



## **Proceedings of the Workshop:**

# **Arctic Mining: Environmental issues, mitigation and pollution control for marine and coastal mining**

**Offered Online on  
March 21,22,23, 2023**

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**June 15, 2023**

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## **I: Foreword by Project Co-Leads**

The idea for this project originated within the Arctic Council's Protection of the Arctic Marine Environment (PAME) Working Group, where a concern was raised about the disposal of tailings from onshore mining operations onto the seafloor. This led us to reflect on the broader impacts of mining operations on the marine environment. Many Arctic governments welcome the development of a mineral extraction industry, if operated with environmentally sound practices, and with the acceptance from the local communities. However, the environmental impact of new as well as planned mining operations is often debated.

We initiated a survey of active mining operations in the Arctic, ranging from marine operations to land-based operations with discharge of water or dust to the marine environment, or causing marine underwater noise. The survey intends to learn about the development of and issues identified in the environmental performance of mining activities within recent decades, and to determine if there are lessons learned which could be shared for the benefit of the environment.

Canada and Kingdom of Denmark decided to move forward and jointly convene a workshop with leading scientists, industry, Indigenous Peoples and community organizations, government regulators and non-governmental organizations to exchange ideas, best practices and lessons learned related to Arctic mining.

The workshop covered a broad scope and had 70 participants - from Alaska to Finland. It is the hope that the workshop will be a starting point for further exchange of experience and ideas between the participants and others involved with mining operations in the Arctic. A web-page has been developed with the presentations from the workshop as well as supporting material, and with the potential to be further developed as a platform for exchange of information.

These proceedings compile all the abstracts and presentations given at the workshop. During the workshop, participant group work was also completed with discussions on major environmental issues and potential solutions. The outcome of the group work is compiled and edited by the organizing committee.

**Maureen Copley, Government of Canada**  
**Anders Mosbech, Aarhus University, Kingdom of Denmark**

## **II: Workshop Background and Objectives**

Reduced sea ice means that the Arctic is opening up for shipping; meanwhile, there is a growing global demand for minerals driven by the transition to green energy. In response, most Arctic nations support strategies for developing a mining industry that strikes a balance between meeting the demand for minerals and achieving sustainable and responsible development, while protecting communities and ecologically sensitive landscapes and marine environments.

Canada and Kingdom of Denmark jointly organized this workshop with a shared goal of identifying and deepening our understanding of how to mitigate the impacts of mining on marine environments. This workshop was designed to share lessons learned from an environmental and technical perspective.

### **Overall Workshop Objectives:**

**To identify and better understand key lessons on mitigating impacts of mining on marine environments, and to share lessons from an environmental and technical perspective. In addition, we sought to improve the knowledge base about the potential impacts of mining to support informed decisions, and to identify how the impacts can be minimized.**

Through the workshop, we aimed to clarify and broaden our understanding of good marine environmental practices in mining with input from across the circumpolar Arctic. We sought to achieve this goal by:

- Exchanging case experiences on environmental impact of arctic mining and distilling the lessons – what have we learned, and looking ahead, what should be considered?
- Building practical solutions and guidelines for mining and development, inspiring positive actions going forward; and
- Building professional networks to support one another, fostering an exchange of ideas and information (amongst professionals in a given sector, such as regulators from different jurisdictions).

The workshop included three days of keynote speakers, short lightning talks, as well as panel discussions and breakouts from key scientists, industry, Arctic Indigenous and community organizations, government agencies and more. During the workshop, we also facilitated break-out discussions, with topics shaped by the issues and interests identified by participants.

### **Workshop Outputs include:**

- i. Creating this Workshop Proceedings Report to document lessons across five thematic areas:

- 1) *Pollution issues: cases of mitigating and reducing environmental issues;*
- 2) *Retaining biodiversity;*
- 3) *Engagement and participation of Indigenous and arctic communities;*
- 4) *Regulation: company, regulator, community perspectives on regulation; and*
- 5) *Sharing and discussing results of the PAME survey;*

ii. Identifying ways to build networks amongst professionals working in this area; and

iii. Identifying participants interested in furthering the workshop's insights into an academic publication.

## **Participants**

Seventy participants registered for the workshop, with representation from academia, industry, governments/regulatory bodies, local and Indigenous organizations and communities, and a variety of interested stakeholders. Participants hailed from eleven different countries, mostly with Arctic connections (Australia, Canada, Finland, France, Greenland, Ireland, Kingdom of Denmark, Norway, Sweden, United Kingdom and the United States).

The workshop took place online by Zoom conference over three days with good participation each day.

Participants expressed an appreciation, at the end of the workshop, for this well-timed opportunity to connect and share ideas and information relevant to the unique Arctic mining environment.

### III: Workshop Programme

<p><b>Workshop background materials distributed via workshop website:</b>  <a href="https://conferences.au.dk/arctic-mining">https://conferences.au.dk/arctic-mining</a></p>	
Ahead of workshop	<p>Participants complete workshop registration.          Participants will receive email confirmation that there is space available in the workshop.          Pre- workshop material and logistical information shall be shared with registrants in advance of the workshop.</p>
<p><b>Workshop Agenda - Day 1 - March 21<sup>st</sup>, 2023 (11:00 am EDT– 1:30 pm EDT / 4:00 pm CET - 6:30 pm CET)</b></p> <p><i>Theme 1: Where are we now? What remains a challenge (defining the problem)?</i></p> <p><i>Theme 2: What can we do better on pollution issues, mitigating impacts, and reducing environmental issues related to mining?</i></p>	
11:00 – 11:20 pm EDT	<p><b>Welcome and Introduction to the Workshop ( <a href="#">Presentation</a> )</b></p>
4:00 - 4:20 pm CET	
11:20 – 12:00 pm EDT	<p><b>Session 1A: Opening Keynote with lightning talks</b></p> <p>Aquatic environment: Modern Mining Impacts and mitigation: An overview of principles and criteria for environmental protection in Mining with a focus on the marine environment. <i>Christian Juncher Jørgensen, Aarhus University ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</i></p> <p>Lightning talk 1: Lessons Learned from the Last Century - Mining Waste and Regulation in Greenland. <i>Jens Søndergaard, Aarhus University ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</i></p>
4:20 - 5:00 pm CET	
<p><b>HEALTH BREAK 12:00 – 12:10 EDT / 5:00 pm - 5:10 pm CET</b></p>	
12:10 – 1:00 pm EDT	<p><b>Session 1B: PAME Survey Findings</b></p> <p>PAME Survey findings &amp; moderated short Q&amp;A - <i>Anders Mosbech, Head of Research and Advisory at Aarhus University ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</i></p> <p>Arctic Mining - Presentation on EU Best Available Techniques Reference Document for the Management of Waste from Extractive Industries: Key principles and examples of BAT conclusions - <i>Soile Nieminen, Centre for</i></p>
5:10 pm - 6:00 pm CET	

	<p><i>Economic Development, Transport and the Environment, Finland</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>Moderated short Q&amp;A</p>
<p>1:00 pm –1:25 pm EDT</p> <p>6:00 pm - 6:25 pm CET</p>	<p><b>Session 1C: What are the Main Issues and Challenges?</b></p> <p>Breakout group work to frame key issues and challenges, <i>guided by Paul Godin and Sarah Daitch, Katalyst Resolutions, workshop facilitators (Proceedings)</i></p>
<p>1:25 pm -1:30 pm EDT</p> <p>6:25 pm - 6:30 pm CET</p>	<p><b>Day 1 Closing</b></p> <p>In light of the challenges identified, what can we do better on pollution issues, mitigation of environmental issues, and protection of the marine environment? <i>Anders Mosbech, Head of Research and Advisory at Aarhus University</i> ( <a href="#">Video</a> )</p>
<p><b>Workshop Agenda - Day 2 - March 22<sup>nd</sup>, 2023 (11:00 am EDT– 1:30 pm EDT / 4:00 pm CET - 6:30 pm CET)</b></p> <p><b><i>Theme 2 continued: What can we do better on pollution issues, mitigating impacts, and reducing environmental issues related to mining?</i></b></p> <p><b><i>Theme 3: What can we do better to maintain biodiversity?</i></b></p>	
<p>11:00 am – 12:10 pm EDT</p> <p>4:00 pm - 5:10 pm CET</p>	<p><b>Session 2A: Welcome and Introduction to the day’s theme: Pollution Issues and Maintaining Biodiversity</b></p> <p>Welcome and review of today’s agenda, highlights from the Conservation of Arctic Flora and Fauna (CAFF) Report - Mainstreaming biodiversity in arctic mining to inform thinking on the day’s themes. <i>Paul Godin and Sarah Daitch, Katalyst Resolutions, workshop facilitators</i></p> <p>Marine Tailing Disposal: The Norwegian Experience &amp; moderated Q &amp; A. <i>Hilde Cecilie Trannum, Norway</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> )</p> <p>Lightning talk 1: Industry process chemicals and discharge of wastewater to the Arctic marine environment. <i>Kim Gustavson, Aarhus University</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> )</p> <p>Lightning talk 2: Impacts related to dredging – Greenland Experience. <i>David Blockley, Scientist at Greenland Institute of Natural Resources</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> )</p> <p>Moderated Q &amp; A for lightning talks</p>



