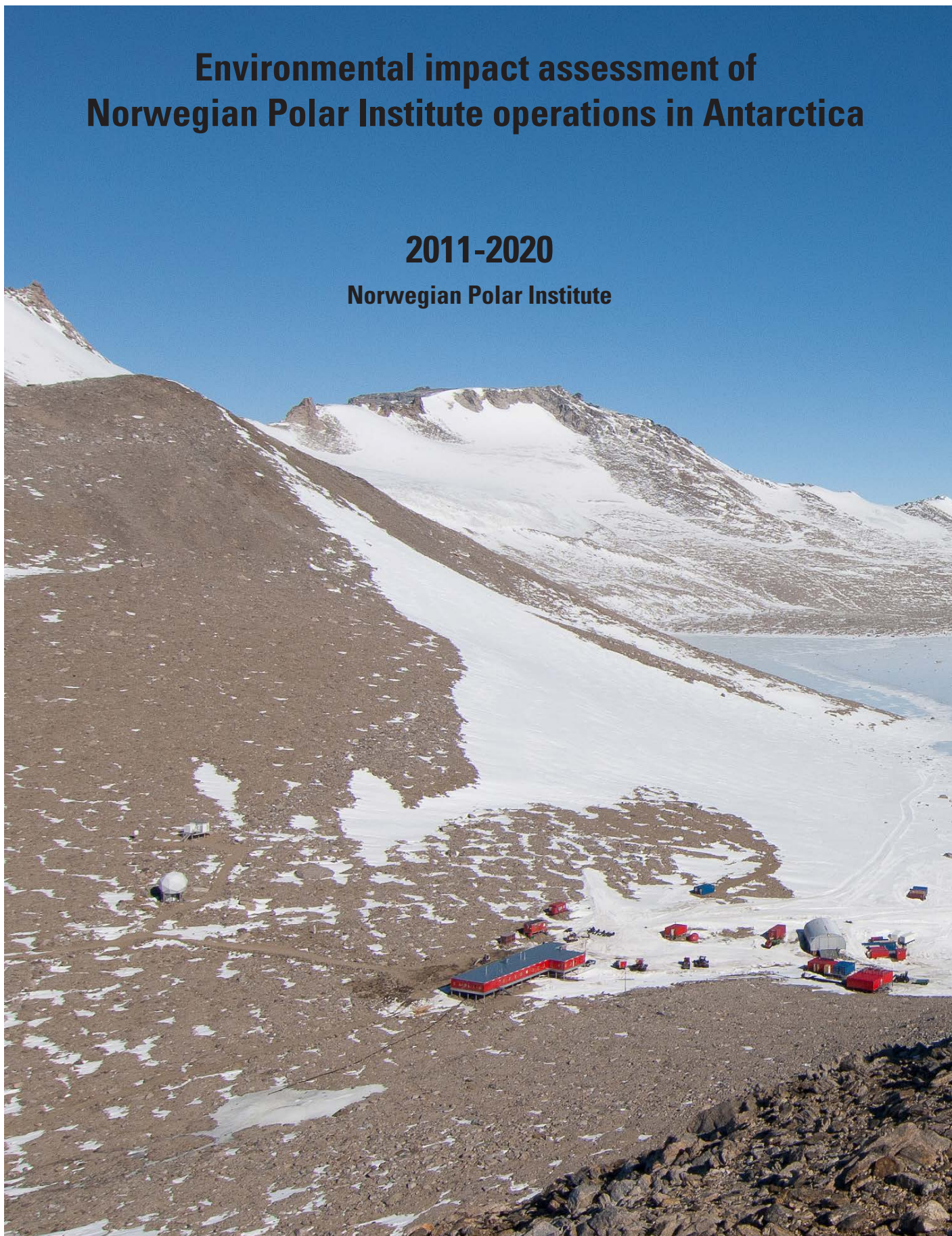


Environmental impact assessment of Norwegian Polar Institute operations in Antarctica

2011-2020

Norwegian Polar Institute





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Norwegian Polar Institute

The Norwegian Polar Institute is Norway's main institution for research, monitoring and topographic mapping in Norwegian polar regions. The Institute also advises Norwegian authorities on matters concerning polar environmental management.

Norsk Polarinstitutt er Norges sentralinstitusjon for kartlegging, miljøovervåking og forvaltningsrettet forskning i Arktis og Antarktis. Instituttet er faglig og strategisk rådgiver i miljøvernaker i disse områdene og har forvaltningsmyndighet i norsk del av Antarktis.

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Troll Station

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PREFACE

The following document is a documentation and assessment of Norwegian Polar Institute's operations in Antarctica 2011-2020. It describes the logistical activities associated with the Norwegian Antarctic Research Expeditions (NARE) in respect of their potential impact on the Antarctic environment, including measures to reduce these impacts.

The activities described comprises vessel operations, aircraft and helicopter operations, shelf and traverse operations, field camps, purchasing, training, education and station operations.

The document has been prepared in accordance with § 10 of the Regulations relating to protection of the environment in Antarctica. The Antarctic Environmental Regulations (AER) requires that anyone intending to start a planned activity in Antarctica or is implementing substantial changes to ongoing activities is to prepare an initial environmental evaluation, containing a description of the planned activity. This includes its purpose, location, duration, intensity, use of means of transport and evaluation of impact.

A Multi-year IEE was prepared for Troll Station by NPI (*Multi-year Initial Environmental Evaluation for the operational aspects of Norwegian Antarctic Research Operations 2000-2010*, B. Njåstad, 2000). In 2004 Troll station upgraded to an all-year station, and a Comprehensive Environmental Evaluation (CEE) was prepared. In 2002 the Troll Runway (now Troll Airfield) was constructed, the IEE (*Construction and operation of Troll Runway*) was prepared for this task.

Over the past 10 years substantial changes has been implemented in the NPI's operations in Antarctica, and NPI therefore presents this document as a new and updated assessment that covers all activity within the framework of operations at Troll station. Scientific projects outside the core area of Troll will require separate IEE's in accordance with § 10 of the Regulations relating to protection of the environment in Antarctica. This assessment does not cover the evaluation of these research activities.

The document has been prepared by the Norwegian Polar Institute. The work has been coordinated by Stein Ø. Nilsen, Environmental Management Section. Birgit Njåstad (Environmental Management Section), Ken Pedersen (Antarctica section) and Øystein Mikelborg (Operation and Logistics department) has contributed actively in the process



Figure 1: A Bassler DC3 arrives at Troll Airfield (2008), Photo: Stein Ø. Nilsen / Norwegian Polar Institute

1.0 INTRODUCTION

1.1 History of Norwegian research activity in Antarctica

1.1.1 The beginning

Norwegian research activity in Antarctica is rooted in a long tradition. Already in the 1920s and 1930s

Norwegian nationals carried through extensive research in Antarctica, most often on expeditions that combined whaling and research activities.

It was the Norwegian-British-Swedish Maudheim Expedition (1949-52) and the activities associated with the International Geophysical Year in 1957-58 that really boosted the level of research effort in Dronning Maud Land. During that time period and the following decades a number of nations have established and operated research stations in Dronning Maud Land. Currently ten nations operate stations (of which seven are all-year stations), while a number of additional nations are involved in the on-going research activities in the area.



Figure 2: Norwegian-British-Swedish Maudheim Expedition 1949-1952 (Photo: Norwegian Polar Institute)

1.1.2 The Norwegian Antarctic Research Expeditions (NARE)

NARE (Norwegian Antarctic Research Expeditions) is an expedition framework that supports the accomplishment of all Antarctic research funded by the Norwegian government. The modern Norwegian Antarctic Research Expeditions (NARE) commenced in 1976, and expeditions have since then taken place regularly. In the period 1990-1997 Norway was part of a Nordic cooperation that entailed that the three Nordic countries active in Antarctica took responsibility for the logistical arrangements of expeditions in turn. Consequently, there was a major Norwegian Antarctic expedition every third or fourth year, with smaller expeditions taking place in the intermittent years when Norway was not responsible for the logistics. The establishment of Troll as an all-year station has, together with the change to air transport as main mode of transportation, had significant impact on the form of the NARE. While a relatively small operation in the beginning, the expeditions are now quite extensive with a continuous presence on the continent.

1.1.3 Establishment of Troll station

The Norwegian summer station Troll was established in 1989/90. This establishment was considered essential in order for Norway to continue to perform modern scientific research in Antarctica. Jutulssessen was selected as the location for Troll because (NPI, 1990b):

1. It was centrally located in relation to Norwegian science priorities.
2. It appeared to have relatively sparse biological activity and therefore environmental impacts would be minimized.

3. It had logistical advantages in terms of no difficult crevasse areas in the vicinity, and there seemed to be possibilities for creating future airstrip.
4. It appeared to have a relatively benign climate.

Since the establishment of the station, the station and its operations have continuously undergone modifications. Although these have mostly been minor in character and must be considered normal development of a station of this kind. The most substantial changes were described and evaluated in the IEE for upgrading of the Norwegian research station Troll (NPI, 1999).

In 2000 a new era was initiated in Norwegian Antarctic research history when a move was made to make air transport the main mode of personnel transportation. Intercontinental flights were conducted in partnership with other national Antarctic operators with landings at Blue One (Henriksenskjæra) initially, and Novo Airfield later, with onward feeder link operations to Troll. This change in operational mode made it possible to expand the research season significantly and the research potential has become wider. It has led to less travel time and a potential for longer and more flexible research seasons (possibility of shorter field periods and exchange of personnel in the course of the season, for example).

In July 2003 Norway took a further step and announced that Troll was to be upgraded to an all-year station, which was fulfilled in 2005. A blue ice airfield was constructed and opened for use the same year (2005). Troll Runway makes it possible to take down intercontinental flights directly at Troll, providing even further flexibility to the current NARE operations.



Figure 3: Map of Dronning Maud Land, Antarctica.

1.2 Current NPI operations in Antarctica

1.2.3 The Norwegian Polar Institute's formal role

The Norwegian Polar Institute is a directorate under the Ministry of Environment, responsible for scientific research, mapping and environmental monitoring in the Arctic and the Antarctic regions. The institute advises Norwegian authorities on matters concerning polar issues, and is Norway's competent environmental authority in Antarctica.

1.2.2 The Norwegian Polar Institute's operations in Antarctica

The Norwegian Polar Institute continues to outfit and organize expeditions to Antarctica (NARE) to provide support to all Antarctic research projects funded by the Norwegian government. This entails providing transport to/from and inside the continent, transport/logistics for field operations, operation of the research station Troll as well as the field station Tor. These operations are described and discussed further in this document.

The Norwegian Polar Institute is furthermore one of the main institutes conducting research activities in Antarctica. The responsibility for these research activities rest with the project leader/primary investigator, and the research activities as such are not described or assessed any further in this document.

1.2.2 Funding Norwegian research operations in Antarctica

The Ministry of Environment finances Norwegian Antarctic research through earmarked funds to the NPI budget. NPI is responsible for allocation of the funds in close cooperation with the Research Council of Norway (who ia. is responsible for the application peer review process). Up to NOK 12 mill per year has been allocated to NARE in the 2011-13 period.

1.2.3 Geographic area

NPI's operations in Antarctica today are mainly concentrated in Dronning Maud Land, and more specifically in the region around Troll. Troll is the main hub of present day NARE activities, and most of the research activities take place at or out from the station.

More extensive field work takes place intermittently, and NPI has recently amongst other provided logistical support for projects involving ground traverse to/from the South Pole and field work at the Fimbul ice sheet.

1.3 Past assessments

The following documents are the major environmental assessments prepared for the NARE operations since 2000. Note that separate IEE's have been prepared for all scientific projects that have taken place in this period:

- **Multi-year Initial Environmental Evaluation for the operational aspects of Norwegian Antarctic Research Expeditions 2000-2010.**¹

This document is the Initial Environmental Evaluation (IEE) for the operational aspects of the Norwegian Antarctic Research Expeditions (NARE) from 2000-2010. The Ministry of Environment made its consideration and approval of the document in 25.10.2000, and has thereafter used it as basis when considering the annual notifications from the Norwegian Polar Institute².

- **Initial Environmental Evaluation. Construction and operation of Troll Runway.**
This document is the Initial Environmental Evaluation (IEE) for the construction and operation of Troll Runway (2002). The Ministry of Environment made its consideration and approval of the document 10.09.2003.
- **FINAL Comprehensive Environmental Evaluation (CEE) for the upgrading of the Norwegian summer station Troll in Dronning Maud Land, Antarctica, to permanent station.**³

In January 2004 the Draft Comprehensive Environmental Evaluation (CEE) for the upgrading of the Norwegian summer station Troll in Dronning Maud Land, Antarctica, to permanent station was submitted to the Ministry of Environment. The draft CEE was submitted for CEPs consideration in accordance with Article 3(4) of Annex I of the Environmental protocol. The CEP considered the Draft CEE and reported to Antarctic Treaty Consultative Meeting (ATCM XXVII) held in Cape Town, South Africa in May/June 2004. Based on comments from the meeting the NPI finalized the document, and the Ministry of Environment made its consideration and approval of the document in 19.10.2004 The Final CEE was circulated to Parties 23.01.2004, prior to the start of the activity in accordance with the provisions of the Environmental Protocol.

1.4 Purpose of the assessment: ENVIRONMENTAL IMPACT ASSESSMENT OF NORWEGIAN POLAR INSTITUTE'S OPERATIONS IN ANTARCTICA

The *Multi-year Initial Environmental Evaluation for the operational aspects of Norwegian Antarctic Research Expeditions 2000-2010*⁴ has expired and this assessment replaces this

¹ Birgit Njåstad, NPI, 2000

² The Norwegian Polar Institute submits advance notifications for its operations (NARE) on an annual basis, providing specific information about the upcoming NARE and any details about operations that are not assessed in earlier documentations.

³ Norwegian Polar Institute, 2004

former assessment. The document provides updated background information on the operations of the Norwegian Polar Institute's activities south of 60°S and an assessment of the environmental impacts of these activities.

The assessment answers to the requirements of the *Regulations Relating to Protection of the Environment in Antarctica*⁵ requiring that all activities be assessed as to any impacts on the environment, including measures that will be taken to limit any harmful effects. The assessment covers all normal NPI ground, marine and air operations in Dronning Maud, as well as operations of the research station Troll and field station Tor. It does not cover operations at Bouvetøya or other NPI operations outside Dronning Maud Land. It does not cover specifics associated with research projects requiring field work outside Troll or Tor stations. These are required to deliver separate Initial Environmental Evaluations.

Thus, this assessment provides the background for the daily running of NPI operations in Antarctica.

2.0 CONSIDERING THE ENVIRONMENT

In order to assess the impacts of the NPI activities in Antarctica the sensitivities and values of the environment in which the activities take place have to be evaluated so that the identified outputs can be considered against the environment they take place in. A summary of this evaluation is presented in Appendix 1, 2 and 3. Three environmental elements of high value have been identified. Three elements of medium value were identified, and a number of elements of low value were however noted, such as flora, fauna, atmosphere, ice, geology and aesthetic values.

3.0. TROLL RESEARCH STATION

3.1 Introduction

Troll is the main hub of present day NARE activities, and has as primary purpose to provide support for high quality national and international research activities. The station is owned by the Norwegian state, while the Norwegian Polar Institute is the state's operator thereby responsible for the daily operation of the station.

The station is located in the Grjotlia nunatak in Jutulsessen (72°00'S, 2°32'E) - for location see Figure 1. Jutulsessen, located 235 km from the coast, is characterized by a relatively stable weather conditions. Troll station is placed on ice-free bedrock, 1295 m above sea level and 235

⁴ Birgit Njåstad, NPI, 2000

⁵ Ministry of the Environment, 1995

km from the ice in Dronning Maud Land. The nearest neighbour is South Africa's research station SANAE, 200 km away.

Neither wind nor precipitation levels are extreme and even temperature is relatively moderate for Antarctica. With an annual average temperature of around -18°C, temperatures as high as 7°C has been recorded in the summer while the temperature in winter now and then can fall close to -50°C. Average wind speed at Troll station is 4 m/s.

Table 1: Temperature at Troll Station 2007-2011

	Jan	Feb	Mar	Apr	Mai	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	1.9	3.5	-5.9	-3.6	-1.8	-5,4	-7,0	-8,0	-6,6	-1.4	6.8	-0.9
Min	-16.0	-26.9	-30.3	-36.5	-41.3	-49.1	-44.9	-41.4	-46.5	-35.2	-29.1	-18.7
Average	-6.5	-10.9	-16.2	-20.7	-21.4	-24.2	-24.8	-25.9	-25.7	-19.0	-12.1	-7.8

The terrestrial biota in the area is very restricted in species diversity and abundance compared to other areas. No rare species have been observed. Invertebrate fauna is found in association with the vegetated areas.



Figure 4: The Snow Petrel (*Pagodroma nivea*) is common in Jutulsessen area. (Photo: Stein Ø. Nilsen, Norwegian Polar Institute)

The vertebrate fauna consists of birds only: snow petrel (*Pagodroma nivea*), Antarctic petrel (*Thalassoica antarctica*) and south polar skua (*Catharacta maccormicki*). Only few other species are observed, both kelp gull (*Larus dominicanus*) and tracks of a possible emperor penguin (*Aptenodytes forsteri*) have been observed at single occasions at Troll station. Two large Antarctic petrel colonies are located in the central parts of Jutulsessen, approximately 10 km from the station area. Breeding south polar skuas are registered in Jutulsessen, while non-breeding young skuas are observed in the vicinity of the petrel colonies. In the station area itself, only a small number of breeding and non-breeding south polar skuas and snow petrels have been observed. The two small snow petrel colonies closest to Troll station are monitored annually.



Figure 5: Troll station 2008/2009 (Photo: Stein Ø. Nilsen / Norwegian Polar Institute)

Originally, the Troll station was set up by the Norwegian Antarctic Expedition of 1989-1990. With its 100 square meters and light construction it was described as a small summer station. This meant that researchers could only be there during the austral summer from November to February. Troll was opened as a year-round station by HM Queen Sonja on 12 February 2005, and is now (2011) an internationally important all-year station that functions as a hub for aerial transport within Dronning Maud Land and South Africa, and the adjacent stations in Dronning Maud Land. Several large joint expeditions have been arranged with Troll as starting point. The station is also important due to its medical facilities which are an important safety factor for conducting expeditions in the area.

