Bluejay Mining Plc

Dundas Ilmenite Project

Environmental Impact Assessment

Draft

February 2020

ORBICON

Bluejay Mining Plc

ENVIRONMENTAL IMPACT ASSESSMENT

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Date	07-02-2020

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1.1. Project overview

Dundas Titanium A/S proposes to develop the Dundas Ilmenite Project (the Project), which will extract ilmenite concentrate with high (3.45%) titanium dioxide content from the black mineral sand deposits found along the coastline of Steensby Land in North-west Greenland (Figure 1). Ilmenite is important for producing pigments, whiting and polishing abrasives while titanium metal is used extensively to produce durable, high-strength, lightweight metal alloys.

Dundas Titanium A/S is based in Greenland and holds 100% of the Project. Dundas Titanium is owned by Bluejay Mining Plc which is listed on the London Stock Exchange AIM market

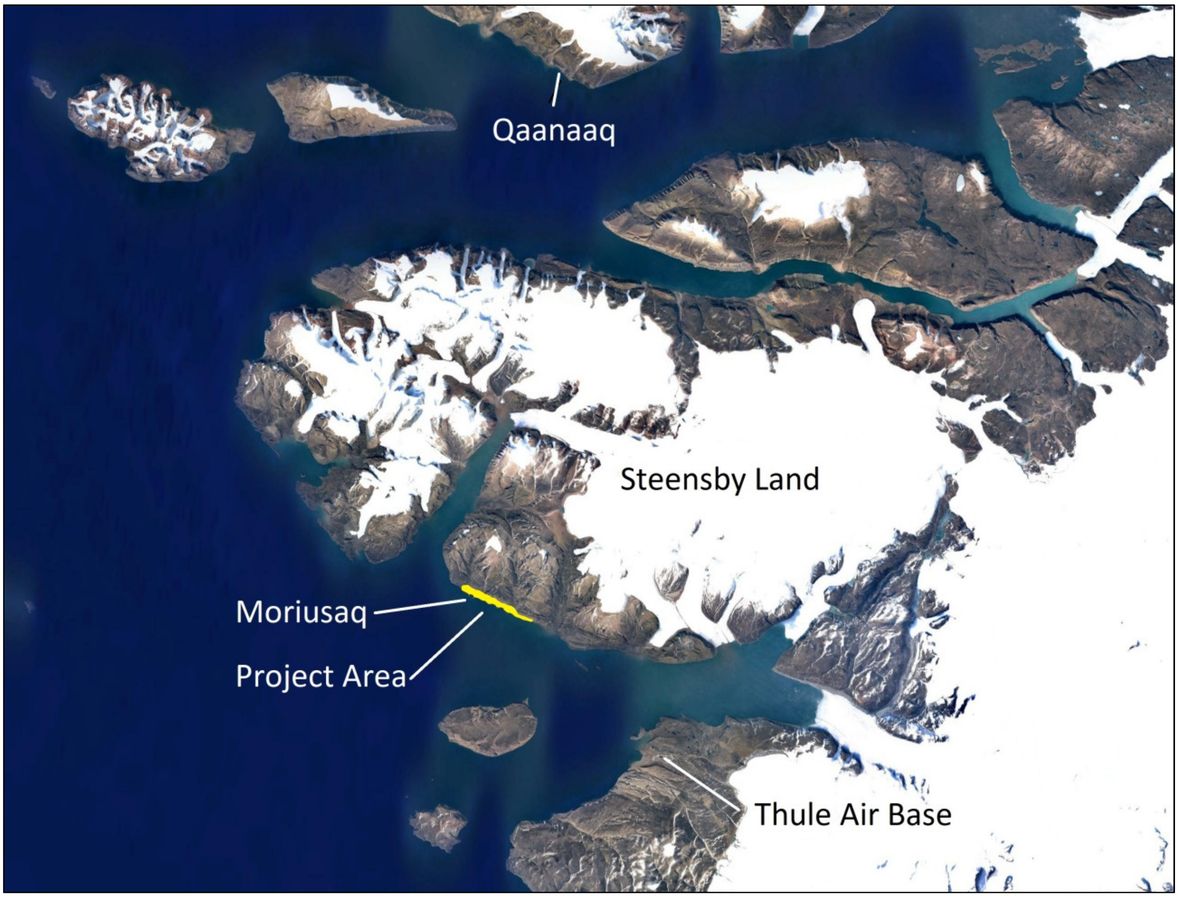


Figure 1. The Project area on the southern shore of the Steensby Land peninsula (yellow marking)

1.2. The Local Population[1]

Qaanaaq is the closest town to the proposed mine (Figure 1). By boat the distance is 135 km. Qaanaaq has around 640 inhabitants. Hunting and whaling are the traditional trades and mainly include seals, narwhales, walruses and sea birds. Less important are white whales. Occasional hunting of caribou and musk oxen also take place.

During winter and spring traditional subsistence harvest of walrus mainly takes place to the northwest of Qaanaaq and around Saunders Island and previously also near Moriusaq. Smaller seals are mostly hunted in the fjords close to Qaanaaq. Traditional subsistence harvest of narwhales mainly takes place in Inglefield Bredning east of Qaanaaq where large numbers concentrate during summer. Subsistence harvesting of birds mainly include Brünnich's guillemot, little auk and eider duck. These birds are only present in the Qaanaaq area during summer.

In recent years halibut fishing has become the most important income for the around 100 hunters/fishermen that live in Qaanaaq. The halibut fishing mainly takes place during winter and east of Qaanaaq.

The settlement Moriusaq on the southern shore of the Steensby Land peninsula (Figure 1) was established in the 1960ies but abandoned in 2010. Around 20 buildings are still left, and a few are occasionally used briefly by the owners, most people from Qaanaaq.

Thule Air Base is a United States Air Force base located c. 40 km to the south-east of the Project site. The airbase is not part of any municipality of Greenland, but an enclave within Greenland, outside of its jurisdiction.

1.3. The mining project

The Project involves the mining and processing of black heavy mineral sand from the coastal plains and beaches on 12 km of the south coast of Steensby Land to produce ilmenite concentrate. The estimated mine life is 10 years. Each year the black sand resource will be mined in specific blocks to an average depth of 4.6 m. Mining will start west of Moriusaq and generally develop from west to east and will include the resource below Moriusaq. After 10 year an 8 km^2 area has been mined.

The sand material will first be transported to a plant close to the mine area for removal of over- and undersize material as well as sand material consisting mainly of light minerals (which cannot be used).

[1] The *Social Impact Assessment* (SIA) prepared by NIRAS (2019) deals with the impacts from the project on the local populations

The heavy sand concentrate will then be transported by trucks to a magnetic plant next to the main camp. This plant separates the highly magnetic ilmenite product from non-magnetic trash sand material to produce ilmenite concentrate, which will be loaded onto ships for transport to customers. No chemical will be used in the processing.

The mining rate will be 7.4 million tonnes per annum, at which rate the Project is expected to produce approximately 440,000 tonnes of ilmenite product per year. All oversized material (rocks and gravel) and light sand material removed during the processing is hauled back to the mine void where it is backfilled. This represents c. 90% of the mined material. The undersize silt fraction and saltwater used to melt and wash the material in the first plant is mixed and pumped directly to the sea and discharged at 10 m depth.

The ilmenite product will be shipped out by ice class C1 40,000 DWT bulk carriers. Due to the ice conditions shipping will only be possible from mid-July to end of October. During this period all available ilmenite products will be exported. All products produced between the closure of a shipping window and the opening of the next will be stored on site.

<u>Main components of the Project</u>
A permanent main camp will be built app. 2.5 km southeast of Moriusaq with accommodation for 175 staff (Figure 2).

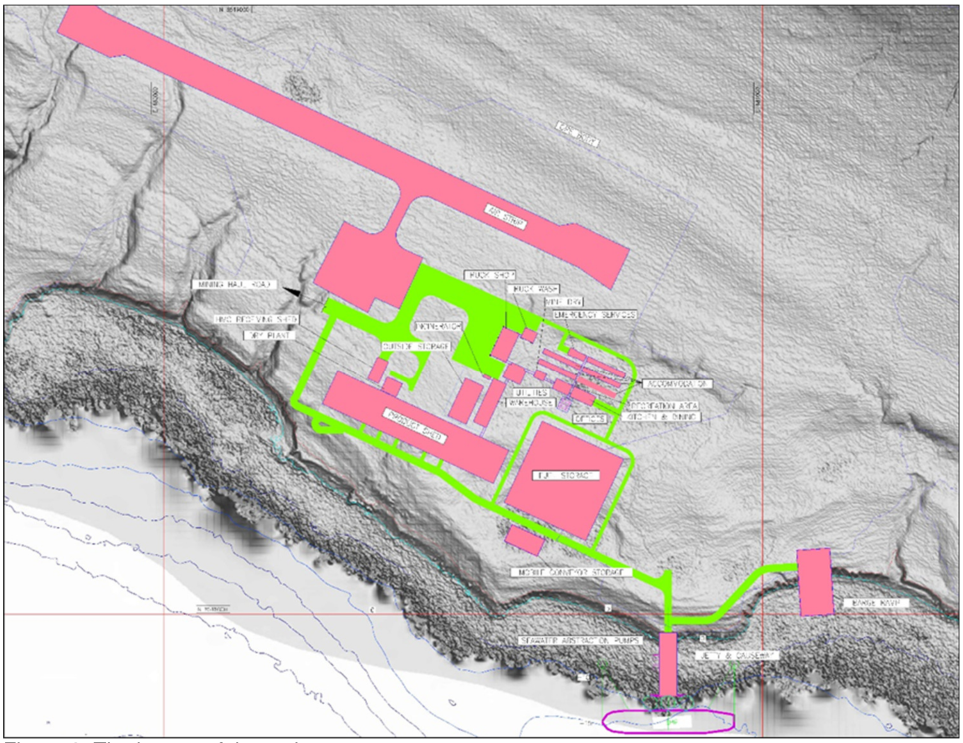


Figure 2. The lay out of the main camp

The main camp will also include service buildings, the magnetic separation plant, storage building, jetty with a ship-loading facility, fuel tank farm and general services such as power and water supply. An airstrip to facilitate the year-round movement of personnel and consumables will be built near the main camp.

A smaller moveable camp will be located near the area that is mined. This camp includes the plant where most of the waste material is removed, will be moved every 2-3 years and have four locations during the 10 years mine life (Figure 3). The mobile camp also includes modular offices, a lunchroom and washrooms to support activities in the mining area.

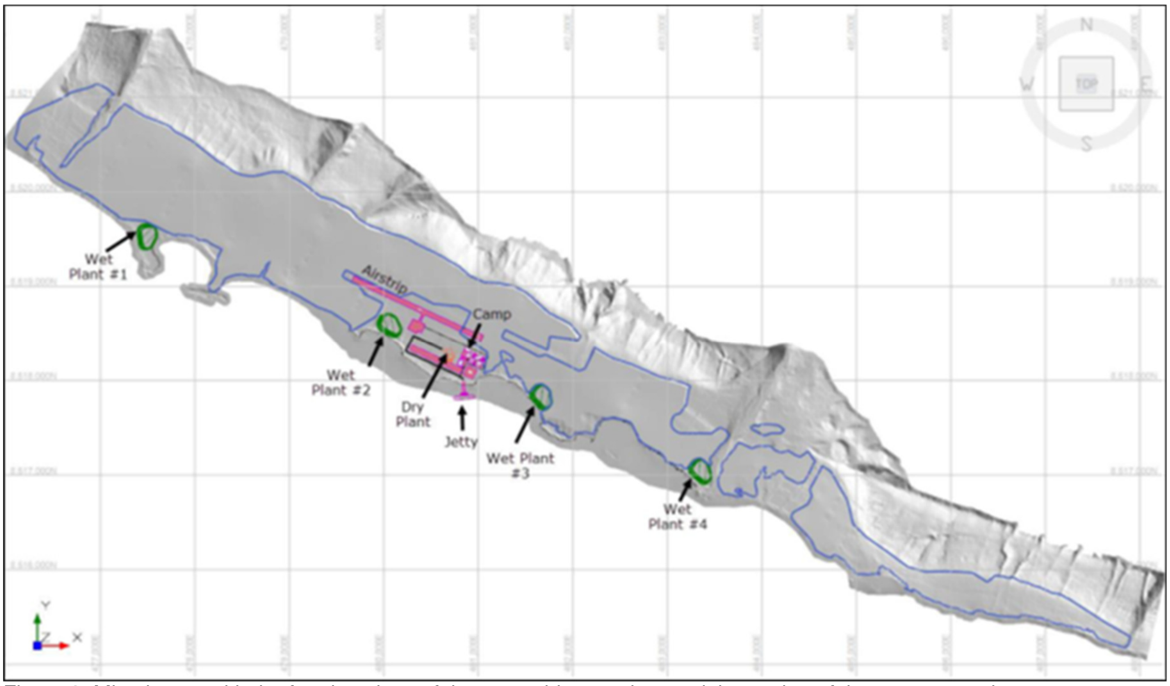


Figure 3. Mine layout with the four locations of the moveable wet plant and the setting of the permanent dry processing facility at the main camp. The blue lines indicate the areas to be mined.

Project phases

The construction phase will take 2 years. During this phase buildings will be erected, and the plants and port will be constructed. The Operation phase is estimated to 10 years. Closure and decommissioning will take 1 year during which time buildings, plants and utilities will be removed and the last mine area will be rehabilitated.

Project Element	Details	Description
Mining rate		7.4 million tonnes per year
Plant feed rate		965 tons per hour
Mine method		Open pit
Construction phase		2 years
Operating phase		10 years
Decommissioning		1 years
Plant operation calendar		12 months - 24/7 operation
Products	Ilmenite product	440,000 tonnes per year
Supporting infrastructure	Diesel power plant	59 mega watts
Size of Project elements	Total footprint (at 10 years)	8.5 km^2
	Mine pits	8 km^2
Water use	Seawater requirements	1,046 m^3/h
Excess water	Discharge of excess seawater to the fjord	913 m^3/h
Waste volume	Material returned to mine void	6.6 million tonnes per year
Product Transport	Handy-Max vessel 40,000 DWT	11 ships per year
Employee Transport	Airport	Dundas Ilmenite Airport
Employees	Construction	270
	Operation	175

Table 1. Project summary

Alternatives considered

Several alternatives for all or part of the Project have been considered during the course of Project design:

Alternative	Details	Consideration
Not proceeding with the Project	This is an alternative if it is considered that the environmental consequences of the project are too large. Not proceeding with the Project would mean any environmental (and social impacts and benefits) would not occur.	Based on the ability to appropriately manage the potential environmental impacts, Dundas Titanium will proceed with the project.
Port location	Two alternative locations were considered. Option 1 is located at Moriusaq while Option 2 is located 3.5 km to the south east of the town	Option two was chosen because this would require the shortest jetty causeway to reach the required water depth reducing material handling (and costs)
Deposition of undersize silt fraction	Two alternatives were examined in detail: • On land deposition (and discharge of excess process water to the sea)	Discharge to the sea was chosen because it would mean least construction work (minimising disturbance and CO_2 emissions) and no risk of dust generation. Analyses of the excess water showed little

	• Discharge of slurry consisting of silt and process water to the sea. In addition to a discharge point at 10 meters water depth, it was considered to discharge the material at 35 m.	risk of contaminating sea water and modelling showed the increase in sedimentation and turbidity of the sea water to be local causing limited impact on marine life. Discharge at 10 m water depth was preferred because modelling showed that the sedimentation would be limited to a smaller area with less impact on marine life (albeit with a thicker layer) that with the discharge at 35 m

Table 2. Project alternatives considered.

1.4. Regulatory Framework

Inatsisartut Act no. 7 of 7 December 2009 (the Mineral Resources Act) requires that mining companies prepare an Environmental Impact Assessment (EIA) in connection with the development of any proposed mineral project. The Act also stipulates that an exploitation license will only be granted once the project's EIA has been accepted by the Government of Greenland.

The aim of a project's EIA is to identify, predict and communicate the potential environmental impacts of the planned mining project in all its phases - construction, operations, closure and post-closure. The assessment should also identify mitigation measures designed to eliminate or minimize negative environmental effects, and such measures, should as far as possible, be incorporated into project design.

This EIA has been prepared in accordance with the *Guidelines for preparing an Environmental Impact Assessment (EIA) report for mineral exploitations in Greenland* (Mineral Resources Authority, 2015), (the Guidelines). The Guidelines identify the requirements for impact assessments relating to:

- Environmental baseline studies, including background concentrations and variations, vegetation and fauna, and local use and knowledge;
- Project related environmental studies, including studies of flora and fauna and quantifying potential sources of contamination such as water discharged to the sea;
- Discharges and emissions to the environment, including air and water emissions.

The Guidelines also specify the requirements for environmental closure and monitoring plans.

This impact assessment was undertaken in compliance with the Terms of Reference (ToR) for this project (Orbicon 2017) and an addendum (Orbicon 2018). Following public consultations, the ToR was approved by the Greenland authorities in 2017 and 2018.

1.5. The structure of this EIA

This EIA has been structured to consider Project impacts associated with each of the headlines set out below:

- Physical environment
- Atmospheric setting
- Living environment

For each headline the assessment considers first the existing status today, s, then the identified potential impacts (disturbance and/or pollution), followed by an assessment of impacts, suggested mitigation (when relevant) and predicted outcomes with mitigation in place.

1.6. Physical environment

The landscape of the south-western part Steensby Land peninsula is dominated by broad, up to 2 km wide, coastal plains which stretch along more than 30 km of the coastline. Further inland ice capped mountains raise to over 1,000m. Several small, low islands are located 3-5 km off the coast.

The climate is dry and cold, with mean summer temperatures around 4-5°C and winter mean temperatures around -25°C. Precipitation is also very low, about 217 mm, most of it falling as snow.

The ilmenite sand in the Project area are derived from a high titanium basalt source further inland, which has been mechanical weathered to create heavy mineral sand deposits along the coast.

A study in 2019 of potential contamination of the Project area following the crash of a US bomber close to Thule Air Base in 1968, showed that this was not the case and that the plutonium concentrations are at the same level as elsewhere in the northern hemisphere.

1.6.1 Potential impacts

The potential impacts on the physical environment have been identified as:

Landscape alterations and visual impact
Constructing the airstrip, causeway to the jetty, foundations and haul roads will require the extraction of large amounts of fill material (gravel and rocks). Mining the black sand will also cause significant landscape alterations. The large buildings in the main camp will be widely visible from the fjord. All this can have aesthetic impact for the life of the mine. Following the decommissioning of buildings and machines and the shading and grading of platforms for building the visual impact for bypasses on the fjord is assessed to be Low.

Erosion
Some construction activities could cause erosion, in particular loss of soil, sand and gravel by the forces of water. By taking erosion into account when selecting construction methods and routing of the alignments the risk of erosion has been assessed to be Very low.

Light emissions
In dark periods the construction areas will be illuminated. Such "Ecological light pollution" can distract wildlife, in particular migrating birds ". Since artificial light will mainly be required during winter when almost no bird migration takes place, this is not expected to be a significant impact.

1.7. Atmospheric setting

Baseline levels of dust and gaseous emissions have not been monitored but are assumed to be very low.

1.7.1 Potential impacts

The potential impacts have been identified as:

Dust dispersal
Excavation and in particular haulage generate dust, which can impact vegetation and animals that feed on the affected vegetation. Since the speed restrictions of mine trucks will be enforced dust generated during haulage is expected to be low and limited to a narrow area along haul roads and the around mine area. The overall significance has been assessed to be Very low.

Gaseous emissions
Mobile equipment and stationary power generation will produce gaseous emissions, including NOx and SOx and increase air emissions. By limiting the amount of fuel combusted as much as practical possible and new, state-of-the-art equipment (Best Available Technique (BAT) equipment, the impact of gaseous emissions is assessed to be Very low.

Greenhouse gas emissions
Mobile equipment and stationary power generation also generate greenhouse gasses which lead to climate change. It is estimated that the land activities will produce 85,700 tons CO_2 emissions per year and increasing Greenland's CO_2 emissions by 16.4%. The export of the concentrate with ship and the flight to the project will bring the total CO_2 emissions up to 91,788 tons of CO2. (17.5% increase in Greenland's emissions).
The amount of fuel combusted should be limited as much as practical possible.

1.8. Living environment

The Project area is in the high arctic with sub-freezing mean annual temperatures. Frozen conditions are usually found from September through May, with snowmelt occurring predominantly in June and July. From late May to September shallow water flow takes place in the active layer above the permafrost from higher elevations toward the coastline.

High arctic dwarf-shrub heath and along the coast also fens and bogs cover most of the Project area. Generally, the plant communities consist of few species most of which are common and widespread in Northwest Greenland. Only rather few land birds and mammals occur.

The sea off the Project area is covered by thick sea ice much of the year. On average the ice start to break up in May-June and the sea is free of ice from late June to late October but there are large annual variations. Seawater movements are dominated by tidal currents with the flow direction generally parallel to the coastline for both ebb and flood.

During summer streams, rivers and glaciers discharge freshwater to the fjord which sometimes forms a brackish surface layer. From May-June to September-October glacial rives discharge large amounts of fine material into the sea. In summer the turbidity of the fjord water is often high due to the sediment load from these rivers.

The sea between NW Greenland and Elsmere Island in Canada is named the North Water Polynya (NOW). A polynya is an area of persistent thin sea ice or open water where thick sea ice would be expected during winter. Although the NOW often has 95 % ice cover in January, the ice is mobile and criss-crossed by open leads permitting marine mammals to remain during winter.

The NOW evolves from a small area in winter, to a large area of ice-free water in June and ultimately in summer ceases to exist as a distinct ice-bounded region. Exceptionally for Arctic areas, phytoplankton biomass and primary productivity in the NOW starts in April and is high throughout the ice-free period. The high primary production results in a diverse zooplankton community which provides food for large numbers of fish, marine mammals and sea birds. The NOW is the largest polynya in the Northern Hemisphere and one of the most biologically productive marine areas in the Arctic.

In summer, NOW supports some of the largest concentrations of seabirds anywhere in the Arctic. The NOW also supports large numbers of ice-associated seals and whales including considerable numbers of narwhale, white whale (beluga) and walrus.

1.8.1 Potential impacts

The potential impacts from the Project on the living environment have been identified as:

Disturbance of terrestrial vegetation
Re-profiling to accommodate buildings and mining activities will remove the vegetation from a large area (c. $8km^2$). In the high arctic climate with very short growing season it will take decades maybe even longer before the vegetation is restored. To minimize this impact infrastructure and mining activities should be planned to have as small a footprint as possible.

At the local level the disturbance (loss) of vegetation is significant but in a larger regional context the loss is minor because the plants occurring in the disturbed area are common and widespread in very large parts of Northwest Greenland. For this reason, the disturbance of terrestrial vegetation and loss of terrestrial habitat has been assessed as Medium.

Disturbance of terrestrial mammals and birds
Noise and visual disturbances from personnel and machinery will cause birds and mammals to avoid the active mine areas. To minimize this disturbance the movement of staff members should be restricted outside the construction and mining areas.
The loss of plant cover (and the changes to the hydrological regime in the active mining blocks - see below) will exclude birds and mammals from utilizing this habitat until the plant cover is restored.

Since only very few birds and mammals are associated with the disturbed habitats (none of which are threatened) and because very large areas of similar undisturbed habitat are widespread in the region, the disturbance impact of terrestrial mammals and birds has been assessed as Low.

Disturbance of freshwater fauna and flora
Construction and operation of the Project will modify hydrological processes, potentially affecting freshwater habitat. This includes diverting water runoff from entering the mining area and camp facilities. This will have large scale impact on the freshwater ecosystems within the mined block.

To mitigate this impact the disturbance of freshwater should be minimized as much as possible and the natural hydrology should be restored as quickly as practically possible. Since undisturbed areas with similar freshwater habitat are widespread in the region, and the disturbance will be temporary only, the impact has been assessed as Low.

Disturbance of benthic flora and fauna

The discharge of silt material to the sea will lead to enhanced concentrations of fine particulate matter in the water and sedimentation on the sea floor near the outlet. The oscillating tidal current will disperse the material along the coastline and result in particularly high sedimentation on both sides of the discharge point. In a nine km long and one km wide zone along the coast high mortality among benthos organisms is expected. In a bigger area stretching 20 km along the coast and 1-1.5 km offshore decreased numbers and possibly lower biomass are expected. Re-colonization is expected to start within one year and after 4 years all the major benthic macrofauna phyla will probably be present. However, a full recovery of the age variation of mussels will take many decades.

Since the impact zones are limited to the Assessment area the overall impact is assessed to be long term with Medium significance.

Disturbance of seabirds

Disturbance of seabirds mainly concerns the area's seabird colonies on islands off the Project area’s coast and Saunders Island (Figure 4) where visits by staff members and shipping could disturb the birds.

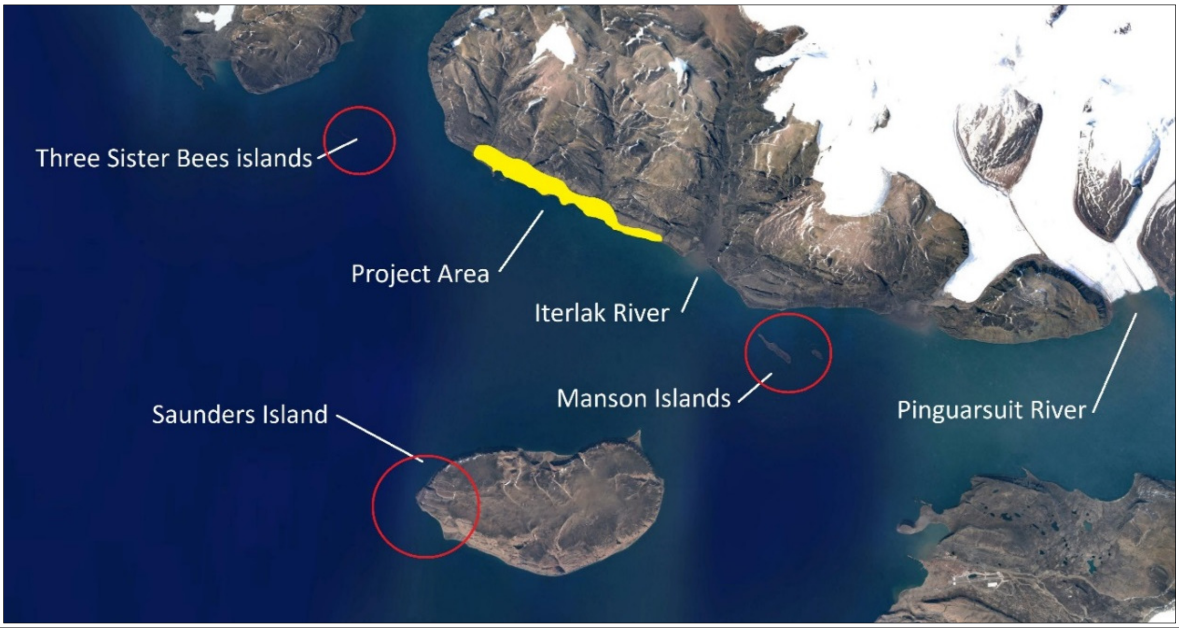


Figure 4. Important seabird colonies near the Project area

To avoid disturbance of breeding birds on Three Sister Bees and Manson Islands (Figure 4) project staff must not visit these islands from 1th May until 1th September. To avoid disturbing the seabirds on Saunders Island vessels to the Project port should maintain a minimum of 5 km distance to this island. With these mitigations in place disturbance of the area's seabird colonies has been assessed as Very low.

<u>Disturbance of marine mammals</u>
The following potential disturbance impacts are identified:

- Noise and visual disturbance from project activities on land and from ships;
- Loss of feeding areas for walrus (mussels); and
- Underwater noise from shipping.

Hunting is also a significant potential disturbance. In recent years hunting of marine mammals off the project area has ended. This is because the hunters in Qaanaaq that previously shot mainly walrus in this area has given up this type of hunting because the distance by boast is too long. But this can change in the future.

Existing data and surveys carried out in connection with this project found that large numbers of walruses migrate along the south coast of Steensby Land in May-June and large pods of white whale often migrate close to the coasts of the Project area in September – October.

Noise and visual disturbance from Project activities on land and from ships
This is mainly a potential problem in relation to walruses which gather at mussel banks off the easternmost end of the Project area. This area will be mined in Year 10. If data collected during the project's environmental monitoring suggest that the animals might be disturbed by noise or the presence of people and machines near the shore, the working schedule must be change so that work in this area only takes place where there are no walruses (during summer).

