

**Environment and Natural Resources Trust Fund
2012-2013 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 013-B

How Do Natural Copper-Nickel Bedrocks Influence Water Quality?

Topic Area: B. Forestry/Agriculture/Minerals

Total Project Budget: \$ 669,267

Proposed Project Time Period for the Funding Requested: 3 yrs. July 2013 - June 2016

Other Non-State Funds: \$ 0

Summary:

Minnesota will promote economic development of mineral resources and preserve the environment in northeastern Minnesota by collecting background chemistry on water, rocks, soils and stream sediments.

Name: Steven Hauck

Sponsoring Organization: U of MN - Duluth NRRI

Address: 5013 Miller Trunk Hwy
Duluth MN 55811

Telephone Number: (218) 720-4273

Email shauck@nrri.umn.edu

Web Address http://www.nrri.umn.edu

Location

Region: NE

County Name: Lake, St. Louis

City / Township:

<input type="checkbox"/>	Funding Priorities	<input type="checkbox"/>	Multiple Benefits	<input type="checkbox"/>	Outcomes	<input type="checkbox"/>	Knowledge Base
<input type="checkbox"/>	Extent of Impact	<input type="checkbox"/>	Innovation	<input type="checkbox"/>	Scientific/Tech Basis	<input type="checkbox"/>	Urgency
<input type="checkbox"/>	Capacity Readiness	<input type="checkbox"/>	Leverage	<input type="checkbox"/>	Employment	<input type="checkbox"/>	TOTAL <input type="checkbox"/> %



Environment and Natural Resources Trust Fund (ENRTF) 2012-2013 Main Proposal

PROJECT TITLE: How Do Natural Copper-Nickel Bedrocks Influence Water Quality?

I. PROJECT STATEMENT

This proposed study will determine if copper, nickel, and other metal concentrations in rocks, streambed sediments, and soils are currently influencing regional water quality in areas of potential base-metal mining. What influence does existing copper, nickel, and other metals occurring naturally in NE Minnesota bedrocks currently have on water quality prior to any mining? An understanding of existing environmental or background conditions is required in watersheds is being proposed to accurately assess and predict water-quality impacts of potential mining.

Site-specific environmental impact studies for proposed mine sites are localized studies that do not give the regional context needed to establish the pre-mining, natural geochemical variability that is critical to effectively protect the regional water quality and manage natural resources in NE MN. Minnesota faces a major challenge: how to promote economic development in NE MN while protecting existing water quality and sensitive ecosystems. The world’s largest deposits of copper, nickel, cobalt, platinum-group-elements and titanium in NE MN can give huge economic and employment benefits and give valuable metals to the Nation. However, streams and rivers that flow over these deposits discharge into the Boundary Waters Canoe Area Wilderness and other environmentally sensitive watersheds. Federal, State, local, and tribal entities, mining companies, and environmental consultants need up-to-date and accurate data to assess and predict water-quality impacts of existing mineralization and potential mining. The complicated geologic setting of NE MN will make predicting the potential water-quality impacts of mining challenging, and yet will be required.

The new data and hydrologic analysis will be used by Federal, State, local, and tribal entities to better assess water-quality impacts of existing mineralization and potential mining. In the proposed study, water-quality, streambed sediments, soil, and rock samples will be collected and analyzed in three unmined watersheds with different mineral deposit settings commonly present in NE MN: (1) copper, nickel-cobalt-platinum group metal deposits, (2) titanium-oxide deposits, and (3) no mineral deposits. In each of the three watersheds, water samples will be collected at four locations on a quarterly basis for two years (total of 96 samples). The water samples will be analyzed for 18 metals, 12 major constituents (ions) and dissolved organic carbon. A total of 23 soil, 15 streambed sediment, and 15 rock samples will be collected in the watersheds and analyzed for 37 metals and 7 major ions. Streamflow data from 3 installed stream gages (1 gage per watershed) will be combined with existing and new water-quality data to develop conceptual hydrologic models for each watershed. Modeling results will better assess the nature and extent of possible mine development impacts on regional water quality. Water-quality and modeling results will be compared to data available in the 1979 *MM Environmental Quality Board Regional Copper-Nickel Study* to assess long-term trends in water quality.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Characterize streambed sediment, soil, and bedrock chemistry **Budget:** \$182,168

1. In each of 3 watersheds, 3 streambed sediment, 5 soil, and 3 bedrock samples will be collected and analyzed for metal and major constituent concentrations. Three bedrock samples from the State of Minnesota core facility will be analyzed for metal and major constituent concentrations.
2. Based on the chemistry, additional 2 streambed sediment and 2 soil samples will be collected in each watershed to describe areas of higher metal and/or major constituent concentrations.

