Addendum

ENVIRONMENTAL IMPACT ASSESSMENT FOR MARINE 2-D SEISMIC REFLECTION SURVEY LABRADOR SEA AND DAVIS STRAIT OFFSHORE LABRADOR BY MULTI KLIENT INVEST AS

Submitted by

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Report No. HOPO417
June 2011

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

EXECUTIVE SUMMARY

MKI proposes to undertake 2-D seismic surveys on the Labrador Shelf occurring over a 40 to 60 day period, intermittently, within a window anytime in July to November in 2011 to 2013.

This document provides a Screening Level Environmental Assessment to allow the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) and Canada-Nova Scotia Petroleum Board (C-NSOPB) to fulfill its responsibilities under the *Canadian Environmental Assessment Act*.

As per the Scoping Document issued by the C-NLOPB, the valued ecosystem components (VECs) include Marine Fish and Shellfish, Marine Mammals, Sea Turtles, Marine and Migratory Birds, Commercial Fisheries, Species at Risk and Sensitive Areas. The biological environment is described in terms of these VECs. The physical environment is also described, including the metocean conditions and sea ice and icebergs. The existing environment descriptions draw on the Labrador Offshore Area Strategic Environmental Assessment.

MKI implemented a comprehensive strategy to effectively engage community-level stakeholder groups to collect and compile information on activities and concerns of these groups in the Study Area. Several fishing industry organizations, multi-stakeholder groups, Aboriginal and First Nations' groups, government agencies and municipalities were involved with the information sharing activities that consisted of telephone interviews, face-to-face meetings, and public meetings. In general there were concerns expressed about the seismic survey relative to fishing, industry representatives did highlight the need to time the survey to avoid potential impact on the fishing activity that occurs in the area. Fishers expressed the need to continue to be informed of progress on the survey.

Environmental management measures (i.e., mitigative measures) include an Environmental Observer(s) onboard the vessel(s) to provide proper identification of marine mammals, sea turtles, and seabirds for mitigation purposes and to collect opportunistic data on their behaviours and distribution with and without air guns operating. Routine checks will be done for stranded birds that may have been attracted to vessel lighting.

In addition, mitigation measures will be applied as set out in the "Geophysical, Geological, Environmental, and Geotechnical Program Guidelines" (C-NLOPB 2011), which incorporates verbatim the Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment. Operational plans will be developed to avoid or lessen any potential effects on the commercial fishery. These plans will include elements such as good communications with fishery organizations (*e.g.,* Fisheries Broadcast notifications and Notices to Shipping), a dedicated Fisheries Liaison Observer on the vessel(s), a Single Point of Contact, use of a picket or chase vessel, avoidance of areas during times of heavy fixed gear use, and a fishing gear damage compensation program.

With the application of mitigative measures, this environmental assessment predicts that potential adverse environmental effects on the above VECs will not be significant because the potential extent of physically harmful sound levels on fish occurs within about 8 m or less

of the air gun source. No other marine species is expected or known to experience physical harm by these seismic surveys. Startle reaction by marine fish may occur within 1 km of the array. Avoidance reaction by cetaceans may occur within 500 m of the array and within 250 m by sea turtles. Harassment levels may be experienced by cetaceans within 32 m of the array.

Species	Effects	Sound Level (RMS)	Predicted Distance From Source Over 300 to 3000 m Water Depth	
			45º	0º Off Horizon
marine fish	startle	156 dB re 1µPa	1 km	250 m
marine fish	transient stunning	192 dB re 1µPa	8 m	2 m
marine fish	internal injuries	200 dB re 1µPa	4 m	1 m
marine fish	egg/larval damage	220 dB re 1 µPa	<1 m	<1 m
marine fish	mortality	230-240 db re 1µPa	<1 m	<1 m
marine mammals	temporary threshold shift	200-205 dB re 1 µPa	4 m	1 m
cetaceans	harassment	180 dB re 1 µPa	32 m	8 m
pinnipeds	harassment	190 dB re 1 µPa	32 m	4 m
marine mammals	strong avoidance	160-170 dB re 1 µPa	500 m	128 m
marine turtles	avoidance	166 dB re µPa	250 m	64 m
marine turtles	erratic behaviour	175 dB re µPa	100 m	30 m

Potential cumulative environmental effects external to the Project include fishing, and marine transportation. Compared to existing vessel traffic in the area, the incremental amount of vessel traffic as a result of this Project will be negligible. Cumulative environmental effects resulting from any of the Project activities will not be additive or cumulative because the Project activities are transitory. With the implementation of mitigative measures and the limited spatial overlap with other activities, the residual cumulative environmental effect of the Project in conjunction with other projects and activities is predicted to be *not significant*.

The potential of accidental events is limited to a diesel spill in the unlikely events of a seismic vessel sinking, or a collision with another vessel. Given how unlikely these events are, and the mitigative measures that will be applied to the Project (including an FLO, on-board spill response plan and equipment), the residual environmental effect of an accidental event is predicted to be *not significant*.

Given the application of planned mitigative measures, significant adverse environmental effects, including cumulative effects, are not predicted to result from the Project. This is summarized in the table below which also shows a level of confidence in the assessment.

VEC	Residual Adverse Environmental Effect Rating	Level of Confidence	Probability of Occurrence (Likelihood)
Marine and Migratory Birds	Not Significant	High	na
Marine Fish and Shellfish	Not Significant	High	na
Marine Mammals	Not Significant	Medium	na
Sea Turtles	Not Significant	High	na
Species at Risk	Not Significant	High	na
Sensitive Areas	Not Significant	High	na
Commercial Fisheries	Not Significant	High	na
na = likelihood is only indicated for those Environmental Components that have a significant residual adverse environmental effect rating.			

1.0 INTRODUCTION

TGS-NOPEC Geophysical Company ASA (TGS) and Multi Klient Invest AS (MKI), a company associated with Petroleum Geo-Service (PGS), have entered into a joint venture to conduct a regional marine 2-D (two-dimensional) seismic reflection survey offshore in the Labrador Sea starting in 2011 for a three year seismic program (2011-2013) (Figure 2.1). MKI has taken the lead role in the regulatory approval requirements.

This document provides a Screening Level Environmental Assessment to allow the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) to fulfill its responsibilities under the *Canadian Environmental Assessment Act* (*CEAA*). The technical and scope advice received from the C-NLOPB and other Federal Agencies through the *Federal Coordination Regulations*, and from other stakeholders consulted by RPS/MKI, has guided the preparation of this Environmental Assessment (EA).

This EA report has been prepared to meet the requirements for an EA to support MKI's application for a Geophysical/Geological Work Authorization under the *Canada-Nova Scotia Offshore Petroleum Board Resources Accord Implementation (Nova Scotia) Act*. It also addresses the factors to be considered under Section 16(1) of the *CEAA* for a screening level assessment and addresses the specific requirements of the *Scoping Document for the Environmental Assessment* issued by the C-NLOPB (Appendix A).

MKI acknowledges that the scope of the Project being assessed in this EA Report extends over several years, during which time the regulatory, biophysical, and socio-economic environment may change from that assessed in this report. MKI will periodically review the EA Report, as directed by the C-NLOPB, for current applicability and will work with regulatory authorities to ensure that this EA remains fit for purpose.

At the time of application for subsequent program authorizations in the Project Area, MKI will be required to provide information to the C-NLOPB regarding these activities.

The purpose of the proposed Project is to determine the presence and likely locations of geological structures within the regional area that might contain hydrocarbon deposits. Seismic data provide high resolution and quality images that are used to find potential locations for exploration drilling. With regard to location, MKI selected survey lines based on existing understanding of the geological conditions within the areas of interest and are intended to test geological concepts.

1.1 PURPOSE AND NEED FOR THE PROJECT

Exploration, development, and production of oil and gas resources contribute to the provincial and federal economies by providing new business opportunities within the region, through large capital and operating expenditures, transfer of technology, providing employment opportunities, and generating royalties to government.

Increasing offshore petroleum exploration has been identified as a priority of the Government of Newfoundland and Labrador. On September 11, 2007, the Government of Newfoundland and Labrador released its long awaited Energy Plan. The plan addresses the energy direction for the province over the next several decades. In 2007, Newfoundland and Labrador was expected to produce almost 45 % of Canada's conventional, light crude oil.

The Energy Plan (2007) states "While many of our offshore and onshore areas are now being actively investigated, it is essential that we encourage seismic and exploration activity in all basins to maintain a high level of industry interest. Without new exploration, there can be no new developments other than those already discovered. The keys to advancing our oil and gas sector are to encourage additional exploration activity and to manage the development of these resources so that investors can earn a fair return while the province maximizes the benefits it receives from these resources."

Similarly, the new provincial innovation strategy (Innovation Newfoundland and Labrador: A Blueprint for Prosperity 2006) recognizes the continued development of our offshore resources as a key element for future growth and an important strategic building block for expansion in related knowledge-based fields.

Interest in oil and gas offshore Labrador dates back to the late-1960s. At that time, several companies were given exploration permits for the Labrador Shelf area. Drilling in the area started in 1971 and continued until 1983. During that period 28 wells were drilled. This early drilling proved the presence of 4.2 trillion cubic feet (tcf) of re-coverable natural gas in five separate wells. The focus of exploration in the 1970s and 1980s was on oil. With the major finds at the time being gas, no development or further drilling has occurred in the area since 1983. However, the increasing demand for clean energy in the Eastern US and Canada creates impetus for a new cycle of exploration drilling for gas resources in Labrador.

1.2 PROPONENT INFORMATION

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TGS provides multi-client geoscience data and services to oil and gas Exploration and Production companies around the globe. TGS' geophysical and geological data products include multi-client seismic libraries, permanent reservoir monitoring, extensive magnetic and gravity data, the industry's largest global database of digital well logs and regional interpretive products. TGS also provides high-end depth imaging services to help resolve complex seismic imaging problems. TGS has acquired 2-D and 3-D multi-client seismic data in North and South America, Europe, Africa, Asia, and the Arctic.

In addition to our Statement of Values and our policies on health, safety, environment, and human resources, we have developed a Code of Conduct that further defines our expectations on ethical behaviour. Each employee and director is required to read and acknowledge his or her understanding of its contents. The code requires employees to report any known or suspected ethical irregularities and ensures that no retaliation will be levied against employees who file reports. We conduct an active compliance program designed to continue to inform and educate our employees on ethical issues and we have a board-appointed compliance officer who reports at least annually on our progress.

1.3 REGULATORY CONTEXT

In accordance with its mandate under the *Canada-Newfoundland Atlantic Accord Implementation Acts,* the C-NLOPB may issue an *Authorization to Conduct a Geophysical Program* to allow TGS/MKI to carry out the seismic survey program described herein. Offshore geophysical surveys (including geohazard surveys) on federal lands are subject to screening under the *CEAA.* In addition, Section 19.1 (a) of the *CEAA*'s Inclusion List Regulations identifies those projects relating to seismic surveys for which a screening level of assessment is required. Under Part II Oil and Gas Projects, physical activities that require an authorization referred to in paragraph 138(1)(*b*) of the *Canada-Newfoundland Atlantic Accord Implementation Act* relate to a marine or freshwater seismic survey during which the

air pressure measured at a distance of 1 m from the seismic energy source is greater than 275.79 kPa (40 psi) requires completion of an EA.