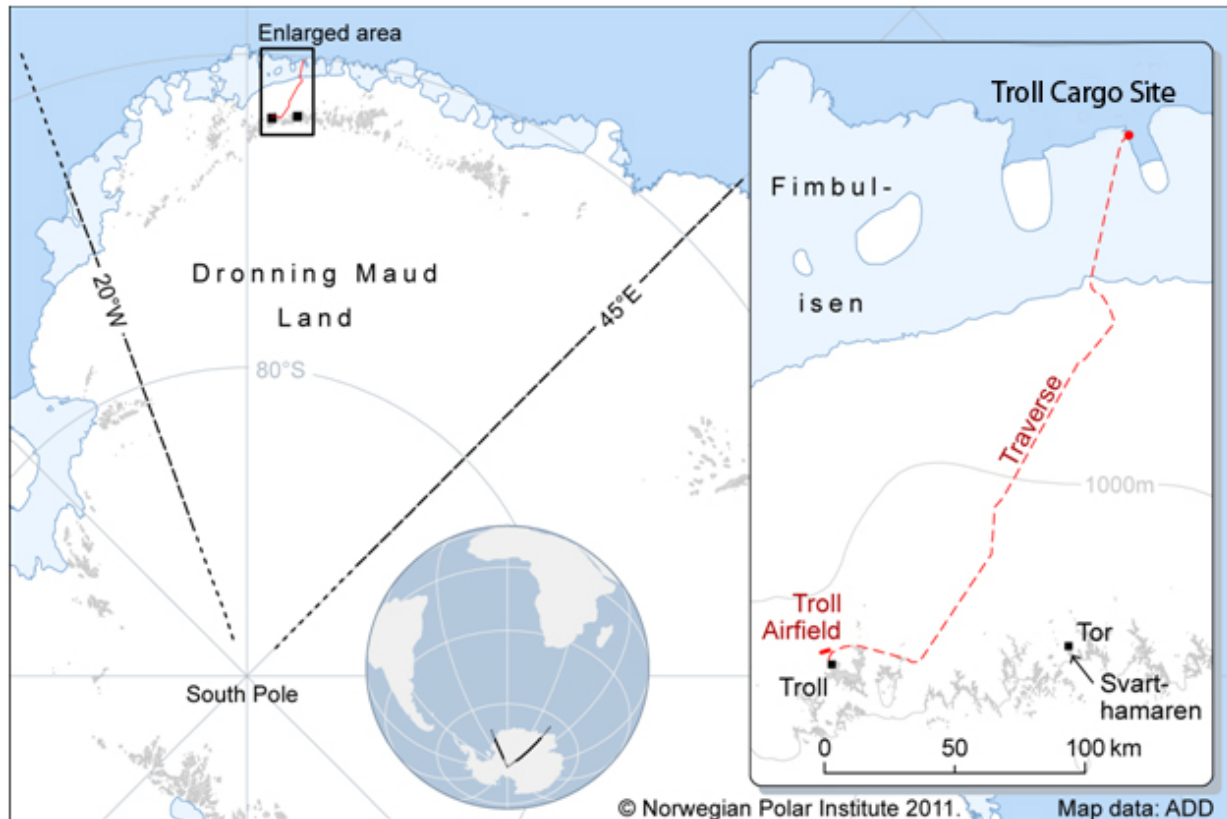


Figure 6: Map of Dronning Maud Land showing the location of Troll and Tor stations and Troll Cargo Site with ca 280 km traverse route.

3.2. Land use and footprint

3.2.1 Description

- The assessment covers land use and footprint considerations related to the core infrastructure and operations at Troll⁶.
- The extent of the station area is defined by outer boundaries of the Troll land use plan (2011), see Appendix 5.
- Most of current station infrastructure is located on ice-free ground although some structures are located on the blue ice near the station.
- The core operational area⁷ covers an area of approximately 50 000 m², plus the air field and outlying cargo lines. Troll station consists of a main building, generator buildings, garages and storage facilities. Scientific infrastructure has been established throughout

⁶ Core infrastructure is defined as all facilities related to accommodation, hygiene, health, energy etc. which any person staying at Troll depends on having access to.

⁷ The core operational area is defined in the land use plan for Troll Station, marked as Core Operational Area (cf. Appendix 5)

the area. See Table 2 for details of station building details. Total amount of gravel roads constructed is ca. 1.6 kilometer (2011).

- Currently one non-scientific/non-governmental operator has established infrastructure within the boundaries of the Troll station land use plan area⁸. These installations are not considered in detail in this document, although considered with respect to the cumulative impacts in the area.
- The aesthetic values in the station area have been diminished by the placement of structures on top of mountains/hillsides or on the blue ice. The station area as such is not very visible due to the placement in the valley between the hills Trollhaugen and Sofietoppen/Nonshøgda. Being a remote station the reduction of esthetic values will only be of concern for the personnel/visitors at Troll.
- The wilderness values near Troll are high. The wilderness values are however diminished due to infrastructure like the airstrip, gravel roads, buildings and antennas, but also noise from airplanes, vehicles and generators contributes to reduce the values of the station area.

Table 2: Buildings at Troll Station (all measurements in meter)

Building Nr.	Name	Length	Width	Area m ²
1	Platform	20	14	280
2	Garage	21	12	252
3	Power Station 2005	14	6	84
4	Power Station 2007	12	10	120
5	Container workshop	6	2.5	15
6	Igloo	5	2.5	12.5
7	Emergency Station	6	5	30
8a	Main Station	35	12	420
8b	Main Station	9	6	54
8c	Main Station	6	5	30
10	Sleeping module	4	2	8
11	Hobby workshop	5	3	15
12	Power Station 2000	6	2.5	15
15	Container platform	20	8	160
Total area				1495.5

- NPI will ensure that further development of the station will fulfill the below minimum requirements and thereby be covered by this assessment:

⁸ Kongsberg Satellite Services AS (KSAT) has established and operates Troll Satellite Station (TrollSat), a satellite reception, control and command station. The company is owned by Norwegian Space Centre (a government organisation reporting to the Ministry of Trade and Industry) and Kongsberg Defence and Aerospace AS with 50% of the shares each..

- **Strategic development:** Further development of the Troll station will be in line with an overarching strategic plan⁹. The plan will provide a strategic framework ensuring that research, logistics and other external activities at Troll are in line with the primary purpose of the station, ie. a platform for high quality national and international research based on an environmentally sound foundation.
- **Land use plan:** Further development of the Troll station will be in line with the land use strategy outlined in the Troll land use plan (2011), which provides a zoning scheme that ensures that environmental and scientific values of the area have the highest priority in further development of the area. See Appendix 5.
- **Aesthetic values and wilderness:** Further devaluation of the aesthetic and wilderness values at the site will be avoided by strictly planning according to strategic plans and the land use plan.

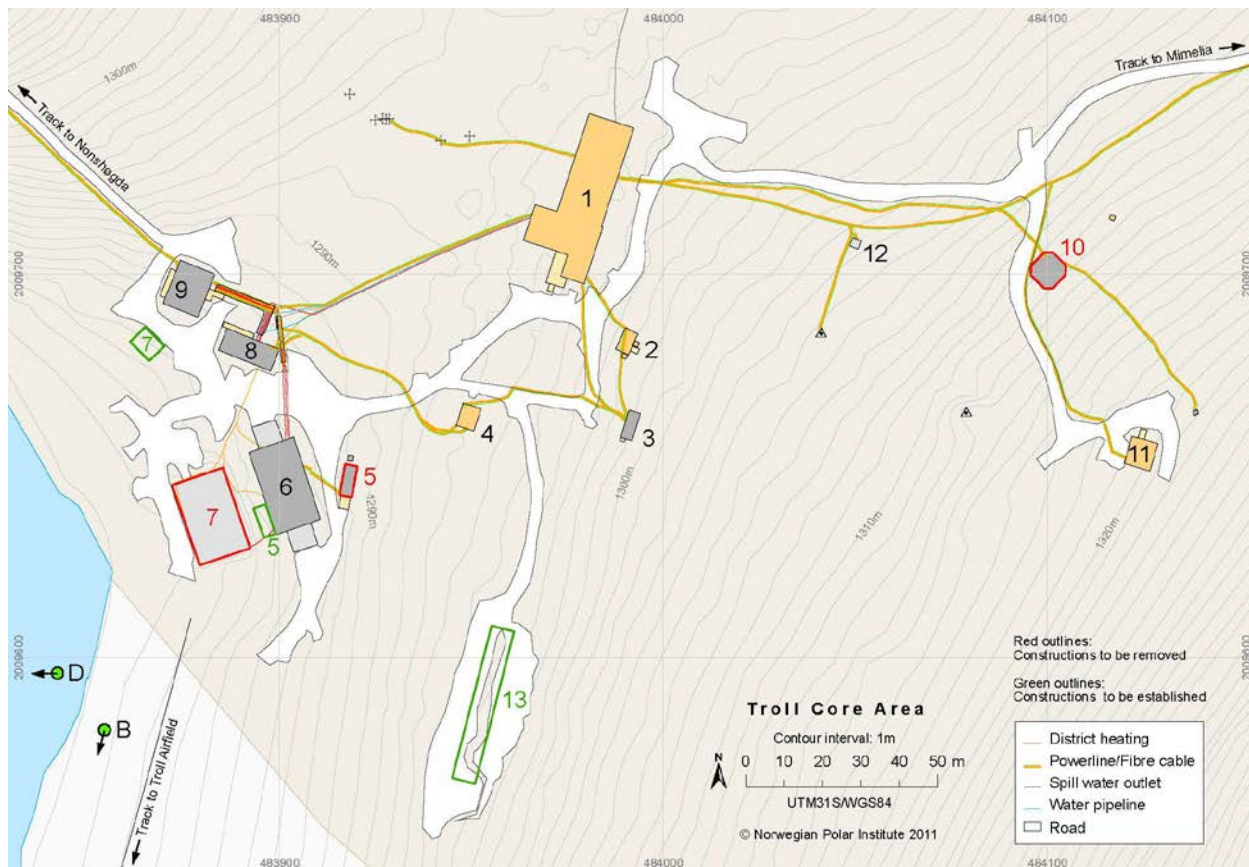


Figure 7: Troll Station, Core operational area

⁹ NPI is currently (Sept 2011) finalizing *Strategisk plan for forskningsstasjonen Troll* (Strategic plan for the research station Troll)

Table 3: Legend, Troll Core Operational Area

Number/Letter	Description
B	Barrels with Petrol, Jet Fuel, engine oil and lubricants storage ca. 300 meter South
D	Polar Diesel; storage ca. 500 meter West, placed on blue ice
1	Main building
2	Carpenter workshop
3	Emergency Power station
4	Emergency station
5	Snow Mobile garage
6	Garage
7	Diesel Pump Housing
8	Power station, Backup
9	Power station, Main
10	KSAT Antenna
11	NILU Station
12	Antenna
13	Container storage area: 25 pcs. 20' containers

3.2.2 Alternatives

As activity at and associated with Troll increases, the potential for an expansion of land use and thereby an increased footprint is large. Having clear strategic framework (including land use plan) provides a useful tool to avoid unplanned growth. An alternative to allowing for planned/strategic growth would be to set a clear limit to number of buildings, extent of land use, etc. (Including no further growth). However, this would by no means enable the freedom necessary to make resources and area available for important and prioritized research.

3.2.3 Impacts

Potential Environmental Impacts from land use and footprint at Troll station

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
<ul style="list-style-type: none"> Physical footprint 	<p>Aesthetic values: Buildings, roads, infrastructure, fuel spill remains and waste introduce visible human elements into the natural landscape and may change the emotional experience for visitors. Visitors in the area are normally associated with research expeditions and will normally expect human elements in environment</p> <p>Wilderness: Troll station occupies ca. 2 % of the total ice-free areas of Jutulsessen and is a factor in reducing the wilderness value of the area. Nonetheless visitors in the area are normally associated with research expeditions and will normally expect human elements in environment.</p> <p>Flora: Construction of new station elements and associated use of vehicles may disturb small vegetation patches in the station areas. Increased pedestrian traffic in the station area (radius 500 meters) will likewise have such effect (Komarkova, 1983). Re-growth in damaged areas will be slow. Vegetation patches occur only sporadically in the area, and no unique assemblages have been recorded.</p>	<p>Extent: Local to regional Duration: Permanent Significance: Low</p>	<p>Strategic plan: The Strategic plan will be used as a guidance for reducing the total physical footprint at Troll station.</p> <p>Land use plan: The document will be used actively in planning future activity and constructions within the designated area to keep the physical footprint as small as possible.</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
<ul style="list-style-type: none"> Physical footprint 	<p>Fauna: Nest sites of snow petrel can be disturbed or destroyed due to construction work.</p> <p>Snow petrel tend to return to original nests, but will normally find alternatives if nest are not available. The number of nest that would be disturbed in this manner is likely to be small and have minimal impact on individuals and no impact on population.</p>		<p>Construction guidance: Construction work will as far as possible be carried out before or after the snow petrels arrive/leave the area. Before construction work is undertaken the affected area will be investigated for nest sites. All attempts will be made to ensure that no nest sites that are in active use will be destroyed in connection with the construction of roads and foundations for buildings. Efforts will also be initiated to limit the number of affected inactive nest sites.</p>
<ul style="list-style-type: none"> Noise 	<p>Fauna: Noise may disturb birds in a manner so that they leave their nests (and expose eggs/chicks to environment and predators), raise stress level and increase metabolism, all which could affect the fine tuned balance of energy intake and energy use (see CAFF (1998) and Giese & Riddle (1999)).</p> <p>It is expected that the limited exposure to output will be too low for any significant impact. The noise from the generators will be a part of the environment when the birds arrive at the start of the breeding season and will likely therefore be of little concern.</p>	<p>Extent: Local Duration: Permanent Significance: Low</p>	<p>Noise reduction: Efforts to minimize generator need during summer season by focus on alternative energy.</p> <p>Noise issues will always be considered when establishing new infrastructure at the station.</p>

3.3 Use of vehicles

3.3.1 Description

- The assessment covers vehicle use needed to support normal day to day operations at Troll.
- A variety of types and numbers of vehicles are used at Troll, see table 1. The vehicle park is upgraded when needed, which leads to investment in new types of vehicles as one goes along. For example, there are additional plans for purchase of 3 Hägglund BV206 and one Prinoth Everest already in 2012.
- NPI will ensure that vehicle use at the station will fulfill the below minimum requirements and thereby be covered by this assessment:
 - **Controlled use:** Unnecessary use of vehicles at Troll will be avoided. All recreational traffic will be carried out on marked (on maps) areas to ensure safety of the personnel. Areas with crevices will be avoided. Outside the mountainous areas around Troll, the field station Tor and the Jutulsessen area are the only destinations for recreational purposes.
 - **Registration of traffic:** All traffic in the clean air zone (cf. land use plan) will be logged due to the air monitoring activity at Troll (NILU).
 - **Use of established tracks:** In general there will be no traffic outside established tracks within the station area. All use of vehicles, with the exception of snow mobiles, occurs on established tracks.
 - **Establishment of new tracks:** New tracks shall only be constructed if there is a permanent use for the track. If not consideration will be given to make a preliminary track/construction road. If there are exceptions to this, actions will as far as possible be taken to avoid interference with wildlife or leaving footprints in the landscape.
 - **Investment in environmentally friendly vehicles:** The environmental friendliness of vehicles will be considered when purchasing new vehicles¹⁰. Consumption, CO2 emission and possibilities for reuse of materials will be considered before purchasing. NPI will as far as possible request the use of environmentally friendly production methods, retrograding routines and reuse of materials in vehicles purchased for use in fragile areas.

¹⁰ See further discussions relating to purchasing in chapter 9.1

Table 4: Vehicles at Troll in 2011

Type of vehicle	Number of vehicles	Fuel
Toyota Hilux Pick-up	1	Diesel
Prinoth Everest Bandwagon	4	Diesel/Jet A1
Prinoth T4-S Bandwagon	1	Diesel/Jet A1
Hägglund/Berco TL-6	4	Diesel/Jet A1
Hägglund BV206 Bandwagon	2	Diesel/Jet A1
Excavator	3	Diesel
Front wheel loader 18 tons	1	Diesel
Tractor	1	Diesel/Jet A1
Snow-mobile 4 stroke	8	Petrol 95 octane
Polaris ATV 6WD	2	Petrol 95 octane

3. 3.2 Alternatives

Due to the size of the Norwegian operations taking place in Antarctica there are no alternatives to not using vehicles. However, using modern technology, such as electrical or hybrid powered vehicles within the station area to reduce emissions will contribute to a decreased impact.



Figure 8: Hägglund BV206 is one of the vehicles used for transport in Dronning Maud Land (Photo: Stein Ø. Nilsen / Norwegian Polar Institute)

3.3.3 Impacts

Potential Environmental Impacts from use of vehicles at Troll station

Output	Description of potential impact	Evaluation of impact	Measures to reduce impact
Emission	<p>Exhaust emission: Air in local area around station will be exposed to exhaust emission. This will affect the air monitoring program at Troll Station negatively. Wind and pollution combined render a relatively large amount of the monitoring data unusable.</p> <p>Dust: Dust from operating vehicles on established roads and tracks will affect the air quality in the local area of the station. This will have an effect on air monitoring performed at Troll Station. Wind and pollution combined render a relatively large amount of the monitoring data unusable.</p>	<p>Extent: Local to regional</p> <p>Duration: Permanent</p> <p>Significance: Medium</p>	<p>Vehicle control: Driving will be limited to that which is necessary. Electrical powered vehicles will be invested in and used in those areas that are most sensitive to air pollution (ie. clean air zone) and noise. Only clean unleaded fuels will be used.</p>
Noise	<p>Fauna: Noise from operating vehicles in the station area could affect breeding birds. Noise may disturb birds in a manner so that they leave their nests (and expose eggs/chicks to environment and predators), raise stress level and increase metabolism, all which could affect the fine tuned balance of energy intake and energy use (see e.g. CAFF (1998) and Giese and Riddle (1999)).</p> <p>It is expected that the limited exposure to output will be too low for any significant impact.</p>	<p>Extent:Local</p> <p>Duration: Permanent</p> <p>Significance: Medium</p>	

3.4 Waste

3.4.1 Description

- This assessment covers waste management resulting from normal day-to-day operations at Troll.
- Currently approximately 74 tons of waste is produced annually at Troll (2010). An overview of types of waste is given in Table 6. NPI has contract with the company Waste Control (Waste Removal Service, Cape Town, South Africa) who ensures that South

African national regulations are followed. A detailed *Certificate of safe disposal* is issued for deliverances made in South Africa.¹¹

- The key principle of the waste management at the stations is established in the national *Antarctic Environmental Regulations (1995)*. In short, this entails that all waste, except waste water, is collected, separated and brought out of Antarctica for appropriate disposal and recycling. **Antarctic Environmental Regulations § 18.**

- The following elements of the waste management procedures should be noted:
 - **Waste compressor:** A waste compressor is used to reduce waste volume of plastics and paper significantly. The compressor is also used to compress empty fuel drums to 20% of full size.
 - **Toilet waste:** Vacuum toilets (Jets system, Norway) and a diaphragm cleansing system for black and grey water (Martin Systems AG, Germany) have been in use since 2008. See Table 3 for amount of waste water and solid waste produced by the system.