With the walruses' present distribution in Wolstenholme Fjord noise and visual disturbance from the planned project activities are assessed as low. However, because of the uncertainties associated with potential walrus hunting in the fjord in the future, and because changes in the fjords ice conditions in the coming years may cause walruses to prefer haul-outs closer to the Project area disturbance is conservatively assessed to Medium.

Loss of feeding opportunities for walruses.
The sedimentation of discharged silt on the sea floor will cause significant mortality among benthic organisms in a small area around the outlet pipe.

The closest mussel bank with high numbers of the mussels preferred by walrus is 5 km from the nearest discharge point. Due to the distance the mussels in this area are unlikely to be harmed by the projects discharge of silt to the sea.

Underwater noise from shipping
Shipping generates underwater noise which can disturb marine mammals. White whale and narwhale are of particular concern. None of these whales have permanent population in the fjords off the Project areas but pass on migration in spring and autumn.

Underwater noise from ships increase with the ships speed. But if the ships slow down the time it disturbs is longer. Studies have shown, that a good compromise for ships of the type that will arrive to the Project port, is to reduce the speed to 8 knots. To minimise disturbance of marine mammals (in particular whales) all skips calling at the project port must therefore reduce the speed to 8 knots when entering the NOW (that is the last 150 km before the port). With this mitigating measure in place disturbance from shipping underwater noise is assessed as Low.

<u>Contamination of fjord due to discharge of excess water</u>
Discharge of water from mining operations to ocean can potentially pollute the marine environment. Two streams of excess water will be pumped to the sea:

- Saltwater used in the mobile concentrator plant; and
- Sewage from the camps.

Water used in the mobile plant will be mixed with under-sized silt material and disposed of in the sea via pipeline. No chemical additives will be used in the process. Tests have shown that heavy sand from some parts of the planned mine area contain high natural concentrations of the heavy metals copper, barium and zinc. When the material is washed with saltwater in the concentrator plant that can cause the concentrations of these metals in the discharged water to exceed the Greenland guideline limits in the sea outside the mixing zone.

To avoid this, ongoing monitoring of the concentration of metals in the discharged water will take place. If the concentration of heavy metals approaches the guideline limits extraction of sand for the area with high heavy metal contain will be stopped (or alternatively the metals will be removed from the discharged water). Sewage from all buildings will be treated in the sewage treatment plant before the effluent is discharged to the sea. Overall, the discharge of water from the project to the sea is assessed to potentially have Medium impact on marine life.

Contamination of fjord due to tanker accidents or oil spills when unloading

A major unloading or shipping accident such as a tanker collision or grounding could give rise to major spills of oil to the fjord. Shipping to and from the Project is not different from other shipping routes in Arctic coastal areas, including routes to other Greenlandic towns and settlements. If all maritime regulations are followed, proper oil spill combat equipment is in place at the port, and the staff is well-trained in response procedures during summer and winter, the likelihood of a significant oil spill is assessed as Very low.

Contamination of land areas due to oil spills

Accidents can lead to spill of oil and hazardous materials on land and into freshwater. Oil is toxic to plants and the consequences of an oil spill on land can be long lasting because the Arctic flora has very slow growth rates. Spills that seep into freshwater can cause an impact on freshwater ecology. The areas of the highest spill probability are at the mine site when mobile equipment is refuelled. Due to the limited fuel storage, the likelihood of a major accidental oil spill occurring on land or into local freshwater resources are assessed as Low.

Introduction of invasive non-indigenous species

Vessels berthing at the Project port will discharge ballast water before loading cargo. The ballast water can contain non-indigenous species that could potentially establish themselves in Greenland waters. When introduced in new areas, these species could thrive and become a threat to indigenous species and the local ecosystem. To minimize a potential introduction of non-indigenous species, the regulations of the International Convention for the Control and Management of Ships' ballast water and Sediments should be followed.

1.9. Local Use

For security reasons hiking on the mine roads, in the mine area and in a zone around the various Project facilities will not be permitted for the public. The effect of these restrictions will be low, as there has been no or only very limited traditional use of natural resources in the land area around Moriusaq since it was abandoned in 2010. Except for the Project port area, the marine area off the project area will remain open for subsistence harvest and recreational use.

1.10. Archaeology

Construction works and mining activities can disturb heritage sites. To localise sites in the Project area, Greenland National Museum & Archives surveyed the area in 2018 and discovered several important findings along the coast. Whenever possible, these archaeological sites will be fenced off to avoid machinery from accidentally damage the ruins. In other cases, the museum will be asked to excavate and, if necessary, recover objects before project activities commence.

1.11. Environmental Management Plan

The Environmental Management Plans describes how the mining company intends to manage the environmental issues identified in the EIA and who is responsible for each commitment. The Plan includes a management program that specifies the activities to be performed in order to minimize disturbance of the natural environment and prevent or minimize all forms of pollution, and a definition of the roles, responsibilities and authority to implement the management program.

1.12. Closure plan

Principles for mine closure are summarized in the conceptual closure plan (in the back of this EIA). These principles are summarised by the following points:

- All buildings, major structures and equipment must be dismantled and removed;
- Foundations should be removed where possible, or covered by natural materials to blend into the natural surroundings;
- The haul roads must be reclaimed;
- Any culverts are removed; and
- The mine port is left as constructed (if agreed with the authorities).

1.13. Monitoring Plan

An Environmental Monitoring Program will be implemented in accordance with the Greenlandic guidelines to monitor residual effects of the Project and the effectiveness of implemented mitigation measures. The plan comprises of the following key-elements:

- Air Quality and Dust Monitoring;
- Sea and Freshwater Monitoring;
- Soil and Terrestrial Biota Monitoring;
- Tailings Facility Monitoring; and
- Meteorological Monitoring.

The EIA report includes a framework for the monitoring plan, including proposed parameters. The conceptual monitoring plan also suggests a sampling frequency for each parameter and proposes monitoring durations. Where relevant the programme includes control sites, where no expected Project impacts are likely to be experienced. The EMP will be developed and updated throughout the mine life.

1.14. Conclusions

The environmental issues identified in this EIA concerns the potential disturbance of animals and plants and the potential pollution of the environment.

With the proposed mitigations in place the impact of all identified issues is assessed as Low or Medium. In the case of accidents with significant impact on the environment, as highly unlikely to take place.

1.15. Summary of environmental impacts assessed

Table 3. Summary of environmental impacts assessed

Potential impact	Project phase	Activities	Mitigation	Significance with mitigations
Aesthetic impact	Construction Operations Closure	1. Construction works will require large amounts of material. 2. Mining the resource will extract large amount of material 3. Mine facilities will be visible from the fjord	1. Plan the extraction of material to blend as far as practical with the surrounding landscape	Low
Loss of soil, sand and gravel by the forces of water	Construction Operations	1. Preparation of construction sites 2. Construction of roads 3. Redirection of water courses from mining area	1. Take erosion into account when selecting construction methods and routing of the alignments	Very low
"Ecological light pollution"	Construction Operations	1. Lights from construction and mining activities at night	1. No action required since problem is negligible	Negligible
Potential pollution of land and water	Construction Operations Closure	1. Surface mining, material handling and in particular hauling generates dust	1. Plan construction works and mining activities to minimize dust generation including speed limits for mine trucks	Very low
Increased air emissions	Construction Operations Closure	1. Mobile equipment and stationary power generation produces gaseous emissions	1. Limit the amount of fuel combusted as much as practical possible and use new, Best Avail-	Very Low

			able Technology (BAT) equipment and service it according to the manufacturer's guidelines.	
Climate change	Construction Operations Closure	1. Combustion of diesel produces emission of greenhouse gases	1. Keep fuel consumption as low as practical possible	-
Disturbance of terrestrial vegetation	Construction Operations	1. Loss of vegetation where buildings and facilities are constructed 2. Removal of vegetation in mining area	1. Minimize the area to be disturbed by planning infrastructure to have as small a footprint as possible. 2. Initiate the restoration of vegetation as soon as mining activities in an area are completed	Medium
Disturbance of land mammals and birds	Construction Operations Closure	1. Noise and visual disturbance from mining activities	1. Restrict the movement of staff members outside the construction and mining areas	Low
Disturbance of freshwater fauna and flora	Construction Operations	1. Hydrological changes to direct water runoff away from mining area and facilities	1. Minimize the disturbance of the water and restore natural hydrology as quickly as practically possible	Low
Disturbance of benthic flora and fauna	Operations	1. Discharge of silt material to seafloor	1. To be defined if unexpected accumulations are recorded	Medium
Disturbance of seabirds	Construction Operations Closure	1. People could visit seabird colonies on small islands off the coast 2. Shipping could pass close to seabird colonies on Saunders island	1. Ban access for staff during the birds breeding season 2. Shipping route at least 5 km from colonies on Saunders Island	Very low

Disturbance of marine mammals	Construction Operations Closure	1. Noise and visual activities close to shore 2. Loss of food resource due to discharge of silt to the seafloor 3. Underwater noise from shipping	1. Plan mining operations so that work close to the shore only takes place during summer 2. Change discharge strategy if loss of food resource becomes unacceptably large 3. Reduce speed of vessels through NOW to 8 knobs	Medium Low
Contamination of fjord due to discharge of excess water	Construction Operations Closure	1. Discharge of process water to fjord 2. Discharge of sewage from camps	1. Ongoing monitoring of the concentration of metals in the discharged water will take place. If the concentration of heavy metals approaches the guideline limits extraction of sand for the area with high heavy metal contain will be stopped (or alternatively the metals will be removed from the discharged water 2. No action required since water is cleaned in sewage plant	Medium
Pollution of marine environment	Construction Operations Closure	1. Tanker accident 2. Unloading accident leading to oil spill	1. Follow recommendations in *Navigational Safety Inspection* report 2. Proper procedures, equipment, plans and training to combat spills	Very low
Contamination of land and freshwater ecosystems	Construction Operations	1. Oil spill on land and in freshwater	1. Impose strict speed limits to reduce risk of traffic accidents 2. Introduce strict procedures for handling of oil	Low
Introduction of invasive non-indigenous species	Construction Operations Closure	1. Vessels arriving to the Project ports needs to discharge ballast water before loading	1. Carry out ballast water management in compliance with international convention before discharging	Unlikely

Restrictions in local use	Construction Operations Closure	1. For security reasons access to the Project area will not be permitted for the public (but offshore hunting can still take place)	1. Minimize restrictions in access to project area as much as practically possible	-
Disturbance of cultural heritage sites	Construction Operations	1. Mining activities could damage cultural heritage sites	1. Request Greenland museum to identify and – if needed- recover cultural heritage sites that could be damaged by mining activities	-

2. INTRODUCTION

2.1. The Mine Company and scope of document

Bluejay Mining Plc is a British mining company based in London and listed on the London Stock Exchange AIM market. Until March 2017, Bluejay Mining Plc. was known as FinnAust Mining Plc. Dundas Titanium A/S is the Greenlandic subsidiary of Bluejay and is headquartered in Ilulissat.

Dundas Titanium A/S (the “Company”) proposes to develop the Dundas Ilmenite Project (the “Project”) to explore ilmenite from black heavy sand deposits in Northwest Greenland.

This document provides an assessment of the potential environmental impacts of the Project. It is prepared to comply with guidelines issued by the Greenland authorities. This document is also available in Greenlandic and Danish.

2.2. Project overview

The Project is located on the southern shore of the Steensby Land peninsula in high arctic Northwest Greenland close to the abandoned village Moriusaq (Figure 5). The nearest town is Qaanaaq 80 km to the north. The US Air force Thule Base is located approximately 40 km southeast of the project site.

The project will extract ilmenite concentrate with high titanium dioxide content from the black heavy mineral sand deposits found along the coastline of Steensby Land. Ilmenite is important for producing pigments, whiting and polishing abrasives while titanium metal is used extensively to produce durable, high-strength, lightweight metal alloys.

Mining operations will involve excavating the unfrozen top surface layer during summer and exposed permafrost material during winter. Processing will include wet gravity and dry magnetic separation. No chemicals will be used in the processing.

The saleable product will be exported from a purpose-built port during the open water summer season. The infrastructure and site services will include an airstrip, mine site access roads, service buildings, fuel storage, generators, water supply system, sewage system and an incinerator.

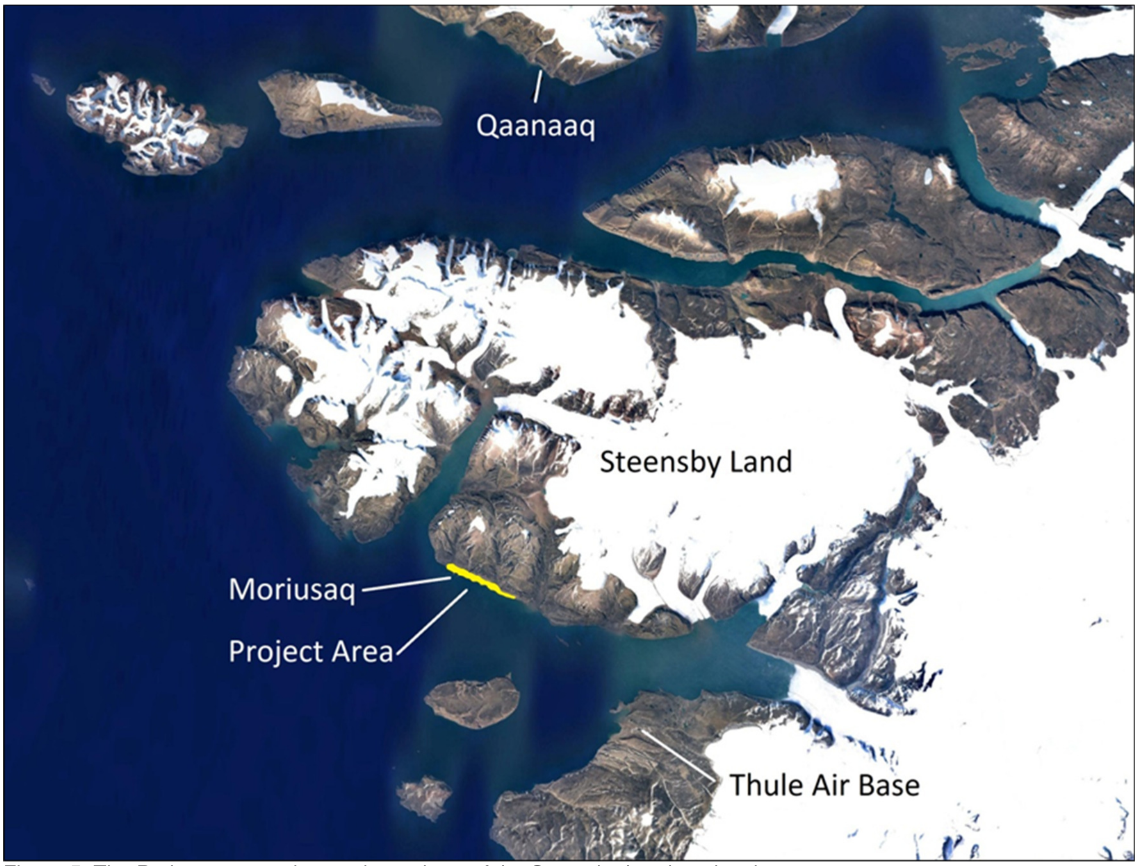


Figure 5. The Project area on the southern shore of the Steensby Land peninsula

2.3. Environmental Impact Assessment process

Inatsisartut Act no. 7 of 7 December 2009 (the Mineral Resources Act) requires that mining companies prepare an Environmental Impact Assessment (EIA) in connection with the development of any proposed mineral project. The Act also stipulates that an exploitation license for a proposed project will only be granted once the project's EIA has been accepted by the Government of Greenland (GoG).

The aim of a project's EIA is to identify, predict and communicate the potential environmental impacts of the planned mining project in all of its phases - construction, operations and closure. The assessment should also identify mitigation measures designed to eliminate or minimize negative environmental effects, such measures, as far as possible, being incorporated into project design.

This EIA has been prepared in accordance with the *Guidelines for preparing an Environmental Impact Assessment (EIA) report for mineral exploitations in Greenland* (Mineral Resources Authority, 2015), ("the Guidelines"). The Guidelines identify the requirements for impact assessments relating to:

- Environmental baseline studies, including background concentrations and variations, vegetation and fauna, and local use and knowledge;
- Project related environmental studies, including quantifying potential sources of contamination; and
- Discharges and emissions to the environment, including air and water emissions.

The Guidelines also specify the requirements for environmental management and monitoring plans.

2.4. Study area

The EIA defines the EIA's "Assessment area" which is the area potentially influenced by the Project including the close vicinity of the project components and infrastructure. The Assessment area is shown in Figure 6.

The EIA also defines a "Project area" (Figure 6), which is the area within the Assessment area where direct impacts occur, such as ground disturbance and loss of habitat for flora and fauna.

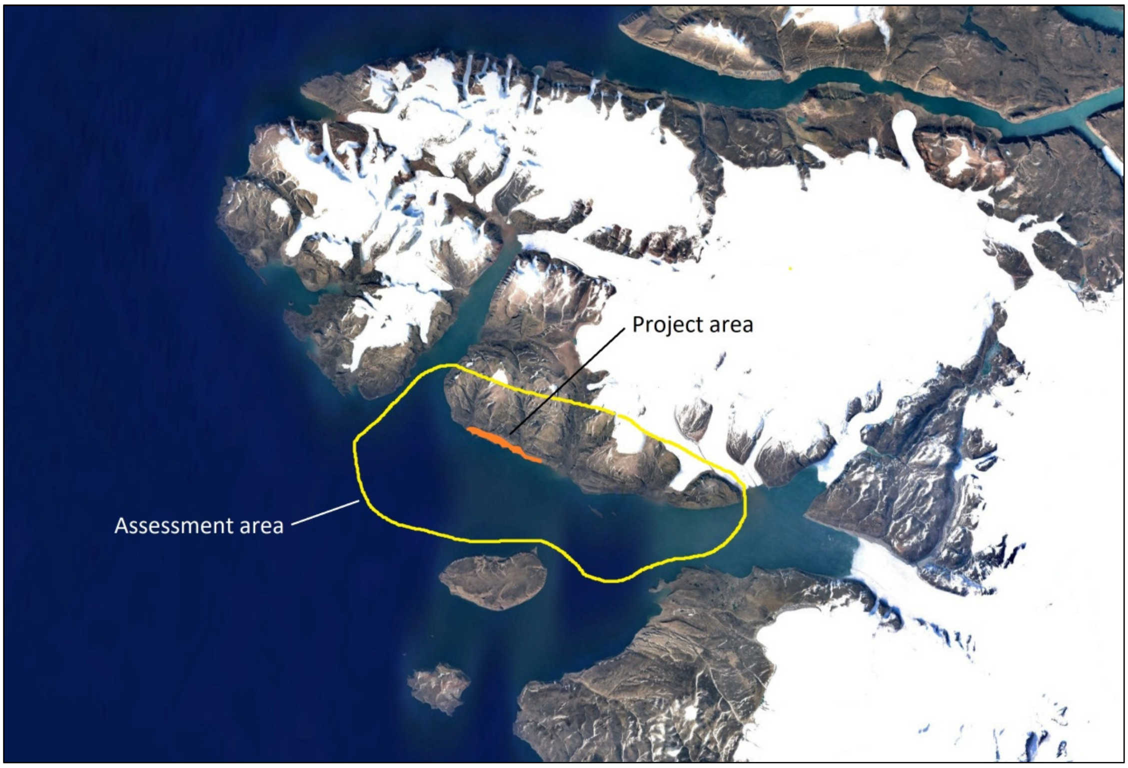


Figure 6. Assessment area and Project area

3. PROJECT DESCRIPTION

3.1. Project setting

The Project is situated on the southern shore of the Steensby Land peninsula. This area has unique geological features, including raised beaches (coastal plains) containing black heavy mineral sand accumulations over widths of more than 1 km, along more than 20 km of coastline. The active beaches, including the beach, tidal zones and surf zone, also contain black heavy mineral sand deposits.

The black sands originate from high titanium basalt sources which have been mechanically weathered to create placer deposits along the coastal plain and beaches. The most common constituents of heavy mineral sands are garnet, magnetite, ilmenite, and epidote.

3.2. The mining project

The Project involves the mining and processing of black heavy mineral sand from raised and active beaches to produce ilmenite concentrate. Ilmenite is a black iron-titanium dioxide and is a primary ore of titanium. Within the Project area the Project has JORC Compliant Ore Reserve of 67.1Mt with a mean grade of 3.45% TiO_2 (equal to7.3% ilmenite in situ).

The Project will be using surface mining techniques due to the shallow nature of the sand deposit. The sand material will be transported to a wet plant for initial processing to produce a heavy mineral concentrate. The heavy mineral concentrate will be transported to a dry magnetic plant to produce ilmenite concentrate, which will be loaded onto ships for transport to customers.

Due to the ice conditions at site shipping will only be possible from mid-July to end of October. During this period all available ilmenite products will be exported. All products produced between the closure of a shipping window and the opening of the next will be stored on site.

Oversize material, light mineral sands and sand consisting of non-magnetic heavy minerals will be transported back to the mined-out areas for disposal. Under-size material (silt) will be discharged to the sea.

The mining rate will be approximately of 7.4 million tonnes per annum, at which rate the project is expected to produce approximately 440,000 tonnes per annum of ilmenite product.

3.3. Local communities

The nearest community is the small town Qaanaaq with a population of approximately 640 (Figure 5). Qaanaaq is situated c. 80 km north of the project site (135 km by boat) and was only settled in 1953.

Qaanaaq has a small airport (with gravel runway) and weekly flights to Ilulissat using Bombardier Dash 8 turboprop airplanes. Qaanaaq has no port. Instead containers and other cargo are first lifted to a barge which then is brought to the beach during high tide. A pier is currently being build which will permit barges to unload even when it is low tide. The construction works are expected to be completed in late 2019. The primary occupations in Qaanaaq include fishing, hunting and public administration.

The settlement Moriusaq on the southern shore of the Steensby Land peninsula (Figure 3) was established in the 1960ies but abandoned in 2010. Around 20 buildings are still left, and a few are occasionally used briefly by the owners, mostly people from Qaanaaq. Moriusaq has no port or airstrip.

Thule Air Base is a United States Air Force base located c. 40 km to the southeast of Moriusaq. The airbase is not part of any municipality of Greenland, but an enclave within Greenland, outside of its jurisdiction.

3.4. Project phases

The phases of Project commencement are described in Table 4.

Phase	Timing	Activities
Construction	2 years	A temporary landing pad will initially be used for beaching barges. The Port will subsequently be constructed. Packaged equipment will arrive on site and be installed by specialist construction workers. Buildings will be erected to provide protection against weather events. There will continuous deliveries of plant and equipment from the Port to the Mine and Plant.
Operations	10 years	Once operations commence the Mine and Plant will gradually ramp up operations until steady state operation is achieved. Mined areas will progressively be rehabilitated
Closure and decommissioning	1 year	Buildings, Plant and utilities will be removed Last mine area will be rehabilitated

Table 4. Project phases

3.5. Main components of the Project:

The Project will consist of the following main components (Figure 7):

- A permanent main camp on the coast app. 2.5 km southeast of Moriusaq with accommodation and service buildings, dry processing facility, storage building for products and fuel storage.
- Moveable Wet Plants located near the area that is mined (four locations over the 10 years period). In addition to the wet plant there will also be modular offices, a lunchroom and washrooms to support activities in the plant area.
- A jetty from which bulk carriers will be loaded with ilmenite product for export.
- An airstrip to facilitate the year-round movement of personnel and consumables.
- Site roads for general construction and operations traffic.

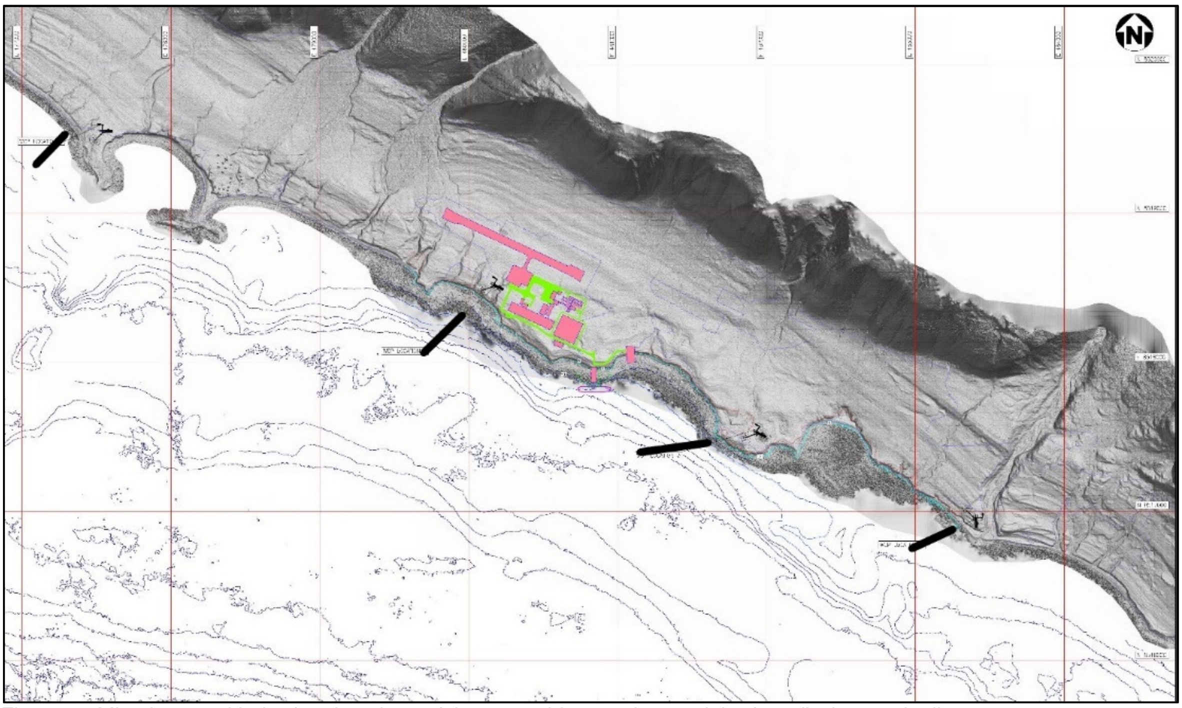


Figure 7. Mine layout with the four locations of the moveable wet plant and the four discharge pipelines (black lines)

3.6. Mining the mineral sand deposits

The black heavy mineral sand deposits will be mined in the 8 km^2 area shown in Figure 9. The mine develops in general from west to east and the blocks mined in each period (app. one year) are highlighted in red.

Most of the inland sand deposit is covered by a thin layer of soil with low high arctic vegetation. Before the mining operations begin, the soil layer (and vegetation) will be gently pushed aside and left in low stockpiles next to the mining area. The black sand will then be mined to an average depth of 4.6 m.

A continuous surface miner will be used with a conveyor loading the haul trucks directly to haul to the plant (Figure 8).