	<b>HEALTH BREAK 12:10 pm – 12:25 pm EDT / 5:10 pm - 5:25 pm CET</b>
12:25 pm – 1:25 pm EDT	<b>Session 2B: What can we do better to maintain biodiversity: Exploring challenges, approaches and solutions</b>
5:25 pm - 6:25 pm CET	<p>Lightning talk 1: Narwhals and underwater noise; new knowledge. <i>Mads Peter Heide-Jørgensen, Professor, Greenland Institute of Natural Resources</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> )</p> <p>Lightning talk 2: A Saami approach to maintaining biodiversity in marine environments affected by mining. <i>Tonje M. W. Johansen, Advisor, Arctic and Environment Unit, Saami Council</i> (<a href="#">Abstract</a>)</p> <p>A short, moderated Q &amp; A to follow both talks</p> <p>Exercise addressing new approaches and solutions</p>
1:25 pm – 1:30 pm EDT	<b>Day 2 Closing</b> <i>Paul Godin and Sarah Daitch, Katalyst Resolutions, workshop facilitators</i>
6:25 pm - 6:30 pm CET	
<b>Workshop Agenda - Day 3 March 23<sup>RD</sup>, 2023 (11:00 am EDT– 1:30 pm EDT / 4:00 pm CET - 6:30 pm CET)</b>	
<b><i>Theme 4: What can we do better - How do we carry out meaningful engagement and participation with Indigenous Peoples and local communities?</i></b>	
<b><i>Theme 5: How could we best regulate arctic mining to prevent environmental issues, and support responsible practices? Perspectives from Scientists, Industry, Indigenous Peoples, local communities and Government.</i></b>	
11:00 am – 12:05 pm EDT	<b>Session 3A: What can we do better on regulating the impacts of Arctic mines, and meaningfully engaging Indigenous Peoples and local communities?</b>
4:00 pm - 5:05 pm CET	<p>Opening: Recap of current practices and way forward, <i>Paul Godin and Sarah Daitch, Katalyst Resolutions, workshop facilitators</i></p> <p>Lightning talk 1: Towards Sustainable Mining: A Global Standard. <i>Katherine Gosselin, Mining Association of Canada</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>Lightning talk 2: Industry perspective on current practices. <i>Bo Stensgaard, CEO, Blue Jay Mining</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>Moderated Q &amp; A following Lightning talks 1 &amp; 2.</p>

	<p>Lightning talk 3: What have we learned about meaningful engagement of Indigenous Peoples and local communities in the Arctic, how does this apply to Arctic mining activities? <i>Marjorie Kaviq Kaluraq, Chair of Nunavut Impact Review Board and Karen Costello, Executive Director, Nunavut Impact Review Board</i> (<a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>Lightning talk 4: Civil society perspective on Arctic mining, regulation and management. <i>Elena Tracy, Senior Advisor, Sustainable Development, WWF Arctic Programme</i> (<a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>Moderated Q &amp; A following Lightning talks 3 &amp; 4.</p>
	<b>HEALTH BREAK 12:05 pm – 12:20 pm EDT / 5:05 pm - 5:20 pm CET</b>
<p>12:20 pm – 1:10 pm EDT</p> <p>5:20 pm - 6:10 pm CET</p>	<p><b>Session 3B: Moderated Panel Discussion – Perspectives across sectors on mining regulation, impact and management - What has been learned? What are the best practices to balance future mining activities with protection of the Arctic environment?</b></p> <p>Opening lightning talk: Strategic Environmental Impact Assessment (SEIA) – A Greenland example on how to inform planning. <i>Janne Fritt-Rasmussen, Aarhus University</i> (<a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>1 Industry –<i>Alex Buchan, Agnico Eagle Director Nunavut Affairs, Stakeholder Engagement</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>2 Regulator/Government - <i>Steen Christensen, Head of Agency, the Environmental Agency for Mineral Resource Activities (EAMRA), Government of Greenland</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>3 Indigenous Organization - <i>Jared Ottenhof, Director of Lands and Resource Management, Qikiqtani Inuit Association</i> ( <a href="#">Abstract</a> / <a href="#">Video</a> )</p> <p>4 Scientist – <i>Lis Bach, Senior advisor at DCE, Aarhus University</i> ( <a href="#">Abstract</a> / <a href="#">Presentation</a> / <a href="#">Video</a> )</p> <p>Panel Discussion ( <a href="#">Video</a> )</p>
<p>1:10 pm – 1:20 pm EDT</p> <p>6:10 pm - 6:20 pm CET</p>	<p><b>Next Steps:</b> Discussions on building networks, developing best practice environment, and developing a communication and engagement approach ( <a href="#">Video</a> )</p> <p>Discussion guided by <i>Paul Godin and Sarah Daitch, Katalyst Resolutions, workshop facilitators</i></p>

1:20 pm -1:30 pm  
EDT

**Closing Remarks:** *Anders Mosbech, Head of Research and Advisory at Aarhus University* ([Video](#))

6:20 pm - 6:30 pm  
CET



## IV: Abstracts and Presentation Materials



### Session 1A) Opening Keynote with Lightning Talks

**Modern mining impacts & mitigation: An overview of principles and criteria for environmental protection in Arctic mining with a focus on the marine environment.**

**Speaker:** Christian Juncher Jørgensen, Aarhus University

**Biography:** *Senior Researcher, PhD, Christian Juncher Jørgensen has an educational background in biogeochemistry and has worked both in academia and in the private sector as environmental consultant. Christian's work has included both studies of pollutants in soil, sediment and groundwater systems as well as emissions of gasses and particles in industrial and natural environments both inside and outside the Arctic.*

**Abstract:**

Modern mining relies on responsible stewardship of environmental resources, balancing the needs of global society, local community and conservation interests. Failure to effectively manage the potential adverse impacts of mining on these shared resources can result in the deterioration of environmental resources and have adverse consequences for human health.

Mining in the Arctic will inevitably lead to some impacts on ecosystem functions in the physical environment where mining activities occur. Public acceptance of where, when and for how long a given impact may be tolerated is not an exact science and is often a matter for discussion before an agreement can be made between communities, authorities and mining companies. Mitigation of mining related impacts on local environments often require special consideration on the overall footprint of the mining operations with a focus on both spatial, temporal, ecological and project-specific aspects and dimensions following a combined set of best environmental practices.

The talk will present an overview of most recent principles for the protection of the environment following mineral extraction operations with direct contact marine ecosystems. The talk will include discussion of recent international guidelines and standards on environmental protection illustrated with examples from sensitive Arctic ecosystems.

**Link to [Presentation](#)**

## Lessons learned from the last century - Mining waste and regulation in Greenland

**Speaker:** Jens Søndergaard, Senior Research Scientist, Aarhus University

**Biography:** *Senior Researcher, PhD, Jens Søndergaard studies trace metal cycling in the Arctic, especially mining pollutants and long-transported pollutants such as mercury as a basis for environmental assessments. My research area lies in the interface between environmental chemistry, geochemistry, analytical chemistry and biology.*

### What is the Purpose of your Talk?

The purpose of the talk is to give an overview of the main lessons learned from the last century of mining in Greenland, in relation to environmental impact from mining waste and how these lessons have improved the regulation.

### Abstract:

Greenland has a long mining history starting with mining of cryolite in 1854 in Ivittuut, South Greenland. However, it was not until the early 1970s that the first environmental studies were conducted. Like many other countries, Greenland has a legacy of long-lasting pollution from former mine sites.

