time of final report

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: More Completely Characterize The Chemistry Of Waters Impacted By Petroleum.
Description: Water samples will be collected from environments impacted by petroleum release and will include impacted groundwater, as well as water from a lake and wetland. We plan to analyze at least 12 sites for ~ 90 chemical parameters. We will analyze the current and historical water chemistry of these locations using well established methods within the PI's expertise as well as developing new techniques to quantify the extractable organic compounds within the real, "whole water" samples. To capitalize on more than 30 years of investments in data and infrastructure already made, we propose to complete this study at the national crude oil research site located near Bemidji, MN; however, this novel approach could be applied to any well-characterized site to improve our risk-based assessment and clean-up of petroleum impacted sites. We expect these data will improve regulators ability to cost-effectively remediate sites by better understanding the use of Monitored Natural Attenuation at these common contaminated sites.

Summary Budget Information for Activity 1:

ENRTF Budget: $ 142,223
Amount Spent: $ 0
Balance: $ 142,223

Outcome	Completion Date
1. Characterize the current and historical chemistry of contaminated water samples using existing and new analytical techniques. Water chemistry will include both in-situ field chemistry and laboratory analyses and measurements for circa 90 chemical parameters.	August 2019
2. Identify areas of greatest risk and communicate results to regulators (MPCA, MDH).	June 2020

Activity 1 Status as of *[Dec 31 2017]***:**

Activity 1 Status as of *[June 30 2018]***:**

Activity 1 Status as of *[Dec 31 2018]***:**

Activity 1 Status as of *[June 30 2019]***:**

Activity 1 Status as of *[Dec 31 2019]***:**

Final Report Summary: *[June 30 2020]***:**

ACTIVITY 2: Determine the Toxicity of Petroleum-Impacted Waters

Description: Samples will be analyzed for approximately 90 different toxicity types (including carcinogenesis, DNA damage, endocrine disruption, neurotoxicity) using cutting-edge techniques where living cells/proteins are exposed to "whole" water samples of interest and screened for changes in biological activity that are indicative of potential toxic effects. Unlike past approaches, these novel methods can quickly and efficiently screen samples for many toxicity responses and evaluate the potential of the complex environmental mixtures to pose health hazards. In addition, assays with aquatic organisms important to ecosystem function (e.g., bacteria/ *Daphnia sp*. and/or native fish) will be conducted. Direct assessments of impacts on aquatic organisms is important as petroleum products are a common water pollutant. The effects on the health of exposed organisms will be evaluated by measuring gene/metabolic responses that are important for maintenance of normal reproductive and metabolic function. Data will be disseminated to peer researchers, managers and entities involved in education (see Section V. *Dissemination* for details).

Summary Budget Information for Activity 2:

ENRTF Budget: $ 157,777
Amount Spent: $ 0
Balance: $ 157,777

Outcome	Completion Date
1. Analyze whole waters for 90 toxicity outcomes using high-throughput techniques.	August 2019
2. Characterize the resulting water chemistry, toxicity and hazard to native aquatic species (e.g., invertebrates/fish) using adverse outcome pathway framework.	December 2019
3. Communicate findings to regulators (MPCA, MDH), peer researchers and consultants.	June 2020
4. Outreach activities via UST courses and extracurricular venues.	May 2020

Activity 2 Status as of *[Dec 31 2017]***:**

Activity 2 Status as of *[June 30 2018]***:**

Activity 2 Status as of *[Dec 31 2018]***:**

Activity 2 Status as of *[June 30 2019]***:**

Activity 2 Status as of *[Dec 31 2019]***:**

Final Report Summary: *[June 30 2020]***:**

V. DISSEMINATION:

Description: Outreach and Dissemination of project data will be used 1) to present and publish findings for researchers in this field, 2) to share findings with regulatory state agencies (e.g., MDH, MPCA), and 3) private entities that facilitate/evaluate effectiveness of oil remediation projects (e.g., consultants). We will also use this data to enhance Minnesota's science, technology, engineering, and math (STEM) education programs via a) direct training of undergraduate research students, b) undergraduate classroom activities, and c) dissemination of educational materials through extracurricular routes (e.g., after-school programs etc.).

