6.0 ENVIRONMENTAL EFFECTS ASSESSMENT METHODS

6.1 Overview

The approach and methods used for the environmental assessment are based largely on the Study Team's experience in conducting environmental assessments of similar projects for the C-NLOPB and their understanding of CEAA. The environmental assessment focuses on the VECs identified through issues scoping, as described in Section 6.2.

6.2 Issues Scoping and Selection of Valued Environmental Components

The Project scope encompasses those components and activities considered for the purpose of environmental assessment. The scope of the proposed exploration drilling program includes all of the components and activities described in Section 2.10.

The issues scoping exercise conducted in relation to this environmental assessment included the following:

- The final Scoping Document (Appendix A), as issued by the C-NLOPB on August 17, 2011;
- Comments from stakeholders (including regulatory agencies and the public) on the draft Scoping Document (issued by the C-NLOPB on February 25, 2011);
- Ongoing consultation with relevant regulatory agencies (including, but not limited to the C-NLOPB, DFO, Environment Canada and Transport Canada) and other stakeholders (including, but not limited to the FFAW, One Ocean, Regroupement des Pecheurs Professionnels des Îles (RPPIM), Regroupement des Palangriers et Petoncliers Unique Madelinots (RPPUM), Association des pêcheurs propriétaires des Îles-de-la-Madeleine (APPIM) and Association of Inshore Fishermen of the Magdalen Islands);
- A review of the Old Harry Prospect Geohazard Program 2010 to 2020 Scoping Document and regulatory review comments to the environmental assessment (Stantec 2010);
- A review of available information on the existing biophysical and socio-economic environments of the region in which the program will occur, and of other environmental assessments undertaken in relation to similar projects;
- A review of relevant regulations and guidelines related to offshore exploration activities; and
- The professional judgment of the Study Team.

It is generally acknowledged that an environmental assessment must focus on those components of the environment that are valued by society and/or that can serve as indicators of environmental change and have the most relevance to the final decision regarding the environmental acceptability of a proposed undertaking. These components are known as VECs and may include biophysical and socio-economic components.

Based on the results of the issues scoping exercise described above, including the final Scoping Document (Appendix A), the following VECs are considered in this environmental assessment:

- Species at Risk;

- Marine Ecosystem;
- Marine Fish, Shellfish and Habitat;
- Marine Birds;
- Marine Mammals and Sea Turtles;
- Sensitive Areas; and
- Commercial Fisheries and Other Users.

The rationale for the selection of these VECs is provided below:

- Species at Risk: There are 19 species of marine fish, marine birds, fish, marine mammals and sea turtles that have designated status under SARA Schedule 1 and and/or 24 species designated as 'at-risk' by COSWEIC that could potentially occur in the Study Area (refer to Tables 5.1 and 5.2). Species at Risk are collectively considered a VEC due to regulatory concern and in recognition of their protected status under SARA.
- Marine Ecosystem: A healthy marine ecosystem supports the biological communities and socio-economic uses of the marine environment. The marine ecosystem includes water (plankton) and benthic (coral) communities.
- Marine Fish, Shellfish and Habitat: Fish and fish habitat are considered a VEC in this assessment because of the biological and commercial significance of several fish species and associated spawning, feeding and nursery habitats within the Study Area. The commercial fishery is an important activity in the Gulf. The fish and fish habitat upon which the fishery depends is therefore an important consideration in the environmental assessment of activities that may influence the marine environment. In addition, fish and fish habitat are an important component of the marine ecosystem. Fish and their habitat are assessed as a single VEC because they are clearly interrelated. The consideration of fish and fish habitat as one VEC is in keeping with current practice in environmental assessment and provides for a more comprehensive, ecosystem-based approach. A number of species of marine fish can be found within the vicinity of the Study Area. Fish and fish habitat in the context of this environmental assessment includes finfish, shellfish, invertebrates, plankton, the water column and benthic habitats where relevant in the assessment.
- Marine Birds: The Gulf hosts a range of seabirds throughout the year. Seabirds are a key ecosystem component near the top of the food chain and are an important resource for tourism and recreational activities, as well as for scientific study. They are, therefore, important socially, culturally, economically, aesthetically, ecologically and scientifically. Marine birds are considered a VEC due to regulatory concern and in recognition of their protected status under the *Migratory Birds Convention Act, 1994*.
- Marine Mammals and Sea Turtles: Whales and seals are key elements in the biological and social environments in the Gulf; sea turtles are generally uncommon. There are 19 species of marine mammals and four species of sea turtles potentially present within the vicinity of the Study Area. Marine mammals play an important role in the offshore ecosystem. This importance is manifested in regulatory protection and scientific and public concern. As well, whale watching (as part of the tourism industry) and the annual seal harvest are economic considerations, as are interactions of marine mammals with the commercial fishery. Marine turtles are occasional visitors to the Gulf and the west coast of Newfoundland and could potentially be affected by Project activities. For these reasons, marine mammals and turtles are considered a VEC. The environmental assessment focuses on marine mammal and turtle species that may live and/or migrate through the Study Area.

- Sensitive Areas: Sensitive areas are often associated with rare or unique marine habitat features, habitat that supports sensitive life stages of valued marine resources, and/or critical habitat for species at risk. As per the Scoping Document (Appendix A), sensitive areas in the Study Area include any EBSAs identified within the Gulf (some consider the Gulf as a whole a significant area). This includes the southern fringe of the Laurentian Channel EBSA and the west coast of Newfoundland EBSA. The Project Area overlaps with a potential redfish (a COSEWIC-designated species) mating area and the Study Area overlaps with a potential redfish larvae extrusion area and a cod (a COSEWIC-designated species) spawning area. Sensitive areas were selected as a VEC due to their importance as unique or critical habitat for various species or species assemblages. Sensitive areas are important socially, culturally, aesthetically, ecologically and scientifically.
- Commercial Fisheries and Other Users: Commercial fisheries and other users was selected as a VEC because historically, the fishery has played an important role in the Gulf and has helped to define much of the Atlantic provinces' character. Other marine users of the area include marine transportation, research surveys and military exercises, and are also considered. The commercial fishery remains an integral component of the economy of the Newfoundland and Labrador as well as communities of the Gulf and, for this reason, is considered a VEC.

These seven VECs represent the key environmental components that are assessed in this document. This environmental assessment provides detailed effects analyses for each of these VECs.

6.3 Environmental Effects Assessment Organization

The specific steps involved in the assessment for each VEC are as follows:

- determining boundaries (see Section 6.3.1);
- describing the existing conditions for each VEC in the vicinity of the Study Area and within the Gulf as a whole (see Section 5);
- identifying potential interactions between VECs and the Project's components / activities and outlining existing knowledge regarding these potential interactions (see Section 7.1);
- proposed mitigation (see sections 7.X.3, where "X" represents the various VEC chapters);
- establishing significance criteria for evaluating residual environmental effects (see sections 7.X.1);
- assessing environmental effects and mitigation (see Sections 7.X.2);
- assessing accidental events (see Section 8);
- assessing cumulative environmental effects (see Section 9);
- providing a summary of the environmental effects assessment (see Sections 7.X.4 and Section 10); and
- identifying the need, if any, for follow-up and monitoring requirements (see Section 11).

Each of these is described in more detail in Sections 6.3.1 to 6.3.10.

6.3.1 Boundaries

Boundaries provide a meaningful focus for an environmental assessment. The Project boundaries are described generally below, as part of the effects analysis for each of the VECs. Establishing the spatial and temporal scope of the environmental assessment for each VEC included consideration of project, ecological/socio-economic and administrative boundaries.

The Project boundaries are also illustrated in Figure 6.1 and have been categorized as follows:

- Project Area: The approximately upper two-thirds of EL 1105; an approximately 304 km^2 area bounded by 48°10'59.740"N, 60°23'56.094"W (northwest corner), 48°10'0.084"N, 60°8'57.480"W (northeast corner), 48°04'45.681"N, 60°8'57.515"W (southeast corner) and 47°58'22.285"N, 60°23'55.732"W (southwest corner). The proposed well coordinates are in the vicinity of Latitude 48°03'05.294" and Longitude 60°23'39.385" (NAD83 datum, geographic coordinates).
- Study Area (note this is the same as the Affected Area as per the Scoping Document): The area that could potentially be affected by Project activities beyond the Project Area (*i.e.*, drill cuttings deposition or an accidental event). The 27,602 km^2 Study Area has been defined by the furthest extent of the drill cutting deposition modelling (AMEC 2011) results (see Figure 2.7) and oil spill trajectory modelling (SL Ross 2011a, updated 2012) results (see Figure 2.23). Note that the area is much larger than the modelling results; the coastal areas are identified as part of the Study Area only in recognition of the supply vessel / helicopter activity. Environmental assessment predictions will be based on this area.
- Regional Area: The northern and southern Gulf.

Project boundaries are defined by the spatial and temporal extent of project components and activities, and are determined primarily by project-specific characteristics. Spatial project boundaries are sometimes defined by project "footprints" and may vary between project components and activities. Temporal project boundaries are defined by the timing and duration of project activities, as described in Section 2.6. Administrative boundaries refer to the spatial and temporal dimensions imposed on the environmental assessment for political, socio-cultural or economic reasons. Administrative boundaries can include such elements as the manner in which natural and/or socio-economic systems are managed.

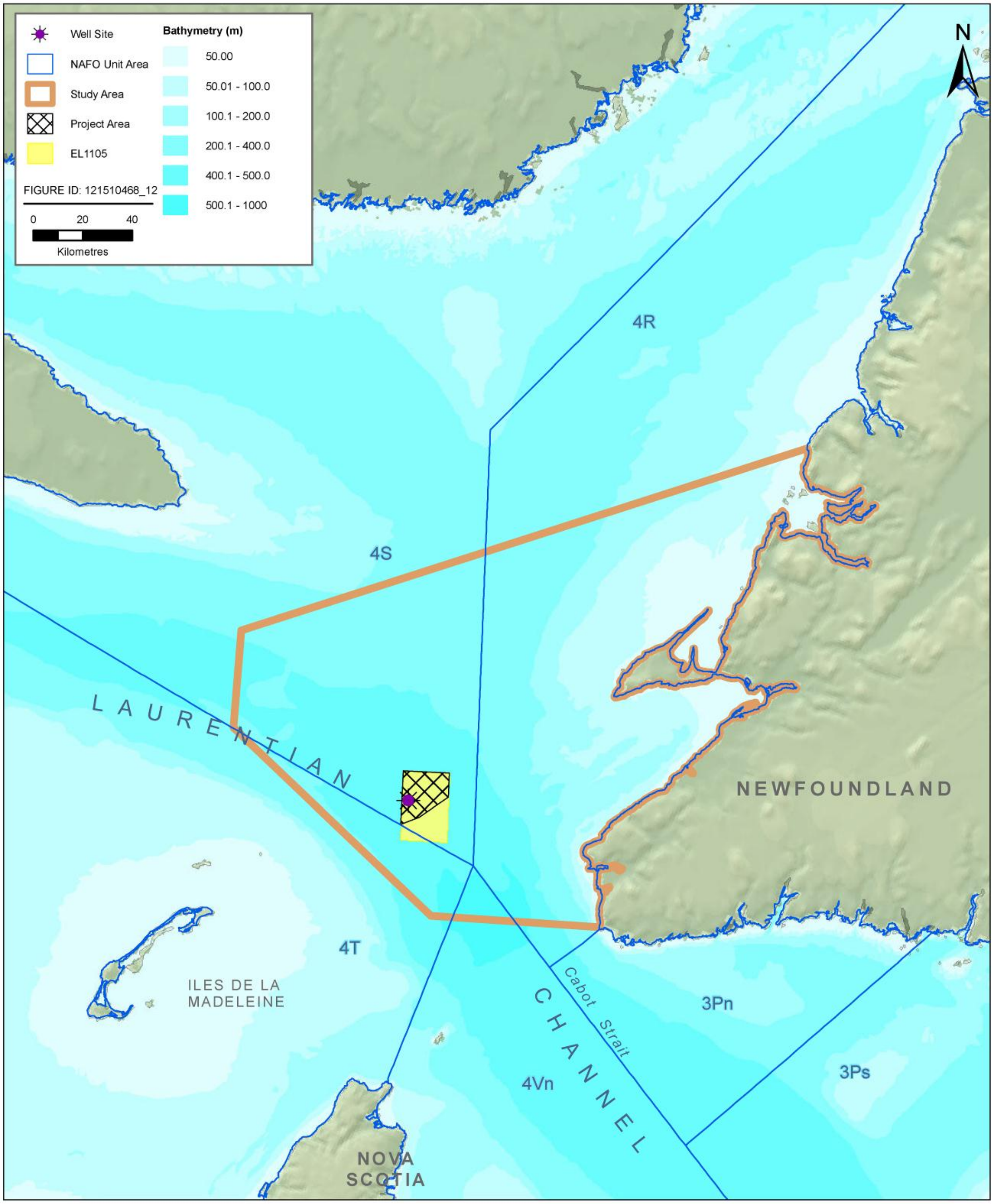


Figure 6.1 Environmental AssessmentSpatial Boundaries

The spatial and administrative boundaries identified for each VEC in this assessment are described in Table 6.1. The temporal boundaries for each VEC are the same and are defined to include the 20 to 50 days to complete the exploration project between 2014 and 2015, during the open water (*i.e.*, ice-free) period of the Laurentian Channel. Although the Project Description indicates a drilling start date as potentially mid-2012, this date is no longer achievable due to several protracted regulatory processes applied to this screening-level environmental assessment, including the implementation and subsequent cancellation of the Independent Review Process by the C-NLOPB.

