



Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-243

Proposal Title: Baseline Asbestos-EMP Study of NE Minnesota Air, Pre-Mining

Project Manager Information

Name: Stephen Monson Geerts

Organization: U of MN - Duluth - NRRRI

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Project Basic Information

Project Summary: Create an essential and time-sensitive mineral dust baseline dataset and sample archive, complete with critical information regarding asbestos minerals, prior to development of non-ferrous mining in northeast Minnesota.

Funds Requested: \$388,000

Proposed Project Completion: 2024-06-30

LCCMR Funding Category: Foundational Natural Resource Data and Information (A)

Project Location

What is the best scale for describing where your work will take place?

Region(s): NE

What is the best scale to describe the area impacted by your work?

Region(s): NE

When will the work impact occur?

During the Project

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

PROBLEM: Presently, size-fractionated baseline mineral dust data – defined by mineral species, including asbestos and elongate mineral particles (EMPs) – are lacking in NE Minnesota.

SOLUTION: A forward-looking project to collect, characterize, and archive aerosol mineral dust and lake sediment samples collected in areas upwind and downwind of potential non-ferrous (e.g., copper-nickel) mining activity in NE Minnesota.

Such a study would be scientific gold to future researchers doing retrospective environmental particulate matter (PM) air quality studies of mining in NE Minnesota. Baseline data (and samples) are vital for understanding pre-development conditions. Case in point: the Minnesota Taconite Workers Health Study (MTWHS) would have benefited greatly from having access to historic airborne PM samples and data collected BEFORE the commencement of taconite mining to best answer, “What had been in the air in the past?” (Geerts et al., 2019a-e; Zanko et al., 2019).

The lack of historical baseline data and samples limited the NRRI’s and the UM School of Public Health’s ability to quantitatively compare their respective MTWHS findings to past conditions. Therefore, essential foundational environmental baseline data must be collected and archived before – not after – potential mining activity commences, to proactively create a scientifically robust future air quality reference.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

We seek funding to conduct a pre-development baseline particulate matter survey that collects, characterizes, and archives aerosol mineral dust samples and age-dated lake sediment to: A) more accurately reflect pre-development (baseline/background) air quality; and B) use as a historical reference against which the impact of future mineral dust-generating activities can be compared. Three rounds of seasonal (winter and summer) sampling will take place over the project’s 3-year duration at three upwind and downwind locations. The NRRI has three Micro Orifice Uniform Deposit Impactors (MOUDIs), used during the MTWHS, to collect respirable mineral dust; and an EPA-approved high-volume sampler to co-locate at one of the downwind MOUDI locations.

This aerosol sampling approach will produce a database and archive of 36 sets of samples. A lake sediment core sample will also be collected, age-dated, characterized, and archived employing techniques described in Zanko et al. (2019). This sampling strategy is consistent with the aerosol sampling that occurred during the MTWHS, thereby providing a dataset that can be directly compared with a similar study of mineral dust associated with taconite mining-related activities.

Project Collaborators: Particle Technology and Electron Microprobe laboratories at the University of Minnesota; UMD’s Research Instrumentation Laboratory.

Project Input: MPCA

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state’s natural resources?

The project is an opportunity to practice the “Precautionary Principle” and collect aerosol PM data in NE Minnesota prior to potential mineral development, creating a statistically robust foundational dataset of high-quality airborne PM characterization information and archived samples that regulatory agencies typically do not produce. Baseline, size-fractionated, mineral species PM data are vital if we are to understand potential environmental/health impacts of development. The project must be done now so that the state doesn’t regret not having these essential data later.

Future investigators would find such a database and sample resource extremely beneficial when conducting follow-up comparative environmental studies.

Activities and Milestones

Activity 1: Air and Lake Sediment Sampling Site Selection and Sampling Plan

Activity Budget: \$75,000

Activity Description:

Three secure particulate matter (PM) air sampling and weather station locations will be selected that are sited: 1) upwind and 2) down-wind of the potential mineral development, and 3) at a background/control location (Ely) that hosts an active MPCA/EPA air monitoring station, and where the project's air sampling equipment can be co-located. A statistically robust project sampling plan will be developed. Air sampling instrumentation and equipment will be prepared, tested, calibrated, and field-checked prior to use. A lake sediment core sampling location downwind and within the watershed of potential mining activity will also be selected.

