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Marie-Claude Lapointe, ነጋበረብረኢ ምኒልክ ዳርፊን ለዲፎንድሚንት ባለቤት (DRDC), Valcartier ምኒልክ ዳርፊን (VRC), ሰብአዊ ምኒልክ ዳርፊን ዳይሬክተር ሆኖ አስተማሩ፡፡

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ፖብረ 16-ፖ 25-ፓ 2026, DRDC-dፍ ለጥቢሳቸው ልዩ ምርጫ ምክር ቤቱ ለፓላት 3 ዓይነት ህዝብ ምክር ቤቶች ለመረጥ ይፈቀዳቸዋል፡፡ ለዚህ ምርጫ ለመረጥ ምክር ቤቱ

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NRI

Scientific Research Licence Application

Section 5_Technical Project Proposal Description

Objectives: Provide well-defined short-term and long-term objectives for the project.

The long-term objective of this project is to provide tools, decision support and technology recommendations for cost effective DND/CAF environmental stewardship and protection in consideration of evolving climate and security challenges.

The five short-term main objectives are: 1) to survey evidence of munition constituents (MC) usage and measure their concentrations in soil and surface water using passive sampling devices; 2) to test new field sampling methods to enhance MC recovery; 3) to assess MC transport parameters from observed quaternary deposits and vegetation cover; 4) to determine the biotransformation potential of MC by local Arctic soil microbial communities and assess respective biotic transformation rates as a function of temperature; and 5) to perform aquatic and terrestrial toxicity tests of MC on ecological receptors representative of the Canadian Arctic macro- and micro-flora.

• **Background and Rationale:** the state of knowledge and research related to the problem or question(s) being investigated. Explain the history and development of the research questions and justify the significance of and need for the project.

Much like other elements of the CAF, the Canadian Army (CA) must continue to generate forces and meet its defence objectives. To continuously improve the environmental sustainability of its operations, bolstering efforts to further reduce environmental harm wherever possible must be maintained. Conducting research to understand, mitigate and reduce the overall environmental impact against potential biodiversity loss and pollution from the use and testing of munitions support well the new DND/CAF Climate Resilience and Environmental Sustainability Science & Technology Strategy (CRESST) objectives. Canada's Arctic and Northern Policy Framework (ANPF)¹ recognizes that climate change and an increasingly accessible Arctic are heightening international interest in the region and shaping Canada's security, now and in the decades ahead. Hence, DND/CAF, along with other government departments, contributes to various roles related to safety and security in the North such as through an array of Canadian Ranger tasks or operations, including sovereignty patrols². As such, the CAF must effectively predict and evaluate the use of energetic compounds in the North for the environmental sustainability of its operations relying on scientific data.

Limited number of data is presently available in the literature on the environmental fate and impact of energetic formulations and their respective compounds in relative pristine environment like the Canadian high North. Environmental assays including transport, degradation and ecotoxicity are often carried out at a temperature approximating indoor

¹ See Canada's Arctic and Northern Policy Framework [here](#).

² [The Canadian Rangers](#) provide community liaison, youth outreach and instruction, support to CAF efforts such as search and rescue, as well as northern surveillance and security reporting.

temperature, i.e. around 20°C, using optimal media and species that grow well under these temperate conditions. Unfortunately, the fate and impact data obtained for selected chemicals under optimal conditions do not transpose well for predicting the fate and impact of the same chemicals in Northern conditions^{3,4}. Hence, new ecotoxicity assays that are more relevant for predicting the environmental impact of chemicals in Northern environments must be developed. Also, assays that are less intensive in human and infrastructure resources and that could be applied and implemented by remote communities is certainly of interest.

The accomplishment of the above objectives will rise findings on the presence, fate and transport of MC in the Arctic needed to better provide advice and recommendation on training with munitions, to develop monitoring tools and help generate new range design.

• **Progress to Date:** Describe the results of any work completed to date. This section should also include information on any progress in the areas of capacity building, communications and/or the use of Indigenous knowledge.

This study on the fate and behavior of munition constituents in the high North will be the first known Defense Research and Development Canada (DRDC) research on the topic. If upcoming results from the collected samples at and surrounding this site prove the presence of munitions constituents at concentration of concern, mitigation and monitoring approaches could be recommended, foreseen and implemented. Indigenous knowledge could be used to proof a new range design proposal and bringing the idea forward.

• **Methodology:** Describe and justify the research design, research methodology, data analysis techniques, and the ethical research protocols to be followed (e.g. protocols to secure informed consent, community engagement). Explain where and when the work will be carried out and justify the selection of research locations.