Table 6.1 Project Boundaries by Valued Environmental Component

VEC	Spatial Boundaries	Administrative Boundaries
Species at Risk	Includes the area within and around the Study Area.	Species at risk are protected under SARA, administered by Environment Canada, Parks Canada and DFO. SARA is intended to protect species at risk in Canada and their critical habitat (as defined by SARA). Only species on Schedule 1 of SARA are subject to the permit and enforcement provisions of the Act. However, species designated as at risk by COSEWIC are also included in this VEC.
Marine Ecosystem	Includes the area within and around the Study Area.	The marine ecosystem is protected by Canada's *Oceans Act.*
Marine Fish, Shellfish and Habitat	Includes the area within and around the Study Area.	Marine fish and fish habitat are protected by federal legislation. Fish habitat is protected under the federal *Fisheries Act* and by DFO's Policy for the Management of Fish Habitat. This policy applies to all projects and activities in or near the water that could alter or destroy fish habitat by chemical, physical or biological means.
Marine Birds	Includes the area in and around the Study Area.	Marine birds are protected federally under the *Migratory Birds Convention Act*, *1994* which is administered by Environment Canada.
Marine Mammals and Sea Turtles	Includes the area within and around the Study Area.	Marine mammals and sea turtles not at risk are protected by federal legislation under the *Fisheries Act*.
Sensitive Areas	Includes the area within and around the Study Area.	This includes the southern fringe of the Laurentian Channel EBSA and the west coast of Newfoundland EBSA. The Laurentian Channel AOI is located approximately 100 km southeast of the Project. The Project Area overlaps with a potential redfish (a COSEWIC-designated species) mating area and the Study Area overlaps with a potential redfish larvae extrusion area and a cod (a COSEWIC-designated species) spawning area.
Commercial Fisheries and Other Users	Includes the area within and around the Study Area, as well as NAFO Divisions 3Pn, 4RST and 4Vn.	DFO manages the fisheries resources in the area and is primarily responsible for scientific surveys. Scientific surveys conducted outside of DFO (*i.e.*, private surveys) come under the jurisdiction of the Coast Guard, C-NLOPB, Quebec and CNSOPB. Boundaries for commercial fisheries have also been defined by NAFO.

6.3.2 Existing Conditions

The existing conditions in the vicinity of the Project (primarily within the Gulf, but also within the North Atlantic Ocean) is described for Species at Risk, Fish and Fish Habitat, Marine Birds, Marine Mammals and Sea Turtles, Sensitive Areas, and Commercial Fisheries and Other Users (refer to Section 5).

6.3.3 Potential Interactions and Existing Knowledge

The assessment focuses on identifying and evaluating potential interactions between program components and activities and each of the VECs under consideration. As a first step in the effects analysis, potential program-VEC interactions are identified and discussed. Existing knowledge concerning these potential interactions is also reviewed and summarized.

6.3.4 Mitigation

Based on the potential interactions identified and existing knowledge regarding these interactions, technically and economically feasible mitigation measures to reduce or eliminate potential adverse effects are identified.

Where possible, a proactive approach to mitigating potential environmental effects has been taken by incorporating environmental considerations directly into program design and planning. Where required and feasible, additional measures are identified in the environmental assessment to further mitigate potential adverse effects. These mitigation measures are identified and discussed within the appropriate effects analysis section(s). Residual environmental effects predictions are made taking into consideration these identified mitigation measures.

6.3.5 Residual Environmental Effects Significance Criteria

Evaluating the significance of predicted residual environmental effects is one of the critical stages in an environmental assessment. Significant environmental effects are those adverse environmental effects that will cause a change that will alter the status or integrity of a VEC beyond an acceptable level. In this environmental assessment, environmental effects are evaluated as significant, not significant or positive, based on definitions of significance developed and used for each VEC.

The definitions for significant adverse environmental effects integrate key factors such as magnitude (*i.e.*, the portion of the VEC population affected), potential changes in VEC distribution and abundance, effect duration (*i.e.*, the time required for the VEC to return to pre-project levels), frequency and geographic extent. They also include other important considerations such as interrelationships between populations and species, as well as any potential for changes in the overall integrity of affected populations. For each VEC, an adverse environmental effect that does not meet the criteria for a significant environmental effect (developed by the proponent in accordance with CEAA guidelines (CEA Agency 1994) and accepted / standard practice) is evaluated as not significant. A positive effect is one that may enhance a population or resource use activity.

6.3.6 Environmental Effects Assessment

This stage entails the assessment of the potential environmental effects associated with the project's components / activities for each of the VECs under consideration. Environmental effects were analyzed qualitatively using the professional judgment of the Study Team and where possible, quantitatively using existing knowledge and appropriate analytical tools.

The evaluation of environmental effects takes into consideration:

- the potential interaction between Project activities for each of the Project phases and their environmental effects in combination with those of other past, present and likely future projects;
- the mitigation strategies applicable to each of the interactions; and
- the CEA Agency's evaluation criteria for determining significance (CEA Agency 1994) and any other evaluation criteria established by the Study Team to further characterize the nature and extent of the environmental effects, where required.

Environmental effects are classified by determining whether they are adverse or positive. This is indicated by the use of a bracketed ("A") or ("P").

The following includes some of the key factors that can be considered for determining adverse environmental effects, as per the CEA Agency guidelines (CEA Agency 1994):

- loss of rare or endangered species;
- loss or avoidance of critical / productive habitat;
- negative environmental effects on the health of biota;
- reductions in biological diversity;
- fragmentation of habitat or interruption of movement corridors and migration routes;
- transformation of natural landscapes;
- discharge of persistent and/or toxic chemicals;
- loss of, or detrimental change in, current use of lands and resources for traditional purposes; and
- foreclosure of future resource use or production.

The environmental effects assessment also includes summary tables for each VEC that summarize the potential effect of each project activity / component using the following criteria (see Table 6.2 as an example):

- magnitude;
- geographic extent;
- frequency;
- duration;
- reversibility; and
- ecological and socio-economic context.

Magnitude describes the nature and degree of the predicted environmental effect. For the biophysical VECs (Species at Risk, Marine Fish and Fish Habitat, Marine Birds, Marine Mammals and Sea Turtles), ratings for magnitudes were defined as follows (effects include mortality, sub-lethal effects or exclusion due to disturbance):

- Low: Affects 0 to 10 percent of individuals in the Study Area;
- Medium: Affects 10 to 25 percent of individuals in the Study Area; and
- High: Affects greater than 25 percent of individuals in the Study Area.

Table 6.2 Potential Environmental Effects Assessment Summary: VEC

Project Components/ Activities	Potential Interactions / Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-economic Context
Presence of Drilling Platform (including safety zones, flights, flaring)								
Drill Mud / Cuttings								
Routine Discharges (*e.g.*, deck discharge, bilge water, sanitary or domestic waste water)								
Support Vessels (supply boat and helicopter)								
VSP Survey / Drilling Noise								
Routine Atmospheric Emissions								
Well Abandonment / Suspension								
Accidental Event (oil spill)								

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius
3 = 11-100 km radius
4 = 101-1,000 km radius
5 = 1,001-10,000 km radius
6 = >10,000 km radius

Frequency
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200events/yr
5 = >200 events/yr
6 = continuous

Duration
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

n/a = Not applicable

Geographic extent refers to the area where the particular effect in question will occur. Frequency and duration describe how often and for how long a disturbance will occur. Quantitative values are provided for geographic extent, frequency and duration (see Table 6.2).

Reversibility refers to the ability of a VEC to return to an equal or improved condition once the activity has ended (*e.g.*, reclaiming habitat area equal or superior to that lost). Predicted environmental effects are rated as reversible or irreversible based on previous research and/or experience. Ecological, socio-cultural and economic context describes the current status of the VEC in the area affected by the Project due to past and/or existing human activities or natural factors.

These criteria are used to provide a common basis for summarizing the potential effects of each Project activity for each VEC.

As described in Section 2.6 (Project Scheduling), an exploration well is anticipated to be spudded between 2014 and 2015, dependent upon the completion of the C-NLOPB review process for this undertaking, regulatory approvals and rig availability. It will take between 20 and 50 days to complete the drilling project, which will take place during the ice-free season.

It is important to recognize that the proposed Project represents one exploration well. As such, some of the discussion presented in this report regarding potential environmental effects may be more applicable to large-scale exploration or production programs, as not all literature distinguishes between the type and scale of the programs being conducted.

6.3.7 Accidental Events

This section entails the assessment of the potential accidental events resulting in an oil spill, including probabilities and trajectory, as modelled by SL Ross (2011a, updated 2012; 2011b).

6.3.8 Cumulative Environmental Effects Assessment

Individual environmental effects are not necessarily mutually exclusive of each other but can accumulate and interact to result in cumulative environmental effects. This environmental assessment includes consideration of cumulative environmental effects for each VEC immediately following the discussion of the environment effects analysis.

Within-project cumulative environmental effects (*i.e.*, those due to the accumulation and/or interaction of each project's own environmental effects) are considered as part of the project-specific environmental effects analyses described above (*i.e.*, the overall effect of each project on a VEC). This section focuses on the cumulative environmental effects of drilling one exploration well in combination with other relevant projects and activities.

The region's natural and human environments have been affected by past and ongoing human activities. The description of the existing (baseline) environment reflects the effects of these other actions. The evaluation of cumulative environmental effects considers the nature and degree of change from these baseline environmental conditions as a result of the proposed program in combination with other ongoing and planned projects and activities.

An important step in undertaking a cumulative environmental effects assessment is the identification of other actions whose environmental effects will likely act in combination with those of the project under review to bring about cumulative environmental effects. CEAA requires that only the following type of projects and activities be considered, including:

- those that are certain (those that will proceed or there is a high probability of proceeding); and
- reasonably foreseeable (those that may proceed).

The degree of certainty that the project will proceed must therefore be considered (CEA Agency 2008). The other projects and activities considered in this assessment, therefore, include those that are ongoing or likely to proceed and have been issued permits, licences, leases or other forms of approval. The cumulative effects assessment considers the cumulative environmental effects of the proposed single exploration well in combination with:

- marine transportation;
- fishing activities;
- research surveys;
- military exercises; and
- other oil and gas exploration programs (including seismic and geohazard programs).

There are a number of exploration licences offshore western Newfoundland. However, due to the distance from the location of these licences to the location of the proposed Project, it is unlikely that potential projects in that area could cumulatively interact with the proposed Project to result in an adverse environmental effect.

6.3.9 Summary of Residual Environmental Effects Assessment

Significance ratings for the predicted residual environmental effects of each project phase and for the Project as a whole are provided in a summary table following the environmental effects analysis (see Table 6.3 as an example).

Table 6.3 Residual Environmental Effects Summary: VEC

Phase	Residual Environmental Effect Rating[A]	Level of Confidence	Probability of Occurrence (Likelihood)[B]
Installation / Operation			
Well Abandonment / Suspension			
Accidental Event			
Cumulative Environmental Effect			

KEY

Residual Environmental Effects Rating:
S = Significant Adverse Environmental Effect
NS = Not Significant Adverse Environmental Effect

Level of Confidence in the Effect Rating:
1 = Low level of Confidence
2 = Medium Level of Confidence
3 = High level of Confidence

Probability of Occurrence of Significant Environmental Effect:
1 = Low Probability of Occurrence
2 = Medium Probability of Occurrence
3 = High Probability of Occurrence

[A] As determined in consideration of established residual environmental effects rating criteria.
[B] If effect is not predicted to be significant, the probability of occurrence rating is not required under CEAA.

The evaluation of the significance of the predicted residual environmental effects is based on a review of relevant literature and professional judgment. Ratings are provided to indicate the level of confidence in each prediction. The level of confidence ratings provide a general indication of the confidence within which each environmental effects prediction was made based on professional judgment and the effects from similar existing projects. The likelihood of the occurrence of any predicted significant adverse effect is also indicated, based on previous scientific research and experience.

Data gaps with respect to our current scientific knowledge regarding biological, physical and scientific processes can and do occur. The data gaps are considered when conducting the environmental effects assessment and will influence the level of confidence applied to an assessment. The means by which the data gaps are incorporated into the assessment is to consider the effect that the activity can potentially have on the environment (such as the duration, extent, seasonality, vector), consider the level or degree of effect on the environment (lethal, chronic, minimal, no effect, short-term, long-term) and the available scientific knowledge about the effects of the activity (such as the ability to cause smothering of benthos within 500 m of discharge, results in potential bioaccumulation of metals to a harmful level in an organism, cause mortality from toxic response). Once these types of information have been considered, then the level of confidence of the environmental effects assessment can be assigned. Ultimately the assignment of the level of confidence incorporates professional judgment and experience of both the assessor and from similar undertakings while considering the data gaps.

6.3.10 Follow-up and Monitoring

Consideration of a follow-up program is required for a screening-level environmental assessment. The purpose of the follow-up program is to:

- verify the accuracy of the environmental assessment; and
- determine the effectiveness of mitigation measures.

Follow-up and monitoring will be considered where there are important Project-VEC interactions, where there is a high level of uncertainty, where significant environmental effects are predicted, or in areas of particular sensitivity.

Follow-up and monitoring programs should be well-defined and focused to allow for efficient use of time and resources. Follow-up and monitoring programs are typically associated with longer-term, larger projects, but are considered in this assessment.

7.0 ENVIRONMENTAL EFFECTS ASSESSMENT

This section discusses the potential effects of routine activities associated with exploration drilling activities on the various VECs. The primary potential environmental effects related to routine activities associated with exploration drilling activities include (but are not limited to):

- disturbance to marine animals from underwater sound associated with exploration drilling activities including VSP profiling;
- displacement or smothering of benthos by accumulation of drill mud and cuttings;
- conflicts with commercial fisheries (especially fixed gear fisheries) from safety zones, vessel traffic and exploration drilling activities; and
- seabird (especially storm-petrels) attraction and stranding on marine vessels and the drilling platform.

A general discussion of these effects is contained in Section 7.1. A detailed list of the potential interactions between the Project and the identified VECs, including Species at Risk is provided in Table 7.1. The potential for residual effects on each of the VECs is assessed in Sections 7.2 to 7.8. Effects of accidental events are assessed in Section 8.

