Amendment of the Environmental Assessment of WesternGeco's Eastern Newfoundland Offshore Seismic Program, 2015–2024

Prepared by

LGL LIMITED
environmental research associates

for

WesternGeco
(Division of Schlumberger Canada Limited)

March 2017
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1.0 Introduction

This document serves as an Amendment of the Environmental Assessment (EA) of WesternGeco Canada's Eastern Newfoundland Offshore Seismic Program, 2015–2024 (LGL 2015) and its associated Addendum (LGL 2016). The Amendment assesses the effects of Project activities not included in the original EA (LGL 2015) on Valued Environmental Components (VECs). Project activities not included in the original EA and assessed here include:

- The collection of gravity data using instrumentation installed on a marine vessel, and magnetic field data using instrumentation towed by a marine vessel.
- Sound velocity profiling using a ScanFish Remotely Operated Towed Vehicle (ROTV) towed by a marine vessel.
- Multi-vessel operations, including:
  - An undershoot seismic survey;
  - Simultaneous (but independent) 2-D, 3-D and/or 4-D seismic surveys; and
  - A two-vessel 1x2 seismic survey.

Details on Project activities are provided in § 2.0. All Project activities will occur in the Project Area defined in the original EA and shown below (Figure 1).

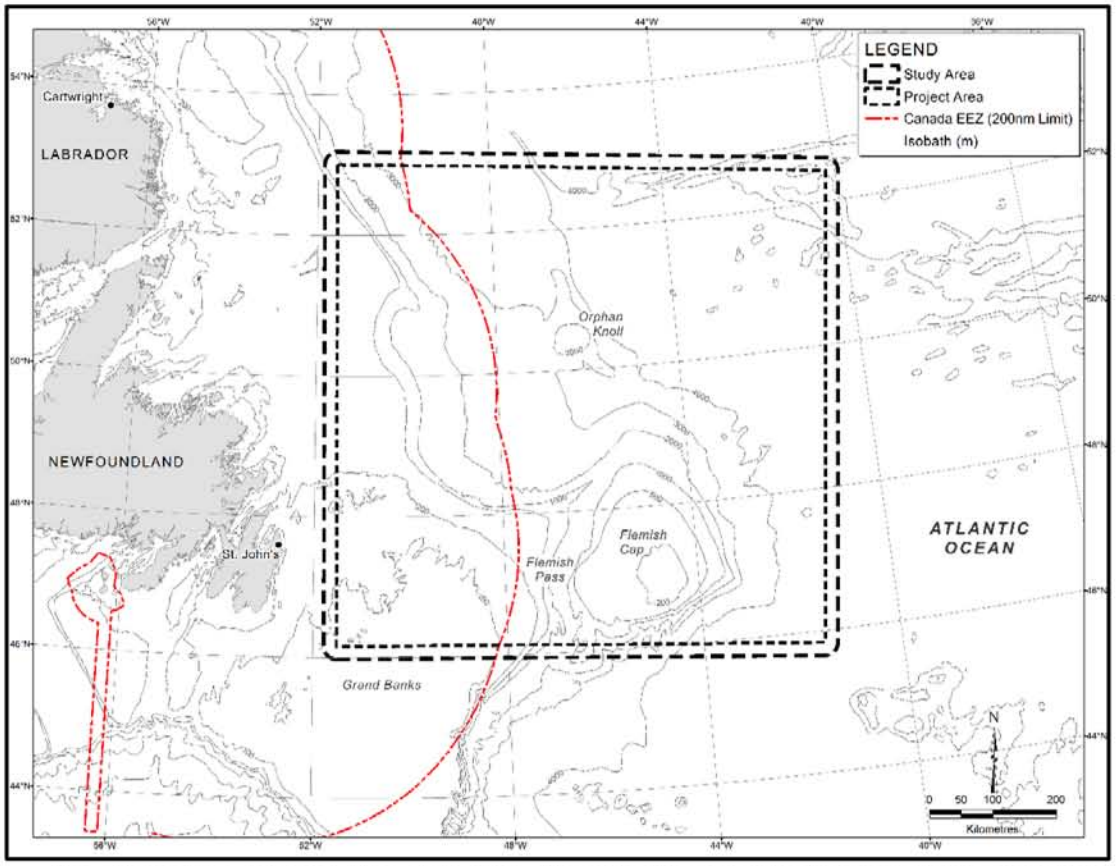

FIGURE 1. Location of the Project Area and Study Area for WesternGeco's Eastern Newfoundland Offshore Seismic Program, 2015–2024.

1.1 The Operator: WesternGeco

WesternGeco provides advanced acquisition and data processing services. WesternGeco's parent company, Schlumberger, employs approximately 120,000 people, representing over 140 nationalities, working in more than 85 countries. WesternGeco Canada has offices in Calgary, Alberta and Halifax, Nova Scotia, as well as a Project Office in St. John's, Newfoundland and Labrador. WesternGeco Canada employs 60 permanent, full-time Canadians in its regional offices, and many more on its vessels.

1.2 Contacts

Relevant contacts at WesternGeco for this EA Amendment are provided below.

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2.0 Project Description

As detailed in the original EA, WesternGeco may conduct 2-D, 3-D and/or 4-D seismic surveys within the Project Area (see Figure 1) during the 2015–2024 period. This section reviews the spatial and temporal boundaries for the Project and provides details on Project activities not included in the original EA and which were the basis for the effects assessment of this EA Amendment.

2.1 Spatial and Temporal Boundaries

The spatial boundaries of the Project Area are shown in Figure 1. The Study Area includes the Project Area plus a 20 km buffer around the Project Area to account for the propagation of seismic survey sound that could potentially affect marine biota (see Figure 1). The areas of the Study Area and Project Area are 643,553 km^2 and 581,299 km^2, respectively. More than half of the Study and Project area is located outside of Canada's Exclusive Economic Zone (EEZ) (200 nm limit). Water depth within the Project Area ranges from approximately 100 m to 4,000 m.

The "corner" coordinates (decimal degrees, WGS84 datum) of the extents of the Project Area are as follows:

- Northwest: 53.008°N, 51.560°W;
- Northeast: 52.436°N, 40.206°W;
- Southeast: 45.828°N, 41.566°W; and
- Southwest: 46.160°N, 51.514°W.

The "corner" coordinates (decimal degrees, WGS84 datum) of the extents of the Study Area are as follows:

- Northwest: 53.149°N, 51.745°W;
- Northeast: 52.535°N, 39.962°W;
- Southeast: 45.689°N, 41.406°W; and
- Southwest: 46.043°N, 51.710°W.

The temporal boundaries of the Project, as defined in the EA, are between 1 May and 30 November during each of 2015–2024.

2.2 Project Overview

In March 2016, the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) completed its EA Determination on the Environmental Assessment of WesternGeco's Eastern Newfoundland Offshore Seismic Program, 2015–2024 (LGL 2015) and its associated Addendum (LGL 2016), and concluded that the EA and its Addendum described the Project in sufficient detail and provided an acceptable assessment of the potential environmental effects of the Project. The C-NLOPB determined that the Project, following the application of mitigation measures, is not likely to cause significant adverse environmental effects (C-NLOPB 2016a).

The C-NLOPB's Determination of Significance (C-NLOPB 2016a) permitted WesternGeco to conduct 2-D, 3-D and/or 4-D seismic surveying in its Project Area (see Figure 1) between 1 May and 30 November 2015–2024. Commencing in 2017, WesternGeco proposes to add the activities described below (§ 2.2.1–2.2.3).

2.2.1 Collection of Gravity and Magnetic Field Data

Gravity and magnetic field data, which are both collected passively (i.e., do not use a controlled source) from the seismic vessel, allow for more accurate interpretation of seismic data.