The lifetime of the Resolute Bay project can be divided in 3 different phases. During the first phase of the project, evidence of MC usage will be survey and their concentrations in soil and surface water will be measured at Defense Research and Development Canada- Valcartier Research Center (VRC). The site of interest is located within the following coordinates (Lat, Lon): Resolute Bay NW 74°46'08.7"N, 95°07'57.8"W; NE 74°46'06.4"N, 94°42'49.3"W; SW 74°40'59.2"N, 95°04'53.1"W; SE 74°38'22.6"N, 94°41'16.0"W. Accompanied by one member of the Canadian Ranger Patrol Group (CRPG), indications on the presence of MC and transformation products in surface water will be assessed using a multiparameter digital water quality meter. Surface water samples will be collected directly from the site and its surrounding for energetic material, metal, ammoniacal nitrogen (N-NH₄⁺), anions and perchlorate analysis. The presence of MC will also be assessed in the soil based on a multi-increment sampling approach where a maximum of 300 kg of soil samples will be collected. If evidence on the use of munitions is observed, an overall of up to three 45-gallon soil barrels using manual tools of soil samples is foreseen to be collected in 2026 by DRDC personnel. GPR survey for the permafrost

³ DRDC-NORTH. Environmental Behavior and Impact of Small-caliber Ammunition Constituents in Arctic Conditions. Report no. 1. NRC-EME-56237. June 2021

⁴ DRDC-NORTH. Environmental Behavior and Impact of Small-Caliber Ammunition Constituents in Arctic Conditions. Report no. 2. NRC-EME-56419. June 2022.

active layer determination will be conducted as well as a photogrammetry with a EXYN and Lidar survey for spatial and temporal variation with an ARA drone. Collected water, surface soil and surface core samples will be brought back for analyzes at Defense Research and Development Canada (DRDC)-Valcartier Research Center (Quebec) in coolers. Collected soil samples will also be analyzed for their mineralogy, grain size distribution, specific surface area, total organic matter content and total organic carbon content permeability. A strict assurance/quality control (QA/QC) program is already in place. On site, fauna and flora will be captured by photo for identification including their surface coverage if any. Abiotic transformation parameter like UVA and UVB light will be recorded daily during the field campaign using a Digital UV AB light meter UV513AV from General®.

The second phase of the project will focus on in house laboratory experiments to assess the environmental fate and ecological impact of most common munition constituents. A monitoring station will be installed to help for the modelization of the transport potential of contaminat The monitoring station will be installed at the site of the evidence. The monitoring stations will contains the following instruments: ULogC16 V3 Data logger 16 channels (2), Expansion analog channels (2), Soil Moisture Sensor Analog Soil(10), Ultrasonic sensor Analog (2), Customized 16 Thermistor, String, 1.5m extension, total length of 5m. (2), Radiation shield Standard plastic (2). The following measurements are projected: Physicochemical and transport parameters (solubility, Kow, Kd) of the MC as a function of temperature; (2) abiotic (photolysis, hydrolysis) transformation rates as a function of temperature; and (3) the aquatic and terrestrial toxicity on relevant Arctic and/or Sub-Arctic ecological receptors such as algae, plants and lichen, while reflecting environmental conditions representative of Range and Training Areas of Northern Canada. Bacterial growth inhibition test with MC will be interpreted based on colony forming units (CFU). MC degradation rates will be reported as a function of temperature and analyzed based on half-lives calculations. Aquatic and terrestrial toxicity benchmark values will be reported in EC and as well as in half maximal inhibitory concentrations (IC50).