Table 7.1 Routine Project Activity Interactions with Valued Ecosystem Components

Project Activities and Physical Works	VEC								
	Species at Risk			Marine Ecosystem	Fish and Fish Habitat	Marine Birds	Marine Mammal and Sea Turtle	Sensitive Areas	Commerciai Fisheries
	Marine Mammal and Sea Turtle	Marine Bird	Marine Fish						
Presence of Drilling Platform (including safety zone, lights, flaring)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Drill Mud and Cuttings			✓	✓	✓				
Routine Discharges (*e.g.*, deck discharge, bilge water, sanitary or domestic waste water)	✓	✓	✓	✓	✓	✓	✓	✓	✓
Support Vessels (supply boat and helicopter)	✓	✓	✓		✓	✓	✓	✓	✓
VSP Survey / Drilling Noise	✓	✓	✓	✓	✓	✓	✓	✓	✓
Routine Air Emissions		✓				✓			
Well Abandonment / Suspension			✓	✓	✓	✓	✓		✓

7.1 Overview of Project Interactions and Potential Effects

7.1.1 Presence of the Drill Platform

The Project could use a semi-submersible or a drillship as a drilling platform. The proposed safety zone could extend approximately 1.5 km from an anchored semi-submersible rig (new types of semi-submersibles have a larger anchorage area with anchors that can extend approximately 1 km out from the rig). The maximum areas of this kind of semi-submersible drill platform safety zones could be as large as between 5 km^2 and 10 km^2. An unanchored drilling platform would require a safety zone of 500 m. No one other than operational or C-NLOPB personnel will be allowed within the zone without the express permission of the Offshore Installation Manager. The Offshore Installation Manager has the authority, granted by the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*, to enforce the exclusion zones. In accordance with the *Newfoundland Offshore Petroleum Drilling and Production Regulations*, all reasonable measures will be taken to warn persons who are in charge of vessels and aircraft of the safety/exclusion zone boundaries, of the facilities within the safety zone and of any related potential hazards. A 'Notice to Shipping' regarding the safety zone will be issued for the exploration well to be drilled.

The presence of the drill platform may result in either a reef effect or an avoidance effect as a result of noise from drilling activities. Some fish species may be attracted to the drill platform due to lights and the artificial reef effect. An artificial reef effect may be created shortly after the arrival of the drill platform in the area with the structure becoming a potential shelter for several species of fish and shellfish, especially juveniles. The creation of an artificial reef effect could alter the local abundance and distribution of fish (in the short-term), thereby concentrating food sources that may attract marine mammals, sea turtles and marine birds to the drill platform. The fisheries exclusion zone (FEZ) (1 to 5 km^2) may also serve as a refuge for some fish species, including commercially fished species.

A drilling rig may create an artificial reef effect that could alter the local abundance and distribution of fish, thus concentrating a food source that may attract marine birds to platforms. There has been little quantification of associations of seabirds with offshore installations, although such associations have been regularly noted (Wiese *et al.* 2001). Galley and sewage discharges further attract seabirds to these artificial habitats and in fact may attract birds directly in much the same way as sewer outlets (Wiese *et al.* 2001). Tasker *et al.* (1986) observed that bird density (birds/km^2) was seven times greater within a 500 m radius of a platform than in the surrounding area. Similarly, seabird concentrations around platforms on the Grand Banks were 19 to 38 times higher than on survey transects leading to the platforms (Wiese and Montevecchi 1999).

The drilling unit emits some noise continuously during operation. Marine mammals will avoid an area of noise, especially sudden changes in frequency or intensity. Depending on the circumstance, the response to noise is highly variable between species and even within a species. Between species, a response to noise can be in the form of changes in swimming direction and speed, breathing rate and vocalization (Richardson *et al.* 1995).

During exploration drilling, vessel traffic and the drill rig may affect seabirds and migrating landbirds by attracting them to lighting. Seabirds primarily navigate by sight, and lights can be an eye-catching visual cue (Wiese *et al.* 2001). Marine birds that are attracted to offshore installations may experience mortality through strikes against infrastructure or may become disoriented by lights. Drizzle and fog tend to increase the problem since during these periods light is refracted by moisture droplets that increase the illuminated area and enhance the attraction (Wiese *et al.* 2001). Attraction could also result in continuous circling around the lights, using energy and delaying foraging or migration, and can result in starvation (Bourne 1979). As well, during shipboard studies conducted in 1999, Leach's Storm-Petrels were observed being attacked by great black-backed gulls after the petrels appeared confused by the lights of vessels and platforms, adding predation as an additional potential problem for species such as Leach's Storm-Petrels (Wiese and Montevecchi 2000). The greatest period of risk of attraction to offshore lights is in September when birds are moving to offshore wintering grounds. Storm-Petrels and other *Procellariformes* (tube-nosed seabirds) are nocturnal foragers on bioluminescent prey and are, therefore, naturally pre-disposed to attraction to light of any kind (Imber 1975). Young-of-the-year birds appear to be more susceptible to light attraction than adults although further research is required (LGL Limited 2005b). Procellariiform seabirds (*e.g.*, petrels, shearwaters, fulmars) also use olfactory cues to navigate (Nevitt and Bonadonna 2005). Therefore, these seabirds may be attracted by sanitary emissions (*e.g.*, wastewater, food waste) in addition to light.

Light attraction's primary effect for fish is that the light / dark cycle may be interrupted and fish and invertebrates in the area may not react in their normal manner. This has the potential to result in physiological stress, as light resulting in 24-hour light regime affects their normal circadian rhythm. The response of fish to changes in their circadian rhythm varies among species. Examples of the effects of a 24-hour light regime on fish species are provided to demonstrate the potential for physiological stresses.

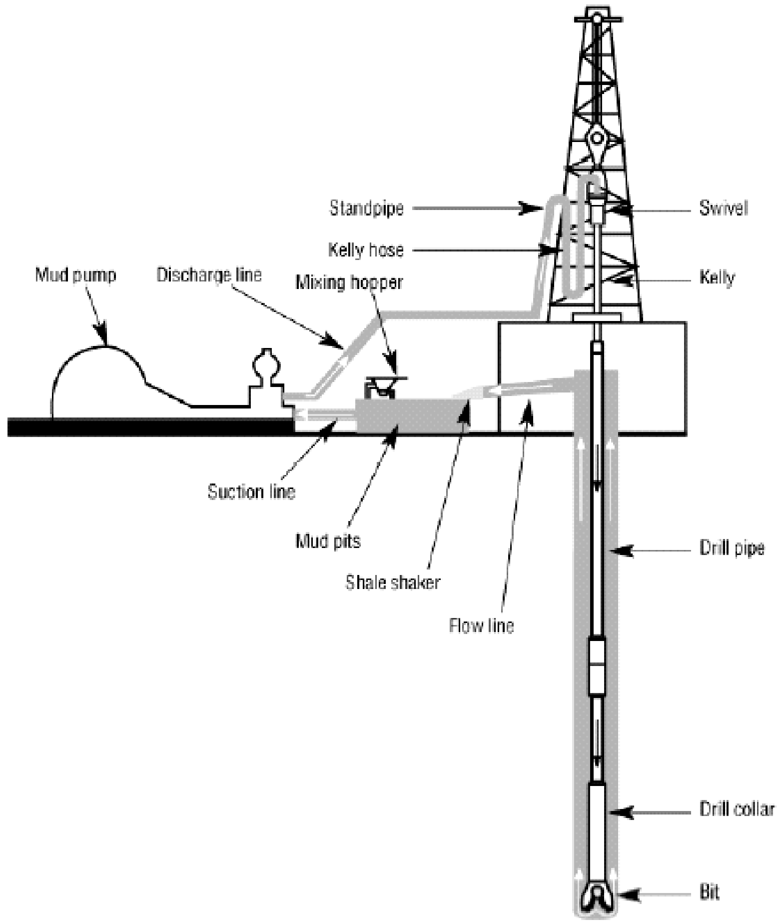
Nighttime rest deprivation in zebra fish was found to result in a significant decline in daytime locomotor activity and in a heightened arousal threshold, compared to basal recordings (Zhdanova and Reebs 2006). Leonardi and Klempau (2003) demonstrated that the application of 24-hour light period for 60 days induced an increase of cortisol in trout that lasted up to two months after return to normal light regimes. The changes observed in fish towards the end of the two-month illumination period (increased haematocrit values and erythrocyte numbers) can be explained as a consequence of acute stress or, alternatively, as a stimulation of erythropoiesis by increased light exposure. Hemre *et al.* (2002) found that a 24-hour light regime for Atlantic cod resulted in a delay in gonadal maturation and evident anaemia.

The presence of lights on the platform may also affect plankton and other pelagic organisms. Many planktonic species and life stages are phototaxic, floating to near surface during the day and settling to deeper water at night. Any lights on the water at night may attract nekton that have active swimming ability. This affect would be localized and temporary, reversing once the drilling period is over.

There may be some short-duration flaring by the drill rig during testing, if it occurs. While gas flaring will produce light that may attract birds, heat and noise generated by the flare may actually deter birds from the immediate area (although there is a paucity of research on this subject). Although strom-petrels are known to fly into flares (Wiese *et al.* 2001 and references therein), 52 Leach's Storm-Petrels were recovered and released with no mortality observed during monitoring on board a Terra Nova vessel over a three-week period during the summer of 1998 (Husky Oil 2000). Given certain environmental conditions (*e.g.*, wind speed and direction), characteristics of Leach's Storm-Petrels (*e.g.*, relatively low mass), and the occurrence of known predators of this species (*e.g.*, Great Black-backed Gull) at and in the vicinity of platforms, it is likely that some unknown proportion of individuals entering into contact with the flare or otherwise negatively affected by the flare would not be recovered during monitoring (Environment Canada 2012b). This is expected to apply to injured and dead birds that fall directly into the water, with similar effects being possible for migratory passerines that are also affected by flares and/or lights (Environment Canada 2012b).

7.1.2 Drill Muds and Cuttings

Drilling is accomplished by a rotating drill bit attached to the end of a hollow drill pipe, referred to as the drill string (Figure 7.1). The drilling mud is pumped from the mud pit through the surface equipment and down the centre of the drill pipe. It exits through holes in the drill bit, where it picks up drill cuttings and lubricates the drill bit. Rotation of the drill bit at the bottom of the hole breaks off small chips of rock, deepening the hole. The fluid exiting the drill bit suspends these rock chips, called cuttings, and carries them up the annulus to the surface where they are removed from the fluid and disposed. The fluid, the drilling mud, usually is recycled down-hole. It passes up the annulus (the space between the drill string and the borehole wall) to the mud return line, through the shale shakers and other mud/cuttings separation devices, and back to the mud pit (Neff 2005).



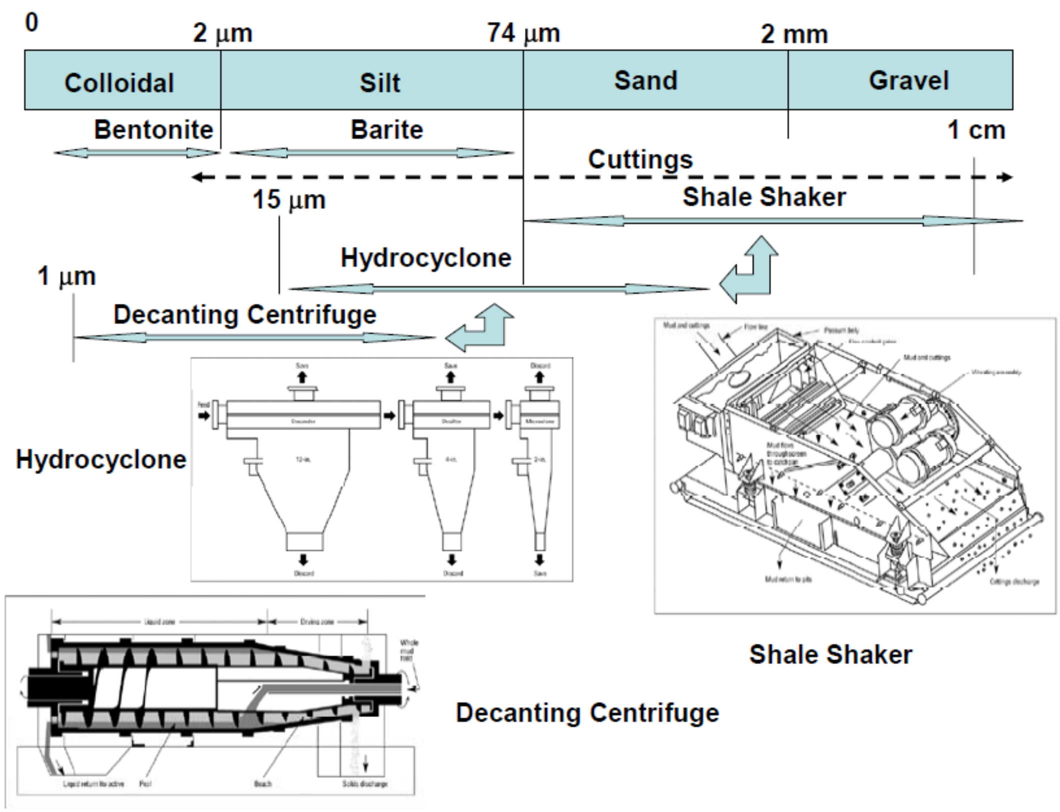
Source: CAPP 2001

Figure 7.1 Drilling Circuit on an Offshore Platform

A wide variety of fluids has been used for drilling, including water, or a mud-in-water slurry, oil, synthetic organic fluids, brine-in-oil or synthetic emulsions, mists, and foams (OGP 2003). Most modern drilling muds are mixtures of fine-grained solids, inorganic salts, and organic compounds in water or an organic liquid. There are two primary types of drilling muds in use today: WBM and SBM (Neff *et al.* 2000; OGP 2003).