Table 5: Amount of annually produced cleansed waste water and solid waste (in Kg) at Troll station

Season	Amount
Winter (February – October)	Ca. 130 m ³
Summer (November –February)	Ca. 320 m ³
Total water discharged:	Ca. 450 m ³
Solid toilet waste (Annual: From Diaphragm Filter System)	Ca. 1000 Kg

- **Food waste:** A grinder/decomposer is used to reduce food waste volumes to 10% of the original amount. The machinery is made by *Global Enviro International AS*, Norway and has a capacity of decomposing 50 tons of food waste per year. Fat is excreted and is delivered separately as toilet waste in South Africa. The remaining solids is packed in 40-liter barrels and shipped to South Africa.
- **Waste collection routines:** All waste is sorted in to eleven different categories. This complies with the demands of the South African company Waste Control, so that waste from Troll can be delivered in accordance with South African laws and regulations¹².
- **Waste retrograding routines:** All waste is prepared and stored in containers at Troll station before shipment to South Africa. Containers with waste can be secured and stored ca. 500 meter away from ice shelf for maximum 4 weeks prior to arrival of the vessel. The waste is delivered in South Africa in containers. The company Waste Control, Cape Town ensures correct

¹¹ See Appendix 6: Waste Control 2010.

reporting, treatment, reuse and disposal in accordance with the provisions of the South African laws.¹²

- **Waste responsibility:** Station Manager is responsible for waste management at the station. **Antarctic Environmental Regulations § 21.**¹³
- Waste water is discharged in rocky outcrops near the Troll station. Currently approximately 450 m³ of waste water is discharged on an annual basis (See table 5). A new diaphragm system for wastewater treatment was installed in 2008 and when operating correctly this ensures high level of treatment of the waste water before it is discharged. Regular samples of the waste water are taken to ensure that the treatment plant is working satisfactory. Discharge of waste water on ice-free ground is in contradiction with the provisions of the Environmental Protocol **Environmental Protocol Article Annex III Art. 4** and dispensation from the Norwegian Antarctic Regulations is required **Antarctic Environmental Regulations § 18**. The Ministry of the Environment has provided such dispensation in the period 2000-2011.
- NPI will ensure that waste management will fulfill the below minimum requirements and thereby be covered by this assessment:
 - **Disposal of waste:** All waste will be shipped out of Antarctica and deposited in South Africa. Records and documentation will be kept as to the amount of waste that has been delivered and treated in South Africa in accordance with relevant South African national¹⁰ and international agreements.
 - **Storage:** All waste to be removed will be stored in such a way so their dispersal is prevented. Storage will take place in tethered cargo containers or indoor in designated area for storage of waste. No waste will be stored at the ice shelf during austral winter. **Environmental protocol, Annex III, Article 6, Antarctic Environmental Regulations § 19.**
 - **Recording:** All figures on amount, type and weight of produced, shipped and disposed waste will be recorded annually **Antarctic Environmental Regulations § 21. Environmental Protocol, Article 4.** The Station manager is responsible for keeping record books.
 - **Waste minimization:** The waste volume will be reduced by focusing on purchase, packing, reuse and recycling. **Environmental Protocol, Article 1**

¹² National Environmental Management Act No. 73 of 1989, National Environmental Management Act No. 107 of 1998, National Water Act No. 73 of 1998, The Health Act No. 63 of 1977, The Occupational Health and Safety Act of 1993, The National Road Traffic Act No. 93 of 1996 and Transport of dangerous substances by road – Chapter 8 of National Road Act.

¹³ Routines and procedures for waste management at Troll is further specified in the Troll Operation Manual

- **Packing:** All shredded paper, polystyrene beads, chips or similar forms of loose packaging will be replaced with bubble wrap, cardboard or paper as far as possible. **Environmental Protocol, Article 2**
- **Reuse:** There is no waste that can be reused at Troll presently; waste delivered in South Africa will be recycled and reused as far as possible.
- **Purchasing:** See chapter 9.1.
- **Littering:** Storage containers will be constructed and maintained in a manner that no littering will take place. In case of an accident or an unforeseen event all litter will be removed immediately.
- **Training:** The person responsible for waste management, and other key personnel, will receive necessary training related to waste management issues **Environmental Regulations § 21.**
- **Waste water treatment:** All efforts will be made to ensure appropriate operations of the waste water treatment system. Water released shall not exceed the limits for the selected indicators as listed in Table 7.
- **Waste water reuse:** Waste water will to the largest extent possible be reused for household washing and in the toilet system. The vacuum toilets use only ab. 0.5 – 0.75 liters for flushing so the gain is relatively minor. The waste water cleansing system requires a certain minimum amount of water to be efficient, so especially during winter season it is not possible to substantially reduce the amount of water used.

Table 6: Waste categories at Troll station.

Category	Type of waste
Blue	Metals
Green	Glass
Orange	Mixed waste
White	Paper/Card board
Yellow	Plastics
Black	Food waste, compost
Red	Sewage, urine (non-composted)
Oil spill	
Drums marked "Oil Spill"	Used Oil filters
Drums marked "Oil Contaminated"	Oil contaminated items
60 liter Plastic drums marked "Food compost"	Food compost
60 liter Plastic drums marked "Sewage Compost"	Sewage compost
Securely packed and marked	Chemicals and batteries

Table 7, Waste water treatment requirements (maximum levels) ¹⁴

Substance	Manufacturer's specification	Maximum level
Suspended matter (TSS):	5 mg/l	10 mg/l
Organic pollution (COD)	1 mg/l	15 mg/l
Total Phosphate (Ptotal)	1 mg/l	3 mg/l

3.4.2 Alternatives

Waste is an unavoidable consequence of operating in Antarctica. Retrograding of all waste is the alternative with least impact on the environment. Incineration is a potential alternative. However, this treatment form is highly dependent on large amounts of fuel in order to ensure acceptable temperature levels and thereby minimize harmful emissions. Due to research activities such as continuous air monitoring at Troll station it is furthermore desirable to minimize the emissions as much as possible. Incineration is therefore not considered a viable alternative at Troll.

¹⁴ Based on advise from KLIF (Climate and Pollution Agency) and specifications provided by system manufacturer, Martins AG, Germany.

3.4.3 Impacts

Potential Environmental Impacts from waste management

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Emission	<p>Waste water: Wastewater may affect micro-flora potentially present in discharge area. Increase due to expanded season and expected higher wastewater discharge. Wastewater is likely to ablate (cf. experience from the area) to a large degree, although ice build-up may be expected during winter season. Wastewater treatment system will ensure minimal pollution in discharged water and thereby exposure to pollution.</p>	<p>Extent: Local Duration: long Significance: Low</p>	<p>Technology: Best available technology will be used for cleansing wastewater (grey-water).</p> <p>Monitoring: The waste water will be monitored on monthly basis to ensure that acceptable discharge quality is maintained (cf. table 7). Discharge of water will be stopped if failure to comply with waste water quality (cf. Table 7) consistently over a longer time period.</p> <p>To increase ablation the ice formed by waste water outlet will be chopped into smaller pieces once yearly.</p> <p>Education: Due care and attention, use of appropriate procedures and equipment when managing waste, reinforced by education and training.</p>
Littering	<p>Waste littering. Waste could be spread in adverse weather, or if waste is inadequately handled or secured. Associated impacts are mainly of an aesthetic nature. Break-down of litter is slow, and litter will remain. Contributes to overall contamination of environment.</p>	<p>Extent: Local to regional Duration: Transitory to Permanent Significance: Low</p>	<p>Avoidance: Procedures to ensure that littering is avoided and that all litter is taken care of immediately will be specified in Troll Station Manual.</p> <p>Handling: If unintentionally littering happens action will be taken to collect litter as soon as possible.</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Non-native organisms and disease	<p>There is a risk of spreading bacteria or possible diseases with wastewater and/or contaminated foodstuff.</p> <p>Human activity can be the cause of disease outbreaks, bringing pathogens unintentionally into Antarctica. So far few, if any, disease outbreaks are however known to have been introduced to Antarctica as a result of human activity. Disease could be detrimental to populations (Hughes & Convey, 2010, Knowles, Riddle & Clarke, 1999 and Gardner et al., 1997).</p>	<p>Extent: Local Duration: Short Significance: Medium</p>	<p>Avoidance: Food wastes will be stored in a secure manner, disallowing littering into the environment. Special care will be given to poultry or other foodstuff that has a potential to inflict diseases to birdlife in the region. Procedures will be specified in Troll Station Manual.</p> <p>Relevant material in the Non-native Species Manual¹⁵ will be used as guidance, eg. the “Checklists for supply chain managers of National Antarctic Programmes for the reduction in risk of transfer of non-native species” developed by Comnap/Scar (2011)</p>

3.5 Management of fuel and hazardous substances

3.5.1 Description

- This assessment covers management of hazardous substances, including fuel, in the context of the normal day-to-day operations at Troll.
- Currently approximately 245,000 liters of fuel is used for power production at Troll annually (2009), and typically up to 500,000 liters of various types of fuels are stored at the station at any one time. An overview of hazardous substances (and approximate maximum amounts) is given in Table 8. The key principle relating to management of hazardous substances is laid out in the Norway’s *Antarctic Environmental Regulations*. In

¹⁵ Cf. ATCM Resolution 6 (2011) available at http://www.ats.aq/documents/recatt%5Catt486_e.pdf

short, no harmful products/substances shall deliberately be disposed/emitted during operation¹⁶ **Antarctic Environmental Regulations § 18.**

- The following additional aspects with respect to fuel and pollution management should be noted:
 - **Fuel depot:** *The Polar Diesel* fuel depot at Troll consists of large containers (Maximum 11, 000 liters/container) located on the ice ca. 600 meters from the station. Total amount stored in 2011 was ca. 340,000 liters. Up to 400,000 liters of Jet fuel A-1 is stored in 200 liter barrels on containment mats. In addition a total of 9000 liters unleaded petrol 95 octane are stored in 200 liter barrels on containment mats.
 - **Fuel transport:** All fuel and chemicals are brought to Troll from the cargo vessel (at Troll Cargo Site) in containers or sleds with 200 liter barrels to Troll station. Polar diesel is transported in 11,000 liters tanks within 20' containers. See Chapter 3.
 - **Monitoring:** All fuel depots are monitored visually regularly to ensure that no barrels or tanks are leaking liquids to the environment.

Table 8; Fuel and other substances stored at Troll station (all numbers showing maximum amounts)

Substance	Amount
Polar Diesel	340 m3
Jet Fuel A-1	800-2000 barrels (160,000– 400,000 liter)
Petrol 95 octane (unleaded)	45 barrels (9000 liter)
Glycol	8 barrels (1600 liter)
Battery acid	50 liter
Cleansing liquid for waste treatment (Caustic Soda 50%, Chlorine cleaner 13%, Citric Acid 50%)	70 liter
Propane gas	3170 kg

- NPI will ensure that management of hazardous substances will fulfill the below minimum requirements and thereby be covered by this assessment
 - **Prohibited products:** No polychlorinated biphenyls (PCBs), non-sterile soil, polystyrene beads, chips or similar form of packaging or pesticides (other than those required for scientific, medical or hygienic purposes) will be taken into or used at Troll **Environmental Protocol, Article 7.**
 - **Storage:** All fuel depots will be inspected regularly during both summer and winter season.

¹⁶ This does not preclude combustion from generators, vehicles and the like.

- **Spill equipment:** Spill material will be available for fuel or dangerous substances operations. The person in charge of the operations will be responsible for having the right type of equipment on site before the operation starts.
- **Spill handling:** All small and large fuel spills will be handled in accordance with routines specified in the Troll Station Manual. In the event of an oil spill incident in excess of 200 liters (and for oil spills less than 200 liters, if considered significant) a full Oil Spill Report will be prepared.

3.5.2 Alternatives

There are a variety of available technologies available for fuel storage and transport, and best practice is evolving over time. NPI considers alternatives continuously, in order to reduce both costs and environmental impacts from fuel transport/storage. Currently consideration is given to testing out 5000 gallon lightweight fuel bladders. Use of such technology could reduce the use of fuel needed due to the lighter equipment.

3.5.3 Impacts

Potential Environmental Impacts from management of fuel and hazardous substances.

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Emission	<p>Ground: Fuel spills can be released into the ground during filling or operation. Jet A-1 and Polar Diesel are relatively volatile and a large portion of a spill is likely to evaporate instead of migrating into ice/ground. Contaminants that migrate into the ice will be encapsulated and remain in the ice for an indefinite period. Impacts at release time depend on point of release, but could affect biota or quality of receiving environment. Such spills will contribute to overall contamination of environment and may have bearings on future ice related research. Limited ice related research is currently ongoing in the area.</p> <p>Fauna: Fuel spills may occur and could produce numerous health concerns to any animal that comes into direct or indirect contact with the substance. Birds and humans that come in direct physical contact with the chemicals can suffer skin and eye lesions or chemical burns. Fuel spills at Troll have so far been few and small due to proper handling routines, and exposure is expected to be small with little impact.</p>	<p>Extent: Local to global Duration: Permanent Significance: Low</p>	<p>Avoidance: Spill equipment will be during filling operations Procedures will be specified in Troll Station Manual..</p> <p>Education: Personnel shall receive adequate environmental information</p>
Waste	<p>Litter: Waste as empty oil drums, contaminated spill equipment, containment mats and straps do occur during filling during ground operations. These will be handled as any other waste produced at the station, and are not expected to affect the environment. Some unintentional littering could occur during operations. Associated impacts are mainly of an aesthetic nature. Break-down of litter is slow, and litter will remain. Contributes to overall contamination of environment.</p>	<p>Extent: Local Duration: Short Significance: Low</p>	<p>Handling: If unintentionally littering happens action will be taken to collect litter as soon as possible.</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Non-native organisms and disease	<p>In the case of fuel handling, introductions may take place via equipment/cargo carried into Antarctica. It is to be expected that establishment of non-native species will only be possible in those species that can tolerate the conditions of the Antarctic environment. Containers used in the Arctic regions could possibly bring arthropods, seeds and/or plants of alien species to Antarctica.</p> <p>There are well-known examples of experimental and accidental introductions of non-native organisms in Antarctica. It is, however, considered likely that most non-native organisms will not find suitable environment to thrive in the Troll area (due to climatic and other environmental factors). Non-native organisms can displace existing vegetation and microflora/fauna (Smith, 1996).</p>	<p>Extent: Local Duration: Short Significance: Low</p>	<p>Avoidance: Relevant material in the Non-native Species Manual will be used as guidance, eg. the "Checklists for supply chain managers of National Antarctic Programmes for the reduction in risk of transfer of non-native species" developed by COMNAP & SCAR (2011)</p>

3.6 Power supply

3.6.1 Description

- This assessment covers power generation, in the context of the normal day-to-day station operations at Troll.
- Currently power supply at the station is mainly based on conventional generators and Polar Diesel consumption.
- The amount of energy produced annually is ca. 810 000 Kwh (2011). Of the core infrastructure the main station building requires most energy. However, it is an external activity (TrollSat) that consumes most of the energy produced at Troll.
- The following aspects related to power supply and energy production should be noted:
 - **Maximum capacity:** The main generator can produce a maximum of 240 KVA, the current energy consumption is currently only ca. 40-45 % of this level (2011).
 - **Fuel consumption:** The generators at Troll are running 24/7 due to the satellite services and instruments operating full time all year. The annual consumption for operating the generators is currently at ca. 245,000 liters of Polar Diesel (2011).
 - **Utilization of waste heat:** At Troll waste heat from the generators is used for melting of ice for drinking water, heating of tap water and for the heating of the

larger buildings such as garages, main building and generator buildings. The water is led by pipelines from generator building to main building.

- **Energy savings:** To reduce the use of energy, lighting has been changed to the use of LED-technology (Light Emitting Diodes). Procedures has been implemented to switch of lights and unnecessary equipment when not needed. The amount of energy used for the buildings has been reduced from 66 KWh to 38 KWh (2010/2011-season) due to the increased education and awareness.
- **Alternative fuels:** Propane gas is utilized for the kitchen stove at Troll.

3.6.2 Alternatives

Use of alternative energy/fuels could be considered in order to reduce the impact (and costs) associated with conventional energy production. The following are under consideration:

- **Wind power:** A wind gauge tower, measuring the extent of available wind at Troll has been in operation since 2007. The conclusion of the analysis is that wind energy can only meet the demand of some parts of the energy consumption. The main reason for the limited potential is the large fluctuation of the wind speed. Most of the time the energy production is low, but there is some small periods of very large energy production. To meet the main part of the energy consumption, large energy storage is needed. This is neither economically or practically available. The economy can, however, be reasonable if 10-15% of the energy production is from wind. NPI will explore these opportunities further in the near future.
- **Solar power:** The 24 hour daylight during the austral summer makes use of solar power a potential additional power supply. This alternative will be considered further.

3.6.3 Impacts

Potential Environmental Impacts from power supply

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Combustion emission	<p>Air: Combustion gases released into the atmosphere can contribute to the greenhouse effect both directly and indirectly. However, in the overall emission picture (both in the Antarctic context and the global context) the contribution from the activity is relatively minor.</p> <p>Air quality in general may be affected by releasing combustion compounds into the atmosphere. Since atmospheric research is one of the main elements of the all-year activity at the station, such emission may have undesirable effects and should be minimized.</p> <p>Ground. Soot emissions from exhaust outlet could contaminate ice and snow and affect the albedo locally, which with time could lead to further alterations of the physical environment and ablation rates. Soot deposition has been shown to cause no measurable changes of snow albedo at the South Pole Station where there is higher and more constant emission (see e.g. Warren and Clarke (1990), Wolff (1992) and Suttie and Wolff (1993)). Ice quality in general may be affected by deposited combustion compounds. This could have bearings on ice related research (e.g. climate research). No ice related research is on-going or planned in the area.</p> <p>Fauna: Soot and combustion products can be potentially harmful if birds get in direct contact with the substances. Although combustion products can affect birds (habitat and health), the exposure is limited due to relatively low emission levels from Troll.</p> <p>Ingestion through food not likely due to marine diet. Inhalation low due to distance from source. Exposure could in the long run affect respiratory system and other vital functions (see e.g. Maniero (1996)).</p>	<p>Extent: Local to regional</p> <p>Duration: Very long</p> <p>Significance: Medium</p>	<p>Technology: Well maintained generators and equipment will be used and generators will not left idling unnecessary. High energy efficient fuel will be used. Continued consideration will be given to potential mechanisms to cleansing of combustion gases.</p> <p>Reduction: Further efforts will be instituted to identify and implement use of alternative energy sources such as wind and sun energy in future. NPI will continue to focus on energy efficiency measures to reduce energy needs.</p>

3.7 Water supply

3.7.1 Description

- Fresh water at Troll station is made from blue ice taken from nearby the station. The ice is melted in a melting-tank heated by waste-heat from the generators.
- The melted ice is cleansed with particle filter and UV-filter.
- The fresh water quality is tested sporadically, and the equipment and melting tank is cleansed at least once annually. The quality complies with Norwegian national drinking water regulations.

3.7.2 Alternatives

There are no alternatives to using melted ice or snow for fresh water supply at Troll.

3.7.3 Impacts

Potential Environmental Impacts from water supply

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Disturbance in landscape	Wilderness: Wilderness and aesthetic values could be affected by taking of ice in a single location. Annual snowfall, wind driven snow and movement of glaciers will obliterate traces from the taking of ice.	Extent: Local Duration: Temporary to short Significance: Low	Avoidance. to avoid visible abrasion snow/ice will be taken over a larger area.