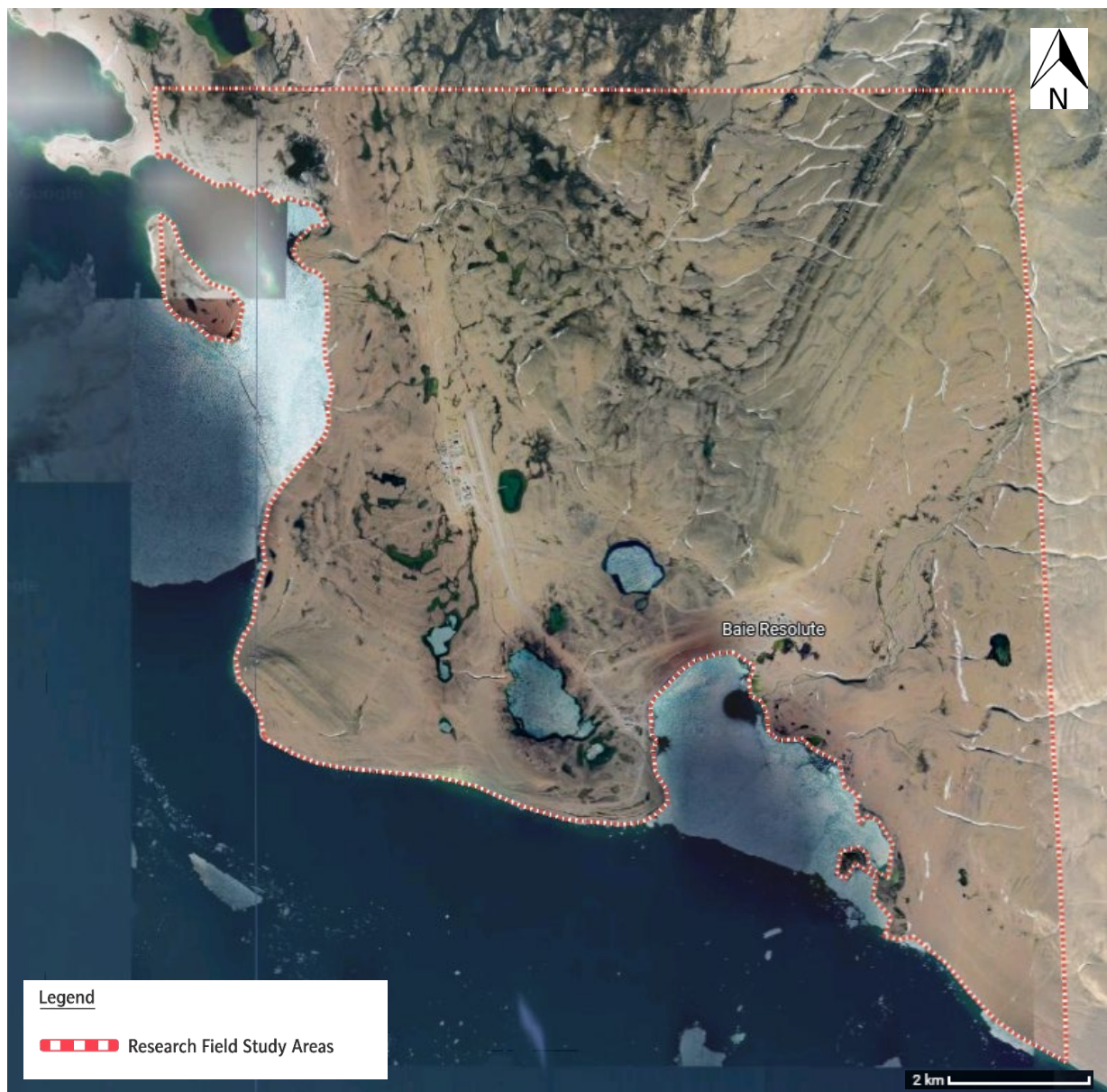
The modelling of the site using ArcGIS is planned for the third and last phase of the Resolute Bay project. It will allow to project vulnerability maps and help providing technology solutions to understand, prevent, and reduce the amount of hazardous substances/environment impact of CA Training and Operations. To help maintain CA environmental stewardship, subsequent field trips to the above-mentioned site might be necessary to better validate and calibrate the model.

• **Data management:** Describe your data management plan, and explain the principles and protocols for collecting, sharing, storing, and using data and information collected from or about Inuit and/or Nunavut

The data generated from the field sampling campaign will be recorded on a DND computer and the management plan will reflect DNDs' directives captured from the Defense Administrative Orders and Directives, DAOD-6000-0.

• **Research outputs:** Describe the major research outputs to be generated through the project (academic theses, publications, presentations, reports, etc.); describe specifically how and when research results will be communicated to research participants and interested organizations in Nunavut.

One of the mandates of DRDC consists of planning and executing applied R&D programs to support the Policy of Defense and the Defense Energy and Environmental Strategy to support force generation and maintain sustainable military training within the CAF. Aligned with the DND/CAF CRESST strategy, this research will help address Arctic and northern-specific needs (i.e. technologies, methods and practices) to help maintain environmental stewardship. Findings are anticipated to be communicated through DRDC reports, DRDC internal and external publications as well as national and international presentations, and possibly by academic memoirs and theses. Findings will be communicated when authorized by DRDC chain of command.



Research Field Study Areas