Natural Resources Canada | Ressources naturelles Canada

November 30, 2023 CIAR: 80468

Brent Parker
Director General, Review Panels and RASA
Impact Assessment Agency

Submitted by email: regionalrof-cdfregionale@iaac-aeic.gc.ca

Subject: Natural Resources Canada FAAR update for Ring of Fire Area Regional Assessment

Dear Colleague,

On October 24, 2023, the Impact Assessment Agency of Canada (the Agency) requested that Natural Resources Canada (NRCan) update the Federal Authority Advice Record (FAAR) to provide input to inform the design of the Regional Assessment process, including the development of the terms of reference (ToR). The assessment is a co-led process between the Agency, Indigenous groups who have traditional territory in the region and potentially the province of Ontario.

NRCan is submitting this response pursuant to section 100 of the *Impact Assessment Act*. Details of NRCan's response can be found in the Appendix A: Regional Assessment in the Ring of Fire Area, Federal Authority Advice Record, and Appendix B: Ring of Fire NRCan Studies of Interest.

NRCan looks forward to revisiting the FAAR once the ToR is provided. If you have any questions, comments, or concerns, please contact Natalie.Robinson@nrcan-rncan.gc.ca.
Sincerely,

Natalie Robinson
Impact Assessment Division
Office of the Chief Scientist

CC: Christina Clarke; Peter Unger

Appendix A
Regional Assessment in the Ring of Fire Area Federal Authority Advice Record
Response due to IAAC.RegionalRoF-CdFRegionale.AEIC@Canada.ca by November 30, 2023

Department/ Agency	Natural Resources Canada
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PART 1 *– In providing your responses to the items below, please include any relevant information on associated Indigenous, public or other consultation or engagement activities and identify any partners or collaborations.*

1. ***MANDATE AND AREA(S) OF EXPERTISE***
   Clearly outline the mandate of your department or agency and detail your area(s) of responsibility or expertise that may be related to the regional assessment

Natural Resources Canada (NRCan) works to improve the quality of life of Canadians by ensuring that our natural resources are developed sustainably, providing a source of jobs, prosperity and opportunity, while preserving our environment and respecting our communities and Indigenous peoples.

NRCan is an established leader in the fields of:

- Natural hazards, including earthquakes, landslides and flooding
- Land based geology
- Groundwater and hydrogeology
- Geochemistry, acid rock drainage and metal leaching
- Greenhouse Gases (GHG)
- Extraction, processing and environmental management of mineral resources
- Mining economics
- Forest ecology, biodiversity and management
- Open Science and Data

The Regional Energy and Resource Table Initiative

- The Regional Energy and Resource Table (RERT) initiative was launched in June 2022, with the aim of enabling every region in Canada to seize the economic opportunities enabled by the energy transition and the advancement of a net-zero economy.
- They are a collaborative initiative between individual provinces and territories, and the federal government, in collaboration with Indigenous partners and with the participation of regional labour and industry groups to advance and accelerate economic growth and energy transformation opportunities.
- The process aims to identify and prioritize a focused set of priorities and action areas with a view of developing economic transformation strategies across the country.
- For Ontario, this means engaging Indigenous partners, including those within the catchment of the Ring of Fire Regional Assessment, to develop economic transformation strategies, and create partnerships around specific opportunity areas.
- This work will be undertaken in partnership with the Government of Ontario.

2. *REGULATORY AUTHORITIES*

List and summarize the nature of the regulatory authorities of your department or agency in relation to physical works or activities in the Ring of Fire area.

Natural Resources Canada administers the *Explosives Act* and the *Explosives Regulations, 2013* and may exercise a power, duty or function related to the manufacturing and/or storage of explosives associated with Ring of Fire development.

Under section 6 of the *Explosives Act*, it is prohibited to make or manufacture any explosive, either wholly or in part, except in a licensed factory or to store any explosive in a magazine that is not a licensed magazine. Under subsection 7(1)(a), however, the Minister of Natural Resources may issue licences for factories and magazines. Mine developments, for instance, typically include a bulk explosives plant which operates under a Division 1 factory licence.

3. *EXPERT INFORMATION OR KNOWLEDGE*

List and summarize the specialists or expert information or knowledge that your department or agency has that may be relevant to the regional assessment. Include all research, reports and data sets in this response inventory.