Status as of *[Dec 31 2017]***:**

Status as of *[June 30 2018]***:**

Status as of *[Dec 31 2018]***:**

Status as of *[June 30 2019]***:**

Status as of *[Dec 31 2019]***:**

Final Report Summary: [*June 30 2020]*

VI. PROJECT BUDGET SUMMARY:

A. Preliminary ENRTF Budget Overview:

***This section represents an overview of the preliminary budget at the start of the project. It will be reconciled with actual expenditures at the time of the final report.**

Budget Category	$ Amount	Overview Explanation
Personnel:	$ 175,918	1 Project Manager (Dr. Dalma-Martinovic-Weigelt, Toxicologist, UST: $44,688 (93% salary, 7% benefits); 8.33% FTE each year for two years; 21.41% FTE for one year); 1 Biogeochemist (Dr. Jennifer McGuire, UST: $63,589 (93% salary, 7% benefits); 16.66% FTE each year for 3 years; 1 Bioinformatician and Data Analyst (Dr. Chih Lai, UST: $31,847 (93% salary, 7% benefits); 8.33% FTE each year for 2 years, 4.17% FTE for 1 year); 1 Mathematician (Dr. Mike Axtell, UST: $5,526 (93% salary, 7% benefits); 4.99% FTE for 1 year); 2 Undergraduate Academic Year Research Assistants (UST: $9,600 (100% salary, 0% benefits); each student @ 8.33% FTE each year for 3 years); 2 Undergraduate Summer Research Assistants, UST: $20,669 (93% salary, 7% benefits); each student @ 16.66% FTE each year for 3 years
Professional/Technical/Service Contracts:	$47,000	US Geological Survey - Analytical chemistry service - 1440 chemical analyses at $32.63 each totaling $47,000 (i.e., 60 analytes at a minimum of 12 site locations in duplicate) will be conducted by USGS laboratories supervised by Dr. Isabelle Cozzarelli.
Equipment/Tools/Supplies:	$68,082	High throughput toxicity assay supplies, assay runs and assay setup - 9000 analyses at $5.56 each totaling $50,000 (i.e., 50 samples tested in duplicate for 90 toxicity parameters); Miscellaneous lab supplies - totaling $18,082 - capillaries, reagents, filters, buffers, sample processing supplies (disposable plastic sampling containers, chemicals, extraction columns),

		animal microcosm setups, and microbiology supplies.
Travel Expenses in MN:	$6,000	Travel for project staff from St. Paul to Bemidji, MN to conduct field sampling/experiments, 1 week field campaign - team of 4 x 5 days x $100 (cost of daily lodging and food) x 3 years = $6,000
Other:	$3,000	Computing time on a supercomputer/server
TOTAL ENRTF BUDGET:	**$300,000**	

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than $5,000: N/A

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 2.64 FTE

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: 0 FTE

B. Other Funds:

Source of Funds	$ Amount Proposed	$ Amount Spent	Use of Other Funds
Non-state			
US Geological Survey	$54,756	$0	In kind support - Dr. Cozzarelli, US Geological Survey - 1 month per year of her salary for 3 years ($16252 per year, $48,756 total) and $2000 per year in field travel funds (total $6000).
University of St. Thomas	$123,000	$0	Indirect costs to University of St. Thomas not recouped (including field and lab equipment, boats, vehicles and miscellaneous supplies).
State	$0	$0	N/A
TOTAL OTHER FUNDS:	$177,756	$0	

VII. PROJECT STRATEGY:

A. Project Partners:

Partners receiving ENRTF funding:

University of St. Thomas, ENTRF funds: $253,000

Dalma Martinovic-Weigelt, Ph.D., Project Manager – Responsible for managing and coordinating overall project, high throughput assay assessment, analyses and interpretation, compiling reports and disseminating results.

Jennifer McGuire, Ph.D., Biogeochemist - Responsible for coordinating and conducting field experiments & chemistry analyses, and compiling reports and disseminating results.

Chih Lai, Ph.D. - Bioinformatician and Data Analyst – Responsible for acquisition/analyses of data from on-line databases, and for statistical integration of project data (field toxicology and chemistry data) with publically available toxicity data.

Mike Axtell, Ph.D., Mathematician – Responsible for predictive mathematical modeling of chemical mixtures.

Two summer and two academic year undergraduate research assistants (to be determined), assist with field and laboratory data generation.

U.S. Geological Survey, ENTRF funds: $47,000

Isabelle Cozzarelli, Ph.D., Chemist- Responsible for conducting field research and chemistry analyses.

Partners NOT receiving ENRTF funding

N/A

B. Project Impact and Long-term Strategy:

Data collected will improve understanding of the longer term effects of oil spills on ecological and human health. The findings of this project will inform: 1) the decisions about use of natural attenuation for remediation of similar sites, 2) monitoring design, and 3) prioritization of sites, site zones and chemical constituents for remedial action. Overall, the approaches and results presented herein will lead to more focused and informed remediation planning by regulatory agencies, such as the Minnesota Pollution Control Agency and Minnesota Department of Health, which are tasked with managing contaminated sites safely.