3.8 Recreational activities

3.8.1 Introduction

Being physically active is considered positive for the general health for the personnel at remote stations like Troll. Skiing, hiking in the mountains, running and shorter trips with snow-mobiles are typical activities for the personnel at Troll. General and specific guidance in the Troll Station Manual provides the necessary safety/environmental measures and restrictions for recreational activities.

4.0 TOR FIELD STATION

The station Tor is located at Svarthamaren nunatak, at 71°53'S, 5°10'E. Svarthamaren is an Antarctic Special Protected Area (ASPA 142) (See figure 10 for the station location). Tor is the only permanent Norwegian operated field station related to the operations in Dronning Maud Land.

The vegetation at Svarthamaren is sparse compared to western parts of the Mühlig-Hofmanfjella. There is rich micro fauna consisting of mite (*Eupodes angardi*, *Tydeus erebus*), protozoa, nematodes and rotifers, as well as one insect species (*Cryptopygus sverdrupi*). No rare species have been identified.

There are large colonies of Antarctic petrel (*Thalassoica Antarctica*), ab. 250.000 pairs in the northeastern slopes of the mountains. This is south of the area of the station. Additionally there are 500-1000 breeding pairs of snow petrel (*Pagodroma nivea*) and approximately 50 pairs of south polar skua (*Catharacta maccormicki*). There are large numbers of non-breeding petrels and skuas located in the area. Wilson's storm petrel (*Oceanites oceanicus*) has been sighted near Tor on rare occasions.



Figure 9: Tor Field station (Photo: Stein Ø. Nilsen / Norwegian Polar Institute, 2008)

4.1. Land use and footprint

4.1.1 Description

- The assessment covers land use and footprint considerations related to the infrastructure and operations at Tor.
- Tor station consists of a main building, and two small huts which are used for storage, a generator building and a field toilet. The station itself is an enclave within Svarthamaren Antarctic Special protected Area (ASPA 142). All the buildings are constructed on gravel and rocks. There is a 10 meter area around the station which is not a part of the protected area. The area used as shown on Figure 10.
- The aesthetic values in the station area have been somewhat diminished by the structures. However, the station as such is not very visible due its size. Being a remote station the reduction of aesthetic values will mainly be of concern for the personnel/visitors at Tor.
- The wilderness values near Tor are high. The wilderness values are somewhat diminished due to infrastructure and noise, but due to low occupancy rate and limited activity the devaluation of the wilderness value is considered low.

4.1.2 Alternatives

Mobile field camps have been used during many large scale field activities throughout Dronning Maud Land (eg. operations at Fimbul Ice Shelf) and could be an alternative to fixed field camps.

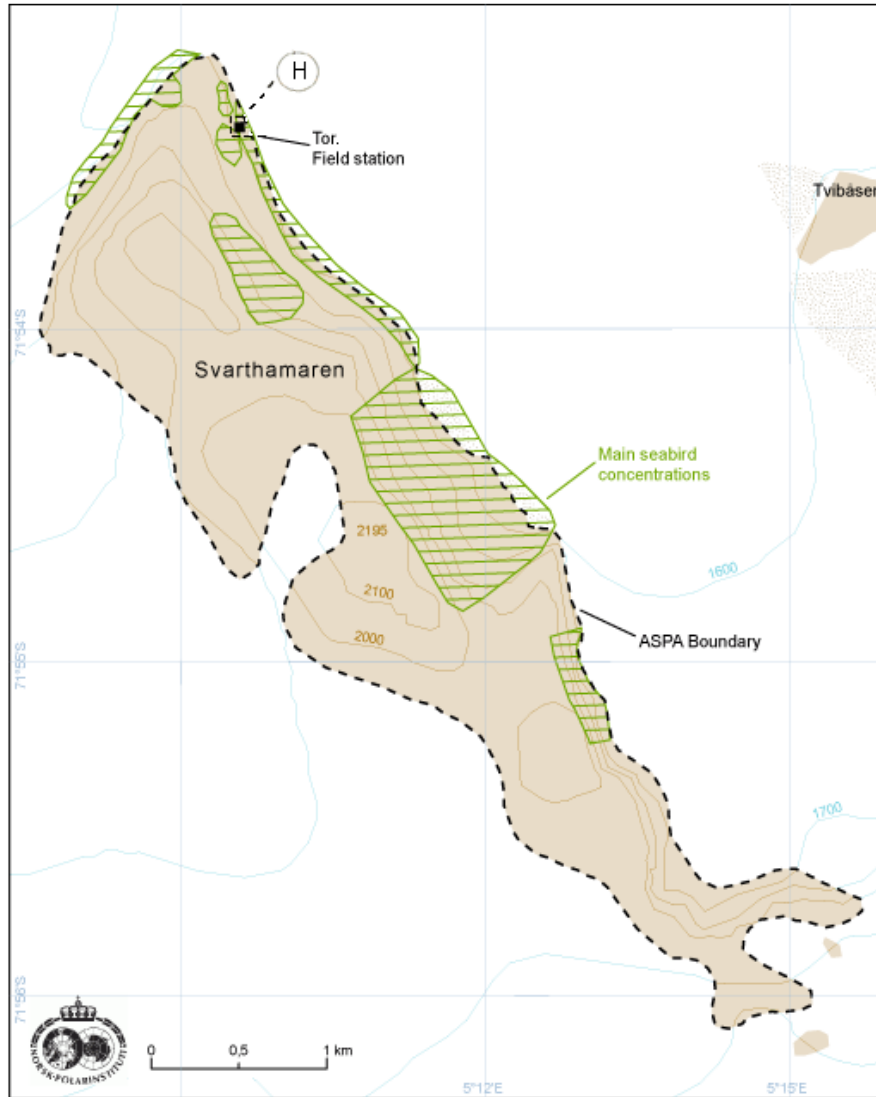


Figure 10: Svarthamaren – Antarctic Special Protected Area (ASP) 142 with placement of field station Tor.

4.2 Waste at Tor field station

4.2.1 Description

- This assessment covers waste management resulting from normal day-to-day operations at Tor.
- Waste management at the stations is in accordance with national *Antarctic Environmental Regulations (1995)*. In short, this entails that all waste, except waste water, is collected, separated and brought out of Antarctica for appropriate disposal and recycling. The following elements of the waste management procedures should be noted:

- **Waste:** All waste, garbage, food waste, waste water (in 200 liter barrels) and toilet waste is brought back to Troll station and shipped out of Antarctica for disposal.
- **Toilet system:** Tor station uses field toilets. All waste is brought back to Troll station and shipped in 200 liter drums out of Antarctica for disposal.
- **Waste responsibility:** The leader of the field activity is responsible for waste management at the field station. **Antarctic Environmental Regulations § 21.**
- NPI will ensure that waste management will fulfill the below minimum requirements and thereby be covered by this assessment. NPI will institute procedures to ensure compliance/implementation during operations:
 - **Disposal of waste:** All waste from Tor will be brought to Troll station for further treatment (cf. Troll station manual). All figures on amount and type will be recorded on an annual basis **Antarctic Environmental Regulations § 21. Environmental Protocol, Annex III, Article 4**
 - **Storage:** All waste to be removed will be stored in such a way to prevent their dispersal into the environment. **Environmental protocol, Annex III, Article 6, Antarctic Environmental Regulations § 19**
 - **Waste minimization:** The waste volume will be reduced by focusing on purchase, packing, reuse and recycling. **Environmental Protocol, Article 1**
 - **Packing:** All shredded paper, polystyrene beads, chips or similar forms of loose packaging will be replaced with bubble wrap, cardboard or paper as far as possible. **Environmental Protocol, Annex III, Article 2**
 - **Purchasing:** See chapter 9.1.
 - **Littering:** Storage will be constructed and maintained so that no littering will take place. In case of an accident or an unforeseen event all litter will be removed immediately.
 - **Training:** The person responsible for waste management, and other key personnel, will receive necessary training related to waste management issues. **Environmental Regulations § 21**

4.2.2. Alternatives

Incineration of waste is a method used by several stations in Antarctica. However, this treatment form is highly dependent of large amounts of fuel in order to ensure acceptable temperature levels and thereby minimize harmful emissions. Incineration will not be a method

used at Tor station. Use of open burning is not allowed in Antarctica **Environmental Protocol, Annex III, Article 3**

4.3 Fuel and hazardous substances at Tor station

- This assessment covers management of hazardous substances, including fuel, in the context of the normal day-to-day operations at Tor. All fuel is brought to Tor station in Jerry cans (20 liters) or drums (200 liters).
- NPI will ensure that management of hazardous substances will fulfill the below minimum requirements and thereby be covered by this assessment
 - **Spill avoidance.** When refueling vehicles, generator or refilling kerosene spill kits shall be available.
 - **Fuel storage:** Fuel will be stored so no unintentionally spill occurs.
 - **Spill handling:** All small and large fuel spills will be handled in accordance with routines specified in the Troll Station Manual. In the event of an oil spill incident in excess of 200 liters (and for oil spills less than 200 liters, if considered significant) a full Oil Spill Report will be prepared.

4.4 Water use

Water for drinking, washing and cooking at Tor station is made from melting of snow or ice. Due to the high amount of birds in the vicinity of Tor, all drinking water must be boiled for disinfection.

4.5 Energy use and electrical power

- This assessment covers power generation, in the context of the normal day-to-day station operations at Tor.
- Currently electricity is produced from a Honda 4-stroke generator 2000 Watts (2011). The generator runs on 95-octane petrol. Electric power is only used for computers and electronic equipment; maximum estimated consumption of petrol is ab. 4 liters/day. The generator at Tor will only run when there is a need of electricity; probable need is 8-10 hours pr. day.
- Tor station uses propane gas for cooking, and Jet A-1 for heating of the 20' container. There is no filtering of the combustion from the kerosene oven. The other buildings have no heating devices.
- Use of alternative energy/fuels could be considered as an alternative in order to reduce the impact (and costs) associated with conventional energy production at Tor. This will be considered further in the future planning of the station.

4.6 Impacts

Potential Environmental Impacts from operations at station Tor

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Combustion emission	<p>Air: Combustion gases released into the atmosphere can contribute to the greenhouse effect both directly and indirectly. However, in the overall emission picture (both in the Antarctic context and the global context) the contribution from the activity is relatively minor.</p> <p>Fauna: Soot and combustion products can be potentially harmful if birds get in direct contact with the substances. Although combustion products can affect birds (habitat and health), the exposure is limited due to relatively low emission levels from Troll.</p> <p>Ingestion through food not likely due to marine diet. Inhalation low due to distance from source. Exposure could in the long run affect respiratory system and other vital functions (see e.g. Maniero (1996)).</p>	<p>Extent: Local to global Duration: Short Significance: Low</p>	<p>Technology: Well maintained generators and equipment will be used and generators will not left idling unnecessary. High energy efficient fuel will be used. Continued consideration will be given to potential mechanisms to cleansing of combustion gases.</p> <p>Reduction: Efforts will be instituted to identify and implement use of alternative energy sources such as wind and sun energy in future.</p>
Emission to ground	<p>Ground: Fuel spills can be released into the ground during filling or operation. The fuels used are relatively volatile and a large portion of a spill is likely to evaporate instead of migrating into ice/ground. Contaminants that migrate into the ice will be encapsulated and remain in the ice for an indefinite period. Impacts at release time depend on point of release, but could affect biota or quality of receiving environment. Such spills will contribute to overall contamination of environment and may have bearings on future ice related research. No ice related research is currently ongoing in the area.</p> <p>Fauna: Fuel spills may occur and could produce numerous health concerns to any animal that comes into direct or indirect contact with the substance. Birds and humans that come in direct physical contact with the chemicals can suffer skin and eye lesions or chemical burns. Fuel spills at Tor have so far been few and small due to proper handling routines, and exposure is expected to be small with little impact.</p>	<p>Extent: Local Duration: Long Significance: Low</p>	<p>Avoidance: Spill equipment will be used during filling operations. Procedures will be instituted and be part of operational procedures at Tor.</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Littering	<p>Waste littering. Waste could be spread in adverse weather, or if waste is inadequately handled or secured. Associated impacts are mainly of an aesthetic nature. Break-down of litter is slow, and litter will remain. Contributes to overall contamination of environment.</p>	<p>Extent: Local to regional Duration: Short Significance: Low</p>	<p>Avoidance: Procedures to ensure that littering is avoided and that all litter is taken care of immediately will be instituted and be part of operational procedures at Tor.</p> <p>Handling: If unintentionally littering happens action will be taken to collect litter as soon as possible.</p>
Noise	<p>Fauna: Noise from helicopters or vehicles could disturb and chase away breeding birds. Noise from operating vehicles in the station area could affect breeding birds. Noise may disturb birds in a manner so that they leave their nests (and expose eggs/chicks to environment and predators), raise stress level and increase metabolism, all which could affect the fine tuned balance of energy intake and energy use (see e.g. CAFF (1998) and Giese and Riddle (1999)).</p> <p>It is expected that the limited exposure to output will be too low for any significant impact.</p>	<p>Extent: Local Duration: Short Significance: High</p>	<p>Vehicle/aircraft control: Driving/flying will be limited to that which is necessary. CEP guidelines for the operation of Aircraft near concentrations of birds in Antarctica¹⁷ will be used as guidance.</p> <p>Education: Field party shall receive adequate environmental information</p>

¹⁷ Cf. ATCM Resolution 2 (2004), available at http://www.ats.aq/documents/recatt/Att224_e.pdf

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Non-native organisms and disease	All equipment brought into Antarctica can transfer non-native species. It is to be expected that establishment of non-native species will only be possible in those species that can tolerate the conditions of the Antarctic environment. Human activity can be the cause of disease outbreaks, bringing pathogens unintentionally into Antarctica. So far few, if any, disease outbreaks are however known to have been introduced to Antarctica as a result of human activity. Disease could be detrimental to populations (Hughes, Kevin A.; Convey, Pete. 2010, Knowles et al., 1999 and Gardner et al., 1997).	Extent: Local Duration: Short Significance: Medium	Avoidance: Food wastes will be stored in a secure manner, disallowing littering into the environment. Special care will be given to poultry or other foodstuff that has a potential to inflict diseases to birdlife in the region. Procedures will be instituted and be part of operational procedures at Tor. Relevant material in the Non-native Species Manual will be used as guidance, eg. the "Checklists for supply chain managers of National Antarctic Programmes for the reduction in risk of transfer of non-native species" developed by COMNAP/SCAR (2011).

5.0 FIELD CAMPS

Field camps are likely to be established for shorter or longer periods when research is performed outside Troll and/or Tor stations.

Field camps can be placed on ice, snow or gravel/rock surfaces depending on the area where the field work will be conducted. Due to different locations and environmental conditions,

remote field activities will require submission of a separate Initial Environmental Evaluation (IEE)¹⁸, and only the general aspects of field camps are covered in this assessment.



Figure 11: 2007-2009 Norway – USA Scientific traverse (Troll – South Pole return). Photo: Norwegian Polar Institute

5.1. Land use and footprint

Field camps often consist of module containers which provide shelter for personnel and facilities for cooking and dining.

The area extent used in these camps is quite limited, and most often the camps are established on snow or ice surface.

Field camps are by nature temporary in nature, and as such requires no permanent land use and leaves no permanent footprint

¹⁸ Environmental Protocol, Article 2

5.2 Waste from field camps

This assessment covers waste management resulting from normal day-to-day operations at field camps established by NPI.

- Waste management at the camps are in accordance with national *Antarctic Environmental Regulations (1995)*. In short, this entails that all waste, including waste water, is collected, separated and brought out of Antarctica for appropriate disposal and recycling. The following elements of the waste management procedures should be noted:
 - **Waste:** All waste, garbage, food waste, waste water and human waste will be brought back to Troll station and shipped out of Antarctica for disposal.
 - **Toilet system:** In field camps field toilets are used. All toilet waste is brought back to Troll or Troll Cargo point and shipped out of Antarctica for disposal.
 - **Waste responsibility:** Leader of the field activity is responsible for waste management in field camps. **Antarctic Environmental Regulations § 21.**
- NPI will ensure that waste management will fulfill the below minimum requirements and thereby be covered by this assessment:
 - **Disposal of waste:** All waste from field camps will be transported to Troll for further treatment (**cf. Troll Station Manual**).
 - **Storage:** All waste to be removed will be stored in such a way to prevent their dispersal into the environment. **Environmental protocol, Annex III, Article 6, Antarctic Environmental Regulations § 19**
 - **Waste minimization:** The waste volume will be reduced by focusing on purchase, packing, reuse and recycling. **Environmental Protocol, Article 1**
 - **Packing:** All shredded paper, polystyrene beads, chips or similar forms of loose packaging will be replaced with bubble wrap, cardboard or paper as far as possible. **Environmental Protocol, Article 2**
 - **Purchasing:** See chapter 9.1.
 - **Littering:** All litter will be recovered immediately and handled in accordance with given procedures (**cf. Troll Station Manual**).
 - **Training:** The person responsible for waste management (i.e. leader of the field activity) and other key personnel will receive necessary training related to waste management issues. **Environmental Regulations § 21**

5.3 Fuel in field camps

- This assessment covers management of hazardous substances, including fuel, in the context of the normal day-to-day operations at Tor.

- Fuel in field camps is mainly for generators and vehicles. Depending on what kind of project and the size of the expedition, the amount and type of fuel will vary. All fuel in field camps is brought in Jerry cans (20 liters) or drums (200 liters).
- NPI will ensure that management of hazardous substances will fulfill the below minimum requirements and thereby be covered by this assessment
 - **Spill avoidance:** When refueling vehicles, generator or refilling kerosene spill kits shall be available. Fuel will be stored so no unintentionally spill occurs.
 - **Spill handling:** All small and large fuel spills will be handled in accordance with routines specified in the Troll Station Manual. In the event of an oil spill incident in excess of 200 liters (and for oil spills less than 200 liters, if considered significant) a full Oil Spill Report will be prepared.

5.4 Water use

Water for drinking, washing and cooking in field camps is made from melted snow or ice. Melting for water is done on kerosene (Jet A-1) or a gas stove.

5.5 Energy use and electrical power

- This assessment covers power generation, in the context of the normal day-to-day camp operations.
- Normally electricity is produced from portable generators. The generator runs on 95-octane petrol or jet A-1. Electric power is only used for computers and electronic equipment; maximum estimated consumption of fuel is ab. 4 liters/day. Field camps uses propane gas or kerosene/Jet A-1 for cooking, and Jet A-1 for heating of the living quarters (container). There is no filtering of the combustion from the kerosene oven. Tents normally have no heating devices.

5.6 Impacts

Potential Environmental Impacts from operations at field camps.