Natural Resources Canada has specialist or expert information or knowledge relevant to the regional assessment in the domains listed below. It should also be noted that specialist expertise and knowledge relevant to natural resources may be held by other federal and provincial partners, reflecting the shared jurisdiction for natural resources within Canada.

- **Forest and Forestry**
  - **Hydrology of forest areas:** Description of potential impacts of projects on the hydrology of surrounding watersheds (surface waters) and description of mitigation measures.
  - **Species at risk habitat (including woodland caribou):** Description of potential impacts of projects on habitat and vegetation of caribou; loss of habitat area and quality; changes in predator movements due to habitat modification, and identification of mitigation measures.
  - **Forest Vegetation and Biodiversity:** Description of potential changes in soil quality, loss, compaction, erosion, etc. that could lead to a reduction in soil

productivity, including methods used to clear trees and shrubs as well as potential impacts on biodiversity and species of cultural value.
    - **Change of use and recovery of forested land:** Description of how projects may impact the change in land use, potential impacts, identification of mitigation measures and remediation.

- **Geology and Hydrogeology**
    - **Geology:** Description of the nature of the superficial formations and their depth, the nature of the bedrock, geohazards, permafrost occurrence, processes and stability.
    - **Groundwater Quantity:** Description of potential project impacts on groundwater and mitigation measures and hydrogeological modelling.

- **Explosives Manufacturing and Storage:**
    - Assessment and licensing for the storage and manufacture of explosives.

- **Minerals and Mining**
    - **Acid drainage and metal leaching*:*** Our expertise encompasses assessing acid rock drainage and metal leaching in various mining materials, such as ore, mine waste rock, construction materials, tailings, and open-pit walls. This extends to understanding potential issues related to acidic mine drainage and metal leaching in mining waste, involving geochemical analysis and prevention/control technology development.
    - **Mine wastes*:*** Assessment of Acid Rock Drainage and Metal Leaching (including new emerging risks from metals such as Pt, Pd, etc.…) and use of this ARD/ML assessment to evaluate the alternatives to the management, treatment and disposal of mine wastes including mine water, processing effluent, waste rock, tailings and sludge.

- **Mining Economics**
    - **Baseline Economic Conditions:** Contribution of the mining industry to baseline economic activity, including direct and indirect GDP and employment.
    - **Mineral markets:** Mineral market analyses and potential impacts of a project on commodity markets and supply chains (local and global).
    - **Economic and Fiscal Impacts:** Potential direct, indirect and induced impacts of a project on GDP and employment; potential impacts of a project on government revenues from taxes and royalties and public expenditures.
    - **Local Socio-Economic Impacts:** Description of potential positive (including new economic opportunities) and negative impacts of a project on local and regional economies and populations.

- **GHG Emissions**
    - Offers specialized knowledge in **greenhouse gas (GHG)** emissions reduction, encompassing Best Available Techniques (BAT) and Best Environmental Practices (BEP), as well as expertise in energy policy. This includes a focus on GHG emissions mitigation, including BAT and BEP, within the context of evaluating mining projects.

- **Earth Observation and monitoring**
    - **Baseline data:** development of baseline data describing the status and trends of ecosystem parameters (biosphere, hydrosphere and cryosphere) across the Canadian landmass.

4. *POLICIES, PROGRAMS OR INITIATIVES*
List and summarize the past, current and planned policies, programs or initiatives of your department or agency that may be relevant to the regional assessment. Include an outline of related funding initiatives in this response and provide information on geographic locations, next steps and timing for the program/initiative.

A list of past, current and planned policies, programs and initiatives that may be relevant to the regional assessment is provided below:

- At CanmetMINING, the Chromite Research and Development program within the Green Mining Innovation division undertakes research to investigate the potential environmental impact of chromite (Cr) mining in the Ring of Fire area. To date, research has been done on the potential Cr-leaching and oxidation potential of model mine tailings associated with chromite mining, a life-cycle assessment on potential mining and smelting operations for Ring of Fire chromite, including GHG emission estimates from planned mining operations, as well as a literature review on the interaction of Cr-bearing dusts with peatlands. Research into the potential for Cr(VI) generation during mine blasting is planned.

- At the Geological Survey of Canada (GSC), under the Environmental and Groundwater Geoscience Program, a project is underway to establish geo-Environmental characteristics of regions with high potential of natural resources development such as the Ring of Fire.