In 2017–2024, gravity data would be collected using an L&R Air-Sea Gravity System II (or an equivalent gravity meter) installed onboard the seismic vessel.

Magnetic field data would be collected via a SeaSPY Marine Magnetometer (or an equivalent magnetometer) housed in a towfish (~1.2 m in length) that is towed behind the seismic vessel. The magnetometer/towfish would be located between the stern of the seismic vessel and the airgun arrays (i.e., 150–500 m behind the vessel) and deployed at a depth of ~10 m below the water surface.

2.2.2 Sound Velocity Profiling

Sound velocity profiling is routinely conducted during seismic surveying, traditionally using a retrievable probe to sample the entire water column; these data allow for more accurate interpretation of seismic data. During the Project, sound velocity profiling will only be conducted within WesternGeco's Project Area (see Figure 1).

In addition to traditional methods, the ScanFish Konia Remotely Operated Towed Vehicle (ROTV) may be deployed. It is 0.90 m long, 0.26 m high and 1.8 m wide (Figure 2). The ROTV would be towed 200–400 m astern of a support vessel, oscillating between the water surface and a 50 m depth during sound velocity profiling.

A typical sound velocity sensor operates at about 4 MHz, emitting up to 25 sound pulses per second. The pulse is highly directional and the minimal amount of sound that does propagate beyond the sensor

FIGURE 2. ScanFish Konia ROTV.

attenuates very quickly. The ROTV/sound velocity sensor would be deployed from either a picket vessel or a supply vessel when the vessel is not performing primary duties and the weather is suitable. The sound velocity sensor would operate continuously when possible. The operation of the sound velocity sensor would be documented in weekly reports submitted to the C-NLOPB.

2.2.3 Multi-vessel Operations

WesternGeco is proposing three types of multi-vessel operations in 2017–2024. Undershoot seismic surveys involve one source vessel whereas the other two types of multi-vessel operations listed below involve at least two source vessels.

1. An undershoot seismic survey;
2. Simultaneous (but independent) 2-D, 3-D and/or 4-D seismic surveys; and
3. A two-vessel 1x2 seismic survey.

For all three types of multi-vessel operations, each airgun array (typically two per vessel but up to three arrays each separated by ~37.5 m) would be 3,000–7,000 in^3 in volume and operate at a depth of 6–15 m. Airgun arrays towed by a vessel would not operate simultaneously but in a flip-flop arrangement. The shotpoint interval is typically 25 m but could range from 16.7 to 37.5 m. Based on a survey speed of 4.5 knots (8.3 km/h) this would equate to a shotpoint approximately every 7 to 16 seconds. The source level of each airgun array could range from 72–146 bar-m (i.e., 257–263 dB re 1 $\mu Pa_{p\text{-}p}$ @ 1 m)[1]. The maximum streamer length in all three scenarios would be 12 km and streamer tow depth range is 8–45 m. The streamer spread towed off the seismic recording vessel will most likely be 1.1–1.3 km wide at the front of the spread, and possibly up to 25% wider at the tail end of the streamers, if fanned. The widest streamer spread would be 1.65 km, based on current technology. The separation between any two streamers is 50–150 m.

[1] Modelled through a DFS V out-128 Hz filter, as per the Society of Exploration Geologists (SEG) standard for reporting arrays.

The following subsections provide additional details regarding each 'multi-vessel operations' scenario.

Undershoot.—Undershooting is a technique used to image the subsurface beneath an obstruction (e.g., drilling rig). During undershooting, two seismic vessels are involved: (1) one vessel tows streamers (i.e., recording vessel); and (2) the other vessel tows and activates the airgun arrays (i.e., source vessel). Typically, the streamer vessel tows fewer streamers during undershooting, allowing it a closer approach to the obstruction. For example, a 12-streamer spread might be reduced to a 10- or 8-streamer spread. However, the use of 12 streamers, as per 3-D seismic surveys, is also possible. The source vessel will typically sail on one side of the obstruction and the recording vessel on the other. This approach is often used in the immediate vicinity of operating production platforms to delineate changes in reservoir structures. In 2017–2024, WesternGeco is proposing to perform undershoot surveys of production facilities and drilling platforms/rigs in the Project Area. The duration of the proposed undershoot depends on a number of factors, including the size of the structure being undershot and prevailing currents, but is typically 3–7 days. The shotpoint interval would range from 16.7 m to 37.5 m, most commonly 25 m, similar to that of a conventional 3-D seismic survey. It is anticipated the source and recording vessels would be separated by a distance of 1 to 3 km.

Simultaneous 2-D, 3-D and/or 4-D Seismic Surveys.—This type of multi-vessel operation involves the simultaneous operations of two or more 2-D and/or 3-D seismic source vessels in the Project Area conducting independent surveys. Typically there is a minimum separation distance (e.g., 30 km) between the independent surveys.

Two-vessel 1x2 Seismic Survey.—IsoMetrix is a technology unique to WesternGeco that records accelerometer data within the seismic streamer in addition to the conventional hydrophone measurement. The addition of the accelerometer data allows for advanced data processing techniques, most notably the ability to reconstruct the seismic wavefield between the streamers. This, in turn, enables unique survey designs, one of which is the two-vessel "1x2" technique described below.

IsoMetrix involves taking a traditional flip-flop dual-source 3-D design (see Figure 3A) and moving one of the two source arrays to a remote source-only vessel (see Figure 3B). The technique yields a greater sub-surface footprint and, thus, can increase the data acquisition efficiency and allow the survey to be acquired faster than with a conventional 3-D survey. Therefore, there is a lower cumulative sound input into the water column.

The two seismic vessels involved in a 1x2 seismic survey are typically abreast of one another with a separation of 500 m to 1.6 km. The primary vessel deploys a single airgun array and streamers, while the second vessel is equipped with only an airgun array. The two airgun arrays would typically be identical in size and source level. The two vessels would alternate activation of their respective airgun arrays similar to the flip-flop arrangement in a conventional 3-D seismic survey (i.e., airgun arrays would not be activated simultaneously). The shotpoint interval would range from 16.7 to 37.5 m, similar to that of a conventional 3-D seismic survey.

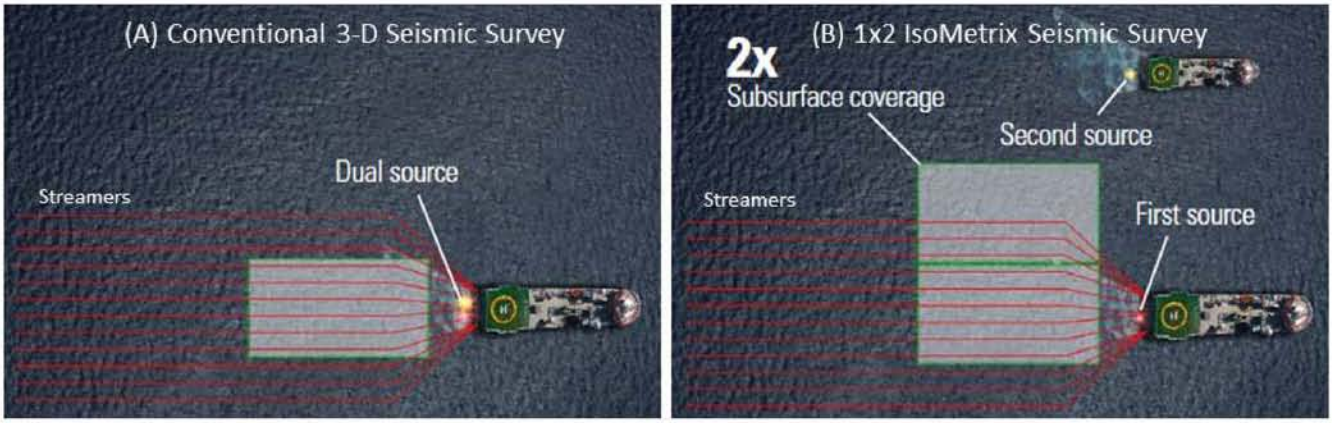

FIGURE 3. Schematic representation of (A) a conventional 3-D seismic survey configuration relative to a (B) two-vessel 1x2 seismic survey (provided by WesternGeco). Note that 'source' indicates an airgun array.