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Combustion emission	<p>Air: Combustion gases released into the atmosphere can contribute to the greenhouse effect both directly and indirectly. However, in the overall emission picture (both in the Antarctic context and the global context) the contribution from the activity is minor.</p> <p>Fauna: Soot and combustion products can be potentially harmful if animals get in direct contact with the substances. Although combustion products can affect animals (habitat and health), the exposure is limited due to low emission levels from field camps</p>	<p>Extent: Local to global Duration: Short Significance: Low</p>	<p>Technology: Well maintained 4-stroke generators and equipment will be used and generators will not left idling unnecessary. High energy efficient fuel will be used. Continued consideration will be given to potential mechanisms to cleansing of combustion gases.</p>
Emission to ground	<p>Ground: Fuel spills can be released into the ground during filling or operation. The fuels used are relatively volatile and a large portion of a spill is likely to evaporate instead of migrating into ice/ground. Contaminants that migrate into the ice will be encapsulated and remain in the ice for an indefinite period. Impacts at release time depend on point of release, but could affect biota or quality of receiving environment. Such spills will contribute to overall contamination of environment and may have bearings on future ice related research.</p> <p>Fauna: Fuel spills may occur and could produce numerous health concerns to any animal that comes into direct or indirect contact with the substance. Animals and humans that come in direct physical contact with the chemicals can suffer skin and eye lesions or chemical burns. Fuel spills in field camps have so far been few and small due to proper handling routines, and exposure is expected to be small with little impact.</p>	<p>Extent: Local Duration: long Significance: Low</p>	<p>Avoidance: Spill equipment will be available during filling operations. Procedures will be instituted and be part of operational procedures in field camps.</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Littering	<p>Waste littering: Waste could be spread in adverse weather, or if waste is inadequately handled or secured. Associated impacts are mainly of an aesthetic nature. Break-down of litter is slow, and litter will remain. Contributes to overall contamination of environment.</p>	<p>Extent: Local to regional Duration: Short Significance: Low</p>	<p>Avoidance: Procedures to ensure that littering is avoided and that all litter is taken care of immediately will be instituted and be part of operational procedures in field camps.</p> <p>Handling: If unintentionally littering happens action will be taken to collect litter as soon as possible.</p>
Noise	<p>Fauna: Noise from helicopters or vehicles could disturb and chase away animals. Noise may disturb birds in a manner so that they leave their nests (and expose eggs/chicks to environment and predators), raise stress level and increase metabolism, all which could affect the fine tuned balance of energy intake and energy use (see e.g. CAFF (1998) and Giese and Riddle (1999)).</p> <p>It is expected that the limited exposure to output will be too low for any significant impact.</p>	<p>Probability: Low Extent: Local Duration: Short Significance: High</p>	<p>Vehicle/aircraft control: Driving/flying will be limited to that which is necessary. CEP guidelines for the operation of Aircraft near concentrations of birds in Antarctica will be used as guidance.</p> <p>Education: Field parties shall receive adequate environmental information</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Non-native organisms and disease	All equipment brought into Antarctica can transfer non-native species. It is to be expected that establishment of non-native species will only be possible in those species that can tolerate the conditions of the Antarctic environment. Human activity can be the cause of disease outbreaks, bringing pathogens unintentionally into Antarctica. So far few, if any, disease outbreaks are however known to have been introduced to Antarctica as a result of human activity. Disease could be detrimental to populations (Hughes, Kevin A.; Convey, Pete. 2010 Knowles et al., 1999 and Gardner et al., 1997).	Extent: Local Duration: Short Significance: Medium	Avoidance: Food wastes will be stored in a secure manner, disallowing littering into the environment. Special care will be given to poultry or other foodstuff that has a potential to inflict diseases to birdlife in the region. Procedures will be instituted and be part of operational procedures in field camps. Relevant material in the Non-native Species Manual will be used as guidance, eg. the "Checklists for supply chain managers of National Antarctic Programmes for the reduction in risk of transfer of non-native species" developed by COMNAP/SCAR (2011).

6.0 MARINE VESSEL SUPPLY OPERATIONS

6.1 Description

- The activity consists of normal vessel operations associated with transport of equipment/personnel.
- The Norwegian Polar Institute’s marine operations normally take place in the South Atlantic sector of the Southern Ocean, in the area between South Africa and Dronning Maud Land. The area of interest is illustrated in Figure 6.

- The marine operations normally take place in the period primo December to primo March when the ice conditions are considered the least complicated. Ice conditions will generally be no worse than occurrence of broken up 1-year sea ice.
- Currently NPI normally charters a ship (in DROMSHIP¹⁹ context) for cargo. For the period 2009 – 2012 a contract has been made with Royal Arctic Line (Denmark). Other charters may well be contracted after this contract has been terminated. The contract between with the ship owner and Norwegian Polar Institute ensures that Norwegian law and all relevant international obligations made by the Norwegian State are followed.
- NPI will ensure that any vessel chartered by NPI or used by NPI in its operations will fulfill the below minimum requirements and thereby be covered by this assessment. If these requirements are not followed during operation, it will be regarded as a breach of contract. NPI will institute procedures to ensure vessel compliance/implementation during operations, preferably through onboard representation during the operation:
 - **Vessel type:** Vessels used during NARE operations are classified as cargo ships and/or research vessels suitable for polar operations.
 - **Vessel flag:** NPI strives to charter vessels flagged by IMO states in order to ensure compliance with IMO regulations aiming at protecting the environment. If this is not possible the Norwegian Polar Institute will oblige the vessel owners through the contract to see that relevant provisions in the following agreements are fulfilled:
 - IMO
 - MARPOL
 - **Ice class:** Vessels shall be ice strengthened, classified in accordance with IMO regulations. Until IMO regulations have been adopted (**IMO mandatory Code for ships operating in polar waters**) the vessels are to be classified preferably a minimum DNV ICE 1A Super for operations in severe ice conditions, where ice floes of 0.8 meters are anticipated.
 - **Fuel type:** No heavy fuel oils will be *used* or *carried* onboard the vessels south of 60°S. **Amendment to MARPOL Annex I (Regulations for the prevention of pollution by oil) on Special requirements for the use or carriage of oils in the Antarctic area**²⁰. MGO or similar light marine diesel fuel with reduced sulfur

¹⁹ The Dronning Maud Land Shipping network (DROMSHIP) is a non-profit, international co-operation formed by the national Antarctic operators of Norway, Germany, Belgium, Finland and Sweden to arrange joint ship transport in support of their Antarctic operations

²⁰ The amendment, which will go into force 1 August 2011, prohibits the carriage, in bulk as cargo, or carriage and use as fuel, of: crude oils having a density, at 15°C, higher than 900 kg/m³; oils, other than crude oils, having a density, at 15°C, higher than 900 kg/m³ or a kinematic viscosity, at 50°C, higher than 180 mm²/s; or bitumen, tar and their emulsions

content will be utilized. **MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships**²¹.

- **Design:** NPI will strive to charter vessels with double hull as described in IMO guidelines for ship operating in Arctic waters § 3.3.
- **Ballast water:** In order to maintain ship stability ballast water may be taken onboard to compensate for fuel used and cargo unloaded. All ballast water exchange shall be conducted in accordance with adopted Antarctic Treaty system guidelines (**ATCM Resolution 3 (2006) on Ballast Water Exchange**²²) until such guidelines have been made mandatory under IMO.
- **Garbage:** No garbage with the possible exception of food waste will be disposed of into the sea in Antarctica (south of 60°S). No waste will, unless it cannot be avoided due to unexpected circumstances, be disposed of into the sea north of 60°S. Food waste might, if no option for storage exists, be disposed into the sea, although no closer than 12 nautical miles of land or ice shelf, and only after being passed through a comminuter or a grinder^{23 24}. The vessels utilized shall have sufficient capacity to store waste (with possible exception of food waste) while operating in the area, and there shall be arrangements for transfer of such waste to appropriate receiving stations.

MARPOL Annex V and Annex IV of the Environmental Protocol to the Antarctic Treaty²⁵

- **Sewage:** Sewage will not be discharged into the sea within 12 nautical miles of land or ice shelves. Sewage which is discharged beyond this distance shall only be discharged gradually while the ship is maintaining a speed of at least 4 knots. A record book of sewage discharges will be kept. **Antarctic Environmental Regulations § 23**
- **Air Pollution:** No incineration of the following products will take place: PCBs, waste with traces of heavy metals, refined petroleum products with halogen compounds or PVC products. **MARPOL Annex VI Regulations for the Prevention of Air Pollution from Ships**²⁶
- **Oil Pollution:** No oil-contaminated water will be discharged into the sea south of 60°S. **MARPOL Annex I on Regulations for the Prevention of Pollution by Oil**²⁷

²¹ Cf. Regulation 14 on Sulphur Oxides (SOx) and Particulate Matter

²² http://www.ats.aq/documents/recatt/att345_e.pdf

²³ MARPOL Annex V www.imo.org

²⁴ Protocol to the Antarctic Treaty on environmental protection 1993 <http://lovdata.no/traktater/index.html>

²⁵ CEP Annex IV, art. 5

²⁶ Cf. Regulation 16 on Shipboard Incineration

²⁷ Cf. Regulation 15 B on Control of discharge of oil in special areas

- **Anti-fouling Paint:** Only non-toxic antifouling paint will be used on vessels contracted by NPI. The AFS Convention banning globally both the application and presence on ships hulls of TBT-based antifouling²⁸. NPI will ask for documentation that non-toxic antifouling is used in the vessels contracted.
- **Noxious substances:** No noxious substances carried in packages (marine pollutants according to the IMDG code) will be disposed into the sea. **MARPOL Annex II on Regulations for the Prevention of Pollution by Noxious Liquid Substances in Bulk**²⁹
- **Contingency plans and environmental procedures training:** Vessels utilized shall have in place reasonable preventative measures that are designed to reduce the risk of environmental emergencies and their potential adverse impact, ie. equipment, procedures, training. **Annex VI to the Environmental Protocol**³⁰
Vessels shall have available Antarctic specific contingency plans for responses to incidents with potential adverse impacts on the Antarctic environment, normally as an addition to the SOPEP plan that the vessel normally will carry. **Annex VI to the Environmental Protocol**³¹
- **Information to the crew:** The crew members on the ships contracted by Norwegian Polar Institute will receive adequate environmental information before travelling into Antarctic waters.
- **Fuel handling at ice shelf:** In order to reduce oil spills during loading of fuel at the ice shelf, all handling of fuel should be made onboard the ship into large tanks or barrels. No use of pipelines from the ship to ice shelf will be utilized during Norwegian Polar Institute operations.

6.2 Alternatives

- Not using vessel for the national Antarctic supply operations is not considered a viable alternative if Norway is to continue to conduct its program in Antarctica. Supply operations are required for transportation of equipment for the research station Troll and other terrestrial operations. Cooperation with other countries operating in Dronning Maud Land will be strived for in order to see that vessel operations are conducted in an efficient manner.
- Other timing of marine operations will increase the risk of accidents and emergency situations due to higher risk of incidents in ice covered waters. This is not considered a viable alternative.

²⁸ International Convention on the Control of Harmful Antifouling Systems on Ships, Adapted by IMO 17.09.2008

²⁹ Cf. Regulation 13 8 on Discharges in the Antarctic Area

³⁰ Cf. Article 3

³¹ Cf. Article 4

- Norway’s primary research interests in Antarctica have traditionally been in the area around and in Dronning Maud Land. Since 2005/06 the station Troll were established as a all-year station. Terrestrial activity will be centered around this station. Operations in other areas would not satisfy the national strategy for Antarctic research.

6.3 Impacts

The table indicates potential impacts and provide a summary of measures that will be instituted to minimize these impacts.

Potential Environmental Impacts from vessel operations

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Combustion emission	Combustion gases released into the atmosphere can contribute to the greenhouse effect both directly and indirectly. Operations can vary from 60 to 150 days between years. However, in the overall emission picture (both in the Antarctic context and the global context) the contribution from the activity is relatively minor.	Extent: Local to global Duration: Periodical Impact: Low	<ul style="list-style-type: none"> • Use of “clean” fuels. • Shared logistics will minimize total emission in area. Continue co-operation within DROMSHIP with this in mind.

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Fuel spill and chemicals	<p>Fuel spills may occur and could produce numerous health concerns to any animal that comes into direct or indirect contact with the substance. Mammals (whales, fur seals), reptiles (sea turtles), and various species of birds that come in direct physical contact with the chemicals can suffer skin and eye lesions or chemical burns. Fish and other invertebrates may experience fin erosion in addition to other ailments. Direct ingestion by any wildlife species commonly results in ulcers, organ damage, immune deficiency, and reproductive failure. Toxic waste and chemicals could have high impact on living organisms in Polar regions.</p>	<p>Probability: Nil to very low Duration: Periodical Impact: Medium</p>	<ul style="list-style-type: none"> • Oil spill contingency plans and equipment and training (cf. vessel requirements). • Use of environmentally friendly ship coating/paint. • Minimum class ICE-1A (or corresponding). • Navigation equipment appropriate to the circumstances to reduce the risk of failure. • Emergency equipment adapted for use in cold climates. • Ship should have the capability to contain and clean up minor deck and over side spills. • Documented expertise / experience in sailing in ice-filled waters. • Strive to charter boats with double hull. • Use of light marine diesel oils (spills will in these cases likely disperse fairly quickly due to wave and wind action).
Waste	<p>Waste spill may occur due to adverse weather or an accident. This could have great consequences for sea mammals and birdlife of the region. Birds and animals are subjected to pollution, strangulation or starvation due to this kind of pollution</p>	<p>Extent: Local to global Duration: Periodical Impact: Medium</p>	<ul style="list-style-type: none"> - No garbage to be discharged from the ship. - Food waste to be discharged no closer than 12 nautical miles from shore or ice shelf. - Sewage will not be discharged closer than 12 nautical miles from shore or ice shelf.
Noise	<p>Disturbance due to load noise/sounds has shown to have an adverse effect on breeding birds and sea mammals. This is mostly due to exposing eggs and small chicks/cubs to predators when the adult individuals are scared off their territories. Juvenile birds and eggs are likely to freeze to death due to the harsh conditions in Antarctic waters.</p>	<p>Extent: Local to global Duration: Periodical Impact: Medium</p>	<ul style="list-style-type: none"> - The use of sirens, fog horns, load radio communication or other form of unnatural load noise/sounds should not occur near sea mammals and seabirds.

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Light	<p>Birds attracted to ships by light can be injured or risks oiling by emissions from cranes and wires etc.</p> <p>Due to light conditions in the area during relevant operating season this impact is not an immediate concern for the activity described in this document.</p>		<ul style="list-style-type: none"> - The use of light when operating in darkness/dusk should be made with caution. This applies to attracting birds and sea mammals to the ship during darkness.³² - Record all incidents of bird strikes through appropriate internal reporting mechanisms. Consideration might be given to training programmes for members of the ship's crew to deal with bird strikes. - Institute appropriate cautionary procedures if there is an increase in observed incidents involving bird strikes.
Non-native organisms and disease	<p>In the case of ships, introductions may take place via ballast water exchange or by fouling of the hull and sea chests (recessed intake areas for seawater used in the ship's operation). The physiology of typical fouling organisms from various parts of the world is a neglected research area.</p> <p>The only non-native marine species that are likely to become established are those that can tolerate Antarctic conditions. However, since many marine environments are similar, e.g., in terms of temperature and salinity, the possibility must be taken seriously.</p>	<p>Extent: Local to regional Duration: Long Impact: Low</p>	<p>Hull fouling will be cleaned from mussels and other alien species attached to cavities in the construction before entering Antarctic waters. Measures will be taken to avoid spreading alien species from north to south. Special attention will be given to ships operating in Arctic oceans not to spread species that could survive in Antarctic waters.</p> <p>Ballast water exchange in accordance with guidance in ballast water guidelines</p>

³² http://www.ats.aq/documents/ATCM33/wp/ATCM33_wp012_e.doc

7.0 AIRCRAFT AND HELICOPTER OPERATIONS

7.1 Aircraft operations

7.1.1 Description

- The assessment covers aircraft operations for the purpose of transport of personnel and equipment to/from the continent, normally to the airfields at Troll or Novolazarevskaya (Russia)³³.
- The assessment further covers helicopter operations for the purpose of transport of equipment to/from supply vessel, for transport of research parties to field operations and for implementing fieldwork in areas where ground transport is difficult or dangerous.
- Flight operations normally take place during primo November to primo March. Flights outside this period will only be considered if an emergency situation occurs, this due to lack of SAR capacity in the area and climate/weather conditions.
- NPI charters air support directly to Troll Airfield or through the DROMLAN network. The contract between with the aircraft operators and Norwegian Polar Institute ensures that all relevant national and international obligations made by the Norwegian State are met.
- All flights are well planned in due time before the start of the season to avoid unnecessary traffic.
- NPI will ensure that any aircraft chartered by NPI or used by NPI in its operations will fulfill the below minimum requirements and thereby be covered by this assessment. If these requirements are not followed during operation, it will be regarded as a breach of contract. NPI will institute procedures to ensure aircraft compliance/implementation during operations:
 - **Aircraft type:** Aircrafts used during NARE operations are suitable for polar operations.
 - **Emission to air:** Combustion gases will be reduced to a minimum by using latest possible technology in aviation, i.e. engines, propellers and turbines to the greatest extent possible.
 - **Noise:** The noise level will be minimized by using modern aircrafts with less noise and by flying at altitudes that ensures no disturbance on bird, animals or personnel.
 - **Protected areas:** No aircraft will land in a protected area unless special permission has been granted. The only Antarctic Specially Protected Area located

³³ These two airfields are part of a hub connecting the other international research stations in Dronning Maud Land. These are part of the DROMLAN “Dronning Maud Land Air Network Project” cooperation.

in the area of normal NARE operations is ASPA No. 142 (Svarthamaren). No flying of aircraft is allowed over and no landings are allowed within the boundaries of this area³⁴.

- **General flight conduct:** All flights will be conducted in accordance with Guidelines for the operation of aircraft near concentration of birds in Antarctica³⁵. Flights in the vicinity of seabird colonies or congregations of mammals will be avoided.
- **On-ground facilities:** All on-ground infrastructures in Antarctica utilized by aircraft operators/supporters shall be run in accordance with the **Protocol on Environmental Protection to the Antarctic Treaty**.
- **Risk reduction:** To reduce the risk of aircraft accidents the pilots should have experience from operating in Polar Regions or similar conditions. All air operations to/from and within Antarctica should follow international safety demands (i.e. ICAO) and follow procedures stated in the Antarctic Flight Information Manual (AFIM)³⁶.
- **Contingency plans and environmental procedures training:** Air operators shall have in place reasonable preventative measures that are designed to reduce the risk of environmental emergencies and their potential adverse impact, i.e. equipment, procedures, training.
- **Environmental information:** Crew members shall receive adequate environmental information before entering Antarctic air space.
- **Field activities:** When aircraft or helicopters are to be used as a main component in field activities or construction work this activity should be covered by the environmental assessment required for the project.

7.1.2 Alternatives

7.1.2.1 Not using aircraft or helicopters for operations

Up until the 2000-2001 season, NARE relied solely on seaborne transport of personnel. Since the 2008-2009 season all personnel transport has been airborne, arranged through the DROMLAN Network. In future only personnel doing marine research or research along the ice sheet can reasonably be transported by vessel. The flexibility gained by using aircraft is considered essential. Air transport reduces the length of time personnel are on site, thus

³⁴ Management plan available at http://www.ats.aq/documents/recatt/Att426_e.pdf

³⁵ ATCM Resolution 2 (2004), available at http://www.ats.aq/documents/recatt/Att224_e.pdf.