  The GSC also has expertise pertaining to regional geology and compilation of surface exposures and diamond-drill core following work that was carried out between 2010 and 2014 in the Ring of Fire area in coordination with the Ontario Geological Survey (OGS). This work was carried out by the GSC under the Targeted Geoscience Initiative. Two references related to this work:

  1. Metsaranta, R.T. and Houlé, M.G. 2017. Geochronology, mineral deposit, drill-core relogging and drill-core compilation data from the Winiskisis Channel, McFaulds Lake and Highbank Lake areas, “Ring of Fire” region, northern Ontario; Ontario Geological Survey, Miscellaneous Release—Data 343.
  2. Metsaranta, R.T. and Houlé, M.G. 2020. Precambrian geology of the McFaulds Lake “Ring of Fire” region, northern Ontario; Ontario Geological Survey, Open File Report 6359, 260p.

- NRCan is collaborating with numerous Federal, Provincial and Territorial contributors to provide access to data, scientific publications and information about development and regulatory activities through the Open Science and Data Platform (OSDP). The goal of the platform is to provide single-window access to a broad suite of content to support impact, regional and cumulative effects assessments and evidence-based decision-making.

  Amongst over 150,000 content records, the OSDP includes a curated content collection entitled *Resources to Understand Cumulative Effects in Northern Ontario* which was developed in collaboration with the Impact Assessment Agency of Canada. The content in this collection has been selected to support the understanding of cumulative effects in the area surrounding the region referred to

as the Ring of Fire area in Northern Ontario, located approximately 540 kilometres northeast of Thunder Bay. This collection features data and scientific publications within the area delineated by several large secondary watersheds in Northern Ontario, namely: Attawapiskat, Ekwan, Lower Albany, Upper Albany, and Winisk watersheds. Through open access to science and data, the OSDP is a tool available to participants in the Ring of Fire Regional Assessment, and through data integration, can support modelling, risk analysis and decision making. Link to content collection: https://osdp-psdo.canada.ca/dp/en/search/metadata/NRCAN-ROF-1-5F183851-3814-4352-85B8-D292EDC2CCA1

- Canada Centre for Mapping and Earth Observation (CCMEO), jointly with the development of the OSDP, is leading activities to develop foundational baseline data describing the status and trends of ecosystem parameters (biosphere, hydrosphere, and cryosphere) across the Canadian landmass and supporting the integration of these data into project and regional assessments.

- The Canadian Forest Service (CFS) provides a national perspective and expertise on forest issues and undertakes long-term, large-scale research and data collection focusing on complex challenges that require multilayered responses. CFS is committed to providing science and technical analysis, including collecting data, collating and harmonizing existing national forest data sets that have already been collected by other organizations and provincial and territorial (P/T) partners, identify relevant gaps in the existing baselines and monitoring, and fund and coordinate P/T field data collation to fill these gaps. Canada's National Forestry Inventory assesses and monitors the extent, state, and sustainable development of Canada's forests and includes traditional forest inventory attributes and a framework for collecting additional data relevant to sustainable development, forest health, biodiversity and forest productivity. So far, CFS has initiated projects that have a potential transferrable research expertise to contribute to Regional Assessments, including:

    - Analyzing cumulative ecological and socioeconomic effects of forest management, natural disturbance, and climate change in Ontario's managed forests;
    - Targeting forest reclamation practices and developing indicators designed to protect and restore water resources and maximize carbon capture in a cumulative effects landscape;
    - Developing a flexible tool for predicting cumulative effects on forest water resources; and
    - Developing a sustainability assessment of mine-affected Indigenous communities, including holistic model to impacts.

A list of past, current and planned funding programs that may be relevant to the regional assessment is provided below:

Indigenous Forestry Initiative (IFI)

Ne-Daa-Kii-Me-Naan Inc. (Nedaak)
$150,000 from 2018-19 to 2019-20
NRCan contributed to Nedaak, a forest management company owned by 7 First Nation communities, four of which are from Matawa First Nations in the Ring of Fire (Constance Lake, Long Lake, Aroland and Ginoogaming). This investment was increased by an

additional $100,000 in 2019-20, for a total investment of $150,000. The 2019-20 investment is supporting business planning for expanded operations, building on the economic development opportunities scan funded by IFI in 2018-19. The Business Expansion project will expand Nedaak's role in the forest sector through vital skill development and training to support forest operations, including building partnerships and the transfer of knowledge and responsibility to local First Nations.

