

Non-Technical Summary

Proposed Project

TGS-NOPEC Geophysical Company ASA (TGS) proposes to undertake a two dimensional (2D) seismic survey and seabed sampling in the western Greenland Sea off North East Greenland between 15 August and 15 October 2012. The Survey Area (Figure A) is entirely within the Arctic Circle. The wider Licence Area includes very deep waters beyond the continental shelf but all proposed survey activities will be located over the continental shelf in relatively shallow waters around 80 to 300m deep.

The purpose of the project is to acquire geophysical and geological data that will be used by various clients (exploration companies) to prospect for hydrocarbon resources. The data acquired by the survey will contribute to a more accurate and advanced understanding of the geology and hydrocarbon potential of the area. Conducting the project as a multi-client project will eliminate (or significantly reduce) the need for the various different exploration companies to acquire the same data independently and thereby limit the overall impact to the environment.

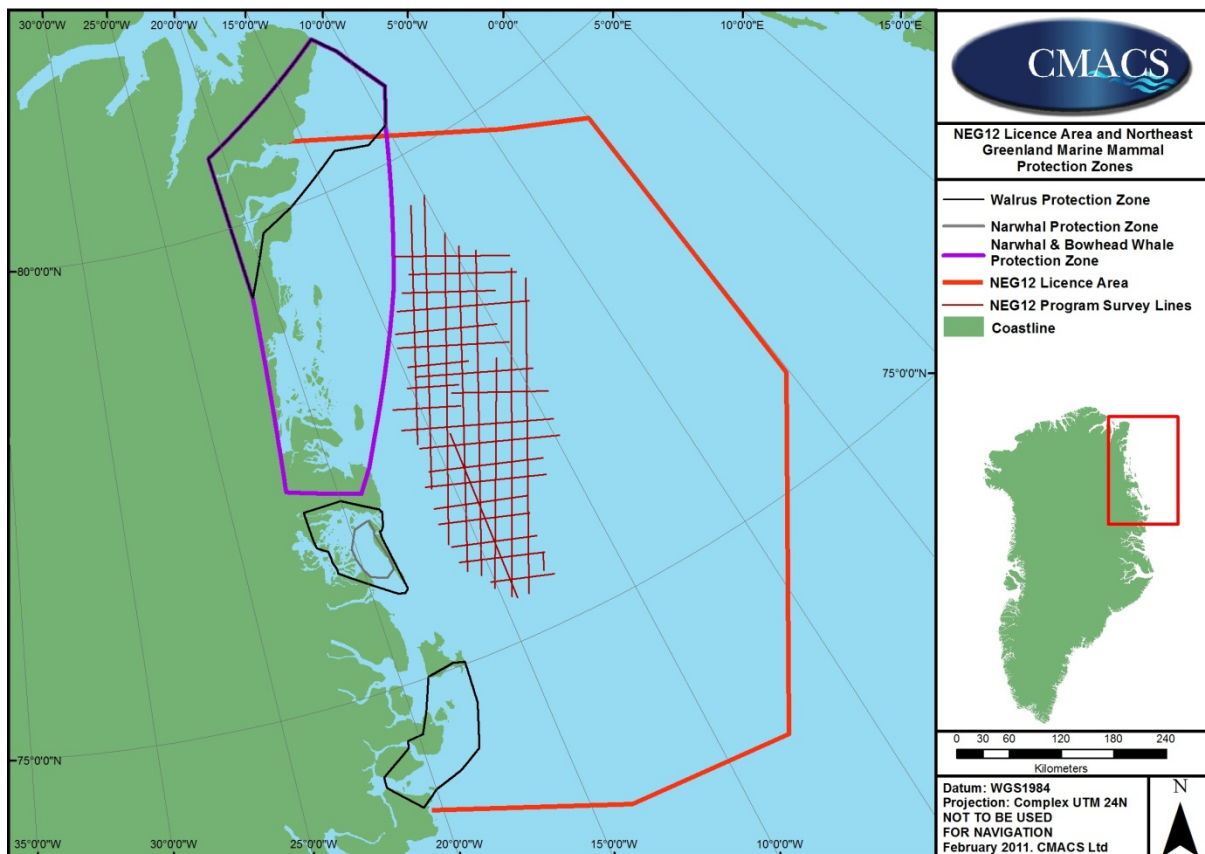


Figure A. Location of proposed seismic survey lines (crossed red lines, known as the Survey Area) within TGS Licence Area (thick red line). Seismic Protection Zones for marine mammals are also indicated.