Figure 8. Surface miner with a conveyor loading a haul truck

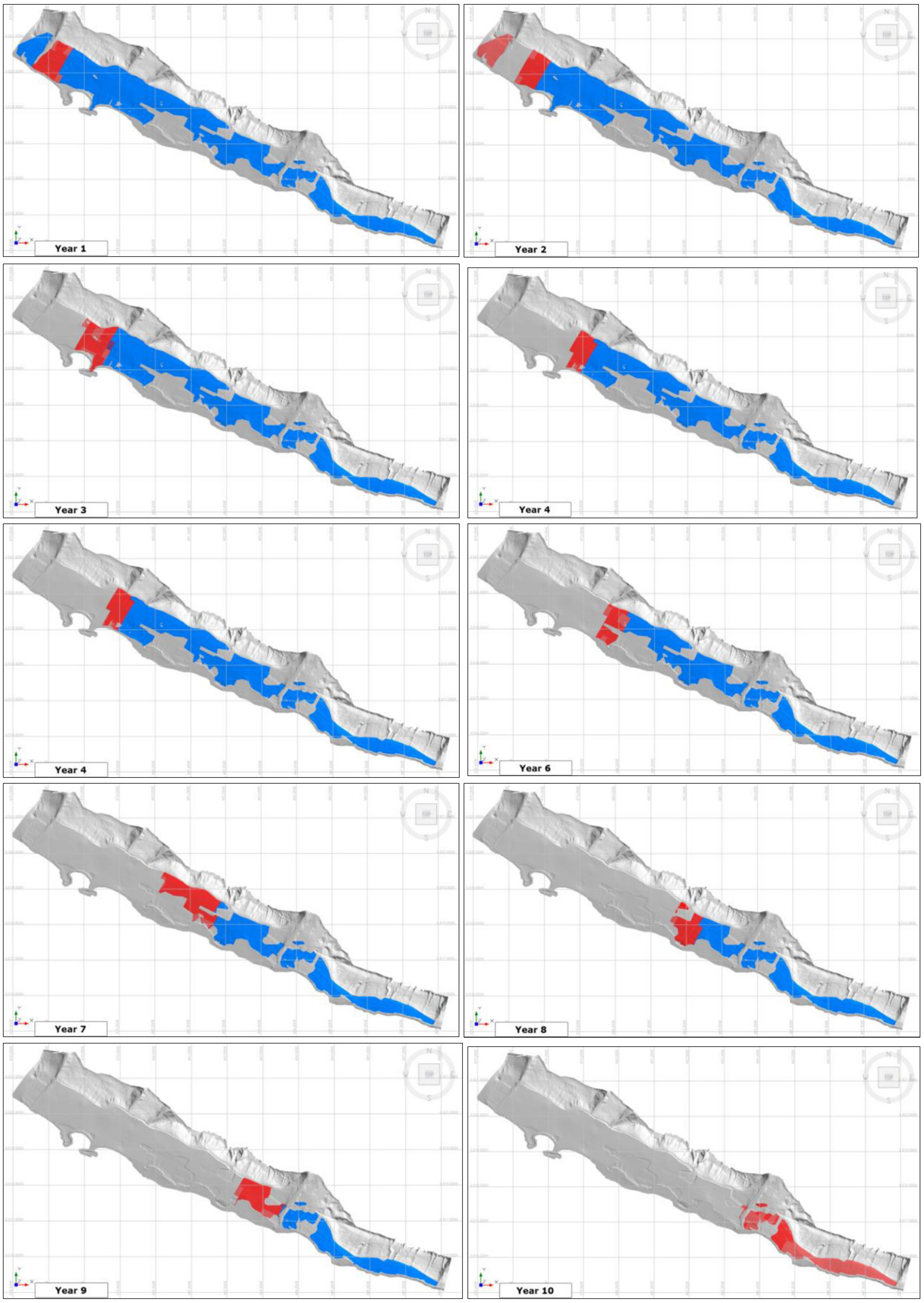


Figure 9. Mining development sequence (Year 1 to 10). The deposit is shown in blue and the blocks mined in each period are highlighted in red.

Mining the deposit will in Year 3 include the resource under the abandoned village Moriusaq (Figure 9) – see section 3.22.3.

3.7. Non-contact Water Management

The mining zone will cross five streams with upstream catchment areas greater than 2 km^2. In addition, many even small temporary or permanent streams occur in the mine area, especially after days with rain.

To avoid contact with this water and the mine area and to reduce water volumes to be collected in open pit non-contact water runoff will be diverted around mining zones as much as possible. Diversion systems will consist of diversion berms, shoreline protection berms and river corridors:

- Diversion berms constructed from backfilled material and with a height of around 1 m will be constructed to ensure separation of contact (see below) and non-contact water. These berms will remain in place throughout the operational phase of a mining area and will be decommissioned when mining moves on to new areas (after app. one year).

- It will be necessary to protect the pit from seawater inrush where the active mine area approaches the shoreline and berms with a height of 2 m will be constructed to reduce risk of waves encroaching into the mining area. The beams will be removed when mining in an area has been completed.

- Where larger streams cross the mining zone unmined ‘river corridors’ will be left in place during the open water months along the existing drainage pathways. The river corridors will be aligned along the natural drainage pathways in the beach, with additional berms on either side, as required, to reduce the risk of water overtopping channel banks into the mining area. These rivers will then be mined out during winter months when stream flows along these drainages will be zero. When mining these areas, the berms will also be removed. Figure 10 presents locations of the five river corridors across the mining area (highlighted in blue).

3.8. Contact Water Management

Contact water in the Project consists of all inflows to the active mining zones, as well as saltwater used to melt and wash the mined material in the wet concentrator plant (see Section 3.9.1).

The contact water will be mixed with the undersize silt fraction and the slurry is pumped to the coast and discharged to the sea.

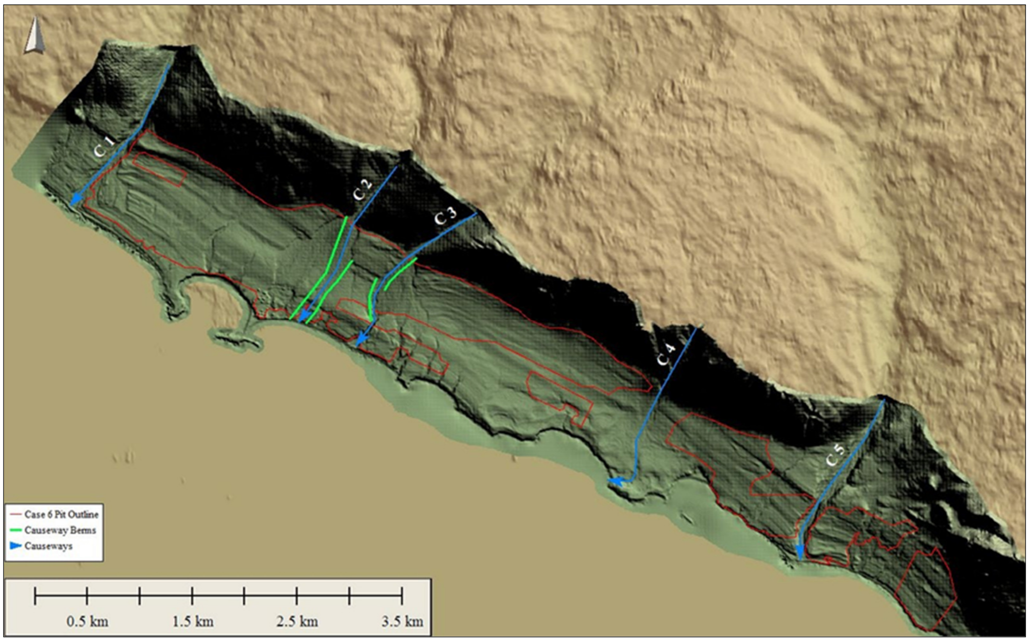


Figure 10. Approximate river corridor berm locations of the rivers that will be mined out during winter

3.9. Processing

The Project will be made up of two main processing circuits; wet gravity separation and dry magnetic separation.

3.9.1 Wet Concentrator Plant

The mined heavy sand will be trucked to the wet concentrator plant which is situated within 1 km of the mine void. The purpose of this plant is to remove over- and under-size material as well as sand consisting mainly of light minerals using gravity separation.

The wet plant will be moveable and will move three times during the mine life (Figure 7). The locations are based on the orebody and grade distribution and a target maximum haulage distance of 1 km.

As a first step + 250mm oversize material will be removed. The remaining material will then be mixed with saltwater and feed into a heated, rotating drum (Kiln facility) where any frozen material will be melted. The washed material then passes through further screening where > 2mm material is rejected. All oversize material will be tucked back to the mine void. In a next step the undersize silt fraction (<63µm material) is removed.

The remaining sand fraction then passes through a gravity separation circuit where light minerals are removed. The sand containing light minerals are returned to the mine void.

The heavy mineral sand fraction is dewatered and transported to the dry concentrator plant.

3.9.2 Dry Concentrator Plant

This is a fixed permanent plant situated in a building next to the main camp (Figure 7). This plant separates the highly magnetic ilmenite product from non-magnetic trash sand material. Before passing through the magnetic separator, the damp material arriving from the wet plant is dried and <850 micron oversize material is removed.

A dust collector system will ensure any dust and off-gases from the drying and magnetic separation are collected and not disposed to the outside atmosphere.

Following magnetic separation, the ilmenite product is dispatched to the storage shed. Oversize material and the non-magnetic sand are returned to the mine void.

3.9.3 Mass Split Summary

A summary of the waste streams and the ilmenite product production (tons per hour) is provided in Table 5.

Material	**Size**	**Solids in tons per hour**
Oversize material removed before processing	Stones and gravel (+ 2 mm)	353
Undersize fraction removed before processing	Silt fraction (<63 micron)	44
Gravity separation rejects	Sand fraction	493
Magnetic separation rejects	Sand fraction	19
Ilmenite product	Sand fraction	55
Total head feed		965

Table 5. Yield mass split summary

3.10. Deposition of waste material

All oversize material as well as the gravity and magnetic separation rejects will be loaded onto trucks and stockpiled in the open pit void. Dozers will subsequently re-work and compact the deposited material to have a top of material grade of c. 1% slope towards beach.

When backfilling is completed the dozers will gently push the soil back and distribute it evenly over the mined area.

The undersize silt fraction slurry is pumped to the coast and discharged to the sea at 10 m depth. During mine life there will be four discharge points (Figure 7) which has been placed to minimise impact on mussel beds which contain important food re-sources for walrus.

3.11. Product Storage Building

The ilmenite product ready for export will be stored in a 315 m long and 61 m wide fabric covered steel frame building located in the main camp close to the port facility. The interiors of the building will be heated to a minimum temperature of 5^0C.

3.12. The Port

Before a jetty is constructed a barge, ramp will be used for ocean going barges to reach the shoreline for the purposes of off-loading materials, equipment, and supplies. The barge ramp will be constructed by gravel fill located to the south-east of the jetty.

Subsequently, a jetty for import of building materials, fuel, spare parts and consuma-bles and for direct product shipment by ice class C1 Supramax 40,000 DWT bulk car-riers will be constructed next to the main camp.

The dock will consist of fenders and steel framed loading deck supported on three caissons and with a 100 m long and 30 m wide rock-filled causeway, as shown on Fig-ure 11. The top elevation of the causeway will be 5 m above normal water level. The circular caissons will be filled with rock.

Due to the ice conditions shipping will only take place from mid-July to the end of Oc-tober. A tuck boat will assist the bulk carries when docking, push aside ice bergs and break sea ice at the port site during the shoulder periods.

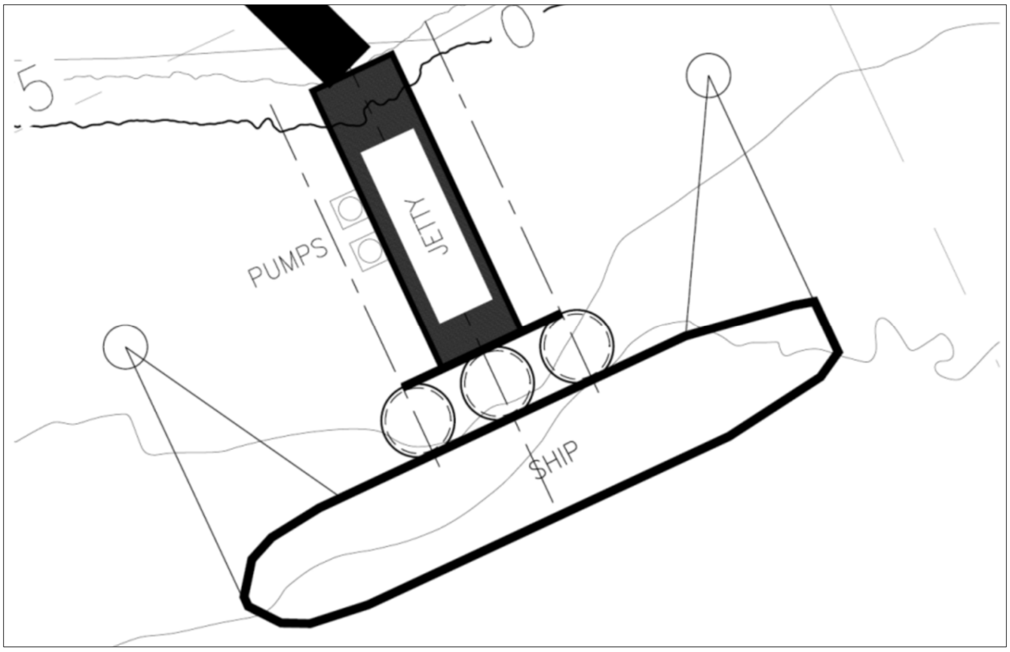


Figure 11. Plan of the jetty causeway and dock. Two fixed mooring dolphins will tie-off the ship.

3.13. Ship loading

Dump trucks will transport the ilmenite product from the storage building to the jetty area where the product is conveyed to a mobile ship loader. The mobile ship loader will then load the product onto bulk cargo ships. The loading system will be designed for a loading rate of 700 tons per hour and ships with 40,000 metric tonnes capacity will therefore be loaded in app. 60 hours.

3.14. Air strip

The principal means for transporting personnel and perishable food products to and from the site will be air transportation year-round. The Project will therefore incorporate a gravel airstrip northwest of the main camp.

The airstrip will be 900 m long with 60 m outruns at each end for a total constructed length of 1,020 m. This will make it possible to utilize turbo propeller type aircrafts (for example Bombardier Dash 8-200).

The runway will be constructed of quarry run rock fill and select crushed aggregate. The airstrip foundation design is to place compacted free draining rock fill to form an embankment with a surface approximately 1.2 m above finished ground. A drainage trench will be provided around the perimeter of the runway.

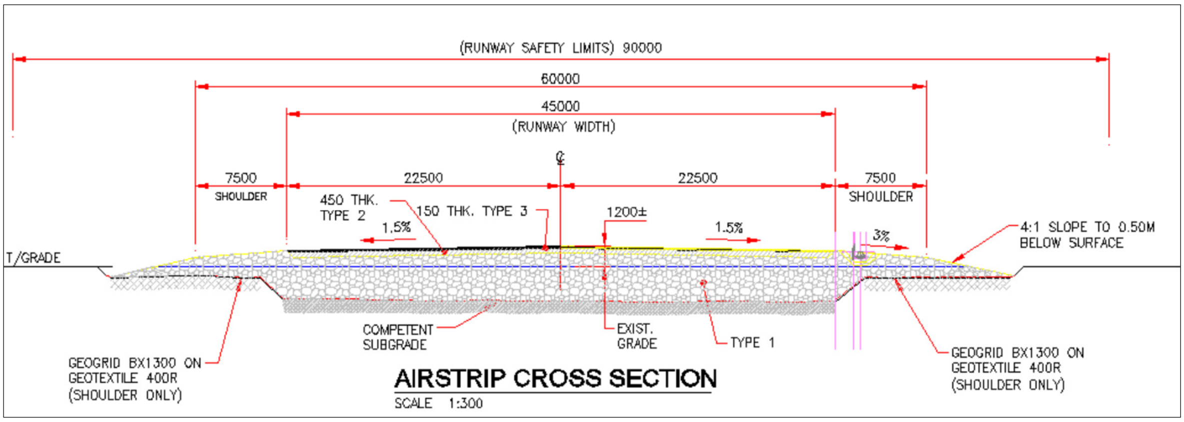


Figure 12. Airstrip cross section

The airstrip will be equipped with the minimum requirements for Visual Flight Rules (VFR).

3.15. Electricity Generation

Two independent power generation plants, comprising of four 1,000 kW diesel generators, will provide the site with electrical power. One system will serve the dry concentrator plant, accommodation complex, product storage and loadout facilities, warehouse and utilities while the other will serve the mining area and the wet concentrator plant and adjacent infrastructure.

The generators will be equipped with systems to recover heat from the exhaust and cooling systems. The recovered heat is used in the building heating systems (see below).

3.16. Heating system

Two heating systems with water/glycol heating boilers fired by diesel will be used. One system will serve the dry concentrator plant, accommodation, product storage, utilities and adjacent infrastructure while the other system will serve the wet concentrator plant and adjacent infrastructure.

3.17. Water Management

The water demand at the site is made up of a combination of saline seawater and fresh water. The required freshwater make-up is supplied by desalinating sea water.

3.17.1 Water balance

The estimated water demand for the wet concentrator plant and infrastructure during normal operations is an average supply of 1,046 m^3/hour of sea water and an average supply of 36 m^3/hour fresh water. Most of this water is used for washing and melting the mined heavy sand (see Section 3.9.1). Only fresh water for personnel is required in the main camp area. This fresh water is estimated to 3 m^3/hour.

3.17.2 Water discharge

The water used for washing and melting the mined sand in the wet concentrator plant will be discharged to the sea as slurry together with the undersize silt material.

All the water used in the main camp will be treated in the sewage plant (Section 3.19) and subsequently discharged to the sea.

3.18. Fuel storage

Two types of fuel will be required at site for the operations of the Project:

- diesel fuel for mobile equipment, heating boilers and diesel generators
- aviation fuel for aircraft

It is assumed that there will be two deliveries of fuel during the shipping season, the first at the beginning of the summer and the second towards the end of October.

3.18.1 Diesel fuel storage design

During the construction phase 95,000 litre Enviro tanks will be used to storage diesel fuel. Storage of 2,000,000 litres of diesel fuel during this phase is expected.

For the operations phase a diesel storage facility with a total capacity of 32,500 m^3 will be constructed. This will include four 38m diameter x 7.35m high steel tanks. The tank farm will be elevated on a 150 x 150m platform of rock-fill app. 1.5m high. A drainage ditch will be excavated around the tank farm to facilitate natural drainage. A 1.8 m high geotextile containment berm will be constructed that can contain a full spill in case of tank rupture.

Diesel fuel will be delivered by tankers to the jetty, and then transported via a lagged heat traced pipeline to the diesel storage facility.

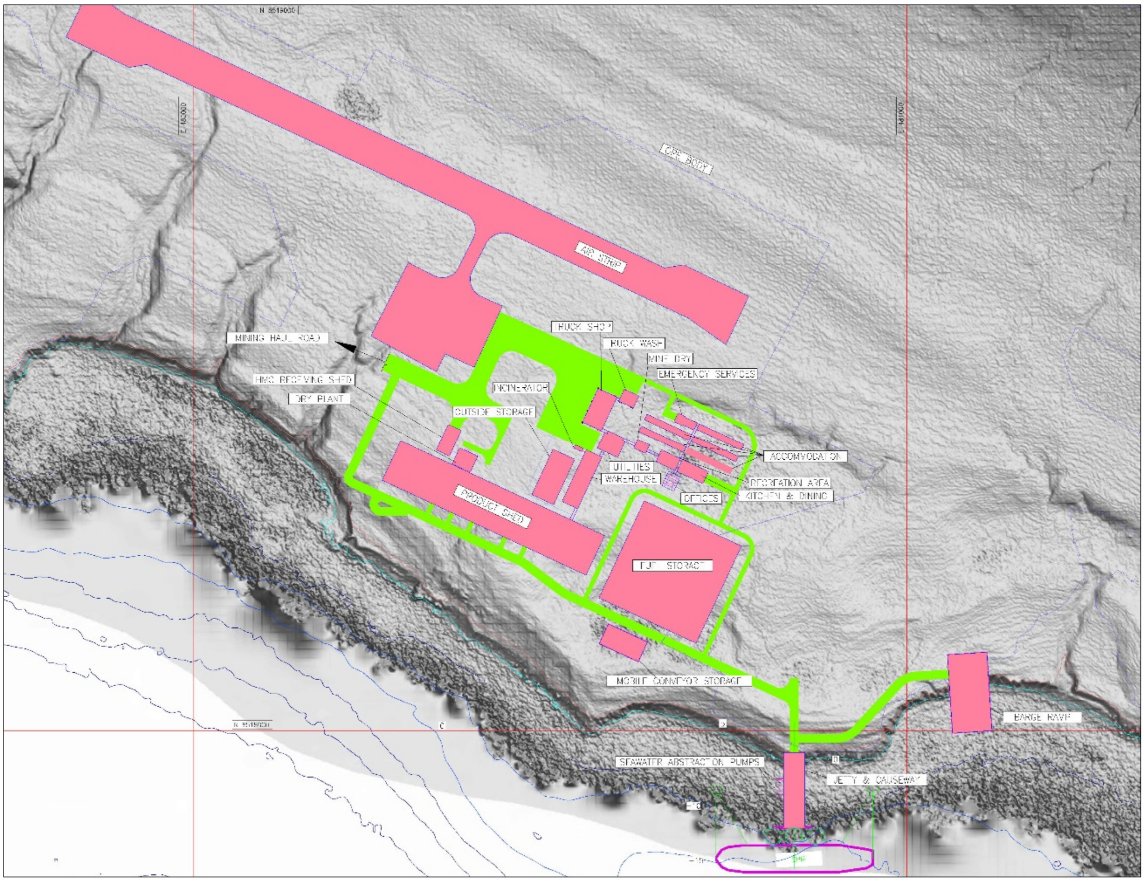


Figure 13. Main camp layout

Each diesel fuel tank will be connected to a common header and pumping system that will distribute diesel fuel to various locations around the main camp site. Fuel distribution piping will be installed inside the connecting arctic corridors (see 3.21.3).

Fuel dispensing systems will be provided at:

- The mine maintenance workshop re-fuelling area for haul trucks and the tanker which will be used to transport diesel to the mine site for re-fuelling the mining equipment;
- The mine site maintenance workshop area for re-fuelling smaller vehicles and mobile equipment.

3.18.2 Aviation Fuel Storage

Some of the prefabricated 95,000 litre Enviro tanks used to provide diesel fuel during the construction phase of the project will be cleaned and positioned for storage of aviation fuel. The Enviro tanks will be located near the main diesel fuel storage facility.

Aviation fuel will be transported to the airstrip to re-fuel aircraft with a small tank located on a truck as required.

3.19. Sewage system

A sewage treatment plant will be installed in the vicinity of the main camp infrastructure. A sewage tank will collect sanitary waste from the control room and from the lunchroom and washrooms at the wet plant. The sanitary sewage from the wet plant area will be trucked to the sewage treatment plant at the main camp.

The sewage treatment plant will also receive domestic or sanitary sewage from the accommodation units, the mine dry, the dining and recreational hall, and the emergency services building.

Treated effluent from the sewage treatment plant will be discharged to the sea. The sludge waste will be burned in the incinerator.

3.20. Incinerator

A diesel-fired incinerator will be installed. It will be used to incinerate general and organic waste collected from the camp accommodation, kitchen, offices and medical facilities, as well as medical waste and the solids residue from the sewage treatment plant.

3.21. Service and accommodation buildings

3.21.1 Service buildings

The following service building complexes will be built:

- A centralized office complex for management, administrative functions and engineering and technical staff involved in the general administration and operations of the Project infrastructure;
- An emergency services complex which will include garage/parking area for emergency services vehicles modules for medical facilities;
- A mine dry building with drying rooms, laundry area and change rooms;
- A truck and general workshop for servicing and maintenance of mining fleet;
- A truck wash to wash mining vehicles before servicing; and

- Warehouse and storage near the mining and maintenance workshops.

3.21.2 Accommodation Complex

The personnel for mining operations and management will work on a 6-week on 3-week off rotational basis with 2 x 12 hours shifts daily.

The accommodation camp will include:

- Dormitories for rooms for 175 people;
- A kitchen and a dining area; and
- A central core complex with TV and recreation rooms, a commissary and the laundry facility.

3.21.3 Arctic corridors

A series of arctic corridors will connect the various buildings and facilities at the site. This will provide access for personnel between the various buildings as well as routing electric cables, glycol heating and water throughout the main camp site.

3.22. Waste management

3.22.1 Industrial waste handling

The incinerator will not be used to dispose of hydrocarbon waste on site. Instead fuel and oil waste will be collected and stored and returned with supply ships for proper disposal at a suitable off-site facility.

Accumulators, batteries, electronic devices, glass, etc. will also be stored in temporary containers and periodically returned with supply ships for further disposal according to regulations and after mutual agreement.

3.22.2 Hazardous material handling

Hazardous waste will be handled in accordance with the regulation concerning hazardous waste (Regulations for disposal of hazardous waste /Regulativ for bortskaffelse af miljøfarligt affald, 2009). In general, hazardous waste is shipped to Denmark and handled in compliance with a comprehensive EU initiated legal framework. Hazardous waste will be registered and traced using code standards (EC waste list / EAK koder (Europæiske Affalds Koder)).

3.22.3 Mining the mineral deposit below Moriusaq

Mining the deposit will in Year 3 include the resource under the abandoned village Moriusaq (Figure 9). This will mean the empty house will be dismantled and the wood disposed of on site in the incinerator. Metal, glass, etc. will be stored in temporary containers and returned with supply ships for further disposal according to regulations and after mutual agreement. Hazardous waste will be handled in accordance with the regulation concerning hazardous waste (see above).

The dump will also be cleared from waste. However, before deciding if the resource under the dump will be mined sediment samples will be collected and analyzed to determine if the material is severely contaminated. The analysis program will include oil compounds, metals, mercury, PCBs etc. If this proves to be the case the dump will not be mined.

4. REGULATORY FRAMEWORK

4.1. Introduction

Greenland is part of the Kingdom of Denmark. Autonomous local governance was introduced to Greenland in 1979 followed in 2009 by a new Act of Greenland Self Government, which states that Greenland can take over the administration of natural resources. In 2009, Naalakkersuisut (the Government of Greenland) took over mineral resource administration from Denmark, including the administration of environmental issues in relation to mine Projects.

The Environmental Agency for Mineral Resource Activities (EAMRA) is the administrative authority for environmental matters relating to mineral resources activities, including protection of the environment and nature, environmental liability and environmental impact assessments. The EAMRA is placed in Ministry of Nature and Environment.

The Mineral License and Safety Authority (MLSA) is the administrative authority for license issues and is the authority for safety matters including supervision and inspections.

In addition to the requirements relating to the preparation of its EIA, the Project will also comply with all other applicable Greenlandic and Danish legislation, including conventions to which Greenland is a signatory.

4.2. Greenland legislation

At the same time Greenland took over the responsibility for regulation and management of the mineral sector, the *Mineral Resource Act* came into force on 1 January 2010 (*Greenland Parliament Act* no. 7 - 7 December 2009). Amendments to the Act have subsequently been introduced in 2012, 2014, 2015 and 2016.

The Mineral Resource Act (“the Act”) is the backbone of the legislative regulation of the minerals sector, regulating all matters concerning mineral resource activities, including environmental issues and nature protection.

4.3. The Mineral Resource Act

The Act stipulates the conditions which need to be met in order to conduct mining activities in Greenland. Initially, a licensee must apply for and obtain an exploitation license for the area, which can be granted pursuant to Section 29 of the *Minerals Resource Act* upon submission to the authorities of the following documents:

- An application with key information on the proposed mining project;
- A bankable Feasibility Study;
- An Environmental Impact Assessment; and
- A Social Impact Assessment.

An Environmental Impact Assessment should have regard to:

- § 53 - Planning and selection of all activities and construction must take place in a manner to cause the least possible pollution, disturbance or other environmental impacts;
- § 52 - The best available techniques must be used, including fewer polluting facilities, machinery, equipment, processes and technologies should be applied;
- § 56 - Impairment or negative impacts on the climate must be avoided; and
- § 60 - Impairment of nature and the habitats of species in designated national and international nature conservation areas and species must be avoided.

When an exploitation licence is granted, the licensee needs to apply for and obtain an exploitation plan from the Greenland government (Section 19 of the Act), which includes submission of a closure plan (Section 43). Provided Section 19 and 43 approvals are granted, all specific constructions, processes, vehicles, devices etc. must be individually approved under Section 86 of the Act. Typically, the authorities will request a single application for all Section 86 approvals, which need to be renewed on an annual basis.

4.4. International obligations

Greenland has ratified several international conventions regarding nature and biodiversity, either as a direct member or through its membership of the commonwealth of Denmark and the Faeroe Islands. Of particular relevance to the Project are the following:

- The Convention on Biological Diversity (CBD) - on the conservation of biological diversity, sustainable use of its components and fair and equitable sharing of benefits arising from genetic resources. The CBD guides national strategies and policies and implements themes such as sustainable use and precautionary principles. Its application to the Project will be through the implementation of national laws and regulations, in particular the *Mineral Resource Act;*

- The Ramsar Convention - on the protection of wetlands of international importance;

- International Union for Conservation of Nature (IUCN) - an International organization dedicated to natural resource conservation. IUCN publishes a "Red List" compiling information from a network of conservation organizations to rate which species are most endangered; and

- UNESCO’s World Heritage Convention - a global instrument for the protection of sites of cultural and natural heritage. In 2004, Ilulissat Icefjord was admitted onto UNESCO's World Heritage List.

The Greenland government also accedes to the MARPOL Convention (relating to pollution from ships), CANDEN agreement (responsibility for emergency response within the waters between Canada and Greenland), and OSPAR (marine protection in the North-East Atlantic). The OSPAR Commission has developed plans to phase out toxic substances and bio-accumulating substances in the marine environment.

4.5. Shipping regulations

Maritime regulations in Greenland comprise the equivalent Danish regulations which have been supplemented with specific regulations for navigation in Arctic regions. In addition, regulations and codes administered by the IMO (International Maritime Organization), together with international conventions adopted by Denmark, apply in Greenland.