Agoke Development Limited Partnership
$500,000 in 2019-20
NRCan contributed in 2019-20 to Agoke Development Limited Partnership, a First Nation's owned and operated company that is responsible for the sustainable management of the Ogoki Forest and developing economic opportunities for the First Nations of Aroland, Eabametoong and Marten Falls in the Ring of Fire. Through this project, the ADLP will establish the Anishnawbe Workforce Development Maintenance Program that will recruit First Nations people and provide them with training and technical skills in order to participate in the forest sector labour force; specifically, to place workers into the Nakina sawmill.

Clean Energy for Rural and Remote Communities (CERRC)

Eabametoong and Neskantaga First Nation — Clean Energy Opportunities Plan
$660,000 from 2021 to 2023.
EFN and NFN have partnered to implement a vision of local and regional community development built upon dialogue and new knowledge networks as we consider steps toward a diesel-free energy future. By combining community-based dialogue and Indigenous knowledge with technical and academic knowledge leaders, we are pioneering a new approach to involving our membership in the active planning of opportunities for the near and long-term benefit of our people.

Fort Severn First Nation — Power at the Margins
$865,817 from 2019 to 2023.
This project aims to reduce the need for diesel-generated electricity and boost the reliability of energy systems in the remote Ontario community of Fort Severn First Nation, fostering health, environmental, and financial benefits to the community. The project includes the installation of 290 kW solar panels and a 10 kW wind turbine and incorporates a training program for community members to support the construction, operations, and management of the project.

Kiashke Zaaging Anishinaabek/Gull Bay First Nation — Microgrid project
$2M completed from 2018 to 2020
Provided support to Ontario Power Generation to demonstrate the integration of a 300-kW high-penetration solar photovoltaic system into the existing diesel microgrid in Kiashke Zaaging Anishinaabek / Gull Bay First Nation, along with 550kWh of battery energy storage and controllers. This project offsets approximately 170,000 litres of diesel fuel and 471 tonnes of CO_2 emissions per year.

Matawa First Nations Management (Eabametoong, Marten Falls, Neskantaga, Nibinamik & Webequie) — Building Energy Literacy
$262,000 from 2020 to 2023.
Matawa First Nations Management will partner with Relay Education to increase energy literacy in 5 remote Matawa First Nations communities (Eabametoong, Marten Falls, Neskantaga, Nibinamik and Webequie). We will train 3 members of each community to

have the capacity to increase energy literacy amongst youth, elders and other members of the community. This will be achieved by: Facilitating renewable energy and energy conservation workshops; organizing and facilitating clean energy literacy; tailoring existing educational content to local culture and realities; educating community members in renewable energy technology, clean energy careers; and career mentorships.

Nishnawbe Aski Nation (Wapakeka First Nation, Nibinamik First Nation, Kitchenuhmaykoosib Inninuwug and Eabametoong First Nation, two other communities TBD)
$2,532,000 from 2019-20 to 2021-22
The project will exchange existing woodstove heating appliances in six remote Nishnawbe Aski Nation communities with upgraded high efficiency woodstoves and will reduce fossil fuel heating use by lowering demand on community electricity supply, currently provided by diesel generators. The project will provide training opportunities and will increase capacity in each community to participate in the bio-economy. The project is expected to create 13 temporary full-time positions for the duration of the project and 18 part-time positions ongoing for operation and maintenance and firewood harvesting and processing.

Opiikapawiin Services LP — Energizing Youth
$400,000 from 2018 to 2024.
Opiikapawiin Services LP will design and develop a capacity building program for youth (ages 18 to 25) from 22 remote First Nations communities in Ontario. The six-week program will include intensive training and skill building, for 5 participants, in July and August each year for six years. The program will build energy literacy and a skilled labour force – critical for employment in the energy sector, and specifically, for the Wataynikaneyap Transmission project.

Opiikapawiin Services LP — Plugged into a Brighter Future
$208,223 from 2019 to 2022.
This project aims to includes interactive and hands-on workshops, targeting Indigenous youth ages 9-14 in 3 rural and 17 remote diesel-dependent communities with the Wataynikaneyap Power project, to provide them with avenues to build energy capacity and knowledge in their communities, enable participation in energy efficiency and conservation discussions, as well as increase community social and economic development.