Mining activities at three legacy mine sites in Greenland; the cryolite mine in Ivittuut (1854-1987), the lead-zinc mine in Mestersvig (1956-1963) and the lead-zinc mine in Maarmorilik (1973-1990), resulted in significant pollution of the environment, mostly by lead and zinc. The polluted marine areas at Ivittuut, Mestersvig and Maarmorilik encompassed areas within a distance of at least c. 10-15 km from the mines during the mining periods, and although the pollution has decreased, it can still be measured today.

At Ivittuut, the pollution was predominantly caused by leaching from waste rock placed in the tidal zone along the coastline and between the mine pit and the Arsuk Fjord. At Mestersvig, the pollution was caused by several sources including uncovered tailings deposited on a mountain slope adjacent to a river and exposed to leaching, erosion and dust dispersion; spills and dust dispersion of concentrate during transport and loading; and later collapse of a quay after mine closure. At Maarmorilik, the pollution was mainly caused by dissolution and dispersion of tailings following deposition of tailings into a small partly enclosed sill-fjord. The sill-fjord was unexpectedly affected by seasonal vertical mixing and ocean currents, which caused transport of pollutants across the sill to the larger Qaamarujuk Fjord system. After mine closure, pollution from the tailings ceased due to natural sedimentation covering the tailings. Today, waste rock deposited on the steep mountain slopes is considered the dominant source of pollution at Maarmorilik.

The three legacy mine sites in Greenland have enabled studies of dispersion, bioaccumulation, and toxicological effects of mining pollution under Arctic conditions during the past 50 years. Since the 1970s, monitoring of Greenland mine sites has been performed regularly at operating and closed mines by the authorities and numerous environmental studies have been carried out by research groups. This has provided valuable information for the development of a regulatory system in Greenland with specific

requirements for environmental impact assessments (EIAs), environmental monitoring, use of chemicals etc. to help minimize the impact of new mining activities. Moreover, the knowledge is applied in the 'daily' advisory to the Greenland authorities by the Danish Centre for Environmental and Energy and Greenland Institute for Natural Resources.

The talk will focus on the main environmental issues at the three legacy mine sites in Greenland, the actions taken, the lessons learned, and how these lessons are applied in the current regulatory system to minimize pollution.

**Link to [Presentation](#)**

Session 1B) PAME Survey Findings

<b>The PAME Survey: Arctic marine and coastal mining</b>
<b>Speaker:</b> Anders Mosbech, Project Co- Lead, Aarhus University
<b>Biography:</b> <i>Anders Mosbech has a long experience as project manager for environmental impact studies. He has acted as advisor to the regulatory agencies in the Danish and Greenland governments, participated in international working groups and conducted ecological research on seabirds, geese, muskoxen, marine mammals and vegetation.</i>
<b>What is the Purpose of your Talk?</b> The purpose of this talk is to give an overview of the results from the PAME survey of Arctic marine and coastal mines. The survey puts the coastal Arctic mines on the map, and based on a questionnaire to each mine a number of issues in relation to the environment is illustrated across the Arctic.
<b>What is the relevant background and context?</b> PAME (the Arctic council working group for Protection of the Arctic Marine Environment) initiated this study based on the interest in most Arctic countries for increased mining activity with the minimum impact on the environment and a sustainable coexistence with local communities. It is the hope that the project can identify lessons learned and help improve the environmental performance of future mining in the Arctic.
<b>What do we need to know about methodology and actors?</b> The project group developed a questionnaire to gather information about each Arctic mine with respect to basics about the mine as well as focus on environmental issues. The questionnaire was approved by the PAME working group and distributed through the national representatives in the PAME working group. The questionnaire was filled out by national experts in each country based on publicly available material like EIA reports. Only mines with discharge (direct or indirect with water or air) to the sea are included in the survey. Mines from US, Canada, Greenland, Norway and Finland are included in the survey.
<b>What are the key learning points you want to share?</b> The survey provides the backdrop for this workshop; showing the diversity of mines, environmental issues and the diversity of solutions in different countries. These experiences make it possible to reflect on what is the best available environmental solution to each unique mining case to minimize pollution now and in the future. The issues identified for further comparative analysis include: <ul style="list-style-type: none"><li>○ Permanent tailing storage facilities</li><li>○ Shipping and underwater noise</li></ul>

- Monitoring and environmental quality guidelines
- Monitoring and transparency

**What are the next steps raised by your talk and/or questions that need to be answered?**

It could be discussed what further needs to be done to extract the lessons learned and disseminate the results.

Link to [Presentation](#)



**Arctic mining - Presentation on EU Best Available Techniques Reference Document for the Management of Waste from Extractive Industries: Key principles and examples of BAT conclusions**

**Speaker:** Soile Nieminen, Centre for Economic Development, Transport and the Environment, Finland

**Biography:** *Soile Nieminen is a Chief Environmental Specialist in environmental safety of mining. She represents the Centre for Economic Development, Transport and the Environment, Finland.*

**What is the Purpose of your Talk?**

The presentation gives a general overview on the European Commission Best Available Techniques (BAT) Reference Document for the Management of Waste from Extractive Industries (MWEI BREF) published in December 2018. The purpose of the talk is to highlight the key principles and approaches of the BAT conclusions as well as to present examples of some important BATs for arctic mining. Also, other recently published European guidance on environmental management of the extractive sector is presented.

**Abstract:**

Mining generates a high amount of extractive waste that requires appropriate management. Inappropriate design and operation of extractive waste management may cause major accidents and have catastrophic impacts.

MWEI BREF is a technical document representing the results of the European exchange of information on the BAT for the management of extractive waste and associated monitoring. It provides information of identified generic and risk-specific BAT to prevent and reduce as far as possible any adverse effects on the environment and human health from the management of extractive waste.

The goal of the MWEI BREF is to ensure the short-term and long-term safe and environmentally responsible deposition of extractive waste. Generic BATs are generally applicable in every site where extractive waste is managed, while risk-specific BATs are applicable to sites where specific environmental risks and possible impacts are identified. Risk assessment is an overarching principle in MWEI BREF BAT conclusions. A risk-specific approach applied in the document enables it to reflect the vast diversity in the extractive waste activities, extractive sectors, and geographical, climatic, and site-specific conditions in Europe. The approach is based on risk assessment and management principles to identify, evaluate, and manage the potential impacts of an extractive waste facility along the whole life cycle. The Environmental Risk and Impact Evaluation is a core BAT in the BREF and requires site-specific assessment of the suitability and application of the risk-specific BATs.

A second key principle of the MWEI BREF is the design for closure approach. To achieve environmentally responsible management of extractive waste, its deposition is planned

and designed for closure from the very beginning and the closure is continuously adapted and improved.

The third key principle of the MWEI BREF is the integrated design approach in the extractive waste management. According to the approach all relevant parameters are considered in designing the construction of the EWFs to optimize the overall environmental, human health and safety aspects in the short and long term.

Recently the European Commission has also published several best practices guides on the extractive sector (e.g., on extractive waste management plans, mine closure and financial guarantees and environmental impact assessment). Also, a guidance on risk management of the extractive sector is being developed. In addition to MWEI BREF these documents are important European guidance to support sustainable mining and environmentally safe extractive waste management.

<https://ec.europa.eu › pdf › waste › mining>

**Link to [Presentation](#)**

## Session 2A) Pollution Mitigation and Maintaining Biodiversity

<b>Marine tailing disposal: The Norwegian experience</b>
<b>Speaker:</b> Hilde Cecilie Trannum, NIVA
<b>Biography:</b> <i>Senior Research Scientist (PhD) at Norwegian Institute for Water Research NIVA) and Associate Professor at University of Agder</i>
<b>What is the Purpose of your Talk?</b> The aim of the talk is to provide insights and lessons learnt from Norwegian sea deposits regarding environmental impacts, and to give an overview of major knowledge gaps, as well as presenting guidelines for the development of best available techniques for submarine tailing disposals.
<b>Abstract:</b> Submarine tailing disposal (STD) in fjords from land-based mines has been a practice in Norway, although controversial. Until quite recently, the impacts on marine ecosystems had received relatively little scientific attention. To increase such knowledge, a multidisciplinary research programme (NYKOS; New Knowledge on Sea Deposits) was initiated. The major results from this programme, as well as other research studies and environmental monitoring programmes will be presented; spanning from geological seabed mapping to toxicity testing and experiments on the benthic community level, and from fjords from the south to the north of Norway. Experience from the Arctic fjord, Repparfjorden, will receive extra emphasis, representing both an old deposition area (> 40 y) and a pre-mining site. By combining a field and an experimental approach, both short- and long-term benthic recovery was studied in this fjord. Major knowledge gaps arising from the existing knowledge will be presented, as well as suggestions for guidelines for the development of best available techniques for submarine tailing disposals, based on the Norwegian experience.
<b>Link to <a href="#">Presentation</a></b>

## Industry process chemicals and discharge of wastewater to the Arctic environment

**Speaker:** Kim Gustavson, Senior Scientist, Aarhus University

**Biography:** *Kim Gustavson has more than 25 years of experience with project management, research and consultancy assignments for private companies and environment authorities. He has key expertise within fate and effect of metal, oil components, pesticides, persistent organic pollutants in aquatic and terrestrial ecosystems, biological and chemical monitoring.*

### **Abstract / What is the Purpose of your Talk?**

Environmental concerns related to use of chemicals in mining projects during processing and enrichment of metals or minerals are to ensure these are degradable, not toxic or can not be bioaccumulated.