All carriers will comply with Greenlandic and IMO regulations. This includes the global requirement for all vessels that operate outside Emission Control Areas (ECAs) to use fuel oil with a maximum sulfur content of 0.5% from 1th January 2020 (IMO2020).

Several international conventions focus on environmental issues. These include:

- The MARPOL convention and the annexes (1973/78 International Convention for the Prevention of Pollution from Ships);

- The BWM convention (2004 - International Convention for the Control and Management of Ships’ Ballast Water and Sediments); and

- The OPRC convention (1990 - International Convention on Oil Pollution Preparedness, Response and Co-operation).

As a result of the special navigational conditions pertaining to Greenland waters, a safety package relating specifically to Greenland topics has been issued by the Danish Maritime Authorities. The safety package includes the following orders and recommendations relevant for the Project:

- Danish Maritime Authority Order no. 1697 of 11. December 2015: "Order on technical regulation on safety of navigation in Greenland territorial waters"; and

- The International Code for Ships Operating in Polar Waters (Polar Code) is an international regime adopted by the International Maritime Organization (IMO) which entered into force on 1 January 2017. The Polar Code sets out regulations for shipping in Arctic and Antarctic regions, principally related to ice navigation, ships design and training.

A special agreement has been entered between the MLSA and the Danish Maritime Authority regarding "Guideline on investigation of navigational safety issues in connection with mineral exploitation Projects in Greenland as basis for navigation in the operations phase". The guideline specifies the contents of a navigational safety investigation to be carried out prior to starting the exploitation activities.

FORCE Institute in Denmark is currently completing a Navigational Safety Study for the Project's shipping requirements.

5. PROJECT ALTERNATIVES

A number of alternative Project configurations have been considered during the Project design phase. This chapter outlines the alternatives that have been considered.

5.1. Not proceeding with Project

Not proceeding with the Project is an alternative if it is considered that the environmental consequences of the project are too large. Not proceeding with the Project would mean any environmental (and social impacts and benefits) would not occur.

Based on the ability to appropriately manage the identified environmental impacts of the project, Dundas Titanium will proceed with the project.

5.2. Port location

Two alternative locations were considered for the location of the port/ jetty to serve the mine. Option 1 is located at Moriusaq and Option 2 is located 3.5 km to the south east.

A water depth of around 12 m is considered adequate for safe manoeuvring and berthing of 40,000 tonne Supramax vessels that will be used to transport product to overseas markets.

Available bathymetric data indicates that at Port Location 1 the jetty / causeway will have to extend for 930 m perpendicular from the shoreline to reach water depths of 12 m. For port option 2 the jetty / causeway will have to extend 105 m obliquely from the shoreline to reach a similar water depth.

The advantage in terms of material handling (and costs) for the jetty/ causeway is therefore with port Option 2.

5.3. Alternative depositions of undersize silt material

Two alternative depositions of undersize (<63µm) silt fraction of the mined material was examined in detail:

- Land deposition of silt material (and discharge of excess clear process water to the sea); and

- Discharge of slurry consisting of silt and process water to the sea.

5.3.1 On land deposition of silt

In this scenario the settling of silt material will take place in in-pit storage cells within backfilled sand and gravel. Excess clear water will drain from the ex-pit and in-pit disposal areas via infiltration to the sea. During production silt cells will be developed and closed continuously in succession of the advancing backfill front.

Potential environmental impacts and hazards:

- The settling ponds will require considerably additional construction works which will lead to excessive noise and CO_2 emissions.

- There is a risk that surface water quality immediately downstream of the waste storage areas is adversely affected by seepage (i.e. suspended solids).

- When a silt cells is full of material and the water cover removed but before the dry silt is covered by backfilled sand, dust generation and migration as a result of wind is another risk.

5.3.2 Discharge of silt to the sea

In this scenario slurry consisting of silt and process water will be discharged directly to the sea. Potential environmental impacts and hazards:

- The heavier fractions of the silt material will deposit on the sea floor while the smaller fractions will be dispersed before settling and increase turbidity in sea water. This can impact marine flora and fauna, including benthos on sea floor; and animals that feed on benthos (such as walruses).

- The process water could potentially contain contaminants.

5.3.3 Conclusion

Scenario 2 was selected for the following environmental reasons:

- Least construction work and transportation of material with dump trucks (minimising noise disturbance and CO_2 emissions);

- Minimal risk of impacting surface water quality on land;

- No risk of dust generation from dry silt;

- No risk of contaminating sea water because the discharged silt is the naturally occurring fine grain size fraction, and no chemicals with potential detrimental effects are added as part of the process. Furthermore, test work has demonstrated that there are no risks associated with leaching of metals or other potential contaminants from the material (see Section 9.4.1);

- The deposition of material on the sea floor and increased turbidity of the sea water caused by the discharged silt will be local and short-term with no significant impact on marine flora and fauna (see Section 9.3.4 and 9.3.6); and

- In addition to a discharge point at 10 meters water depth, it was considered to discharge the material at 35 m. Discharge at 10 m water depth was preferred because modelling of both alternatives showed that the sedimentation would be limited to a smaller area (albeit with a thicker layer) that with the discharge at 35 m (TT-Hydraulics 2019).

6. ENVIRONMENTAL ASSESSMENT METHODOLOGY

6.1. Introduction

This impact assessment was undertaken in compliance with the Terms of Reference (ToR) for this project (Orbicon 2017). Following public consultations, the ToR have been approved by the Greenland authorities in 2017. The ToR identifies the key environmental issues to investigate and asses in the EIA report as well as the environmental studies required to compile the required data. The mining company's subsequent decision to discharge the undersize silt material into the sea (Section 5.2) meant that there was a need to prepare a supplement to ToR. This document describes a number of further studies that are necessary to be carried out as part of the EIA process (Orbicon 2018). The identified studies are:

- Aerial surveys of marine mammals during spring and autumn for two years (Orbicon);
- Study of breeding population of common eider and arctic tern on the island within the Assessment area (Orbicon);
- Study of terrestrial vegetation (Orbicon);
- Grab sampling and underwater video of the seafloor benthic flora and fauna off the Project area (Orbicon);
- Analyses of saltwater from shake flask tests of undersize silt material (Global ARD Testing Services Inc.);
- Modelling of the dispersal and sedimentation of material by discharge of silt material to the sea (TT-Hydraulics);
- Assessment of plutonium content in soil in Project area (DTU-Nutech); and
- Archaeological survey (Greenland National Museum & Archives).

6.2. Impact assessment methodology and structure

Consistent with the *Guidelines for preparing an Environmental Impact Assessment (EIA) report for mineral exploitation in Greenland* (Mineral Resource Authority, 2015) and in order to best present the environmental baseline data and the assessment of potential environmental impacts, this report has been structured to consider Project impacts associated with each of the environmental factors set out below:

- Physical Environment (Chapter 7)
- Atmospheric Setting (Chapter 8)
- Living Environment (Chapter 9)

- Local Use (Chapter 10)
- Archaeology and cultural heritage (Chapter 11)

For each of the environmental factors the assessment has considered disturbance aspects and pollution.

The assessment has been structured to consider (if relevant):

- Existing environment
- Potential impacts
- Assessment of impacts
- Mitigation
- Predicted outcomes.

6.3. Assessing the impact significance

The assessment of the predicted outcomes considers, for each potential impact, the spatial scale of the impact, the duration of the impact and the significance of the impact.

6.3.1 Spatial scale

The special scale classes used in this EIA are listed in Table 6.

Spatial scale	Status
Project area	Direct disturbance by the Project, i.e. confined to the activities, the infrastructure itself and the very close vicinity of the Project
Assessment area	Project area and surrounding area - see Figure 4
Regional	From 10 to 100 km from the activity
National	Greater than 100 km.

Table 6. Spatial scale classes used when assessing potential impacts

6.3.2 Duration (reversibility)

Duration means the time horizon for the impact. Duration also incorporates the degree of reversibility of the impact, i.e. to what extent the impact is reversible, ranging from completely reversible to irreversible. Table 7 defines the classes used in this EIA.

Duration	Status
Short Term	The impact will last for a short period without any irreversible effects
Medium Term	The impact will last for a period of months or years but without permanent effects or irreversible effects
Life of Mine	The impact will last for the life of the Project
Long Term	The impact will potentially go beyond the life of the Project

Table 7. Duration classes used in the EIA

6.3.3 Significance of the impact

Significance is how severe the impact is. Table 8 defines the classes used in the EIA.

Significance	When concerning pollution	When concerning disturbance
Very Low	Very small/brief elevation of non-toxic contaminants in local air/terrestrial /freshwater/marine environments	Decline/displacement of a few (non-key) animal and plant species and/or loss of habitat in part of the Project area.
Low	Small elevation of non-toxic contaminants in local air/ terrestrial/freshwater/ marine environments	Decline/displacement of a few key animal (such as Red-listed) and/or plant species and/or significant loss of habitat in Project area.
Medium	Some elevation (above baseline, national or international guidelines) of contaminants, including toxic substances, in local or regional air /terrestrial/ freshwater/marine environments	Decline/displacement of key animal and/or plant species and/or loss of habitat in Assessment area (i.e. also outside Project area).
High	Significant elevation of contaminants, including toxic substances, (above baseline, national or international guidelines) in local and regional air/terrestrial/freshwater/ marine environments	Decline/displacement of key animal and/or plant species and/or loss of habitat at Regional or National level.

Table 8. Significant classes used in the EIA

7. PHYSICAL ENVIRONMENT

7.1. Existing environment

7.1.1 Climate

The climate in Northwest Greenland is very cold, with mean summer (July-August) temperatures around 4-5°C and winter mean temperatures in January-March around -25°C. Precipitation is also very low. The average annual precipitation at Thule Air Base (*c.* 40 km from Project area) is about 217 mm, most of it falling as snow. Precipitation is greatest in August and September. The snow depth is greatest in April while in July and August the snow disappears totally from the ground in the lowlands. The predominant wind direction is from west-northwest, throughout the year but during storms the direction is nearly always from southeast.

7.1.2 Topography

The landscape along the southwest side of the Steensby Land peninsula is dominated by wide coastal plains which stretch along more than 30 km of the coastline (Figure 14). Further inland ice capped mountains raise to over 1,000m. There are also some small, low islands 2-3 km off the coast.

The key ilmenite accumulations are associated with the coastal plains and the active beach zone (and the shallow waters off the coast).

7.1.3 Geology and soils

The Project area contains high-grade accumulations of ilmenite occurring primarily as marine placer deposits. These deposits consist of active beach deposits and deposits formed during periods of higher sea level. The paleo beach ridges are typically parallel to the modern coastline.

The ilmenite sand accumulations are derived from a high titanium basalt source further inland, which has been mechanical weathered to create heavy mineral sand placer deposits along the coastal plain. The main heavy minerals are ilmenite and magnetite. Magnetite is only a minor constituent of the heavy mineral sands at 5%, whereas the ilmenite content can reach more than 70%.

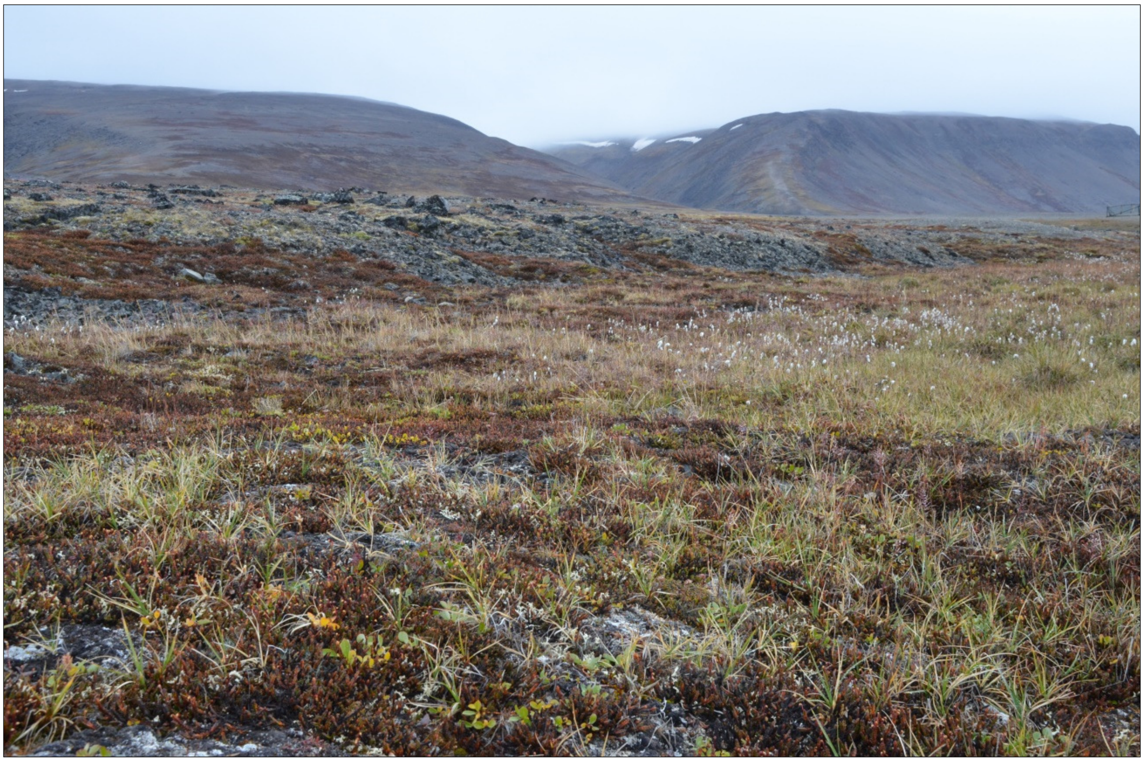


Figure 14. Coastal plains near Moriusaq

A potential plutonium contamination of soil in the Project area following the crash of a US bomber close to Thule Air Base in 1968 has been studied by DTU Forsknings-center Risø and DTU Nutech. It was found that the plutonium concentrations in all analysed soil samples from the Project area were low and at the same level as elsewhere in the northern hemisphere which is only subject to fallout from nuclear weapons tests (Roos 2019).

7.2. Potential impacts

The potential impacts from the Project on the physical environment have been identified as:

- Landscape alterations and visual impact
- Erosion
- Light emissions

7.3. Assessing the impacts

7.3.1 Landscape alterations and visual impact

The following Project activities can potentially cause significant landscape alterations and visual impacts:

Construction phase

- Constructing the airstrip, causeway to the jetty, foundations of tank farm, storage shed, other buildings and haul roads will require the extraction of c. 425,000 m^3 fill material (gravel and rocks). Some of this material will be recovered close to the locations for the site infrastructure and some around the base of the foothill where the mountains meet the top of the coastal plains. The construction works will also require some re-profiling of the landscape. The most significant will occur where the airstrip and the port are established.

Operational phase

- Mining the resource will extract large amount of material and potentially alter the landscape.

- Mine facilities including the storage shed, plant facilities, tank farm and jetty as well as the mining activities will be highly visible from the fjord.

7.3.1.1. Impact assessment

The extraction of 425,000 m^3 of material will require considerable borrow–pitting in one or several locations. Mining the black heavy sand will also cause significant temporary landscape alterations. The extraction of material and mining activities can have aesthetic impact.

7.3.1.2. Mitigations

To minimize the landscape alterations and aesthetic impact, the following procedures for excavating material for the construction works and for the opening, working and rehabilitation of borrow pits and mining areas should be adopted (if practically possible):

- Scrape off the thin organic layer (if relevant) and stockpile the top-soil material in shaped berms;
- When the extraction of material is completed, grade, contour and rip the floor of the borrow area/grade and contour the backfilled material; and
- Spread the top-soil evenly over the surface.

With these rehabilitation procedures in place there will be little or no landscape alterations (or aesthetic impact) in the mined areas because only around 10% of the material has been removed (the exported ilmenite product and silt material discharged to the sea).

Over time natural vegetation re-growth will occur and gradually restore the vegetation cover of the mined areas and the borrow pits. However, this is expected to take decades (Section 9.3.1). Some visual impact of the mining and bit-borrowing will therefore remain for a long period of time.

The Project facilities, in particularly the large storage building but also the port will be highly visible from the fjord during the operational phase. However, at mine closure, the buildings and equipment will be removed while the gravel airstrip and the raised rock fill platforms for buildings in the main camp will remain. To minimize the permanent landscape alterations and visual impact the rock filled platforms will be shaped and graded to blend into the surrounding landscape.

7.3.1.3. Predicted outcomes

During the construction and operational phases, the project will cause significant, long term landscape alterations of the coastal plains within the Project area. Following the decommissioning of project facilities and the rehabilitation of the landscape the overall significance is assessed to be low.

Some of the Project's components, for example the storage shed, tank farm and the port facility will be widely visible from the fjord but will not be visible from Qaanaaq or any other Greenlandic town or settlement. This impact will last for the life of the mine. Following the decommissioning of buildings and machines and the shading and grading of platforms for building the visual impact for bypasses on the fjord is assessed to be low.

7.3.2 Erosion

In this context erosion is defined as transport of soil, sand and gravel by the forces of water, ice or wind. A number of construction and operational activities have the potential to lead to erosion. These are:

- Preparation of construction sites
- Construction of roads
- Redirection of water courses from mining and camp areas

In connection with the present project only erosion caused by water is considered a potential issue. This is because construction works that could cause erosion will almost exclusively take place during summer, where the risk of ice or wind erosion is generally low.

The limited slope of the coastal plains means that the flow of water in streams is mostly low reducing the risk of erosion. By taking erosion into account when selecting construction methods and routing of the alignments the risk of erosion has been assessed to be very low.

7.3.3 Light emissions

Construction activities will take place day and night, year-round, as will activities during the Project's operations phase at the mine and processing plants. In periods of darkness, the construction areas will be illuminated. The consequences of such "ecological light pollution" where artificial light alters the natural light regimes in ecosystems are generally not well known.

The serious consequences of light in otherwise dark areas, such as the attraction of migratory birds and the risk of collisions with tall-lighted structures are well described; however, since artificial light will mainly be required during the winter months when almost no bird migration takes place, this is not expected to be a significant impact in the Project site.

8. ATMOSPHERIC SETTING

8.1. Existing environment

Baseline levels of dust and gaseous emissions have not been monitored in the Project area but since only very small and widely scattered settlements are present in North west Greenland and the nearest (Thule Air Base) is more than 40 km away they are assumed to be very low.

8.2. Potential impacts

The Project's potential impacts to the atmospheric setting are:

- During the construction, operation and closure phases, the Project will generate dust which has the potential to result in reduced air quality.
- During the construction, operation and closure phases, the Project will generate gaseous air emissions (oxides of nitrogen, oxides of sulphur, black carbon and polycyclic aromatic hydrocarbons (PAH)) which have the potential to reduce air quality.
- Construction, operation and closure of the Project will produce greenhouse gas (GHG) emissions from the combustion of diesel in mobile equipment and at the Power station. GHG contribute to unnatural global warming.

8.3. Assessment of impacts

8.3.1 Dust

Construction, operation and closure of the Project have the potential to generate dust. Dust deposition from mining operations can have an impact on tundra vegetation via the coating of leaves with dust. Dust deposited on vegetation might also have an impact on mammals and birds that feed on the affected vegetation such as arctic hare and ptarmigan.

Surface mining, material handling and haulage are the mining activities which are expected to have the greatest impact on dust emissions. Experience from other mines suggest that dust stirred by mine trucks when hauling material on the unsealed haul roads will most likely be the main dust source. However, since the speed of the mine trucks will be limited to 40 km/t the amount of dust generated during haulage is expected to be low. Furthermore, the haul roads will be constructed from locally sourced gravel the composition of the dust particles will model the road construction material.

Since the impact of dust is expected to be mainly limited to a narrow area along haul roads and the around mine area (which birds and animals will most likely avoid) the overall significance is assessed to be very low.

8.3.2 Gaseous emissions

During the construction, operation and closure phases, diesel powered mobile equipment and stationary power generation will produce gaseous emissions which include oxides of nitrogen and oxides of sulphur. Black carbon and polycyclic aromatic hydrocarbons (PAH) are also produced if incomplete combustion of diesel fuel takes place. This will increase air emissions in the Project area.

The very low background levels of gaseous emissions in the Project area and the relatively small number of diesel combustion sources emissions from NOx and SOx implies that it is unlikely that the Greenlandic (or EU or Canadian) ambient air quality assessment limit criteria will be exceeded. By limiting the amount of fuel combusted as much as practical possible and by use Best Available Technology (BAT) equipment the air emissions generated by the Project are assessed to be very low.

The mining fleet and diesel generator will be new, state-of-the-art equipment (BAT) and will be services according to the manufacturer's guidelines. Incomplete combustion of diesel fuel is therefore unlikely to take place except for very shorts periods of time. The potential impact of black carbon and PAHs from the Project has therefore been assessed as negligible.

8.3.3 Greenhouse gas emissions

Construction, operation and closure of the Project will result in increased greenhouse gas emissions which lead to climate change. The combustion of diesel produces emission of various greenhouse gases (GHG); including carbon dioxide (CO), methane (CH_4) and nitrous oxide (N_2O). However, since CO_2 emissions in the context of the Dundas Ilmenite project are expected to contribute with 99% of the total GHG emissions only the contribution of CO_2 has been included in the following.

The emissions sources considered for this assessment are:

- Mobile combustion: including emissions due to diesel combustion in mobile sources.
- Stationary combustion: including emissions generated due to fuel consumption for power generation.

The total annual site diesel fuel requirement is estimated to 34.2 million litres.

Using an emission factor for Diesel Fuel Arctic (DFA) of 72.00 kg CO_2-emissions/GJ, a heating value of 43.5 GJ/tons and a density of 0.8 kg/l, a total of 85,700 tons CO_2 emissions per year is estimated for the land activities.

The annual CO_2 emissions from energy production in Greenland were 523,963 tonnes in 2015 (Grønlands Statistic 2019). The land activities will then increase Greenland's CO_2 emissions by 16.4%. The main sources are:

- Mining equipment: 26%
- The two processing plants: 51%
- The Camp: 14%
- Mobile equipment: 5%

The annual CO_2 emissions from shipping has been calculated for the bulk carriers that will ship out the product. It is expected that the vessels that will bring oil and supplies to the project will be the same that are already servicing towns along the Greenland coasts, such as Royal Arctic Line. The additional emissions from entering the project port will therefore be small.

The emissions from the bulk carriers is calculated from the southern tip of Greenland to the Project port and back (2 x 2,100 km). The following additional key data have been used:

- 11 ships per year (40.000 DWT bulk carrier);
- A shipping speed of 12.5 knots (except through the NOW); and
- Average fuel consumption of 22 tons/day (one trip ballast and one trip laden).

This equals a consumption of 1.830 tons of fuel per year. Using an emission factor for Diesel Fuel Arctic (DFA) of 72.00 kg CO_2-emissions/GJ, a heating value of 43.5 GJ/tons and a density of 0.8 kg/l, a total of 5,730 tons CO_2 emissions per year is estimated for shipping with the bulk carriers.

The annual emissions from flight has also been calculated. For the purpose of this calculation flights between Ilulissat and the Project airport are assumed. using a Bombardier Dash 8-200 turboprop aircraft. The following additional key assumptions are included in the calculations:

- 52 flights a year;
- One return flight takes four hours of flying; and
- A Bombardier Dash 8-200 uses 2,750-liter Jet fuel (Jet A-1) for each flight.

This equals 143.000 liter of Jet A-1 fuel annually. Using an emission factor for Jet A-1 of 72.00 kg CO_2-emissions/GJ, a heating value of 43.5 GJ/tons and a density of 0.8 kg/l, a total of 358 tons CO_2 emissions per year is estimated for the flights to the Project.

If the CO_2 emissions from the project activities on land are combined with the emissions from the bulk carriers and the flight the total CO^2 emissions are 91,788 tons per year. This will increase Greenland’s emissions by 17.5%.

9. LIVING ENVIRONMENT

9.1. Existing environment

9.1.1 The land area

The Project area is in the high arctic with sub-freezing mean annual temperatures. Frozen conditions are usually found from September through May, with snowmelt occurring predominantly in June and July. In the summer months shallow water flow takes place in the active layer above the permafrost from higher elevation mountainous terrain to the north toward the coastline. Such water flow usually takes place from late May to September.

Five streams with upstream catchment areas larger than 2 km^2 cross the planned mining zone – see Figure 16. The runoff varies considerably due the daily snowmelt and rain-fall-runoff. Several smaller lakes close to the coast drain through streams into the fjord.

Figure 15. The coastal plains near Moriusaq with sparse high arctic vegetation

High arctic dwarf-shrub heath as well as fens and bogs cover large parts of the Project area (Figure 15), but some parts of the coastal plains are almost without vegetation. Generally, the plant communities consist of relatively few species associated with the high arctic and a continental climate. Most of these plants are common and wide-spread in Northwest Greenland. The number of land birds and animals is also rather low in both number of species and individuals. For example, are arctic hare and arctic fox the only land animals recorded from the Project area.

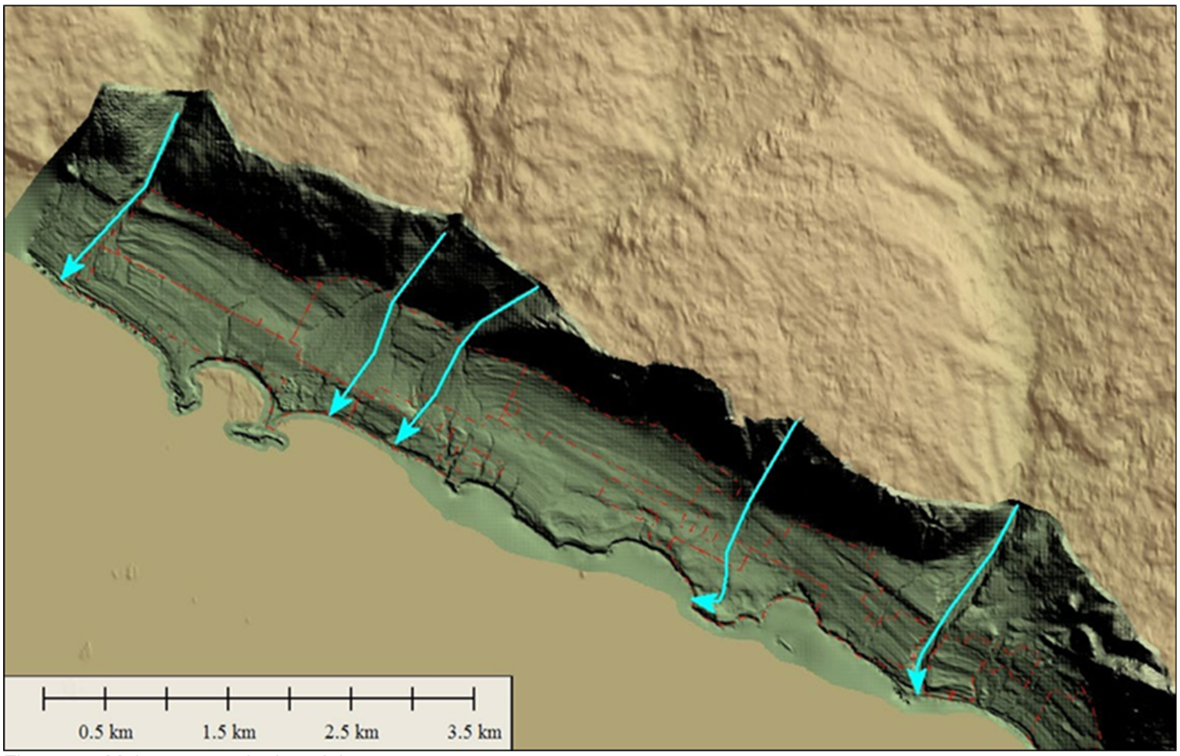


Figure 16. Major streams in the mining area.

9.1.2 The fjord

The sea off the Project area is covered by thick sea ice much of the year. On average the ice start to break up in May-June and the sea is free of sea ice from late June to late October (Svašek Hydraulics 2016, pers. obs.). However, there are large annual variations with open water already in April or May in some years while in other years (such as 2016) much ice can still be present in late June.

Seawater movements in the Project area are dominated by tidal currents with the flow direction generally parallel to the coastline for both ebb and flood (Figure 17). The magnitude of the current is significantly higher during flood than under ebb conditions. The most common wind direction is from the east and in periods with strong winds that can contribute to the seawater movements off the Project area.