The C-NLOPB is the designated federal representative mandated under the Atlantic Accord Implementation Acts as well as the *CEAA*. The C-NLOPB acts as the federal environmental assessment coordinator in this context. Because seismic survey activities have the potential to affect seabirds, marine mammals, and fish and fisheries, both Fisheries and Oceans Canada (DFO) and Environment Canada (EC) are the primary federal agencies with interests and expertise in the environmental aspects of the proposed program. Relevant government regulations and guidelines to be reviewed during the issues scoping process will include:

- Canada-Newfoundland Atlantic Accord Implementation Acts;
- CEAA;
- Fisheries Act;
- Oceans Act
- Migratory Birds Convention Act and Regulations;
- Canadian Environmental Protection Act;
- Committee on Endangered Wildlife in Canada (COSEWIC)
- Species at Risk Act (SARA)
- Navigable Waters Act
- Canada Shipping Act
- Offshore Waste Treatment Guidelines (NEB *et al.* 2002); and
- Geophysical, Geological, Environmental, and Geotechnical Program Guidelines, (C-NLOPB 2011)

Specific C-NLOPB Guideline relevant to this Project is the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2011) and the Offshore Waste Treatment Guidelines (NEB *et al.* 2002).

The Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment (DFO 2007a) is references in the mitigation sections.

1.3.1 Species at Risk

The Project must comply with *SARA*, which serves to protect listed species by prohibiting activities that may harm individuals or critical habitat. Under *SARA*, species are protected in part through an established process:

- The species assessment process is conducted by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Based on the status report, a committee of experts assigns the status of a wildlife species believed to be at some degree of risk.
- In response to an assessment and status designation, the appropriate Minister issues a response statement. This document reflects the jurisdictional commitment to action and acts as a start to the national recovery process.

- A recovery strategy outlines what is scientifically required for the successful recovery of a species at risk. This indicates an identification of its critical habitat and what needs should be addressed. Critical habitat is the habitat that is necessary for the survival or recovery of a listed species.

Through the EA process, proponents are required to demonstrate that no harm will occur to listed species, their residences, or critical habitat. *SARA* has been linked to *CEAA* through requirements in both Acts. Section 79 of *SARA* requires that a Regulatory Authority (RA) must notify the competent minister (of DFO or EC) in writing if a Project being assessed is likely to affect a listed wildlife species or its critical habitat. The RA must identify the adverse effects of the project on the species/critical habitat and, if the project is carried out, must ensure that measures are taken to avoid or lessen the effects and to monitor them. The measures must be taken in a way that is consistent with any applicable recovery strategy and action plan. *CEAA* specifically includes within its definition of "environmental effect" any change a project may cause to a listed wildlife species (*i.e.,* listed under *SARA*), its critical habitat (*i.e.,* the habitat that is necessary for the survival or recovery of a listed species and that is identified in the recovery strategy or action plan for the species) or the residences of individuals of that species (*i.e.,* a dwelling place, such as a den, nest, or other similar area or place, that is occupied or habitually occupied by one or more individuals during all or part of their life cycles, including breeding, rearing, staging, wintering, feeding, or hibernating).

SARA does allow for issuance of Incidental Harm Permits under specific conditions. If affecting the species is incidental to the activity being carried out; it must be shown that all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted; all feasible measures must be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and the activity must not jeopardize the survival or recovery of the species. Any relevant recovery strategies and management plans will be evaluated as part of this EA Report.

The objective of the proposed project is to determine the presence and likely locations of geological structures within Canadian Arctic offshore acreage, which may contain petroleum hydrocarbons. If such locations are identified, more precise (*i.e.,* 3-D) surveys may be conducted in future years by other operators.

2.0 PROJECT DESCRIPTION

2.1 PROJECT OVERVIEW, LOCATION, AND SCHEDULE

TGS proposes to conduct an offshore two-dimensional (2-D) seismic reflection survey in the Labrador Sea over the next three years (2011-2013). Figure 2.1 represents proposed survey lines in the jurisdiction the C-NLOPB, totalling 9,600 km in 2011 within a survey area of about 541,423 km^2. . The proposed survey lines represent the proposed program for 2011. Infill lines will be acquired in subsequent seasons. At the time of application for subsequent program authorizations in the Project Area, MKI will provide information to the C-NLOPB.. No survey lines will enter the waters of the Labrador Inuit Settlement Area (the Zone) as defined pursuant to the Labrador Inuit Land Claims Agreement, or within 12 nautical miles of the coast of Labrador.

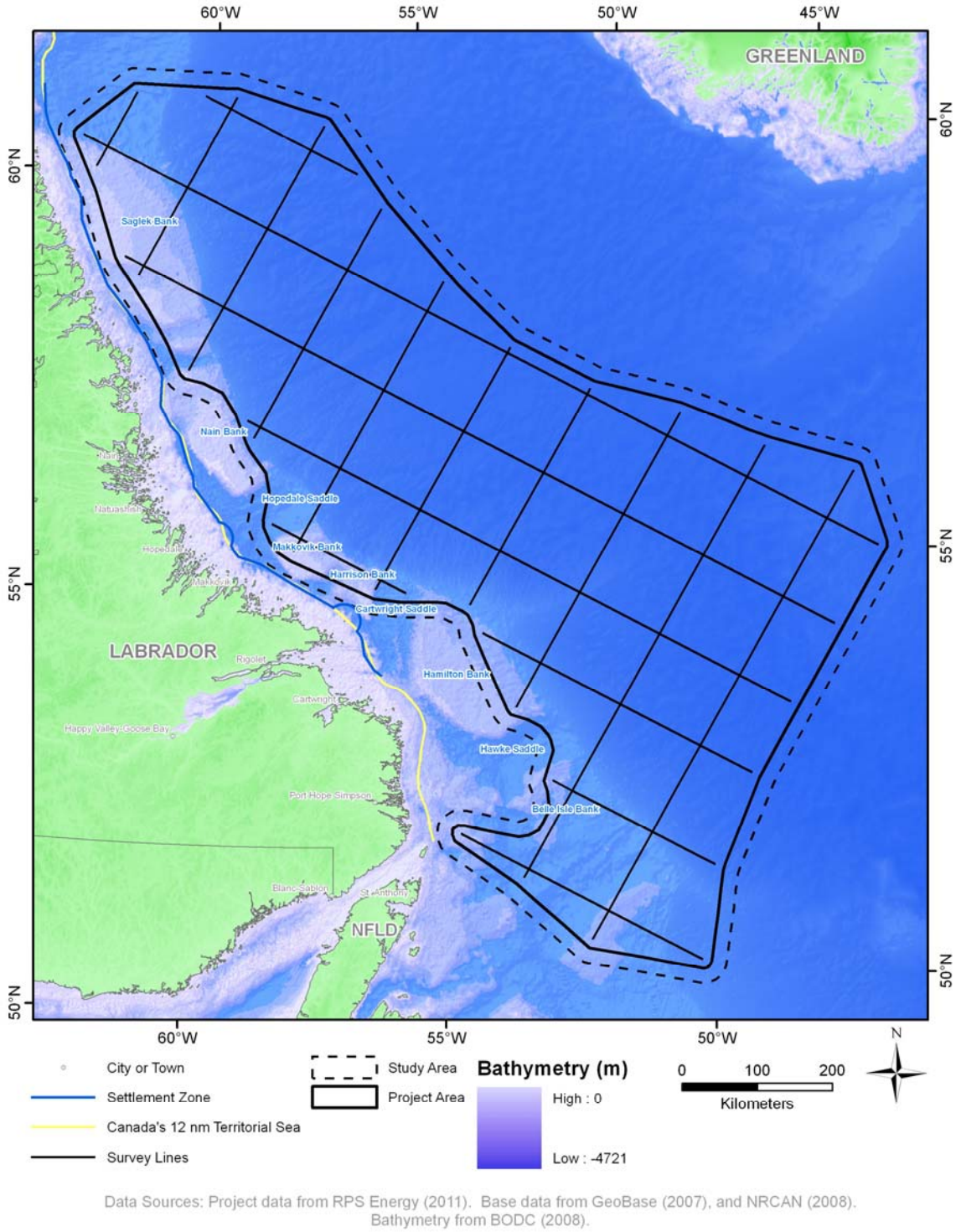
The proposed project is a regional survey designed to provide a better understanding of the offshore geology of northern Labrador Shelf, and to use this information to introduce new exploration opportunities to the industry. This information will be used to determine the regional extent of geological formations. This program is being used to develop geological concepts and is not the basis of an exploration drilling program, as the survey line spacing is much too coarse for that purpose.

The proposed survey season is July through November 2011 and in subsequent years. Each program will be about 40 to 60 days in duration. The exact dates will depend on the location, weather conditions, and vessel availability. Based on previous work in Labrador weather usually allows productive recording until approximately mid-October. It is expected that work might be able to continue as late in the year as November.

Although the proposed survey vessel is an ice-class vessel (1A1 Ice C) data will not be acquired in areas of pack ice. The survey data will be acquired such that ice-free areas are surveyed first (*i.e.,* the southern portion of the survey area) then, as the season progresses, the vessel will move north.

The vessel will be at sea and operate continuously (*i.e.,* 24-hour operations) during survey operations. Seismic vessels typically operate on a 5/6 week crew change schedule, which will be maintained for this project. Crew changes will be made via port call.

MKI will provide updates to the C-NLOPB on the timing of Project activities as soon as they are determined. Given the length of this Project timeframe, MKI has committed to the periodic review of the EA Report, including proposed mitigation and proposed monitoring to ensure on-going validity and applicability of this assessment.



Data Sources: Project data from RPS Energy (2011). Base data from GeoBase (2007), and NRCAN (2008). Bathymetry from BODC (2008).

Figure 2.1 Location of Proposed 2011 Survey Lines

2.2 PROJECT ALTERNATIVES

2.2.1 Alternatives to the Project

Alternatives to the Project are defined as functionally different ways of achieving the same end [Canadian Environmental Assessment (CEA) Agency 1997]. The one alternative to the proposed seismic Program is the 'do nothing' scenario. In the case that the project does not proceed, the mitigated impacts of seismic operations on the environment will of course not occur, however, the environment will not necessarily maintain its current baseline condition as impacts from fishing and vessel activity (*i.e.,* ice breakers, cargo vessels, cruise ships, and other research vessels), waste materials, sedimentation, fall-out of atmospheric pollutants, discharge of ballast waters, etc. will still take place.

The 'no-go alternative' would also mean that the renewed interest in exploration in this area would cease, or at least be significantly set back, as geologists would not have the information required to map the subsurface in this area. This would consequently mean that the potential to assess the hydrocarbon potential of this area would not proceed, along with the assessment of opportunity for further subsurface exploration and drilling programs. Ultimately, the project not proceeding in this case would effectively preclude the potential to evaluate the area's offshore hydrocarbon resources. This would result in the removal of future potential business, royalty, and tax revenue sources and the data would not exist for future knowledge and research.