Drilling muds are needed to convey the drill cuttings out of the hole and keep formation fluids from entering the well. Drill cuttings are particles of crushed rock produced by the grinding action of the drill bit as it penetrates into the earth (Neff *et al.* 1987). Drill cuttings range in size from clay-sized particles (approximately 2 µm) to coarse gravel (>30 mm) and have an angular configuration. Their chemistry and mineralogy reflect that of the sedimentary strata being penetrated by the drill.

During the drilling of the top hole sections, the riser is not in place and drilling mud and cuttings (or sediments) from the top part of the hole are discharged from the hole to the seabed. Once the riser is in place, the mud and cuttings are brought to the surface for cleaning and recycling. Once on board the rig, the drill cuttings are removed from the mud in successive separation stages and discharged (Figure 7.2). Separation of SBM and cuttings commences with the coarser, sand/gravel-sized cuttings particles removed by the shale shakers. The solids that pass through the shale shaker screens may also be passed to hydrocyclones and, occasionally, decanting centrifuges, where finer particles are removed.



Source: Neff 2005

Figure 7.2 Separation of Drilling Fluid and Cuttings

Some mud remains with the discharged cuttings. The treated cuttings are discharged via a chute to just below the water's surface. The mud and cuttings are dispersed in the water column and settle on the sea floor with the heavier particles near the hole and the fines at increasing distances from the rig.

All drilling in eastern Canadian waters is conducted using either WBM or SBM. All drilling in Newfoundland uses SBM for drilling after the riserless section has been completed and a closed circulation system is in place. A physical and chemical description of the discharge of mud and cuttings can be found in Section 2.11.1. The proposed drill program for this Project will most likely employ WBM and SBM.

Drilling mud is a solution of suspended solids and dissolved materials in a carrier liquid. There is debate regarding which type of mud is the most "environmentally friendly". It has been argued that WBM are better environmentally because they consist of mostly water and cannot form sheens on the surface whereas SBM may form sheens under certain operational and/or sea state conditions. On the other hand, SBM generally do not disperse as widely as WBM and, therefore, accumulate closer to the wellsite than WBM. Compared to SBM, WBM remain suspended in the water column longer and therefore have greater potential to affect filter feeding organisms (Cranford *et al.* 2005). SBM has been proven to reduce downhole risk due to significantly improved wellbore stability compared to WBM. Reducing downhole risk results in less time drilling and therefore less environmental impact.

Drill cuttings contain, in addition to formation solids, small amounts of liquid and solid drilling mud components (Neff 2005). The amounts of drilling fluid solids that remain attached to cuttings vary, depending on the grain size of the crushed rock from the strata being drilled. Clay sized cuttings are more difficult than larger cuttings to separate from drilling mud. A typical cuttings discharge during drilling usually contains 5 to 25 percent drilling fluid solids after passage through the solids control equipment on the drill platform. Cuttings from the fossil fuel-bearing intervals in a well also may contain crude oil or gas condensate.

The chemical composition of drill cuttings reflects the geochemistry of the formation being drilled and the amount of drilling mud ingredients adhering to the cuttings at the time of disposal. Barium is more abundant in drilling mud than cuttings, as expected because of its abundance in drilling muds. Most of the metals associated with cuttings are in immobile forms in minerals from the geologic formations (Neff 2005). Cuttings produced during drilling with WBM may also contain small amounts of petroleum hydrocarbons. The hydrocarbons in cuttings generated with WBM may come from spotting fluids and lubricants added to the mud, or from the geologic strata being penetrated by the drill.

7.1.2.1 Water-based Muds

The carrier liquid for WBM is water (either salt or fresh). WBM is generally used on wells in the earliest sections of drilling. WBM is essentially non-toxic, with the main component of WBM being seawater and the primary additives are bentonite (clay), barite and potassium chloride. Chemicals (see Table 7.2) such as caustic soda, soda ash, viscosifiers, inorganic salts, surfactants, corrosion inhibitors, lubricants and shale inhibitors are added to control mud properties and unique drilling problems (Thomas *et al.* 1984; GESAMP 1993; Neff 2005). All constituents used for drilling utility or production chemicals that have the potential to reach the environment are screened using the Offshore Chemical Selection Guidelines (NEB *et al.* 2009. The screening assesses the potential toxicity. Where chemicals are deemed to have unacceptable toxicity ratings, a substitution for that chemical is sought. Discharge of WBM and associated cuttings is regulated by the C-NLOPB. WBM may be discharged without treatment (NEB *et al.* 2010).

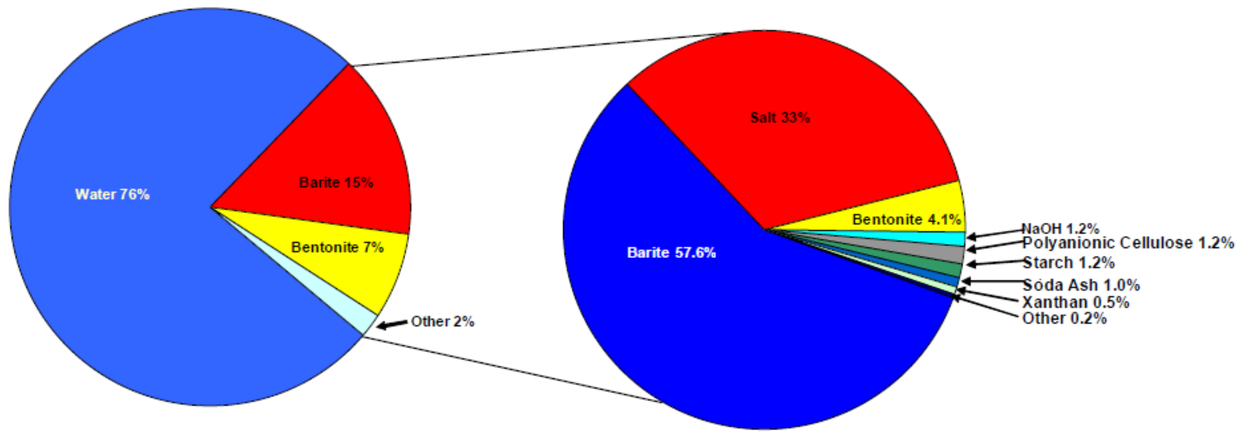
Table 7.2 Functional Categories of Materials Used in Water-based Mud, their Functions and Examples of Typical Chemicals in Each Category

Functional Category	Function	Typical Chemicals
Weighting Materials	Increase density (weight) of mud, balancing formation pressure, preventing a blowout.	Barite, hematite, calcite, ilmenite
Viscosifiers	Increase viscosity of mud to suspend cuttings and weighting agent in mud.	Bentonite or attapulgite clay, carboxymethyl cellulose and other polymers

Table 7.2 Functional Categories of Materials Used in Water-based Mud, their Functions and Examples of Typical Chemicals in Each Category

Functional Category	Function	Typical Chemicals
Thinners, Dispersants and Temperature Stability Agents	Deflocculate clays to optimize viscosity and gel strength of mud.	Tannins, polyphosphates, lignite, ligrosulfonates
Flocculants	Increase viscosity and gel strength of clays or clarify or de-water low-solids muds.	Inorganic salts, hydrated lime, gypsum, sodium carbonate and bicarbonate, sodium tetraphosphate, acrylamide-based polymers
Filtrate Reducers	Decrease fluid loss to the formation through the filter cake on the wellbore wall.	Bentonite clay, lignite, Na-carboxymethyl cellulose, polyacrylate, pregelatinized starch
Alkalinity, pH control additives	Optimize pH and alkalinity of mud, controlling mud properties.	Lime (CaO), caustic soda (NaOH), soda ash (Na_2CO_3), sodium bicarbonate ($NaHCO_3$) and other acids and bases
Lost Circulation Materials	Plug leaks in the wellbore wall, preventing loss of whole drilling mud to the formation.	Nut shells, natural fibrous materials, inorganic solids, and other inert insoluble solids
Lubricants	Reduce torque and drag on the drill string.	Oils, synthetic liquids, graphite, surfactants, glycols, glycerin
Shale Control Materials	Control hydration of shales that causes swelling and dispersion of shale, collapsing the wellbore wall.	Soluble calcium and potassium salts, other inorganic salts, and organics such as glycols
Emulsifiers and Surfactants	Facilitate formation of stable dispersion of insoluble liquids in water phase of mud.	Anionic, cationic, or nonionic detergents, soaps, organic acids, and water-based detergents
Bactericides	Prevent biodegradation of organic additives.	Glutaraldehyde and other aldehydes
Defoamers	Reduce mud foaming.	Alcohols, silicones, aluminum stearate (C54H105AlO6), alkyl phosphates
Pipe-freeing Agents	Prevent pipe from sticking to wellbore wall or free stuck pipe.	Detergents, soaps, oils, surfactants
Calcium Reducers	Counteract effects of calcium from seawater, cement, formation anhydrites, and gypsum on mud properties.	Sodium carbonate and bicarbonate (Na_2CO_3 and $NaHCO_3$) , sodium hydroxide (NaOH), polyphosphates
Corrosion Inhibitors	Prevent corrosion of drill string by formation acids and acid gases.	Amines, phosphates, specialty mixtures
Temperature Stability Agents	Increase stability of mud dispersions, emulsions and rheological properties at high temperatures.	Acrylic or sulfonated polymers or copolymers, lignite, lignosulfonate, tannins
Source: Boehm *et al.* 2001, in Neff 2005		

The most abundant ingredients (other than water) in most WBM (Neff 2005) are barite weighting material, salts (in several functional categories), and bentonite viscosifier (Figure 7.3).

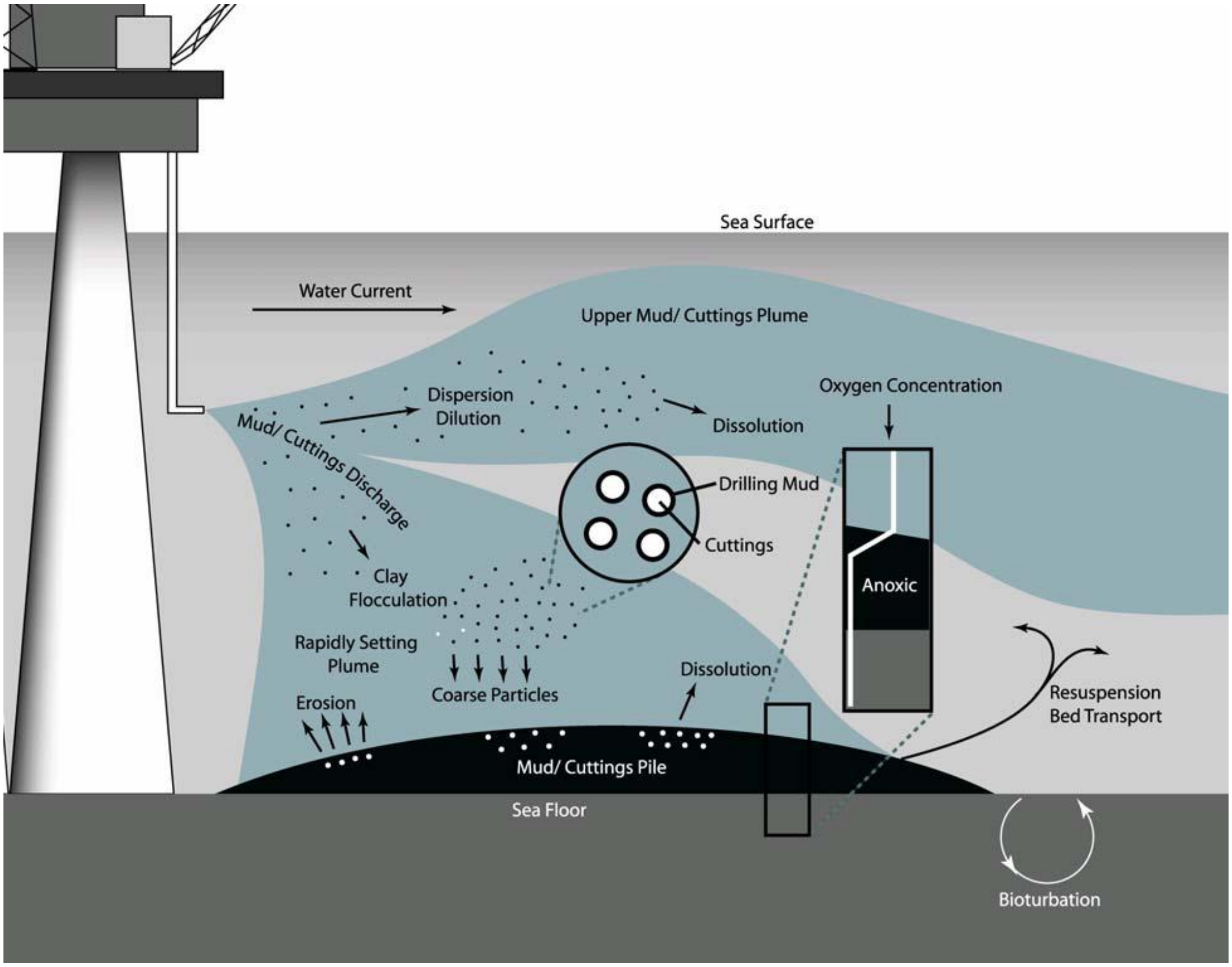


Source: Neff 2005.

Figure 7.3 Composition of a Typical Water-based Mud and of the Additives to a Typical Water-based Mud

WBM and cuttings are composed of a slurry of particles with a wide range of grain sizes and densities in water. Clay, silt, and most cuttings solids have densities of about 2.3 to 2.65 g/cm^3; drilling mud barite has a density of about 4.3 g/cm^3 (Nedwed 2004). Silts and clays, as well as drilling mud barite, have diameters of less than approximately 74 µm. Particle diameter has a greater influence than density on the rate of settling of WBM and cuttings particles. Bentonite clay in a WBM usually flocculates upon dilution in seawater (Muschenheim and Milligan 1996; Curran *et al.* 2002). The clay flocculate is a loose aggregate of clay particles that may include barite particles. These aggregates settle more rapidly than unflocculated silt and clay (Neff 2005, 2010).

