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The project entitled "Impacts of Melting Tidewater Glaciers on Marine Biogeochemical Cycles" (NPC File No: 149049; NIRB File No: 19YN020) is being proposed by Dr. Maya Bhatia from the Department of Earth and Atmospheric Sciences at the University of Alberta. The project location is in the Qikiqtani Region, at Devon Ice Cap on Devon Island and in Jones Sound, Nunavut. The closest community to the proposed work is the Hamlet of Grise Fiord. The project will not encroach on any protected areas. The project is intended to be multi-year, conducted annually in the spring/summer, consisting of a small party (<6 people) of scientists spending approximately 1 month in the field. The project goal is to understand how melting glaciers are exporting nutrients and sediment to the ocean and the impact of this material on regional marine primary production and biogeochemistry. To achieve this goal, we will conduct ice-based activities on Devon Ice Cap and marine-based activities in Jones Sound. Our on-ice activities will be to install, download and retrieve time-lapse cameras and pressure transducers around Sverdrup and Belcher glaciers on Devon Island Ice Cap. Equipment will be deployed at the glacier terminus, and in/around ice-marginal ponds and streams, recording (i) changes in glacier hydrology as the melt season progresses and (ii) changes in plume development at the glacier terminus. We expect seasonal changes in the glacier hydrology to correspond to the timing, magnitude, and nature of discharge events at the glacier terminus. Finally, we will also collect glacier ice and meltwater samples and process them for chemical and microbial analyses and experiments. Our marine-based activities will involve oceanic surveys from the termini of glaciers on Devon and Ellesmere Islands, measuring changes in seawater conductivity, temperature, and pressure. This work will be conducted from small boats, consisting of a private sailboat and/or boats provided by the Grise Fiord Ranger Patrol group. Seawater samples in Jones Sound will also be collected to measure marine chemical and microbial properties. Collectively, the new knowledge generated by this project has valuable long-term implications by providing understanding of the drivers of marine production at the base of the food web in this region, as well as broader scale marine carbon cycling, and the susceptibility of these drivers to climate change. Field access will be provided by twin otter from the Polar Continental Shelf Project (PCSP), Resolute Bay to Grise Fiord. From Grise, we will board a private sailboat and/or Grise Fiord Ranger Patrol Group boats. To conduct our on-ice work we will travel to Truelove Inlet on Devon Island by boat. Travel on the ice cap will be achieved by helicopter/on foot. In some years, a temporary camp (party of 2 and the helicopter pilot) may be established at TrueLove Inlet for a few days, where we will meet the helicopter (provided by PCSP) in preparation for our airborne and on-ice sampling work. In other years, a temporary camp (<10 tents) may be established on the ice cap for a few weeks. All temporary camps will be dismantled seasonally at the conclusion of our annual field season. All fuel drums cached at TrueLove Inlet to support the helicopter work will be removed by PCSP at the end of the field season. All equipment not needed for subsequent field seasons will be removed annually. Some equipment and fuel needed for subsequent years may be cached on the northern margin of the ice cap. All equipment and cached materials will be removed at the end of the project. There should be no need for restoration as camp sites on land will be minimally used, avoid any plant development by being situated on bedrock, and all equipment on the ice/bedrock can be easily removed. The Hamlet of Grise Fiord is surrounded by melting tidewater glaciers. Local indigenous knowledge indicates that waters near the termini of these glaciers are biologically productive. The community has expressed interest in understanding the impacts that climate change and enhanced glacial melting in particular are having on the regional marine ecosystem. This project is being undertaken in collaboration with the Hamlet and the Geological Survey of Canada, who have been long-term partners to monitor the acceleration of glacier melt in this region. Data generated by this study will be used in student theses, research publications, public talks, and climate change assessment reports. Data will also be made available of the Hamlet of Grise Fiord. Ultimately, data will be deposited in a public data repository. Results will be communicated through annual reports to the Nunavut Research Institute and Nunavut Climate Change Center, and summaries of research results to Grise Fiord and Resolute Bay communities in Inuktitut and English. NRI will receive copies of published articles.

[illegible]

Operations Phase: from 2019-06-27 to 2024-07-28

$\Delta \varepsilon_{\text{r}} \approx \frac{\sigma}{\rho} \left( \frac{1}{\nu} - \frac{1}{\nu_0} \right)$ 