It would also lead to significant reduction in direct employment opportunities on the vessel and the opportunity to collect biological observation information.

2.2.2 Alternative Means for the Project

Alternative means for the Project are defined as methods of similar technical character or methods that are functionally the same (CEA Agency 1997). Alternative means for carrying out this Project include variations in technology, Project schedule, and location.

2.2.3 Alternatives to Survey Method

Airgun arrays are the most common, environmentally responsible and practical energy sources for marine geophysical surveys (Richardson *et al.* 1995). Noise pulses with high peak levels are produced; however, each pulse is short, limiting total energy. Richardson *et al*. (1995) also indicated that pulses from airgun arrays generally decrease in intensity, but increase in duration further away from the site. Sleeve exploders and gas guns have similar effects to airguns. Although marine vibrators produce lower instantaneous pressure than airguns, the total acoustic energy transmitted is similar due to the extended duration of the signal. Marine vibrators are also in their infancy and are not a practical alternative. Marine vibrators cannot substitute for the airgun array in seismic surveys as they provide a lower output at low frequencies.

There are few alternatives for the proposed survey methodology that would provide the information required to assess the area's submarine hydrocarbon resources. Exploration and production companies would not accept alternatives for their purposes. Airborne

electromagnetic and magnetic (aeromag) surveys are valuable tools, but do not provide the level of detail required for precise resource assessments.

The compressed air array proposed for the current survey uses a proven technology and program design that is standard throughout many parts of the world. It has been used successfully on many occasions over the past several years on the Scotian Shelf, the west coast of Newfoundland, the Gulf of St. Lawrence, the Grand Banks, and the Labrador Shelf and Slope. Because of its reliability for data acquisition, the history of use in similar areas, and the available information related to its minimal environmental impacts, the compressed air technology proposed by TGS/MKI is the preferred alternative.

2.2.4 Alternatives to Survey Parameters

The main survey parameters such as line position, line length, line spacing, shot-point interval, and streamer length are determined by geophysicists considering the objectives of the survey. With regard to location, proposed survey lines are carefully selected based on a current understanding of the geological conditions of the Study Area and are intended to test geological concepts at those specific locations. The survey lines tie into the grid established offshore in Greenland where exploration is also taking place.

Parameters such as airgun array and streamer tow depths may be adjusted at the start of the survey to optimize data quality. Gun types, array configurations, and streamer type are limited to what equipment is available on the vessel and, therefore, cannot be easily changed.

2.2.5 Alternatives to Program Timing

The proposed program is scheduled to occur between June and December 2011 to 2015. Specific timing of the program will depend on a variety of factors, including ice conditions, weather conditions, timing, and sensitivities associated with biological and socio-economic constraints. For example, mitigation options to minimize potential impacts can potentially include modification of the operations schedule within specific areas, and the survey plan has been developed on this basis.

2.3 PROJECT COMPONENTS

The components of a 2-D survey include a seismic vessel, the source towed array (air source units); the receiver (hydrophone) towed array; a support chase/picket vessel, helicopter, and a shorebase.

2.3.1 Seismic Vessel

The program is proposed to be conducted with a dedicated seismic research vessel, the M/V Sanco Spirit, which was purpose built in 2009 (Figure 2.2).

Figure 2.2: Survey Vessel M/V Sanco Spirit

The vessel will have equipment, systems, and protocols in place for prevention of pollution by oil, sewage, and garbage in accordance with international standards and certification authorities, specifically the Arctic Shipping Pollution Prevention Act (ASPPA) and Arctic Shipping Pollution Prevention Regulations (ASPPR). These regulations require that the survey vessel possess an Arctic Pollution Prevention Certificate. The vessel will be subject to pre-survey audits by the operator in the port of mobilization prior to survey commencement. Transport Canada (TC) will conduct a Safety Inspection of the vessel in accordance with the issuing of the Coasting Trade License to operate in Canada.

The survey vessel will comply with all applicable regulations concerning management of waste and discharges of materials into the marine environment. The vessel has a ballast water management plan. The International Maritime Organization (IMO; http://www.imo.org/) is the United Nations specialized agency with responsibility for the safety of shipping and the prevention of marine pollution by ships. Canada became a member of the IMO in 1948.

Vessel speed will be approximately 4.5 kn when the survey gear is deployed, similar to trawling fishing vessels. The airguns are discharged every 25 m, or about once every 10 to 16 seconds. Typical survey vessels are capable of cruising at 10 kn while in transit (with gear onboard). During the survey, the ship sails along a track from 12 to 20 hours depending on the size of the survey area. Reaching the end of the track will take two to three hours to turn around. It is estimated that the survey vessel will require a turning radius of 10 km outside the identified survey area. Seismic operations can generally continue up to a Sea State of 5 or wave heights of about 3 m.

2.3.2 2-D Seismic Survey Towed Array

For the 2-D surveys, typical ships are usually about 60 to 90 m long and tow a single source array 100 to 200 m behind the ship. Each source array is about 20 m long and 24 m wide. Following 100 to 200 m behind the source array is a single streamer between 8 and 10 km

long. A tail buoy with radar reflectors is attached at the end of each streamer. At the end of the track, the ship will take two to three hours to turn around and start along another track. Spacing between tracks is about two km; however the spacing for this program will be 120 km.

The seismic air guns for the 2011 program are Sercel – G Gun 2. The guns have a working pressure of 2000 psi and the typical array is a single source array made up of 6 sub-arrays. The survey parameters for the program are shown below in Table 2.1

Table 2.1: Sercel – G Gun 2 Seismic Survey Parameters

Effective volume of standard array(s)	4135 cu in
Maximum number of sub-arrays	6
Standard array depth(s)	7 m
Position of depth transducers	Front and tail of sub-array
Working pressure	2000 psi
Type of firing sensors	Pressure activated
Type of firing synchroniser unit	RTS BigShot
Timing resolution	0.1ms ms
Timing accuracy	+/- 1.0ms
Air compressors capacity	Neuman & Esser, 2200 cfm each
Number of air compressors	2

The larger the cylinder volume and the higher the internal air pressure, the louder the sound. The individual source unit volumes range from 45 cu. in. to 250 cu. in. The 4105 cu. in. array configuration is shown in Figure 2.3.

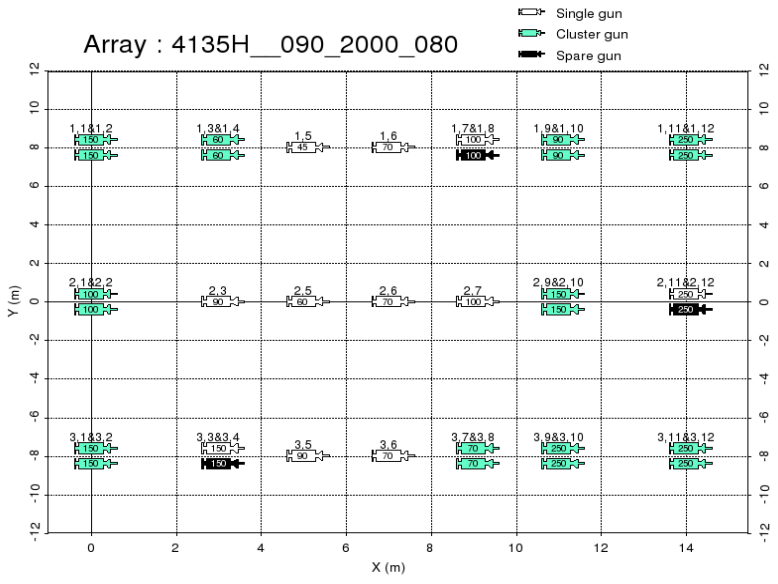


Figure 2.3 Array configuration top view, i.e. positive Y denotes starboard.

2.3.2 Streamer

The vessel utilizes the PGS GeoStreamer® which is a solid streamer. Solid streamers are less sensitive to weather related noise than liquid streamers and further minimize the environmental impact of fluid loss from breaks or tears in conventional fluid filled streamers. Technical specification of the streamer system is provided in Table 2.2.

Table 2.2: PGS GeoStreamer® Solid Streamer Specification

Skin material	Polyurethane
Outside diameter	62mm cm
Length of each group	12.5m m
Streamer set-up	Typical 1 x 10050m
Manufacture and type of hydrophones	Hydrophones: Teledyne T-2BX or equivalent, Velocity Sensors: PGS confidential (Mark III)
Type of array (*e.g.,* linear, binomial)	Linear
Number of hydrophones per group/distance apart	Hydrophones: 12 per 12.5m, Velocity Sensors: PGS confidential
Coupling between phones and pre-amp	Capacitive
Sensitivity of near and far group at 1/P to recorder	20V/Bar
Bandwidth over which above sensitivities apply	Specified at 100Hz
Availability of shore-side spares if required	Pool system
Manufacturer and type of depth controller and compass	ION DigiCourse 5011

Regardless of the exact nature, all seismic surveys share the same basic concept. Seismic airguns send sound waves through the water, and formations beneath the seafloor reflect the sound waves back to hydrophone streamers trailing behind the vessel (Figure 2.4).

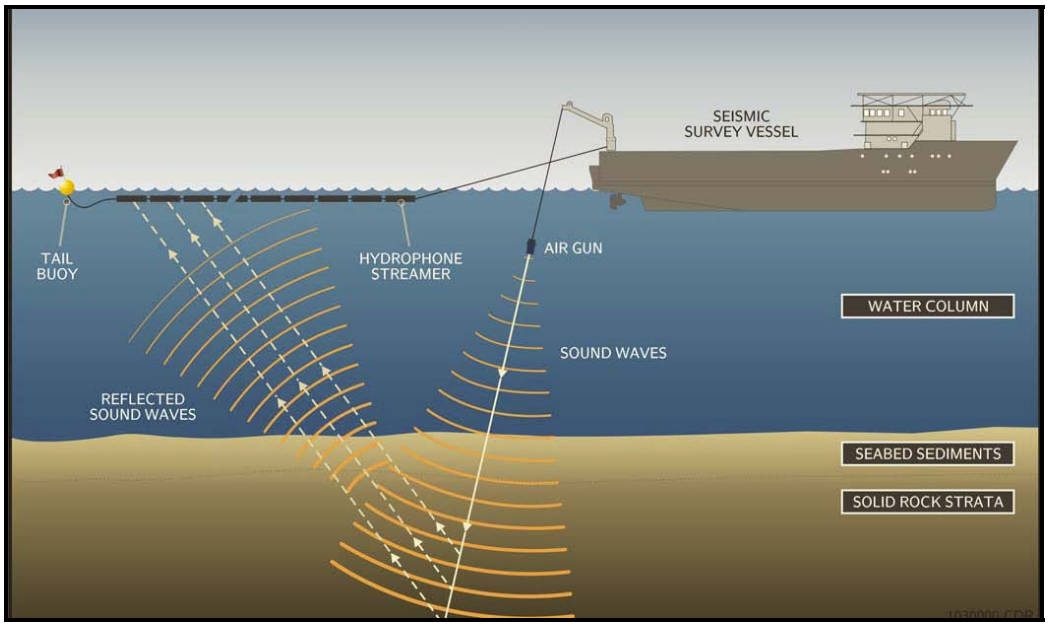


Figure 2.4: Seismic vessel and towed array

The energy source will be a dual air source array system. An air source unit is essentially a stainless steel cylinder charged with high-pressure air. Despite the term, no explosive devices are incorporated. The firing of an air source generates an oscillating bubble in the surrounding water. At the time of firing, the pressure of the air inside the cylinder far exceeds the outside pressure in the surrounding water. This difference in pressure causes a bubble to rapidly expand in the water around the air source. The seismic signal is a popping sound created when air is released forcefully into the water column. It is this initial bubble expansion that generates the relatively broadband seismic pulse. The produced broadband source level for a typical array is about 252 dB re 1 µPa-m, with the highest energies falling between 10 to 100 Hz.