³⁶ Published by COMNAP as a tool towards safe air operations in Antarctica as per Antarctic Treaty Consultative Meeting (ATCM) recommendation XV-20 (Paris 1989)

limiting the pressure on the stations and the surrounding environment. Efficient transport to and from the continent reduces the amount of time personnel are unable to carry out their ordinary duties. Efficient transport within the continent means that less time and fewer resources are spent on ground transport of personnel to and from the place of arrival/departure. Flexibility as to when the personnel arrive on the continent helps accommodate the needs of research projects, and that personnel do not have to spend more time on the continent than necessary.

Flying personnel to the continent entails less combustion than if they are transported by ship. International cooperation to coordinate transport of equipment on a single vessel per season also reduces the total combustion for all operations in Dronning Maud Land.

7.1.2.2 Different temporal framework

A different timing of flight operations would increase the risk of accidents and emergency situations due to difficult flight conditions. Moreover, the discussion in the previous paragraph shows that timing issues generally favour flying over seaborne transport. This is not considered a viable alternative³⁷.

7.1.2.4 Different geographic region

Norway's primary research interests in Antarctica have traditionally been in the area around and in Dronning Maud Land. This is likely to continue to be the main area of focus. Aircraft and helicopter operations in other areas would not satisfy the national strategy for Antarctic research. In certain cooperative projects with other nations outside Dronning Maud Land, NARE have used aircraft operations for transporting equipment and personnel (i.e. IPY 2007-2008). This could also be considered likely in the future.

7.2 Troll Airfield operations

- In the period 2005-2011 an average of 15 flights were performed annually.
- The Troll Airfield was established in 2003. This was due to increased need for several large runways in Dronning Maud Land for reasons of increased safety for flights in the area and the increased activity at Troll Station. The timeframe for using the airfield is the austral summer October – March. The airfield is situated at the northern part of

³⁷ In 2008 one staff member was transported from Troll Airfield one month earlier than flights normally take place in Dronning Maud Land. This was due to an emergency situation.

Jutulsessen Mountains at 71°57'42"S, 2°27'35"E. Closest ice-free area is ab. 6 km from the runway.

- The airfield is established to accommodate aircrafts operated by all the national programs in DML. Troll Airfield is part of a triangular flight pattern between Cape Town, Novolazarevskaya and Troll, and provides a back-up runway for the runway at Novolazarevskaya
- A number of different aircraft types are able to utilize the Troll Airfield. Airplanes on both wheels and ski that do not need more than 3000 meters for landing are capable to utilize Troll Airfield. NPI will ensure that all aircraft that utilize Troll Airfield adhere to the same rules/requirements
- Around 10 intercontinental flights per season can be expected in the event that Troll Airfield becomes the primary hub for flights associated with the Norwegian Antarctic program. The number of intercontinental flights depends on how much through-traffic spins off the intercontinental traffic. This is likely to vary widely between flights and seasons.
- Fuel is stored in drums at Troll station and transported to the airfield when needed. In the future it is likely that fuel will be stored at in larger container tanks which will be transported from Troll station to the airfield at need.
- Due to the close proximity of Troll station there is only a minimal of ground facilities at the runway. Services that are considered necessary to operate the runway include weather and communication services, as well as medical services for emergency situations. There is a container unit (standard 20' container) for communication equipment and a 5 kW generator. There is also an Emergency Airfield Lighting System for use in the dark season available. There is a second similar container unit for storage of rescue and firefighting equipment, as well as contingency equipment. The fire-fighting equipment consists of AB fire extinguishers. In addition there are numbers of oil spill kits available for operations.
- Due to the nearby location of Troll Station any accommodation and meals for transfer passengers will take place there. A passenger transit hall (tent) is mounted seasonally to accommodate transit passengers during short ground stops.
- Transport to Troll Station is performed by 4WD car or by bandwagon depending on the amount of passengers/crew. The procedures during landing and take-off adhere to the current contingency plan for Troll Station³⁸.
- Runway grooming is done with a heavy-duty snow and ice grinder/blower. This treatment is only required when the surface is not affected by melting. The ice and

³⁸ Updated on an annual basis.

snow is deposited at the leaside of the runway. The personnel at Troll utilize several snow groomers for preparation and maintenance. Grooming of the airstrip adhere to the contingency plan for Troll Station.

- NPI will ensure that operation of the Troll Airfield will fulfill the below minimum requirements and thereby be covered by this assessment:
 - **Fuel handling:** No fueling of aircrafts or helicopters will normally take place outside Troll Airfield. Spill kits are to be used during operations. The personnel at Troll station are responsible for refueling aircrafts at Troll airfield and to ensure that the necessary precautionary and mitigation measures are taken during operations.
 - **Waste treatment:** All waste generated at the airfield will be secured and transported to Troll station for further treatment and storage.
 - **Tourism:** The Troll Airfield will not be utilized for purposes other than governmental activities (ie. the airfield will not be utilized as starting point for tourism and other non-governmental activities). NPI do not hold the capacity and resources to support tourist activities. There are no plans or wishes to build such capacity in future.

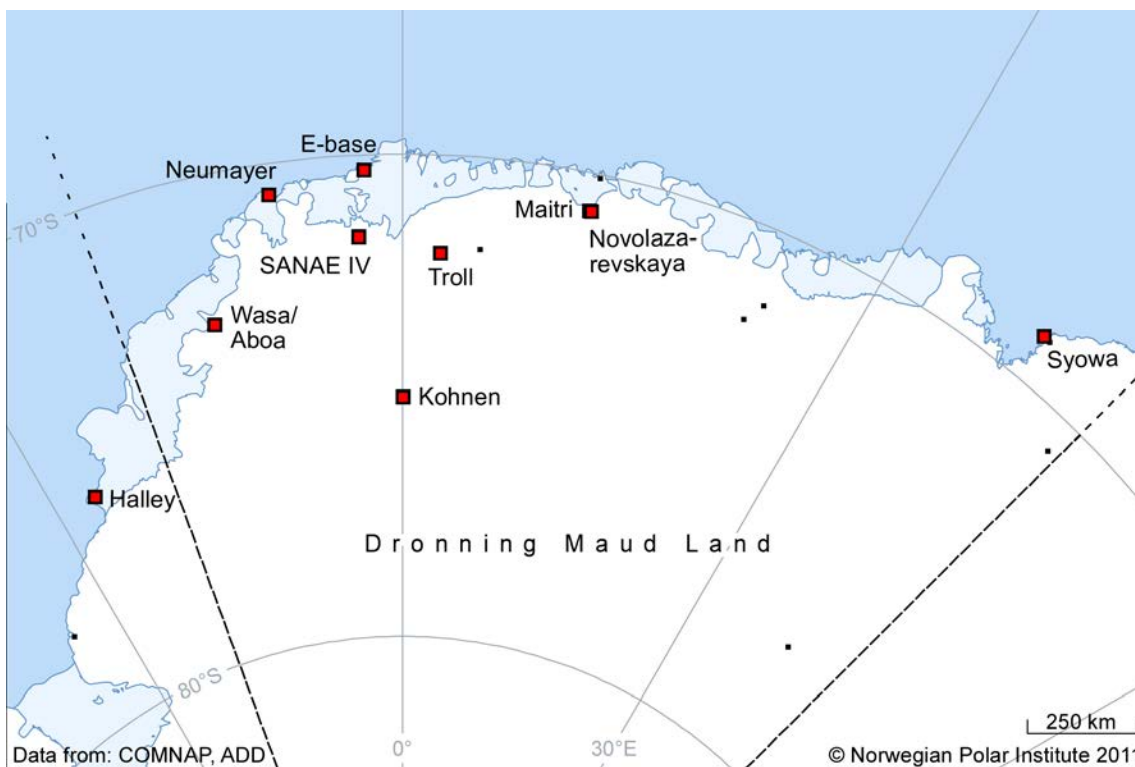


Figure 12: Map of Dronlan network (NPI 2011)

7.3 Alternatives to activity

- The only true alternative to using the Troll Airfield is to continue using Novolazarevskaya Airfield as the main landing site in DML. This alternative will still entail the need to maintain and operate a small runway for feeder link operations (from Novolazarevskaya) to support the NARE operations.
- The Novolazarevskaya Airfield will be less available during periods with extensive melting during midsummer.
- There is also a matter of safety being able to receive large aircrafts at Troll Airstrip outside season during emergency operations.
- Having only the airstrip at Novolazarevskaya without an alternate landing strip at Troll will reduce the general safety level of all intercontinental flights to DML

7.4 Impacts

Potential Environmental Impacts from aircraft, helicopter and runway operations

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Combustion emission	<p>Combustion gases released into the atmosphere can contribute to the greenhouse effect both directly and indirectly.</p> <p>Air quality in general may be affected by releasing combustion compounds into the atmosphere. Could affect atmospheric research in the region.</p>	<p>Probability: Certain Extent: Local to global Duration: Very long Significance: Low</p>	<ul style="list-style-type: none"> • Emissions are inevitable but will be minimized by well planned logistics to reduce flights. • Use of high energy efficient fuel • Shared logistics will minimize total emission in area. Continue co-operation within DROMLAN with this in mind. • Well maintained vehicles will be used and not left idling unnecessary.

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Fuel spill	<p>Fuel spills may occur and could produce numerous health concerns to any animal that comes into direct or indirect contact with the substance. Birds and humans that come in direct physical contact with the chemicals can suffer skin and eye lesions or chemical burns. Direct ingestion by any wildlife species commonly results in ulcers, organ damage, immune deficiency, and reproductive failure. Toxic waste and chemicals could have high impact on living organisms in Polar regions.</p>	<p>Probability: Low Extent: Local Duration: Long Significance: Low</p>	<ul style="list-style-type: none"> • Oil spill contingency plans and equipment and training (cf. aircraft requirements) • Due care and attention, use of appropriate spill prevention material when refueling, reinforced by education and training.
Littering	<p>No garbage is to be discharged during flight operations or operations at Troll.</p> <p>No sewage should be discharged on ice or snow.</p>	<p>Probability: Low Extent: Local Duration: Short Significance: Low</p>	
Noise	<p>Noise from aircrafts could disturb and chase away breeding birds, with great impact on eggs and chicks due to the extreme conditions in Antarctica.</p>	<p>Probability: Low Extent: Local Duration: Short Significance: High</p>	<p>Adhere to AFIM and CEP guidelines. Pilots and crew shall receive environmental information before entering Antarctic airspace.</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Non-native organisms and disease	<p>In the case of aircrafts, introductions may take place via the landing wheels/skis or via equipment/cargo carried in to Antarctica.</p> <p>It is to be expected that establishment of non-native species will only be possible in those species that can tolerate the conditions of the Antarctic environment.</p> <p>Helicopters used in the Arctic regions could possibly bring arthropods, seeds and/or plants of alien species to Antarctica.</p>	<p>Probability: Medium</p> <p>Extent: Local</p> <p>Duration: Short</p> <p>Significance: Low</p>	<p>Measures will be taken to avoid spreading alien species from north to south. Special attention will be given to aircrafts operating in Arctic areas not to spread species that could survive in Antarctica.</p> <p>Relevant material in the Non-native Species Manual will be used as guidance, eg. the "Checklists for supply chain managers of National Antarctic Programmes for the reduction in risk of transfer of non-native species" developed by COMNAP/SCAR (2011)</p>

8.0 SHELF AND TRAVERSE OPERATIONS

8.1 Description

All fuel, foodstuff and building materials for Troll station and the Norwegian operations in Dronning Maud Land are delivered at Troll Cargo Site by marine vessel, see Figure 6. The goods are transported to Troll on sleds pulled by strong vehicles. The distance from Troll to Troll Cargo Site is approximately 280 Km (2011). The trip takes ca. 2.5 days utilizing 12 hour shifts; normally the convoy takes normally 6 days back and forth. The vessel arrives at the ice shelf mid December and all the on/offloading of cargo is done within about a week. The 10-12-person crew that handles operations on the shelf uses the toilet and washing facilities aboard the ship when they are at the shelf.

8.2 Land use and footprint

The traverse is performed on snow and ice from Troll to the ice shelf, "Troll Cargo Site", the distance is ca. 280 km (2011). No part of the traverse is involving ice free ground.

8.2.1 Alternatives

Due to the amount of cargo delivered annually there is no alternative to shelf operations. Smaller amount of fresh food and delicate equipment are brought with air cargo to Troll Airfield.

8.3 Use of vehicles

The cargo is currently transported with 4-5 Everest vehicles going 10-12 trips back and forth to Troll Station and the ice shelf every season.

8.4 Waste

All waste produced during transport shall be returned to Troll station for further treatment in accordance with Troll Station Manual. During traverse field toilets are used and all waste is brought back to Troll station for further storage and transport. Small amounts of waste water and urine may be left on snow or in crevasses.

Waste containers brought to the shelf are secured and stored ca. 600 meters from the ice shelf awaiting loading onto ship for transport out of Antarctica. No waste (or other cargo) is stored on the shelf during the austral winter season.

8.5 Management of fuel and hazardous substances

All fuel handling and refueling during the transport between Troll and the ice shelf is in accordance with Troll Station Manual.

Fueling of Fuel container 11000 liter is done within the ships premises, and lifted into the ice shelf directly on to the sleds. This is done to avoid leakage from unsafe couplings or pipelines.

8.6 Power supply

No 220 V electrical power is normally utilized during transport.

8.7 Water supply

All drinking water during transport operations is brought from Troll station.

8.8 Impacts

Potential Environmental Impacts from shelf operations.

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Combustion emissions	<p>Combustion gases released into the atmosphere can contribute to the greenhouse effect both directly and indirectly.</p> <p>Air quality in general may be affected by releasing combustion compounds into the atmosphere. Could affect atmospheric research in the region.</p> <p>Use of kerosene or Jet A-1 for heating the field camp releases combustion gases. Use of kerosene for cooking will release combustion gases.</p>	<p>Probability: Certain Extent: Local to global Duration: Short Significance: Low</p>	<ul style="list-style-type: none"> • Well maintained vehicles will be used and not left idling unnecessary • Use of high energy efficient fuel
Fuel spills	<p>Fuel spills may occur and could produce numerous health concerns to any animal that comes into direct or indirect contact with the substance. Birds and humans that come in direct physical contact with the chemicals can suffer skin and eye lesions or chemical burns. Direct ingestion by any wildlife species commonly results in ulcers, organ damage, immune deficiency, and reproductive failure. Toxic waste and chemicals could have high impact on living organisms in Polar regions.</p> <p>Transport with band-wagons or snow-mobiles is performed on ice or snow and the footprint on these surfaces is minimal.</p>	<p>Probability: Low Extent: Local Duration: Long Significance: Low</p>	<ul style="list-style-type: none"> • Oil spill contingency plans and equipment and training (cf. station contingency plans) • Due care and attention, use of appropriate spill prevention material when refueling, reinforced by education and training.
Waste	<p>Waste spill may occur due to an accident during ground operations. Strong winds could move garbage large distances away from field camps.</p>	<p>Probability: Low Extent: Local to regional Duration: Short Significance: Low</p>	<p>No garbage is to be discharged during flight or ground operations in field.</p> <p>No sewage should be expelled on ice or snow. Field camps uses field toilets, and the waste is brought back to Troll and shipped out of Antarctica for disposal.</p> <p>Due care and attention, reinforced by education and training</p>

Output	Description and evaluation of potential impact	Summary of impact	Measures to reduce impact
Noise	Noise from vehicles could disturb and chase away breeding birds, with great impact on eggs and chicks due to the extreme conditions in Antarctica.	Probability: Low Extent: Local Duration: Short Significance: High	Field crew and scientists shall receive adequate environmental information.
Non-native organisms and disease	<p>Equipment used in the Arctic regions could possibly bring arthropods, seeds and/or plants of alien species to Antarctica.</p> <p>Field equipment used in the Arctic region can transfer non-native species to Antarctica. It is to be expected that establishment of non-native species will only be possible in those species that can tolerate the conditions of the Antarctic environment.</p>	Probability: Medium Extent: Local Duration: Short Significance: Medium	<p>Measures should be taken to avoid spreading alien species from north to south. Special attention will be given to vehicles and equipment operating in Arctic areas not to spread species that could survive in Antarctica.</p> <p>Relevant material in the Non-native Species Manual will be used as guidance, eg. the "Checklists for supply chain managers of National Antarctic Programmes for the reduction in risk of transfer of non-native species" developed by COMNAP/SCAR (2011)</p>

9.0 OTHER ISSUES

9.1 Purchasing

Certification of products and services is based on compliance with stringent environmental criteria that are established in consultation with industry, environmental groups, and independent experts and are based on research into the life-cycle impacts of a product or service.

In order to decrease human impacts on the Antarctic environment it is important to minimise the environmental effects stemming from the daily use of material and equipment. One way of encourage this is to use green procurement, i.e. take into account and compare environmental

considerations when purchasing goods, services or works. By purchasing wisely, you can save materials and energy and reduce waste and pollution.

In practice this means that the person responsible for procurement in NPI will emphasize pollution prevention as a natural part of the purchasing process. Some general examples are;

- Products manufactured from recycled materials,
- Environmentally preferable products,
- Energy efficient products,
- Bio based products,
- Alternative fuels and fuel efficient vehicles,
- Non-ozone depleting substances, and,
- Products complying with state of the art environmental solutions.

A 10 question check list has been developed as aid in the procurement process. See Appendix 4.

9.2 Training and education

All NPI personnel receive adequate environmental training and education before entering Antarctica. This to ensure they have the knowledge needed and the attitude required for operating according to the national Antarctic environmental regulations (1995) and the Troll Station Manual (2011).

“Environmental education is the process of recognizing values and clarifying concepts in order to develop skills and attitudes necessary to understand and appreciate the inter-relatedness among man, his culture and his biophysical surroundings. This also entails practice in decision-making and self-formulation of a code of behaviour about issues concerning environmental quality” (IUCN, 1970)

9.3 Removal of the station

Removal of Troll and/or Tor stations are not part of the Multi-year Initial Environmental Evaluation for the operational aspects of Norwegian Antarctic Research Expeditions 2000-2010 (NPI, 2000) nor FINAL Comprehensive Environmental Evaluation (CEE) for the upgrading of the Norwegian summer station Troll in Dronning Maud Land, Antarctica, to permanent station (NPI, 2004). A separate IEE for the removal of either of the stations must be prepared in accordance with Antarctic Environmental Regulations § 10.

10 MONITORING

All possible environmental impacts described in this document shall be monitored and reported. A Monitoring handbook will be prepared and shall be part of the Troll Station Manual.

The aims of the monitoring program will be to:

- assess whether the actual impacts from the activity are as anticipated
- establish the geographic extent of impact, and assess any changes to this "footprint"
- provide a basis on which to initiate processes to mitigate and minimize impacts
- assess changes in intensity of activity
- ensure that the activity is carried out in accordance with international agreements and national legislation

Currently the monitoring program bases itself mainly on registration of activity, ie. fuel consumption, fuel spills, presence at station (person days), waste produced, etc.

The goals of the monitoring program will remain the same, but an updated practical monitoring plan will be developed in order to take into account the new operational framework as well as take advantage of the opportunities the all-year presence gives for more specific and analytic monitoring.