Area	Activity	Location	Notes	Access	Remarks
Ice-free regions of Devon Island	Camp	Crown	Truelove lowlands has been the site of a research station in the past.	N/A	Closest community is Grise Fiord. We will only be establishing a temporary 4-day camp here while we conduct a helicopter reconnaissance survey.
Sydkap glacier and terminus area	Marine Based Activities	Marine	N/A	N/A	Closest community is Grise Fiord. We will be conducting measurements and taking samples from small boat based operations.
Devon Ice Cap between Sverdrup and Belcher glaciers	Scientific/International Polar Year Research	Crown	Devon Ice Cap is monitored through Natural Resources Canada National Glaciology Program by the Geological Survey of Canada	N/A	Closest community is Grise Fiord (located across Jones Sound). We will be flying over the region in a helicopter to photograph the ice cap and outlet glaciers.
Belcher glacier and terminus and surrounding area	Scientific/International Polar Year Research	Crown	Devon Ice Cap is monitored through Natural Resources Canada National Glaciology Program by the Geological Survey of Canada.	N/A	Closest community is Grise Fiord (located across Jones Sound). We will be flying over Belcher glacier and its terminus. We will deploy

					time-lapse cameras and pressure transducers around the glacier to understand its hydrology.
Sverdrup glacier and terminus and surrounding area	Scientific/International Polar Year Research	Crown	Devon Ice Cap is monitored through Natural Resources Canada National Glaciology Program by the Geological Survey of Canada	N/A	Closest community is Grise Fiord (located across Jones Sound). We will be flying over Sverdrup glacier and its terminus. We will deploy time-lapse cameras and pressure transducers around the glacier to understand its hydrology.
Western Devon Island Ice Cap	Scientific/International Polar Year Research	Crown	Devon Ice Cap is monitored through Natural Resources Canada National Glaciology Program by the Geological Survey of Canada	N/A	Closest community is Grise Fiord (located across Jones Sound). We will be flying over the region to photograph the ice cap and outlet glaciers.

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ᐱᐅᑦᐱᑕᐅᐅ <sup>ᖃ</sup>	Jimmie Qaapik	Grise Fiord Ranger Patrol Group	2019-01-03

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### Project transportation types

Transportation Type	How the Work will be Done	Length of Use
Air	We will take a twin plane from resolute bay to Grise Fiord; We will also use a helicopter to conduct work on Devon Island Ice Cap.	
Water	We will conduct small boat operations from Grise Fiord using a sailboat and/or boats provided by the Grise Fiord Ranger Patrol Group.	

### Project accomodation types

## Temporary Camp

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Sailboat	1	15.3 m x 4.20 m	Travel within Jones Sound and marine-based scientific activities
Twin Otter	1	15.77 m x 2.0 m	Travel to and from field site. Provided by the Polar Continental Shelf Project.
Helicopter	1	12.9 m x 3.14 m	Travel to and from field sites, and air surveys of field site. Provided by the Polar Continental Shelf Project.

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Aviation fuel	fuel	5	55	275	Gallons Fuel for twin plane and helicopter. PCSP will determine each year the amount of fuel required for transport to the field site, and will coordinate fuel storage and drum (container) clean up upon completion of the field season.
Gasoline	fuel	4	10	40	Liters Held on-board sailboat; fuel for outboard motors and generators.
Diesel	fuel	4	1125	4500	Liters Held on-board sailboat in 250, 1450, 1450, and 1350 L tanks. Max fuel

						consumption is 160 L max per day. Fuel safety protocol and spill equipment on-board: valves to isolate a leak, anti-dispersive product, fire extinguishers.
Hydrochloric Acid (UN 1789)	hazardous	1	1	1	Liters	Used to preserve water samples and clean tubing. All quantities will be shipped up and returned according to hazardous material regulations. No chemicals will be left or disposed of on-site or in Nunavut.
Methanol (UN 1230)	hazardous	1	1	1	Liters	Used to preserve water samples. All quantities will be shipped up and returned according to hazardous material regulations. No chemicals will be left or disposed of on-site or in Nunavut.
70% Ethanol (UN 1170)	hazardous	1	1	1	Liters	Used to clean (sterilize) equipment. All quantities will be shipped up and returned to according to hazardous material regulations.



						No chemicals will be left or disposed of on-site or in Nunavut.
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Camp	ᖁᑕᖂᑦ ᐸᖅᑐᒃᔫᒃᓄᖅᑐᒃ	0	To minimize the impacts of our research activities every effort is made to keep the camp clean, all scientific equipment and solid waste is backhailed to Resolute Bay, and water consumption is minimized. All scientific equipment will be removed at the end of the project, and all fuel drums will be removed.	N/A
Marine Based Activities	ᐸᐤᐸᑦ ᖁᑕᖂᑕᓄᖅᑐᒃᔫᒃ	100 L	For marine-based work, all grey waste water will be stored in holding tanks on-board and then discharged offshore via international norms. There will be no excess fuel disposal.	N/A
Scientific/International Polar Year Research	ᖁᑕᓄᖅᑐᒃᔫᒃ	0	All hazardous chemicals will be shipped to and from Resolute Bay and our field sites with the appropriate Dangerous Goods paperwork. Efforts are made to ship the absolute	N/A