About 30 minutes prior to arriving at the start of a line, the airgun array is slowly brought up to a specified power, a ramp-up procedure referred to as a "soft start". This procedure is an environmental protection measure to permit marine animals opportunity to temporarily vacate that area if the sound levels are perceived as a disturbance. A soft start approach would occur at the beginning of a new line within the perimeter or at the start of operations anywhere within the program area. This approach is discussed in greater detail below. Vessels towing streamers have reduced manoeuvrability when the equipment is deployed. MKI will include a 10 km vessel turn-around perimeter around the survey area.

For each air source unit, the amplitude (or loudness) of the seismic signal is a function of the volume and pressure of the air inside the cylinder and the cylinder's depth under the water surface. The larger the cylinder volume and the higher the internal air pressure, the louder the sound. The individual source unit volumes can range from 70 cu. in. to 290 cu. in. The larger source units are positioned at the front of the array with progressively smaller volumes to the back of the array.

2.3.2.1 Marine Mammal Safety Zone and Ramp-up Procedure

MKI, TGS, and PGS will implement a 500 m safety zone monitoring program for whale species at risk during survey data acquisition. The airguns will be shut down every time an endangered whale enters the defined safety zone. An environmental observer, trained for marine mammal observations, will watch for marine mammals from the bridge of the seismic vessel throughout the survey. Safety zones for marine mammals are commonly defined by the areas within which specific sound level thresholds are exceeded. These have been quantified by the US National Marine Fisheries Service (NMFS) (NMFS 2000). NMFS policy regarding exposure of marine mammals to high-level sounds is that whales should not be exposed to impulse sounds exceeding 180 dB re 1µPa (rms). These sound levels are the received levels above which, in the view of a panel of bioacoustics specialists convened by NMFS, one cannot be certain that there will be no injurious effects, auditory or otherwise, to marine mammals.

The *Statement of Canadian Practice for Mitigation of Seismic Noise in the Marine Environment* (DFO 2007) provides guidance to the seismic program, as stipulated in the scoping document. This DFO document aims to formalize and standardize the mitigation measures used in Canada with respect to the conduct of seismic surveys in the marine

environment. It is based on a DFO-sponsored peer review by Canadian and international experts. MKI, TGS, and PGS will adhere to the mitigation measures outlined in the *Statement of Canadian Practice on the Mitigation of Seismic Noise in the Marine Environment*, to the extent reasonably practical.

2.3.2.2 Logistical Support

Details of logistical operations to support the subject geophysical program will largely depend on seismic acquisition company, season, and weather.

Helicopters

The larger seismic vessels are usually equipped with a helicopter platform and helicopters are often used for crew changes, and can be used in case of medical and other emergencies and re-supply. In some cases, survey contractors may prefer to come to shore for crew changes and re-supply (if required).

Helicopters may or may not be utilized depending on type of helicopter available and seismic vessel procured. For the duration of the seismic program, it is possible that the fleet of helicopters available out of St John's will be Sikorsky S-92s only. The implication of this is that many of the seismic vessels currently available on the market are not capable of allowing S-92s to land on their helideck. Super Pumas or equivalent are the only type of helicopter potentially available that are approved for landing on the helidecks of the anticipated seismic vessels.

Shore Base

TGS/MKI will use shore facilities in St. John's, NL. During a short operational program, re-supply may not be needed. No new shorebase facilities will be established as part of this Project.

Support Vessels

The primary functions of support boats are to provide supplies for the seismic vessel and to assist in emergency situations (including oil spills). At least one support vessel will be utilized for the duration of the proposed seismic survey.

Seismic vessels are recognized as having restricted manoeuvrability and, in this respect, under marine sailing directions, they have priority over vessels that are not similarly restricted. In areas where poor charting, or the presence of other vessels, may pose a potential problem to the survey operation, the support boats will ensure that other vessels do not cross over, or otherwise interfere with, the towed equipment. The support boats may also check that the way ahead of the survey vessel is clear of obstructions, such as uncharted shallow water and fishing equipment. The seismic vessel or the support vessel carries a Fisheries Liaison Observer to make communication with the fisheries in order to ensure that seismic activity does not interfere with the fishermen.

2.4 EMISSIONS AND WASTE DISCHARGES

The vessels and towed array will generate underwater noise. The vessels also generate atmospheric, light, liquid, and solid emissions. Discharges and emissions from this program will be similar to those of any standard marine vessel. These emissions and discharges are described below.

2.4.1 Noise Emissions

2.4.1.1 Signals

The firing of an air source generates an oscillating bubble in the surrounding water. At the time of firing, the pressure of the air inside the cylinder far exceeds the outside pressure in the surrounding water. This difference in pressure causes a bubble to rapidly expand in the water around the air source. It is this initial bubble expansion that generates the relatively broadband seismic pulse.

The output of an air source array is in terms of time vs. pressure and frequency. The frequency characteristics of an air source array signature relate to how the signal sounds. Hertz (Hz) is the unit of measure for frequency. Air source signatures are called broadband, as they contain a whole range of frequencies. The produced broadband source level for this array is about 252 dB re 1 µPa-m, with the highest energies falling between 10 to 100 Hz. For the purpose of evaluating the environmental impact of an air source, the signature should be reported at the widest bandwidth.

The acoustic patterns (plots of energy vs. radiation angle) are relatively accurate and need to be accurate to obtain the required subsurface geological information. Real time measurements at sea are difficult to obtain because of the inherent safety risk of moving around and among an operational array and damage to hydrophones.

2.4.1.2 Source Directivity

The array is configured in such a way as to maximize the amount of seismic energy projected vertically into the geologic formation being surveyed. Although the direction of the greatest sound intensity is directed vertically downwards from the array, some energy is radiated in directions away from the beam axis and into the surrounding environment. Because of the pattern of air source placement in an array, the signature changes as a function of direction (azimuth) and emission angle (angle from the vertical). The firing times for all the air sources in the array are synchronized to ensure that the primary pulses from each gun align exactly with one another along the vertical axis of the array.

These differences in the array signature with respect to direction and angle from the vertical are referred to as the array response. It means that the "sound" (*i.e.*, frequency content) and "loudness" (*i.e.*, pressure strength) of the array signature will be different at different locations in the water. These differences are known as the acoustic radiation pattern and can be mapped in three dimensions.

The array output plots broadband pressure distribution at various distances away from the array. It is important to analyze how different frequencies are emitted as a function of azimuth and emission angles. The following plots shows the acoustic radiation emitted for different frequencies (0 to 120 Hz) from the 4,135 cu. in. [Figure 2.5 shows air source array in the vertical plan along the inline (front to back of vessel) and crossline (port to starboard of vessel) axes of the array].

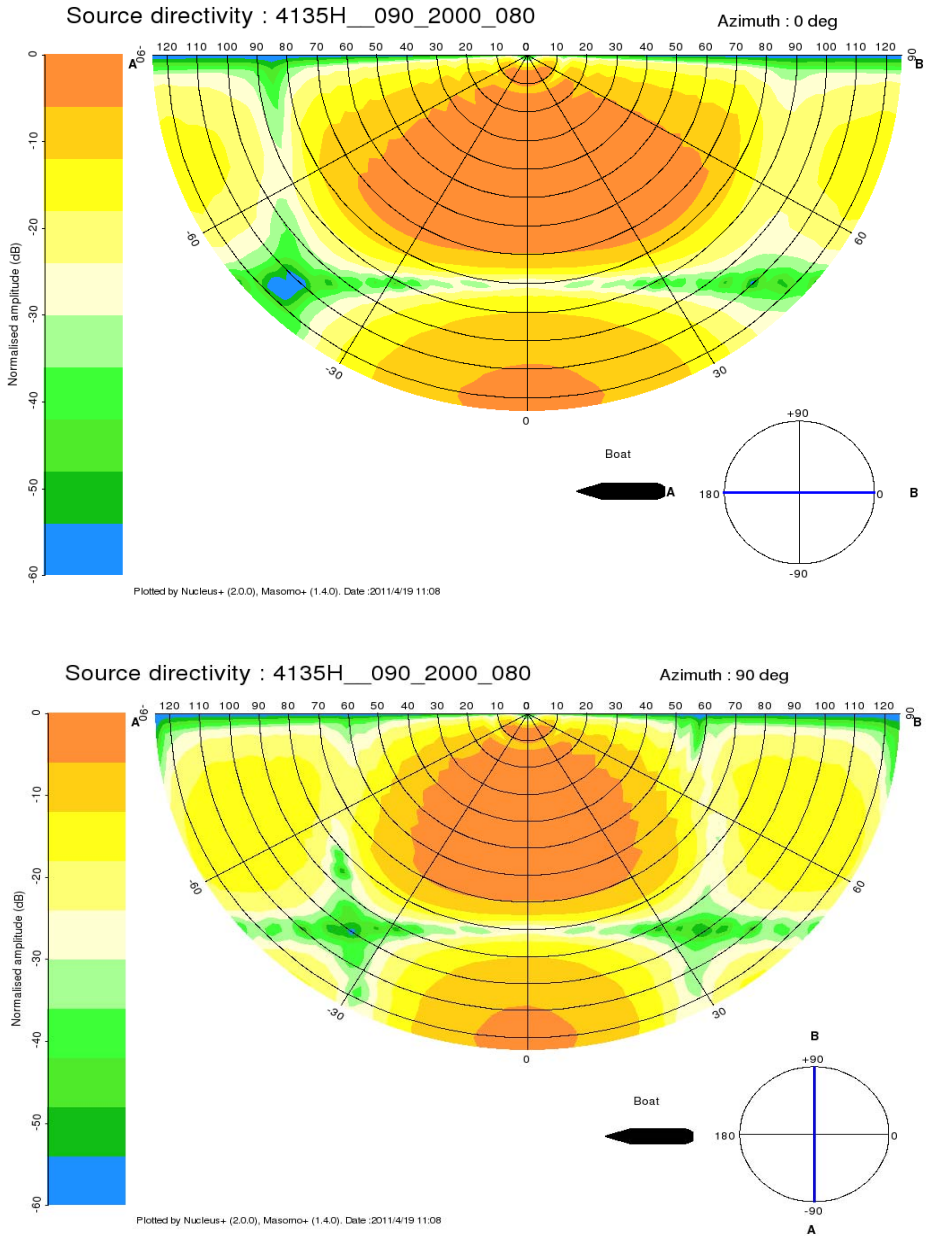


Figure 2.5: 4,135 cu. in. Array Source Directivity Plots for Azimuth 0 Degrees (Inline) and 90 Degrees (Crossline) at Frequencies 0-100 Hz

Most of the broadband energy is concentrated close to the vertical. Emissions at frequencies above 300 Hz are highly attenuated along radiation paths away from the vertical. When comparing the radiation plots it can be seen that there is more high frequency energy emitted side-ways from the array than from front-to-back. When the peak pressure amplitude and frequency emission plots are reviewed together, the following summary statements can be made about the direct air source pressure pulses propagating through the water column:

- Most of the broadband energy emitted from the air source array is concentrated close to the vertical emission angle.
- In the array's near-field, pressure amplitudes will be significantly less than predicted from point source extrapolation (by as much as –20 dB *i.e.,* 1/10th reference).
- The pressure amplitude rapidly diminishes at emission angles greater than 45 degrees.
- Coherent high frequency energy generated by air source arrays is generally less than 300 Hz.