2.2.4 Concurrent Surveys

In most years, including 2017, there will be a maximum of two concurrent surveys. However, it is possible that three concurrent seismic surveys may occur in the Project Area within a given year. This applies to a combination of 2-D, 3-D, 4-D, undershoot and/or 1x2 IsoMetrix surveying.

2.2.5 Mitigation Measures

The mitigation measures described in the original EA will be implemented for applicable Project activities, including the new activities (Table 1). A discussion of mitigation measures that will be implemented for new Project activities is provided below and included in Table 1.

TABLE 1. Summary of mitigation measures presented in the WesternGeco EA (LGL 2015) and supplemented for multi-vessel seismic operations.

Potential Effects	Primary Mitigations
Interference with fishing vessels/mobile and fixed gear fisheries	• Upfront communications, liaison and planning to avoid fishing activity • Continuing communications throughout the program • Fisheries Liaison Officers (FLOs) • Single Point of Contact (SPOC) • Advisories and communications • Vessel Monitoring System (VMS) data • Avoidance • Start-up meetings on vessels
Fishing gear damage	• Upfront communications, liaison and planning to avoid fishing activity • Use of support vessel • FLOs • SPOCs • Compensation program • Reporting and documentation • Start-up meetings on vessels
Interference with shipping	• Advisories and at-sea communications • FLOs (fishing vessels)

Potential Effects	Primary Mitigations
	• Use of support vessel • SPOC (fishing vessels) • VMS data
Interference with DFO/FFAW-Unifor research program	• Communications and scheduling • Avoidance
Temporary or permanent hearing damage/disturbance to marine animals (marine mammals, sea turtles, seabirds, fishes, invertebrates)	• Pre-watch of safety zone • Delay start-up if marine mammals or sea turtles are within 500 m of airgun array • Ramp up of airguns • Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles within 500 m of airgun array • Use of qualified/experienced MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations • During simultaneous seismic surveys (2-D, 3-D, 4-D, undershoot and/or 1x2 IsoMetrix), source vessels from different surveys will maintain a minimum separation distance (nominally >30 km) when operating airgun arrays.
Temporary or permanent hearing damage/ disturbance to Species at Risk or other key habitats	• Pre-watch of safety zone • Delay start-up if marine mammals or sea turtles are within 500 m of airgun array • Ramp up of airguns • Shutdown of airgun arrays for *endangered* or *threatened* marine mammals and sea turtles within 500 m of airgun array • Use of qualified/experienced MMO(s) to monitor for marine mammals and sea turtles during daylight seismic operations [No critical habitat has been identified in or near the Study Area] • During simultaneous seismic surveys (2-D, 3-D, 4-D, undershoot and/or 1x2 IsoMetrix), source vessels from different surveys will maintain a minimum separation distance (nominally >30 km) when operating airgun arrays. • During undershoot and IsoMetrix seismic survey, only one seismic vessel to activate airgun(s) at a time.
Injury (mortality) to stranded seabirds	• Daily search of seismic and support vessels • Implementation of handling and release protocols • Minimize lighting when practical and safe to do so
Exposure to hydrocarbons	• Adherence to International Convention for the Prevention of Pollution from Ships (MARPOL) • Adherence to conditions of CWS migratory bird permit • Spill contingency and response plans • Use of solid streamer(s)

Gravity and Magnetic Field Data Collection.—Since gravity and magnetic field data collection techniques are passive in nature, the mitigation measures that apply pertain to the physical presence of the towed magnetometer (the gravity meter would be installed on and operate from the seismic vessel) and the vessel which tows it. The potential effects of towing a magnetometer include interference with fishing vessels, interference with shipping, and interference with Fisheries and Oceans Canada (DFO)/Fish, Food and Allied Workers (FFAW)-Unifor research vessels. Mitigation measures include

upfront planning and scheduling, SPOC, advisories and communication, and presence of a FLO (see Table 1).

Sound Velocity Profiling.—The sound emitted by a sound velocity sensor will have a frequency of about 4 MHz and will therefore, be undetectable by marine biota. The mitigation measures that apply to the physical presence of an ROTV, which houses the sensor, are the same as those indicated above for the magnetometer towfish: upfront planning and scheduling, SPOC, advisories and communications, and presence of a FLO) (see Table 1). Although the FLO will be located on the seismic vessel and the ROTV will be towed by either the picket or support vessel, the FLO will monitor the general area of operations with assistance from the vessel crew.

Multi-vessel Operations.—Mitigation measures intended to minimize the potential effects on VECs (see Table 1) of 2-D, 3-D, and 4-D seismic surveying are discussed in detail in § 5.7 and summarized in § 5.9 of WesternGeco's EA (LGL 2015). These same measures will be applied during multi-vessel operations and these measures follow (and in some cases exceed) DFO's *Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment*, which is included in Appendix 2 of the C-NLOPB's "Geophysical, Geological, Environmental and Geotechnical Program Guidelines" (C-NLOPB 2016b). Table 1 summarizes the proposed primary mitigation measures for each anticipated potential effect associated with multi-vessel operations. In addition, for undershoot and two-vessel 1x2 seismic surveys, only one airgun array will be activated at a time. During simultaneous seismic surveys (2-D, 3-D, 4-D, undershoot and/or 1x2 IsoMetrix), source vessels from independent surveys will maintain a minimum separation distance (nominally >30 km).

2.2.6 Consultations

In December 2016, an information package describing the new activities assessed in this EA Amendment was distributed to all consultees included in the original EA (LGL 2015). The transmittal letter and information document are included in Appendix A. WesternGeco will make a formal request for further face-to-face meetings in early 2017.

3.0 Effects of the Proposed Additional Project Activities on the Environment

The assessment of the potential effects of 2-D, 3-D and 4-D seismic surveying on VECs presented in WesternGeco's EA of the Eastern Newfoundland Offshore Seismic Program, 2015–2024 (LGL 2015) was used as the basis for the assessment of the potential effects of the proposed additional Project activities. Where appropriate, we have updated the effects literature.

3.1 Collection of Gravity and Magnetic Field Data

As indicated in § 2.2.1 and § 2.2.5, gravity and magnetic field data would be collected passively. In other words, neither the gravity meter nor the magnetometer is characterized by emissions of any type. Only the magnetometer would be towed by a vessel, thereby potentially causing physical interference with other users of the ocean. Considering that the potential residual effects of the presence of vessels and associated equipment on the VECs were predicted to be *not significant* in the WesternGeco EA (LGL 2015), the potential residual effects of gravity and magnetic field data collection with an onboard gravity meter and a towed towfish/magnetometer are predicted to be *negligible* in magnitude for a duration of *<1 month* to *1–12 months* over a geographic extent of *<1 km*^{2}. Based on these criteria ratings, the *reversible* residual effects on VECs associated with the collection of gravity and magnetic field data are predicted to be *not significant*. The level of confidence associated with this prediction is *high*.