The survey lines are widely spaced (approximately 20km); up to 5,000 km of lines will be surveyed. Seismic surveys acquire data on seabed geology using subsurface acoustic (sound) reflections to identify boundaries between different geological layers. The acoustic source is provided by an array of airguns towed approximately 250m behind a 'source' vessel (the *M/V Akademik Shatskiy*) which also tows an array of hydrophones to 'listen' to the reflected sound. The hydrophone arrays are known as streamers and will be towed around 8km behind the source vessel. The source vessel will be assisted by two further vessels, the icebreaker *MSV Botnica* (when required) and support vessel *M/V Kvitbjørn*.

2D seismic surveys such as this contrast with more intensive 3D surveys where lines are much more closely spaced and very detailed information is collected, often over smaller areas. This is an important point in relation to the assessment since it means that any environmental effects at a given location will be very short term. In contrast, the survey will take place over a relatively large area and thus has potential to affect a wider area, albeit less intensively.

Two airgun arrays will be available: one of up to 3350 cubic inch and a larger array with a total volume of up to 5025 cubic inch. The smaller array will generate less noise and will be used whenever possible; the larger array is proposed to be available where there are deep-lying targets (i.e. deep in the seabed- these will also more likely be in deep water). The smaller array is therefore more likely to be used in shallow waters and is also expected to be required under ice conditions which can limit the size of the array.

The vessel will conduct the survey whilst travelling at 5 knots with a firing interval of 10 seconds (approximately every 25m separation). The survey vessel is intended to be operational 24 hours a day except in periods where weather does not allow for data acquisition.

The seabed survey will collect up to 100 gravity core and 20 dredge samples to provide supplementary geological data regarding previously identified areas of interest on the seabed as well as to ground-truth sediment data, including for areas where seismic data are insufficient or difficult to obtain. The survey vessel *Sermilik II* will undertake this work between 15 August and 15 October 2012, operating independently from the seismic survey. The precise seabed sampling locations will be developed and finalized through the summer but the main areas of interest are inshore and to the north and south east of the seismic survey area.

Sea (drift) ice and icebergs may be present all year round, brought on the East Greenland Current from Arctic waters further north. Fast ice usually begins to form in the northern part of the Licence Area in September, moving south through October. At least part of the survey is likely to require use of an ice breaker to move ice away from the source vessel in order to prevent ice damaging the airgun array, hydrophone streamers or the vessel itself.

Following submission of a Scoping Document which outlined the proposed survey specifications, Bureau Minerals and Petroleum (BMP), National Centre for Energy and Environment (DCE) and Grønlands Naturinstitut (GINR) have advised TGS that an Environmental Mitigation Assessment (EMA) should be prepared. Comments have been received from BMP and its technical advisers which have been taken into account in the EMA.

Centre for Marine and Coastal Studies Ltd (CMACS) has prepared the EMA with support from NIRAS who have provided information on background environmental conditions (marine ecology and human activities) and undertaken detailed underwater noise modelling of the proposed airgun array, including predictions of propagation in relation to local conditions (i.e. the expected noise at varying distances from source and at different depths).

Human Activities and Ecology of the Area

The biological environment of this area of the Greenland Sea is strongly influenced by short lived phytoplankton blooms which occur after the break-up of sea ice in the spring. This fuels a period of intense biological production.

The EMA summarises the various human activities and natural environment features that could potentially be affected by the survey. The natural environment includes seabed communities which in shallow areas, especially below 100m, are important areas of production supporting wider marine species such as walrus that feed on bivalves (molluscs) living on the seabed. There is relatively little information on fish and shellfish but it is believed that diversity and abundance is lower than in the sea off South East Greenland or the commercially important South West. There is relatively little subsistence or commercial fishing or hunting. Most activities, including hunting of marine mammals, is focused in coastal areas and inshore of the survey area. Coastal areas are also of considerable importance to seabirds over summer months, some of which will pass through or may forage in the survey area.

A wide range of marine mammal species occur off North East Greenland and may be present in or around the survey area. Bowhead whale and narwhal are identified as being of particular importance and potential sensitivity in relation to the proposed seismic survey; there are protection zones for these species (and walrus) in the Licence Area and although the seismic survey will not enter these protection areas it may approach the offshore (eastern) edge of the Northeast Water Polynya which is an all year round protection zone for walrus (1 July to 30 September for bowhead whale and narwhal). Seals, and potentially polar bear, could occur on ice within the survey area.

Potential Impacts

A number of potential impacts of the seismic and seabed surveys were identified. Effects potentially giving rise to impacts are summarised in Table A, below.