Activity Milestones:

Description	Completion Date
Literature search performed; historic meteorological and air quality data compiled	2021-09-30
Sampling sites and secure set-up locations identified, field-checked, and selected	2021-10-31
Sample characterization methodologies finalized; analytical laboratories selected	2021-11-30
Supplemental sampling equipment obtained	2021-12-31
Air sampling equipment tested; project support supplies obtained; protective housings for equipment purchased or fabricated	2022-01-31

Activity 2: Years 2 & 3 Air Sampling and Analysis, Characterization, and Archiving

Activity Budget: \$163,000

Activity Description:

Remaining seasonal samples (24) will be collected, as in Activity 2, and undergo gravimetric, chemical, mineralogical, and microscopic analysis and characterization. A database of analytical results will be assembled/interpreted, and samples will be archived. In addition to the final report, the project team intends to develop a peer-reviewed journal manuscript and submit it for publication in a scientific journal. Peer-reviewed publication of this work may be a vital component to obtaining future industry, state and/or federal funding to continue this work (see below; Long-Term Implementation and Funding).

Activity Milestones:

Description	Completion Date
Ancillary data (e.g., MPCA/EPA, meteorological, etc.) compiled, analyzed, and compared to project data	2023-12-31
Air sample PM characterized per Activity 2; results compiled and interpreted.	2024-03-31
All samples documented, archived, and stored	2024-04-30
Final report published of baseline PM characteristics of ambient air in the project area	2024-06-30

Activity 3: Year 1 Air and Sediment Sampling, and Initial Laboratory Analysis

Activity Budget: \$150,000

Activity Description:

The project team will conduct week-long (168-hour) air sampling at the three locations identified in Activity 1, with sampling occurring every 3 months, beginning in 2022. Size-fractionated PM mineralogical data will be collected,

consistent with protocols developed by the NRRI in the MTWHS. One high-volume aerosol and three MOUDI sampling devices will be used. Week-long sampling is required due to low PM measurements in NE Minnesota and also eliminates any bias that may occur due to work week/weekends (Monson Geerts et al., 2019a-e; Zanko et al., 2019). Twelve sets of samples (3 locations sampled 4 times per year – winter, spring, summer and fall) will be collected and characterized. Lake sediment core will be collected through the ice in early 2022. As practiced during the MTWHS, analytical methods and mineral species identification will follow guidelines established by the National Institute of Occupational Safety and Health (NIOSH) (NIOSH, 2011), International Organization for Standardization (ISO), U.S. Environmental Protection Agency (USEPA), and the Minnesota Pollution Control Agency (MPCA), including using Minnesota Department of Health (MDH) transmission electron microscope (TEM) methods 851 and 852. Gravimetric (mass), lake sediment PM isolation, electron microprobe, X-ray diffraction, and chemical analysis of PM will be conducted.

Activity Milestones:

Description	Completion Date
Lake sediment core sample collected, sampled, freeze-dried, and age-dated	2022-06-30
Lake sediment samples elutriated to isolate EMPs (e.g., PM2.5); TEM analysis MDH 851	2022-12-31
Air samples collected at three locations every three months; twelve (12) sample sets, total	2022-12-31
Laboratory prep work and gravimetric (mass) analysis of twelve (12) Year 1 air sample sets	2023-02-28
Air sample PM characterized (mineralogy, chemistry, and electron microscopy). TEM analysis by MDH method 852	2023-04-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Bernard Olson	University of Minnesota Particle Technology Laboratory, Department of Mechanical Engineering	Aerosol science and air sampling equipment consultation.	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

This project will produce foundational PM air quality data and an archive of PM and lake sediment samples. Following project completion, these baseline data/archived samples will be available to future researchers/agencies as a valuable historic environmental reference for follow-up air quality and sediment characterization surveys as NE Minnesota mineral resource development evolves. Taking a time-sensitive strategy, the project will be a model for conducting similar baseline PM characterization studies in this area and elsewhere in Minnesota. If additional work is needed, funding from sources such as the federal government (e.g., NIOSH), industry, and NGOs would be sought.

Project Manager and Organization Qualifications

Project Manager Name: Stephen Monson Geerts

Job Title: Senior Research Geologist and Mineralogy Lead

Provide description of the project manager's qualifications to manage the proposed project.

The project manager, Stephen Monson Geerts, led the NRRI's environmental field sampling and laboratory characterization efforts during the Minnesota Taconite Workers Health Study (MTWHS). The NRRI's environmental particulate matter (PM) characterization efforts were focused on quantifying the presence of elongate mineral particles (EMPs), as well as the mass concentration, mineralogy, and chemistry of the PM present in communities and taconite facilities on the Mesabi Iron Range (MIR). The study resulted in the production of an executive summary report...

Monson Geerts, S.D., Hudak, G.J., Zanko, L.M., & Fosnacht, D.R. (2019). Summary Report: Environmental Particulate Matter Characterization.