In a Greenland context, discharges of processed water from mining projects will in many cases result in discharges to the marine environment. The marine environment in the Arctic regions is characterized by low water temperatures and low concentrations of nutrient salts. Both are conditions that will limit or prolong the degradation of chemicals and other substances. In addition, the organisms and food chains are characterized by slow growth and a high content of lipids, which increases the risk of bioaccumulation especially of lipophilic chemicals.

A central question is how regulation can aid to ensure that the use of processing chemicals will not result in negative effects and long-term burden on the arctic marine environment and organisms. Is it possible to apply the same classification and regulation to chemicals in Arctic mining projects as are being used under the OSPAR in relation to offshore oil and gas extraction? Can data from standard tests for biodegradability, bioaccumulation and toxicity be applied?

What uncertainties will there be in using data from standard tests for regulation under Arctic conditions?

**Link to [Presentation](#)**

**Eelgrass in Greenland- Mapping of distribution and vulnerability in relation to seabed material extraction**

**Speaker:** Dr. David Blockley, Greenland Institute of Natural Resources

**Biography:** *Dr. Blockley provides advice to government regulators and conducts research related to marine impacts from mining and hydrocarbons exploration. Additional research includes impacts of sea level changes on subtidal benthic ecosystems, monitoring long term biological indicators of climate change and ecotoxicology.*

**What is the Purpose of your Talk?**

Environmental impacts, monitoring and assessment for impacts of shallow coastal mining on marine vegetation.

**Abstract:**

Eelgrass is the only flowering plant that grows in the sea around Greenland. In the fjord near the capital, Nuuk, eelgrass forms geographically isolated populations of plants in the inner-most and warmest fjord arms. Eelgrass meadows have an important function as habitats and food sources for a wide range of organisms, and thus can support a rich animal and plant life on an otherwise species-poor sandy bottom. However, the distribution and growth of eelgrass in Greenlandic fjords is limited by the low sea temperatures and so the quantitative importance is not as great as in more temperate environments. Nonetheless, eelgrass is categorized as "vulnerable" on the Greenlandic endangered species list and is at risk from anthropogenic disturbance.

One of the most notable risks to eelgrass meadows in Greenland is from the seabed extraction of sand and gravel via ships equipped with a suction pipe lowered onto the seabed. A slurry of water and materials are pumped from the seabed up into the ship, with excess water and fine material continuously discharged over the side. This process can leave holes up to 10 m deep and about 30 m in diameter and can result in the absorption of organisms and destabilization of the seabed. The discharge water containing fine sediments forms a plume which makes the water opaque, reducing light penetration, potentially limiting growth of marine plants. Eventual settlement of the plume may also smother bottom dwelling organisms.

Mapping of the distribution of eelgrass was carried out at the sites where a permit for dredging had been applied for and where there was also an expectation of eelgrass occurrence. To assess the actual distribution of eelgrass in the relevant locations, a handheld underwater video camera was used to record the seabed and the presence of eelgrass. At all the sites studied, in Kobbefjord and in Ameralik Fjord, the occurrence of eelgrass was confirmed in sand habitats adjacent to current or potential dredging activity.

To ensure the protection of eelgrass, it is recommended that dredging be carried out only with a safety distance of 500 meters from identified eelgrass meadows to protect plants from physical damage or impacts from increased silt. Future work would further refine and map the distribution of eelgrass in relation to all dredging activity. There is also a need for

monitoring programmes to determine temporal trends in distribution and to understand any impacts from ongoing dredging activity.

**Link to [Presentation](#)**

**Session 2B) What can we do better to maintain biodiversity: Exploring challenges, approaches and solutions**

<b>Narwhals and underwater noise: New knowledge</b>
<b>Speaker:</b> Mads Peter Heide-Jørgensen, Greenland Institute of Natural Resources and the University of Copenhagen
<b>Biography:</b> <i>MPHJ is a professor in marine biology at the Greenland Institute of Natural Resources and the University of Copenhagen. He has worked with North Atlantic marine mammals for over 40 years and has pioneered several novel techniques for collecting biologging data from marine mammals, including a variety of methods for satellite tracking whales. He is a permanent member of the Scientific Committee of North Atlantic Marine Mammal Commission.</i>
<b>What is the Purpose of your Talk?</b> To present the latest experimental data as well as real-time information on effects of noise on narwhals
<b>Abstract:</b> The effects of ship noise and small seismic air guns on narwhals has been studied in a controlled dose experimental setup in East Greenland. Narwhals proved to be extremely sensitive to disturbance, changing speed and swimming direction at distances of up to 24 km from moving vessels. Other behavioral responses included a reduction of feeding and cessation of deep dives. Physiological responses included marked cardiovascular, respiratory and locomotor reactions. Some of the reactions were triggered at distances larger than 40 km from the ship. There were no indications of narwhals being habituated on the short term after repeated exposures to ship noise. A large-scale effect of disturbance of narwhals has been observed in connection with increasing ship traffic over several years to and from the Mary River mine in coastal areas of northern Canada. The most serious observed effect was a massive displacement of narwhals out of Eclipse Sound and into Admiralty Inlet. It has been estimated that about 25.000 narwhals have emigrated from the Eclipse Sound population to the neighboring Admiralty Inlet, with no more than 2.000 narwhals left in 2021. There is no evidence suggesting that the displacement could have other causes like climate change or increased predation from killer whales.
<b>Link to <a href="#">Presentation</a></b>

**A Saami approach to maintaining biodiversity in marine environments affected by mining\***

**Speaker:** Tonje M. W. Johansen, Saami Council

**Biography:** *Tonje Margrete Winsnes Johansen is an advisor at the Saami Council's Arctic and Environmental unit. In her work, she focuses mainly on societal issues in Sápmi and the societal aspects of a changing climate and environment.*

**Abstract: What is the Purpose of your Talk?**

The need for minerals must be assessed against the consequences for nature, biodiversity, nature-based livelihoods, and social development.

Indigenous rights need to be the basis when decisions on mining licenses are made to avoid breaching human rights.

The world's richest countries should be at the forefront of developing and demanding as environmentally friendly mining as possible, particularly in vulnerable ecosystems such as those in the Arctic. This does not include dumping mining waste in the ocean.

The very same countries should also lead the way in transforming the economy into a circular one and raising the issue of everlasting growth.

The Saami Council wants with this talk to challenge the countries that the Sámi people live within to be role models when it comes to mining in Indigenous land, including marine areas.

\*Denotes oral presentation given without visual tools.



**Session 3A) What can we do better on regulating the impacts of Arctic mines, and meaningfully engaging Indigenous Peoples and local communities?**

<b>Towards Sustainable Mining; an overview</b>
<b>Speaker:</b> Katherine Gosselin, Mining Association of Canada
<b>Biography:</b> <i>Katherine is the Director of the Towards Sustainable Mining (TSM) program, a globally recognized standard for sustainability in the mining sector. She supports the adoption and implementation of TSM by Mining Association of Canada members and other national mining associations. She holds an MSc in Global Politics from the London School of Economics and Political Science.</i>
<b>What is the Purpose of your Talk?</b> To provide a brief overview of TSM – <i>Towards Sustainable Mining</i> – a global mining sustainability standard that helps companies manage social and environmental risks.
<b>Abstract:</b> TSM has been helping mine sites manage, report, and verify their sustainability performance since 2004. Today, more than 200 mining companies around the world implement the TSM program, which sets rigorous standards for environmental and social risks, such as tailings management, water stewardship, and relationships with Indigenous peoples. The program is currently implemented in several Arctic jurisdictions, including Canada, Finland, and Norway. The aim of this talk is to improve awareness of this widely adopted standard for sustainability in the mining sector.
<b>Link to <a href="#">Presentation</a></b>

**Discovering and delivering commodities for our future, in Greenland and Finland**

**Speaker:** Bo Stensgaard, CEO, Blue Jay Mining

**Biography:** *Dr. Stensgaard is a Danish national and preeminent geologist with extensive operational experience in Greenland. Bo was a senior research scientist at the Danish state survey and has advised multiple European federal and commercial entities in the field of commodity development.*

**Abstract:**

Bluejay Mining has been an industry leader in growth and research into new concepts and practices. A case study of the Dundas project will analyze several new concepts and practices in use that aim to create projects that are: lower risk, realizable, and resilient.