11 CUMULATIVE IMPACTS

The Jutulsessen area is a relatively pristine and untouched area, with the exception of the impact created by the Norwegian station facilities at Troll. Although some research has taken place in the local area, most activities that use Troll as logistical hub has in fact been conducted in more remote areas. The Jutulsessen area has consequently mostly been visited only for recreational purposes by the core personnel at Troll station.

The relatively major changes currently occurring in the area, i.e. increase in air traffic and upgrading of Troll to an all-year station, the related influx of national program personnel and the potential increase in non-governmental activities, will all have bearings on the level of activity in the area of the planned activity. It must be expected that the Jutulsessen area will experience a higher intensity with respect to use of the area, be it recreational activities, expansion of existing facilities, establishment of new facilities, etc. The following may be noted in this respect:

- The activity in the area continues to grow with respect to fuel combustion and thereby a higher level of emission to air. The total level of emission is still relatively low, compared both to global values and to comparable operations in Antarctica, and relative to levels considered harmful to the environment. The cumulative consequences for the local environment are therefore not considered significant.
- Stress for the seabirds in the Jutulsessen area may increase due to the increased activity level, but overall impacts on fauna are expected to be quite limited
- The ice-free areas in the interior of Antarctica are relatively rare, and are as such vulnerable. All the on-going activity in the Troll area adds pressure on the land use. Although the station building mass has expanded and continues to expand with the upgrading to an all-year station, the area affected by the building mass will remain relatively constant, as expansion will occur within the perimeters of the already affected station area (cf. land use plan). The Troll Airfield is prepared on the blue-ice, and does not as such directly affect the ice-free areas. An unknown, and somewhat unpredictable factor, is the future potential addition of

research and monitoring facilities associated with the station. Stipulating that a total area of 5 km² would be impacted directly by station and facility operations in the future, less than 2% of the ice-free ground in the Jutulsessen area would be affected.



Figure 13: Wilderness is associated with the concept of no physical human presence.

- With the upgrading of Troll to an all-year station, atmospheric research and monitoring are important elements of the research established. This requires a clean environment (pollutants/noise), and continued efforts will therefore be made to ensure limited impact on the science, which also will have positive consequences with regard to environmental impacts.
- Wilderness and aesthetic values will be affected by the new elements introduced into the environment. However, since this is an area that is already affected by ongoing activity, the cumulative impact is expected to be quite limited.

12 REFERENCES

Antarctic Flight Information Manual (AFIM) 1989

ATCM. 2004. ATCM XXVII Information Paper 109: The Dronning Maud Land Air Network (DROMLAN). Submitted by Norway and Russia.

Bintanja, R. 1999. "On the glaciological, meteorological, and climatological significance of Antarctic blue ice areas". *Reviews of Geophysics* 37 (3): 337-359.

CAFF Circumpolar Seabird Working Group. 1998. Cambell et al., Human disturbance at Arctic Seabird Colonies.

CEP (Committee for Environmental Protection). 1999: Guidelines for Environmental Impact Assessment in Antarctica. Adopted as ATCM Resolution 1 (1999).

COMNAP/SCAR. 2011: "Checklists for supply chain managers of National Antarctic Programmes for the reduction in risk of transfer of non-native species"

Dallmann, Winfried K., Håkon Austrheim, Kurt Bucher-Nurminen and Yoshihide Ohta. 1990. Geology around the Norwegian Antarctic Station 'Troll', Jutulessen, Dronning Maud Land. Norwegian Polar Institute Meddelelser No. 111.

Gardner, H., K. Kerry, M. Riddle, S. Brouwer, L. Gleeson. 1997: "Poultry virus infection in Antarctic penguins". *Nature*, 387 (6630), p. 245.

Giese M. and M. Riddle. 1999. "Disturbance of emperor penguin *Aptenodytes forsteri* chicks by helicopters". *Polar Biology* 22 (6): 366-371

Hughes, Kevin A.; Convey, Pete. 2010 The protection of Antarctic terrestrial ecosystems from inter and intra-continental transfer of non-indigenous species by human activities: a review of current systems and practices. *Global Environmental Change*, 20 (1). 96-112.
<http://dx.doi.org/10.1016/j.gloenvcha.2009.09.005>

Knowles, K., M. Riddle and J. Clarke. 1999: Diseases in Antarctic Wildlife – A report on the workshop on diseases in Antarctic Wildlife (hosted by the Australian Antarctic Division August 1998).

Komarkova, V. 1983: "Plant communities of the Antarctic Peninsula near Palmer Station". *Antarctic journal of the United States*, 18(5), 216-218

Maniero, T.G. 1996. "The effects of air pollutants on wildlife and implications in Class I Areas". National Park Service. Available on www.aqd.nps.gov/ard/wildl.htm .

MoE (Ministry of the Environment)1995: Regulations Relating to protection of Environment in Antarctica

NIVA (Norwegian Institute for Water Research). 1991. Blågrønnalger og alger fra Dronning Maud Land. Gjelsvikfjella og Muhlig-Hofmannfjella (Blue-green algae and algae from Dronning Maud Land. Gjelsvikfjella and Muhlig-Hofmannfjella). Memorandum on analyses results.

NIVA (Norwegian Institute for Water Research). 2000: Analysis Report (2000-428): Evaluation of drinking water at Troll, Antarctica.

Njåstad, B. 2000: Multi-year Initial Environmental Evaluation for the operational aspects of Norwegian Antarctic Research Expedition 2000-2010. Norsk Polarinstitutt Intern rapport Nr. 4.

NPI (Norwegian Polar Institute). 1990: Establishment of Troll, a new station facility for summer operations. Initial Environmental Evaluation” Norwegian Polar Institute Report No. 65.

NPI (Norwegian Polar Institute). 1990b. Report of the Norwegian Antarctic Research Expedition 1989/90. O. Orheim (ed.). Meddelelser nr. 113.

NPI (Norwegian Polar Institute). 1999: Initial Environmental Evaluation: Upgrading of the Norwegian Research Station Troll, Dronning Maud Land, Antarctica.

NPI (Norwegian Polar Institute). 1999b: Miljøovervåkingsprogram for Norwegian Antarctic Research Expedition (Environmental Monitoring Program for NARE).

NPI (Norwegian Polar Institute), 2002: Initial Environmental Evaluation. Construction and operation of Troll Runway. Norsk Polarinstitutt.

Ohta, Y (ed). 1993. Nature environment map, Gjelsvikfjella and Western Muhlig-Hofmannfjella, Dronning Maud Land, Antarctica, 1:100 000.

Smith, R.I.L. 1996: “Introduced plants in Antarctica: potential impacts and conservation issues”. *Biological conservation*, 76 (2), 135-146.

Suttie, E.D and E.W. Wolff. 1993: " The local deposition of heavy-metal emissions from point sources in Antarctica". *Atmospheric Environment Part A-general topics*. 27 (12), 1833-1841.

Warren, S.G. and A.D. Clarke. 1990: “Soot in the atmosphere and snow surface of Antarctica”. *Journal of Geophysical Research*, 95 (D2), pp. 1811-1816.

Winther, J-G., M.N. Jespersen, G.E. Liston. 2001. “Blue-ice areas in Antarctica derived from NOAA AVHRR satellite data”. *Journal of Glaciology* 47 (157), 325-334.

Wolff, E. 1992. “The influence of global and local atmospheric-pollution on the chemistry of Antarctic snow and ice”. *Marine Pollution Bulletin* 25 (9-12), 274-280.

13 APPENDIXES

Appendix 1: Considering the Environment: Troll

In considering the value of an environmental element the following terms have been used:

N/A: Values not present.

Low: The loss of the environmental elements would at the most have bearings on the local environment, in this instance the Troll station area and the immediate surrounding area.

Medium: The loss of the environmental elements could have bearings on the regional environment, in this instance Jutulsessen area, or could affect science or station operations.

High: The loss of the environmental elements could have significant bearings for the overall environment in Antarctica.

Environmental Element	Description	Value
Flora	<p>Elements:</p> <ul style="list-style-type: none"> - Limited flora is present on location. - Sparse occurrences in the Jutulsessen mountains (lichens and algae) <p>Consideration of values:</p> <ul style="list-style-type: none"> - No unique occurrences/assemblages have been registered in the local area. - Relatively undisturbed outside the local area <p>Background information:</p> <ul style="list-style-type: none"> - NPI (1990) - Ohta (1993) - NIVA (1991) 	Low
Fauna	<p>Elements:</p> <ul style="list-style-type: none"> - Micro-fauna is present on location in limited amounts. - Two small snow petrel colonies in the vicinity of Troll – Nonshøgda to the north and an area just south of the station. Sporadic occurrences of 	Low

Environmental Element	Description	Value
	<p>skua in station area and Jutulsessen in general.</p> <ul style="list-style-type: none"> - A number of larger seabird colonies are located in the more remote and inaccessible parts of Jutulsessen <p>Consideration of values:</p> <ul style="list-style-type: none"> - No unique occurrences registered. - Relatively undisturbed outside the local area. <p>Background information:</p> <ul style="list-style-type: none"> - NPI (1990) - Bye (1993) - Ohta (1993) 	
Freshwater	<p>Elements:</p> <ul style="list-style-type: none"> - Freshwater reservoir in the blue ice in the station area <p>Consideration of values:</p> <ul style="list-style-type: none"> - Was formerly valuable to operations (as drinking water), but not considered environmentally unique. <p>Background information:</p> <ul style="list-style-type: none"> - NPI 	Low
Sea water	Not present on location.	N/A
Soil	<p>Elements:</p> <ul style="list-style-type: none"> - Ground cover in station area <p>Consideration of values:</p> <ul style="list-style-type: none"> - Ground cover in station area affected by near 15 years of operations at Troll station. - No unique occurrence. 	Low

Environmental Element	Description	Value
	<p>Background information:</p> <ul style="list-style-type: none"> - Ohta (1993) 	
<p>Air</p>	<p>Elements:</p> <ul style="list-style-type: none"> - Air <p>Consideration of values:</p> <ul style="list-style-type: none"> - Air is relatively pristine as only affected by operations at Troll - Atmospheric research currently on-going in the area, this is important in the context of the all-year station using 24/7 Diesel generators. <p>Background information:</p> <ul style="list-style-type: none"> - Njåstad (2000) 	<p>Medium</p> <p>(pollution will affect research)</p>
<p>Ice</p>	<p>Elements:</p> <ul style="list-style-type: none"> - Blue ice area next to station. <p>Consideration of values:</p> <ul style="list-style-type: none"> - Not significantly affected by earlier activity. - No unique ice conditions registered in the area. - Blue ice covers only 1% of Antarctica – relatively rare type of surface. - Common surface condition in the region <p>Background information:</p> <ul style="list-style-type: none"> - Bintanja, R (1999) - Winther, Jespersen & Liston (2001) 	<p>Low</p>
<p>Geology</p>	<p>Elements:</p> <ul style="list-style-type: none"> - The Troll station is located in the Jutulsessen nunataks (description provided in chapter 3.1) <p>Consideration of values:</p>	<p>Low</p>

Environmental Element	Description	Value
	<ul style="list-style-type: none"> - No unique geologic elements registered in association with the Jutulsessen mountains. - Area interesting for geological research due to good exposure of elements <p>Background information:</p> <ul style="list-style-type: none"> - Dallman et al. (1990) - Ohta (1993) 	

Environmental Element	Description	Value
Wilderness	Wilderness is associated with the concept of no physical human presence. As this is an area with station facilities and associated activities, it is considered that wilderness is not present in the station area.	N/A
Aesthetics and intrinsic values³⁹	<p>Elements:</p> <ul style="list-style-type: none"> - Isolated and visually pleasing area, although obstructed by existing station facilities. <p>Consideration of value:</p> <ul style="list-style-type: none"> - The Jutulsessen Mountains are not very high, steep or unique in any manner and other areas of the DML nunataks are more spectacular and are likely to be considered of higher aesthetic and intrinsic value. 	Low
History	No historic sites or monuments (HSM).	N/A

³⁹ Aesthetic value can for example be defined as "the response derived from the experience of the environment or particular natural and cultural attributes within it. This response can be to either visual or non-visual elements and can embrace emotional response, sense of place, sound, smell and any other factors having a strong impact on human thought, feelings and attitudes" (Australian Heritage Commission & Department of Conservation and Natural Resources 1994, p. 5).

Environmental Element	Description	Value

Appendix 2: Considering the Environment: Tor

In considering the value of an environmental element the following terms have been used:

N/A: Values not present.

Low: The loss of the environmental elements would at the most have bearings on the local environment, in this instance the Tor station area and the immediate surrounding area.

Medium: The loss of the environmental elements could have bearings on the regional environment, in this instance Jutulsessen area, or could affect science or station operations.

High: The loss of the environmental elements could have significant bearings for the overall environment in Antarctica.

Environmental Element	Description	Value
<p>Flora</p>	<p>Elements:</p> <p>-Flora</p> <ul style="list-style-type: none"> - The flora and vegetation at Svarthamaren are sparse compared with other area in Mühlig-Hofmannfjella and Gjelsvikfjella to the west of the site. The only abundant plant species is the green algae, <i>Prasiola crispa</i>. There are few lichen species on glacier-borne erratics 1-2 km away from the bird colonies: <i>Candelariella hellettensis</i> (<i>C. antarctica</i>), <i>Rhizoplaca malanophthalma</i>, <i>umbilicaria</i> spp. and <i>Xanthoria</i> spp. A melting dam below the bird colonies supports strong growth of the yellowish-green unicellular algae <i>Chlamydomonas</i> sp. <p>Background information: Management plan for ASPA No. 142 Svarthamaren (2009)</p>	<p>Low</p>
<p>Fauna</p>	<p>Elements:</p> <p>-Seabirds</p> <ul style="list-style-type: none"> - The nunatak holds the largest known seabird colony in Antarctica. More than 250.000 pairs of Antarctic petrels (<i>Thalassoica antarctica</i>) are breeding annually, and about 500.000 non- 	<p>High</p>

Environmental Element	Description	Value
	<p>breeding birds are present during breeding season. In addition there are ca. 500-1.000 pairs of snow petrel (<i>Pagodroma nivea</i>) and 50-100 pairs of South Polar skua (<i>Catharacta maccormicki</i>)</p> <ul style="list-style-type: none"> - -Invertebrates -Large amounts of collembola (<i>Cryptopygus sverdrupi</i>) and a rich fauna of mites (<i>Eupodes anghardi</i>, <i>Tydeus erebus</i>) protozoan, nematodes and rotifers are described from Svarthamaren. No unique species are found. - Background information: Management plan for ASPA No. 142 Svarthamaren (2009) Sømme, L. (1986) 	Low
Freshwater	<ul style="list-style-type: none"> - There is no source of freshwater at Tor station. A ca. 10 meter wide melted pond near the station is heavily polluted by wind-blown petrel carcasses and is covered with yellowish-green algae <i>Chlamydomonas sp.</i> 	Low
Sea water	Not present on location.	N/A
Soil	<p>Elements:</p> <ul style="list-style-type: none"> - Soil <p>Consideration of value: The slopes are covered by decomposed felspathic sand. No unique type of soil is found at Tor.</p>	Low
Air	<p>Elements:</p> <ul style="list-style-type: none"> - Air <p>Consideration of value:</p> <ul style="list-style-type: none"> - Air is relatively pristine as only affected by small scale operations at Tor 	Low
	<p>Elements:</p> <ul style="list-style-type: none"> - Blue ice areas next to station 	

Environmental Element	Description	Value
Ice	<p>Consideration of value:</p> <ul style="list-style-type: none"> - No unique ice conditions registered in the area <p>Background information:</p> <ul style="list-style-type: none"> - Bintaja, R. (1999) - Winther, Jespersen & Liston et al. (2001) 	Low
Geology	<p>Elements: Geology</p> <p>Consideration of value:</p> <ul style="list-style-type: none"> - The main rock types in the area are coarse and medium grained charnockites with small amounts of xenoliths. Included in the charnockitoids are banded gneisses, amphibolites and granites of the amphibolite facies mineralogy. <p>Background information:</p> <ul style="list-style-type: none"> - Management plan for ASPA No. 142 Svarthamaren (2009) - Ohta, Y et al. 1990 	Low
Environmental Element	Description	Value
Wilderness	<p>Wilderness is associated with the concept of no physical human presence.</p> <p>Consideration of value:</p> <p>Due to small size of Tor the wilderness value as such is present in the area outside the station.</p>	Medium
Aesthetics and intrinsic values ⁴⁰	<p>Elements:</p> <ul style="list-style-type: none"> - Isolated and visually pleasing area, although 	High

⁴⁰ Aesthetic value can for example be defined as "the response derived from the experience of the environment or particular natural and cultural attributes within it. This response can be to either visual or non-visual elements and can embrace emotional response, sense of place, sound, smell and any other factors having a strong impact on human thought, feelings and attitudes" (Australian Heritage Commission & Department of Conservation and Natural Resources 1994, p. 5).

Environmental Element	Description	Value
	<p>obstructed by existing station facilities.</p> <p>Consideration of value: The size and magnitude of the sea bird colonies and the birdlife makes Svarthamaren an special area in Antarctica.</p>	
History	No historic sites or monuments (HSM).	N/A

Appendix 3: Considering the Environment: Troll Cargo Site and Traverse Route

In considering the value of an environmental element the following terms have been used:

N/A: Values not present.

Low: The loss of the environmental element would at the most have bearing on the local environment, in this instance the Troll Station area, the traverse route to the cargo site and the areas immediately surrounding these.

Medium: The loss of the environmental elements could have bearings on the regional environment, in this instance Jutulsessen and the area surrounding the traverse route, or could affect science or station operations.

High: The loss of the environmental elements could have significant bearings for the overall environment in Antarctica.








Environmental Element	Description	Value
Flora	- Not present	N/A
Fauna	<p>Elements:</p> <p>-Seabirds Individuals of Adelie Penguin (<i>Pygoscelis adeliae</i>) are found breeding in low numbers at Troll Cargo Site. Several petrel spp. are feeding in open water adjacent to the site.</p> <p>-Mammals Furred seals can be observed near Troll Cargo Site.</p>	Low
Freshwater	- Not present	Low
Sea water	<p>Elements:</p> <p>Sea water is pristine in Antarctic waters. Consideration of value: The value of clean sea water is high. The vessel used in the marine operations shall not release any ballast water, waste water or food waste in to the sea during</p>	Low


Environmental Element	Description	Value
	operation in Antarctic waters (South of 60° S).	
Soil	Not present	N/A
Air	<p>Elements:</p> <ul style="list-style-type: none"> - Air <p>Consideration of values:</p> <ul style="list-style-type: none"> - Air is relatively pristine as only affected by small scale operations in area - 	Low
Ice	<p>Elements:</p> <ul style="list-style-type: none"> - Blue ice <p>Consideration of values:</p> <ul style="list-style-type: none"> - Not significantly affected by earlier activity. - No unique ice conditions registered in the area. - Common surface condition in the region 	Low
Geology	<ul style="list-style-type: none"> - Not present 	N/A


Environmental Element	Description	Value
Wilderness	Wilderness is associated with the concept of no physical human presence.	High
Aesthetics and intrinsic values⁴¹	<p>Elements:</p> <ul style="list-style-type: none"> - Isolated and visually pleasing area <p>Consideration of value:</p> <ul style="list-style-type: none"> - Clean ice sheets with no traces of human activity is present in the area and do have a aesthetic value, but no unique structures for Antarctica are found. 	Low
History	No historic sites or monuments (HSM).	N/A

⁴¹ Aesthetic value can for example be defined as "the response derived from the experience of the environment or particular natural and cultural attributes within it. This response can be to either visual or non-visual elements and can embrace emotional response, sense of place, sound, smell and any other factors having a strong impact on human thought, feelings and attitudes" (Australian Heritage Commission & Department of Conservation and Natural Resources 1994, p. 5).