A conceptual schematic of WBM and cuttings discharge is presented in Figure 7.4 showing that the larger particles associated with drill muds and cuttings discharge (representing approximately 90 percent of the mass of the cuttings discharge) settles to the bottom near the drill platform (Neff 2010). The remaining mass of the mud solids consisting of fine-grained unflocculated clay-sized particles (approximately 10 percent of the drill muds and cuttings discharge) along with a portion of the soluble components of the drill mud form a plume in the water column that drifts with prevailing currents away from the platform rapidly diluting in the receiving waters (Ayers *et al.* 1980a, 1980b; Brandsma *et al.* 1980; National Research Council 1983). The fine-grained solids associated with the plume settle slowly over a large area of the sea floor.



Source: Neff 2005

Figure 7.4 Dispersion and Fate of Water-based Drilling Mud following Discharge

Based on modelling results (AMEC 2011), drilling operations could result in:

- sea floor discharge of 196 m^3 of cuttings;
- surface discharge of 211 m^3 of cuttings; and
- sea floor discharge of 1,210 m^3 of WBM of various density and composition.

Sea floor discharge of cuttings is expected to result in a mound extending approximately 30 m from the well site, with cuttings thicknesses greatest immediately adjacent the well site. Average thickness is approximately 22 cm out to approximately 20 m from the well site; maximum thickness is approximately 4.7 m. From 20 to 50 m out from the well site, the average thickness is less than 1 mm.

Surface release of cuttings is expected to produce a deposit with thickness greatest near the drill origin, due to the most rapid fall of the heavier pebble and sand cuttings particles, and may be as thick as 15 mm directly below the point of origin. Out to approximately 100 m from the origin, modelled thicknesses are approximately 2 mm on average with a maximum of approximately 6 mm. From 100 to 200 m, thicknesses average from approximately 0.5 to 1 mm, with a maximum of approximately 6 mm.

Bioavailability and Accessibility

Bioavailability is the extent to which a chemical can be absorbed (bioaccumulated) by a living organism by active (biological) or passive (physical or chemical) processes (Neff 2002a). Thus, a chemical is bioavailable if it can move through or bind to a permeable surface coating (such as skin, gill epithelium, gut lining, cell membrane) of an organism (Newman and Jagoe 1994). Metal bioavailability from sediments (cuttings piles) can be divided into two components: environmental accessibility and environmental bioavailability.

Environmental accessibility is a measure of the fraction of the total chemical that is in a form or location in the environment that is accessible for bioaccumulation by organisms. Metals of all forms in cuttings have a low accessibility to marine organisms as the metals in cuttings piles are present primarily as insoluble inclusions in barite, clay, and cuttings particles. These solid metals are not bioaccessible. A small portion of the metal component may be in solution in the pore water of the cuttings pile (Shimmield *et al.* 2000). If the cuttings pore water is accessible to marine organisms, or is mixed up into the overlying water column by sediment disturbance, some of the dissolved and colloidal metals in it may be in bioavailable forms and may be bioaccumulated by marine organisms (Neff 2005).

Environmental bioavailability is dependent on the interactions between a marine organism and its environment. Exposure occurs at the interface between environmental media (water, sediment, and food) and permeable biological membranes of the marine organism. Environmental bioavailability is controlled by the relative amount of permeable epithelia in contact with the environmental media, the duration of contact, and the physical form of the chemical in the environmental medium. Dissolved, free ionic forms, some metal-organic colloid complexes, and low molecular weight organo-metal compounds of metals are the most bioavailable forms of most metals to marine organisms (Neff 2002). The most bioavailable fraction of metals associated with WBM and cuttings is that dissolved in the pore water or loosely complexed with particles. The majority of metals associated with WBM and cuttings are associated with sulphide mineral inclusions in the barite and are not soluble in anoxic marine sediment pore waters (Trefry *et al.* 1986; Neff 2002). The distribution of metals in different geochemical fractions of North Sea cuttings pile sediments found that approximately 17 percent of the lead and 36 percent of the nickel in North Sea cuttings piles are in potentially bioavailable forms (Westerlund *et al.* 2001, 2002).

Barium and Chromium

The most abundant metal in most WBM is barium. Nearly all the barium in drilling mud is from barite ($BaSO_4$) added to the mud to increase its density (Neff 2005). Using barium as a tracer, the zone of detection for both single and multiple wells found that background levels for barium were achieved at 1,000 to 3,000 m from the drill source. Barite in drilling muds and sediments has a low solubility in seawater (because of the high natural concentration of sulfate in the ocean), and because it is insoluble in seawater, it has a low bioavailability and toxicity to marine organisms (Neff 2005). The extent of barium contamination has been confirmed by the Grand Banks EEM programs. Drill cuttings releases at White Rose and Terra Nova are a mixture of WBM and SBM, both of which contain barium as tracers. Background barium concentrations have been achieved at Terra Nova within 1,000 to 2,000 m from drill source (Suncor Energy 2010) and within 2,400 m at White Rose (Husky Energy 2009). Hibernia has been discharging only WBM since 2002, although prior to Q3 2002 a mixture of SBM and WBM was released. Barium concentrations remain elevated out to 500 m from the Hibernia discharge point and the results beyond 500 m are comparable to baseline levels (Stantec 2009).

Dissolved barium concentrations in the North Sea cuttings pile pore water were found to increase with depth in the mud and cuttings accumulation (Shimmield and Breuer 2000; Shimmield *et al.* 2000; Breuer *et al.* 2004). The solubility of barium in seawater and marine sediments is controlled by the concentration of reactive sulphate, which is high in seawater (Neff 2002). Sulphate reducing bacteria in suboxic layers of the cuttings pile use dissolved sulphate as an electron acceptor for organic matter biodegradation and, in the process, convert sulphate to sulphide (Neff 2005). As the sulphate concentration in cuttings pile pore water decreases, barite becomes more soluble, releasing small amounts of barium into the pore waters. This reaction is thought to be self-limiting because dissolution of barite results in the release of sulphate.

High barite concentrations can serve as a source of reducible sulfate for sulfate-reducing bacteria (Ulrich *et al.* 2003), releasing dissolved barium into the pore water (Phillips *et al.* 2001). Much of the barium in pore water diffuses upward to the oxygen-containing layers of the sediment or into the overlying water column, where it precipitates with sulfate in the oxygenated water phase (Paytan *et al.* 2002). Thus, barite is highly persistent in marine sediments containing WBM and cuttings. Most other metals present in barite are primarily associated with insoluble sulfide salts (Leuterman *et al.* 1997; Trefry 1998; Trefry and Smith 2003). These metal sulfides have an extremely low solubility and mobility, even in anoxic, sulfidic sediments where some of the barite dissolves (Shimmield and Breuer 2000; Trefry and Smith 2003).

Neff *et al.* (1989a), Leuterman *et al.* (1997) and Schaanning *et al.* (2002) conducted studies on the bioavailability of several metals in different grades (purities) of drilling mud barite in sediments to marine organisms. There was some accumulation of small amounts of one or more metals (arsenic, cadmium, copper, lead, mercury, nickel and zinc) during chronic exposure to the high concentrations of the barites containing the highest concentrations of metals. It is probable that some of the metals that apparently bioaccumulated were actually still associated with fine particulate barite or other sediment particles in the gut and gills (Jenkins *et al.* 1989). Marine invertebrates can take up fine particles into epithelial cells by pynocytosis. The metals associated with the particles remain in the particles and are not actually assimilated by the animal. These sorbed, particulate metals are toxicologically inert (Nott and Nicolaidou 1989, 1990, 1993, 1994). Neff *et al.* (1989a) and Leuterman *et al.* (1997) concluded that metals associated with drilling mud barite have a low bioavailability to marine organisms that might come in contact with discharged drilling fluid solids.

Drilling mud chromium is derived primarily from chrome- or ferrochrome-lignosulfonates or chromate salts added intentionally to the mud for viscosity control; as well barite and bentonite clay may also contain traces of chromium (Neff 2005). The chromium in a drilling mud, even that added as chromate, is in the trivalent, chromic valency state. Trivalent chromium salts have low solubilities and limited mobility in the environment. They usually have a low toxicity to plants and animals (Neff 2005).

Neff *et al.* (1989a) exposed lobsters and flounder to sediments containing solids from a WBM for up to 99 days in mesocosm tanks. In addition, some of the test organisms were fed polychaete worms that had been exposed to WBM solids. Concentrations of barium and chromium, the two most abundant metals in most WBM, were measured at different times during the study. Lobster and flounder accumulated small amounts of barium, but not chromium. Flounder, but not lobsters, exposed simultaneously to WBM sediments and food accumulated slightly more barium than those exposed to WBM alone. Neither species accumulated chromium from the food source. It is hypothesized that some of the barium apparently bioaccumulated by the lobsters and flounder was present as unassimilated barite particles in the digestive system. Chromium, mostly from chrome lignosulfonate, was probably in the low solubility trivalent state and was not very bioavailable. These experiments show that there was very little food chain transfer and no biomagnification of barium and chromium from drilling muds in marine organisms.

The results of a joint URS, Dames and Moore, and TNO team (URS 2002) study found similar findings as those of Neff *et al.* (1989a, 1989b), Leuterman *et al.* (1997), and Schaanning *et al.* (2002) indicating that the metals associated with drilling mud ingredients and cuttings have a low bioavailability to marine animals. During the exposure, turbot fed on the polychaetes in the mesocosm tanks (URS 2002). The biomagnification factor of the metals by turbot was estimated as the ratio of the concentration in the turbot tissues to the concentration in the food. Biomagnification factors ranged from <0.01 to 0.42, indicating that biomagnification was not taking place. These results confirm those of Neff *et al.* (1989a) that there is little trophic transfer and no biomagnification of metals from drilling mud and cuttings in benthic environments.

There have been several surveys of the concentrations of metals in tissues of marine animals from the vicinity of offshore platforms (Neff *et al.* 2000; Neff 1987, 2002b). These surveys have shown that metals concentrations in tissues of marine organisms near platforms are similar to concentrations in tissues of the same or similar species from reference areas. Thus, the metals discharged from platforms in drilling muds and cuttings are diluted rapidly to natural background concentrations or are in forms that are not bioavailable to marine animals (Neff 2005).

Concentrations of barium and chromium were slightly elevated in sediments near exploratory drilling operations on Georges Bank after drilling (Neff *et al.* 1989b). However, metals concentrations in sea clams (*Arctica islandica)* collected from surface sediments near the drilling rigs were in the normal range for bivalve mollusks (Phillips *et al.* 1987). There was no correlation between concentrations of barium in sediments and bivalve tissues.

Thus, while the discharge of WBM may increase metals in sediments such as barium, arsenic, cadmium, copper, mercury, lead and zinc, these increases are generally limited to within 250 to 500 m of the drill site. Occasionally increases may be observed farther depending upon mud volumes and environmental conditions. The metals most frequently present in drilling muds at concentrations substantially (>100-fold) greater than natural concentrations in soils and sediments are barium, chromium, lead, and zinc (Neff 2005). Few, if any, biological effects have been associated with these increases in metals due to drill rig discharges (CAPP 2001b; Neff 2005).

Hydrocarbons

There is limited information available regarding the bioavailability of organic compounds from WBM. Payne *et al.* (1984) and Phillips *et al.* (1987) examined saturated and aromatic hydrocarbons by UV fluorescence and gas chromatography / flame ionization detection in sediments, sea clams (*Arctica islandica*) and flounder (*Paralichthys oblongus*) from the vicinity of exploratory wells on Georges Bank off the New England coast. One of the exploratory rigs had added diesel fuel to the WBM to assist in freeing a stuck pipe. When WBM was discharged, it contained approximately 100 L of petroleum hydrocarbons. Concentrations of saturated and aromatic hydrocarbons were low in sediments, clams, and fish. Sediments near the rigs contained less than 1 µg/g total aromatic hydrocarbons (mainly PAH), consistent with background concentrations in this region (Boehm and Farrington 1984). There was no evidence that the two benthic/demersal marine animals bioaccumulated any hydrocarbons.

Sjøgren *et al.* (1989) measured concentrations of petroleum hydrocarbon in livers of Atlantic cod from the immediate vicinity of North Sea platforms discharging WBM cuttings or oil-based mud cuttings, and compared concentrations to those in cod collected more than 10,000 m from the nearest discharge. TPH concentration was similar in livers of fish from all three locations. However, PAH and decalins concentrations were higher in livers of fish from the vicinity of the WBM- and oil-based mud-discharging platforms. Livers of fish from the vicinity of the WBM-discharging platforms contained lower concentrations of PAH and decalins than livers of fish from the vicinity of the oil-based mud-discharging platforms. Alkylcyclohexane concentrations were similar in livers of fish from the WBM-discharging and reference platforms. These results indicate that PAH and decalins (two-ring saturated hydrocarbons), probably from petroleum, are bioavailable from WBM and oil-based mud cuttings accumulations. It is possible that some of the hydrocarbons (particularly decalins) could have been derived from produced water and other discharges from the platforms, as decalins are abundant in many North Sea produced waters (Durell *et al.* 2005).

Toxicity of Water-based Muds

Several marine toxicity tests have been performed with dispersions of barite particles in seawater. Particulate barite is nearly insoluble and is essentially inert toxicologically to marine organisms. Most bioassays with marine organisms have produced median lethal concentrations greater than 7,000 mg/L suspended barite (National Research Council 1983). Barium (as barite) is toxic to embryos of crab (*Cancer anthonyi*) at concentrations greater than 1,000 mg/L (Macdonald *et al.* 1988). This concentration is 20,000 times higher than the aqueous solubility of barium in seawater, so any adverse effects probably are caused by physical effects of fine-grained barite particles.