Whitesand First Nation — Sagatay Cogeneration LP
$4.168M from 2019-20 to 2020-21
Sagatay will develop all engineering drawings and plans for a biomass cogeneration system to provide heat and electricity for the Whitesand Pellet Mill. The implementation of the project for which NRCan is funding the engineering, will create local employment and some energy independence for the community.

Whitesand and Muskrat Dam First Nations — Regional Community Energy Plan
$442,900 from 2019 to 2022.
The Independent First Nations Alliance will partner with Mohawk College to create an online tool that can streamline the Regional Community Energy Plan process by increasing ownership of the process at the First Nations Tribal Council level, as well as First Nations energy capacity building by having First Nations organizations co-lead the development and implementation of the process.

5. *Outline any additional responsibilities, information or knowledge and any partners or collaborations that have not been specified, above.*

NRCan scientists have established relationships with scientists working at the Ontario government and with different Universities such as Lakehead University, University of Guelph and University of Waterloo.

***PART 2** – To contribute to the design of the regional assessment process and development of the terms of reference, please provide information or advice in relation to the items below.*

1. *Potential outcomes of the regional assessment*

NRCan has outlined below some of aspects of a regional assessment that it deems important. This list is meant as an overview of these important aspects, not as an exhaustive list, while keeping in mind the NRCan's expertise and science.

Data Gathering / Trend Analysis

- Mapping of landforms, wetlands, vegetation changes, geology, environmental geochemistry, groundwater and surface water modelling.
- Provide socioeconomic and economic baseline data and analysis to support future project-level analysis.
- Ecosystem modelling that can be updated and verified with monitoring results (to improve our understanding of the risks and impacts of cumulative effects on forest ecosystems using different tools (e.g., Spatial Discrete Event Simulation (SpaDES) modelling, BOWTIE risk assessment).
- Provide an understanding of long term monitoring needs and associated capabilities to fill gaps and determine trends; aid analysis; inform project-level assessments; and aid economic recovery in post COVID era.

Setting Thresholds / Standard Mitigation

- Provide a risk assessment and analysis for woodland caribou habitat, and other species at risk in the region.

Regional Development Planning

- Plan an Indigenous-led, co-developed, long-term monitoring program to fill gaps in baseline data, extend datasets temporally, assess impacts for identified value components and inform local, provincial and federal decision makers.
- Include in this plan, opportunities for the co-development of research between the Government of Canada and Indigenous groups.

2. *Relevant geographic and temporal boundaries*

Based on NRCan's expertise that spans across biophysical and social sciences, we have identified key characteristics of the relevant geographic and temporal boundaries for the regional assessment of the Ring of Fire region. Namely, NRCan may provide to the Agency the following advice:

- Different geographic and temporal boundaries may be needed for biophysical and socio-economic domains. Similarly, different components of the biophysical and socio-economic domains might also require different boundaries (for ex9ample, different species at risk such as the wolverine, the woodland caribou or the polar

might have different habitat requirements and ranges).

- The biophysical domain should include the five watersheds associated with Ring of Fire mineral deposits: Attawapiskat, Ekwan, Lower Albany, Upper Albany and Winisk (see Figure 1).
- The socio-economic domains should include the First Nations associated with the Mattawa Tribunal council (located across the Ring of Fire mineral deposit) and the First Nations associated with Mushkegowuk Tribunal Council, which is located downstream of the Ring of Fire mineral deposit.

3. *Factors to be considered in the regional assessment and the scope of those factors;*
NRCan supports the factors considered in the Impact Assessment Act, which states, among other aspects, that:

> "The changes to the environment or to health, social or economic conditions and the positive and negative consequences of these changes that are likely to be caused by the carrying out of the designated project, including:
>
> - the effects of malfunctions or accidents that may occur in connection with identified potential designated projects.
> - any cumulative effects that are likely to result from the identified potential designated project in combination with other physical activities that have been or will be carried out.
> - the result of any interaction between those effects."

