

**Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 065-B

Evaluating Oils Toxic Effects on Water Resources

Category: B. Water Resources

Total Project Budget: \$ 346,470

Proposed Project Time Period for the Funding Requested: 3.5 years, July 2016 to August 2019

Summary:

Evaluate the toxicology of natural waters impacted by crude oil spills using innovative high-throughput, high-content biological assays together with current and historical water chemistry data to evaluate health hazards.

Name: Jennifer McGuire

Sponsoring Organization: University of St. Thomas

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Web Address

Location

Region: NW

County Name: Beltrami

City / Township:

Alternate Text for Visual:

Study Site Image

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____ %



Environment and Natural Resources Trust Fund (ENRTF)
2016 Main Proposal
Project Title: Evaluating oil's toxic effects on water resources

PROJECT TITLE:

Evaluating oil's toxic effects on water resources

I. PROJECT STATEMENT

Minnesota is known for its quality water resources, but they are threatened by spills of petroleum from leaking underground storage tanks, oil refineries, and spills from the transnational pipeline that crosses our state. Though we understand the risks of cancer from drinking water contaminated with oil, far less is known about other possible toxicological effects (especially on endocrine disruption). The work proposed here would expand our understanding of the lasting effects of oil spills on drinking water and allow regulators to better prioritize clean-up efforts to mitigate risk to human and ecological health given limited funds.

Minnesota is located between the vast oil reserves of Alberta and oil refining facilities in the south, and petroleum spills are prevalent throughout the state; the MN Pollution Control Agency-Petroleum Remediation Program (MPCA-PRP) is monitoring more than 19,000 leaking tank sites. Billions of gallons of crude oil are moving across the state through hundreds of miles of pipelines, with requests to increase that volume under consideration. When large volumes of any substance are transported and stored, there will inevitably be releases to the environment and small releases occur often. And though we should work to minimize these events, realistically our goal cannot be to attempt to prevent all releases but rather to have strong scientific data to enable us to select effective remediation strategies that prioritize risks to human and ecosystem health so that our limited funds can be best spent to protect the people and resources of Minnesota. The long-term research **goals** of our group are to better understand the hazards posed by oil spills in natural systems.

We will test waters from the National Crude Oil Spill Research Site, located west of Bemidji, MN, where a pipeline rupture released 10,000 barrels of crude oil into a wetland-aquifer-lake system in 1979. This is an ideal site, as our work will build on more than 30 years of research into how oil moves and breaks down. Recent studies suggest that some chemicals found in petroleum can be toxic via a variety of mechanisms, including producing hormone-like activity (estrogenic or androgenic). Our work is significant in that we will expand our understanding of the hazards posed by oil spills by using state-of-the art, high throughput (fast measurements) and high content (many measurements at once) biological. These assays will allow us to quickly, cheaply and efficiently evaluate approximately 150 biological responses indicative of toxicity of the oil-water solutions that result in various real-life and simulated environments as oil moves and breaks down.

Activity 1: Characterize the water chemistry and toxicological activity of natural waters contaminated by crude oil.

Budget: \$ 151,340

Water samples will be collected from environments at the National Crude Oil Spill Research, including locations within the aquifer plume, wetland, and lake. We will analyze the current and historical water chemistry of these locations using well established methods within the PI's expertise. Samples will also be analyzed for approximately 150 different modes of toxicity (including carcinogenesis, DNA damage, endocrine disruption, neurotoxicity etc.) using cutting-edge techniques where living cells/proteins are exposed to water samples and screened for changes in biological activity that are indicative of potential toxic effects. These recent, innovative methods can quickly and efficiently screen samples for toxicity responses to evaluate the potential of the complex environmental samples to pose hazards to human and ecosystem health.

Outcome	Completion Date
1. Characterize the current and historical chemistry of contaminated water samples	June 2017
2. Characterize the toxicity of samples from the site using cell/protein assays	September 2017
3. Identify areas of greatest risk and communicate results to regulators (MPCA, MDH)	October 2017



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Activity 2: Determine the chemistry and toxicity of waters generated by mixing at interfaces including groundwater and surface water interactions.

Budget: \$ 195,130

Our prior research has shown that these mixing interfaces are the most dynamic parts of the system and warrant further investigation. Experiments will be conducted in which waters from the site are mixed in the presence of natural sediments to initiate reactions. The resulting water chemistry will be representative of that which would likely occur at the interfaces between groundwater and surface water (wetland or lake) and will be analyzed as described in Activity 1. . In addition, assays with live animals important for ecosystem functioning (e.g., *Daphnia* species (waterflea) and native fish) will be conducted. Direct assessments of impacts on organisms is important as they commonly use these interface areas for feeding and reproduction. To investigate effects on organisms we will conduct in vivo survival and reproduction toxicity tests. Effects on the health of exposed animals will be evaluated using high content assessment, where the responses of the whole genome are evaluated at once, using microarray and/or RNA sequencing techniques.