3.2 Sound Velocity Profiling

The sound emitted by a sound velocity sensor would have a frequency of about 4 MHz and would therefore be undetectable by marine biota. The currently known maximum detectable frequencies for the marine biota groups in the Study Area that are most susceptible to the effects of exposure to underwater sound are 180 kHz (0.18 MHz) for fishes (see § 5.7.4.1 and Appendix 3 *in* LGL 2015), 160 kHz (i.e., 0.16 MHz) for marine mammals (see § 5.7.7.1 and Appendix 4 *in* LGL 2015), and 1.6 kHz (0.0016 MHz) for sea turtles (see Appendix 5 *in* LGL 2015). Recent studies of the behavioural responses of Atlantic herring (*Clupea harengus*) to sonar signals with frequencies ranging between 1 and 7 kHz indicate minimal responses to the sound (Doksaeter et al. 2009, 2012; Sivle et al. 2012). Atlantic herring and a limited number of other fish species appear to be able to detect higher frequencies than most other fishes. It is unlikely that biota with the capability of hearing higher frequency sound (e.g., toothed whales) would be affected by sound velocity sensor acoustic emissions with a frequency well beyond the known upper hearing limits of marine biota. Seabirds are less of an issue with respect to effects of exposure to underwater sound. Birds as a group are most sensitive to sounds within the 1–4 kHz frequency range. Although they can hear sounds with frequencies outside of that range, no species of bird has yet exhibited sensitivity to ultrasonic frequencies (i.e., >20 kHz) (Beason 2004; Crowell 2016). Based on the sound detection capabilities of the various biota groups discussed above, the sound emitted by the sound velocity sensor will also be outside of the detectable frequency ranges of species at risk. In addition to being characterized by frequencies well above those detectable by marine

biota, the minimal amount of sensor sound that will propagate beyond the sensor will attenuate very quickly due to its ultrasonic frequency.

The physical presence of the ROTV/sound velocity sensor would also have *negligible* effect on the VECs. A key role of a picket vessel, which would most likely tow the ROTV, is to minimize the potential for conflict between fishing gear and seismic operations. The presence of the ROTV would not interfere with the primary duties of either a picket vessel or a supply vessel. The WesternGeco EA (§ 5.6.2.2 *in* LGL 2015) predicted that the potential residual effects of the physical presence of the seismic vessels and equipment on VECs, including the Fisheries VEC, will be *not significant*. It is justified to predict that the physical presence of the ROTV/sound velocity sensor would also not result in significant residual effects on VECs.

In summary, the residual effects of the sound velocity sensor pulse emissions and the physical presence of the ROTV are predicted to be *negligible* in magnitude for a duration of *<1* to *1–12 months* over an area of *<1 km*^{2}. Based on these criteria ratings, the *reversible* residual effects of the sound velocity sensor acoustic emissions and the presence of the ROTV on all VECs are predicted to be *not significant.* The level of confidence associated with this prediction is *high*.

3.3 Multi-vessel Operations

An assessment for each of the three proposed multi-vessel operational scenarios is provided below. Where appropriate, we reference the original EA (LGL 2015) including the applicable assessment tables (Table 2).

TABLE 2. Assessment tables for each VEC in the original EA (LGL 2015) that were used as the basis for the assessment of multi-vessel 3-D operations.

VEC	Interaction Tables	Assessment Tables	Significance Tables
Fish and Fish Habitat	Table 5.3	Table 5.4	Table 5.5
Fisheries	Table 5.6	Table 5.7	Table 5.8
Seabird	Table 5.9	Table 5.10	Table 5.11
Marine Mammals and Sea Turtles	Table 5.12	Tables 5.13 and 5.14	Tables 5.15 and 5.16
Species at Risk	Table 5.17	Table 5.18	Table 5.19
Sensitive Areas	Refers to tables for other VECs	Refers to tables for other VECs	Refers to tables for other VECs

3.3.1 Undershoot

As noted above, this multi-vessel operation is of relatively short duration (typically 3–7 days) and would be used to acquire seismic data under and near production facilities and drilling platforms/rigs in the Project Area. Although it involves two seismic vessels only one of these vessels operates airgun arrays (in a flip-flop arrangement) during the undershoot survey; the other vessels tows streamers to record the data. Relative to the effects predictions made in the original EA for conventional 2-D and 3-D seismic surveys, the potential residual effects would occur over a much shorter duration (i.e., 3–7 days vs. 120–210 days). With mitigation measures in place (see Table 1), residual effects on VECs associated

with sound from the airgun arrays during an undershoot survey are predicted to range from *negligible to medium* in magnitude for a duration of *<1 month* over an area of *<1 km² to 101–1000 km²*. Based on these criteria ratings, the *reversible* residual effects of airgun sound on VECs are predicted to be *not significant* (LGL 2015). The level of confidence associated with this prediction is *medium to high* (Table 3). Similarly, no significant effects are predicted for other Project activities associated with an undershoot survey (e.g., vessel presence, lights etc.) and the level of confidence is judged as *medium* to *high* (Table 3).

3.3.2 Simultaneous 2-D, 3-D and/or 4-D Seismic Surveys

Of the three multi-vessel scenarios, the simultaneous operations of two or more 2-D and/or 3-D seismic source vessels in the Project Area conducting independent surveys has the greatest potential to adversely affect VECs. In most years, including 2017, there will be a maximum of two concurrent surveys. However, it is possible that three concurrent 2-D and/or 3-D seismic surveys may occur in the Project Area within a given year. The "worse-case scenario" of three simultaneous 3-D seismic surveys in the Project Area is assessed.

Fish and Fish Habitat.—WesternGeco source vessels from independent 3-D surveys will maintain a minimum separation distance (nominally >30 km) when operating airgun arrays. This should decrease the probability of synergistic effects on fish and invertebrates. Relative to the effects predictions made in the original EA for a single 2-D or 3-D seismic survey, the potential residual effects on the Fish and Fish Habitat VEC related to sound from three simultaneous 3-D seismic surveys, would occur over a larger area (i.e., maximum geographic extent of *1001–10,000* km² vs. *101–1000* km²). With mitigation measures in place (see Table 1), residual effects on the Fish and Fish Habitat VEC associated with sound from the Project during simultaneous 3-D seismic surveys are predicted to range from *negligible to medium* in magnitude for a duration of *<1 month* to *1–12 months* over an area of *<1 km² to 1001–10,000 km²*. Based on these criteria ratings, the *reversible* residual effects of underwater sound on the Fish and Fish Habitat VEC are predicted to be *not significant (*see Tables 5.4 and 5.5 *in* LGL 2015). The level of confidence associated with this prediction is *medium* to *high* (Table 3). Similarly, no significant effects are predicted for other Project activities associated with simultaneous seismic surveys (e.g., vessel lights, sanitary/domestic wastes etc.) and the level of confidence is judged as *medium to high* (Table 3).

Fisheries.— Relative to the effects predictions made in the original EA for a single 2-D or 3-D seismic survey, the potential residual effects on fisheries related to sound from three simultaneous 3-D seismic surveys, would occur over a larger area (i.e., maximum geographic extent of *1001–10,000* km² vs. *101–1000* km²). With mitigation measures in place (see Table 1), residual effects on the Fisheries VEC associated with sound from the Project during simultaneous 3-D seismic surveys are predicted to range from *negligible to medium* in magnitude for a duration of *<1 month* to *1–12 months* over an area of *<1 km² to 1001–10,000 km²*. Based on these criteria ratings, the *reversible* residual effects of underwater sound on the Fisheries VEC are predicted to be *not significant* (Tables 5.7 and 5.8 *in* LGL 2015). The level of confidence associated with this prediction is *medium* to *high* (Table 3).