**Link to [Presentation](#)**

## **Nunavut Impact Review Board (NIRB) and meaningful engagement**

**Speaker:** Kaviq Kaluraq, Executive Director and Chair, Nunavut Impact Review Board

**Biography:** *Kaviq joined the Nunavut Impact Review Board in February 2010. Kaviq was nominated by her fellow Board members to be Chair of NIRB in 2019 - She was recently re-appointed as Chair, with a term until 2026. Kaviq lives in Baker Lake, Nunavut where she teaches in the Nunavut Teacher Education Program for Nunavut Arctic College and she speaks both English and Inuktitut.*

*Karen Costello joined the NIRB in June 2020 as Executive Director where she is responsible for providing direction, leadership and ongoing management of NIRB operations and staff. She provides advice, direction and recommendations to the Board on the mandated duties of the NIRB. Prior to joining the NIRB, Karen spent over 15 years with the federal government, working in Iqaluit and Yellowknife.*

### **Abstract: What is the Purpose of your Talk?**

To introduce the Nunavut Impact Review Board as an institution of public governance that effectively engages with Indigenous Peoples and local communities to recognize and utilize traditional and western knowledge to address impacts of industry.

We will explore the different methods used to consult and participate. This includes: public hearings, interpretation support and full translations of documents, early involvement and early community sessions.

**Link to [Presentation](#)**

**The Importance of integrating biodiversity values in mining during the earlier stages of decision-making cycle**

**Speaker:** Elena Tracy, WWF Arctic Programme

**Biography:** *Dr. Tracy's research and teaching interests include the domestic and international politics of environmental protection, institutional design and environmental policies, the politics of GMOs, and other topics related to environmental governance.*

**What is the Purpose of your Talk?**

Mining is identified among key drivers of biodiversity loss in the Arctic region. Therefore, integrating biodiversity values during the decision-making process throughout the entire mining cycle, from pre-planning/planning, to production and decommissioning, is essential.

**Abstract:**

The presentation focuses on the importance of integrating biodiversity values during the earliest stages of project planning, when biodiversity-related impacts, including cumulated and wide-ranged, can be appropriately addressed and prevented. The inclusion of civil society stakeholders and Indigenous rights holders also happens at earlier phases of project planning.

WWF offers criteria for mainstreaming biodiversity into mining activities, which is particularly useful during the earliest stages of planning that allow us to prevent or significantly reduce negative impacts on biodiversity from mining as well as from associated shipping activities.

These criteria include the consideration for protected areas (eg. ArcNet), ecological corridors connecting the protected areas, as well as establishing clear processes for engaging Indigenous peoples and local communities while utilizing traditional knowledge.

**Link to [Presentation](#)**

**Session 3B) Moderated Panel Discussion - Perspectives across sectors on mining regulation, impact and management - What has been learned? What are the best practices to balance future mining activities with protection of the Arctic environment?**

**Strategic Environmental Impact Assessment – A Greenland example on how to inform a planning process**

**Speakers:** Janne Fritt-Rasmussen, Aarhus University

**Biography:** *Janne Fritt-Rasmussen, Ph.D., is an environmental engineer with >10 years of experience in Arctic research, project management and teaching at university level. Since 2012 she has been working with consultancy regarding the environmental aspects of oil exploitation in Greenland, at the DCE - Danish Centre for Environment and Energy, Aarhus University.*

**What is the Purpose of your Talk?**

The purpose of this talk is to introduce the concept of strategic environmental impact assessments and its potential as a tool in an environmentally sound planning and regulation of mining activities.

**What is the relevant background and context?**

As an aid to obtain a regional overview of nature and environmental conditions, the Greenland Environmental Agency for Mineral Resources Activities, has commissioned the preparation of Regional Environmental Baseline Assessments (RBA) of mining activities. The Assessments are being developed by DCE and GINR.

**What do we need to know about methodology and actors?**

Knowledge of nature and the environment is needed to be able to plan and regulate raw material activities. For most marine, and selected land areas in Greenland, the latest knowledge is gathered in regional environmental assessments and background study reports. They describe the physical and biological environment, including protected areas, endangered species, and the exploitation of biological resources. Local knowledge is an important part of the assessments.

The environmental assessments also include a description of background levels for pollutants and possible local sources of pollution.

Based on this knowledge of the current situation, areas of multiple interest are identified, and the general potential environmental impact of raw material activities is discussed and assessed. The draft RBAs are going into public hearings and can inform the decision process.

**What are the key learning points you want to share?**

As an important part of the regional environmental assessments, significant deficiencies and uncertainties in the available knowledge are identified, and research projects are

carried out to obtain supplementary data. These background studies have made it possible to provide an overall mapping of particularly sensitive nature areas such as bird colonies, moulting areas for diving ducks, concentration areas for marine mammals and coastal spawning areas for fish. The regional environmental assessments thus provide an overview of the latest knowledge about nature and the environment for a given area based on research and local knowledge, and the data can be used in many contexts.

**What are the next steps raised by your talk and/or questions that need to be answered?**

How can we further ease how locals and other stakeholders contribute to the environmental assessments?

How can we improve our methodology to further ease the access to nature and environmental information to inform public discussions and make it easier for both industry and authorities to plan mining activities wisely?

Link to [Presentation](#)

**Moderated Panel Discussion:**

**Perspectives across sectors on mining regulation, impact and management - What has been learned? What are the best practices to balance future mining activities with protection of the Arctic environment?**

**Panel Speaker 1:** Alex Buchan, Agnico Eagle Director of Nunavut Affairs, Stakeholder Engagement

**Biography:** *Alex Buchan is an Inuk residing in Cambridge Bay, Nunavut with a background in wildlife management and community economic development with previous work experience at the municipal and territorial government levels. He is an active marine mammal and fish harvester. He has been actively supporting Hope Bay gold mine development for over 15 years, and is now the Agnico Eagle Director of Nunavut Affairs, as well as representing the company as Vice President (Nunavut) on the NWT/Nunavut Chamber of Mines.”*

**Abstract:**

It is possible to discover, explore, permit, construct and operate a modern mine in Canada’s Nunavut territory without significant adverse effects on the marine environment.

Agnico Eagle Mines Ltd. is the largest mine operator in the Nunavut territory of Canada, with 3 operating areas that have existed for 14, 13 and 6 years respectively.

Agnico Eagle makes use of the marine environment to conduct an annual commodity and equipment resupply, and for discharging tested and treated mine effluent. Agnico Eagle Nunavut operations have been subject to Canadian Mining and Marine Transportation regulation, Nunavut co-management environmental assessment and licensing, and Inuit Owned Land Management practices. Annual reporting under this regime demonstrates that no significant adverse environmental impacts have been experienced within this level of development.

Existing Nunavut marine environmental management could be considered a best practice among similar jurisdictions.

**Link to [Presentation](#)**

**Panel Speaker 2:** Steen Christensen, Environmental Agency for Mineral Resource Activities, Government of Greenland

**Biography:** *Since December 2019, Dr. Christensen has been based in Nuuk working with the Government of Greenland. From December 2019 - October 2021 as the Chief Advisor with the Ministry of Fisheries, Hunting and Agriculture. And since November 2021 as Head of the Environment Agency for Mineral Resource Activities (EAMRA).*

**Abstract**

The presentation presents a brief overview of the evolution of the mining industry in Greenland from the first cryolite mine opening in Ivittuut in 1854 to the opening of the zinc-led mine Maarmorilik in the 1970s where the first environmental studies on effects of mine site activities were conducted.