Outcome	Completion Date
1. Determine Metal/Major Constituent Distribution in bedrock	12/2013
2. Determine Metal/Major Constituent Distribution in soils	12/2014
3. Determine Metal/Major Constituent Distribution in streambed sediments	12/2014

Activity 2: Determine natural metal and major constituent loads in streams **Budget:** \$274,255

1. Three gages will be installed and operated, one gage in each watershed, in streams that drain the watersheds selected for the study to assess temporal flow changes in the watersheds.
2. Streamflow measurements will be made to develop a water-level/flow rating curve at each gage. A precipitation gage will be installed at each stream gage.
3. In each of the 3 watersheds, water quality samples will be collected 4 times a year for two years and analyzed for 18 metals, 12 major constituents, and dissolved oxygen to determine temporal and spatial variations in metal, major constituents, and dissolved oxygen concentrations.
4. Streamflows and water-quality data will be used to assess variations in metal and major constituent loads in streams in the three watersheds.

Outcome	Completion Date
1. Determine temporal flow rates in streams - stream gages	4/2013
2. Determine background metal and major constituent loads in streams	6/2015

Activity 3: Assess hydrologic conditions prior to potential future mine development **Budget:** \$212,844

1. A conceptual hydrologic model will be developed for the three watersheds to assess hydrologic settings present in the watersheds prior to mine development and assess potential impacts of various mining activities on the water quality.
2. A final interpretive report will be written to summarize all collected data, interpretations, and hydrologic modeling results, describing the regional geochemical and hydrological landscape.

Outcome	Completion Date
1. Develop Conceptual Hydrologic Models – 3 watersheds	12/2015
2. Develop Hydrologic Scenarios of Various Mining Activities – 3 watersheds	5/2016
3. Summary of Collected Data and Hydrologic Modeling Results – 3 watersheds	6/2016

III. PROJECT STRATEGY

A. Project Team/Partners

Partners to receive funding from the Environment and Natural Resources Trust Fund

Duluth Minerals Section of the Natural Resources Research Institute [NRRI]: **Steve Hauck** (Director) will co-manage the project and serve as the fiscal agent; **Mark Severson** (geologist) will provide the bedrock samples and mineral deposit expertise.

U.S. Geological Survey: **Laurel Woodruff** (geologist) will co-manage the project, overseeing streambed sediment, soil, and bedrock sampling and geochemical analyses; **Perry Jones** (hydrologist) will oversee stream gaging, water-quality sampling and analyses, and hydrologic model development.

Minnesota Department of Natural Resources: **Carrie Jennings** (geologist,) will provide expertise on glacial and sediment geochemistry. All parties will be responsible for report completion.

B. Timeline Requirements

The project will be completed in 3 years. Between July 2013 and Sept. 2014, all stream-bed sediment, soil, and rock samples will be collected and analyzed; stream gages will be installed and water quality sampling begin in 2013 and be completed by 2015. Between September 2014 and December 2014, all water-quality and geochemical data on streambed sediments, soils, and bedrock will be available and compiled; hydrologic modeling will begin. Between Dec. 2014 and June 2016, hydrologic modeling will be completed; a final report on the landscape geochemistry and hydrologic modeling will be completed.

C. Long-Term Strategy and Future Funding Needs

The large metal tonnage in NE MN deposits and increasing metal prices strongly suggest that metal mining in the area will occur at some point in time. If regional details about current, existing surface water quality, and the concentration and distribution of elements in rocks, soils, and stream-bed sediments are not available before mining begins, then it will not be possible to accurately predict mining impacts on the environment. The data collected for this study could be a template for both larger-scale and more focused water-quality/geochemical studies along the mineralized zones in NE MN.