2.4.1.3 Transmission Loss and Sound Attenuation

Sound decreases with distance from the source. This is referred to as transmission loss and it is influenced by geometric spreading loss and attenuation. Pressure measured at some distance away for the air source array is determined by using the model of spherical and cylindrical spreading. Sound travels out in a progressively large area from the sound source in all directions. This unrestricted spreading in water is called spherical spreading. The loss of sound is described as 20logR dB, where R is distance from the source in metres. This calculates to a transmission loss of about 6 dB with each doubling of distance from source. As in the example to follow, if the array output is 255 dB re 1 uPa at 1 $m_{o\text{-}p}$, the source pressure would decrease to about 249 dB at 2 m, to 243 dB at 4 m, etc. However, this is too simplistic as there are many factors that contribute to decay a sound wave, including frequency and local conditions such as water temperature, water depth, and bottom conditions. The sound can be compressed between the sea surface and the seafloor and other obstructions (*e.g.,* thermal layers), thus channeling it. Therefore, sound spreads in a cylindrical fashion. The transmission loss is half that of spherical and is then described as 10logR dB, a loss of about 3 dB with each doubling of distance.

In areas of very strong acoustic contacts at the seafloor (*i.e.,* bedrock), much of the acoustic signal will be reflected back into the water column, and there will be a lower decay rate with distance than expected. As these seismic surveys map sub-sea structures, in most cases the seafloor conditions will be transparent to the low frequency seismic signals and the variation in seafloor sediment (sand, till, and silt) will not have significant effects on sound propagation from seismic surveys.

The sea surface acts as a mirror for sound waves causing ghost reflections of the real source. These two signals cancel each other out at the sea surface. This effect can result in rapid decay of the waterborne seismic signal.

The conditions above describe how seismic signal loses energy and results in stronger attenuation of the seismic signals over distance. There are some conditions that cause lower energy decay, the most noted is sound channels. Sound can be trapped between geological layers, but these are subsurface conditions. Sound channels in the sea are formed by temperature and pressure which changes sound propagation velocity. Sound channels act as ducts that can focus sound energy and attenuation is much less than normal for spherical spreading, and the sound can travel considerable distances. Sound channels can be complex; there are shallow water sound channels, deep water sound channels, and mixed layer sound channels.

The projected energy and horizontal propagation (transmission loss) at source for the 4,135 cu. in. array for 100 Hz from 0º to 90º off vertical and azimuth 90º are provided in Table 2.3.

Table 2.3: Transmission Losses (TL) at Source in Peak Amplitude, RMS and Sound Exposure Level at 90° Azimuth and 0-90° From Vertical

Degree Off Vertical	TL (dB)	Sound Level		
		0-p	RMS	SEL
0	0	255	243	233
30	12	243	231	221
45	24-36	231-219	219-207	209-197
90	36-48	219-207	207-195	197-185
Notes: 0-p = zero-to-peak amplitude RMS = root mean square SEL = sound exposure level				

The following Tables 2.4 and 2.5 show the predicted sound levels over the Study Area water depths (300 to 3000 m) at distances from a typical array. Lawson (2000) reviewed seismic studies on the accuracy of model predictions to cases where monitoring was undertaken. He highlighted the discrepancies between modeled and measured sound propagation. Received sound levels varied from 10 to 30 dB range. As the distances to safety radii (*e.g.,* 160, 170 and 180 dB) varied, some within, some outside by twice this distance or more, there is the need to be conservative with the data. The values are based on crossline levels at 45º and 90º off vertical (i.e. horizontal) of a source of 243 db re 1 µPa @1 m $_{(rms)}$ with the array towed at 6 m depth.

Table 2.4: Predicted Sound Levels (rms dB), 45º Off Vertical (or Horizontal) Based On Spherical And Cylindrical Spreading Transmission Losses

Distance (m) from Array	Depth of water being surveyed (metres)						
	300	500	1000	1500	2000	2500	3000
1	213	213	213	213	213	213	213
2	207	207	207	207	207	207	207
4	201	201	201	201	201	201	201
8	195	195	195	195	195	195	195
16	189	189	189	189	189	189	189
32	183	183	183	183	183	183	183
64	177	177	177	177	177	177	177
128	171	171	171	171	171	171	171
256	165	165	165	165	165	165	165
512	162	159	159	159	159	159	159
1024	159	156	156	153	153	153	153
2048	156	153	153	150	150	147	147
4096	153	150	150	147	147	144	144
8192	150	147	147	144	144	141	141
16384	147	144	144	141	141	138	138
32768	144	141	141	138	138	135	135

Table 2.5: Predicted Sound Levels (rms dB), 90º Off Vertical Based On Spherical And Cylindrical Spreading Transmission Losses

Distance (m) from Array	Depth of Water Being Surveyed (m)						
	300	500	1000	1500	2000	2500	3000
1	201	201	201	201	201	201	201
2	195	195	195	195	195	195	195
4	189	189	189	189	189	189	189
8	183	183	183	183	183	183	183
16	177	177	177	177	177	177	177
32	171	171	171	171	171	171	171
64	165	165	165	165	165	165	165
128	162	159	159	159	159	159	159
256	159	153	153	153	153	153	153
512	156	147	147	147	147	147	147
1024	153	144	141	141	141	141	141
2048	150	141	138	138	135	135	135
4096	147	138	135	135	132	132	132
8192	144	135	132	132	129	129	129
16384	141	132	129	129	126	126	126
32768	138	129	126	126	123	123	123

2.4.2 Atmospheric Emissions

Atmospheric emissions will result from vessel and equipment exhaust. These emissions are minor and will be reduced through best management practices and preventative maintenance procedures. These include properly maintaining and routinely inspecting ship equipment, controlling vapour loss from fuel tanks, and avoiding engine idling when not in use. Emissions from ship engines and onboard equipment will comply with the Air Pollution Control Regulations (*Newfoundland and Labrador Environmental Protection Act*) and the Ambient Air Quality Objectives (*Canadian Environmental Protection Act*).

2.4.3 Liquid Emissions

Ballast water is stored in dedicated ballast tanks to improve vessel stability. No oil will be present in these tanks or in any discharged ballast/preload water. If oil is suspected to be in the water, it will be tested and, if necessary, treated to ensure that oil concentrations in the discharge do not exceed 15 mg/L as required by the MARPOL 73/78 (International Convention for the Prevention of Pollution from Ships, 1973, and the Protocol of 1978 related thereto), IMO and the Offshore Waste Treatment Guidelines (OWTG) (NEB *et al.* 2002).

The OWTG were developed specifically for the treatment and control of waste generated by petroleum operations related to exploration and production on Canada's offshore areas. Bilge water often contains oil and grease that originate in the engine room and machinery spaces. Before discharge, bilge water is treated in accordance with MARPOL 73/78, IMO and OWTG, using an oil/water separator. The extracted water is tested to ensure that the discharges contain no more than 15 mg/L of oil.

MKI will implement best practices to maintain equipment and avoid release of flotation fluid. Further, the contracted seismic vessel is equipped with solid-streamer technology, as this type of streamer is not reliant on flotation fluid to achieve a neutral ballast state, thus eliminating the risk of an accidental spill.

2.4.4 Solid Waste

All solid waste will be transferred to shore and disposed of at an approved facility. Any hazardous materials (*e.g.,* oily rags) will be handled separately in hazardous materials containers. Sanitary and food wastes will be macerated to a particle size of 6 mm or less and then discharged as per the OWTG.

2.4.5 Light Emissions

The survey vessel will carry operational, navigation, and warning lights. Working areas will be illuminated with floodlights as required for compliance with occupational health and safety standards and will be fully equipped with emergency lighting. If a helideck is present, it will be floodlit and have omni-directional guidance lights with an average illumination intensity of between 20 and 25 candelas. Hazards in the vicinity of the helideck will also have omni-directional hazard lighting. Lighting will comply with relevant offshore standards/regulations, including TC's *Guidelines Respecting Helicopter Facilities on Ships.* The Geophysical Contractors will adhere to the Leach's Storm Petrel Program.

2.4.6 Potential Malfunctions and Accidental Events

There are unplanned situations that may be encountered during seismic operations. Potential hazards are addressed during site-specific planning as part of emergency response planning. Procedures are developed by TGS to ensure that such events are managed in a safe and environmentally sound manner. MKI will have policies, plans, and procedures to prevent or mitigate effects of malfunctions and accidents. These policies, plans, and procedures will be located on the seismic vessel, and in MKI St. John's (shore office). During seismic surveys, there will be limited amounts of marine fuel and lube oil onboard that could potentially be spilled to the ocean. All of the vessels involved in the survey will use diesel fuel. The fuel capacity of seismic ships can range up to 1,550 t for large 3-D vessel. Any accidental spill will be reported to the C-NLOPB immediately.

The contracted vessel is equipped with solid-streamer technology, as this type of streamer is not reliant on flotation fluid to achieve a neutral ballast state, thus eliminating the risk of an accidental spill from a damaged streamer.

Other accidental events could include damage or loss of seismic equipment, entanglement of seismic equipment with fishing gear, and vessel collisions. Best management practices and communications will be used on the survey vessel to avoid equipment loss or damage. Gear will be retrieved from the water if wave heights reach or exceed unacceptable limits. In case of severe weather, the vessel may return to shore until conditions improve. A trained Fisheries Liaison Observer will be onboard during the seismic program to liaise with fishers who may have gear deployed in the Project Activity Area, in order to ensure effective and ongoing communication and avoid unnecessary gear conflicts and possible vessel collisions. Entanglement of marine mammals in seismic equipment is not likely since streamers have no tangle gear and marine mammals are expected to avoid the vessel during operations. The trained onboard Environmental Observer will keep watch for marine mammals during the survey program.