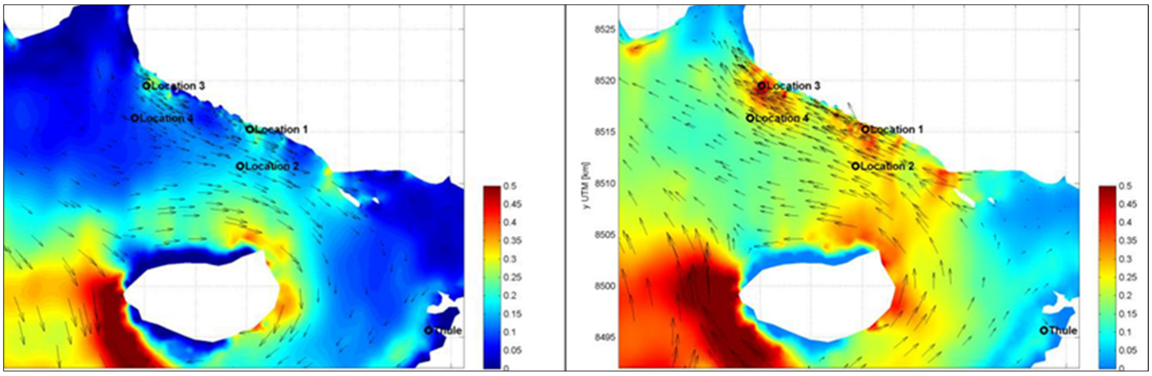


Figure 17. Example of tidal current velocities patterns (m/s) in the assessment area (from Svašek Hydraulics 2016)

9.1.3 Glacial rivers

From May-June to September-October the glacial rives Iterlak and Pinguarsuit (Figure 18) discharge large amounts of freshwater and fine material into the sea. Measurements by Orbicon in June 2019 found that during summer the Iterlak River discharges between 20 and 40 m^3 of freshwater per second to the fjord containing between 20 and 120 tons of fine sediments (<63µm) per hour. The content of fine sediment in the river water was measured to between 241 and 834 mg/l. Since tidal currents are dominant the silt plume is mostly limited to a zone parallel to the coastline (Figure 19). The discharge of Pinguarsuit has not yet been measured but could well be of the same magnitude as Iterlak.

Due to the large amounts of fine material discharged to the fjord by the glacial rivers the turbidity of the fjord water is generally rather high during summer. This is particularly apparent on days when there is strong flood current (Figure 19).

Figure 18. Iterlak and Pinguarsuit Rivers discharge large amounts of fine material into the fjord

Figure 19. Silt plume off the outlet of Iterlak River on 27 June 2016 during flood tidal conditions with the sea water flowing to the west along the coastline

9.1.4 North Water Polynya (NOW)

The sea between Northwest Greenland and Ellesmere Island in Canada is named the North Water Polynya (NOW), see Figure 20.

A polynya is an area of persistent thin sea ice or open water where thick sea ice would be expected during winter. Although the NOW often has 95 % ice cover in January, the ice is mobile and criss-crossed by open leads permitting marine mammals to remain during winter.

The NOW evolves seasonally from a relatively small area in winter, where ice is thinner than elsewhere, to a large area of ice-free water in June and ultimately in summer ceases to exist as a distinct ice-bounded region. The NOW is the largest polynya in the Northern Hemisphere.

Exceptionally for Arctic areas, phytoplankton biomass and primary productivity in the NOW starts very early in April and is high throughout the ice-free period. The high primary production results in a diverse zooplankton community which provides food for large numbers of fish, marine mammals and sea birds. This makes the NOW one of the most biologically productive marine areas in the Arctic.

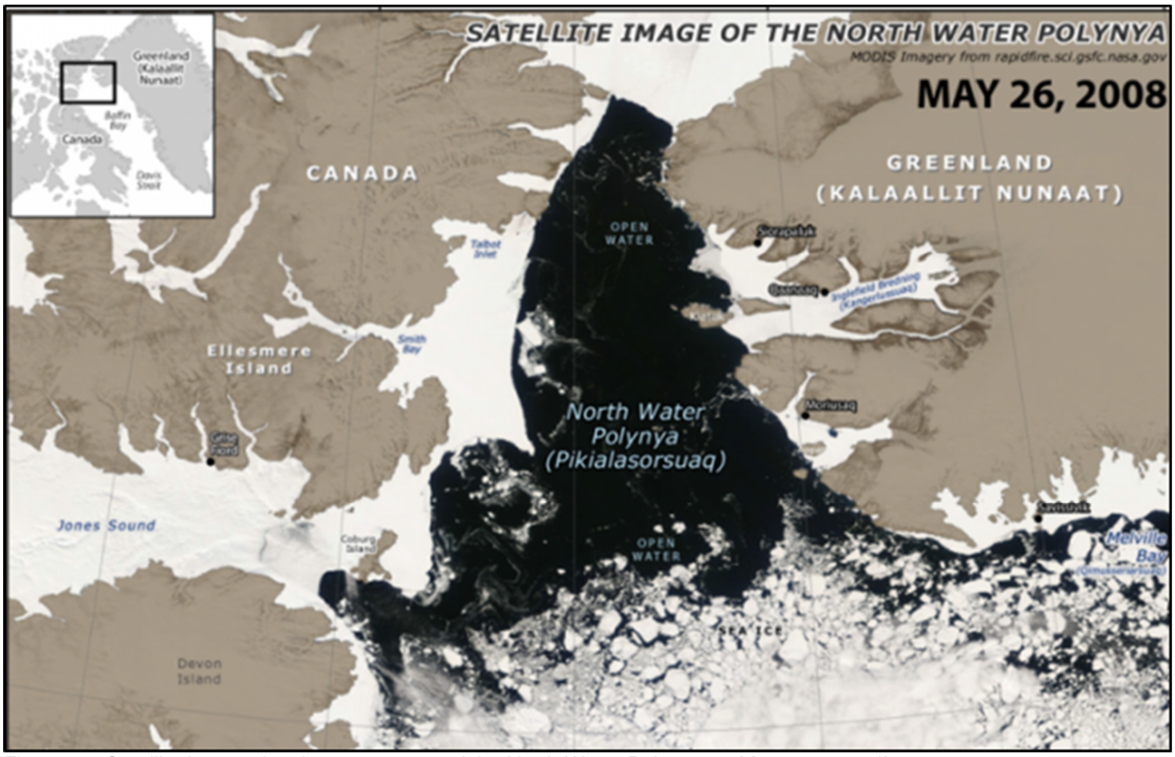


Figure 20. Satellite image showing open water of the North Water Polynya on May 26, 2008 (from http://wattsupwiththat.com/2013/12/31/polynyas-are-very-important-for-marine-life-and-cooling-the-oceans/)

In summer, the region of the NOW supports some of the largest concentrations of seabirds anywhere in the Arctic, dominated by little auks, which breed in tens of millions along the Greenland coast. The NOW also supports large numbers of ice-associated seals and whales including considerable numbers of narwhale, white whale (beluga) and walrus. For this reason, the NOW has been identified as one of the most important marine area in Greenland (Christensen *et al*. 2012).

9.1.5 Terrestrial vegetation

Much of the Project area is covered with low high arctic vegetation. However, the wind-swept sand and gravel plains which cover some of the higher ground have almost no plant cover.

Almost 100 vascular plant species have been recorded, mostly by Bay (1992) who studied the area in 1988. During field work in 2016-2018 a few more species were added to the list. Dwarf shrub heath, fens and bogs dominates the coastal plains, but several other plant communities are also found. Table 9 summarizes key information on the six plant communities recorded from the Project area. More details on the terrestrial vegetation are found in Orbicon 2020a.

Plant community	Description and dominating plant species
Dwarf-shrub heath	The most widespread vegetation on the coastal plains and dominated by *Cassiope tetragona, Salix arctica, Dryas integrifolia* and *Carex bigelowii*
Stream surrounding	A rich flora found along many small streams that penetrates the drier heathland. Typical plants include *Pyrola grandiflora* and *Pedicularis hirsute.*
Fens	Fens and bogs cover large parts of the coastal plans and are dominated by grasses, sedges and cotton-grass such as *Eriophorum triste*, *E. scheuchzeri, Carex bigelowii,* and *Luzula confuse.*
Fell-fields	On wind-swept sand and gravel plains with no or very little permanent snow cover during winter only few plants occur - the most common being *Salix arctica, Dryas integrifolia*, *Festuca brachyphylla*, *Papaver radicatum, Epilobium latifolium* and *Saxifraga oppositifolia.*
Snow beds	Snow bed vegetation is found in depressions where snow accumulates in winter resulting in a long-lasting snow cover and a short growing season. Common vascular plants are *Salix herbacea*, *Oxyria digyna* and *Potentilla hyparctica.*
Fresh water lakes	The shallow lakes of the area are mostly without any submerse or floating vegetation. In most lakes *Hippuris vulgaris* grows along the shores

Table 9. Vegetation communities in the Project area (from Orbicon 2020a)

9.1.6 Land mammals

Arctic hare and arctic fox are the only common land mammals in the Project area. Polar wolf is probably a rare visitor to the area, but no definite data exists.

Muskoxen have not been recorded from the Project area in recent decades but have been re-introduced to Cape Atholl close to Thule Air Base. Also, reindeer has been introduced to the region with a small population restricted to Olrik Fjord c. 100 km northeast of the Project area. There are no indications that muskoxen or caribou will colonize the Project area.

Table 10 summarizes the status of the land mammals in the Project area. More details on the occurrence of these mammals can be found in Orbicon 2020a.

Species	Status in Project area
Arctic fox	Common and widespread and several observed during field work in 2016 - 2018. Present throughout the year.
Arctic hare	Quite common and several observed during field work in 2016 - 2018. Pellets found throughout the coastal plains, including inside Moriusaq, suggests that it is wide-spread on Steensby Land peninsula. Present all year.
Polar wolf	Little is known about its status on Steensby Land peninsula, but polar wolf is proba-bly a rare visitor only

Table 10. Land mammals in the Project area (from Orbicon 2020a)

9.1.7 Birds

Most of the birds in the area are associated with the coast and the fjord. This includes ducks, geese, waders, gulls, terns and guillemots. By contrast, the number of land birds (species and individuals) is low.

Most of the birds are migratory arriving in May-June and leaving again in September-November. Exceptions are ptarmigan, gyrfalcon and raven which occur in small num-bers throughout the year.

Table 11 summarizes the status of the most common birds recorded from the Assess-ment area. This includes the Project area and surrounding land areas, Manson Islands and Three Sister Bees islands off the coast of the Project area and the sea between the Project area and Saunders Island (Figure 6). Most of the information was col-lected during field work in 2016 – 2018. More information on the areas birds is found in Orbicon 2020a.

Bird species	Status in assessment area
Snow goose	Breeds on Manson Islands and Three Sister Bees islands just off the coast. After breeding flocks of up to 150 adults with goslings have been recorded along coast of mainland. In some year's flocks of up to 100 non-breeding geese stay through-out the summer in the Project area
Common eider	Very large colonies on Three Sister Bees and Manson islands (4,000 and 6,000 pairs, respectively). After breeding the females and ducklings quickly leave the As-sessment area

Long-tailed duck	A few pairs probably breed on lakes along the coast, but definite proof is lacking
Red-throated diver	Small numbers breed at lakes along coast and on Manson Islands
Fulmar	Common visitor from a large colony on Saunders Island to the offshore part of the Assessment area
Ptarmigan	Occurs throughout the land area. Numbers seems to fluctuate between years
Peregrine falcon	One pair breed on cliff face near Moriusaq
Gyrfalcon	One pair breed on cliff faces opposite Manson Islands (in some years) i.e. outside the Project area
Ringed plover	Breeds in small numbers along the coasts
Turnstone	No records of breeding from the Assessment area, but migrants from nearby breeding grounds common along the coast in late July and August
Knot	No proof of breeding from the Assessment area but adults and young from neighbouring breeding grounds are common along the coast in late summer/autumn
Sanderling	Probably breeds on Manson Islands where young were observed in late July. No signs of breeding on the mainland.
Baird's sandpiper	Probably breeds on Three Sisters Bees Islands and Manson Islands where young were seen in August. No indications of breeding on the mainland
Purple sandpiper	Rare breeder on the mainland where one pair with juveniles was observed near Moriusaq in 2017
Arctic skua	Several pairs observed defending territories on the mainland and on Manson Islands, but no definite proof of breeding
Glaucous gull	Small numbers breed on the small cliff island off Moriusaq and on Three Sisters Bees and Manson Islands
Kittiwake	Birds from colonies on Saunders island are common in the marine part of the Assessment area, especially in autumn
Arctic tern	Two small colonies in the Assessment area: c. 30 pairs on the small cliff island off Moriusaq and c. 50 pairs on Manson Islands (in 2016)

Brünnich's guil-lemot	Birds from the large colony on Saunders Island are common in the most offshore part of the Assessment area
Black guillemot	Several small colonies in the Assessment area: on the small cliff island off Mori-usaq, on Three Sisters Bees and on Manson Islands
Raven	Small numbers often seen, mostly near Moriusaq. Probably breeds in the Assess-ment area but definite proof lacks
Common wheat-ear	Low density breeder on the mainland
Lapland bunting	Low density breeder on the mainland
Snow bunting	Quite common breeder on the mainland and islands off the coast
Arctic redpoll	Rare breeder with only one record from easternmost part of the Assessment area in 2017

Table 11. Status of the bird species most frequently observed in the Assessment area. For the full list see Orbicon 2020a

9.1.8 Freshwater fauna

Iterlak and Pinguarsuit Rivers are the largest watercourses in the area (Figure 18). Both are glacial rivers with a high content of silt. Many small streams with clear water run over the plain. The watercourses have the flow limited to the summer months. Shallow ponds are widespread on the coastal plans. A few small lakes are found along the coast. Both the ponds and lakes have brief ice-free period.

No indications of freshwater fish were found in the streams, rivers, ponds or lakes. Instead the fishless ponds appear to have rich zooplankton faunas, which include rather large species such as the tadpole shrimp *Lepidurus arcticus*.

9.1.9 Marine flora and fauna

Marine biological studies were carried out in the sea off the Project area in 2016-2019 (Orbicon 2020d). This included underwater video footage and grab sampling of the seabed along eight transects from the shoreline to c. 50 m water depths. Four main physical structures were identified:

- <u>Sandy seafloor with ripples</u>. Except for smaller areas with rocky coast or boulders, the shoreline consists of a sandy substrate with well-developed ripples from the shore to 2-3 m depth. No benthic animals or plants were recorded from the sandy substrate. This is probably due to wave action and ice scouring that takes place much of the year.

- Rocky substrate with the seafloor mainly covered by large stones. Rocky substrate almost completely covered by macro algae was found to be limited to a few small stone reefs off the western part of coast and around the two island groups Three Sister Bees and Manson Islands. This physical structure is especially well developed from around 2-3 m to 7-8 m depth.

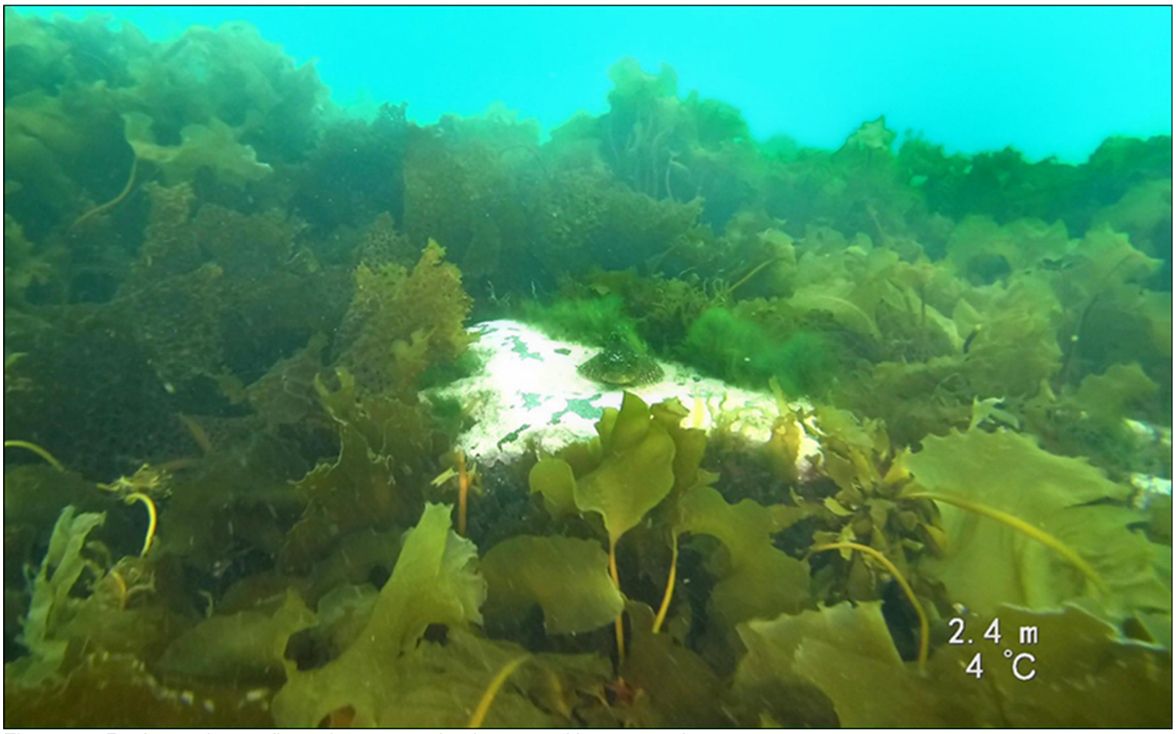


Figure 21. Rocks on the seafloor almost completely covered by macro algae

- Hard substrate with the seafloor covered by gravel mixed with sand. Areas with hard bottom consisting of small stones mixed with sand were limited to the western part. Here, most of the sea floor is covered by small stones and gravel between c.4 m and 8-9 m water depths. The field work only revealed low densities of macro invertebrates from this type of sea floor.

- Soft substrate with the seafloor covered by silt and fine sand. Soft bottom dominates the eastern part of the area from around 2-3 m to at least 20 m, as well as all the deeper parts of the entire area (i.e. below 8 – 10 m). Much of the fine material on the sea floor is probably discharged by glacial rivers. The soft bottom areas are rich in macroinvertebrates, with some areas having large numbers of bristle worms and mussels.

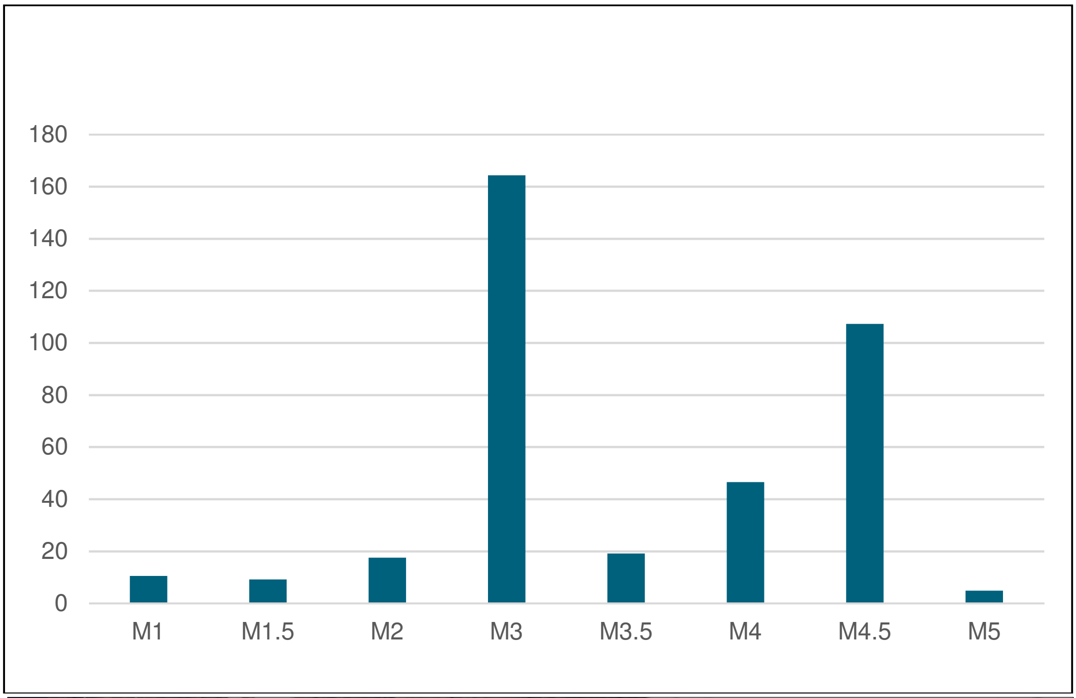
Figure 22. Soft bottom substrate with high density of bristle worms (*Pectinaria*) and mussel siphons (*Mya*)

Efforts were made to quantify the mussels because some the species are an important food resource for walruses. The biomass of all mussels along the eight transects (M1 - M5) are shown in (Figure 23) with a map showing the position of transects.

Obvious environmental factors that vary and can explain some of the variations in biomass seen in Figure 23 are the physical structures of the seafloor. While the seafloor along the westernmost transect M 1, 1.5 and 2 is mainly hard bottom with low numbers of mussels, transects further east has mainly soft bottom which generally hold many mussels.

Another important factor is two glacial rivers which in spring and early summer discharge large amount of sediment into the sea. Although our limited data does not allow firm conclusions, it is notable that the two transects located in front of these rivers' outlet (transect M3.5 and M5) both have low biomass while the two transects positioned a short distance to the west of the deltas (M 3 and M 4.5) have the highest recorded biomass.

One possible explanation could be that most of the larger sediment (sand) fraction washed out by the rivers settle on the sea floor within a short distance of the river deltas suppressing a rich benthos fauna to develop while finer silty material (possibly containing nutrition) is transported a short distance to the west along the coastline with the prevailing flood tidal current (Figure 17) before settling on the seafloor. This is supported by observations of large plumes of silt extending mainly to west from the Iterlak delta.



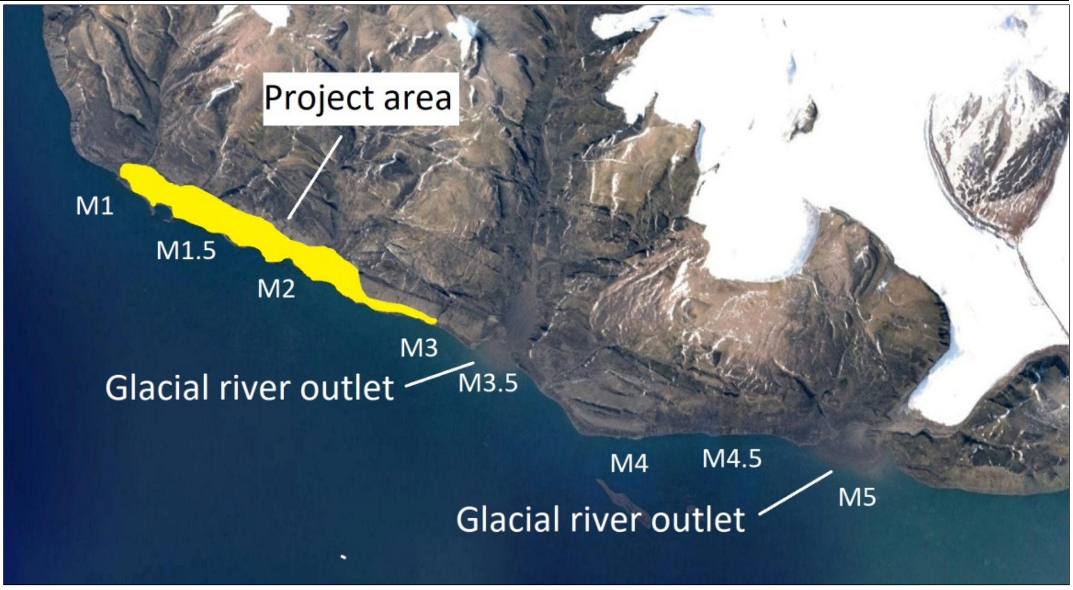


Figure 23. The pooled biomass of all mussels (g dry weight pr. m^2) at the eight stations (M1 – M5) is presented in the table above with the position of the sampling stations (M1 – M5) shown on the map below

9.1.10 Mussels as potential food resource for walruses

Although walruses may feed on a variety of bottom dwelling invertebrates, only a few bivalves—usually *Mya sp.*, *Hiatella sp.* and *Serripes* sp.—make up the bulk of their diet (Vibe 1950). Of these only two were recorded from the Assessment area in significant densities:

- *Mya truncate* was found to be widespread at all gap sampled depths (5 – 20 m) and in most places the most common mussel. Especially high numbers were recorded at transect M 3 and M 4.5 (3).

- *Hiatella spp.* was recorded in highly variable numbers and only in large numbers from transects M 3 and M 4.5 – see Figure 23 (while it went undetected from M 3.5 and M 5).

This suggests that within the surveyed area the mussel species usually preferred by walrus mainly occur in high biomass in limited areas just west of the outlet of glacial rivers (see possible explanation in section 9.1.8).

9.1.10.1. Marine mammals

The marine part of the Assessment area is important to several ice-associated seals, whales and walrus. Some seals are present all year, but the majority only arrive when the sea ice breaks up in spring and leave when new ice covers the fjord in autumn. In early spring the area is important to walrus while in autumn, large numbers of white whale and some narwhales pass on migration.

Table 12 summarizes the status of the most common marine mammals in the Assessment area. Much of the information was collected during field work in 2016 – 2018. More information on the marine mammals is found in Orbicon 2020a and 2020b.

Species	Status in Assessment area	Main habitat in Assessment area	2018 Greenland red-list status	Importance of population
Polar bear	Occasionally observed mainly in spring (common in adjacent NOW)	Drift ice and ice edges (rarely on land)	Vulnerable	Low
Walrus	Some years quite common from October/November to June (occasionally early July). Sometimes a few stays during winter	Drift ice and pack ice in areas with shallow water	Vulnerable	High
Hooded seal	Small numbers occur from May/June to October/November	Open water	Vulnerable	Low
Bearded seal	Small numbers probably occur throughout the years	Ice edges and shear zone	Least concern	Low

Harp seal	Migratory, quite common from August to October	Coastal, open water	Least concern	Low
Ringed seal	Common throughout the year	Coastal	Least concern	Low
White whale	Large numbers pass on migration between mid-September and October/November (at least in some years)	Open water	Vulnerable	High
Narwhale	Small numbers pass on migration in June and again in October	Open water	Near threatened	Medium

Table 12. Status of marine mammals recorded from the Assessment area

9.1.11 Threatened species

Four birds, six mammals and one plant species recorded from the Assessment area are listed on the 2018 Greenland Red List of threatened species (/http://www.natur.gl/roedliste/1-roedlisten/) - see Table 13 and Table 14.

Species	Status in Assessment area	Main habitat in Assessment area	2018 Greenland red-list status	Importance of population
Gyrfalcon	Breeding – present all year	Inland, coast	Near threatened	Low
Black-legged kittiwake	Visitor (spring, summer, autumn)	Fjords	Vulnerable	Low
Arctic tern	Breeding summer visitor	Coastal, fjords	Near threatened	Low
Brünnich's guillemot	Summer visitor	Fjords	Vulnerable	Low
Polar wolf	Very rare visitor	Inland, coastal	Vulnerable	Low
Polar bear	Rare (winter) visitor	Coastal, fjords, inland	Vulnerable	Low
Walrus	Some years common in late winter/spring	Fjords	Vulnerable	High
Hooded seal	Rare summer visitor	Fjords	Vulnerable	Low
White whale	Common on autumn migration	Fjords	Vulnerable	High
Narwhale	Low numbers in autumn	Fjords	Near threatened	Low

Table 13. Animal species occurring in the Assessment area and included on the 2018 Greenland Red list of threatened species.

Most of the threatened species are listed *Vulnerable*. Exceptions are gyrfalcon, arctic tern and narwhale which are *Near Threatened*:

- Gyrfalcon because of a small (but apparently stable) population in Greenland consisting of c. 500 breeding pairs/1,000 individuals.
- Arctic tern due to a large decline in the breeding population in recent decades (including colonies in Qaanaaq district). The reason for the decline is not known.
- Narwhale because of a decline over a long period of the time. The population is currently believed to be increasing again.

Species	Status in assessment area	Main habitat in assessment area	2018 Greenland red-list status	Status in assessment area
Fisher's tundra grass	Recorded in 1988 (Bay 1992)	Rich fen	Vulnerable	Recorded near Moriusaq in 1988 by Bay (1992)

Table 14: Plant species occurring in the assessment area and included on the Greenland Red list of threatened species.

In Greenland Fisher's tundra grass is the only known from Moriusaq, two sites near Thule Airbase, Qeqertat (east of Qaanaaq) and Zackenberg in East Greenland (Bay 1992). It has a circumpolar distribution and is widespread and, in some places, common in Canadian Arctic Archipelago (https://nature.ca/aaflora/data/www/podufi.htm).