Recognizing that the old mine sites might be potential sources for pollution, environmental studies were initiated in the early 1970s. The research and continued monitoring at these polluted sites have enabled studies on the effects of mining pollution under Arctic conditions and provided a solid knowledge platform for sustainable development of the mining industry in Greenland under the guidance of the Environmental Agency for Mineral Resource Activities.

The presentation highlights some of the extreme climatic and logistic conditions that the mining industry faces in Greenland and emphasizes the conditional Environmental Impact Assessment that is designed to evaluate and mitigate the potential risks to the sensitive arctic environment.

To continue the sustainable development of the mining industry in Greenland the presentation highlights the need for stronger community engagement, application of best available practice (BAP), best available technologies (BET), and promoting reduction of emissions and use of renewable energy.

**Link to [Presentation](#)**



**Panel Speaker 3:** Jared Ottenhof, Qikiqtani Inuit Association\*

**Biography:** *Jared began working in Northern Canada with the Kitikmeot Inuit Association, living in Kugluktuk, representing the organization for impact assessments and other regulatory work, then moved to Nunavut Tunngavik Incorporated in Rankin Inlet as an Environmental Resource Management Advisor, and currently works as Director of Lands and Resource Management for the Qikiqtani Inuit Association in Iqaluit, NU.*

**Abstract:**

I provided a short summary of the functioning purpose of the Qikiqtani Inuit Association, and other similar regional organizations, and the role they play in relation to Industry. Currently, the QIA is the recipient group of several Inuit Impact Benefit Agreements, and are able to provide feedback on projects (such as the Mary River Project) as they continue to be reviewed by governing bodies.

\*Denotes Oral presentation given without visual tools.

**Panel Speaker 4:** Lis Bach, Aarhus University

**Biography:** *Lis Bach is a Senior advisor at DCE, Aarhus University. Marine ecology and ecotoxicology. She is a researcher on fate and effects of contaminants in the marine environment, and provides advisory tasks to the environmental authorities on environmental issues related to mining industries.*

**Abstract:**

Mining in the Arctic holds special precautions. The environment is more fragile to disturbances than in other parts of the world and climate conditions need special attention.

Although mining activities are expected to increase, there are still few active mines in the Arctic.

Arctic mining is expanding into greener mining with focus on lower environmental impacts.

To promote such a process there is a need for more research under Arctic conditions to support both technology and regulation and increased collaboration between researchers and industries could pave the way.

Link to [Presentation](#)

## V: Key Issues, Challenges Identified and Possible Solutions

In the latter part of Day One of the workshop, participants worked in small groups to identify key challenges for Arctic mining and waste management in the marine environment. In six small groups, they reviewed a list of challenges that had been identified by participants when they initially registered for the workshop, discussing the question:

*What have you heard in presentations today or in your work that you see as a key challenge for stewardship of the Arctic marine environment, in an era of increased mining activity? What is the specific challenge?*

Participants were tasked with adding to and expanding on the list of challenges, and then highlighting 1-2 challenges they deemed as most pressing.

The following is the complete list of challenges generated by participants, listed in order of those selected by the groups as particularly significant. All of the issues are significant, but the number of asterisks (\*) indicates how many groups of participants selected that challenge as one of the most pressing.

### **Key Issues and Challenges Identified by Workshop Participants**

- A. **Waste\*\*\*\***: How can we manage wastewater and waste rock? How can we address leaching from tailings management? Participants flagged the need to consider dust management, and the need for more accurate predictions about the behaviour and impact of waste.
- B. **Indigenous/Local Engagement\*\*\*: Approaches** to Arctic mining that use **Indigenous knowledge** (for example, Inuit Qaujimajatuqangit<sup>1</sup> (IQ) and other forms of traditional knowledge) for stewardship and monitoring (of caribou populations, for example), and contribute to **Indigenous social, cultural and economic well-being** (for example, food security considerations with marine species). Participants emphasized the need to gauge the impacts of mining and shipping activity, for example on Indigenous subsistence and livelihoods with an emphasis on local communities. Participants also identified that more work is needed for gaining social acceptance from Indigenous and local communities around planning and engaging in mining activities.
  - 1. Consultation processes could be initiated early, even before Indigenous knowledge is engaged for stewardship (in its various forms), to gain consent and to increase understanding of the issues.

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<sup>1</sup> refers to Inuit “Traditional Knowledge” while Inuit Qaujimaningit refers to Inuit Traditional Knowledge as well as Inuit epistemology without reference to temporality (Source: <https://www.nirb.ca/inuit-qaujimajatuqangit>).

2. More than regulatory monitoring, but also partly as a 'social license' - companies need to make more of an effort to engage indigenous and local peoples and find new approaches to seek social acceptance for projects.
- C. **Climate Change\*\***: Participants emphasized the need to better understand and manage the **risks of climate change** as they relate to mining activity in the Arctic [marine] environment. Future models are required for new mines. Key considerations include how climate change affects waste and waste water management, and what the impact is on species. We need to:
1. Understand how climate change affects waste and water management;
  2. Consider climate changes in the terrain and the distribution of animal species when planning projects and predicting immediate and cumulative impacts;
- D. **Maintaining Biodiversity\*\***: Maintaining biodiversity in a rapidly changing climate is crucial; participants suggested better use/handling of mine by-products to reduce impacts on biodiversity; and consideration for habitat impacts.
- E. **Spills\***: Participants flagged the risks of major spills from accidents, discussed the need to focus on preventing spills; spills are catastrophic and have high intensity risks; we need to look closely at the effect of increased traffic with more open sea lanes.
- F. **Monitoring\***: Significant challenges face us in carrying out good quality **monitoring** both in the short- and long-term to support sustainable development onshore and offshore. Currently, there are limitations on breadth, type and location of knowledge. For example, what is the baseline for long life cycle mines; what are the baseline norms for species; where does the responsibility lie for management and cleanup; how extensive should baseline studies be?
- G. **Regulation and Innovation\***: Participants identified that there is a **role for regulators** in disseminating best practice, and a need to consider the **role of industry** in piloting emerging best practices.
- H. **Transboundary Environmental Impacts\***: Many impacts cross local or national political boundaries in the Arctic, particularly in the marine environment. For such **transboundary environmental impacts** - across jurisdictions- who is doing what, when and how? How can you plan and prepare to avoid issues later? How are responses identified and coordinated?
- I. **Noise Impacts and Disturbance**: Participants expressed concerns related to vessel traffic and underwater noise impacts on wildlife and habitat (as demonstrated by the impact on narwhals).
- J. **Vessel Routing Issues**: As noted above, ship traffic can have impacts from noise, pollution and the risk of both large- and small-scale spills. Given that climate change is opening up the number of routes and the frequency of their usage, careful thought must be given to vessel routing- size, type, frequency, etc.
- K. **Cumulative Impacts**: Prepare for **Ecosystem-Based management** across industries and sectors in a rapidly changing Arctic. There is great need for

**cumulative impact** assessments of activities, (in particular for long life cycle projects, and numerous projects occurring in one region).

- L. **Processing Issues:** The nature and location of mineral processing is a key challenge; should it occur offsite (in the south) versus onsite (in the fragile Arctic environment)? What related infrastructure is needed and what are the associated impacts? What minerals are or should be mined? What are the implications for toxicity of minerals, tailings, waste rock, and waste products of processing methods (organic or inorganic)? How does the processing fit that site's specific ecosystem?
- M. **Remoteness:** Participants spoke about the challenge that remoteness of location poses: emergency responses are harder; the nature and quality of the response is likely challenged; and costs of most activities are higher when mining activity occurs in remote areas.
- N. **Uncertainty:** Participants noted the difficulty of dealing with **uncertainty** around environmental impacts for scientists and regulators. In the near term, it is hard to gauge what will happen to particular ecosystems. Robust dialogue and negotiations are needed between regulators and companies, with ways to identify the issues early on.

## **Possible Solutions**

On Day Two of the Workshop, participants had a brief session working with the list of challenges and key issues they had identified and discussed on Day One. Participants were asked to select one challenge from the list to work on in their small groups. Those groups then worked on identifying some proposed solutions, considering what strategy could help, how it could work and what stakeholders would be involved.

A summary of the ideas generated by workshop participants is set out below, grouped by the challenge to confront.

### **1) *Solutions related to Waste - managing wastewater and leaching, dust, tailings & waste rock\*\*\*\****

Significant progress on mitigating contamination can be achieved when companies do the necessary planning and spend money to plan for and mitigate contamination from the outset of a project. Planning should look at exactly how much is needed to mitigate which level of risk, to provide greater clarity and guidance for companies, investors, and regulators.