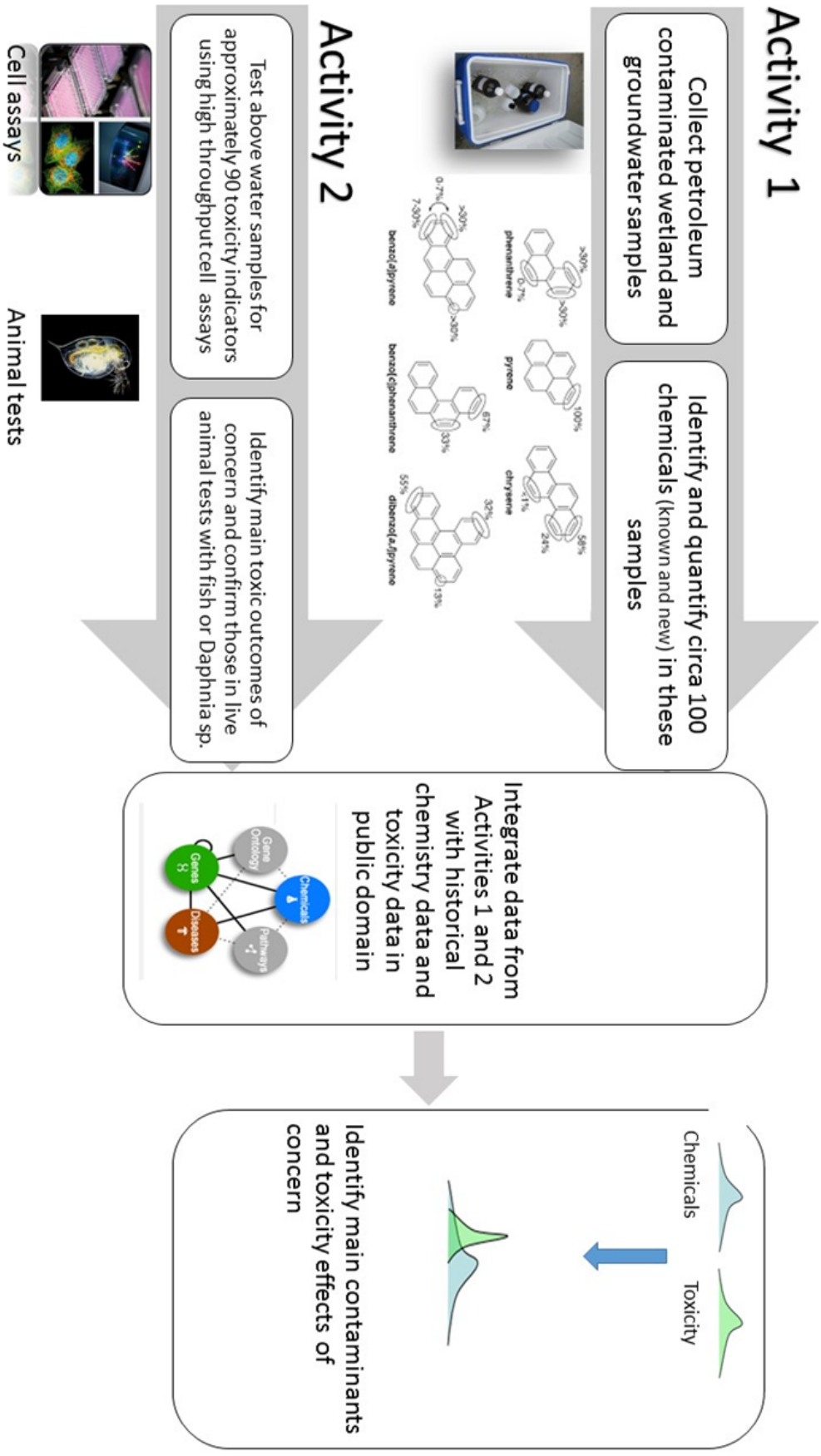
C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	$ Amount
National Crude Oil Spill Fate and Natural Attenuation Research Site, a collaborative venture of the USGS, Enbridge Energy, Limited Partnership, the Minnesota Pollution Control agency, and Beltrami County: Evaluating oil spill toxicity to improve water remediation II. ($11,949). Mc-Guire (PI) Martinovic-Weigelt (co-PI) - project to be completed by July 1 2017.	05/16-08/17	$11,949
National Crude Oil Spill Fate and Natural Attenuation Research Site, a collaborative venture of the USGS, Enbridge Energy, Limited Partnership, the Minnesota Pollution Control agency, and Beltrami County: Evaluating oil spill toxicity to improve water remediation. ($14,517) Mc-Guire (PI) Martinovic-Weigelt (co-PI) - project not active; funds exhausted and project completed.	05/15-08/16	$14,517