9.1.12 Protected areas

9.1.12.1. Sea bird colonies

Three Sister Bees and Manson Islands (Figure 24) have very large colonies of common eider duck. A survey in 2016 estimated the number of nests to 10,000 (Orbicon 2020a). It probably makes the colonies the most important for eiders in North Greenland.

Small colonies of arctic tern and black guillemot are also found on Three Sister Bees and Manson Islands and on a small island off Moriusaq (Orbicon 2020a).

Very larger seabird colonies are also located on the cliffs of Saunders Island further to the south (Figure 24), where in particular many Brünnich's guillemot and black-legged kittiwakes breed.

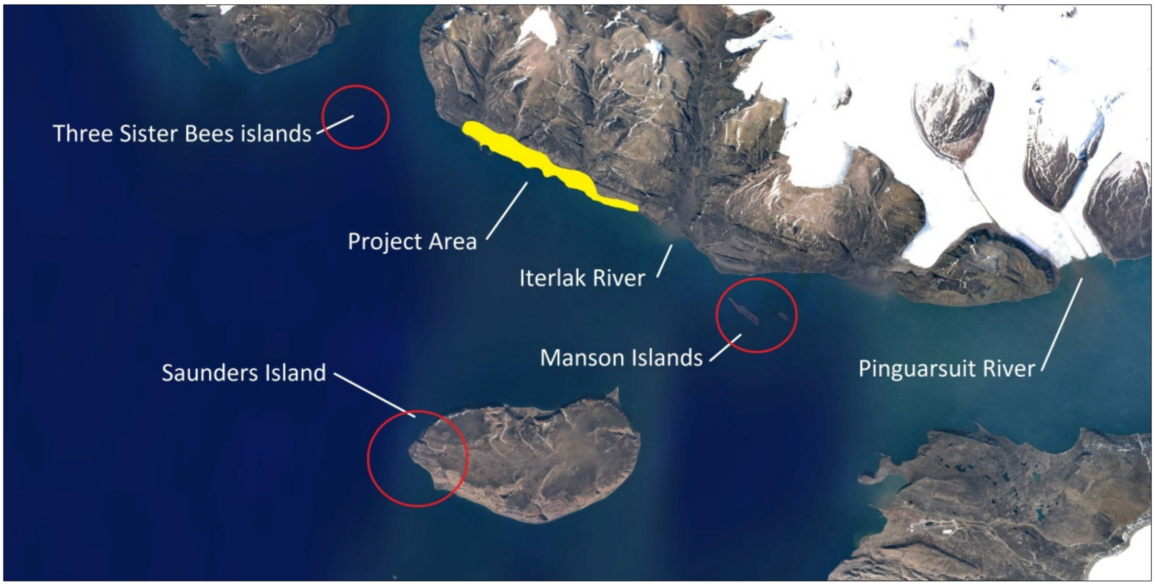


Figure 24. Larger seabird colonies near the Project area (red circles)

9.2. Potential impacts

The following sections assess the Projects disturbance of animals, plants and their habitats and the potential contamination of natural habitats.

<u>Disturbance</u>

In this context disturbance includes:

- Active scaring of animals, for example when underwater noise from shipping excludes white whales from an area;
- When a habitat becomes unavailable to animals, for example if ptarmigan is excluded for utilizing an area with vegetation because it is close to a haul road; and
- Habitat loss, for example when vegetation is lost due to the construction of infrastructure.

<u>Contamination</u>

The potential contamination impacts are:

- Discharge of process water from the Project during operation which has the potential to affect sea water quality and marine life near the discharge point; and

- Accidents in connection with transport, storage and handling of oil and hazardous materials which can cause contamination of land areas, freshwater bodies and the ocean.

Each of these identified potential impacts is discussed below.

9.3. Assessment of impacts - disturbance

9.3.1 Disturbance of terrestrial vegetation

Mining and in particular haulage on the unsealed roads have the potential to stir dust that can impact tundra vegetation by coating of leaves with dust (Section 8.3.1). This again might also impact animals and birds that feed on the affected vegetation. Because the speed of the mine trucks will be restricted to 40 km/t the amount of dust generation is expected to be low and the deposition mainly limited to a narrow area along the haul roads and the mine area (Section 8.3.1). To verify this, monitoring activities will be part of the overall monitoring program – see Section 15.

Mining activities and re-profiling to accommodate buildings and infrastructure will remove the terrestrial vegetation from a large area. This implies that most of the vegetation of the coastal plains within the Project area will be disturbed. Areas where some vegetation will remain intact includes some parts of the coast, along the two largest watercourses, some areas near the inland mountains and around the airstrip/main camp (see Figure 9). The area of undisturbed vegetation within the Project area is estimated to c. 20%. In addition, there are large unaffected areas of coastal plain vegetation immediately east and west of the Project area.

To minimise the impact on the vegetation the following procedure will be followed:

- Before mining operations begin in one of the blocks (Figure 9) the topsoil and vegetation is pushed aside and left in stockpiles next to the mining area. When mining has been completed in a block after c. 1 year the soil is pushed back and evenly spread. No or only very few plants will survive this. During the 10 years of mining the topsoil layer will be temporarily removed from approximately 8 km^2 of coastal plains most of which has some vegetation cover. It is to be expected that the natural vegetation in this area will be lost and will have to regenerate though natural succession.

- Construction works to accommodate the new port, air strip, storage building and other facilities and the construction of roads will also lead to loss of natural vegetation. At mine closure all buildings will be removed, and the disturbed areas will gradually be re-vegetated.

The topsoil that is pushed back and spread over the mined areas most likely contain a selection of seeds from the former vegetation which will germinate and start the regeneration of the vegetation cover. Seeds that blow into the area from the surroundings will also promote the restoration of the natural vegetation. But in the high arctic climate with a very short growing season, it will take decades - maybe even longer - for the vegetation to be restored. It should therefore be considered to also introduce active re-vegetation. Such activities will be considered in a study program that will test different ways to facilitate the re-vegetation of the mined areas. The study program is part of the closure plan (see Section 14) and will build on feedback from ongoing monitoring of the vegetation in the reclaimed areas (see Section 15).

The plant communities and plant species in the Project area are common and widespread throughout Northwest Greenland. Only Fisher's tundra grass is red listed in Greenland, but this grass is also known from several other sites close to the Project area and therefore has to potential to return.

At local level, the destruction of terrestrial vegetation in the mined area will be significant. But from a regional perspective, the loss is minor because the plants occurring in the disturbed area are common and widespread in very large parts of Northwest Greenland (except Fisher's tundra grass). Against this background, the loss of vegetation and terrestrial habitat due to the Project activities is assessed as Medium.

9.3.2 Disturbance of terrestrial mammals and birds

The loss of vegetation and changes to the hydrological regime (Section 9.3.3) in the active mining blocks will also result in a significant loss of natural habitat for the area's animals. It will, for example, prevent birds from breeding and foraging during mining and for most species until the vegetation is restored. Since this is expected to take decades, many birds will be excluded from the mined areas for a very long time.

Noise from mobile and fixed equipment, which can be heard at a significant distance, has the potential of startling mammals and birds.

Visual disturbances from personnel, machinery, vehicles, buildings and other project structures might cause mammals and birds to avoid utilising habitat in and near the mine area, roads and camps.

Only few birds breed in the Project area. This includes small numbers of red-throated divers and possibly also long-tailed duck and arctic skua, which breeds at ponds and waders such as ringed plover which nest along the coast. Purple sandpiper, common wheatear, Lapland bunting, snow bunting and possibly also ptarmigan are regular low-density breeders on the coastal plains.

Throughout summer flocks of non-breeding snow geese are also common on the plains in some years. These birds are joined in late summer and autumn by snow geese with goslings from breeding areas on the small islands off the coast (Manson and Three Sisters Bees).

One or two pairs of peregrine falcon, gyrfalcon and probably also raven breeds on cliffs further inland and sometimes occur on the plains and along the coast. Of the birds recorded from the Project area gyrfalcon is listed as “Near threatened” on the Greenland Red List because of its small population in Greenland.

In winter ptarmigan, raven and possibly also a few gyrfalcons are the only terrestrial birds in the Project area.

Arctic hare and arctic fox are the only common terrestrial mammals in the Project area. These animals usually habituate well to human activities, where they are not hunted. Polar wolf is probably a rare visitor only. Wolf is listed as “Vulnerable” on the Greenland Red List.

The loss of vegetation and terrestrial habitat due to mining will be long lasting but will only affect small numbers of terrestrial birds and mammals. The Red-listed gyrfalcons breed high on cliff faces and will probably not be disturbed by the Project activities. Since few birds and mammals will be directly affected by the mining activities and because very large areas of similar habitat are widespread in the region, the disturbance impact of terrestrial mammals and birds is assessed as low.

Outside the areas where active mining will take place, noise and visual disturbance will cause only localized disturbance. To minimize disturbance in these areas, the movement of staff members must be restricted outside the construction and mining areas. Overall, the noise and visual impact of terrestrial mammals and birds is assessed as low.

9.3.3 Disturbance of freshwater fauna and flora

Construction and operation of the Project will modify hydrological processes, potentially affecting freshwater habitat. The major hydrological changes are:

- Natural ponds inside the active mine block will be temporarily drained and diversion berms will be constructed to avoid water runoff to enter the mining area.

- Where larger streams cross the active mining zone berms on either side of the rivers will be constructed, as required, to reduce the risk of water overtopping channel banks into the mining area. The smaller of these streams will be mined out during winter months when stream flows along these drainages will be zero (the two largest rivers are left undisturbed – see Figure 9). The beams around the active mining zone and streams will be removed when mining moves on to new areas (after c. 1 year). After mining the streams during winter, the natural flow pattern will be re-established.

- To protect the mine void from seawater inrush where the active mine area approaches the shoreline berms with a height of 2 m will be constructed to reduce risk of waves encroaching into the mining area. The shoreline beams will be removed when mining moves on to new blocks (after c. 1 year).

- Diversion channels and beams will be constructed to direct rainwater and water from melting permafrost and snow away from the airstrip and the main camp facilities. During decommissioning all trenches, channels, culvers and beams from the air strip area and buildings in the main camp will be removed.

- Where haul roads cross streams culverts will be installed as required. These will be designed to cause no significant flow constrictions to the water flow and will be removed during decommissioning.

These major hydrological changes will imply that the flora and fauna associated with freshwater bodies such as many ponds and streams will be lost. Therefore, the disturbance of freshwater must be minimized as much as possible and the natural hydrology must be restored as quickly as practically possible.

When mining is completed and the hydrology and natural run-off restored again, freshwater organisms and plants will gradually recolonise the freshwater bodies. But because of the very cold climate with short summers it will take a long time, perhaps decades.

The project activities will have long term impact on the freshwater ecosystems within the Project areas. But since there are large undisturbed areas with similar freshwater habitat in the region, the overall impact on freshwater fauna and flora is assessed as low.

9.3.4 Disturbance of benthic fauna and flora

9.3.4.1. Sedimentation and increased turbidity

The discharge of silt material to the sea will lead to enhanced concentrations of suspended solids (SS) consisting of fine particulate matter in the seawater near the outlet. The discharge will also cause accumulation of the heavier material fraction around each of the four outlet pipes.

9.3.4.2. Discharge strategy

Surveys of the seafloor in the area expected to be affected by high turbidity and sedimentation has shown that it consist mainly of a mix of hard substrate with the seafloor covered by small stones and with low densities of macro invertebrates and of soft substrate with a richer macroinvertebrate fauna, with some areas having large numbers of bristle worms and mussels (Section 9.1.9). A few small areas with large stones and many macro algae are found mainly in the north western part (Section 9.1.9). The marine species in the Assessment area are common along the coasts of North Greenland (see Orbicon 2020d for details).

In order to minimise the impact of increased turbidity and sedimentation from the project on the marine flora and fauna several discharge strategies were considered. Studies of the sea currents off the Project area showed that the hydraulic conditions are dominated by an oscillating tidal current which moved parallel to the coastline (Svašek Hydraulics 2016). This implies that the dispersal of a SS plume and the material sedimentation will take place predominantly in areas to the northwest and southeast of the discharge point along the coastline. It must further be expected that the discharge of material will result in particularly high concentrations of SS and sedimentation near the discharge point at slack tides between the flood and ebb currents.

Since the benthic diversity and biomass in the Assessment area has been found to be lowest in the shallow water near the coast line and increase with depth (Section 9.1.9 and Orbicon 2020d) discharge close to the shore would minimise the impact on the benthic flora and fauna. Taking also operational considerations into account (such as ice conditions in winter) a discharge depth of 10 m was chosen (as oppose to for example 35 m water depth – see Section 5.3.3). In order to further minimise the dispersal of material into deeper water (and elsewhere) it was chosen to discharge the sediment close to the seafloor.

When deciding the location for each of the four discharge points the physical structure of the seabed and the distribution of benthic communities was taken into account. A main concern was to impact mussel banks with high biomass of species known to be important to walruses. For this reason, a minimum distance of 5 km was chosen from a discharge point to an area identified to have high density and biomass of *Mya truncate* and *Hiatella spp* –Figure 25. Another concern was large rocky areas with many macro algae which would suffer from reduced light penetration in situations with large amounts of suspended solids in the water column. Stone reefs are also important habitat for many species of fish. The marine surveys showed that rocky substrate was limited to a few small stone reefs off the western part of coast and around the two island groups Three Sister Bees and Manson Islands. However, with tidal current moving parallel to the coastline and the discharge points to be established close to the coastline significant disturbance of the main stone reefs at Three Sister Bees and Manson Islands was considered to be unlikely.

TT-Hydraulics (2019) modelled the dispersal of the suspended solids plume and the sedimentation of silt material using the MIKE 3 software. This software provides data with a very fine geographical resolution of the dispersal during a six-day period. It was considered to model the plume dispersal and sedimentation using a software that would provide data covering a longer period of time but this would reduce the resolution considerable. Since the dispersal of SS and sediment was expected to be limited to a rather narrow zone close to the coastline (because of the strong tidal current) maps with high resolution was considered more valuable when assessing the potential project impact on the marine flora and fauna. For this reason, the dispersal of SS and sediment was mapped using the MIKE 3 software.

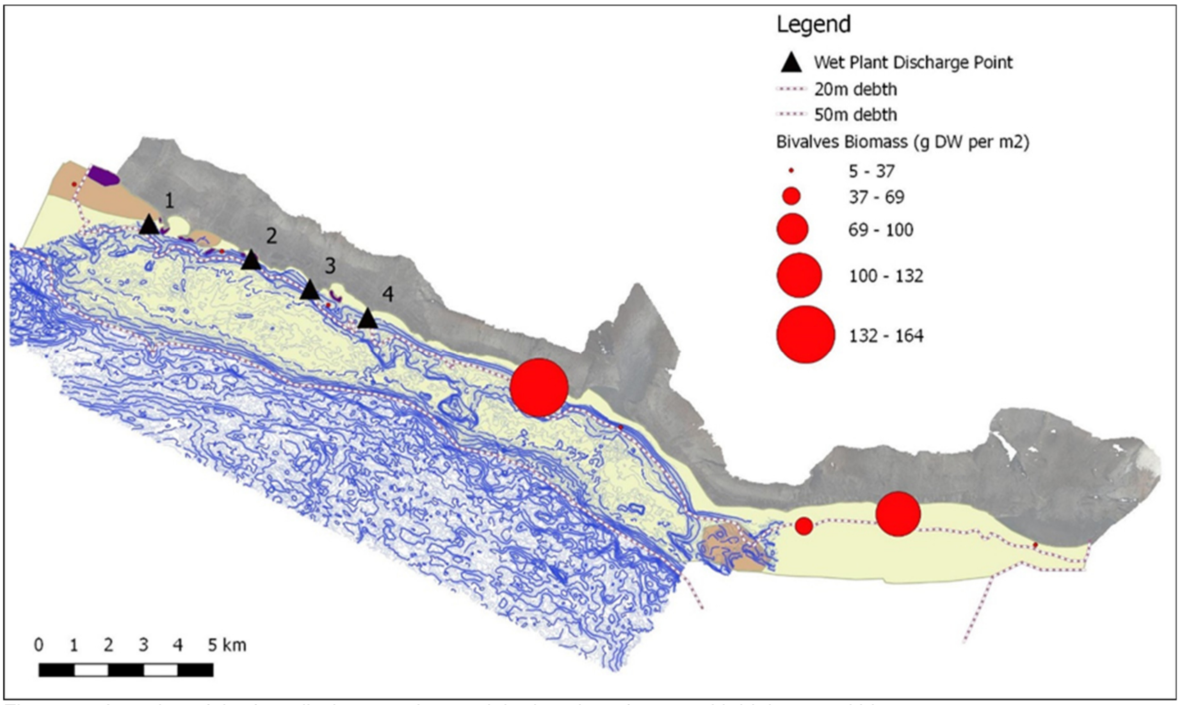


Figure 25. Location of the four discharge points and the location of areas with high mussel biomass

9.3.4.3. Effects of sedimentation on benthos

The effects on benthos when sediment is discharged to the sea floor depends on the sedimentation rate (how much sediment that accumulates within a certain period), the size of the impacted area but also to what extent the species composition of the already established bottom communities is adapted to sedimentation.

Studies of the impact of sedimentation on benthos is summarized in Orbicon (2019d). This includes a study of the tailings deposition from a titanium mine in a Norwegian fjord (Jøssingfjord). Here clear adverse effects were found in areas with a sedimentation rate in the order of 40-50 mm per year (Olsgard & Hasle 1993). This included changes in community composition with a general reduction in species numbers, and increase in abundance and changes in dominance patterns (Olsgard & Hasle 1993). However, in areas with a deposition rates of 1 mm $year^{-1}$ no impacts on benthos were detectable.

Although there are differences between the discharge of tailings into the Norwegian fjord and the present project the observed effects on the benthic fauna in Jøssingfjord is used here to determine conservative estimates of the impact in Wolstenholme Fjord.

Based on the observations in Jøssingfjord we define the following impact zones based on the recorded sedimentation thresholds:

- No-effects are expected where the sedimentation is less than 1 mm $year^{-1}$;
- Minor effects with decreased diversity and possibly lower biomass are expected in areas with a sedimentation rate between ~1 mm and ~40mm $year^{-1}$;
- Major effects with significant effects including high mortality among benthos organisms are expected where the annual sediment deposition exceeds 40 mm.

By combining the threshold values defined above with maps of the modelled sedimentation around the discharge points (Figure 26) it is possible to determine the boundaries and the size of the two affected zones (Figure 27) – see Orbicon 2020d for more details. Figure 27 shows the total areas to be affected by discharge at all four discharge points. However, it should be noted that discharge only takes place at one point at a time. This implies – for example - that when discharge commence at point 4, it will be five years since the discharge ended at point 1.

The total area with minor effects extent c. 20 kilometers along the coast and about 1 – 1.5 km off the coast and covers c. 25 km^2 (Figure 27).

The total area with major effects stretches about 9 km along the coast and about 1 km off the coast. The size of this area is c. 9 km^2 (Figure 27). Within this zone all or most benthic organisms are expected to perish. This area is relatively small compared to the total fjord area at the same depth range (0-25 m) and in particular the shallowest parts are strongly affected by ice and natural disturbances.

It should be noted that this is most likely a conservative estimate that does not take into account to what extent the species composition of the already established bottom communities is adapted to sedimentation.

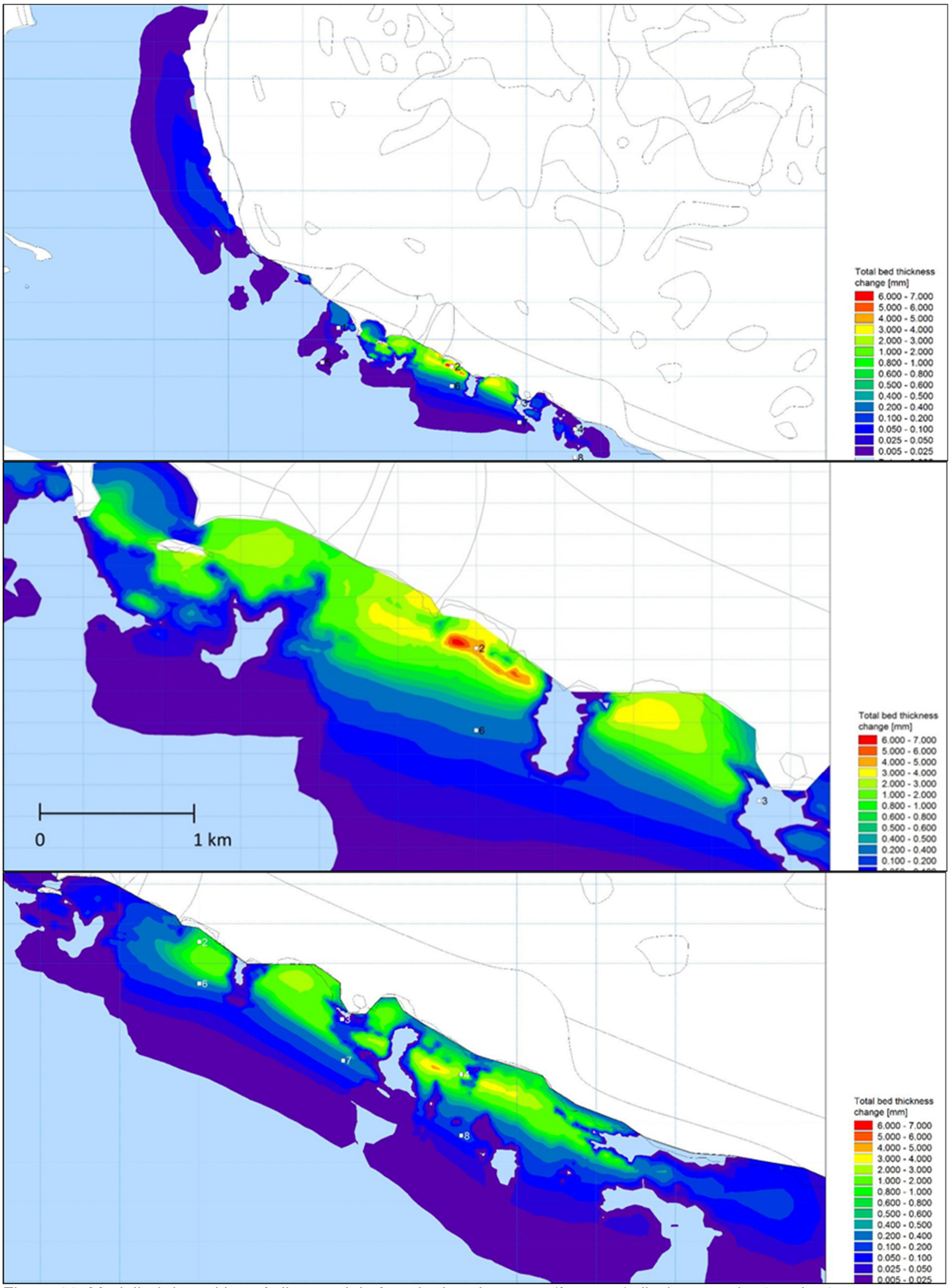


Figure 26. Modelled deposition of silt material after six days in mm at (from top) discharge point 2, point 2 enlarged and point 4 (from TT-Hydraulic 2019)

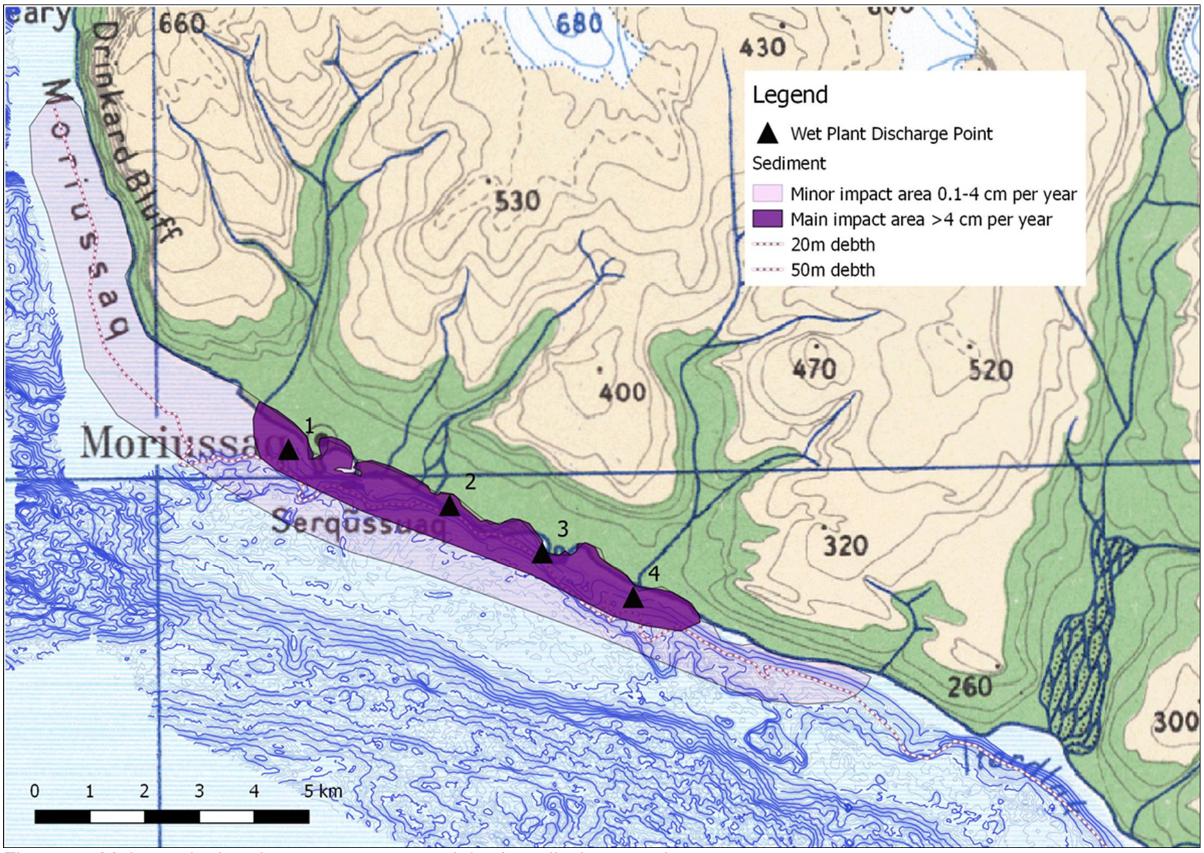


Figure 27 Major and minor impact zones around the four discharge points

In some parts of Wolstenholme Fjord considerable natural sedimentation takes place during summer when the glacial rivers discharge sediment to the sea (Section 9.1.3). Based on flow measurements and measurements of suspended solids in Iterlak River water in June 2019, Orbicon calculated that during summer Iterlak River discharges between 20 and 120 tons of fine sediments (<63µm) per hour and 100,000 – 346,000 tons material annually (see Orbicon 2020d). The river water had a content of suspended solids ranging between 241 and 834 mg/l. The discharge of the other glacial river in Wolstenholme Fjord, Pinguarsuit (to the east of the Assessment area) has not been measured but could be of the same order of magnitude. For this reason, the benthic fauna near the outlet of these rivers may already have favored a fauna and flora tolerant to considerable turbidity and sedimentation.

As an adaptation to large scale natural discharge of sediment, many of the infauna species are able to move vertically in the sediment and the epifauna species are generally also able to relocate themselves on the seabed (see Orbicon 2020d for a discussion of this). It is therefore likely, that many of the benthic animals are able to cope with depositions up to 20 mm year^{-1} (see Orbicon 2020d).

9.3.4.4. Increased turbidity caused by the discharge

The natural turbidity in the sea off the project area is observed to be generally rather high during summer (Section 9.1.3) when glacial rivers wash large amounts of fine material into Wolstenholme Fjord. But since the flow of the key rivers - Iterlak and Pinguarsuit – vary considerably from day to day (and often also during the day) and because the suspended material is dispersed mainly by oscillating tidal currents, long time monitoring is required to determine the fjords (average) background level of suspended solids.

Such measurements are currently not available, but from other sites with dynamic environments such as the soft bottom in most of the Assessment area suspended levels of up to 10 mg/l are usually within the normal tolerance levels for benthic fauna (Orbicon 2020d). Since the benthic fauna seems generally well developed in the Assessment area, we use 10 mg/l as the background SS level until more accurate data are available.

The discharge of silt material to the sea will lead to enhanced concentrations of suspended solids (SS) consisting of fine particulate matter in the seawater near the outlet. Exposure to high turbidity for longer periods can affect benthic invertebrates by subjecting them to clogged gills and guts and ultimately increase mortality. High concentrations of suspended solids can also influence macro algae, primarily through limiting the amount of light penetration through the water column. This in turn reduces photosynthetic activity and limits primary production.