In chronic studies with shrimp (*Palaemonetes pugio*) and substrates containing solid barite, barium, as barite, accumulated in the exoskeleton, hepatopancreas, and muscle tissue. The ingestion of barite caused damage to epithelial tissue of the gut. Barite mixed with sediments or as a layer on the sediment surface interfered with, but did not prevent, recruitment of several planktonic larvae of polychaetes and mussels to sediments (Tagatz and Tobia 1978). No adverse effects were observed in the polychaete worm (*Mediomastus ambiseta*) on fecal production, growth, and tube production of adults living in barite-covered sediments (Starczak *et al.* 1992). Tagatz and Tobia (1978) found that fewer individuals and species colonized sediments covered by a thin layer of barite as compared to control sediments.

Cranford *et al.* (1999) exposed juvenile sea scallops (*Placopecten magellanicus*) to barite suspensions of 0.5 and 2.5 mg/L (ppm) for 28 days. Survival at both doses was similar to that among controls. However, scallops exposed to the barite concentrations had lower gonad growth than control scallops did and, at the higher dose, digestive gland weight was significantly different from control.

Acute and chronic exposure of scallops to 100 mg/L water based drilling mud had no significant effect on survivorship or growth (Cranford *et al.* 1998). It is probable that concentrations of suspended barite, clay, or drilling mud particles increased in the exposure water during the chronic flow-through toxicity tests, so the scallops were actually exposed to higher than the nominal suspended solids concentration late in the test when most effects were observed. The effects of barite were similar to those of bentonite clay and probably were caused by physical damage to delicate gill epithelial membranes and interference of the suspended particles with feeding efficiency in this active filter-feeding mollusk. Research has demonstrated that suspended WBM at concentrations less than 10 mg/L may affect sea scallop feeding, growth and reproduction (Cranford *et al.* 2005).

Clams (*Cerastoderma edule*) that were exposed to 1 to 3 mm of a barite mud mixture for 12 days experienced coagulated and shortened cilia. In some extreme cases the gill structure disintegrated, probably caused by clogging and abrasion by the fine barite particles. There was 100 percent mortality within 12 days (Barlow and Kingston 2001).

The mysid (*Mysidopsis bahia*) was identified as one of the most sensitive species to WBM (Neff *et al.* 1980). Bioassays performed by the US EPA (1985a, 1985b) with the suspended particulate phase of eight generic WBMs and mysids (Table 7.3) resulted in 96-h LC50s ranging from 3,300 to >100,000 mg/L WBM (Duke *et al.* 1984).

Table 7.3 96-hour LC50 Mysid Toxicity Test Results

Drill Mud Type	Mysid 96-hour LC50 Result (mg/L)
KCl Polymer Mud	3,300
Seawater Lignosulfonate Mud	62,100
Lime Mud	20,300
Non-dispersed Mud	>100,000
Seawater Spud Mud	>100,000
Seawater / Freshwater Gel Mud	>100,000
Lightly Treated Lignosulfonate Mud	68,200
Freshwater Lignosulfonate Mud	30,000

Field Studies

In summary, most microcosm and field studies (Neff 2010) on the effects of WBM cuttings (from studies conducted in North Sea, Barents Sea, off Sakhalin Island, Beaufort Sea) have shown:

- no or minimal short-term effects on zooplankton communities;
- effects on benthic macro- and mega-faunal communities are minimal and restricted to approximately 100 m;
- no evidence of ecologically significant bioaccumulation of metals and petroleum hydrocarbons by marine organisms residing or deployed in cages near WBM discharges;
- no evidence of toxicity effects associated with WBM constituents;
- ecological effects are due to physical disturbances of water column and benthic environment;
- ecological effects associated with WBM are similar to physical disturbances associated with natural process, such as ice scour, river floods and storms; and
- benthic communities recover quicker with WBM releases than SBM releases.

Most laboratory and field studies to date have shown low acute and chronic toxicities of marine organisms to WBM. This is due primarily to the expected and observed rates of dilution and dispersal of drilling muds in the ocean after discharge. WBM effects are restricted primarily to the ocean floor in the immediate vicinity of, and for a short distance down current from, the discharge. The bioaccumulation of metals from drilling fluids appears to be restricted to barium and chromium and is observed to be small in the field. This was demonstrated by Daan and Mulder (1993, 1996) who studied the effects of WBM discharges from a platform in the Dutch Sector of the North Sea where surveys were performed two months and one year after completion of drilling. These surveys revealed no measurable adverse effects on the benthic community, even at stations as close as 25 m from the discharge (the transect studies ranged from 25 to 5,000 m down-current from the WBM discharge). Only small amounts of mud and cuttings solids were detected in sediments near the platform, suggesting that the discharged solids were transported away from the site and diluted to non-detectable concentrations within two months after completion of drilling.

All studies discussed above as well as other studies (and references cited in summary reviews such as Neff 2005, 2010) have demonstrated that significant effects of drilling waste discharges on benthic ecosystems occur only when large amounts of solids accumulate on the bottom near the discharge site or the solids accumulations associated with the cuttings pile contain a high concentration of biodegradable organic matter. Effects of cuttings piles on bottom living biological communities are caused mainly by burial and hypoxia caused by organic enrichment. Toxic effects, when they occur, are probably caused by sulfide and ammonia by-products of organic enrichment. Ecological recovery of benthic communities from burial and organic enrichment occurs by recruitment of new colonists from planktonic larvae and immigration from adjacent undisturbed sediments. Recovery begins as soon as discharge of drilling wastes is completed and often is well advanced within a year. However, it may be delayed until concentrations of biodegradable organic matter decrease through microbial biodegradation to the point where surface layers of sediment become anoxic (Hartely *et al.* 2003).

7.1.2.2 Synthetic-based Muds

SBM includes mud whose base fluids are composed of synthetic hydrocarbons (olefins, paraffins, and esters) (OGP 2003). SBM also often contains barite, clays, emulsifiers, water, calcium chloride, lignite, and lime. Water or a saline brine (usually containing calcium chloride: CaCl2), at a concentration of 10 to 50 volume percent, is dispersed into the hydrocarbon phase to form a water-in-organic phase emulsion with water droplets less than 1 μm in diameter (Hudgins 1991; Norwegian Oil Industry Association Working Group 1996). This emulsion is stable because of the small size of the water droplets and because emulsifiers often are used to stabilize it. It is called an invert emulsion because water is dispersed in the organic phase and formation solids that come in contact with the drilling mud become oil-wet (Neff 2005).

The persistence of SBM is related to the physical conditions on and near the sea floor (*e.g.*, re-suspension and transport, current velocity, sediment characteristics), re-working of sediments by burrowing biota and biodegradation of the base fluids. SBM cuttings are treated as per the OWTG requirements prior to discharge and are subject to C-NLOPB approval. The disposal of whole SBM is prohibited and therefore only cuttings retaining residual SBM after treatment is assessed. SBM enters the aquatic environment as a coating on rock cuttings, discharged from the drilling platforms, and accidental spills.

When SBM is discharged to the ocean, it tends to clump together in large particles that settle rapidly to the sea floor (Brandsma 1996; Delvigne 1996), especially if the cuttings are shunted to near bottom from fixed drilling platforms (Cordah 1998). The effect of shunting is to decrease the area of the sea floor over which cuttings accumulate and to increase the mass of cuttings deposited per unit area near the well site.

Ester based SBM is more easily dispersed than olefinic SBM. Water cannot easily penetrate the oleophyllic mass of cuttings, so they do not disperse efficiently (Neff *et al.* 2000). Therefore, most SBM settles rapidly and accumulates at the bottom near the drilling platform discharge sites. Therefore, SBM cuttings stay closer to the well site and do not disperse as widely as WBM and cuttings. Studies from the North Sea, Gulf of Mexico, Australia and Ireland have shown that SBM cuttings accumulate in a very irregular pattern in sediments around a drilling rig (Neff *et al.* 2000). Thus, no additional mortality (smothering) of sessile benthic invertebrates is expected to occur as a result of SBM discharge as the area will have already been subjected to smothering from WBM deposition.

The pattern of cuttings deposition will be determined by the following conditions at each site:

- quantities and rate of cuttings discharged;
- cuttings discharge configuration (*i.e.*, depth of discharge pipe);
- oceanographic conditions (*e.g.*, current velocities, water column density gradient);
- total amount and concentration of SBM on cuttings;
- water depth; and
- fall velocity distribution of the cuttings particles and aggregates.

Since the particles are wet with the SBM, the cuttings tend to aggregate once they are discharged. The aggregates fall at a greater fall velocity than the particles in the more easily dispersed WBM cuttings. Less dispersion and greater fall velocity of the SBM cuttings generally results in smaller area but thicker deposition on the seabed compared to WBM cuttings discharged under the same conditions (OPG 2003).

Bioavailability

Bioavailability of nonpolar (un-ionizable) organic chemicals, such as SBM base chemicals, to marine organisms depends on the physical and chemical forms of the compounds (Neff *et al.* 2000). Nonpolar organic chemicals, such as SBM base chemicals, usually have a low aqueous solubility and a high solubility in the lipids of plants and animals. They are classed as hydrophobic or lipophilic compounds. The rate and extent of bioaccumulation of hydrophobic compounds by marine organisms depends on the relative affinities of the chemical for the ambient water phase and the tissue lipid phase.

Hydrophobic chemicals with a log Kow (octanol-water partition coefficient) less than approximately 3 to 3.5 may bioaccumulate rapidly but not to high concentrations in tissues of marine organisms, particularly if they are readily biodegradable (ECETOC 1996). Hydrophobic chemicals with a log Kow greater than about 6.5 to 7 do not bioaccumulate effectively from the water, because their solubility in both the water and lipid phases is very low (Chessels *et al.* 1993).

Log Kow values for several SBM base chemicals have been measured or estimated in order to predict their bioavailability to marine organisms. Esters are moderately soluble and have a low log Kow. They probably are bioavailable; however, they are readily biodegradable and probably do not bioaccumulate to biologically significant concentrations in tissues of marine animals. The liver and gut enzymes involved in fat metabolism in marine animals can hydrolyze ester bonds and convert the resulting alcohols and fatty acids to low molecular weight organic nutrients. Food chain transfer is significant only for hydrophobic chemicals with log Kows greater than approximately 5 (Thomann 1989). Therefore, esters are not readily bioaccumulated from food and will not biomagnify in marine food chains.

Olefins and paraffins of the sizes found in SBM base chemicals are relatively large linear chains that do not permeate membranes efficiently. They have high log Kows, mostly higher than 9, indicating extremely low aqueous solubility and low potential to bioaccumulate. There is an inverse relationship between log Kow and aqueous solubility. The types of SBM used for offshore oil and gas exploration in Atlantic Canada have been paraffin-based and as such have a low potential to bioaccumulate.

Schaanning *et al.* (1996) added marine polychaete worms Hedeste (Neries) diversicolor to NIVA simulated seabed sediment chambers containing sediments contaminated with two esters, one internal olefin, one linear alpha olefin, or a mineral oil base chemical. The results of these studies concluded that SBM base chemicals have a very low bioavailability to marine organisms. There is little or no risk that these chemicals will bioaccumulate to potentially harmful concentrations in tissues of benthic animals or be transferred through marine food chains to important fishery species (Neff *et al.* 2000).

A potential concern associated with the deposition of treated SBM is the potential of increased risk of marine habitat contamination due to increases in metals concentrations of barium, arsenic, cadmium, copper, mercury, lead and zinc and hydrocarbon concentrations in sediments. SBMs are essentially non-toxic, have the potential to biodegrade relatively rapidly, require less mud (compared to WBM) for the same distance drilled and tend to disperse less than WBM (LGL 2005b). The specific rates of biodegradation of SBM are mostly unknown under all environmental conditions but are known to be related to the type of base fluid, temperature, oxygen levels, the type of bacteria present (aerobic or anaerobic), the species of bacteria present, and the form, mass and topography of the material (OGP 2003; Roberts and Nguyen 2006). In general, biodegradation is expected to occur faster under aerobic conditions than anaerobic conditions (OGP 2003).

Toxicity

SBMs are more biodegradable, and because of their high cost, SBMs are usually recycled rather than disposed of in the environment or reinjected. However, some SBMs reach the ocean in association with drill cuttings discharges. Cleaned SBM cuttings usually contain approximately 10 percent synthetic chemical (Annis 1997; Neff *et al.* 2000). Synthetic-based fluids (SBFs) typically have a total PAH concentration of less than 10 mg/kg (<0.001 percent) and are non-acutely toxic in most or all marine toxicity tests. The drilling mud (Paradril-IA35) that has been used for most drilling operations on the Grand Banks is a SBM with PureDrill IA-35 as the base fluid, together with weighting agents, wetting agents, emulsifiers and other additives. PureDrill IA-35 synthetic drilling fluid is classified as a high purity synthetic alkane consisting of isoalkanes and cycloalkanes (Petro-Canada Technical Bulletin). PureDrill IA-35 is a clean, colourless, odourless fluid that is safe to handle. It has an aromatic content of <0.01 percent and a PAH content of <0.001 ppm. It is non-toxic to human, plant and marine life.

PureDrill IA-35 has undergone an evaluation using the Offshore Chemical Management System. The fluid was screened from a facility, human health and environmental perspective. PureDrill IA-35 base fluid is a component of a whole mud system called ParaDrill that received a Group E classification by the Offshore Chemical Notification System classification system employed in the United Kingdom. The Group E classification is the best rating achievable under the Offshore Chemical Notification System and is assigned to chemicals that have relatively low toxicity and/or does not bioaccumulate or readily biodegrades.