VIII. REPORTING REQUIREMENTS:

- **The project is for 3 years, will begin on 07/01/2017, and end on 06/30/2020.**
- **Periodic project status update reports will be submitted *[06/30]* and *[12/31]* of each year.**
- **A final report and associated products will be submitted between June 30 and August 15, 2020**.

IX. VISUAL COMPONENT or MAP(S):



Environment and Natural Resources Trust Fund
M.L. 2017 Project Budget

Project Title: Reassessing Toxicity of Petrochemical Spills on Groundwater and Surface Waters
Legal Citation: M.L. 2017, Chp. 96, Sec. 2, Subd. 04e
Project Manager: *Dalma Martinović-Weigelt*
Organization: *University of St. Thomas (UST)*
M.L. 2017 ENRTF Appropriation: $*300,000*
Project Length and Completion Date: 3 *Years, June 30, 2020*
Date of Report:

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	***Chemistry of petroleum-impacted waters***			***Toxicity of petroleum-impacted waters***				
Personnel (Wages and Benefits)	$78,723	$0	$78,723	$97,195	$0	$97,195	$175,918	$175,918
Dr. Dalma Martinovic-Weigelt, Project Manager, Toxicologist, UST: $44,688 (93% salary, 7% benefits); 8.33% FTE each year for two years; 21.41% FTE for one year								
Dr. Jennifer McGuire, Biogeochemist, UST: $63,589 (93% salary, 7% benefits); 16.67% FTE each year for 3 years								
Dr. Chih Lai, Bioinformatician and Data Analyst, UST: $31,847 (93% salary, 7% benefits); 8.33% FTE each year for 2 years, 4.17% FTE for 1 year								
Dr. Mike Axtell, Mathematician, UST: $5,526 (93% salary, 7% benefits); 4.99% FTE for 1 year								
2 undergraduate Academic Year Research Assistants, UST: $9,600 (100% salary, 0% benefits); each student @ 8.83% FTE each year for 3 years								
2 undergraduate Summer Research Assistants, UST: $20,669 (93% salary, 7% benefits); each student @ 16.67% FTE each year for 3 years								
Professional/Technical/Service Contracts	$47,000	$0	$47,000	$0	$0	$0	$47,000	$47,000
US Geological Survey - Analytical chemistry service - 1440 chemical analyses at $32.63 each totaling $47,000 (i.e., 60 analytes at a minimum of 12 site locations in duplicate) will be conducted by USGS laboratories supervised by Dr. Isabelle Cozzare								
Equipment/Tools/Supplies								
High throughput toxicity assay supplies, assay runs and assay setup - 9000 analyses at $5.56 each totaling $50,000 (i.e., 50 samples tested in duplicate for 90 toxicity parameters)	$0	$0	$0	$50,000	$0	$50,000	$50,000	$50,000
Miscellaneous lab supplies - totaling $18,082 - capillaries, reagents, filters, buffers, sample processing supplies (disposable plastic sampling containers, pipette tips, chemicals, extraction columns), animal microcosm setups, and microbiology supplies.	$10,500	$0	$10,500	$7,582	$0	$7,582	$18,082	$18,082
Travel expenses in Minnesota								
Travel for project staff from St. Paul, MN to Bemidji, MN to conduct field sampling/experiments, 1 week field campaign - team of 4 x 5 days x $100 (cost of daily lodging and food) x 3 years = $6,000	$6,000	$0	$6,000	$0	$0	$0	$6,000	$6,000
Other - Computing time on a supercomputer/server	$0	$0	$0	$3,000	$0	$3,000	$3,000	$3,000
COLUMN TOTAL	**$142,223**	**$0**	**$142,223**	**$157,777**	**$0**	**$157,777**	**$300,000**	**$300,000**

Visual Component (also incorporated in the Work Plan document):

Project Manager Name: *Dalma Martinović-Weigelt*
Project Title: *Reassessing toxicity of petroleum spills with new technologies*