...and six separate NRRI technical reports. The project manager was principal author for five of the six reports (links provided)

Geerts et al., 2019a: <https://conservancy.umn.edu/handle/11299/208473>

Geerts et al., 2019b: <https://conservancy.umn.edu/handle/11299/208474>

Geerts et al., 2019c: <https://conservancy.umn.edu/handle/11299/208475>

Geerts et al., 2019d: <https://conservancy.umn.edu/handle/11299/208476>

Geerts et al., 2019e: <https://conservancy.umn.edu/handle/11299/208477>

Monson Geerts was also project manager for the ENRTF-supported project, "Assessment of Natural Copper-Nickel

Bedrocks on Water Quality" conducted in collaboration with the United States Geological Survey (USGS) and MDNR, completed on June 30, 2017. He received his B.S. and M.S. Degrees in Geology (with a minor in Hydrogeology) from the University of Minnesota, Duluth in 1984 and 1994, respectively, is a registered professional geologist, and has considerable knowledge of and experience with the geology and mineralogy of the Duluth Complex and its associated mineral deposits.

Organization: U of MN - Duluth - NRRI

Organization Description:

The Natural Resources Research Institute (NRRI) is an applied research and economic development engine for the University of Minnesota research enterprise. NRRI employs over 130 scientists, engineers and technicians to deliver on its mission to deliver research solutions to balance our economy, resources and environment for resilient communities. NRRI collaborates broadly across the University system, the state and the region to address the challenges of a natural resource-based economy.

NRRI researchers have extensive experience in managing large, interdisciplinary projects. NRRI's role is as an impartial, science-based resource that develops and translates knowledge. Projects include characterizing and defining resource opportunities, minimizing waste and environmental impact, maximizing value from natural resources and maintaining/restoring ecosystem function.

Major outcomes from NRRI projects include informing environmental management and policy and assisting industry and communities in defining and maintaining the social license to operate in natural systems. NRRI has an established mechanism for sharing outcomes through press releases, publication in peer-reviewed journals, annual reports (<https://www.nrri.umn.edu/resources-publications/annual-reports>), periodicals, and through social media channels.

The project will be led by NRRI's Minerals & Metallurgy Group, and will be comprised of a multidisciplinary team of researchers representing the NRRI and UMTC.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Euan Reavie, Researcher 7		co-investigator: Paleolimnologist, lake sediment core sampling and analysis			26.7%	0.15		\$25,034
Sara Post, Researcher 4		GIS, field, and lab work; data assembly and analysis			24.1%	0.6		\$35,650
Lawrence Zanko - Senior Research Program Manager, Researcher 7		co-investigator and manager			26.7%	0.3		\$45,827
Bernard Olson - Mechanical Engineer		Aerosol scientist - aerosol sampling equipment testing and operation			26.7%	0.15		\$22,620
Kitty Kennedy - Lab Technician Researcher 4		Field and laboratory work			24.1%	0.1		\$6,600
Elizabeth Alexson - Lab Technician Researcher 4		Field and laboratory work			24.1%	0.1		\$7,945
TBD - Temporary casual position		Miscellaneous field, lab, and office assistance			7.3%	0.15		\$5,154
TBD - Researcher 4		Field and laboratory assistance, data compilation			24.1%	0.3		\$22,471
TBD - Undergraduate student worker		Laboratory and field assistance and data entry			0%	0.15		\$4,773
Stephen Monson Geerts - Senior Research Geologist and Mineralogy		Project manager			26.7%	0.75		\$80,561

Lead, Researcher 6								
Meijun Cai, Researcher 6		Statistician			26.7%	0.15		\$15,340
George Hudak		Geologist/mineralogist/project overview			26.7%	0.09		\$17,633
							Sub Total	\$289,608
Contracts and Services								
St. Croix Watershed Research Station	Professional or Technical Service Contract	Processing and age-dating of one lake sediment core. Lake sediment core will provide pre-settlement to present day material for chemical, mineralogical, and microscopic characterization, including respirable mineral particles				-		\$3,000
Pace Analytical	Professional or Technical Service Contract	MDH 851, Transmission Electron Microscope analysis to identify elongate mineral particles (EMPs) from lake sediments: 20 samples @\$500/sample MDH 852, Transmission Electron Microscope analysis to identify elongate mineral particles (EMPs) from aerosol samples: 40 samples @\$500/sample. Provides mineral particulate matter identification for elongate mineral particles using Minnesota Department of Health criteria				-		\$30,000
Elemental Analysis, Inc.	Professional or Technical Service Contract	Proton Induced X-Ray Emission (PIXE) chemical analysis of particulate matter from lake sediments and aerosol: 100 samples @\$115/sample. Provides chemical analysis of PM				-		\$11,500
Maxxam Analytical	Professional or Technical Service Contract	X-ray Diffraction to identify/quantify respirable silica analysis: 40 samples @ \$150/sample. To provide respirable silica baseline information				0		\$6,000
University of Minnesota Duluth	Internal services or fees (uncommon)	UMD Instrumentation Laboratory (\$5,250): Fees for use of scanning electron microscope (SEM) and X-ray diffractometer; for mineral particle analysis. Supplemental characterization of PM				-		\$5,100
University of Minnesota	Internal services or fees (uncommon)	UM Twin Cities Electron Microprobe Laboratory (7 days of expenses at \$1155/day). Detailed mineralogical and microscopic characterization of PM				-		\$8,085