2012-2013 Detailed Project Budget

IV. TOTAL ENRTF REQUEST BUDGET

3 years

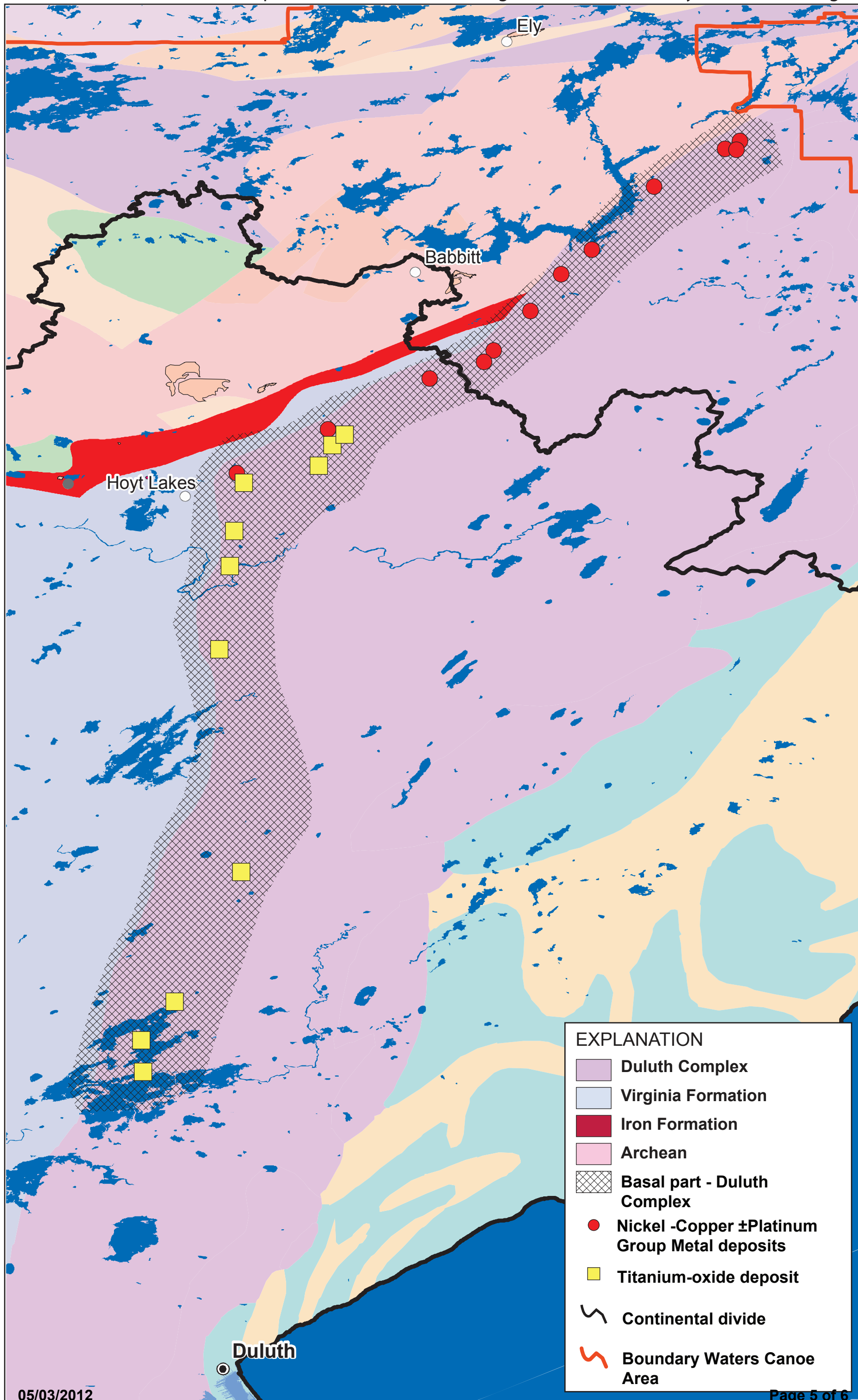
BUDGET ITEM <i>(See list of Eligible and Non-Eligible Costs, p. 11)</i>	AMOUNT
Personnel: Natural Resources Research Institute Director, 74% salary, 26% fringe, co-manager and fiscal agent	\$ 38,400
Personnel: Natural Resources Research Institute Geologist, 74% salary, 26% fringe, site selection, collection, and interpretation of bedrock samples	\$ 23,400
Contract: U.S. Geological Survey	\$ 589,867
Contract: Minnesota Department of Natural Resources Glacial Geologist, 4% FTE over 3 years, 30% fringe, site selection, collection, and interpretation of soil and bed-sediment samples	\$ 12,600
Travel: Natural Resources Research Institute Hotel/Per Diem Costs - for soil, bed-sediment, and bedrock sampling	\$ 5,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 669,267