3.0 SCOPE OF THE ASSESSMENT

A focused EA requires a process of scoping to define the components and activities that are to be considered in the assessment, to identify the key environmental issues, and to set the spatial and temporal boundaries of the assessment. While the Project activities are generally focused within the footprint of the Project activities (*i.e.*, area of influence), the effects of these activities may extend beyond these footprints. This section provides an overview of the scoping exercise conducted as part of this environmental assessment.

The scope of an EA must be established early in the process to ensure that the analysis remains focused and manageable. The scoping process for this assessment has included the following:

- Project Description submitted by MKI (MKI 2011)
- The *Scoping Document for the Environmental Assessment* by the C-NLOPB (March 2011; see Appendix A);
- Stakeholder consultation;
- Preliminary research, which included a review of existing literature, relevant scientific research publications, and regulatory guidelines; and
- Professional judgment of the EA study team.

The scope of the project includes the combination of works and activities that must be considered during the environmental assessment. The Project components were identified by the Scoping Document (C-NLOPB 2011; Appendix A), based on analysis of the Project Description submitted by MKI.

3.1 C-NLOPB SCOPING REQUIREMENTS

The Project to be assessed consists of the following components (C-NLOPB 2011):

- MKI proposes to conduct a 2-D seismic survey program in 2011 and other surveys will be conducted as needed in subsequent years.
- Operation of support craft associated with the above activities.
- Approximately 9,200 km of 2-D seismic data will be collected commencing in 2011 within an approximate 561,423 km^2 survey area. Additional 2-D surveys will be undertaken between 2012 and 2013. The timing of survey activities will be between June and December of any given year. The duration of the initial 2-D survey is estimated at 40 to 60 days.

The EA will include (but is not restricted to) a consideration of factors in accordance with Section 16 of *CEAA* (C-NLOPB 2009):

- the purpose of the Project;
- the environmental effects including those due to accidents that may occur in connection with the Project and any change to the Project that may be caused by the environment;
- cumulative environmental effects of the Project that are likely to result from the project in combination with other projects or activities that have been or will be carried out;

- the significance of the environmental effects described in bullets two and three;
- measures, including contingency and compensation measures as appropriate, that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the Project;
- the significance of adverse environmental effects following the employment of mitigative measures, including the feasibility of additional or augmented mitigative measures;
- the need for, and the requirements of, any follow-up programs in respect of the Project consistent with the requirements of *CEAA* and *SARA* (refer to the CEA Agency's 2002 "*Operational Policy Statement" regarding Follow-up Programs*"); and
- report on consultations undertaken by MKI with interested parties who may be affected by program activities and/or the general public respecting any of the matters described above.

As the Regulatory Authority for the Project, the C-NLOPB identified the following issues of concern to be included within the scope of the EA:

- physical environment effects on the Project;
- marine and migratory birds;
- marine fish and shellfish;
- marine mammals;
- sea turtles;
- species at risk;
- sensitive areas;
- noise/acoustic environment;
- presence of the seismic vessel;
- fisheries and other ocean users; and
- accidental events.

3.2 COMMUNITY ENGAGEMENT AND INFORMATION GATHERING

A critically important aspect of conducting an effective environmental assessment is the participation of appropriate regulatory agencies, fishing representatives and organizations, representatives from users of alternative resource sectors within the Study Area, First Nations, and relevant communities with an interest in the Project. Sikumiut Environmental Management Ltd. (Sikumiut) was engaged by RPS Energy (Canadian Lead Consultancy for the Operator) to carry out a consultation program in support of the EA for a proposed Seismic Project to be conducted on the Labrador Offshore Shelf in 2011. Appendix B provides the list of contacts and the notes from the First Nations and Aboriginal Community engagement meetings.

Contacts were made with 105 stakeholders in communities on the north coast of Labrador from Nain to Rigolet; the upper Lake Melville towns of Happy Valley-Goose Bay, North West River and Sheshatshiu; and the south coast communities from Cartwright to Mary's Harbour. Some non-residents with business interests in coastal Labrador were also consulted.

An Information package was distributed to 105 stakeholders and follow-up contacts were made to each individual. A total of 13 of the stakeholders provided an immediate response by e-mail and an intense effort was made by Sikumiut staff to contact the others by telephone. The overall effort resulted in receiving responses and holding discussions with the majority of those contacted.

Direct meetings were held with the Fish Food and Allied Workers Union (FFAW) and One Ocean and the Chairperson of the Labrador North Coast Fishers' Committee at their request.

A full report on these consultations can be found in Appendix B. As a result of these consultations it was agreed that in-house meetings would be held in the communities as listed below.

In order to assist in scoping the effects assessment and mitigation plan and to aid in addressing any issues of concern, RPS and consultants (Sikumiut Environmental Management Ltd) undertook a consultation program with the interested parties in communities chosen within Labrador and relevant stakeholders, including but not limited to:

- Nunatsiavut Government;
- Innu Nation;
- Combined Councils of Labrador;
- Labrador Metis Nation;
- Labrador Friendship Centre;
- Central Labrador Environment Action Network;
- Labrador Inuit Development Corporation;
- Torngat Fish Producers Co-operative Society Ltd.;
- Central Labrador Economic Board;
- Sivunivut Inuit Community Corporation;
- Eagle River Development Corporation;
- Southern Labrador Economic Board;
- ECO;
- Eagle River Development Corporation;
- Southern Labrador Economic Development Board;
- Battle Harbour Regional Development Association;
- Labrador Fishermen's Union Shrimp Company Ltd.;
- One Ocean;
- Association of Seafood Producers;
- Fish, Food and Allied Workers Union;
- Labrador Sea Products;
- Quinlan Brothers Ltd.;
- Coastal Labrador Fisheries;
- Canadian Association of Prawn Producers;
- town councils/managers and/or mayors in the various communities visited during the consultation process;
- fish processors;
- fishers' committees; and

- other relevant parties as identified.

MKI and RPS remains open to continuing consultation with interested stakeholders.

3.2.1 Consultation with Communities and Key Stakeholders

Consultations and community engagements were held in Nain, Hopedale, Makkovik, Postville, Rigolet, Happy Valley – Goose Bay, and Port Hope Simpson.

The public consultation meetings were held during April 11–April 15, 2011. These consultations were a follow-up of previous consultation efforts that were conducted by Sikumiut in February, 2011 and which involved introductory correspondence and information about the proposed Project, provided to over 100 stakeholders in the area followed by subsequent discussions via phone. The purpose of this process was to facilitate the consideration of stakeholders regarding public issues and concerns relevant to the overall project and that will need to be specifically addressed in the EA report.

Based on the various requests for meetings and other comments during this preliminary consultation process, a decision was made to hold the April consultation meetings. In addition, a meeting was also held with the management of the Torngat Fish Producers Co-operative Society Ltd. in Happy Valley – Goose Bay on April 11 before traveling to Nain to begin the public meetings.

The public meetings were held on behalf of TGS Nopec Geophysical ASA and PGS, the Operator Multi Klient Invest AS (an association of PGS) by Darlene Davis, Project Manager, RPS Energy and Harold Murphy of Sikumiut Environmental Management Ltd. The PGS operations manager, Gary Morrow, was present for meetings in Happy Valley – Goose Bay and Port Hope Simpson.

Attendance at the individual meetings ranged from two to nine people for a total of 37 people in attendance at all meetings.

The main discussions and concerns raised during the public meetings included:

- the sensitivity of the area in relation to the commercial fishery resources such as crab, shrimp, and turbot;
- concerns related to the effects of seismic surveys on fish, including commercial fisheries, and other animal populations;
- inquiries as to the compensation for damage to the environment and the fishery;
- requests for more effective communications between fishing operations and seismic operations;
- community benefits particularly in the context of employment;
- need for follow-up by the consultants in providing additional information about the Project; and
- involvement of Labradorians in any such projects activities that are conducted in Labrador, particularly in regards to employment opportunities (as raised by the vice-chairman of the Combined Community Councils of Labrador).

Detailed consultation reports from both processes are provided as Appendix B.

3.2.2 Consultation with Regulators

The following agencies were contacted for information during the preparation of this environmental assessment:

- EC;
- Canadian Wildlife Service (information on birds);
- DFO
- Parks Canada;
- Fisheries and Aquaculture;
- Natural Resources; and
- Environment and Conservation.

Table 3.1 Stakeholder List

Agency	Contact Person (s); Affiliation / Title (s)
Nunatsiavut Government	Jim Lyall / President
Town Council	Tony Andersen / AngajukKâk
Nunatsiavut Government	Molly Shiwak
Nunatsiavut Government	Simon Kohlmeister / Conservation officer
Nunatsiavut Government	Joe Dicker / Community Liaison Officer
Fishers' Committee	Joey Angnatok
Parks Canada	Ms. Judy Rowell
Nunatsiavut Government	Ernie Ford / Environmental Enforcement officer
Innu Nation	Joseph Rich / President
Town Council	Band Council
Nunatsiavut Government	Susan Nochasak / Minister, Education & Economic Development
Town Council	Wayne Piercy / AngajukKâk
Nunatsiavut Government	Ian Winters / Conservation officer
Nunatsiavut Government	Ethel Hunter / Community Liaison Officer
Fisher's Committee	Ross Flowers
Town Council	Diane Gear / AngajukKâk Shirley Goudie / Town Manager
Nunatsiavut Government	Brenda Colbourne / Community LiaisonOfficer
Nunatsiavut Government	Wilfred Lane / Conservation Officer
Town Council	Herb Jacque / AngajukKâk Terry Rice / Town Manager
Nunatsiavut Government	Carol Gear / Community Liaison Officer
Nunatsiavut Government	Errol Andersen / Conservation Officer

Agency	Contact Person (s); Affiliation / Title (s)
Nunatsiavut Government	Linda Pottle / Team Leader
Fisher's Committee	Lester Mitchell
Town Council	Charlotte Wolfrey / AngajukKâk Sarah Blake / Town Manager
Nunatsiavut Government	Paula McLeans Sheppard / Community Liaison Officer
Nunatsiavut Government	David Wolfrey / Conservation Officer
Fisher's Committee	Richard Rich
Nunatsiavut Government	Darryl Shiwak / Minister Lands and Natural Resources
Combined Councils of Labrador	Nick McGrath / President
Labrador Metis Nation	Chris Montague / President
Nunatsiavut Government	Carl Mclean / Deputy Minister of Lands & Natural Resources
Nunatsiavut Government	Tim McNeill / Deputy Minister of Education & Economic Development
Nunatsiavut Government	Ataomie Blake / Community Liaison Officer
Nunatsiavut Government	Joseph Townley / Conservation Officer
Labrador Friendship Centre	Stanley Oliver / Executive Director
Central Labrador Environment Action Network	Frank Russell / Executive Director
Labrador Inuit Development Corporation	Chris Webb / Assistant General Manager
Torngat Fish Producers Co-operative Society Ltd.	Keith Watts / General Manager
Central Labrador Economic Board	Carol Best / Executive Director
Town of Happy Valley-Goose Bay	Maire- Leo Abbass / Town Manager Karen Wheeler / Wyman Jacque Development
Fisher's Committee	Ralph Tooktashina
Town of North West River	Wendy Hillier / Acting Manager Ken Nelson / Manager
Town of North West River Nunatsiavut Government	Dean McLean / Conservation Officer
Sivunivut Inuit Community Corporation	Ed Tuttauk / Director, Chairperson
Town Council	Rosetta Holwell / Mayor Shirley Hopkins / Town Manager/Clerk
Eagle River Development Corporation	Wendy Greenleaves
Fisher's Committee	Alexander Dyson / Local Chair Person
Plant Manager	David Williams