Appendix 4: 10-question Purchasing Check-list

<p>1. Does the product have an official eco-label?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ The overall goal of environmental labeling (or eco-labeling) is to encourage the demand for, and supply of, those products and services that are environmentally preferable through the provision of verifiable, accurate and non-deceptive information on environmental features of products and services. ○ Products meeting a set of predetermined criteria earn the label. Criteria are established for distinct product categories by the labeling body and deal with multiple environmental aspects of the product. These labels are sometimes directed at specific types of products, such as the Environmental Choice¹ label for paints and surface coatings, or Energy Star² for lighting and appliances. These labels are usually represented by a logo on the product or product packaging. ○ Overview of eco-labels can be found at eg.: <ul style="list-style-type: none"> - http://www.miljomarkarna.se (Swedish) - http://www.miljoeogsundhed.dk/default.aspx?node=3845 (Danish) - http://www.gronnhverdag.no/artikkel.php?artikkelid=1940#miljo (Norwegian)
Ask for/check:	<ul style="list-style-type: none"> ○ Does the product have an eco-label granted under an official eco-labeling system. ○ If no, can the product be equally well be substituted by an eco-labeled product, eg.: <ul style="list-style-type: none"> - Swan (www.svanemarket.no, http://www.svanen.nu/, http://www.sfs.fi/ymparist) - The EU Flower (http://europa.eu.int/comm/environment/ecolabel/index_en.htm) - Blaue Engel (www.blauer-engel.de/englisch/navigation/body_blauer_engel.htm)
<p>2. Is the product labeled according to regulations governing environmental, health, fire and explosion hazards?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ In the Nordic countries products that have a high risk of causing environmental, health, fire or explosion hazard must be labeled. Such products should be avoided (or the least hazardous product should be preferred). ○ The symbols you should check for are the following: <div style="display: flex; flex-wrap: wrap; justify-content: space-around; text-align: center;"> <div style="width: 20%;">  <p>Explosive</p> </div> <div style="width: 20%;">  <p>Oxidising agent</p> </div> <div style="width: 20%;">  <p>Extremely or Highly Flammable</p> </div> <div style="width: 20%;">  <p>Toxic or Very Toxic</p> </div> <div style="width: 20%;">  <p>Corrosive</p> </div> <div style="width: 20%;">  <p>Harmful or Irritant</p> </div> <div style="width: 20%;">  <p>Dangerous For The Environment</p> </div> </div>

Ask for/check:	<ul style="list-style-type: none"> ○ Is the product labelled according to regulations governing environmental, health, fire and explosion hazards? ○ If yes, which symbols and warnings? ○ Is a product with the same function, but lower hazard class available?
<p>3. Does the product contain environmentally harmful substances?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ Health and environmentally harmful substances is one of the largest environmental challenges we face. Such substances have a variety of negative impacts and are used in many products and production processes. ○ Information about harmful substances can be found at eg.: <ul style="list-style-type: none"> - http://www.miljosanering.no/id25.htm (Norwegian) - http://www.miljostatus.no/templates/PageWithRightListing____2833.aspx (Norwegian) - http://www.bastaonline.se/ (Swedish and English) ○ Some substances are prohibited to use in the country in which the activity is organized from. Information about prohibited chemicals can be found at: <ul style="list-style-type: none"> - Norway: http://www.lovdatab.no/for/sf/md/td-20040601-0922-014.html - Sweden: http://www.kemi.se
Ask for/Check:	<ul style="list-style-type: none"> ○ Does the product contain any environmentally harmful substances? ○ In what amounts? ○ What impacts can these chemicals have on the environment? Is this a concern in the Antarctic context? ○ Does the product contain chemicals prohibited in Finland, Norway or Sweden?
<p>4. Does the product contain any of the substances prohibited in Antarctica?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ Certain substances are prohibited in Antarctica. These are: <ul style="list-style-type: none"> - Polystyrene  , often used as packaging material and found in a range of plastic products - Polychlorinated biphenyls (PCB), often found in transformers, paint, hydraulic fluids, rubbers, waxes, etc. - Pesticides. More information at eg.: <ul style="list-style-type: none"> ○ http://www.grip.no/Tekstiler/kjemikalier/2005-06-14-12%20OtMa%20Plantevernmidler.pdf (Norwegian)

Ask for/Check:	<ul style="list-style-type: none"> ○ Does the product contain one or more of the substances prohibited in Antarctica? ○ If yes, is a product with the same function, not using this substance available? ○ If no, and the product is essential, contact the environmental authorities for information on how to proceed.
<p>5. Does the product contain PVC?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ Certain substances are discouraged used in Antarctica. These are - PVC  found in numerous plastic products such as pipes, rubber tubing. Environmentally contrivernal as it contains the disadvantageous combination of carbon and chlorine. Can also contain harmful substances such as phthalates and tin compounds. Rarely marked with the arrow. More information at eg. http://europa.eu.int/comm/environment/waste/pvc/index.htm: -
Ask for/Check:	<ul style="list-style-type: none"> ○ Does the product contain PVC? ○ If yes, is a product with the same function, but with no (or less) PVC available?
<p>6. Is the product durable?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ Good durability contributes to long lifetime, and thereby often to good economy and lower total environmental stress.
Ask for/Check:	<ul style="list-style-type: none"> ○ What is expected lifetime? ○ Has the product good ratings in objective lifetime testing? ○ What upgrading possibilities exist – to what price?
<p>7. How is the energy requirement of the product?</p> <p style="text-align: right;"><input type="checkbox"/> High <input type="checkbox"/> Low</p>	
Information:	<ul style="list-style-type: none"> ○ Energy consumption is often decisive of the costs associated with the use of a product. The purchase price may be considerably higher and yet a low-energy product may compare favourably. The energy consumption is easy to measure and easy to compare. For some products, such as vehicles, you risk an increase in the energy consumption during their service life. The supplier ought to be able to guarantee that this will not happen.

Ask for/Check:	<ul style="list-style-type: none"> ○ What energy source is used (petrol, gas, electricity)? ○ Can a more environmental friendly source be used (gas better than diesel)? ○ What is the energy consumption (l/km, kWt/year)? ○ Are energy saving types of the product available?
<p>8. Does the product or any part of the product have to be disposed of as hazardous waste when the product is scrapped?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ One day the <input type="checkbox"/> product can no longer be used and will have to be disposed of in appropriate manner. Waste handling in Antarctica is both complicated and expensive, and even more so if the waste is classified as hazardous. ○ Hazardous waste is wastes that, because of its quantity, concentration, or characteristics, may be hazardous to human health or the environment when improperly treated, stored, transported, or disposed. ○ To see what constitutes hazardous waste refer to eg.: <ul style="list-style-type: none"> ○ Annex VIII to the Basel Convention; http://www.basel.int/text/con-e-rev.pdf (English) ○ Den europeiske avfallslisten: http://www.lovdato.no/for/sf/md/td-20040601-0930-053.html (Norwegian) ○
Ask for/Check:	<ul style="list-style-type: none"> ○ Will the product or any part of the product have to be disposed of as hazardous waste when the product is scrapped? ○ If yes, how should it be handled and where should it be delivered?
<p>9. Will the product emit noise?</p> <p style="text-align: right;"><input type="checkbox"/> Yes <input type="checkbox"/> No</p>	
Information:	<ul style="list-style-type: none"> ○ Noise can be a disturbance to biotic elements of the environment and can also be bad for humans affected by it. Noise should therefore be reduced to the lowest level possible. ○ More about acceptable noise levels at eg.:
Ask for/Check:	<ul style="list-style-type: none"> ○ How much noise does the product make in normal use? ○ Is this a level which falls within normally acceptable noise levels? ○

<p>10. Has recycled material been used to produce the product or are does the product contain re-used parts?</p>		<p><input type="checkbox"/> Yes <input type="checkbox"/> No</p>
<p>Information:</p>	<ul style="list-style-type: none"> ○ Recycling is the reuse of materials that would otherwise be considered waste, usually in some other form (as compared to reuse, which is reuse of the material in the same form). ○ Some products contain re-used parts. Some copying machine suppliers now offer such products. These copying machines are cheaper than completely new products and are subject to the same warranties etc. This is a trend that should be encouraged. 	
<p>Ask for/Check:</p>	<ul style="list-style-type: none"> ○ Does the product consist of recovered material (either recycled or re-used)? ○ If no, is a similar product with (larger fraction of) recovered material available? 	

Appendix 5: Land Use Plan

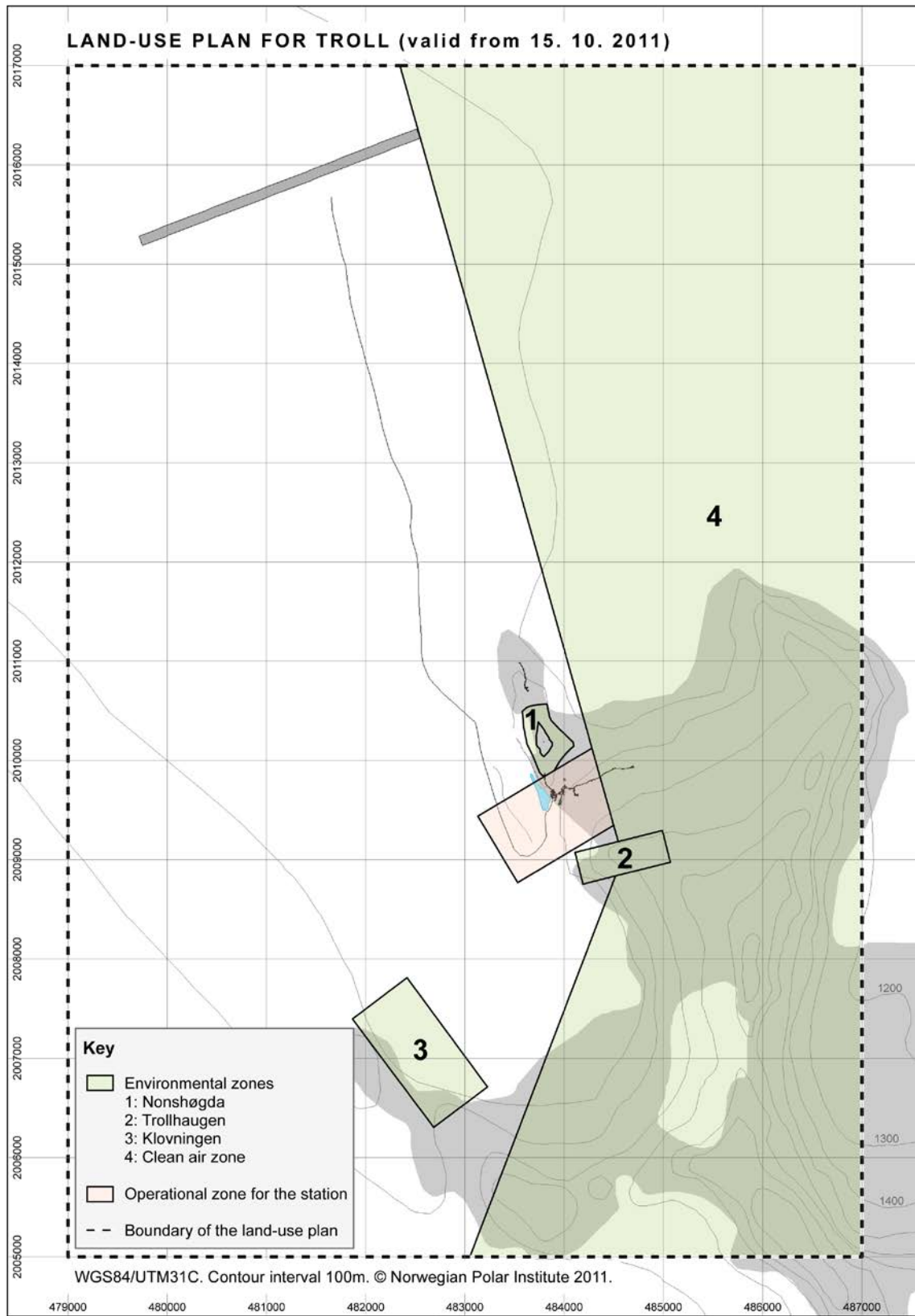


Figure 15: Land Use Plan, Troll Station 2011

Land-use plan for Troll: description

This land-use plan specifies the areal limits of the Norwegian Troll Research Station. The plan is intended to constitute some of the framework conditions controlling the development at Troll as regards research, logistics and other activities linked with the research station.

The basis for the land-use plan is a simple division of the area into zones. Instructions are given below for development and/or environmental protection within each zone. The zones and instructions must be complied with when implementing new measures or activities at Troll.

In the area beyond the applicability of the land-use plan, all activity must accord with the framework conditions stated in the requirements and provisions of the Environmental regulations^[1]. To the extent that such activity is linked with what is taking place at Troll and occurs near the station, its influence on the area surrounding the station (the land-use plan area) must be assessed in an overall perspective.

Environmental zone 1 (Nonshøgda)

The zone is designated to safeguard a nesting site for birds. The following instructions apply to the zone:

- No installations or infrastructure may be built unless they are intended for invaluable, approved and prioritized research.
- Consequences for the environment and other activities in the area must be investigated before new activity takes place or new installations or infrastructure are built. If the proposed activity is likely to have more than a transitory or minor impact, a comprehensive environmental evaluation must be prepared in accordance with § 11 of the *Regulations relating to protection of the environment in Antarctica*.
- Motorized traffic must not occur within the area unless it is absolutely essential in connection with construction work and approved and prioritized research, perhaps in connection with the establishment of approved installations on the summit of Nonshøgda.

Environmental zone 2 (Trollhaugen)

The zone is designated to safeguard a nesting site for birds. The following instructions apply to the zone:

- No installations or infrastructure may be built unless they are intended for invaluable, approved and prioritized research.
- Consequences for the environment and other activities in the area must be investigated before new activity takes place or new installations or infrastructure are built. If the proposed activity is likely to have more than a transitory or minor impact, a comprehensive environmental evaluation must be prepared in accordance with § 11 of the *Regulations relating to protection of the environment in Antarctica*.

^[1] Regulations relating to protection of the environment in Antarctica

- Motorized traffic must not occur within the area, unless it is absolutely essential in connection with construction work and approved and prioritized research.

Environmental zone 3 (Klovningen)

The zone is designated to safeguard a nesting site for birds. The following instructions apply to the zone:

- No installations or infrastructure may be built unless they are intended for invaluable, approved and prioritized research.
- Consequences for the environment and other activities in the area must be investigated before new activity takes place or new installations or infrastructure are built. If the proposed activity is likely to have more than a transitory or minor impact, a comprehensive environmental evaluation must be prepared in accordance with § 11 of the *Regulations relating to protection of the environment in Antarctica*.
- Motorized traffic must not occur within the area unless it is absolutely essential in connection with construction work and approved and prioritized research.

Environmental zone 4 (clean air zone)

The zone has been designated to ensure that the air is as little as possible affected by local activity, which is, among other things, essential to safeguard the requirements of the Troll Observatory, which monitors the air and atmosphere. The following instructions apply to the area:

- No installations or infrastructure may be built that result in polluting emissions.
- Consequences for the environment and other activities in the area must be investigated before new activity takes place or new installations or infrastructure are built. If the proposed activity is likely to have more than a transitory or minor impact, a comprehensive environmental evaluation must be prepared in accordance with § 11 of the *Regulations relating to protection of the environment in Antarctica*.
- When any new installations or infrastructure are to be established in the area, this must be done in such a way that emissions in connection with the construction work are as limited as possible and are accommodated to the requirements of the Troll Observatory.
- Motorized traffic must be as limited as possible and is only permitted in connection with construction and maintenance work that requires heavy and/or cumbersome equipment. Demands may be laid down regarding the type of vehicle. All motorized traffic must be logged and reported at an appointed place at Troll.

Operational zone for the station

This zone has been established to ensure adequate space for the operational running of the Troll Research Station, including preparations and logistic support for research projects in the Antarctic. The following instructions apply to the area:

- Basically, no installations or infrastructure may be set up in this zone that are not related to the purpose of establishing the zones. Should this be done, it must not be a hindrance for maintaining the purpose of the zones.

- Consequences for the environment and other activities in the area must be evaluated before new activity takes place or new installations or infrastructure are built. If the proposed activity is likely to have more than a transitory or minor impact, a comprehensive environmental evaluation must be prepared in accordance with § 11 of the *Regulations relating to protection of the environment in Antarctica*.

Other areas

The following instructions apply to other areas within the boundary of the land-use plan:

- Consequences for the environment and other activities in the area must be investigated before new activity takes place or new installations or infrastructure are built. If the proposed activity is likely to have more than a transitory or minor impact, a comprehensive environmental evaluation must be prepared in accordance with § 11 of the *Regulations relating to protection of the environment in Antarctica*.
- Before new activity is established, clearance must be obtained from other scientists in the region to ensure that it does not clash with ongoing activity.



Figure 16: Troll Station 72°S 02°E. (Photo: Stein Ø. Nilsen, Norwegian Polar Institute)

WASTE CONTROL
WASTE REMOVAL SERVICE



A DIVISION
OF THE

CERTIFICATE OF SAFE DISPOSAL

CUSTOMER : WORLD SHIPPING AGENCIES
DATE : 18 FEB- 1 MARCH 2010
MATERIAL : 12 X 20FT NPI CONTAINERS
74 TON MIXED GENERAL WASTE (SEE ATTACHED LIST)
DISPOSAL SITE : COCT LANDFILL SITE

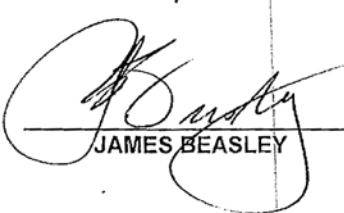
This serves to certify that the above mentioned material has been responsibly and correctly disposed of in accordance with the provisions of the Environment Conservation Act No. 73 of 1989, National Environmental Management Act No. 107 of 1998, the National Water Act No. 36 of 1998, the Health Act No. 63 of 1977, the Occupational Health and Safety Act of 1993 No. 85 of 1993, the National Road Traffic Act No. 93 of 1996 and Transport of dangerous substances by road – Chapter 8 of the National Road Act.

REPRESENTATIVE:



ESTE VAN DYK

DIRECTOR :



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