In the current context, many companies are motivated to better address waste due to the reputational risk involved - serious companies want to mitigate future waste risks.

There is an opportunity to mitigate considerable risk of contamination by carrying out thorough planning and mapping ahead of a project starting. One of the tools to achieve this is through baseline studies and thorough plans for restoration, for example in coastal mining settings.

Another useful tool is the recent International Council on Mining and Metals (ICMM) recent global tailings standard; mining companies are now committed to adhering to a strict set of principles and there is wide acceptance in the industry that these standards are necessary and important.

While regulation varies amongst different jurisdictions, one solution is to place greater focus on ensuring existing regulations are adhered to and that they are enforced. Sharing of best practice standards across jurisdictions, as discussed in this conference, is one way to ensure a shared high-quality approach.

In some settings, better use of natural topography can help to appropriately manage and mitigate risks of contamination from mining waste.

One group also discussed reducing the processing footprint by sharing processing facilities across multiple mines and projects. While potentially efficient, the challenge is how such shared processing could be incentivized and regulated.

For some projects, it may be best to do processing (particularly the more environmentally impactful processing) in less fragile environments, offsite.

In regards to addressing the effects of dust, another group noted that there is a need for more accurate dust emission factors (e.g., vs USEPA AP-42). The group noted the need to better understand and gather knowledge about dust emission factors, and proposed an approach to do so: first, meeting to better understand different interests, find a common approach to present to decision makers, and then implement an updated approach to dust emission factors.

## **2) *Maintaining Biodiversity\****

In a changing climate, we need to be working across different sectors, with good monitoring across these sectors and for different species and parameters such as noise, pollution, etc. Regulation and management is needed across sectors, with a holistic monitoring approach. This approach is intended not just to monitor at one time window, but to consider the entire project life cycle including the pre-approval process. For this approach to work, there needs to be sufficient depth and quality of the Strategic Environmental Assessment or Environmental Impact Assessment.

Participants agreed it would be useful to implement integrated ecosystem-based management, building in a wide array of rights holder and stakeholder participation.

Participants also identified the need to adhere to the “precautionary principle”, that a project should not go ahead until there is proof it is not harmful to the environment, to people and to biodiversity. This principle is particularly important given the lack of good baseline data (on species, impacts, etc.) in many Arctic areas, and the uncertainty risks noted earlier.

## **3) *Indigenous and Local Engagement and Knowledge\*\*\****

A good starting point is to map out who are the relevant knowledge holders - where they are and what they know? This step helps to establish a key network. It is a proactive response to anticipating problems. By establishing and maintaining the network and pathways, problems can be identified and addressed proactively. Regulatory bodies are increasingly seeing the value in getting input from Indigenous and local communities early and often, even before proponents file proposals.

Related to this challenge, there is an active Arctic Council project, through Conservation of Arctic Flora and Fauna (CAFF), the biodiversity working group of the Arctic Council: Mainstreaming Biodiversity in Arctic Mining.

Another group proposed more robust approaches to Indigenous engagement-incorporating IQ (traditional Inuit knowledge) and community knowledge for monitoring and project design. To be effective, early engagement is required, with a demonstration of how this information can be incorporated. For example, in one region, Indigenous knowledge of caribou migration and saltwater flooding patterns was very helpful.

#### **4) Transboundary Environmental Impacts**

Participants noted that in Alaska, one solution is the creation of an oversight and negotiation group that is represented by all key stakeholder groups. This approach creates the conditions for empowered Indigenous representation, and can set the stage for implementing a co-management system to delegate authority to the local peoples.



## VI: Emerging Themes and Questions

The workshop identified a number of important themes and questions that need further consideration. These points are summarized below.

### Theme 1: Where are we now? What remains a challenge (defining the problem)?

- In the Arctic, environmental harm from mineral extraction can be significant and long-lasting.
- What will be the long-term impacts of climate change and related changes in exploration and mining activities? There is likely to be much greater access to remote mining prospects, increased exploration, increased air and shipping traffic, etc. We need to think about the changes that climate change will bring (water temperatures, species migrations, breakdown and movement of waste; increases in glacial melt, runoff and sedimentation) and plan accordingly.
- How can we build our knowledge base? Our knowledge about the environment in the Arctic is quite limited, when compared to the vast regions now accessible for potential mining activity. We need more research (reflecting diverse perspectives, rights holders, and a range of stakeholder groups) on many topics to fill in the current gaps and unknowns.

### Theme 2: What can we do better on pollution issues, mitigating impacts, and reducing environmental issues related to mining?

- How can modern methods minimize the impacts of mining from exploration to mine closure and rehabilitation (like the Blue Jay Mining approach to building facilities in the south and bringing them in by floating barge, then taking them out the same way at project closure, or the use of drones in indigenous monitoring of animal populations)? New technologies? How can new approaches be put into practice?
- Can mining truly be “sustainable” or is the real target to make mining more responsible and less impactful in negative ways, balancing costs and benefits appropriately? While mining cannot be sustainable in the strictest sense, as the mineral resource extracted is not renewed, the word is sometimes used meaning “responsible and less impactful” on the environment.
- How should processing be done, and where, to minimize potential harm?

- How can we minimize the risks of impacts from increased volume and spread of shipping traffic in the Arctic?
- How can mining activity and mining waste become, as much as possible, part of a circular economy, minimizing waste and negative impacts?
- Can mining by-products be a resource for Arctic? Companies are starting to look into this further through “re-mining” where tailings can be recovered. Waste management is influenced by economics and financing – how can more responsible mining and waste management approaches be incentivized?

### **Theme 3: What can we do better to maintain biodiversity?**

- How do we identify the existing biodiversity accurately without more research? Can traditional knowledge be utilized more effectively to maintain biodiversity?
- How do we minimize the many risks to the fragile Arctic environment that were identified?
- How big will impacts on species (such as the narwhal) be? And what will be the long-term consequences?

### **Theme 4: What can we do better - How do we carry out meaningful engagement and participation with Indigenous Peoples and local communities?**

- We *must* meaningfully engage with and respect the rights of local and Indigenous communities and knowledge keepers.
- Engagement should be early, effective, and ongoing.
- Local and Indigenous communities are important sources of relevant knowledge about the ecosystem and component species, both currently and historically.

### **Theme 5: How could we best regulate arctic mining to prevent environmental issues, and support responsible practices?**

- Ecosystem-based management approaches are needed, with a long-term vision attuned to cumulative impacts, not just select impacts measured in isolation or over a short time frame.

- How can appropriate quality standards for best available techniques and best practices (BATs etc.) be adopted and then enforced? And how can this be achieved in a transboundary environment?
- Understanding ecosystems requires good baseline data over an extended period (the lesson of fjord water movement dynamics changing with seasons or years). Environmental Impact Assessments need to be done early and well, with a comprehensive approach.

## **VII: Next Steps**

One goal of this workshop was to begin important conversations between interested people with the right expertise and connections. Another long-term objective is to encourage the dissemination of helpful information and best practices. To achieve these goals and to hone future efforts at improving mining and mine waste management processes, this workshop has outlined a variety of ongoing steps as set out below.

### **1. Proceedings of the Workshop**

The publishing and circulation of these proceedings is one method for sharing the workshop's knowledge and materials.

### **2. Conference Website**

The conference website (<https://conferences.au.dk/arctic-mining>) was established both to advertise and host the workshop registration, and to act as an ongoing repository for information for participants and others with an interest in Arctic mining and marine ecology.

### **3. Solutions Worksheet**

We have encouraged workshop participants to reflect on the key issues and challenges in this field that were identified during the workshop, and then to consider and share tailored solutions. Some of those solutions are summarized in the sections above.

### **4. Network Building and Contact List - Staying in Communication**

The workshop organizers have encouraged participants to make connections with relevant people and organizations through the workshop, during informal conversations like the Northern Lights Lounge component of the workshop, online chats, and by the sharing of a contact list.

### **5. Contact Creation**

The workshop encouraged participants to identify helpful contacts from the speakers and fellow participants, and organizers made efforts to facilitate such connections based on a number of requests.

Participants were invited to make ongoing requests for connection and information through the conference email ([Arctic.Mining.Workshop.2023@ecos.au.dk](mailto:Arctic.Mining.Workshop.2023@ecos.au.dk)).