Agency	Contact Person (s); Affiliation / Title (s)
Southern Labrador Economic Board	Blair Gillis / President
ECO	Eli Sheppard / Manager
Eagle River Development Corporation	Marjorie Learning
Town Council	Kate Turnbull
Fisher's Committee	Albert Dyson
Fish Plant Manager	Phillip Hillyard
Town Council	George Roberts / Chairperson
Fisher's Committee	George Roberts
Town Council	Charmaine Powell / Mayor Zillah Kippenhuck / Town Clerk
Fisher's Committee	Earl Stone / Local Chair person
Labrador Choice Seafoods, (Fish Plant)	Pius Walsh
Fishers person	Don Kippenhuck
Town Council	Harrison Campbell / Chairperson
Fisher's Committee	Harrison Campbell / Shrimp & Crab Harvester
Fish Plant Manager	Clarence Burden / Manager
Town Council	Reg Russell / Chairperson
Fisher's Committee	Reg Russell
Town of Port Hope Simpson	Margaret Burden / Mayor Michelle Clarke / Town Clerk
Conservation Officer	Nina Penney
Fisher's Committee	Doyle Penney
Fisher's Committee	Andrew Strugnell Lloyd Hicks / Shrimp & Crab Harvester
Southern Labrador Economic Development Board	Roxanne Notley / Economic Development Manager Margaret Rumbolt / Economic Development Officer
Town Council	Lorraine Poole / Town Clerk
Fisher's Committee	John Chubbs Roy Mangrove / Shrimp Committee Member
Town Council	Larry Rumbolt / Mayor Glynes Rumbolt / Town Clerk

Agency	Contact Person (s); Affiliation / Title (s)
Southern Labrador Economic Development Board	Byron Rumbolt / Natural Resources Director
Fishers Contact	Alton Rumbolt
Fish Plant	Denley Rumbolt / Manager
Battle Harbour Regional Development Association	Gina Pye / Development Coordinator
Fisher's Committee	Allister Russell Alton Rumbolt / FFAWU Council Member Aubrey Russell /Chair Shrimp & Crab offshore Committee
Town Council	Keith Rumbolt / Chairperson
Labrador Fishermen's Union Shrimp Company Ltd.	Gilbert Linstead / General Manager Ken Fowler / Assistant Manager
DFO	Carole Grant / Section Head: Habitat Evaluation, Marine Environment and Habitat Management
Department of Fisheries and Aquaculture	Tom Dooley / Director, Resource Policy
Department of Natural Resources	Fred Allen / Manager, Regulatory Affairs, Petroleum Resource Development, Energy Branch
Department of Environment and Conservation	Martin Goebel / ADM
EC	Glenn Worthman
Canadian Wildlife Service	Kim Mawhinney
One Ocean	Maureen Murphy
Association of Seafood Producers	E. Derek Butler / Executive Director Sherry Day / Executive Secretary
FFAW Union	Earl McCurdy / President
Labrador Sea Products	David Earle / Chief Financial Officer
Quinlan Brothers Ltd.	Patrick Quinlan / President Robin Quinlan / Manager
Coastal Labrador Fisheries	Keith Pardy
Canadian Association of Prawn Producers	Bruce Chapman / Director

3.3 EXISTING LITERATURE

A number of studies have already been performed in the area which will be key references to the EA. These are:

- Strategic Environmental Assessment Labrador Shelf Offshore Area (2008);
- GSI-Labrador Shelf 2-D Seismic Program 2007 - 2009 (2007);
- Husky Energy Labrador Shelf Seismic Program (2010); and
- Chevron Labrador Seismic Program (ongoing)

The Strategic Environmental Assessment (SEA) for Offshore Labrador will form the base of the EA report. A stand alone document will be provided, but the effort in the SEA will not be reiterated. The purpose of the SEA is to provide a broad scale review and assessment of important resources in the Labrador Offshore Area in light of potential oil and gas activities over the next five years. SEA is defined as "*The systematic and comprehensive process of evaluating the environmental effects of a policy, plan or program and its alternatives"*. The SEA is essentially a planning document intended to assist the C-NLOPB in their decision process concerning which areas may or may not be suitable for offshore exploration, and/or which areas may require special mitigations if exploration activity is to proceed. Data that require updating will be species at risk, the commercial fishing efforts, and public consultation.

The Labrador SEA Report concluded that petroleum exploration activity generally can proceed in the Labrador Offshore Area with the application of standard mitigation measures currently applied to offshore exploratory activities elsewhere in the Newfoundland and Labrador offshore. The findings of this SEA Report identified areas potentially affected by the planned geophysical program proposed by MKI/PGS and TGS.

4.0 ENVIRONMENTAL ASSESSMENT METHODOLOGY

The EA scope and methodology for the Project have been developed to meet the regulatory requirements of a screening under *CEAA*, as well as the C-NLOPB and Canada-Nova Scotia Offshore Petroleum Board (C-NSOPB) requirements for environmental assessment of offshore seismic projects under the *Canada-Newfoundland and Labrador Offshore Resources Accord Implementation Act* and the *Canada-Nova Scotia Offshore Resources Accord Implementation Act.* The EA methodology for this Project addresses the scope of the Project, as defined in Section 15(1) of *CEAA*, as well as the requirements of the Scoping Document for the Environmental Assessment prepared by the C-NLOPB (Appendix A).

In accordance with subsection 16(1) of the *CEAA*, the EA shall include a consideration of the following factors:

- the environmental effects of the project, including the environmental effects of accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- the significance of the effects referred to above;
- comments from the public that are received in accordance with the *CEAA* and the regulations; and
- measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the Project.

4.1 APPROACH

The approach used in this report has evolved from Beanlands and Duinker (1983), who stressed the importance of focusing the assessment on environmental components of greatest concern to society or as indicators of environmental health. In general, the methodology is designed to produce an EA Report that:

- focuses on issues of greatest concern;
- addresses issues raised by the public and other stakeholders;
- addresses regulatory requirements;
- integrates mitigative and monitoring programs into a comprehensive environmental management planning process; and
- integrates cumulative effects assessment into the overall assessment of residual environmental effects.

The EA methodology for this Project includes an evaluation of the potential effects from routine activities, as well as accidents, with regard to valued environmental components (VECs). The evaluation of potential cumulative effects with regard to other projects and activities generally includes past, present, and future activities that will be carried out and will interact temporally or spatially with the proposed Project.

For each VEC, effects of the Project, as well as any potential accidental events, are evaluated within specified temporal and spatial boundaries. While the Project activities are generally focused within the footprint of the Project activities (*i.e.*, area of influence), the effects of these activities may extend beyond these footprints. Boundaries are defined for each VEC.

Preparation of this EA Report consists of several steps including:

- Assembling Project baseline information, including a clear description of the proposed Project (Section 2.0) and developing an understanding of existing conditions (Section 5.0);
- Establishing the scope of the assessment (Section 3.0); and
- Assessing the potential environmental effects of the Project including residual, cumulative, and potential effects of accidental events (Section 6.0).

4.2 ENVIRONMENTAL EFFECTS ASSESSMENT METHODOLOGY

The analysis methodology employed for the environmental effects assessment represents accepted practice as defined in the CEA Agency's Practitioner's Guide to the *Canadian Environmental Assessment Act* (CEA Agency 1994), as well as evolving effects assessment methodologies practiced and accepted over the course of many assessments in recent years.

4.2.1 Identification of Valued Environmental Components

The issues scoping process identified a focused list of environmental components. Scoping considerations for these components are presented in Table 4.1 along with the rationale for inclusion or exclusion of a VEC for further evaluation.

Table 4.1: Selection of Valued Environmental Components

Environmental Component	Scoping Considerations	Selected VEC
Marine and Migratory Birds	An assessment of the potential adverse environmental effects on bird species at risk will be undertaken. Bird species on Important Bird Area (IBAs) will be discussed under Sensitive Areas and Species at Risk (as applicable).	Marine and Migratory Birds Species at Risk Sensitive Areas
Marine Fish and Shellfish	Spawning activity may be affected by seismic operations. Vessel noise may affect fish behaviour by causing fish to avoid areas of vessel travel and/or by causing a 'startle response'. This may result in diversion from spawning areas.	Marine Fish and Shellfish Species at Risk Ocean Users
Marine Mammals	Several species of marine mammals of special status are likely to be present in the Study Area year-round and could potentially be affected by Project noise and vessel traffic.	Marine Mammals Species at Risk
Sea Turtles	An assessment of the potential adverse environmental effects on sea turtle species at risk will be undertaken.	Sea Turtles Species at Risk

Environmental Component	Scoping Considerations	Selected VEC
Species at Risk	The Project may interact with fish, mammal, turtle, and bird species at risk (rare, endangered, or threatened species) or their critical habitat (see above). Of particular concern are the species currently listed on Schedule 1 of the *SARA* and those that have potential for future listing. Therefore, an assessment of the potential for significant adverse environmental effects on species at risk in the Study Area shall be included in the EA.	Species at Risk
Commercial Fisheries	The commercial fishery is an important element in Newfoundland and Labrador's socio-economic and cultural environments. Seismic operations will interact with commercial fisheries directly and indirectly (*i.e.*, potential effects on fish). The assessment will focus on commercial fisheries occurring within the Study Area.	Commercial Fisheries
Ocean Resource Users	Other resources users (*e.g.,* marine traffic) conduct activities along the coast and on the waters of Labrador within the Study Areas, thereby potentially interacting with the Project. Various research surveys are conducted within the Study Area that may interact with Project activities and are included in the assessment of other ocean users. Other projects and activities are considered in the assessment of cumulative effects as appropriate.	Ocean Resource Users

To ensure that the assessment is holistic, the CEA Agency (1994) suggests a description of each VEC, and its ecological and/or socio-economic context. This includes an evaluation of the relationship of each VEC with other components of the ecosystem or human systems (*e.g.,* trophic relationships). A description of the VEC, along with a rationale for its selection is provided for each VEC assessment in Section 6.0.

4.2.2 Description of Existing Conditions

Section 5.0 of this report provides a description of the existing conditions (*i.e.,* pre-Project) for each VEC. The description is focused on the status and characteristics of the VEC within the boundaries established for the assessment and focuses on aspects that are relevant to potential Project interactions. In some cases, baseline data are only available on a larger regional basis extending beyond the boundaries of the assessment, but are still considered relevant and appropriate for the purposes of the assessment.