The toxicity data for PureDrill IA-35 (Petro-Canada Technical Bulletin; Harris 1998) are:

- mysid shrimp 96-hour LC_{50} of >500,000 ppm;
- rainbow trout 96-hour LC_{50} of >400,000 ppm;
- amphipod *(Corophium volutator*) 10-day LC_{50} of 2,633 mg/L;
- Macoma 20-day LC_{50} of >50,000 mg/L;
- echinoid fertilization (*Lytechinius pictus*) IC_{50} (20 minutes) of >100 percent; and
- bacterial bioluminescence (Microtox test using *Vibrio fischeri*) EC_{50} of >100 percent.

Toxicity studies conducted by the DFO using American plaice, winter flounder (*Pleuronectes americanus*) and the amphipod (*Rhepoxynius abronius*) on Hibernia drill cuttings and solids (Payne *et al.* 2001a, 2001b) found:

- no acute toxicity in juvenile American plaice exposed for 30 days to Hibernia cuttings approximating hydrocarbon concentrations found 200 to 500 m from platforms in the North Sea;
- no acute toxicity in adult winter flounder exposed to Hibernia cuttings for 90 days; and
- in a dose response study using amphipods, a toxic response at 5,000 ppm hydrocarbon concentration only. The cuttings demonstrated a low acute toxicity potential and extrapolations have been carried out to determine possible size of toxic zones that would occur in the field. The extrapolations indicate little or no risk of toxicity as close as 1,000 m or less from the platform.

Several SBM base chemicals have been tested using the mysid water column test (Table 7.4). In most cases, the toxicity of SBM base chemicals decreases (LC50 increases) as molecular weight of the chemical increases. This undoubtedly is because as molecular weight increases, the aqueous solubility and bioavailability of most organic chemicals decreases. Most of the SBM base fluids or precursors pass the toxicity criterion of 30,000 mg/L (as noted in Table 7.4). SBM and SBM constituents exhibit a low overall acute toxicity in water column and solid phase tests with a variety of marine plants and animals. LC_{50}s nearly always are higher (less toxic) than acceptability criteria (Neff *et al.* 2000).

Table 7.4 Acute Toxicity of Synthetic-based Mud Base Chemicals to Mysids

SBM Base Chemical	Chemical	96-hour LC_{50} (mg/L)
Poly-α-Olefin	Polypropene (MW 170)	10,800
	Polypropene (MW 198)	30,000
	Decene Dimer (MW 290)	574,330
	Polypropene (MW 310)	914,650
	Polybutene (MW 320)	> 1,000,000
	Polypropene (MW 400)	> 1,000,000
Internal Olefin	C_{14}-C_{16} IO	< 30,000
	C_{15}-C_{18} IO	119,658
	C_{16}-C_{18} IO	321,000
Ether	Dibuthyl Ether	> 10,000
	Dihexyl Ether	61,659
	Dioctyl Ether	156,800
Esther	Methyl Laurate	< 10,000
	Isopropyl Palmitate	271,701
	Isopropyl Oleate	52,319
	C_{10}-C_{14} Alcohols	< 10,000
	C_{16} Alcohols	30,158

While pelagic and benthic organisms may be affected by WBM discharges, benthic organisms are the most likely to be affected by SBM cuttings discharges. The effects of SBM cuttings on pelagic organisms are expected to be even less than those of WBM because of the low toxicity of SBM and the reduced exposure time due to rapid settling of aggregations of SBM cuttings and particles out of the water column. Field studies seem to indicate that much of the effects of high concentrations of SBM cuttings in sediments is caused by nutrient enrichment and resulting oxygen depletion in the contaminated sediments rather than by direct toxicity of the SBM base chemicals themselves (Neff *et al.* 2000).

Biological effects of SBM cuttings on the benthos are expected to be similar to or greater than those of WBM. The mass of SBM discharged to the ocean per well is much less than the mass of WBM discharged per well, because the drilling fluid itself is not discharged and cuttings are cleaned before discharge (Veil and Daly 1999). SBM cuttings may impact benthic communities by production of anoxia in sediments through microbial biodegradation if SBM cuttings concentrations in sediments are high enough (Olsgård and Gray 1995). WBM cuttings do not usually cause sediment anoxia because they contain only low concentrations of biodegradable organic chemicals. However, they impact benthic communities by burial and smothering, or they may alter sediment texture, rendering the local benthic environment less suitable for some species of benthic fauna and better for others (Neff 1987). Thus, biological effects of SBM cuttings discharges are likely to be greater than effects of WBM cuttings discharges in the immediate vicinity (within 50 to 100 m) of platforms where SBM cuttings are likely to accumulate to high concentrations (Neff *et al.* 2000).

Field Studies

In 1994, 19 monitoring surveys were performed near platforms discharging SBM to offshore waters of the Norwegian Sector of the North Sea (Bakke *et al.* 1996). Eight of these surveys included observations of benthic communities near platforms. Low concentrations of SBM base chemical could be detected in sediments up to 2 km from the well site (Frøy platform). The benthic fauna appeared normal, and there was no evidence of disturbance from the drilling and discharge activities. Ester was detected in sediments from the four stations closest to the discharge (Yme Gamma Platform) and in two stations down-current to a distance of 500 m from the platform. Concentrations were low. Elevated concentrations of barium, but not other metals, were detected at most stations. The benthic fauna was highly diverse throughout the field; there were minor effects of the discharges up to a distance of 500 m from the platform.

Elevated concentrations of SBM base chemical were detected in sediments up to 2 km down current from the Bragge platform (Bakke *et al.* 1996). Barium concentrations had increased gradually in the sediments of the area since 1992. The benthic community near the platform had a reduced diversity. Effects of the drilling fluid accumulations on the benthos were detected up to 1 km down current of the discharge and to a maximum of 250 m in other directions.

Elevated barium concentrations were distributed uniformly in sediments around the Tordis platform (Bakke *et al.* 1996). Concentrations of SBM base chemical in sediments were low, but could be detected up to 2 km from the platform. There was a gradient of benthic community structure in sediments across the field that was not there at the time of the baseline survey. Benthic faunal disturbance was detected at three stations out to 500 m from the platform.

The physical and biological effects of SBM cuttings discharges were studied at a drilling site in 39 m of water in the northwestern Gulf of Mexico (Candler *et al.* 1995). WBM was used to drill the first 1,036 m of the well. A PAO SBM was used to drill from 1,036 to 2,453 m. Three field surveys, nine days, eight months and 24 months after completion of mud and cuttings discharges were performed at the site. Samples for benthic community analysis were collected only on the 24-month survey. During all three surveys, sediment samples were collected at 25, 50, 100, 200, and 2,000 m along transects in the four compass directions from the well site. A total of 106 taxa of benthic invertebrates were identified in sediments near the drill site two years after completion of drilling. The benthic community was typical of those in shallow waters of the western Gulf of Mexico. The benthic community apparently was unaffected by the drilling discharges (two years after drilling) at all stations east and north of the well site and at stations more than 50 m south and west of the well site.

Impacts of SBM cuttings discharges on deep-water benthic ecosystems are largely unknown (Neff 2000). The only study that included some observations of bottom fauna near a deep-water discharge site was at the Pompano II platform in 565 m of water (Fechhelm *et al.* 1999). Sediments for benthic faunal analysis were collected with a remotely operated vehicle from stations 25, 50, and 75 m northeast and 25, 50, 75, and 90 m southwest of the template. A total of 2,100 macrofaunal animals were collected; polychaetes were most abundant, followed by gastropod mollusks. The abundance of benthic fauna was significantly higher in sediments along the northeastern transect (highest SBM concentrations in sediment) than in sediments along the southwestern transect. Demersal megafauna (mostly fish) were counted from videotapes taken along each transect. Numbers and densities of demersal fish observed along the four transects were similar. The densities were higher than observed at other locations at similar depths in the northern Gulf of Mexico. The fish may have been attracted to the Pompano drilling template or disturbed sediments nearby. Neither benthic fauna nor demersal fish abundance seems to have been adversely affected by the discharge of SBM cuttings (Neff 2000).

Results similar to those reported in other regions have been reported for the Fortescue Field, located in 70 m of water in the Bass Straight off southeast Australia (Terrens et al. 1998). While most the drilling was conducted with WBM, the long-reach, high-angle sections of seven wells required the use of SBM. The fate of these discharges was monitored during five seabed surveys undertaken between August 1995 (pre-SBM cuttings discharges) and August 1997 (11 months after completion of SBM cuttings discharges). Effects of the drilling fluids and cuttings discharges on benthic faunal communities was limited to within 100 m of the platform with recovery evident within four months after completion of drilling. During the time of SBM cuttings discharges, numbers of nematodes and crustaceans decreased and numbers of polychaetes increased in sediments 100 m southwest of the platform. Total abundance of benthic fauna remained nearly constant and benthic faunal diversity declined. These effects are typical of an organic enrichment effect (Pearson and Rosenberg 1978). Within four months after completion of drilling, benthic biological parameters had returned to pre-drilling conditions. Recovery was attributed to a combination of ester biodegradation and the active physical seabed dispersion processes in the eastern Bass Straight.

Field studies (OGP 2003) have shown that for SBM cuttings discharges, the areas that recovered most rapidly were those characterized by higher energy seabed conditions. Because of the tendency for adhesion between SBM cuttings, re-suspension of SBM cuttings requires higher current velocities than those required for WBM cuttings. Laboratory tests found that the critical current velocity required for erosion of SBM cuttings was 36 m/s for cuttings with 5 percent oil content (OGP 2003). SBM would be expected to be less persistent in areas with thinner deposits as this leads to quicker recovery than areas with deep piles. Therefore, it is important to consider factors that govern the initial deposition thickness and the potential for erosion in assessing recovery potential. Initial deposition thickness will depend on the current profile and water depth. Stronger currents lead to wider dispersion before deposition, and greater water depth generally will lead to thinner initial deposits (OGP 2003).

The water column effects (OPG 2003) from discharging SBM are considered to be limited due to the following:

- low solubility of base fluid of the SBM in seawater;
- low water column dispersion and residence time due to rapid settling rate; and
- drilling discharges are intermittent and transient.

Hurley and Ellis (2004) reviewed 19 studies to assess environmental effects associated with SBM and found that the area of detection and scale of biological effects were more localized than for WBM. Biological impacts were generally detected at distances of 50 to 500 m from well sites with recovery of benthic communities occurring within one year of well completion. While the biological effects of SBM are localized, there is uncertainty regarding degradation processes of SBM (it can produce anoxic conditions in the sediment). Elevated levels of metals have been found to occur within 250 to 500 m of the drill site, but sometimes occur further, depending on environmental conditions and the number of wells drilled (Hurley and Ellis 2004). Signals of drill muds (*e.g.*., barite) have been detected 5,000 m from Terra Nova (18 production wells) and 8,000 m from Hibernia (32 production wells) (Hurley and Ellis 2004), but not at levels likely to have any biological effect.

Marine birds exposed to metals from drill muds could potentially experience harmful effects. However, a study by Gallagher *et al.* (1999) found that very high concentrations of heavy metals were required to produce a physiological response in Mallard ducklings (*Anus platyrhynchos*). The concentrations required to produce such a physiological effect were higher than would be expected at an offshore site (Husky 2000).

7.1.3 Routine Discharges

The OWTG (NEB *et al.* 2010) encourage the reduction of generated waste and substances of potential environmental concern. All solid waste as well as excess chemicals or chemicals in damaged containers will be brought ashore. The transportation of dangerous goods and WHMIS Regulations govern the handling, use, storage, transport and disposal of hazardous materials. All routine discharges associated with the exploration drill program will be discharged in accordance with the OWTG (NEB *et al.* 2010). Discharge limits are based on best available technologies and are the focus of continuous improvement programs. Where practicable, use of technology to reduce discharge limits below those in the OWTG (NEB *et al.* 2010) will be implemented.

Mobil (1985) estimated that grey water discharge (*e.g.,* showers, dishwashing, deck drains) associated with an offshore drilling rig accommodating approximately 100 persons would be 40 m^3/day, while black water discharge (sanitary waste) would be 19 m^3/day. This represents a fair estimate of potential discharge for the Project, since the number of persons on the drilling rig is likely to be between 85 and 120. Sanitary waste will be treated and discharged as per the OWTG (NEB *et al.* 2010). Waste water discharge is treated and tested for compliance with the OWTG (NEB *et al.* 2010). Organic matter associated with discharges will disperse quickly in an open ocean environment and be quickly degraded by bacteria. The effects of this relatively small amount of organic matter and nutrients on the offshore marine environment will be negligible and not significant.

Other discharges such as BOP fluid will be a glycol-water mixture with low toxicity and other fluids containing oils, such as deck drainage and bilge water, will be treated, recycled, or discharged below the water surface. All treated fluids will comply with the OWTG (NEB *et al.* 2010). Drilling will require seawater, most of which will be used as cooling water (non-chlorinated). The volume of entrainment will be low and the area of thermal effects small. Therefore, the effects of discharges of these fluids on marine birds (including Species at Risk) will be negligible. Other materials, such as drilling fluids, deck drainage and bilge waters, may negatively affect marine bird health due to the presence of residual hydrocarbons. Any discharged oily water will comply with the OWTG (NEB *et al.* 2010), as will any other regulated liquid or solid discharged from the drilling platform. The attraction of gulls to platforms as a result of discharges of sanitary and domestic waste may increase the potential for predation of smaller marine birds such as Leach's Storm-Petrels.

Domestic garbage will be transported to shore and will not interact with marine birds. However, sanitary and food waste will be macerated to a particle size of 6 mm or less and discharged at a depth of approximately 15 m. Gulls may be attracted to the discharge area; however, the small amount discharged below the surface is not likely to result in an increase in gull populations in the area. Organic matter associated with discharges will disperse quickly in an open ocean environment and degraded by bacteria. Any biocides used will be screened in accordance with an approved and established chemical management system.

7.1.4 Supply Vessels

Supply vessels will be involved in support of exploration, serving a variety of roles, ranging from personnel transport to re-provisioning to inspection, cargo and maintenance work. It is anticipated that two to three support vessel trips will be required per week (*e.g.*, one standby vessel and one to two supply vessels). Any support vessels that may come from St. John's, Newfoundland, will use the recognized shipping lane through the Laurentian Channel.