With application of the mitigation measures outlined in Table 1, effects of vessel presence, including all gear being towed by three seismic vessels, on the Fisheries VEC are predicted to be a *negligible* to *low* magnitude for a duration of *<1* to *1–12 months* over a geographic area of *<1 km²* to *11–100 km²* . Based on these criteria ratings, the *reversible* residual effects of vessel/gear presence associated with three simultaneous 3-D seismic surveys on the Fisheries VEC are predicted to be *not significant* (Tables 5.7 and 5.8 *in* LGL 2015). The level of confidence associated with this prediction is *high*. Similarly, no significant effects are predicted for other Project activities associated with simultaneous seismic surveys (e.g., vessel lights, sanitary/domestic wastes etc.) and the level of confidence is judged as *medium* to *high* (Table 3).

Seabirds.—It is anticipated that the mitigation measures in place for seabirds will greatly minimize potential effects from simultaneous 3-D seismic surveys. Key amongst these measures are daily and systematic searches for stranded birds by experienced personnel (MMO on seismic vessel and designated vessel crew on support vessels) of Project vessels. Locating and handling stranded birds, the majority of which are Leach's Storm-petrels, according to CWS protocols will greatly minimize mortality. The geographic extent of possible effects associated with seismic surveys is relatively small. With mitigation measures in place (see Table 1), residual effects of three simultaneous seismic surveys on seabirds are predicted to range from *negligible to low* in magnitude for a duration of *1–12 months* over an area of *<1* to *1–10 km²*. Based on these criteria ratings, the *reversible* residual effects of simultaneous seismic surveys on the Seabird VEC are predicted to be *not significant* (Tables 5.10 and 5.11 *in* LGL 2015). The level of confidence associated with this prediction is *medium to high* (Table 3).

Marine Mammals and Sea Turtles.—Each of the three seismic vessels will have two qualified and experienced MMOs onboard who will conduct a visual monitoring program during all daylight hours and ensure appropriate mitigation measures are implemented. The mitigation measures of delaying ramp up of the airguns if any marine mammal or sea turtle is detected within the 500 m safety zone around the airgun arrays as well as a 30-minute ramp up procedure will minimize the potential for individuals being exposed to sound levels expected to cause hearing impairment. Given this, the primary concern with three concurrent 3-D surveys is the increased potential for disturbance and masking in marine mammals. Appendices 4 and 5 and § 5.7.7.1 of the original EA (LGL 2015) provide an overview of the scientific literature on disturbance and masking in marine mammals.

Airgun arrays produce intermittent sounds, involving emission of a strong pulse for a small fraction of a second followed by several seconds of near silence. As noted in § 2.2.3 of this document, for a single 3-D seismic survey, airgun arrays would be activated about every 7–16 seconds. Depending on the timing of array activation for each survey, it is possible that marine mammals in the Study Area will be exposed to airgun pulses more frequently, i.e., every few seconds—thereby increasing the likelihood that sounds important to marine mammals will be masked. However, the intermittent nature of the airgun pulses presumably still reduces the potential for masking—acknowledging that the degree of any reverberation of airgun sound in the Project Area is unknown but that situations with prolonged strong reverberation are infrequent (Appendix 4 *in* LGL 2015). If cetaceans exposed to airgun sounds sometimes respond by changing their vocal behaviour, this adaptation, along with directional hearing

and preadaptation to tolerate some masking by natural sounds (Richardson et al. 1995), would all reduce the importance of masking by seismic pulses.

To the best of our knowledge, the marine mammal monitoring report prepared for Chevron's 2005 seismic program in Orphan Basin provides the only available analysis of disturbance effects on marine mammals from concurrent seismic surveys in Atlantic Canada (Moulton et al. 2006). In 2005, there was a 12-week period when the M/V *Geco Diamond* and M/V *Western Patriot* conducted 3-D seismic surveys simultaneously in the Orphan Basin. The two vessels, which operated 5085 in^3 and 3000 in^3 arrays, were typically separated by distances of 50 km but were occasionally as close as 35 km during seismic operations (Moulton et al. 2006). Baleen whales, toothed whales, and dolphins were regularly sighted by MMOs on both seismic source vessels during periods with and without airgun activity. For baleen whales (humpback, fin, sei, minke whales combined), there were no statistically significant differences in sighting rates (number of sightings/hour) nor radial distances (closest point of approach) during periods with vs. without airgun activity. Baleen whales were more likely to be observed swimming away from the seismic vessel during periods when the airguns were active vs. inactive. Similar results were observed for toothed whales (sperm whale, northern bottlenose whale, and Sowerby's beaked whale combined). Dolphins (long-finned pilot whale, Atlantic white-sided dolphin, striped dolphin and bottlenose dolphin) were seen significantly farther from the seismic vessels during periods with (mean CPA= 807 m) vs. without airgun activity (mean CPA= 652 m). However, there were no statistically significant differences in sighting rates or types of behaviour recorded by MMOs. It is noteworthy that in 2004, Chevron undertook a single 3-D seismic survey in Orphan Basin (SR/V *Veritas Vantage*, 4450 in^3 array) and very similar marine mammal monitoring results, including sighting rates, were found relative to 2005 (Moulton et al. 2005, 2006).

WesternGeco source vessels from independent 3-D surveys will maintain a minimum separation distance (nominally >30 km) when operating airgun arrays. This should decrease the probability of synergistic disturbance effects on marine mammals. Relative to the effects predictions made in the original EA for a single 2-D or 3-D seismic survey, the potential residual disturbance effects on marine mammals (and sea turtles) of three simultaneous 3-D seismic surveys, would occur over a larger area (i.e., maximum geographic extent of *1001–10,000 km^2* vs. *101–1000 km^2*). With mitigation measures in place (see Table 1), residual effects on the Marine Mammal and Sea Turtle VEC associated with sound from the airgun arrays during simultaneous 3-D seismic surveys are predicted to range from *negligible to medium* in magnitude for a duration of *<1 month* to *1–12 months* over an area of *<1 km^2 to 1001–10,000 km^2*. Based on these criteria ratings, the *reversible* residual effects of airgun sound on marine mammals and sea turtles are predicted to be *not significant* (Tables 5.13 and 5.14 *in* LGL 2015). The level of confidence associated with this prediction is *medium* (Table 3). Similarly, no significant effects are predicted for other Project activities associated with simultaneous surveys (e.g., vessel presence, lights etc.) and the level of confidence is judged as *high* with the exception of accidental releases which is judged as *medium to high* (Table 3).

Species At Risk.—There are 11 species listed as Endangered or Threatened on Schedule 1 of the *Species at Risk Act* (*SARA*) that are considered in this assessment (LGL 2015). There has been no critical habitat identified in the Study Area for any of these species.

As described in § 5.7.8.2 of LGL (2015), effects of a single conventional seismic survey are not predicted to significantly affect either white shark, northern wolffish, spotted wolffish, or Atlantic wolfish in the Study Area. With mitigation measures in place and as per the effects assessment in § 5.7.4 of LGL (2015) and above for the Fish and Fish Habitat VEC, the predicted effects of three simultaneous seismic surveys on at-risk fish species will range from *negligible* to *medium* in magnitude for a duration of *< 1 month* to *1–12 months* over a geographic area of *< 1 km²* to *1001–10,000 km²*. Based on these criteria ratings, the predicted effects of activities associated with three simultaneous 3-D seismic surveys on white shark, northern wolffish, spotted wolffish, or Atlantic wolfish are predicted to be *not significant* (Table 3). The level of confidence associated with this prediction is *medium* to *high* (Table 3).