More specifically, NRCan supports consideration of these factors in the regional assessment, including:

- Fish and fish habitat, effects of climate change on water levels, forest fire, and land cover, importance of peatlands in carbon storage, water cycle and hydrology
  - NRCan can support these federal jurisdictions through its hydrogeological and hydrological data collections and modelling as input for baseflow quantity and other hydrological indicators to streams, rivers and wetlands. These research efforts will enhance understanding of the surface water bodies that support fish and fish habitat in the Ring of Fire region.
- Rights of Indigenous peoples and moving forward with reconciliation
  - NRCan can support this federal duty through ongoing engagement with local Indigenous people and research opportunities.
- Species at Risk including: polar bears, wolverines, woodland caribou and sturgeon
  - NRCan can support this federal jurisdiction through its expertise in forest ecology, biodiversity and management of critical habitat for woodland caribou, among other species.
- Socioeconomic and economic structures and status.
  - NRCan can support through its expertise in mineral and mining economics.

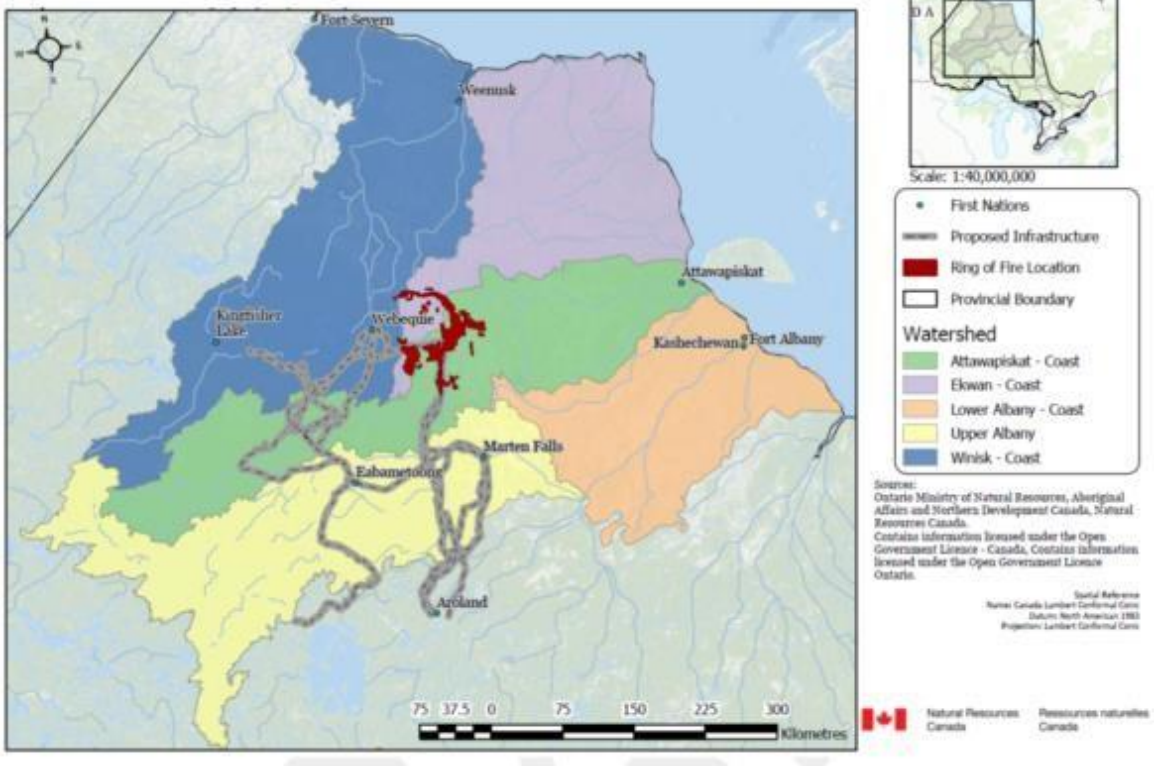
4. *Means of communication and engagement that would best facilitate participation of your department or agency in the regional assessment.*

In terms of means of communication, the current methods between NRCan and IAAC are working and should be maintained.

5. *Input or advice on any other aspect of the regional assessment.*
'NRCan is committed to open science and open governments for all Canadians. Open government plays a critical role in ensuring citizens are served by their governments in ways that are responsive, efficient and fair. It connects people to the governments who

serve them and helps make policies and services more citizen-centred. In the context of the Ring of Fire regional assessment, open science is a keystone to provide science that can inform future planning and future project impacts assessment in the region.