							Sub Total	\$63,685
Equipment, Tools, and Supplies								
	Tools and Supplies	Peristaltic Pump	Adjustable flow-rate peristaltic pump for water elutriation isolation of respirable mineral particles from lake sediment samples					\$2,500
	Tools and Supplies	Davis weather station (\$700) and support supplies (\$50)	For collecting/recording weather conditions during air sampling					\$750
	Tools and Supplies	Field and lab supplies	Lab supplies (\$2,457): air sampling filter substrates (polycarbonate, mixed cellulose ester, foil, Teflon), flexible tubing for pumps and MOUDIs, lubricant, reagents, cutting tools, gloves, glassware, cleaning supplies, thermometer. Field supplies (\$2,000): safety gear and first-aid supplies, extension cords for powering sample collection instrumentation and support instruments/equipment, battery power backups for air sampling instrumentation					\$4,457
	Tools and Supplies	Four (4) vacuum pumps	For providing air flow for ambient air sampling to three MOUDI and one high-volume PM aerosol samplers					\$4,000
							Sub Total	\$11,707
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Conference Registration	Vehicle mileage and usage	Mileage (~20,000 miles reimbursed at \$0.575/mi, +100 days at \$10/day for					\$12,500

	Miles/ Meals/ Lodging		vehicle usage) for travel between NRRI, sampling/field sites; and to Twin Cities for meetings/consultations/laboratory visits; in-state conferences to present results of project.					
	Miles/ Meals/ Lodging	Lodging and daily per diem meal expenses for in-state travel	52 nights of lodging (2 people x 26 nights) for field work at project site and travel to Twin Cities for additional project work and meetings. Estimate \$150/night based on apportioning lodging and M&IE to 75% Standard and 25% Mpls/St. Paul GSA rates Total: 50 nights x \$150 = \$7,500					\$7,800
	Conference Registration Miles/ Meals/ Lodging	Conference attendance and presentation for 3 people	To cover registration cost for 2024 SME conference in Duluth for 3 attendees to present project findings.					\$1,500
							Sub Total	\$21,800
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
		Shipping/mailing (\$1,250): Delivery of samples to analytical labs, and return of samples	To cover shipping costs associated with sample analysis and supply acquisition					\$1,200
							Sub Total	\$1,200
							Grand Total	\$388,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
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Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	-
Non-State				
In-Kind	UMN unrecovered indirect costs are calculated at the UMN negotiated rate for research of 55% modified total direct costs.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	\$213,400
			Non State Sub Total	\$213,400
			Funds Total	\$213,400

Attachments

Required Attachments

Visual Component

File: [043250a5-316.pdf](#)

Alternate Text for Visual Component

The attached visual for the proposal "Baseline Asbestos-EMP Study of NE Minnesota Air, Pre-Mining" depicts the region in NE Minnesota where future mining (precious metal deposits) would most likely occur, shows the proposed project sampling locations at the northern margin of the Duluth Complex, and illustrates prevailing winter and summer wind directions, including a wind rose diagram. The visual also shows photographs of air sampling and laboratory equipment, and a microscopic image of an elongate mineral particles/fibers (EMP). The visual highlights the project's anticipated results and benefits, stressing the importance of conducting baseline air sampling, lake sediment sampling, and mineral dust characterization (including the identification of asbestos-EMPs) downwind of these potential mining locations, to create an archived data and sample reference for (future) air quality and health studies once mining commences.