# **Additional Information**

**SECTION A1: Project Info**

**SECTION A2: Allweather Road**

**SECTION A3: Winter Road**

**SECTION B1: Project Info**

**SECTION B2: Exploration Activity**

**SECTION B3: Geosciences**

**SECTION B4: Drilling**

**SECTION B5: Stripping**

**SECTION B6: Underground Activity**

**SECTION B7: Waste Rock**

**SECTION B8: Stockpiles**

**SECTION B9: Mine Development**

**SECTION B10: Geology**

**SECTION B11: Mine**

**SECTION B12: Mill**

**SECTION C1: Pits**

**SECTION D1: Facility**

**SECTION D2: Facility Construction**

**SECTION D3: Facility Operation**

**SECTION D4: Vessel Use**

**SECTION E1: Offshore Survey**

**SECTION E2: Nearshore Survey**

**SECTION E3: Vessel Use**

## SECTION F1: Site Cleanup

## SECTION G1: Well Authorization

## SECTION G2: Onland Exploration

## SECTION G3: Offshore Exploration

## SECTION G4: Rig

## SECTION H1: Vessel Use

We plan to use a private small sailboat and/or small boats provided by the Grise Fiord Ranger Patrol Group (see letter). The sailboat we will hire (the Vagabond: <https://vagabond.fr/en/>) is a 47 ft sailing vessel , crewed by a family of 4, previously used as a marine platform to launch small scientific operations from. As the proponent of this scientific work, we will ensure that any private vessel hired has all the required permits to conduct the scientific work described here in this project application. Details of materiel use and waste use are provided in those sections of this application. Boats provided by the Grise Fiord Ranger Patrol Group will be managed / captained directly by them.

## SECTION H2: Disposal At Sea

N/A: a disposal at sea permit is not required for this project since we are not disposing of any dredged material, excavated material or fish waste at sea. The Arctic Shipping Pollution Prevention Regulations currently allow for the discharge of human waste generated aboard a ship as per international norms. There will be no disposal of any wastes except grey water, and the grey water will not contain any oily substances. There will be no discharge of bilge water.

## SECTION 11: Municipal Development

[illegible]

This project will focus on research sites on Devon Island Ice Cap and in Jones Sound. This project does not encroach on any protected areas. It will not involve any work in the Nifjutiqavvik National Wildlife Area around Coburg Island in Lady Ann Strait.

[illegible]

Land-based work for this project will occur on Devon Ice Cap on Devon Island. Devon Island is uninhabited and the ice cap is devoid of wildlife. Marine-based work for this project will occur in Jones Sound, which encompasses the traditional harvesting grounds of the Hamlet of Grise Fiord. As such, this project is being undertaken in collaboration with the Hamlet (see letter from the mayor of Grise Fiord), and will utilize small boats (e.g. a sailboat or boats provided by the Grise Fiord Ranger Patrol Group).

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The closest community to the proposed project is the Hamlet of Grise Fiord. The Hamlet of Grise Fiord is surrounded by melting tidewater glaciers. The community has expressed interest in understanding the impacts that climate change and enhanced glacial melting in particular are having on the regional marine ecosystem. This project is being undertaken in collaboration with the Hamlet and the Geological Survey of Canada, who have been long-term partners to monitor the acceleration of glacier melt in this region. Jones Sound encompasses the traditional harvesting grounds of the Hamlet of Grise Fiord.

### Miscellaneous Project Information

[illegible]

## Cumulative Effects

The proposed project will have negligible environmental impact owing both to its small size and the types of work proposed. The small scientific party (<6), minimal time spent in the field (maximum 1-2 months), establishment of only temporary (not permanent) camps, and complete removal of equipment and waste at the seasonal conclusion of each field season ensures a negligible environmental impact. Finally, the scientific work to be done will be non-invasive, involving the deployment of cameras or small pressure transducers, which will be rock-bolted and easily removed at the conclusion of the field season. Water sampling will be limited to chemical and microbial analyses - involving small volumes (< 10L maximum) that are filtered/processed on-site. Cumulatively the project will provide valuable information to scientists and the Hamlet of Grise Fiord about the effects of climate change, and in particular glacial melt, are having in the region, and provide opportunities to involve community members from Grise Fiord in the research.

## Impacts

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1	polygon	Ice-free regions of Devon Island
2	polygon	Sydkap glacier and terminus area
3	polygon	Devon Ice Cap between Sverdrup and Belcher glaciers
4	polygon	Belcher glacier and terminus and surrounding area
5	polygon	Sverdrup glacier and terminus and surrounding area
6	polygon	Western Devon Island Ice Cap
7	polygon	Jakeman glacier terminus and surrounding area

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|---|---------|---|
| 1 | polygon | Ice-free regions of Devon Island                    |
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