Figure 1: Five watersheds associated with Ring of Fire mineral deposits
(Estimated area of 291,000 km^2)



Appedix B: Ring of Fire – NRCan Studies of Interest

To support the implementation of the Impact Assessment Act, Natural Resources Canada (NRCan) is conducting research between 2018-2023 by three of NRCan's science sectors – the Canada Centre for Mapping and Earth Observation within the Strategic Policy and Innovation Sector, the Canadian Forest Service, and the Geological Survey of Canada within the Lands and Minerals Sector – to conduct key earth observation, forest, and geoscience research. The overarching goal of this research is to inform regional assessment and related impact assessment processes, with a central focus on making the science and knowledge generated open and accessible to the public via the Open Science and Data Platform. The Cumulative Effects science generated by NRCan can be found through the Cumulative Effects Story Map Platform. The following studies of potential interest have been provided below.

- **Land Surface Characterization R. Latifovic NCR 2018**
  Land Use/Land Cover change (LULCC) datasets for Canada for 2010, 2015 and 2020 from Landsat sensor observations specific to user requirements. The datasets assist studies of land-surface processes that characterize environmental, social and economic aspects of sustainability.
  Land Surface Characterization. R Latifovic NCR - 2015 Land Cover of Canada
  Land Surface Characterization. R Latifovic NCR - 2020 Land Cover of Canada
  Land Surface Characterization. R Latifovic NCR - Moderate Resolution Time Series Data Managment and Analysis
  Land Surface Characterization. R Latifovic NCR - Circa 2010 Land Cover of Canada Local Optimization Methodology and Product Development

- **National Scale Vegetation Status and Trends Monitoring System. D Janzen, R Fernandes NCR 2019**
  Maps of vegetation biophysical parameters from satellite imagery that provides national coverage with multi-decadal temporal coverage for historical and future use at a spatial resolution suitable for environmental assessments.
  Validation of Simplified level 2 prototype processor sentinal 2 fraction of canopy cover, fraction of absorbed photosynthetically active radiation and leaf area index products over North American forests
  Leaf Toolbox/. R Fernandes

- **Dynamic Surface Water Maps of Canada**
  Historical surface water maps have been created from moderate resolution radar and optical satellite data archives to create time-series showing changes in surface water extents. From these time-series, the percent frequency of every location's inundation was calculated and depicted spatially on a map.
  Dynamic Surface Water Maps of Canada 1984-2019 2022. I Olthof NCR 2018
  Dynamic Surface Water Maps of Canada from 1984-2021 2023. I Olthof NCR 2018

- **Regional Applications for Wildlife Habitat. W Chen, R Fraser, S Leblanc, J Lovitt, L He, C Prevost NCR 2019**
  This project aims to support regional assessments under the *Impact Assessment Act*. Among various valued components typically considered in impact assessment, caribou stands out as one of the top priorities because of their importance to Indigenous peoples' economy, culture, and way of life. The project maps lichen availability for caribou ranges in the Ring of Fire region and other areas and assess the cumulative effects of human

and natural disturbances on lichen availability.
Regional Applications for Wildlife Habitat. W Chen, R Fraser, S Leblanc ,J Lovitt, L He, C Prevost NCR 2019
Regional Applications for Wildlife Habitat. W Chen, R Fraser, S Leblanc ,J Lovitt, L He, C Prevost NCR 2019 A

- **Canadian Wetland Inventory. K Murnaghan, B Briso, NCR 201**8
  Earth Observation data used for national scale wetland mapping (Canadian Wetland Inventory Map (CWIM) and monitoring applications.
  RADARSAT Constellation Mission's Operational Polarmetric Modes: User-Driven Radar Archtecture

- **A Flexible Tool for Predicting Cumulative Effects on Forest Water Resources. J Leach GLFC 2019**
  Forests supply high quality water and help moderate flood and drought risks for downstream stakeholders and users. Being able to model and predict how changes in forest cover and recovery, because of mining, forestry, climate change, wildfire, and insect outbreaks, will impact downstream water resources is critical for informing effective management approaches. A modelling tool (Raven and Robin) has been developed to predict cumulative effects on forest cover and their impacts on water resources.
  A flexible tool for predicting culative effects on water resources.