Optional Attachments

Support Letter or Other

Title	File
Sponsored Projects Authorization	f2e7afce-d15.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

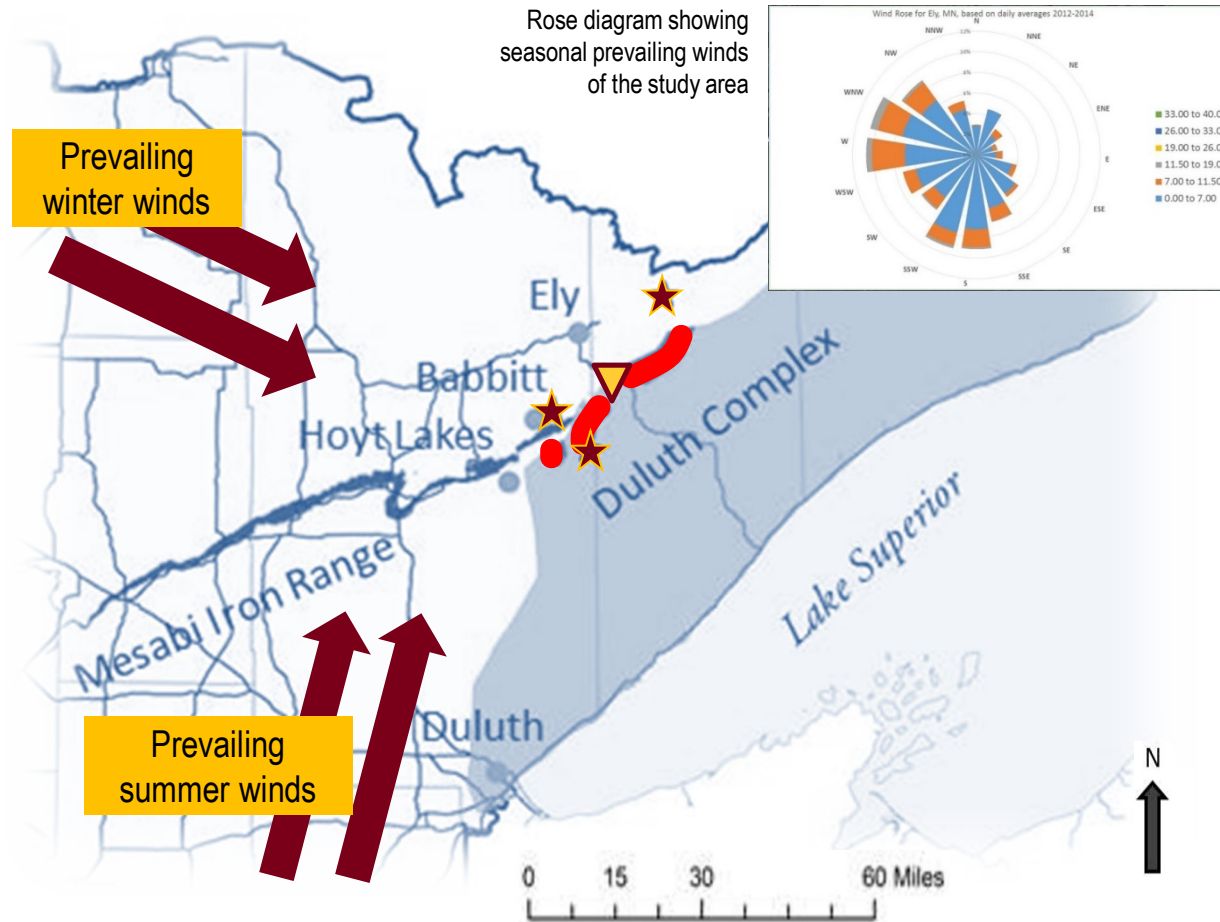
No

Does your project include research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration



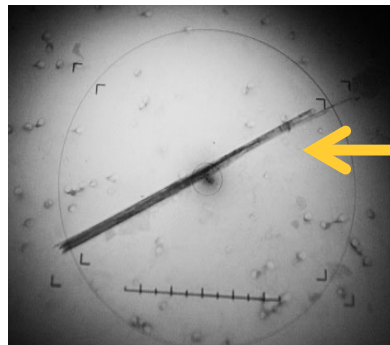
MAP KEY

- Lake Sampling Location**
Lake sediment can act as an air quality archive and time capsule, and allow us to assess what was in the air years ago.
- Air Sampling Locations**
(based on seasonal prevailing winds)
- Prospective Cu-Ni mining**



**Davis
Weather
instrument**

**MOUDI
sampler**



Actinolite fiber
L: 4.8 μm W: 0.2 μm
Aspect Ratio: 24:1
Surface Area: 3.92 μm^2

Mineral Particle ID
and measurement



PROJECT RESULTS AND BENEFITS

- ✓ Better baseline air quality data
- ✓ Accurate characterization at the particle-scale
- ✓ Creates resource for researchers and regulatory scientists to improve future air quality assessments