As noted in the original EA, blue whales, North Atlantic right whales, northern bottlenose whales (Scotian Shelf population) and leatherback sea turtles (all listed as Endangered on Schedule 1 of *SARA*) are not expected to occur regularly in the Study Area. In addition to a minimum separation distance (nominally 30 km) between independent seismic surveys, delay of ramp ups, and the ramp up procedure, all airguns will be shut down anytime one of these species is detected within or approaching the 500 m safety zone around the airgun arrays. As noted above, the primary concern with three simultaneous seismic surveys is the increased potential for masking and disturbance effects in marine mammals. With mitigation measures in place and as per the effects assessment in § 5.7.7 of LGL (2015) and above for marine mammals and sea turtles, the predicted effects of three simultaneous seismic surveys on blue whales, North Atlantic right whales, northern bottlenose whales and leatherback sea turtles will range from *negligible* to *medium* in magnitude for a duration of *< 1 month* to *1–12 months* over a geographic area of *< 1 km²* to *1001–10,000 km²*. Based on these criteria ratings, the predicted effects of activities associated with three simultaneous 3-D seismic surveys on blue whales, North Atlantic right whales, northern bottlenose whales and leatherback sea turtles are predicted to be *not significant* (Table 3). The level of confidence associated with this prediction is *medium* to *high* (Table 3).

As described in § 5.7.8.3 of LGL (2015), Ivory Gulls are not expected to occur in the Study Area and if this species does interact with one or more of the simultaneous seismic surveys, residual effects are predicted *negligible* and *not significant* (Table 5.19 *in* LGL 2015). The level of confidence associated with this prediction is judged as *medium* to *high* (Table 3).

Sensitive Areas.—Based on the conclusions of § 5.7.4 to 5.7.8 in LGL (2015) and the assessment above, the residual effects of activities associated with three simultaneous 3-D seismic surveys on sensitive habitat and/or the species therein within the Study Area are predicted to be *not significant.* The level of confidence associated with this prediction is *medium* to *high*.

3.3.3 Two-vessel 1x2 Seismic Survey

The two-vessel Isometrix seismic survey primarily differs from a conventional 3-D seismic survey in that the second airgun array used in a flip-flop arrangement is operated from a second source vessel (see Figure 3B). The airgun arrays would not be operated simultaneously and the shotpoint interval would range from 16.7 to 37.5 m, similar to that of a conventional 3-D seismic survey. MMOs would be

located on both source vessels and would conduct monitoring and implement mitigation measures outlined in Table 1. The physical footprint of the 1x2 seismic survey would be similar (albeit slightly larger) to that of a conventional 3-D seismic survey given that the second source vessel does not tow streamers. With mitigation measures in place (see Table 1), residual effects on VECs associated with sound from the airgun arrays during a 1x2 seismic survey are predicted to range from *negligible to medium* in magnitude for a duration of *1–12 months* over an area of *<1 km^2 to 101–1000 km^2*. Based on these criteria ratings, the *reversible* residual effects of airgun sound on VECs are predicted to be *not significant* (Table 3). The level of confidence associated with this prediction is *medium to high* (Table 3). Similarly, no significant effects are predicted for other Project activities associated with a 1x2 seismic survey (e.g., vessel presence, lights etc.) and the level of confidence is judged as *medium* to *high* (Table 3).

3.3.4 Concurrent Seismic Surveys

As noted in §2.2.4, in most years, there will be a maximum of two concurrent seismic surveys. However, it is possible that three concurrent seismic surveys may occur in the Project Area within a given year. This applies to a combination of 2-D, 3-D, 4-D, undershoot and/or 1x2 IsoMetrix surveying. For multi-vessel operations, we assessed the worse-case scenario of three simultaneous 3-D seismic surveys above and the reader is referred to that assessment.

In summary, the residual effects of the activities associated with concurrent seismic surveys, including those involving multi-vessel operations, are predicted to be *negligible* to *medium* in magnitude for a duration of *<1* to *1–12 months* over an area of *<1 km^2* to *1001–10,000 km^2*. Based on these criteria ratings, the *reversible* residual effects of activities associated with concurrent seismic surveys on all VECs are predicted to be *not significant.* The level of confidence associated with this prediction is *medium* to *high*.

3.4 Residual Effects Assessment Summary

A summary of the Project's residual effects on the environment are shown in Table 3. All activities associated with WesternGeco's proposed additional Project activities are predicted to have *no significant* effects on VECs. The level of confidence associated with these predictions ranges from *medium* to *high*.

TABLE 3. Significance of potential residual environmental effects of WesternGeco's proposed additional program activities on VECs occurring within the Study Area.

Valued Environmental Component: Fish and Fish Habitat, Fisheries, Birds, Marine Mammals, Turtles, Species at Risk, Sensitive Areas				
Project Activity	**Significance Rating**	**Level of Confidence**	**Likelihood [a]**	
	Significance of Predicted Residual Environmental Effects		**Probability of Occurrence**	**Scientific Certainty**
Collection of Gravity and Magnetic Field Data				
Towfish presence	NS	3	-	-
Sound Velocity Profiling				
Sound emissions	NS	3	-	-
ROTV presence	NS	3	-	-
Multi-vessel Operations				
Underwater Sound				
Airgun arrays	NS	2-3	-	-
Seismic vessel	NS	2-3	-	-
Support vessel	NS	2-3	-	-
Supply vessel	NS	2-3	-	-
Echo sounder	NS	2-3	-	-
Vessel Presence				
Seismic vessel, including airgun arrays and multiple streamers	NS	3	-	-
Support vessel	NS	3	-	-
Supply vessel	NS	3	-	-
Vessel Lights	NS	3	-	-
Helicopter Presence	NS	3	-	-
Sanitary/Domestic Wastes	NS	3	-	-
Atmospheric Emissions	NS	3	-	-
Accidental Releases	NS	2-3	-	-

Key:

Significance is defined as either a high magnitude, or a medium magnitude with duration greater than 1 year and a geographic extent >100 km^2

Residual Environmental Effect Rating:
- S = Significant Negative Environmental Effect
- NS = Not-significant Negative Environmental Effect
- P = Positive Environmental Effect

Level of Confidence: based on professional judgment:
- 1= Low
- 2= Medium
- 3= High

Probability of Occurrence: based on professional judgment:
- 1= Low
- 2= Medium
- 3= High

Scientific Certainty: based on scientific information and statistical analysis or professional judgment:
- 1= Low
- 2= Medium
- 3= High

[a] Considered only in the case where 'significant negative effect' is predicted.

3.5 Cumulative Effects

WesternGeco's EA of the Eastern Newfoundland Offshore Seismic Program, 2015–2024 (LGL 2015) assessed cumulative effects from non-Project activities that are either occurring or are planned for the Regional Area. These activities included:

- fisheries (commercial and research);
- marine transportation; and
- other offshore oil and gas activities.

As indicated in § 5.8.3 of LGL (2015), there is potential for cumulative effects with other seismic programs proposed for 2017–2024 (e.g., MKI, Statoil, Polarcus, Nexen). Seismic programs involving companies other than WesternGeco could potentially be operating in relatively close proximity. During these periods, VECs will be exposed to noise from more than one of the seismic surveys. It will be in the interests of the different seismic operators to have good coordination between programs in order to provide sufficient buffers and to minimize acoustic interference. Assuming a minimum separation of seismic vessels (nominally 30 km) operating concurrently in and near the Project Area, cumulative effects of seismic sound on fish and fish habitat, fisheries, seabirds, marine mammals, sea turtles, species at risk and sensitive areas are predicted to be *not significant*. However, there are uncertainties regarding this prediction—particularly regarding effects of masking and disturbance on marine mammals from sound produced during multiple seismic surveys. The potential for temporal and spatial overlap of future activity of seismic programs (2017 and beyond) in the area will be assessed in the EA update process. Uncertainty due to the large Project Areas will be reduced as specific survey designs (covering smaller area) become available.