Figure 28 shows the mean SS concentration in the middle water layer at discharge point 2 and the maximum SS concentration at slack tides. The highest mean SS concentration values are around 0.05 – 0.08 kg/m^3 (TT-Hydraulics 2019) corresponding to 50-80 mg/l (60-90 mg/l including a background level of 10 mg/l). The modelled maximum value in a small area around the discharge point during slack tides is up to c. 0.4 kg/m^3 (TT-Hydraulics 2019) or 400 mg/l (410 mg/l).

The Greenland Water Quality Criteria for suspended solids in seawater is 50 mg/l. The discharge of sediment to the sea will exceed this value in some areas (Figure 28). The size of the area around one outlet pipe, where the mean SS concentration will exceed 50 mg/l is estimated to 1.0 km^2. Since the tidal current and the seafloor topography is generally similar along the project coast the size of the area where the water quality criteria is exceeded is believed to be of the same order of magnitude at the other three discharge points (i.e. c. 1 km^2).

The areas with high (over 50 mg/l) concentrations of suspended solids will be the same as the zones with high sedimentation and the high turbidity will probably be an extra stressor to the challenged benthos organisms and will probably lead to additional mortality in the major impact zone.

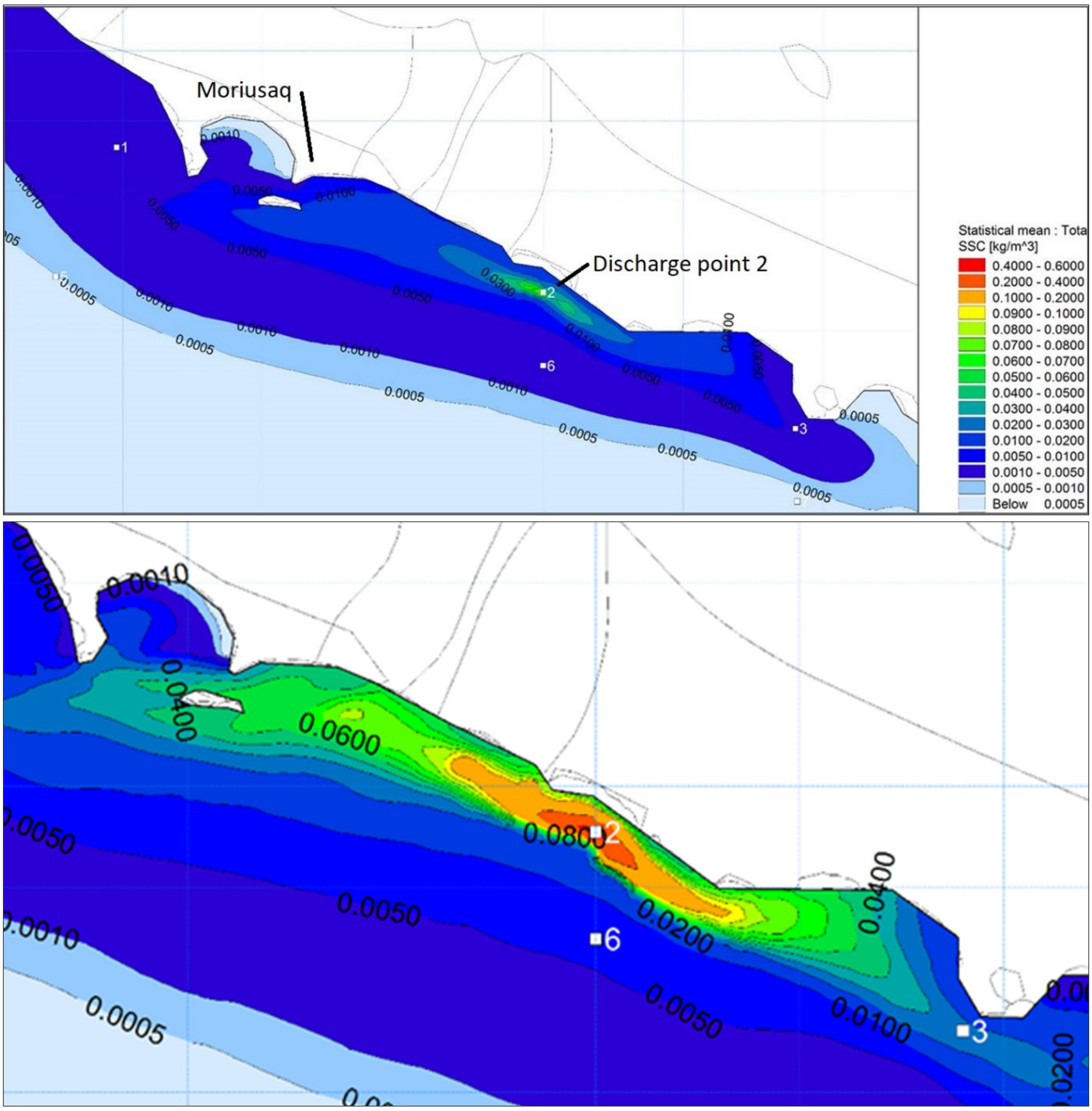


Figure 28. The upper figure shows the modelled mean concentration of suspended solid (middle of water column) at discharge point 2. The lower figure shows the maximum SS concentration at slack tides (from TT-Hydraulic 2019).

9.3.4.5. Recovery time

The recovery time for benthos after discharge of tailings stopped has been studied in connection with the titanium mine in Jøssingfjord (see Orbicon 2020d for more details). In Jøssingfjord re-colonization on the tailings deposit commenced within one year after cessation of discharge, and within 4 years all the major benthic macrofauna phyla were present.

However, despite an initial rapid colonization, differences in faunal composition and structure may persist for a much longer time and the ecosystem may take decades to recover to its original state (see Orbicon 2020d for more details). This is particularly true for many Arctic species, which often have slow growth rates, are long lived, and have delayed maturity and low reproductive output with a variable larval and juvenile survival.

Recovery in both the main and minor impact zones is also expected to commence within a year in Wolstenholme Fjord. The discharged material may have low organic content but fine material washed out with the glacial rivers during summer as well as resuspended material due to the dynamic character of the tidal zone all year will probably facilitate the recovery. Full recovery for the benthic community including full recovery of biodiversity, abundances and biomass is then mainly dependent on the age range of the benthic fauna in the impact area.

The size distribution of the thick shelled and dominating bivalves sampled from the impact zones include relatively large mussels. Studies from other parts of the arctic has documented that large mussels can be very old (see Orbicon 2020d). A conservative estimate of the time it will take for a full recovery of the benthos in the major impact zone, including the same age variation may therefore be over 150 years, however much of the community is likely reestablished after c. 40 years.

9.3.4.6. Impact assessment

The expected impacts from the project and the recovery of the benthic organisms can be summed up as follows:

- The major impact area with expected high mortality among benthos organisms is a 9 km long narrow zone along the coastline which covers c. 9 km^2 of seafloor.

- The minor impact area where decreased diversity and possibly lower biomass are expected is a 20 km long zone along the coastline which covers c. 25 km^2.

- The benthic fauna in the affected areas have generally low species diversity and biomass (see Figure 25 & 27) and the species are common along the coasts of North Greenland.

- Re-colonization is expected to start within a year and after 4 years all the major benthic macrofauna phyla will probably be present. However, a full recovery of the age variation of mussels will take many decades.

- In particular in the eastern part of the impacted area the benthic fauna and flora may already be tolerant to considerable turbidity and sedimentation. The benthic organisms in this area may therefore survive the sedimentation and high turbidity better.

- Large areas of similar undisturbed benthic flora and fauna are present in the region which will facilitate the re-colonisation of the deposits.

Since the impact zones are limited to the Assessment area the overall impact is assessed to be long term with Medium significance.

Because the sedimentation modelling only covers a six-day period the long-term deposition is associated with some uncertainty. Monitoring of the sedimentation of material on the seafloor and the impact on the marine ecosystem must therefore be initiated soon after the discharge commence. If the sedimentation is observed to accumulate in significant amounts outside the predicted zones the discharge strategy must be modified. This could include the application of a different discharge nozzle, lower discharge depth as well as moving the discharge point more often.

9.3.5 Disturbance of seabirds

A possible disturbance of seabirds primarily relates to the area's seabird colonies. No known important foraging, wintering or moulting areas for seabirds will be disturbed by Project activities.

Manson Islands and Three Sister Bees islands have large numbers of breeding seabirds. This includes probably the largest and most important eider duck colony in North Greenland.

A large seabird colony is also located on the western cliff faces of Saunders Island where thousands of guillemots, kittiwakes and other seabirds breed (see Section 9.1.8.1 and Figure 24). Recent studies have shown that many of these seabirds catch most of the food for the young in the sea to the west of Saunders Island (Boertmann & Mosbech 2017), and only relatively few seabirds rest and forage in the sea between Saunders Island and the coast of the Project area (Orbicon 2020a).

Several Project activities could potentially disturb the seabird colonies. This includes disturbance of breeding eider ducks, if for example project staff members visited the Three Sister Bees or Manson Islands during the nesting season or if ships to the Project port pass close to the cliff faces with seabird colonies on Saunders Island.

To avoid disturbance of breeding eiders (and other birds) on Three Sister Bees and Manson Islands project staff must not be allowed to visit these islands from 1th May until 1th September. To avoid disturbing the seabirds on Saunders Island, vessels to the Project port must maintain good distance to the cliff faces (minimum 5 km).

With a ban on access to Three Sister Bees and Manson Islands during the birds' breeding season and a shipping route at least 5 km from the seabird colonies on Saunders Island, disturbance of the area's seabird colonies is considered very low.

9.3.6 Disturbance of marine animals

Marine mammal occurring close to the Project area, can potentially be disturbed by mining activities on land and by shipping to and from the Project port. Of special concern is walrus who sometimes congregate at shallow banks close to the coast for longer periods to feed on mussels.

The following Project activities have been identified as potentially disturbing marine mammals:

1. Noise and visual disturbance from Project activities on land and from passing ships;
2. Loss of food resources (mainly mussels); and
3. Underwater noise from ships.

9.3.6.1. Visual and noise disturbance from land and from shipping to the Project port

Most whales occurring in the fjords nears the Project area are white whale and narwhales on migration (Orbicon 2020b). These animals normally move relatively quickly through the area and stay away from the shore. Visual disturbance or noise from mine activities on land are therefore unlikely to disturb these animals significantly. When passing the shipping route to the Project port whales can be disturbed, but mainly from underwater noise – see Section 9.3.6.4.

Ring seals are very common along the coast, and usually adapts well to human activities. Bearded and harp seals are mostly associated with the deeper parts of fjords, away from areas with noise and visual impacts. It is therefore not likely that the project will significantly disturb any of the seal species.

Although walruses often show little fear from people or even approaching boats, project staff members, moving mine equipment on land, such as mine trucks and excavators can potentially cause disturbance.

Disturbance of walrus

Walruses are almost exclusively present in the Wolstenholme Fjord system in spring (April-June) and autumn (late October – November). Small numbers may also be present during winter (see Orbicon 2020b for more details). During their stay in the fjord system the walruses feed on mussels and haul-out on drifting ice (occasionally on land). Since they are good swimmers the haul-outs can be some distance from the feeding banks.

Although walruses may feed on a variety of bottom dwelling invertebrates, only a few mussel species - usually *Mya sp*., *Hiatella sp*. and *Serripes* sp. - make up the bulk of their diet (Vibe 1950). Walruses are able to dive to more than 500 meters depth but by far the majority of their dives are to less than 50 meters (Garde *et al*. 2018).

Mining activities on land such as noise from material excavation and trucks as well as visual disturbance from workers and mine facilities may disturb feeding and resting walruses. In order to assess if this would be a potential issue in connection with the present project field-studies were carried out and data from other studies compiled.

To document if significant feeding areas are situated close to planned project activities surveys of the seafloor were carried out using grab sampling and underwater video recordings (Orbicon 2020d). The surveyed area covers the sea off the Project area from the shore to 50 m depts. The survey also included coastal areas 12 km east of the Project area and two kilometres to the west (to the entrance of Granville Fjord). Within this area high densities of mussels including many *Mya truncate* and *Hiatella spp*. were recorded along two transects: M3 and M4.5 – see Figure 23 and Section 9.1.10. In the other surveyed areas including the soft bottom at depths between 25 and 50 m only low densities of mussels were recorded.

Knowledge about haul-outs in the Wolstenholme Fjord system was collected from hunters in Qaanaaq (including people that used to live and hunt from Moriusaq), published and un-published source and aerial surveys (see Orbicon 2020d for details). This showed that in recent years walruses have mainly hauled-out in four areas (Figure 30). The closest of these is more than 10 km from the project area. It should be noted that this is mainly based on data from spring and early autumn while little or no information is available from the dark winter period. It is therefore possible that other locations are used in the dark period. Furthermore, if the amount and distribution of sea ice in the fjord changes in the future, it is possible that the haul-outs may also change and include sites closer to the Project area.

Based on available knowledge the following potential noise and visual disturbances of walrus are identified:

- Disturbance of feeding walruses can potentially be an issue if animals forage at the mussel bank just west of the Iterlak Delta (M3 in Figure 23) when mining activities in Year 10 take place on land app. 1 km away. However, this can be largely mitigated by organized the excavations in such a way, that activities close to the shore only takes place between July to mid-October when practically the entire Greenland walrus population is in Canadian waters.

- If ice conditions change in the fjord system in the future it cannot be ruled out that walruses will haul-out closer to the project and potentially be disturbed by mining activities on land. If this happens the mitigation mentioned above can be applied.

Shipping to and from the Project port will only take place in the ice-free period from early July to mid-October. During this period practically the entire Greenland walrus population is in Canadian waters. The tugboat at the project port will almost exclusively be used for berthing and unberthing ships during the open water season. Any significant visual or noise disturbance from shipping in connection with the project is therefore unlikely (but see Section 9.3.6.4 for an assessment of underwater noise from ships).

Figure 29 Walruses off Narssarssuk on 20 June 2018

Subsistence hunting is also a significant potential disturbance. There is a long tradition for hunting marine mammals among the communities that lived along the shores of the Wolstenholme Fjord system. But with the abandonment of the last permanent community at Moriusaq in 2010, the hunting pressure was reduced significantly. Hunters from Qaanaaq continued for some time to hunt mainly walruses in the Wolstenholme Fjord system, but in recent years this has also been given up because the distance (150 km by boat) is considered too long (Source: group of hunters including chairman of the hunter's association in 2017, pers. com). Marine mammals (walruses, whales and seals) are therefore not hunted regularly in the Wolstenholme Fjord system at present. However, the populations of these marine mammals are subject to significant hunting in other parts of Greenland and it cannot be ruled out that hunting in Wolstenholme Fjord will resume in the future.

With the walruses' present distribution in Wolstenholme Fjord noise and visual disturbance from the planned project activities are assessed as low. However, because of the uncertainties associated with potential walrus hunting in the fjord system in the future, and because changes in the fjords ice conditions in the coming years may cause walruses to prefer haul-outs closer to the Project area disturbance is conservatively assessed to be Medium.

9.3.6.2. Potential loss of food resources (mussel)

The area that will be affected by increased turbidity and sedimentation from the discharge of silt to the sea is limited to a narrow zone along the coastline (Figure 27 and 28). The impacted area has low density and biomass of mussels (Section 9.1.9, Orbicon 2020d).

An area just west of the Iterlak delta with high density and biomass of mussels (Figure 25) is the only significant potential feeding area for walruses close to the Project area (that is within 5-8 km). This mussel bank is outside the area modelled to be impacted by high turbidity or sedimentation from the discharge of silt (see Figure 27).

For this reason, it appears unlikely that the discharge of sediment to the sea will lead to significant loss of food resources for walrus.

9.3.6.3. Underwater noise from shipping

The Project will annually export around 440,000 tons ilmenite concentrate from mid-July to late October using bulk carriers. This corresponds to 11 ships per year. Other ships will provide the mine with supplies, fuel and spares during the same period of the year. In total, the Project port is expected to receive c. 14 ships per year.

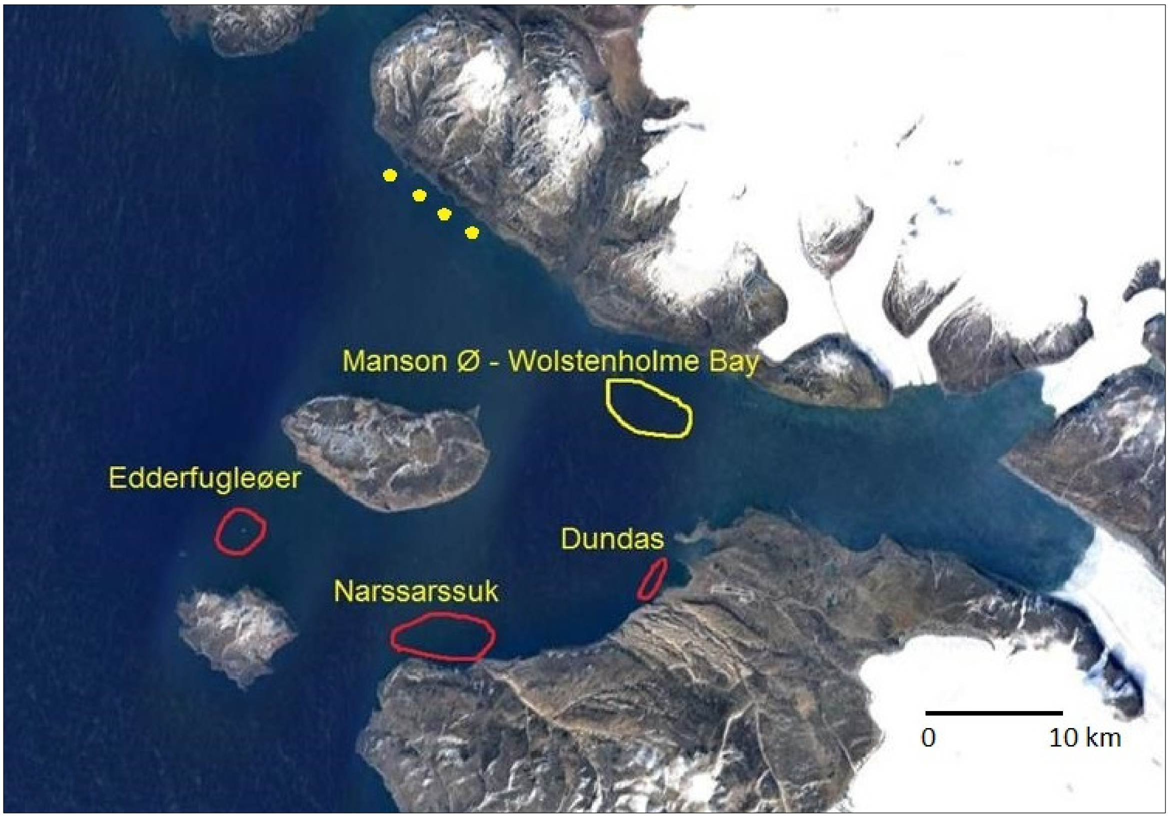


Figure 30 Locations where herds of walruses were observed in June 2017 and/or June 2018 (red polygons) and other locations where herds of walruses have been rerecorded regularly within the last 10 years (yellow polygon). The four planned discharge points are shown with yellow spots.

Underwater noise from ships can have undesired effects on marine mammals (and other organisms), and if the noise spectrum overlaps with the hearing sensitivity of a marine mammal, it can impact communication,navigation and change behaviour (see Orbicon 2020c for a more detailed discussion of this).

Shipping to and from the Project port will navigate the southwestern section of the North Water Polynya (NOW) (Section 9.1.2). The NOW is one of the most biologically productive marine areas in the Arctic. Persistent thin sea ice or open water during winter permits large numbers of marine mammals to overwinter, but as the sea ice surrounding the polynya breaks up and melts in spring, most of these mammals leave the area. In addition to the many marine mammals that winter in the NOW large numbers also migrates through the polynya is spring and autumn.

Due to their sensitivity to underwater noise from marine traffic, their high numbers in the NOW and off the Project area during certain periods of the year and their listing on the Greenland Red List of threatened animals, the following marine mammals are of particular concern when assessing the potential disturbance of shipping to the Project port (see Orbicon 2020c for more details):

- Walruses that spend the winter in NOW move towards the Greenland shores in spring, when the coastal sea ice begins to break up. Later, when the coastal sea ice melts away during May-June, the walruses leave Greenland waters, swim across the NOW and spend the summer in Canada. This means that hundreds of walruses migrate along the south coast of Steensby Land in May-June on their way to Canada.

- Narwhales from different wintering areas concentrate in the NOW in spring before moving into Inglefield Bredning, north of the Project area, in June, where they spend the summer. The narwhales return to the NOW from late September to early November. Only relatively few have been recorded from the fjords off the south coast of Steensby land and the majority probably migrates further offshore in central NOW.

- White whales (belugas) from different wintering areas meet in the NOW before continuing to Canadian High Arctic where they spend the summer. When returning in autumn, large numbers of white whales often migrate along the coasts of North-west Greenland with large pods recorded off Moriusaq in September – October.

Only few other marine mammals are present in the NOW or in the sea off the Project area during the planned shipping season (mid-July to the end of October). This mainly includes bearded and ringed seals, which are mostly associated with large floes of ice near to the coast i.e. outside the expected sailing routes. In addition, pods of harp seal arrive from the south, to spend the summer months feeding on fish in the polynya. Also, small numbers of minke whales have been recorded during the summer months in recent years.

Underwater noise from shipping is linked to speed, with higher speed generally generating higher noise levels (see Orbicon 2020c for a more detailed discussion of this). However, traveling slower will cause a ship to spend more time in an area, potentially leading to a longer disturbance of marine mammals. By calculating the cumulative Sound Exposure Level (SEL) or the integration of the noise over a specific duration it is possible to take this into account and to also calculate the speed to obtain the maximum net reduction in SEL for a given ship

Available data does not permit this for the bulk carriers that will call at the Project port (or other ships arriving to the port). However, another study has found the largest reduction in cumulative sound exposure (for a container ship) is when traveling at 8 knots (see Orbicon 2020c). Although the operational speed for a bulk carrier is slower that for container ships it is recommended to use the same speed reduction until data on the source level of ships approaching the project port is available (see Monitoring program Section 15.3).

Reduced speed also decreases noise disturbance of other marine mammals, including walruses and seals and reduces the risk of collisions between ships and whales, although this is not generally considered a significant problem with fast moving tooted whales such as narwhals and white whales.

To reduce the disturbance of migrating marine mammals, the vessel slowdown to 8 knots must apply to all ships calling at the Project port and must stay in effect from entering the North Water Polynya to the Project port, that is the northernmost c. 150 km of the planned shipping route. When passing through the same area ships should only use echo sounders of a frequency above 150 kHz, in which case they are inaudible to marine life in the area.

About 17-25 ships pass through the eastern section of the North Water Polynya (NOW) annually (Orbicon 2020c). The majority are calling at Thule Air Base (9-12 ships) while others are Royal Arctic Line serving Qaanaaq (2), cruise ships, the Royal Danish Navy, research vessels and tankers providing fuel to Qaanaaq and other small towns (Orbicon 2020c). Shipping to the Project port will increase the number of vessels in the eastern section of the NOW by 56-82%. However, the cumulative impact will be less because the ships to the Project will travel with reduced speed. With this mitigation in place the underwater noise disturbance of marine mammals is assessed to be Low.

Figure 31 Pod of migrating white whales near Moriusaq in late September 2018

9.4. Assessment of impacts - contamination

9.4.1 Contamination of the sea due to discharge of excess water

Two streams of excess water will be pumped to the fjord:

- Saltwater used in the wet concentrator plant; and
- Sewage from the camps.

Discharge of saltwater from the concentrator plant
The saltwater used in the wet plant to melt and wash the mined material will be mixed with excess silt material and disposed of in the sea via pipeline. No chemical additives will be used in the process circuit.

To determine if the seawater after being used to wash the excavated material could be enriched in metals and have obtained concentrations that could pose a risk to marine life a series of simulations were carried out (shake flask tests). In these tests, material from different drill holes were mixed with saltwater and subsequently analysed.

The shake flask study showed that the contents of metals (natural background levels in local seawater plus metals released from some samples of excavated material) could exceed the limits set by the Greenlandic and European Guidelines in a small area near the discharge point (see Table 5 in Orbicon 2020e).

Because particularly high concentrations of copper, barium and zinc occur naturally in some parts of the mined area, material from locations can cause the concentrations of these metals in the discharged water to exceed the guideline limits in a larger area outside the mixing zone (see Orbicon 2020e for details).

This area will correspond to the area with high turbidity (Figure 27) and heavy deposition of discharge material (Figure 28). Increased concentration of copper, barium and zinc will be an additional stressor to the benthic flora and fauna on top of the impacts from turbidity and sedimentation. The heavy metals may also persist in the local environment, and potentially reduce the speed of recovery of the seabed flora and fauna.

The ongoing monitoring of the concentration of metals in the discharged water during the operational phase (see Section 15) will immediately detect if the water contains significantly elevated concentration of copper, barium and zinc. If the concentration of these heavy metals is approaching the Greenlandic and European Guideline limits, mitigation measures must be implemented. This includes one or several of the following actions:

- Stop extracting from sites where the natural heavy metal concentration is very high; and
- Remove the metals before the water is discharged to the sea.

Sewage from the camps
Sewage from all buildings will be treated in the sewage treatment plant before the effluent is discharged to the sea.

Overall, the discharge of water from the project to the sea is assessed to potentially have Medium impact on marine life.

9.4.2 Contamination of the sea due to a tanker accident or oils spills when unloading

During the construction, operational and closure phases approximately 56,000 m^3 of fuel will arrive to the port site each year in tankers. An unloading accident or a major shipping accident, such as a tanker collision or grounding could give rise to major spills of oil. Due to tidal currents in the fjords, oil leaked to the marine environment will be transported over long distances quickly. Other hazardous materials such as grease, paints and chemicals will also be shipped to the project port but in much smaller quantities.

9.4.2.1. Consequences of marine oil spill

Potential impacts of marine oil spills include marine and shoreline fouling. The consequences to the marine life, including birds, may be significant. In particular birds are extremely vulnerable to oil spills. Most fatalities typically result from the oiling of a bird's plumage, but many birds also die from intoxication. Several large bird colonies are located near the shipping routes to the Port and the birds breeding in these colonies are vulnerable to marine oil spills since they feed on fish and small crustaceans. Marine mammals are generally less sensitive to oiling. Furthermore, tanker will mainly call at the Project port in the summer, which is outside the periods of the year where the largest numbers of whales and walruses are present in the sea off the Project area.

9.4.2.2. Mitigation

To reduce the risk of operational spills of fuel and other hazardous materials in the sea and in the port the following mitigating measures must be implemented:

- Follow recommendations in Navigational Safety Survey;

- Proper procedures for loading and unloading ships must be in place;
- Properly dimensioned equipment for combating operational spills must be available, including containment booms available for berthed ships;
- It is also essential to have contingency plans and procedures for detecting and combating operational spills in place, including procedures for operational spills in sea ice; and
- Regular training must take place to ensure readiness for emergency responses. Planning must include winter and summer response procedures and training.

9.4.2.3. Assessment of marine oil spills

Shipping to and from the Port creates potential hazards. These hazards are, however, not different from other shipping routes in Arctic coastal areas, including routes to other Greenlandic towns and settlements.

Most spills from tankers result from routine operations in connection with loading, discharging and bunkering. This type of operations spill is typically small and localized. The impact on marine life will be local and can be removed using the oil spill combat equipment available at the Port.

If all maritime regulations are followed, proper oil spill combat equipment is in place at the port and staffs is well-trained in response procedures during summer and winter, the likelihood of a significant oil spill occurring during shipping or unloading is very low.

9.4.3 Contamination of land areas due to oil spills

During the construction phase 95,000 litre Enviro tanks will be used to storage 2,000,000 litre of diesel fuel. The diesel fuel storage during the operational phase will consist of four tanks (total capacity 32,500 m^3). Smaller fuel storage tanks are also located in the mine area. Jet fuel will be stored in Enviro tanks.

During the operational phase fuel arriving to the port will be pumped from the tankers through pipelines to the storage tank farm. All fuel storage tanks will have geotextile containment berms that can contain a full spill in case of total tank rupture. The containment berms eliminate the potential spread of an oil spill from the tank farm.