Outcome	Completion Date
1. Conduct field and lab experiments to simulate groundwater-surface water interfaces	June 2018
2. Characterize the resulting water chemistry, toxicity and hazard to native aquatic species (invertebrates and fish)	December 2018
3. Communicate findings to interested parties as in Activity 1	June 2019

Activity 3: Educational Dissemination and Outreach

Budget: \$ 0 new,
included above

We will use project data to enhance Minnesota's STEM education through a) the direct training of students, b) classroom activities developed for undergraduate courses taught by the PIs, and c) dissemination of educational materials through online academic routes such as SEAK. The SEAK ("Scientists Eagerly Acquiring Knowledge") program is a partnership between Wolf Ridge Environmental Learning Center, the Boys & Girls Clubs, and several schools to give urban students an opportunity to explore careers in science.

Outcome	Completion Date
1. Incorporation of new activities in UST Biology Courses	September 2018
2. Dissemination of knowledge via SEAK program	June 2019

III. PROJECT STRATEGY

A. Project Team/Partners

This project will be carried out under the supervision of Drs. McGuire and Martinovic (University of St. Thomas), with collaborators Dr. Cozzarelli (United States Geological Survey) and Dr. Vinas (MS State University). Information transfer and study design will be conducted with existing and new contacts at the MN Department of Health and Minnesota Pollution Control Agency Petroleum Remediation Program Staff.

B. Timeline Requirements

Sampling will occur 2016-2019. Final reports will be issued August 2019 and PIs will disseminate results as they are obtained at National Meetings, through peer-reviewed publications, and information transfer meetings with above identified collaborators. Additional no-cost outcome will be curriculum development from project data.

C. Long-Term Strategy and Future Funding Needs

This project will provide critical data of the longer term effects of oil spills on human and ecological health for use by regulatory agencies, such as the MN pollution control agency and MN Dept. of Health, to best manage contaminated sites in a cost effective and safe manner.

2016 Detailed Project Budget

Project Title: *Evaluating oil's toxic effects on water resources*

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM <i>(See "Guidance on Allowable Expenses", p. 13)</i>	AMOUNT
University of Saint Thomas Personnel: Jennifer McGuire, Principal Investigator (PI), 2 months salary (16.6% effort) per year (totaling \$59,070 for 3 yrs) plus 7.65% fringe (\$ 4,519) for 3 years). Duties: Responsible for coordinating project, conducting field experiments & chemistry analyses, and compiling reports and disseminating results. Dalma Martinovic, Co-Principal Investigator (Co-PI), 1 month salary (8.33% effort) per year (totaling \$27,260 for 3 yrs) plus 7.65% fringe (\$2,085.37 for 3 years). Duties: Responsible for high throughput assay assessment, analyses and interpretation of those assays, compiling reports and disseminating results. Undergraduate students , Assist with field sampling and lab analyses. One student during the academic year, 10 hrs for 32 weeks each year @ \$10/hr, totaling \$9,600 for three years, no fringe (0%). 2 students during each summer, 40 hrs/week for 10 weeks @ \$10/hour totaling \$24,000 plus 7.65% fringe (\$1,836).	\$128,370
Contracts: Some of the water and sediment sampling and analytical chemistry (ex. organic chemistry characterization) work will be conducted by USGS laboratories supervised by Dr. Cozzarelli. The subcontract amount will include supplies for chemical analyses and travel to field sites in Minnesota to collect samples for these analyses. High content (microarray/RNA sequencing analyses on native animal tissues from fish (28 samples) and invertebrates (28 samples) will be conducted by Dr. Vinas at MS State University who has access to state of the art genomic facility and is a leader in this field.	\$ 121,000
Equipment/Tools/Supplies: \$57,200 - High Throughput toxicity assay runs - ca \$4,400 per sample. \$6,900 Field sampling supplies (bottles, tubing, filters, reagents): \$13,400 Miscellaneous lab supplies (capillaries, reagents, filters, buffer solutions) and sample processing supplies (disposable plastic sampling containers, chemicals, extraction supplies etc.); \$4,900 Lab animal microcosm setups and microbiology supplies.	\$ 82,400
Acquisition (Fee Title or Permanent Easements): <i>In this column, indicate proposed number of acres and and name of organization or entity who will hold title.</i>	-
Travel: Travel to conduct field sampling and field experiments, 1 week field campaign - team of 4 x 5 days x 100 (lodging and food)x 3 yrs = \$6,000; Mileage for travel to field sites in MN @ \$0.50/mile = \$5,100; Present findings of the study at the annual conference of Society of Env Toxicology and Chemistry (McGuire), \$3,000.	\$ 14,100
Additional Budget Items: Computer Software for TOXcalcs (\$600)	\$ 600
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 346,470