As discussed in this EA, negative effects (auditory, physical, and behavioural) on key sensitive VECs, such as marine mammals, appear unlikely beyond a localized area from the sound source. In addition, all programs will use mitigation measures such as ramp-ups, delayed startups, and shutdowns of the airgun arrays as well as spatial separation between seismic surveys. Thus, it seems likely that while some animals may receive sound from multiple geophysical programs, the current prediction is that *no significant residual effects* will result. The level of confidence associated with this prediction is rated as *medium*.

3.6 Follow-up Monitoring

WesternGeco's approach and commitments for follow-up monitoring were detailed in § 5.9 of LGL (2015). Given the increased uncertainty associated with effects, particularly disturbance, on marine mammals (and sea turtles) from multiple concurrent seismic surveys, a comprehensive marine mammal and sea turtle monitoring report will be prepared for submission to the C-NLOPB. The report will provide analyses of data collected by MMOs onboard each source vessel; analyses will compare sighting rates, distances, and behaviour of marine mammals during periods with and without airgun activity. All mitigation and monitoring procedures and an assessment of their efficacy will be provided as required in the C-NLOPB's "Geophysical, Geological, Environmental and Geotechnical Program Guidelines" (C-NLOPB 2016b).

4.0 Literature Cited

Beason, R.C. 2004. What can birds hear? Proc. 21st Vertebrate Pest Conference. University of California, Davis. p. 92-96.

Crowell, S. C. 2016. Measuring in-air and underwater hearing in seabirds. Advances in Experimental Medicine and Biology 875:1155-1160.

C-NLOPB (Canada-Newfoundland and Labrador Offshore Petroleum Board). 2016a. Determination of Significance Report for WesternGeco Canada Eastern Newfoundland Offshore Program, 2015–2024 Environmental Assessment. 2 p.

C-NLOPB. 2016b. Geophysical, Geological, Environmental and Geotechnical Program Guidelines, June 2016. 45 p. + appendices.

Doksaeter, L., P.H. Kvadsheim, F.-P. A. Lam, C. Donovan and P.J.O. Miller. 2009. Behavioral responses of herring (*Clupea harengus*) to 1-2 and 6-7 kHz sonar signals and killer whale feeding sounds. J. Acoust. Soc. Am. 125(1): 554-564.

Doksaeter, L., N.O. Handegard, O.R. Godø, P.H. Kvadsheim and N. Nordlund. 2012. Behavior of captive herring exposed to naval sonar transmissions (1.0-1.6 kHz) throughout a yearly cycle. J. Acoust. Soc. Am. 131(2): 1632-1642.

LGL (LGL Limited). 2015. Environmental Assessment of WesternGeco's Eastern Newfoundland Offshore Seismic Program, 2015-2024. LGL Rep. FA0035. Prepared by LGL Limited in association with Canning & Pitt Associates Inc., St. John's, NL for WesternGeco (Division of Schlumberger Canada Limited), Calgary, AB. 255 p. + appendices.

LGL. 2016. Environmental Assessment of WesternGeco's Eastern Newfoundland Offshore Seismic Program, 2015-2024 Addendum. LGL Rep. FA0035. Prepared by LGL Limited in association with Canning & Pitt Associates Inc., St. John's, NL for WesternGeco (Division of Schlumberger Canada Limited), Calgary, AB. 11p.

Moulton, V.D., B.D. Mactavish and R.A. Buchanan. 2005. Marine mammal and seabird monitoring of Chevron Canada Resources' 3-D seismic program on the Orphan Basin, 2004. LGL Rep. SA817. Rep. by LGL Limited, St. John's, NL, for Chevron Canada Resources, Calgary, AB, ExxonMobil Canada Ltd., St. John's, NL, and Imperial Oil Resources Ventures Ltd., Calgary, AB. 90 p. + appendices.

Moulton, V.D., B.D. Mactavish, R.E. Harris and R.A. Buchanan. 2006. Marine mammal and seabird monitoring of Chevron Canada Limited's 3-D seismic program on the Orphan Basin, 2005. LGL Rep. SA843. Rep. by LGL Limited, St. John's, NL, for Chevron Canada Limited, Calgary, AB, ExxonMobil Canada Ltd., St. John's, NL, and Imperial Oil Resources Ventures Ltd., Calgary, AB. 109 p. + appendices.

Richardson, W.J., C.R.J. Greene, C.I. Malme, and D.H. Thomson. 1995. Marine mammals and noise. Academic Press, San Diego, CA. 576 p.

Sivle, L.D., P.H. Kvadsheim, M.A. Ainslie, A. Solow, N.O. Handegard, N. Nordlund and F.-P. A. Lam. 2012. Impact of naval sonar signals on Atlantic herring (*Clupea harengus*) during summer feeding. ICES J. Mar. Sci. 69: 1078-1085.

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Appendix A: Transmittal Letter and Information Package Distributed to Consultees in December 2016

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December 16, 2016

Re: Environmental Assessment Amendment Notification to Stakeholders

Good day,

Please find attached reference information regarding WesternGeco Canada's intention to modify two (2) existing Environmental Assessments currently in place with the Canada-Newfoundland & Labrador Offshore Petroleum Board (C-NLOPB).

C-NLOPB File Number: 30006-020-001

- *Eastern Newfoundland Offshore Seismic Program 2015-2024*
- *Southeastern Newfoundland Offshore Seismic Program 2015-2024*

The actual amended documents will be submitted to the C-NLOPB via LGL Limited and will be distributed to stakeholders accordingly for review and comment.

Additional communication from WesternGeco will be forthcoming in the New Year to extend an invitation to meet and discuss the amendments as well as to provide information on WesternGeco's potential 2017 plans offshore Newfoundland & Labrador.

Should you have any questions please do not hesitate to contact us.

Regards,

[redacted]

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This document is being distributed to provide stakeholders in the offshore Newfoundland and Labrador area with information relating to WesternGeco Canada's two (2) Environmental Assessments (EA) currently in place with the Canada-Newfoundland & Labrador Offshore Petroleum Board (C-NLOPB).

C-NLOPB File Number: 30006-020-001

- *Eastern Newfoundland Offshore Seismic Program 2015-2024*
- *Southeastern Newfoundland Offshore Seismic Program 2015-2024*

Positive determinations for both EAs were received from the C-NLOPB on March 21, 2016. An EA Annual Update for the *Eastern Newfoundland Offshore Seismic Program 2015-2024* was submitted on March 24, 2016. No annual update was provided for the Southeastern area as we had no plans to acquire data in that area in the 2016 season.

In 2016, WesternGeco Canada had one (1) seismic vessel and two (2) support vessels (guard and supply) working in the Flemish Pass Basin area conducting a 3D seismic program. This project commenced in mid-May and was completed mid-October.

In preparation for future programs offshore Newfoundland and Labrador, WesternGeco Canada intends to submit amendments to both EAs specifically as they relate to the vessels, equipment and operational plans to be used in subsequent years. This will be for programs commencing in 2017 and beyond.