4.2.3 Temporal and Spatial Boundaries and Study Area

Temporal and spatial boundaries encompass those periods, and areas within which, the VECs are likely to interact with or be influenced by the Project.

4.2.3.1 Temporal Boundaries

The temporal boundaries considered for this assessment include seismic activities from the time the vessel arrives within the licence area, until it departs the licence are, and estimated

time frames for recovery of pelagic and nektonic communities. Effects of the routine activities associated with the proposed Project have been assessed from June to December for the period 2011 to 2015.

4.2.3.2 Spatial Boundaries

Spatial boundaries encompass those periods, and areas within which, the VECs are likely to interact with, or be influenced by, the Project. Spatial ecological boundaries may be limited to the Study Area, or may extend well beyond the immediate footprints, as the distribution and/or movement of an environmental component can be local, regional, national, or international in extent. Spatial boundaries for the assessment vary according to the VEC. Such factors as population characteristics and migration patterns are important considerations in determining ecological boundaries, and may influence the spatial extent and distribution of an environmental effect and are particularly important for assessing cumulative environmental effects.

This assessment considers two levels of spatial boundaries: the Study Area, as directed by the Scoping Document, and the Regional Area.

- The Study Area encompasses the 2011 2-D project shot line grid area; a 30 km estimated distance from the array that sound attenuation could reach at a level that will startle fish (156 dB re 1 µPa) and accidental spills. This area also includes potential interactions with other vessels. This area encompasses the 'Project Area' and is defined as the area where seismic data could be acquired plus an additional area around the outer perimeter of the data acquisition area to accommodate the ships' turning radii. It also encompasses the 'Affected Area' which is defined as that area within which effects (physical or important behavioural effects) have been reported to occur. It is likely that in the present case most potential effects will be confined within the Project Area.

- The Regional Area is the boundary as defined in the Labrador Shelf SEA Area and is retained here for consistency.

Bathymetry is varied in the Study Area, ranging from 300 to 3000 m as the Study Area is located on the Labrador Shelf. Sound attenuation varies with depth and oceanographic process (salinity/temperature features) and the potential for a sound channel to propagate sound transmission. The Cumulative Effects Assessment applies to the Regional Area which encompasses the Study Area.

4.2.3.3 Ecological Boundaries

Ecological boundaries are determined by the spatial and temporal distributions of the biophysical VECs under consideration. Factors such as population characteristics and migration patterns are important considerations in determining ecological boundaries, and may influence the extent and distribution of an environmental effect. Spatial socio-economic boundaries are determined by the nature of the VECs under consideration (*e.g.,* the spatial

distribution of fishing activity). Such boundaries are particularly important for assessing cumulative environmental effects.

Temporal ecological boundaries consider the relevant characteristics of environmental components or populations, including the natural variation of a population or ecological component, response and recovery times to effects, and any sensitive or critical periods of a VEC's life cycle (*e.g.,* spawning, migration), where applicable.

4.2.3.4 Administrative Boundaries

Administrative boundaries are the spatial and temporal dimensions imposed on the environmental assessment for conservation, political, socio-cultural, or economic reasons. Spatial administrative boundaries can include such elements as the way in which natural and/or socio-economic systems are managed [*e.g.,* North Atlantic Fisheries Organization (NAFO) Fishing Areas]. Temporal administrative boundaries may include, for example, fishing seasons.

4.2.3.5 Technical Boundaries

Technical boundaries or knowledge gaps represent any technical limitations on the ability to assess, evaluate, and/or monitor potential environmental effects. For example, insufficient data on the abundance, status, and distribution of a fish or wildlife population may limit the ability to predict the potential effects of a project. Where limitations exist, it is important that they be recognized and acknowledged.

4.2.4 Interactions Between Project Activities and VECs

The scope of the proposed Project includes all of the components and activities detailed in Section 2.0 of this report, including any potential accidental events that may occur in relation to the Project. To further focus the assessment, the interactions between Project activities and the VECs need to be identified (Table 4.2). A potential interaction, signified by an "X", does not necessarily indicate a predicted effect, but warrants further analysis in the EA. A full assessment of these interactions is contained in Section 6.0 (planned events and accidental events). Where appropriate, the assessment includes a summary of main concerns regarding the effect of each Project activity on the VECs being considered. Knowledge may exist in the scientific literature and is referred to where possible. Negligible interactions are blank and are not discussed further. An interaction may be negligible due to the limited nature of the activity and interaction, strict regulations, or lack of sensitive receptors.

Table 4.2: Potential Project-Environment Interaction Matrix

Valued Environmental Component	Marine and Migratory Birds	Marine Fish and Shellfish	Marine Mammals	Marine Turtles	Species at Risk	Sensitive Areas	Commercial Fisheries	Marine Traffic
2-D and 3-D Seismic Surveys - Noise Emissions (Acoustic Array)	X	X	X	X	X	X	X	
Well Site Survey - Noise Emissions (Acoustic Array)		X	X	X	X	X	X	
Vertical Seismic Profile - Noise Emissions (Acoustic Array)		X	X	X	X	X	X	
Vessel Presence	X		X	X	X		X	X
Presence of Streamers and Cables			X	X	X			
Accidental Spills	X	X	X	X	X	X	X	

4.2.5 Significance Criteria and Evaluation

Section 16(1)(b) of *CEAA* requires that the significance of environmental effects be determined. Accepted practice in meeting this requirement involves establishing and applying criteria for the determination of significance (significance criteria). Residual environmental effects evaluation criteria are established based on information obtained in issues scoping, available information on the status and characteristics of each VEC, and may involve the application of environmental standards, guidelines or objectives, where these are available (*e.g.,* applicable waste management guidelines). Consideration of the carrying capacity, tolerance level, or assimilative capacity of the area or VEC may be helpful, even though it may not be possible to quantify these characteristics. For each VEC, a definition is provided for a “significant adverse effect” and a “non-significant adverse effect”.

4.2.6 Analysis, Mitigation, and Environmental Effects Evaluation

For each VEC, the potential interactions are investigated and evaluated based on current scientific knowledge with regard to each interaction. Effects are analyzed qualitatively, and, where possible, quantitatively, using existing knowledge, professional judgment, and appropriate analytical tools.

Where applicable, mitigation measures are identified and the significance of the predicted environmental effects of the Project are evaluated based on a set of defined significance criteria tailored to the Project. The significance evaluation of residual effects for each VEC is adapted from the attributes recognized by the CEA Agency (1994, 1997) as commonly accepted by EIA practitioners. The rating of options and their definition depends on the

nature of the VEC and the potential effect from this Project. The significance attributes for this Project are as follows.

Magnitude – the nature and degree of the predicted environmental effect.

Negligible	Essentially no effect	rating = 0
Low	Affects a specific group or critical habitat for one generation or less; within natural variation	rating = 1
Medium	Affects a portion of a population or critical habitat for one or two generations; temporarily outside the range of natural variability	rating = 2
High	Affects a whole stock, population, or critical habitat (may be due to the loss of an individual(s) in the case of a species at risk) outside the range of natural variability rating	rating = 3

For socio-economic components, the magnitudes of potential effect are defined as:

Negligible	Essentially no effect	rating = 0
Low	Does not have a measurable effect on fishing or catch levels or marine traffic	rating = 1
Medium	Has a measurable effect on marine traffic and other offshore operators or on fishing or catch levels, but is within natural variability	rating = 2
High	Has a measurable and sustained adverse effect on marine traffic and offshore operations or fishing activities or catch levels beyond natural variability	rating = 3

Geographic extent – the area over which the particular effect will occur.

Immediate	Effects are adjacent to the array or vessel, within 10s of metres	rating = 1
Local	Within <500 m of array or vessel	rating = 2
Near Field	1 – 10 km of array or vessel	rating = 3
Far Field	10-50 km of array or vessel	rating = 4
Regional	> 50 km	rating = 5

Frequency – how often the effect will occur.

Isolated	occurring once or twice	rating = 1
Intermittent	occurring repetitively with starts and stops	rating = 2
Continuous	occurring non-stop	rating = 3

Duration – how long the disturbance will occur.

Immediate	limited to days	rating = 1
Short-term	limited to two weeks	rating = 2
Mid-term	limited to one month	rating = 3
Long term	limited to two months	rating = 4

Reversibility – the ability of a VEC to return to an equal, or improved, condition once the disturbance has ended (for example, reclaiming habitat area equal or superior to that lost). Predicted effects are rated as reversible (R) or irreversible (I), based on previous research and experience.

Ecological/Socio-cultural and Economic Context – rating 1 = relatively pristine area or area not adversely affected by human activity; 2 = evidence of existing adverse effects.

Uncertainty - This allows for disclosure of the level of scientific confidence in the predicted outcomes, and the general reliability of the data and models used to predict impacts.

4.2.7 Follow-up and Monitoring

Monitoring by the proponent may be undertaken for a number of reasons including compliance, permit approval/renewal, evaluation of mitigating measures, strengthening predictive capacity in future EAs, and commitments to third parties.

Monitoring and follow-up requirements are evaluated for each VEC and are linked to the sensitivity of a VEC to both Project related and cumulative environmental effects. The likelihood and importance of such effects, as well as the level of confidence associated with the adverse residual effects rating, are also taken into consideration.

4.2.8 Cumulative Environmental Effects Assessment

Individual environmental effects can accumulate and interact to result in cumulative environmental effects. Past and ongoing human activities have affected the region's natural and human environments. The description of the existing (baseline) environment reflects the effects of these other actions. An EA pursuant to *CEAA* must, however, include consideration of the "cumulative environmental effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out." A critical step in the EA, therefore, is determining what other projects or activities have reached a level of certainty (*e.g.,* "will be carried out") such that they must be considered in an EA.

It is helpful to consider the clarification provided by the Joint Review Panel for the Express Pipeline Project in Alberta (NEB and CEA Agency 1996). Following an analysis of

subsection 16(1)(a) of the *CEAA*, the Joint Review Panel determined that certain requirements must be met for the Panel to consider cumulative environmental effects:

- there must be a measurable environmental effect of the Project being proposed;
- the environmental effect must be demonstrated to interact cumulatively with the environmental effects from other projects or activities; and
- it must be known that the other projects or activities have been, or will be, carried out and are not hypothetical (NEB and CEA Agency 1996).

Furthermore, the Joint Review Panel indicated that it is an additional requirement that the cumulative environmental effect is likely to occur, that is, there must be some probability, rather than a mere possibility, that the cumulative environmental effect will occur. These criteria were used to guide the assessment of cumulative environmental effects. The other projects and activities considered in this assessment include those that are likely to proceed (such as those listed in the *CEAA* registry), and those which have been issued permits, licences, leases, or other forms of approval (as specified by the CEA Agency 1994).

Past and present activities that may impact cumulatively with the Project have been assessed as part of the assessment of routine Project activities in Section 6.0. Future activities that have the potential to interact cumulatively with the Project include:

- Marine traffic (domestic and international);
- Commercial fishing activities;
- Research surveys; and
- Other seismic projects in the regional area.