- **Sustainability Assessment of Indigenous Communities Affected by Mining. E Antwi GLFC 2019**
  This project develops and tests frameworks, tools, and concepts to improve the cumulative effects assessment of multiple disturbances on livelihoods and ecosystems in Canada's North. The framework integrates biophysical and socioeconomic indicators and draws on knowledge and perspectives from Indigenous communities, industry, scientists, and government stakeholders. The project works with Experts and First Nation communities to co-design tools and approaches to support local capacity, create future scenarios that respond to cumulative effects' risks and impacts, and guide management decision support practices. The project adopts interdisciplinary and transdisciplinary approaches in several iterative stages from data collection, analysis, and reporting.
  Sustainability ssessment of Indigenous communities affected by mining - holistic model to impact assessment under the Canadian Impact Assessment Act (2019).

- **Cumulative Ecological and Socioeconomic Effects of Forest Management, Natural Disturbance and Climate Change in Ontario's managed forests. L Venier GLFC 2019**
  This project is designed to measure and ultimately project the cumulative effects of multiple anthropogenic and natural disturbances on a suite of ecological and socioeconomic components of concern for Ontario's area of the undertaking. The components of concern to be considered are elements of biodiversity including caribou, birds, and aquatic communities, as well as mercury contamination in fish, and socioeconomic consequences including effects on Indigenous communities and timber supply. This project is part of a larger cumulative effects project that will develop a comprehensive framework for measuring and projecting cumulative effects using ensemble modelling to address uncertainty. The proposed project is scalable such that additional research can be added once the underlying data, infrastructure, and tools are compiled and developed.
  Cumulative ecological and socioeconomic effects of forest management, natural disturbance and climate change in ON managed forests.

- **National bio-economic analyses of timber supplies, forest management, caribou and cumulative effects - trade-offs, cost effectiveness, risks and opportunities. D McKenney; J Pedlar, L Venier GLFC 2019**
  This is a national scaled project that examines economic and ecological trade-offs through time. Specifically, the work examines how large-scale disturbances, such as forest fire, timber harvesting, and other land uses (e.g., existing or planned mining operations) impact habitat for caribou and other selected taxa (e.g., migratory birds) in a cumulative effects context. A modeling framework to simulate these large-scale disturbances within the forested regions of Canada under current and future climate.
  National bio-economic analysis of timber supplies, forest management, caribou and cumulative effects trade-offs, cost effectiveness risks and opportunities.

- **Ring of Fire: Reconstructing Long-term Environmental Records to Support Regional Assessment Webequie to Atawapiskat Coverage. J Jautzy 2020**
  While five years of baseline monitoring data have been acquired by the Ontario provincial government (Ontario Ministry of the Environment Parks and Conservation), further knowledge is required to understand how these baseline conditions will respond to ongoing climate change and new anthropogenic stresses associated with future mining activities and related infrastructure development (e.g., roads, large mining camps, traffic) in the Ring of Fire (RoF). While airborne dust, effluent, waste rock and mine tailings from mining activities are the most likely vectors for metal(loid) contamination in the environment. Changes in lake sediment redox transition zone (i.e., either seasonally or anthropogenically driven) and forest fires can potentially enhance the remobilization of metal(loid)s over time. This increases the possibility of the interplay of different sources and the evolution of their relative contributions over time due to climate forcing and transformation of surface and subsurface environments. The research activities involve targeted sampling of natural environmental archives (lake sediment, tree ring, peat) as well as surface water, groundwater and soil and rock material. Exploration of new environmental indicators adapted to the monitoring of the RoF environment will be developed such as fire intensity molecular indicator and biocarbonate as a sentinel of chromium loading.
  Ring of Fire: Reconstructing long-term environmental records to support regional assessment 2021
  Ring of Fire: Reconstructing long-term environmental records to support regional assessment 2021a

- **Ring of Fire: Reconstructing long-term Environmental Dynamics to Support Regional Assessment. N Benoit GSC-Quebec 2020**
  The project explores the chromium mobility on two former mines in the Thetford Mines area as a cumulative effect in an environmental system. The study will provide Canadians with a methodology for chromium isotope sampling and analysis as well as a geochemical approach to metal characterization in a chromite deposit context. The project outcome is to inform decision-making in natural resource management in the Ring of Fire that includes an effective approach to sampling and analysis of Chromium species (Cr (III) and Cr (VI)) in water, as well as knowledge of the effect of climate change on the mobility of metals or metalloids in water and sediments
  Ring of Fire: Reconstructing long-term environmental dynamics to support regional assessment