The current EAs were submitted and consultations were conducted with information to include 2D, 3D and/or 4D seismic acquisition using one (1) seismic vessel and two (2) support vessels. It is WesternGeco's intention to update these documents to include the following:

- Recording of gravity and magnetics data
- Sound velocity profiling (ScanFish)

As well as multi-vessel operations including:

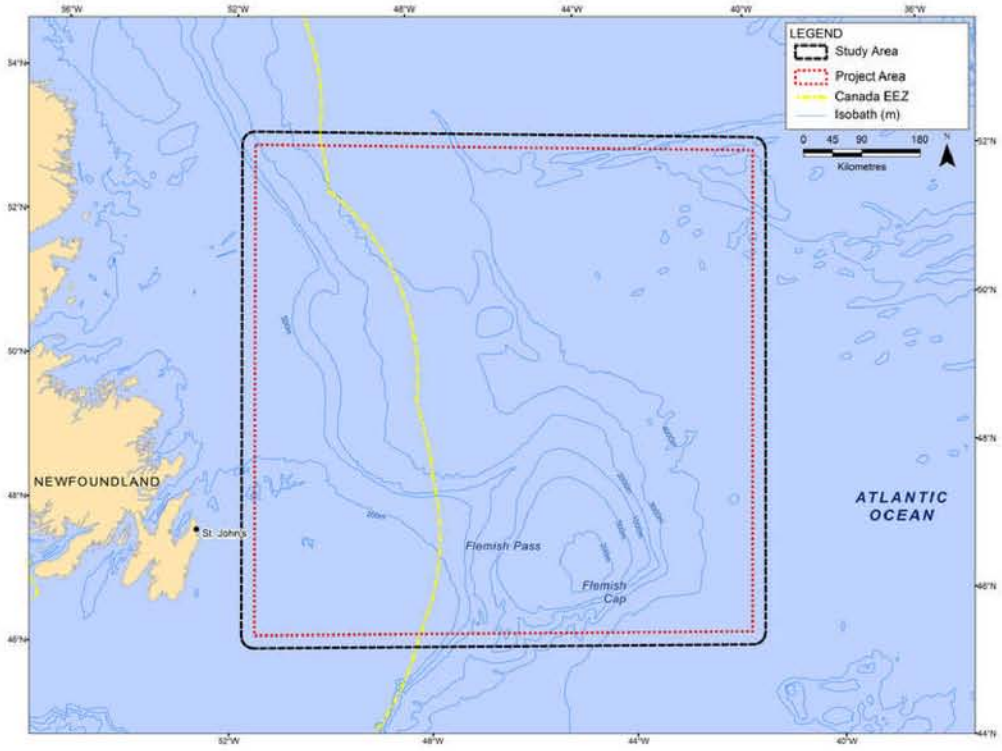
- Undershoot (one (1) recording vessel and one (1) nearby source-only vessel)
- Simultaneous operations of two (2) seismic vessels in two independent areas

Further information for each of these additions is included with this document.

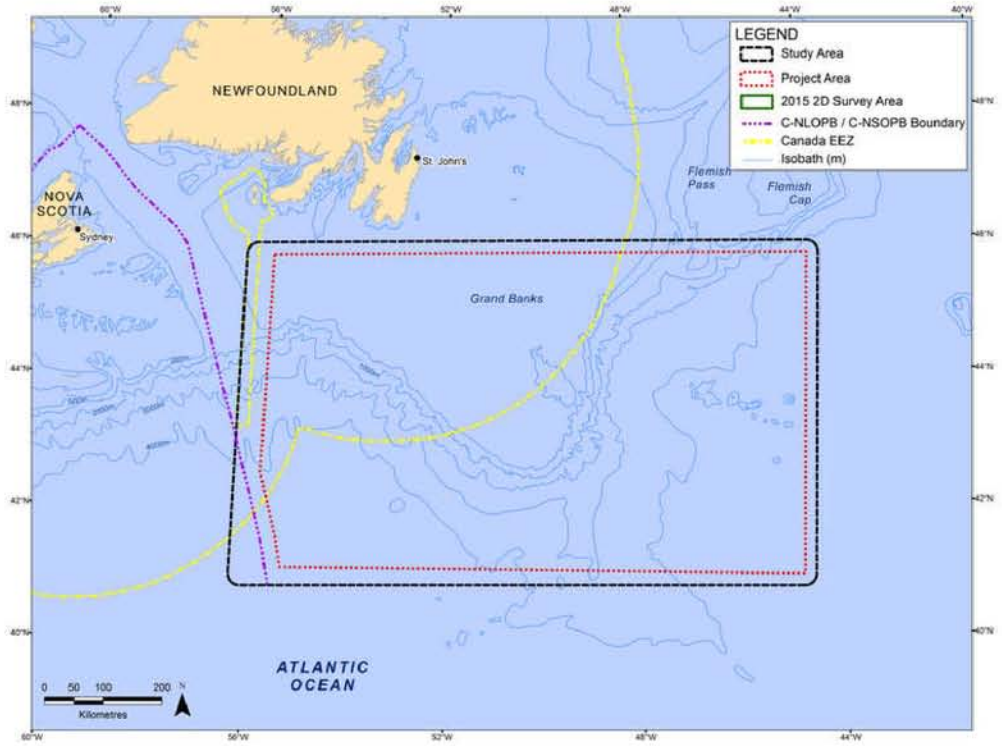
LGL Limited have been tasked with updating both EAs to include the information noted above and official submission of these documents to the C-NLOPB will be forthcoming.

The purpose of this document is to provide stakeholders with initial reference information on our future plans and to give you an opportunity to ask any initial questions you may have. There will be another formal request for further face-to-face consultations coming to all stakeholders in the near future.

WesternGeco Eastern NL Project Area 2015-2024



WesternGeco Southeastern NL Project Area 2015-2024



Spatial and Temporal Scopes

The Project and Study areas defined in the EAs remain unchanged as per the previous maps. The temporal scope defined in the EAs as May 1st to November 30th during each year of the 2015-2024 period also remains unchanged.

Vessels and Equipment

As per the current EAs, WesternGeco still intends to carry out 2D, 3D and/or 4D seismic programs in future years, however with the addition of the following technologies and/or operational changes:

- Recording of gravity and magnetics data

  The gravity meter will be installed onboard the seismic vessel and at no time enters the water. The magnetometer will be located within a towfish towed behind the vessel. The magnetometer is typically towed at about 10 m depth, and between 150 m and 500 m behind the seismic vessel, in front of the seismic source arrays. It is a passive recording instrument that measures the earth's natural magnetism. The towfish is typically about four feet long.

- Sound velocity profiling (ScanFish)

  The sound velocity profiling vehicle is towed behind a support vessel supporting the seismic operation. The vehicle is designed to take sound velocity measurements over a range of depths in the near surface of the water column, typically between the surface and 50 m. The vehicle typically describes a "V" shape trajectory, constantly descending and ascending (at 0-2 m/s) as the towing vessel moves forwards through the water. We anticipate the vehicle being towed between 200 m and 400 m behind the towing vessel. The vehicle itself is approximately 1 m long, ¼ m high and almost 2 m wide.

As well as multi-vessel operations including:

- Undershoot (one recording vessel and one nearby source-only vessel)

  If there is an obstruction within the survey area, for example a drill rig, then to gain seismic coverage underneath the drill rig the primary (recording) survey vessel tows streamers on one side of the drill rig and a second seismic vessel towing only seismic sources (the undershoot vessel) provides the sound source on the other side of the drill rig. Such an arrangement is used only for the duration of the undershoot, typically a period of three (3) days to two (2) weeks depending on factors that may include the size of the structure being undershot, prevailing currents, etc. The undershoot vessel will travel at the same speed as the recording vessel. The sound source array of the undershoot vessel will be identical to that of the recording vessel. Seismic sources are active on only one vessel (the undershoot vessel) during the undershoot.

- Simultaneous operations of two (2) seismic vessels in two independent areas within one EA.

As noted above, the EA Amendment documents will be submitted to the C-NLOPB via LGL Limited in the near future.

As always, should you have any questions or require any clarifications on this matter, please do not hesitate to contact us at any time.

Kindest Regards,

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