Table A. Potential Impacts

Effect	Receptors Considered	Potential Impact(s)
Underwater noise of airgun array	Fish, Marine Mammals	Physical injury Disturbance/displacement
Accidental oil/fuel spills	Fish, Birds, Marine Mammals, Benthic Habitats	Direct/indirect impacts through contamination of the marine environment as discussed
Physical disturbance from seabed samplers	Benthic habitats	Damage to sensitive habitats
Attraction to vessels	Birds	Collisions/interference with normal behaviour, potentially fatal to individuals.
Ice breaking	Marine Mammals Marine Mammals, Birds	Creating open water which re-freezes Disturbing animals on the ice

The guidance documentation for EMA places considerable emphasis on noise modelling to underpin the assessment of effects and to support mitigation to reduce or avoid resulting adverse impacts. A detailed noise modelling report is appended to the EMA. The modelling made use of best available information to develop predictions of Sound Pressure Level (noise) at source and at a range of over 100km from the source and at all depths to the seabed. Wherever there was uncertainty conservative 'worst case' assumptions were made to ensure that, if anything, the magnitude of sound and predicted effects are over-estimated. This represents a precautionary approach in that any impacts should in reality be rather less than predicted (and mitigation more effective). Key assumptions made include the following:

6. It was assumed that the larger array, with higher noise level, would be used.
7. The source noise level is assumed to be 264dB re. 1 μ Pa @ 1 m. This is known to be higher than the true source noise level because in reality the airgun array is not a point source but an area.
8. The airgun array is assumed to be omnidirectional whereas in reality it will be focused vertically downwards, towards the seabed, since it is in the interests of the survey to target the energy here to maximise data return. The horizontal pressure (sound) can in fact be up to around 20dB lower than the vertical pressure (a drop of 6dB represents a halving of the noise).

9. Finally, conservative assumptions were made for key environmental parameters such as seabed sediment character that influence effects at distance.

A detailed summary of the Noise Report (itself appended to the EMA) is provided in Section 6.2 of the EMA. In summary:

- sound propagation from the seismic survey is expected to be much greater for lower frequency components of the sound spectrum;
- there will be rapid attenuation (noise reduction) over short distances (the first few hundred metres), especially of higher frequency noise;
- levels of noise that could injure marine mammals are not expected to be present more than 500m from the airgun array (conversely, it is acknowledged that potentially dangerous levels of noise may be present close to the airguns);
- taking into account the parts of the sound spectrum over which different marine mammal species have maximum sensitivity (hearing ability), levels of noise that could disturb (displace) sensitive marine mammals, such as bowhead whale, may be present to a considerable distance from the survey, conservatively estimated as potentially disturbed at up to around 50km.

Whilst there is a focus on potential impacts relating to noise effects the EMA addresses the range of issues summarised in Table A. Controls are essential to minimise risk of impacts from oil (fuel) spills but with such controls in place (as standard best practice) there are not considered likely to be any other significant adverse impacts. Nonetheless, certain precautionary mitigation is suggested and summarised below.

Mitigation

Mitigation is proposed to avoid significant adverse impacts, such as death or injury, to marine mammals. Mitigation relating to noise from the airguns will follow current guidance from DCE which is based on JNCC (UK) best practice procedures with some extra measures to protect animals in Greenlandic waters. The detailed mitigation, to be led by a dedicated marine mammal and seabird observer (MMSO) team is explained in the EMA; key mitigation and best practice proposals include:

- the smaller seismic array will be used wherever possible;
- a mitigation gun will be available if needed, this is a single gun of low output;
- airguns will not be used unnecessarily away from the transect line;
- two qualified marine mammal and seabird observers (MMSO) will be present on the source vessel with a minimum of one observer continuously monitoring during pre-firing watches;
- Passive Acoustic Monitoring (PAM) will be deployed during hours of darkness and during times of poor weather (above sea state 3);

- If a mammal approaches within 200m of the airguns the gun output will be minimised, to a single mitigation gun if possible;
- MMSOs will be especially aware of the potential for bowhead whales to occur and will act in a precautionary manner if the animals are known to be in the area. If possible the survey will move away from any area where bowheads have been reported to be active to a distance of at least 50km with survey commencing away from the area in question.

Additional mitigation (relating to potential impacts where there is uncertainty in the assessment) is suggested by placing marine mammal observers on the ice breaker to advise if animals are present on or around the ice and, importantly, to gather information about the frequency of encounters with marine mammals both on ice and in the water around floes when the ice breaker is operating.

No other effects are considered to require mitigation beyond control measures currently planned.