9.4.3.1. Consequences of oil spills on land and in freshwater

Most spills on land are much smaller than a shipping accident. However, although the effects of an oil spill on land will likely be smaller and more localised, the consequences for the vegetation can be long lasting, stretching into decades. This is because oil is toxic to plants and Arctic flora has very slow growth rates. Because spills on land typically affect small areas only, it will normally be easy to prevent terrestrial mammals and birds from being exposed to the spills.

Spills into freshwater can cause an impact on the diversity and abundance of invertebrates and plants in steams and ponds on the coastal plains (but not freshwater fish which have not been recorded from the Project area). Since most oil spills are usually small the impact will mostly be small. The impact will potentially be worst in summer when running melting and rainwater can disperse a spill.

9.4.3.2. Mitigation

To reduce the risk of operational spills of fuel on land and into freshwater bodies the following mitigating measures must be implemented:

- Impose strict speed limits to reduce the risk of traffic accidents involving fuel tankers and avoid road transport when weather conditions are difficult (slippery roads); and

- Introduce strict procedures for handling of oil and equipment to minimize any oil spill impact.

9.4.3.3. Assessment of oil spills on land and into freshwater

The areas of the highest spill probability are at the mine site when mobile equipment (mine trucks, excavators, etc.) are refuelled. The causes can be human failures, malfunctions of valves, rupture of hoses, etc. The consequences are much lower, as the quantities of spilled oil in such an event are usually smaller.

Due to the limited fuel storage the likelihood of a major accidental oil spill occurring on land or into local freshwater resources are low.

9.4.4 Introduction of invasive non-indigenous species

Vessels berthing at the Project port will discharge ballast water before loading cargo. The ballast water can contain non-indigenous species that could potentially establish themselves in Greenland waters. When introduced in new areas, these species could thrive and become a threat to indigenous species and the local ecosystem.

The BWM Convention aims to prevent the potentially devastating effects of spreading harmful aquatic organisms carried by ships' ballast water. The BWM requires all ships to implement a Ballast Water and Sediments Management Plan. All ships are required to carry out ballast water management procedures to a given standard. To minimize a potential introduction of non-indigenous species, the mine company require all skips that berth at the port to follow the regulations of the BWM Convention.

Provided vessels that call in at the Project port follow the BWM regulations, the risk of introducing invasive non-indigenous species with ballast water is unlikely.

10. LOCAL USE

10.1.1 Existing environment

Moriusaq is the only settlement on the Steensby Land peninsula but was abandoned in 2010. Around 20 buildings are still left, and a few are occasionally used briefly by the owners, mostly people from Qaanaaq.

Qaanaaq, with around 640 inhabitants, is the closest settlement to the proposed mine. The distance to the Project area by boat is c. 135 km. Hunting and whaling is the traditional trades and mainly includes seals (bearded and ringed seals), narwhales, walruses and sea birds. Occasional hunting of caribou at Olrik Fjord and musk oxen at Cape Atholl close to Thule Air Base also take place. Less important are white whales. A few Minke whales have been shot in recent years.

During winter and spring traditional subsistence harvest of walrus mainly takes place in the northern part of NOW (to the north of Qaanaaq) (Egevang 2015). Years ago, walruses were also hunted off the Project area near Manson Islands along the south coast of Steensby Land. This area is no longer used, primarily because it is so far away from the Qaanaaq (local hunter’s pers. com)

In June most walruses leave the eastern NOW coasts to move to feeding areas along the Canadian side of the NOW. Walruses belonging to the NOW population are protected from hunting between 1th July and 1th October.

Smaller seals are mostly hunted in the fjords close to Qaanaaq. Traditional subsistence harvest of narwhales mainly takes place in Inglefield Bredning east of Qaanaaq (Egevang 2015), where large numbers concentrate in the eastern part of the fjord from May to October.

Subsistence harvesting of birds mainly include Brünnich's guillemot, little auk and eider duck. These birds are only present in the Qaanaaq area during summer.

In recent years halibut fishing has become the most important income for the around 100 hunters/fishermen, that live in Qaanaaq. The halibut fishing mainly takes place during winter through holes in the ice. The most important fishing areas are east of Qaanaaq, especially near Qeqertat, 60 km east of Qaanaaq in the bottom of Inglefield Bredning (see Figure 5).

10.1.2 Restrictions in local use

For security reasons hiking on the mine roads, in the mine area and in a zone around the various Project facilities will not be permitted for the public. The effect of these restrictions will be low, as there has been no or only very limited traditional use of natural resources in the land area around Moriusaq since it was abandoned in 2010.

Except for the Project port, the marine area off the Project area will remain open for subsistence harvest and recreational use.

11. ARCHAEOLOGY AND CULTURAL HERITAGE

An archaeological survey of the license area was conducted by the Greenland National Museum & Archives in 2018 (Greenland National Museum & Archives. 2018). Among the prehistoric finds that were made, eight are within the Project area. These are:

- Site MRQ087 - c. 2 km northwest of Moriusaq village. This settlement consists of several winter house ruins spanning several phases of occupation. The latest phase of occupation has left five very well-preserved winter houses with complete stone wall and roofing structures, partly built with large whale bones.
- Site MRQ062 - on the coast c. 3.5 km south-east of Moriusaq. This is a Late Dorset dwelling ruin.
- Site MRQ055 - on the coast c. 1 km to the south-east of MRQ062. This is a tent ring (of stones) with a mid-passage feature
- Site MRQ040 – tent ring with mid-passage feature
- Site MRQ043 - tent ring with mid-passage feature

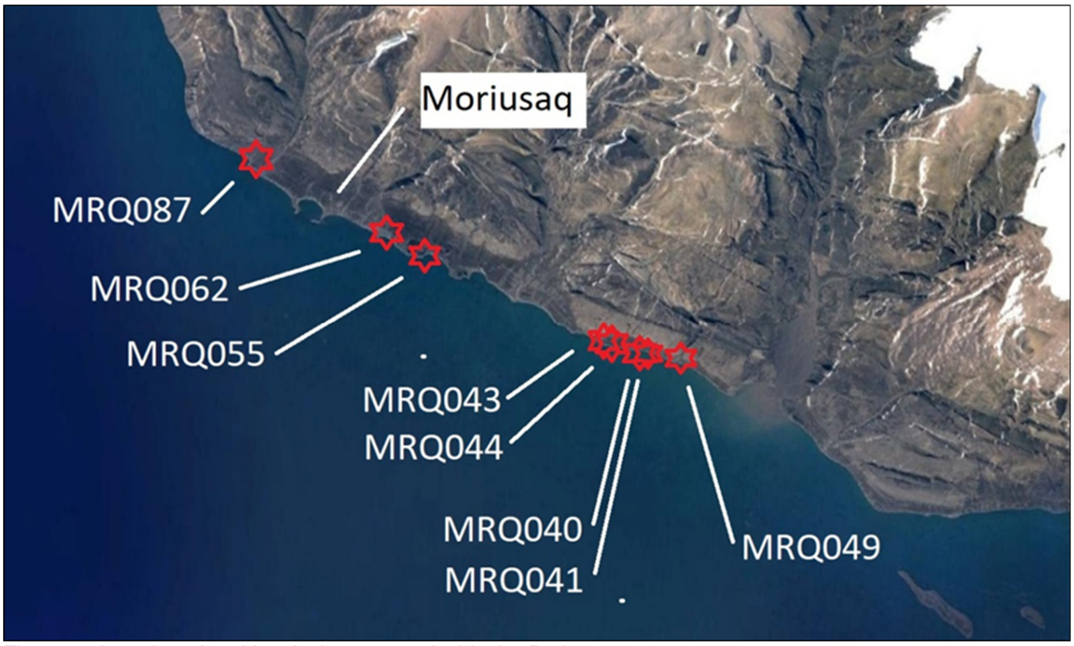


Figure 32 Location of prehistorical structures inside the Project area

- Site MRQ041 - tent ring with mid-passage feature
- Site MRQ044 - tent ring with mid-passage feature
- Site MRQ049 – three tent rings from early phase of the Thule Culture

Site MRQ087 is located at the northern border of the Project area (Figure 32 and 33). To avoid damage of this important ruin complex, this area will not be mined. Instead the site will be fenced off to avoid machinery from accidentally damage the ruins.

Site MRQ055 and MRQ062 are located on the beach close to where the planned Project port will be constructed (Figure 32). Because of the risk for damage, the mine company will ask Greenland National Museum & Archives to carry out further archaeological investigations to document the sites in more detail and, if necessary, recover objects made or modified by humans, before construction works commence.

Site MRQ040, MRQ041, MRQ043, MRQ044 and MRQ049 are situated southeast of the planned Project port and main camp, in an area which is planned to be mined in Year 10 (Figure 32). Two years before mining will commence in this part of the Project area, the mine company will ask Greenland National Museum & Archives to also carry out further archaeological investigations of the five sites.


Figure 33 One of the house ruins that are part of MRQ087 (Photo: Mikkel Myrup)

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13. APPENDIX 1 – ENVIRONMENTAL MANAGEMENT PLAN

Conceptual
Environmental Management Plan

13.1. Introduction

The Environmental Management Plans (EMP) for a mine project describes how the mining company intends to manage the environmental issues identified in the EIA. The EMP also identifies who is responsible for each commitment.

13.2. Dundas Environmental Management Plan

The Dundas Environmental Management Plan (EMP) will be prepared before construction works commence at site. It will include commitments and management measures that the mining company will implement to ensure the project risks are managed to an acceptable level.

The EMP will outline the management objectives under each environmental aspect identified in the EIA, the potential impacts to the environment, the mitigation measures for each impact, who is responsible for each commitment as well as the applicable Construction, Operational or Closure Phase for which management is required. The commitments outlined in the EMP aim to provide a basis for which environmental performance and compliance can be measured throughout the Project.

The EMP and work procedures will be periodically reviewed and updated over the life of the mine and continuously improved based on the results of the monitoring program. Environmental management commitments detailed in the EMP will be included in relevant contract documents and technical specifications prepared for the Project. All the mine company's employees, contractors and other personnel employed on the Project will be made aware of the EMP through the site induction process. During all phases of the Project, compliance with environmental management measures will be regularly monitored, any non-compliances addressed, and improvement actions will be implemented.

The EMP presented below is a framework which consists of the following key elements:

- A management program that specifies the activities to be performed in order to minimize disturbance of the natural environment and prevent or minimize all forms of pollution.
- A definition of the roles, responsibilities and authority to implement the management program.

The EMP is tabulated in spreadsheets below, which are laid out with the following divisions:

- Project activity – the activity associated with the mining project which has been identified to pose a potential impact or risk to the environment.
- Environmental impact – description of the negative impact of the activity (such as pollution or disturbance of natural environment);
- Action – the mitigating measure or actions identified to prevent or minimize the adverse environmental impact; and
- Responsibility – party/ies responsible for ensuring the action, measure, or principle is done.

Initial responsibility for meeting some of the management commitments in the tables will be transferred to the mine company's contractors. Dundas Mining will commit the contractors to meeting the relevant management responsibilities. This will be done by developing a code of responsible environmental practice that will be included in tender documents and contracts. Dundas Mining will fully recognize that it is not absolved from those management responsibilities. Ultimate responsibility for meeting all commitments in this section lies with the mine company. In most cases the person (or persons) assigned responsibility for a certain commitment is seen as the driver of the requirement. This will typically be the Resident Mine Manager and/or the company Environmental Manager.

Some of the environmental commitments include a whole range of linked actions and will therefore be combined into specific plans:

- Plan for safe handling of oil, which describes the company's procedure for safe handling of oil in the port, during transport with tankers, when filling in the camp and in the mining area, etc. A proposal for such a plan will be prepared by the mining company before project start and presented to the authorities.
- Contingency plan for handling oil spill in the sea, on land and in fresh water. This plan describes the workflows for combating different types of oil spills, both in summer and winter. The plan also describes the combat equipment that must be present in the harbor as well as the equipment that should be available in case of land or freshwater spillage. A proposal for the plan will be prepared by the mining company before the start of the project and submitted to the authorities.

13.3. Dundas Mining's Environmental Management System

Before mine start, Dundas Mining is committed to also developing and implementing an Environmental Management System (EMS) consistent with the International Organization of Standardization's ISO 14001 guidelines for managing the EMS. The purpose is to formalize procedures for managing and reducing environmental impacts from the Dundas Ilmenite project. The EMS will assist the company to maintain compliance with Greenland's environmental regulations, lower environmental impacts, reduce risks, develop indicators of impact and improve environmental performance. The ISO 14001 (2015) is based on the methodology known as Plan-Do-Check-Act (PDCA):

- **Plan**: establish the objectives and processes necessary to deliver results in accordance with the organization's environmental policy.
- **Do**: implement the processes.
- **Check**: monitor and measure processes against environmental policy, objectives, targets, legal and other requirements, and report the results.
- **Act**: take actions to continually improve performance of the environmental management system.

The EMS will ensure that the environmental obligations associated with the Dundas Ilmenite Project are adequately managed in a manner that is planned, controlled, monitored, recorded and audited. Environmental incidents will be reported, investigated, analysed and documented. Information gathered from the incident investigations will be analysed to monitor trends and to develop prevention programs, which include corrective and preventative actions taken to eliminate the causes of incidents. All employees, contractors and sub-contractors will be required to adhere to the EMS and the non-conformance and corrective action system in place at the project site.

Ref no.	Project activity	Environmental impact	Action	Responsibility
7.3.1	Extraction of building material and mining	Aesthetic impact	Plan the extraction of material to blend as far as practical with the surrounding landscape	Mine Manager / Environmental Manager
7.3.2	Construction activities could cause erosion	Loss of soil, sand and gravel by the forces of water	Take erosion into account when selecting construction methods and routing of the alignments	Mine Manager / Environmental Manager
8.3.1	Excavation and haulage generate dust	Potential pollution of land and water	Plan construction works and mining activities to minimize dust generation	Mine Manager / Environmental Manager
8.3.2	Mobile equipment and stationary power generation produces gaseous emissions	Increased air emissions	Limit the amount of fuel combusted as much as practical possible and use BAT equipment	Mine Manager / Environmental Manager
8.3.3	Mobile equipment and stationary power generation generate greenhouse gasses	Climate change	Limit amount of fuel combusted as much as practical possible	Mine Manager / Environmental Manager
9.3.1	Re-profiling to accommodate buildings and mining activities	Loss of terrestrial habitat	Minimize the area to be disturbed by planning infrastructure to have as small a footprint as possible	Mine Manager / Environmental Manager
9.3.2	Noise and visual disturbances from personnel and machinery	Disturbance of terrestrial mammals and birds	Restrict the movement of staff members outside the construction and mining areas	Mine Manager / Environmental Manager
9.3.3	Construction of beams and diversion channels	Disturbance of freshwater organisms	Minimise the disturbance of the water and restore natural hydrology as quickly as practically possible	Mine Manager / Environmental Manager
9.3.4	Discharge of silt to ocean	Disturbance of benthic fauna and flora	Ensure that monitoring of the impact of sedimentation on the sea floor is monitored regularly	Mine Manager / Environmental Manager

9.3.5	People could visit nearby island. Shipping could pass close to islands	Disturbance of seabirds	Ban access to islands with bird colonies and ensure shipping route to port is at least 5 km from colonies on Saunders Island	Mine Manager / Environmental Manager
9.3.6.1	Mining activities close to the shore	Disturbance of marine mammals	If this assessed to be a problem, limit mining activity near the coast to mid-July to mid-October	Mine Manager / Environmental Manager
9.3.6.2	Discharge of silt to ocean	Loss of food resources for walrus	Analyse the data from the monitoring of walrus distribution to determine if the discharge of sediment might impact feeding banks	Mine Manager / Environmental Manager
9.3.6.3	Shipping generates underwater noise	Disturbance of marine mammals	Reduce shipping speed through NOW in shoulder periods	Mine Manager / Environmental Manager
9.4.1	Discharge of water from mining operations to ocean	Pollution of marine environment	Ensure that results of analyses of discharged water show no content of polluting elements and that guideline limits for heavy metals are not exceeded	Mine Manager / Environmental Manager
9.4.2	Accidents can lead to spill of oil and hazardous materials	Pollution of marine environment	Ensure that all arriving skips follow recommendations in Navigational Safety Survey. Ensure that the plan for safe handling of oil is followed. Ensure that contingency plan is well known to the responsible, that combat equipment is available and that efficient combat readiness is trained summer and winter	Mine Manager / Environmental Manager
9.4.3	Accidents can lead to spill of oil and hazardous materials	Pollution of land areas and freshwater habitats	Ensure that contingency plan and equipment is available, and use is trained	Mine Manager / Environmental Manager
9.4.4	Discharge of ballast water in Greenlandic waters	Introduction of invasive alien species with ballast water	Ensure that arriving skips regulations of the International Convention for the Control and Management of Ships' ballast water and Sediments	Mine Manager / Environmental Manager

11	Construction works along coast and mining	Disturbance of heritage sites	Contact staff members of the Greenland National Museum and Archives	Mine Manager / Environmental Manager
14	The mining activities require that the plant cover is removed	Because of low temperatures and short growing season, it will take very long for the vegetation to recover.	Ensure that re-vegetation study program is initiated and that the results are used	Mine Manager / Environmental Manager
15	Implementation of Monitoring plan	-	Ensure that all activities included in the Monitoring program are carried out as agreed with the Greenlandic authorities and that the data are used in the environmental management	Mine Manager / Environmental Manager

Table 15. Draft Environmental Management Plan for the Dundas Titanium Project

14. APPENDIX 2 – CLOSURE AND DECOMMISSIONING PLAN

Conceptual
Closure and Decommissioning Plan

14.1. Introduction

The Closure Phase is an integral part of a mining project and the environmental management of the project. This part of the EIA summarizes the legal framework for project closure and describes broadly how each individual project component will be decommissioned.

14.2. Closure obligations

The Mineral Resources Act of 2009 (amended in 2012, 2014 and 2016) specifies that a Closure Plan shall be prepared and approved before exploitation begins (Part 10, section 43).

In the Act it is stipulated that: "*the licensee must submit a plan for steps to be taken on cessation of activities in respect of facilities, etc. established by the licensee, and how the affected areas will be left (closure plan). If the licensee plans to leave facilities, etc. in the area that for environmental, health or safety reasons will require maintenance or other measures after the closure, the closure plan must include plans for the maintenance or the measures and monitoring thereof*".

14.3. The Dundas Titanium's Closure and Reclamation Plan

This draft closure plan is based on the current mine configuration and production rates and that the mining operations will cease after 10 years of operation, at which stage mine closure activities will commence. However, temporary suspension and possibly premature closure may be required if the operations are no longer viable due to a change in Project economics or other difficulties.

Since the plan is prepared before the mine is constructed it contains broadly identified tasks of the closure works and will be refined and expanded before the closure date for the mining and processing operations.

The plan covers the Closure Phase, which is estimated to take approximately 1 year. During this phase the decommissioning of equipment, buildings and other structures will take place.

Post-closure follows decommissioning and rehabilitation and is the phase during which monitoring continues. During this phase, no active care will be required except the occasional maintenance of the gravel roads to the mine facilities. Post-closure is managed through a monitoring plan and with liaison with the authorities. Towards the end of the life of the Project, the post closure objectives will be refined to accommodate the site conditions prevailing at the time.

14.4. Purpose and Scope of the Closure and Reclamation Plan

The overall closure and reclamation goal are to return the mine site and affected areas to viable and self-sustained ecosystems.

In order to achieve this, the following core closure principles will be followed:

- *Physical Stability* – All project components that remain after closure will be physically stable to wildlife and vegetation;
- *No Long-Term Active Care* – Any project component that remains after closure will not require long-term active care and maintenance.

14.5. Closure implementation

The closure works e.g. how each individual project component will be decommissioned is broadly described below. As mentioned above, this conceptual plan is prepared before mine operations have started, and the plan will be expanded and refined during the Operational Phase.

14.5.1 Open pit mine workings

Except for the silt fraction, all mine rejects will be returned to the open pit void in each mine blocks, where the material will be re-work and compacted by dozers to have a top of material grade of c. 1% slope towards beach. When backfilling is completed the dozers will gently push the soil back and distribute it evenly over the mined area.

14.5.1.1. Mine infrastructure

This includes the on-site roads, electrical power supply system, the air strip, culverts and the port.

The haul roads will be reclaimed as soon as the mining operations no longer require them. The roads are ripped to encourage re-vegetation (see below). Any culverts that could act as hydraulic conduits at closure are removed. A road connecting the Project port with the mined blocks is left intact to facilitate future inspections and monitoring activities (if agreed with the Greenland authorities). The Project port will be left as constructed (if agreed with the Greenland authorities).

14.5.2 Buildings and equipment

This includes the following main structures: service buildings, accommodation complex, storage building, processing plants, power generation plant, fuel tanks, mobile equipment and pipelines. All buildings and major structures will be dismantled and removed. Foundations will be removed where possible or covered by natural materials to blend into the natural surroundings.

14.5.2.1. Re-vegetation study program for mined areas and areas covered by mine facilities

A re-vegetation study program must be initiated as soon as mining activities is completed in an area. The study program should consider if natural re-vegetation is the best way to restore the natural vegetation or active re-vegetation activities such as spreading seeds, planting or the use of fertilizer in designated plots should be tested. It should be considered to carry out such test work in cooperation with the Greenland agricultural research center, Upernaviarsuk.

When backfilling and shaping the landscape depressions must be created to allow fens, bogs and shallow lakes to be restored.

It should also be considered if the removal of silt from the material that is returned to the mined areas and the higher content of salt this material will have after being washed in seawater in the wet plant could have an impact on the reestablished vegetation, for example by favoring plants that are more tolerant to salt content in the soil. If this proves to be the case, mitigating measures should be considered for example, by permitting freshwater from melting snow further inland to flow over the mined area for some time before the soil layer is laid back.

In addition to knowledge from other closed mines in the Arctic, the study program must be developed on feedback from the monitoring program that must also start as soon as the mining activities have been completed in an area and the soil layer has been pushed back (Section 15).

15. APPENDIX 3 – ENVIRONMENTAL MONITORING PLAN

Conceptual Environmental Monitoring Program

15.1. Introduction

Dundas Titanium will develop and implement an Environmental Monitoring Program (EMP) in accordance with the Greenlandic guidelines to monitor the predicted residual effects of the Dundas Ilmenite Project and the effectiveness of implemented mitigation measures. The EMP will encompass all phases of the project (construction, operation, closure and post-closure) and identify any variances from predictions that occur and whether such variances require action, including any additional mitigation measures.

15.2. Content of Environmental Monitoring Program

The Dundas EMP will be a best practice approach comprising sampling of water, air, soil, lichens, plants, mussels, seaweed and fish from numerous locations in and around the mine site. The monitoring results will be submitted to regulatory authorities for review.

The monitoring program will comprise of the following key-elements:

1. Marine and Terrestrial Biota and Soil Monitoring.
2. Excess Water Monitoring.
3. Marine Mammals Monitoring.
4. Hydrology Monitoring.
5. Meteorological Monitoring.

The EMP will be developed and updated throughout the mine life.

15.3. Conceptual Monitoring Program

Prior to project operations, a more detailed study design will be developed for each of the EMP's elements. This will be done in cooperation with the Greenland authorities.

Below are descriptions of the proposed approach for each element of the EMP. In addition to the studies outlined below, supplementary studies may be conducted for specific, well-defined objectives and are not expected to continue throughout the program.

15.3.1 Marine, Freshwater and Terrestrial Biota Monitoring

To establish background concentrations of metals in marine, freshwater and terrestrial habitats, samples of fish in the sea (Short-spined sea scorpion), mussels, sea weed, lichens, leaves of two plant species and soil have been collected in 2016, 2017 and 2018 from four stations along the coast and from a reference area on Saunders Island.

Monitoring will continue at these locations and include the same sample species and types. The results of the monitoring are compared to baseline values to determine if there is a change as a result of mine activities.

15.3.2 Excess Water Monitoring

Monitoring of the excess water discharged to the sea will continue during all phases of the mine project to ensure that the process water is not enriched by heavy metals during the washing in the wet concentrator.

The sampling frequency, reporting requirements, parameters to be monitored will be defined both for field monitoring activities and laboratory activities in cooperation with the Greenlandic authorities.

15.3.3 Dust monitoring

Dust dispersal and deposition on vegetation along haul roads and the active mine area will be monitored to determine if this is a significant problem that require dust control activities (such as spraying of water on the roads during summer). Dust samples must also be analysed for metal content.

The monitoring activities, sampling frequency and reporting requirements will be defined in cooperation with the Greenlandic authorities.

15.3.4 Marine Mammal Survey

Further data on the timing and magnitude of marine mammal movements in the area will be carried out using SoundTraps or similar acoustic dataloggers.. This will be combined with data collection of shipping noise. Experts on underwater noise monitoring will be consulted when the noise monitoring program is developed.

This monitoring activity will be designed to collect information on noise from all ships in the area (not just vessels calling in at the Project port) and this could make it possible to further refine the speed restrictions.

Additional aerial surveys of walrus will be carried out in the Wolstenholme Fjord system in spring. The surveys will follow the same survey method as in 2017-2018 and described in Orbicon 2020b. This will provide more information on the spatial, temporal and numerical changes in the walrus population in the area and establish a firmer baseline.

This information will be important when determining if mining activities in the western sections of the mine area could disturb walruses at the known shallow banks off the coast with high density of the preferred mussels.

The extent of this monitoring and reporting requirements will be defined in cooperation with the Greenlandic authorities.

15.3.5 Hydrology Monitoring

Surface water flow monitoring will be continued at the established stations to monitor seasonal and annual flow patterns.

Annual surveys will be conducted of the blocks where mining has been completed to ensure that the hydrology including the natural run-off has been restored.

15.3.6 Meteorological Monitoring

Collection of meteorological data will continue during the Construction, Operational and Closure Phases at an established weather station next to the main camp.

The Meteorological Monitoring reporting will include a summary of the measured parameters, including temperature, precipitation and wind.

15.3.7 Monitoring of the re-establishment of natural vegetation is the mined areas

A program must be set up to monitor how natural vegetation re-establish itself in the areas where mine activities have been completed and the soil layer restored. This monitoring will feed into the development of the active re-vegetation that is developed as part of the closure plan (Section 14.5.2.1).

15.3.8 Framework for the monitoring parameters and sampling locations

Table 16 below show a framework for the monitoring parameters and sampling locations proposed.

Monitoring aspect	Sites/activities to be monitored	Parameter to be monitored	Frequency	Duration	Assessment criteria	Reporting
Marine fish, mussels and seaweed	Short-spined sea scorpion, mussels and seaweed at baseline stations	Metals	Annually (August)	Construction, operational and closure	To be defined in cooperation with EAMRA	Annual Monitoring Report
Lichens and terrestrial plants	Lichens and plants at Baseline stations	Metals	Annually (August)	Construction, operational and closure phases	To be defined in cooperation with EAMRA	Annual Monitoring Report
Freshwater and soil	Soil and freshwater at Baseline stations and reference station	Metals	Annually (August)	Construction, operational and closure phases	To be defined in cooperation with EAMRA	Annual Monitoring Report
Excess water discharged to the sea	To be defined in cooperation with EAMRA	Heavy metals including copper, barium and zinc and suspended matter	To be defined in cooperation with EAMRA	Operational phase	To be defined in cooperation with EAMRA	Weekly
Sedimentation of silt on sea floor	Silt deposition around discharge point	Distribution and thickness of silt layer	To be defined in cooperation with EAMRA	Operational phase	To be defined in cooperation with EAMRA	Ad hoc
Dust deposition on vegetation	To be defined in cooperation with EAMRA	Amount of dust on leaves Metal content in dust	To be defined in cooperation with EAMRA	Construction, operational and closure phases	To be defined in cooperation with EAMRA	Annual Monitoring Report

Re-growth of vegetation in mined areas	To be defined in cooperation with EAMRA	Plant cover, species diversity etc.	Annually (July-August)	Operational and closure phases	To be defined in cooperation with EAMRA	Annual Monitoring Report
Marine mammals and ships	Cetacean and porpoise detectors (C-PODs) deployed in the sea off license area	Number and species of whales	Spring and autumn	Construction, operational phases	To be defined in cooperation with EAMRA	Annual Monitoring Report
Walrus	Aerial survey of Wolstenholme Fjord system	Spatial, temporal and numerical distribution	Spring (June)	To be agreed with the authorities	To be defined in cooperation with EAMRA	Annual Monitoring Report
Hydrology	Mine blocks where mining has been completed	Location of ponds, streams and water run off	Annually (August)	During operational and closure phases	To be defined in cooperation with EAMRA	Annual Monitoring Report
Local climate	Weather station at Main camp	Temperature, precipitation and wind speed and direction	Continual	Life of mine	-	Annual Monitoring Report

Table 16. Conceptual monitoring program