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ Being Applied to Project During Project Period: <i>Indicate any additional non-state cash dollars to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.</i>	\$ -	<i>Indicate: Secured or Pending</i>
Other State \$ Being Applied to Project During Project Period: <i>Indicate any additional state cash dollars (e.g. bonding, other grants) to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending approval.</i>	\$ -	<i>Indicate: Secured or Pending</i>
In-kind Services During Project Period: <i>Dr. Cozzarelli will contribute 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)</i>	\$ 54,756	<i>Indicate: Secured or Pending</i>
Remaining \$ from Current ENRTF Appropriation (if applicable): <i>Specify dollar amount and year of appropriation from any current ENRTF appropriation for any directly related project of the project manager or organization that remains unspent or not yet legally obligated at the time of proposal submission. Be as specific as possible. Describe the status of funds in the right-most column.</i>	\$ -	<i>Indicate: Unspent? Not Legally Obligated? Other?</i>
Funding History: <i>Indicate funding secured prior to July 1, 2014, for activities directly relevant to this specific funding request, including past ENRTF funds. State specific source(s) of funds.</i>	\$ -	

Project Managers Qualifications and Organization Description

The University of St. Thomas (UST) - Jennifer McGuire, Ph.D. , Principal Investigator – Dr. McGuire is a Professor at UST, St. Paul, MN (2008-present). From 2002-2008 she served as an Assistant Professor at Texas A&M University where she was tenured. She completed her Ph.D. in Environmental Geoscience-Environmental Toxicology, at Michigan State University, 2002. Dr. McGuire has co-authored circa 20 research manuscripts that address chemical fate and transport and environmental biogeochemistry. Her research focuses on understanding the controls on the spatial and temporal variability of microbial metabolism which is necessary to evaluate health and safety concerns such as: chemical routes of exposure (risk assessment), natural attenuation and bioremediation capabilities, and the management of redox sensitive environments such as lakes, wetlands and estuaries. Dr. McGuire has been awarded, and has managed several externally-funded projects at UST (ca \$1,550,000) including MN PCA's Field Studies of Chemical and Microbiological Controls on Biodegradation Rates of Crude Oil in Aquifer and Wetland Systems and NSF's Biocomplexity in the Environment: Quantifying the Role of Mixing Interfaces in Biogeochemical Cycling in a Contaminated Aquifer-Wetland System: Linking Hydrogeological, Microbiological, and Geochemical Processes Grants.

The University of St. Thomas (UST) – Dalma Martinović-Weigelt, PhD –

Dalma Martinović-Weigelt completed her Ph.D. in Fisheries Science and Water Resources at the U of MN (2005), and served as National Academies Research Associate at the U.S. Environmental Protection Agency (USEPA) from 2006-09. Dr. Martinovic is an associate professor at University of St. Thomas in St. Paul, MN (2009-present). Dr. Martinovic-Weigelt's research interests include: 1) Characterization of proximate mechanisms that underlie behavior and reproduction in fish, 2) Assessment of effects of environmental stressors and contaminants (e.g., hypoxia, nitrates, chemicals of emerging concern) to inform adverse outcome pathway development for small fish models, 3) Optimization and development of approaches for bioeffects-based monitoring (using high-content, omic-based approaches). Dr. Martinovic has co-authored two reports to MN Legislature (Endocrine Disrupting Compounds, lrp-ei-1sy08; Wastewater Treatment Plant Endocrine Disrupting Chemical Monitoring Study, lrp-ei-1sy11) and circa 40 research manuscripts that assess occurrence and the effects of chemicals of emerging concern and other stressors on fish and aquatic ecosystems. Dr. Martinovic is a recipient of several US EPA's Scientific and Technological Achievement Awards. She has served on the Editorial Board of the Environmental Toxicology and Chemistry Journal, as a member of The Contaminant Screening Criteria and Prioritization Development Task Group for MN Dept. of Health, and as a president of Midwest Chapter of Society of Environmental Toxicology and Chemistry. Since her arrival to UST in 2009 Dr. Martinović-Weigelt has received external-funding from a variety of state and federal agencies including MN Pollution Control Agency, USEPA and National Science Foundation.

The University of St. Thomas (UST) – Institution Description

UST was founded in 1885 and emphasizes values-based education and career preparation, it helps solve community problems through education and service-learning programs. 56% of UST students receive need-based *scholarship or grant* aid. The largest private university in Minnesota (11,000 students, 461 full-time faculty), it offers bachelor's degrees in 85 major fields of study and 45 graduate degree programs, and is ranked as a National University. UST's Biology Department views -faculty research as essential - over the past 10 years, the faculty in Biology Department have received research grants from the NSF, NIH, USDA, USEPA, USGS, and multiple MN agencies (DNR, MPCA). Currently, the UST's Science Division has ca \$5.7 million of capital equipment, nearly half of which is owned/ maintained by Biology.