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ Being Applied to Project During Project Period: U.S. Geological Survey, Federal Water Cooperative Funds	\$ 235,098	<i>Pending</i>
In-kind Services During Project Period: U.S. Geological Survey GS-14 geologist additional time - analysis of soil, bed-sediment, and bedrock chemistry data	\$ 12,800	Secured
Funding History: U.S. Geological Survey, Midwest Area, Mining Initiative Funds (2012 - 2014)	\$ 216,000	Secured

Project Title: How Do Natural Copper-Nickel Bedrocks Influence Water Quality?

NE Minnesota Metal Deposits Can Influence Background Water Quality Prior to Mining



Steven A. Hauck, Deputy Director (**Manager**)

Economic Geology, Particle/Material Characterization, and By-Product Utilization/Remediation Section
Minerals Division

Center for Applied Research and Technology Development

Natural Resources Research Institute, University of Minnesota Duluth

Adjunct Research Fellow - Dept. of Geosciences, University of Minnesota, Duluth – (2002 to present).

M.S. - Geology, University of North Carolina, Chapel Hill, North Carolina, 1977

B.A. with Honors in Geology - Albion College, Albion, Michigan, 1971.

Natural Resources Research Institute (NRRI) (1986 to present) NRRI Mission is to create jobs in environmentally sound manner in Minnesota

Deputy Director/Program Director (Nov. 1999 to present)

Oversees ten professional geologists and peat specialists covering research in non-ferrous, ferrous, industrial minerals, peat research and restoration, environmental remediation, particle and material characterization, and by-product usage, including project budgets, project execution, report editing, and report completion. Research on the Duluth Complex Cu-Ni-PGE and Cr occurrences, Rare Earth Elements, diamond exploration techniques and possibilities in Minnesota, and heat-mining/geothermal possibilities in Minnesota.

Research Fellow (Feb. 1994 – Nov. 1999) – Manager/Deputy Director, Economic Geology Group/Researcher

Senior Scientist – Scientist (July. 1985 – Feb. 1994) – Supervisor Economic Geology Group/Researcher

Publications – Author or Co-Author

Peer-Reviewed - 12

NRRI Internal Reports (34) - Duluth Complex (Cu-Ni-PGE deposits) – 15; Minnesota Clays – 13; Geochemistry – 8; Iron Ore – 4; Energy-Related – 2; and VMS & SEDEX – 4.

Laurel G. Woodruff, Research Geologist (**Co-Manager**)

Eastern Minerals & Environmental Resources Science Center

U.S. Geological Survey

Ph.D. – University of Chicago, Chicago, Illinois, 1989

M.S. – Geology, Michigan Technological University, Houghton, Michigan, 1977

B.S. – Geology, University of Michigan, Ann Arbor, Michigan, 1973

U.S. Geological Survey (USGS) (1983 to present)

Research Geologist (1988 to present)

Currently project Research Scientist on two USGS projects: 1) Landscape Geochemistry Project - finalizing multi-scale and multi-dimensional soil geochemical and mineralogical maps based on 15,000 soil samples collected from nearly 5000 sites across the conterminous 48 states; and 2) Concealed Deposits Project – Lake Superior Region, tasked with identify specific factors that influence the localization of the major mineral deposits in the Lake Superior region, including development of mineral deposit models for magmatic Cu-Ni-PGE sulfide and magmatic Fe-Ti oxide deposits, both types of mineralization found in the Duluth Complex in Minnesota. Currently supervising 3 geologists.
in Reston, Virginia. Supervised 2 technicians.

USGS Projects in the Lake Superior Region

- 1) Bedrock mapping of rocks of the Midcontinent rift in Michigan and Wisconsin, producing 5 maps at 1:100,000 scale.
- 2) Geochemical baseline study, Huron River Basin, Michigan.
- 3) Effects of forest fire on mercury in soils in the Boundary Waters Canoe Area Wilderness and Voyageurs National Park.
- 4) Metallogeny of the Midcontinent rift in the Lake Superior region.
- 5) Bedrock and soil geochemistry of federal lands in western Lake Superior (Voyageurs and Isle Royale National Parks, and Grand Portage National Monument).

Publications – Author or co-author

Peer-Reviewed - 31

USGS Reports - 24