### **6. Ideas? Focused network groups?**

Workshop participants were challenged to share ideas with one another on the themes of the workshop, and to make connections with individuals and experts of

similar or compatible interest. One such group, of governmental regulators from multiple jurisdictions, was connected during the workshop and given space to share thoughts in a breakout during the Northern Lights Lounge.

## **7. Abstracts and Presentation Materials**

Abstracts and presentation materials from the speakers at the workshop will be shared universally through the conference website (<https://conferences.au.dk/arctic-mining>) once appropriate permissions are confirmed.

In addition, videos of the majority of the presentations will also be available on the website for viewing.

Additional resources highlighted by conference speakers and participants will also be shared online via the website.

## **8. Academic Publication**

Following the Workshop, Anders Mosbech of Aarhus University will coordinate a possible academic publication building on the themes of the workshop and the information shared. Input from selected experts will be sought.

The workshop organizers hope that this workshop has planted seeds that will continue to bear fruit in a variety of productive ways, as evidenced by some of the connections and conversations that have already begun.

## VIII: Conclusions

This workshop has been a diverse forum for presentations and discussions among academia, industry, governments/regulatory bodies, Indigenous Peoples and local communities. It has been very fruitful to gather the diverse views of all the different stakeholders and hopefully the valuable discussions will continue for the benefit of the environment. Here I take the risk of simplifying the complexity and extract a few take-home messages.

Mining projects and environmental issues and conditions in the Arctic are clearly very diverse and complex, and so are the solutions to environmental issues. From the presentations at this workshop, it is also apparent that there have been improvements in the overall environmental performance in many of the recent Arctic mining projects, compared to mining projects initiated in the last century. Mining companies have heightened their focus on the environment, and regulators have made significant advances in the guidelines and approaches to mining activities. The use of environmental impact assessments based on detailed studies of the potential impact including geo-chemistry of waste rock and tailings, waste management, long-term waste facilities and detailed baseline studies of biodiversity and habitat issues have been important tools for improving the environmental performance. Standards have been developed for Tailings Management by the industry (International Council on Mining and Metals (ICMM)). The European Union and others have worked on how the principles of BAT (Best Available Technology) and BEP (Best Environmental Performance) can be applied for specific mining activities.

Several environmental issues were highlighted for continued focus and dialogue between mining companies, authorities, Indigenous peoples and local communities, consultants, technicians and scientists, in order to further minimize the impact of mining:

- An in-depth understanding of the **geo-chemistry of waste rock and tailings** and the potential leaching of pollutants is essential for minimizing pollution, requiring focus on developing environmentally safe waste storage facilities. It was highlighted that the environmental geo-chemistry and leaching tests should be started early in the process. There may also be potential for better coordination of the environmental geo-chemistry studies and the geological and mineralogical studies, furthering robust results.
- The accelerating Arctic **climate change** makes it a challenge to design **long-term waste facilities**. It must be considered that there will be melting of permafrost, changes in the precipitation, and there may be changes in the risk of flooding as well as more frequent extreme weather events.
- Marine **discharge of wastewater with process chemicals** also needs special attention. Often the chemicals used are only tested for degradation and toxic properties under temperate conditions. However, in the Arctic slow degradation

can be expected, and the toxic effects may be different on the local organisms which in the Arctic often have a high content of fat.

- In the Arctic, precipitation can be very low, resulting in long dry periods. Hence, most mines have **dust issues** which require attention. It was discussed to be “a lesson learned” that monitoring and mitigation of dust should be planned thoroughly before the start of the operation.
- The impact of **anthropogenic underwater noise** on marine mammals has been an emerging issue globally. The impact of underwater noise needs special attention in the Arctic where many waters are relatively pristine and marine mammals like narwhals appear to be very sensitive to ship noise. The “footprint” of shipping noise related to a large mine in the Arctic can be significant.
- **Robust baselines and continuous monitoring** of both pollutants and biodiversity is very important. Experience shows that **surprises do occur** and mitigation steps may need to be taken. New opportunities for smart year-round monitoring with new technical devices may be available.
- The **accelerating climate change** has severe impacts on the distribution and abundance of **Arctic biodiversity**. Climate change can cause unexpected changes in the ecosystems and there can be shifting baselines. It may be difficult to unravel the specific pressure causing an observed change. Monitoring of populations of important species, as well as pressures like mining and shipping, on a regional or population scale are needed to inform sustainable Ecosystem-Based Management.

Involving Indigenous peoples and local communities in mining projects from the very early start in the planning process will improve transparency, good communication, and decision-making. Locals can contribute with valuable information on local conditions, human use and biodiversity, and there are mutual advantages with local involvement in baseline and monitoring studies. For example, early online reporting of monitoring results can increase transparency and help to build trust.

The Arctic Council has been recommending the use of Ecosystem-Based Management (EBM) to help Arctic societies to cope and adapt in a changing Arctic. EBM was highlighted as a way forward at the workshop. It will be an advantage for the mining sector to be prepared for engaging in discussions on managing cumulative impacts across sectors, with research-based solutions.

Finally on behalf of the organizing committee I would like to thank all presenters and participants for their valuable participation.

**Anders Mosbech, Aarhus University, Kingdom of Denmark**

## Appendix A- Supplementary Materials and Comments Shared

- Tolvanen A et al. 2019. Mining in the Arctic environment – A review from ecological, socioeconomic and legal perspectives. Journal of Environmental Management, 233,832-844.
- Some vivid examples of the interplay between the physical environment and drivers of dust emission in Greenland/Arctic can be seen at Nasa's Earth Observatory. Here the combination of catabatic fall winds from the Ice Sheet and cyclonic driven storms may generate large amounts of dust emissions from natural dust prone landforms. Some processes could emit contaminated dust from mismanaged mine tailings, and specific mitigation actions are needed. <https://earthobservatory.nasa.gov/images/148995/dust-storms-in-greenland>
  - Adding to factors that are special for the Arctic (ibid session 1): the presence of low-level temperature inversions during the Arctic winter in complex terrain is known to efficiently limit the exchange of surface layer air with the upper atmosphere. This may lead to high concentrations of gases and particles in the air at the surface which could lead to increased exposure to humans and ecosystems. Again, assessment of local/regional weather regime for the entire year over several seasons is needed to identify potential air emission related issues.
- Katherine Gosselin: Responding to questions about compliance with TSM standards, here are a few thoughts (speaking from the perspective of how we do things in TSM):
  - 1) At the association level, we require companies to demonstrate evidence of improvement towards a minimum Level A on all performance indicators. If a company is not willing to implement the standard or does not demonstrate a commitment to improving performance, they can ultimately be rejected from the industry association (this has happened on a few occasions).
  - 2) Since we offer a five-level rating scale and not a certification, we provide transparency around sustainability performance (including where facilities are still reporting a Level C or Level B--less than good practice). So, communities, NGOs, unions, customers, investors, and others have an important role to play in engaging with companies on this performance data and holding them to account to improve performance. In fact, we have increasingly seen engagement from manufacturers and investors around TSM performance data.
  - 3) As mentioned briefly during my presentation, the standards themselves are in a constant state of review. So, if the requirements of a standard are not creating the desired results, we will take note and conduct a minor or comprehensive review of that protocol (with our independent advisory body and a public comment period). You can find all Canadian company



performance (for 2022 and all previous years) here:  
<https://mining.ca/towards-sustainable-mining/tsm-progress-report/company-performance/>

- For Finland, you can find their results here (and on some adjacent pages if you can navigate the site in Swedish):  
<https://www.kaivosvastuu.fi/kaivosvastuujarjestelma/tulokset/>
- TSM partner associations have five years to reach full implementation, so others' results are on their way. Argentina's should be published shortly. Philippines will publish first verified results later this year. Etc.
- The following link is leading to the proceedings from the NAMMCO workshop  
<https://nammco.no/scientific-workshops-symposia-reports/>
- The following link on the Greenland Government website was active until the fall 2022. However, there has been a temporary fall out, so it might not be working at the moment. [https://naalakkersuisut.gl/en/Hearings/Hearing-Archive/2015/Ironbark\\_SIA\\_EIA\\_NSI](https://naalakkersuisut.gl/en/Hearings/Hearing-Archive/2015/Ironbark_SIA_EIA_NSI)
- EU standards currently under consideration for waste management:  
<https://ec.europa.eu/environment/industry/stationary/ied/evaluation.htm>
- The following link was shared to inform the discussion and thinking about the circular economy and critical minerals as part of the green transition, when considering recycling minerals: <https://sintef.brage.unit.no/sintef-xmlui/handle/11250/3032049>