Objectives: The overarching goal of this project is to assess the implications of climate change on drinking water quality and practices, and to provide tools to implement a community-based monitoring program across the Canadian North. Specifically, we will (1) engage and work with local communities to co-design and undertake a drinking water quality monitoring program; (2) characterize the link between DOM properties and DBP formation and the microbial communities in sources of drinking water for northern communities, and (3) investigate the fate of microbial communities and chemical contaminants across water purification procedures, delivery and storage. This database built using state-of-the-art methods in parallel to low cost methods will then (4) allow the development of algorithms to quantify DOM, cyanobacteria and DBPs with hand-held sensors that can be used locally.

Rationale: Intensive economic development across the Arctic is acting in parallel with climate change, causing an increasing pressure on water resources. Water quantity and quality is of great concern in the North as many communities still struggle to access potable drinking water. As climate continues to warm, previously frozen soils may release contaminants such as mercury (Hg) and potential harmful bacteria and viruses to aquatic ecosystems. The physicochemical changes caused by the release of nutrients and organic matter from thawing permafrost may also push aquatic ecosystems beyond tipping points, putting at risk the ecoservices they are providing to northern communities. To secure water safety until the point of use, disinfection with chlorine is typically used to inactivate pathogens. Yet, when dissolved organic matter (DOM) is elevated in water, its chemical reaction with chlorine generates unwanted disinfection by-products (DBPs), some presenting chronic risks such as carcinogenicity. Moreover, the sub-chronic effects of DBPs are not well characterized or regulated. There is a need to control DBP formation in drinking water supplied to northern communities, particularly as increasing levels of DOM linked to permafrost thawing may exacerbate the problem. The direct assessment of DBPs by northerners is crucial as communities expand and exploit new sources of water. Global warming and the subsequent browning of northern waters may also contribute to the emergence of noxious cyanobacterial blooms in these regions. Browning-driven cyanobacterial growth can lead to the presence of cyanotoxins known to have hepatotoxic and neurotoxic effects, and these are not removed through boiling or chlorination. While many would consider chlorination as a simple solution to microbial threats, this may not be an accepted practice in some Indigenous communities. Thus, there is a need to find solutions to protect health and wellbeing of northerners taking into account the cultural differences.

Progress to Date: We received funding in 2019 from the New Frontiers in Research program and we are expecting additional funding with our proposal submitted to Polar Knowledge that has been selected (still waiting for a confirmation of funding). Due to the COVID-19 situation no work has been done in 2020 so far. In 2019, we initiated some activities in other northern regions (Nunavik and Northwest Territories) and visited the community of Pond Inlet in July 2019. During this visit, we had a meeting with the senior administrative officer (SAO) and had the opportunity to visit drinking water treatment plant facilities. We were scheduled for a hearing with the council this spring but this has been cancelled due to the virus outbreak. In 2019, we also discussed the project with the

SAO of Resolute Bay, and started discussing our project with the Hunters and Trappers Organization (HTO). In addition, we initiated collaboration with ArctiConnexion that has ongoing projects in Taloyoak and Baker Lake on water quality. Our work is complimentary to their activities and allowed for example to document the potential for DBPs in these villages (not covered by ArctiConnexion). We have recruited two graduate students who started in January 2020 at l'INRS. Thanks to local connections in Cambridge Bay, we are also initiating discussions on the implementability of our project in the community. For all communities, we will include analyses and research questions that are of interest to local officials, to ensure that the project is useful to community leaders.

Methodology: Once we have obtained formal support from community officials, we will use the 2020-2023 period of initial funding to co-create with three communities (Pond Inlet, Resolute Bay, Cambridge Bay) a timeline for data gathering and local sampling of surface waters exploited as drinking water supplies. Contacts have been initiated in each community. During the first year, our team will visit the communities (only when the COVID-19 situation allows, and after we have obtained authorizations from the communities) to partner with, hire (New Frontiers in Research Funds, other applications pending such as Polar Knowledge) and train local coordinators on sampling procedures. During the following years, local communities will perform additional sampling as part of the community-based monitoring plan, expanding the spatiotemporal coverage. More communities will be visited as collaborations develop, through the ArctiConnexion network. Site visits will include meeting with community members, recruitment of a local research coordinator identified by the community and coordinated with ArctiConnexion, exchanging knowledge on drinking water sources and sampling procedures, gathering social science data, measuring limnological properties of water sources and collecting water samples from source to tap. Water samples will be further analysed in researchers' laboratories to characterize DOM properties, microbial communities and chemical properties. In addition, community members will be trained and provided with a pair of portable fluorometers (Turner Designs AquaFluor®) to quantify DOM, DBPs and cyanobacteria. On second year, we will leave the fluorometers with trained community designates who will use them over a longer time frame. Samples that required laboratory analyses will be shipped in prepaid coolers to Quebec city to our facility at l'INRS. **Water chemistry** - Water samples will be analyzed for dissolved organic carbon, DOM optical properties (spectroscopy) and high-resolution mass spectrometry. Cyanotoxin concentrations will be assessed, and DBPs will be analysed according to EPA methods. Key priority inorganic pollutants (arsenic, mercury, lead) will be analysed to assess the potential risks to communities. **Microbiology** - Microbial community composition including viruses and bacteria will be determined using next generation sequencing technologies, while coliforms and cyanotoxins producing genes will be detected by quantitative PCR assays. **Algorithm development** - This is done through the comparison of state-of-the-art laboratory measurements (DOM, cyanobacteria and DBPs) to the fluorometric assessments (Aquafluor sensors), and the determination of region-specific or pan-arctic algorithms. **Indigenous research -** Research team members have experience with mixed-methods approaches, Two-eyed Seeing Bayesian Belief System models for

blending indigenous and ecological data, as well as arts-creation methods for disseminating research findings. We are committed to ensuring respectful knowledge exchange with communities, and to supplying Indigenous communities with information useful for their policy and practices around drinking water, using three approaches. First, meaningful engagement with workshops, interviews and other methods as directed by community members, second, co-creating opportunities to build capacity for sovereign water monitoring, and third, co-producing knowledge towards the mutual goal of sustaining health and wellbeing through engagement of community coordinators and ensuring gender-equal access and appropriate opportunities to be involved in the analyses.

Data management: We will include our data on the Polar Data Catalogue and make them fully available through media such as NordicanaD and other data repositories. Prior to deposit data, they will be presented and made available to the respective communities for their own use. Part of the knowledge transfer will be to train scientific coordinator to database management. Water quality data will also be submitted to the NRI and Nunavut Government prior to data communication.

Research outputs:
This project aims to train 2 PhD students, 1 postdoctoral researcher and up to 5 scientific coordinators.
We will organize outreach activities in collaboration with northern communities, to present the main findings of the research and discuss their specific needs. These activities will be organized each year.
The results from this work will be published in high-impact journals (northern aquatic ecology, northern community health, water governance). Authors will include PIs, community scientific coordinators, students and postdoctoral fellows. This work will also be presented at international conferences and annual ArcticNet meetings. For example, the PIs and community scientific coordinators could chair a special session on drinking water security in the North. We are also planning funds to secure trips and registration to these conferences for as many of the community scientific coordinators as possible.
We will co-create with local scientific coordinators culturally relevant outputs for the communities such as documentaries, art on the theme of water. We will seek the participation of schools and Elders in these activities.