In addition to marine vessel traffic, helicopters will fill a vital role especially in the transport of personnel to and from ships and platforms.

This section focuses on effects other than noise, which is discussed in detail in Section 7.1.5.1. Support vessels may affect marine birds through discharges, lighting, the physical presence of the structure, and noise. Marine birds are habituated to vessel activity and some species such as gulls and Northern Fulmar are actually attracted to ships and often stay with them for extended periods (Wahl and Heinemann 1979; Brown 1986; Montevecchi *et al.* 1999). Direct effects to marine birds are not anticipated because these species are highly mobile and can avoid vessels by flying or diving. Energy expended during these events would be minimal and have no physiological effect on the birds.

Research has shown that seabirds react most strongly to low-level flights and the effects of these responses tend to be short-lived. Helicopter overflights at 300 m failed to cause a visible reaction among moulting sea ducks in the North Sea while overflights at 100 m resulted in short-term avoidance reactions (Ward and Sharp 1974). As with their response to vessel traffic, seabirds may habituate to air traffic over time. The greatest sensitivity to aircraft traffic would be at large nesting colonies. An aircraft flying near a seabird colony could cause panic in birds, resulting in eggs and flightless young being accidentally pushed off cliff ledges, being exposed to harsh weather conditions or predation when adults flush.

Toothed whales and pinnipeds are rarely struck by vessels (Laist *et al.* 2001; Jensen and Silber 2003). These marine mammals are fast swimming and agile, enabling them to avoid approaching vessels. In contrast, the most commonly struck of all marine mammals are the baleen whales (Laist *et al.* 2001; Jensen and Silber 2003). It is thought that these large, slow-moving animals are often unable to react fast enough to avoid approaching vessels (Laist *et al.* 2001; Jensen and Silber 2003). High speed container ships are considered to be potentially one of the greatest threats to blue whales. However, evidence suggests that serious (or lethal) vessel strikes to whales are infrequent at vessel speeds less than 25.9 km/hr (14 knots) and are rare at vessel speeds less than 18.5 km/hr (10 knots) (Laist *et al.* 2001). Supply vessel strikes with marine mammals are therefore considered unlikely given the predictable direction and slow speed of advance 7.4 to 9.3 km/hr (4 to 5 knots) of the vessels. However, as a precautionary mitigation measure, all Project-related vessels will be restricted to a maximum speed of 18.5 km/hr (10 knots) within the Project Area (*i.e.*, not in transit to / from the Project Area).

With respect to sea turtles, a study of green sea turtles by Hazel *et al.* (2007) suggested that 60 percent of observed turtles (n = 1,819) actively avoided vessels travelling at 3.7 km/hr (2 knots), but only 22 percent avoided vessels travelling at speeds of 11.1 km/hr (6 knots). Such a study has not been done for leatherback turtles; however, this species is recognized as being the fastest reptile 35.2 km/hr (19 knots) when frightened (McFarlan 1992) and might be expected to be better able to avoid a strike. However, the more relevant variable is whether the animal is foraging or transitting. Foraging sea turtles are more vulnerable to strikes (DFO 2012c).

7.1.5 Underwater Sound Sources Associated with Exploratory Drilling

Underwater sound has the potential to affect species at risk in a variety of ways depending on source levels, duration of exposure, proximity of sound source, animal sensitivities, environmental conditions, and other factors. Marine mammals and in particular marine mammal species at risk are generally believed to be the group most sensitive to underwater sound. The main sources of sound for the proposed Project include helicopters, supply / support vessels, drill rig machinery and thrusters, echo sounders, VSP seismic array, and wellhead removal explosives (if used).

7.1.5.1 Sounds Associated with Well Site Surveys, Vertical Seismic Profiles (VSP) and Drilling

The most intense sound sources associated with this Project would be associated with a VSP, if required. This source of sound produces frequencies in the range of 5 – 300 Hz (Lee *et al.* 2011) with sound pressure levels between 220 and 245 dB re 1 µPa @ 1 m. VSP surveys use similar equipment to the full 2-D and 3-D seismic surveys though the sound sources are smaller and less intense and the duration of the surveys to support exploratory drilling are also shorter than the full 2-D or 3-D seismic programs.

A VSP is a survey utilized to further define hydrocarbon resources and identify geologic formations surrounding the borehole. The receiving geophones are located within the borehole as opposed to geophones towed in the water column behind a vessel during conventional 2-D/3-D surveys. Since the acoustic energy needs to only pass one way through the earth, the source power (sound pressure levels) can be decreased. The sound sources are similar, though fewer, to those employed during 2-D and 3-D seismic surveys and often use a single source array (IAGC 2002). The SPL from a typical single source array has a peak pressure output of 230 dB re 1 µPa @ 1 m (Davis *et al.* 1998). VSP surveys are respectively short, lasting one to two days.

A study by McQuinn and Carrier (2005) discusses the results of acoustic monitoring that occurred during a 3D seismic program conducted on the Scotian slope adjacent to the Gully MPA. The survey, conducted for Marathon, resulted in the maximum average SPL in the far-field of 145 dB re 1 µPa, which was measured 50 km from the array. Within the near-field (2.6km), the maximum average SPL was 175 dB re 1 µPa (Lee *et al.* 2005). These SPL measurements were collected at 30 m from the surface where sound attenuation is greater as compared to deeper stations. A semi-submersible drill rig (one potential drill platform that may be used for drilling the exploration well at Old Harry) produces a broad band sound level of approximately 154 dB re 1 µPa @ 1m (Richardson *et al.* 1995). Sound from a dynamically positioned drillship is emitted at a level of about 190 dB re 1 µPa @ 1m (Richardson *et al.* 1995). The increased sound pressure levels caused by the drillship are based on the cavitation caused by the propellers used to dynamically position the ship over the borehole and the transmissivity of the metal hull (Richardson et al 1995).

Table 7.5 lists multiple sources of marine sound along with the measured sound pressure levels in dB re1 µPa @ 1m and dominant frequency in Hz.

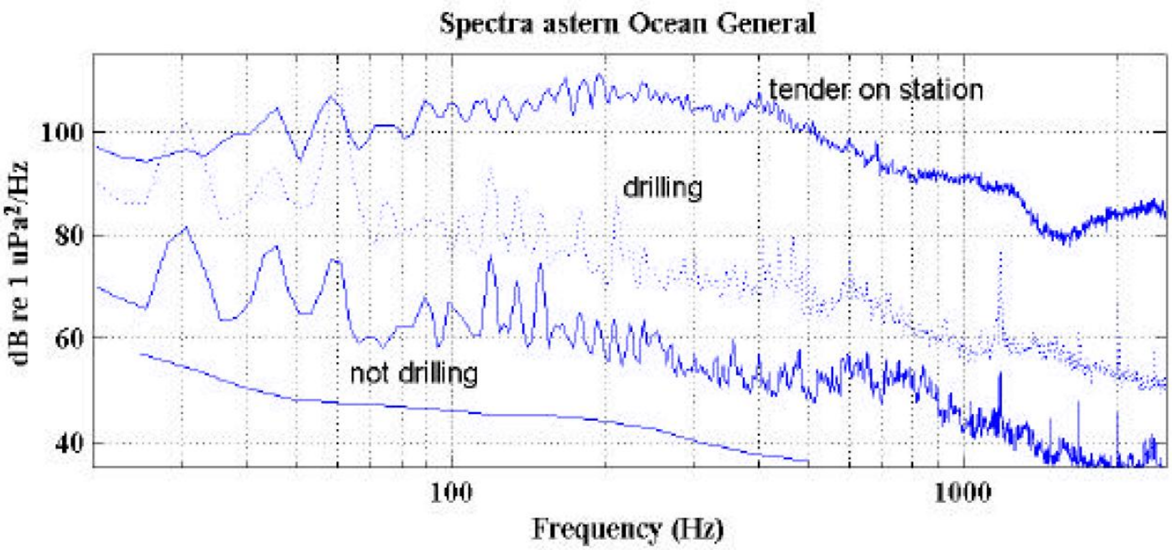
Table 7.5 Sources of Underwater Sound Levels

Source	Sound Pressure Level (dB re 1µPa@ 1m)	Dominant Frequency (Hz)	Reference
Ambient Noise			
Moderate sea state	102	100-700	Hurley and Ellis 2004
St. Lawrence Waterway median value	112	400-800	Simard *et al.* 2010
St. Lawrence Waterway maximum value	136	400-800	Simard *et al.* 2010
Bull male sperm whale clicks	232	400-2,000	Mohl *et al.* 2000; Goold and Jones 1995
Blue whales/ Fin whales	Up to 190	10-25	Cummings and Thompson 1971; Thompson *et al.* 1979
Well Site Survey / Vertical Seismic Profiles (VSP)			
Well site surveys	220-245	5 - 300	Lee *et al.* 2011
Vertical seismic profiles	230	5 - 300	Davis et al 1998; Lee *et al.* 2011
Drilling Related Noise			
Jack-up rig	119 – 127	5	Hurley and Ellis 2004
Semi-submersible	154	Broadband	Richardson *et al.* 1995
Dynamically positioned Drillship	190	10 -10,000	Richardson *et al.* 1995
Supply vessel	170-180	100	Hurley and Ellis 2004

Figure 7.5 illustrates the noise spectra measured from 2.5 to 2,500 Hz at a distance of 175 m from a semi-submersible drill platform during four operating conditions. The platform was anchored in 110 m of water approximately 12 km from a shelf in the Timor Sea Northern Austrailia (MacCaulay 1998). The spectral lines are explained below:

- The bottom line represents ambient sound pressure levels within the marine environment;
- The second line from the bottom represents sound pressure levels from an active anchored platform on site with no drilling or supply vessel support;
- The second line from the top represents sound pressure levels with rig anchored on site and drilling with no supply vessel support; and
- The topmost line represents sound pressure levels with the rig drilling and supply vessel (tender) support.

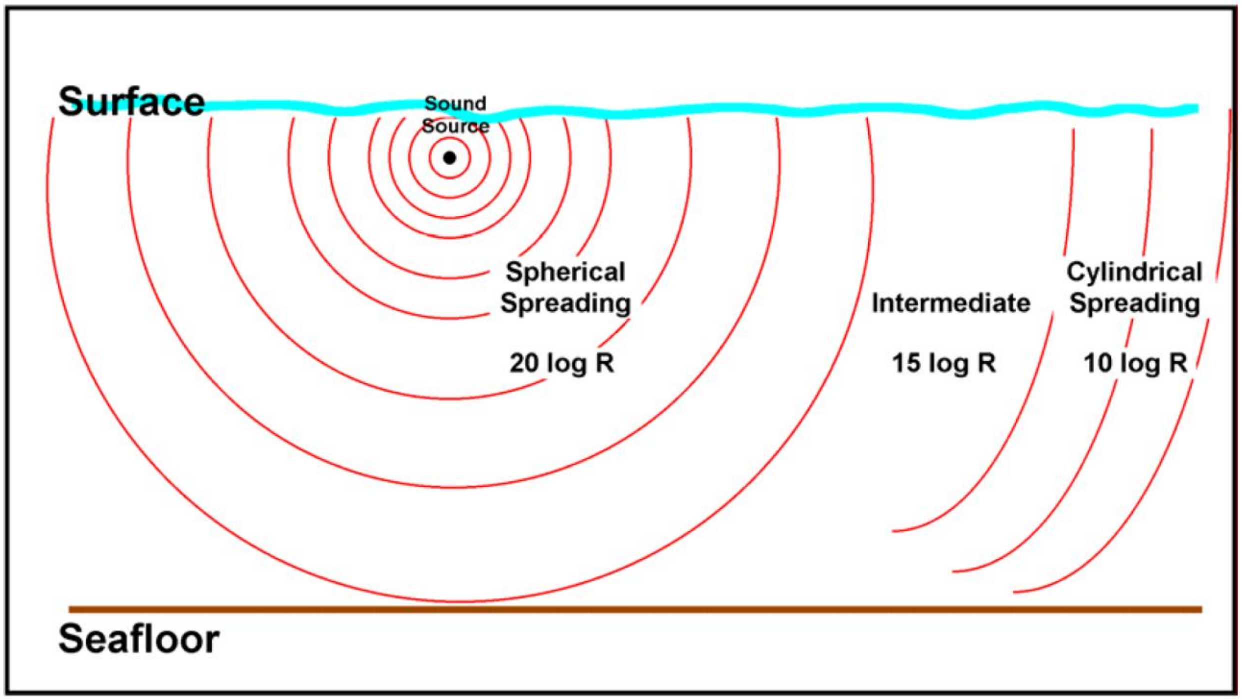
The figure illustrates that the highest sound pressure levels are produced while the platform is drilling while a support vessel is in the vicinity. The line labelled ‘not drilling’ also illustrates the sound pressure levels resulting from general operation of the drilling platform (*e.g.*, generating equipment, bilge water control, *etc.*) while on site (MacCaulay 1998).



Source: MacCauley 1998

Figure 7.5 Frequency Spectrum Analysis of Sound Pressure Levels 175 m from a Semi-submersible Drill Rig

The process in which sound radiates from a source is complex and can be altered by the physical and chemical characteristics of the fluid through which it radiates. Physical characteristics such as temperature, pressure (as depth), fluid velocity, air-water or air-substrate interfaces and particulate matter, chemical characteristics such as dissolved salts (salinity), and entrained air/gases can play a role in the way sound energy is transmitted. Generally sound propagates in a uniform spherical pattern until bounded by a boundary layer such as thermoclines, air-surface interface and/or seafloor (Lawson *et al.* 2000; NRC 2003). During this uniform dispersion termed “geometric” or “spherical spreading”, the sound pressure level decreases by 6 dB for every doubling of distance. Once the sound source is bounded by two layers, the propogation decreases to 3 dB for every doubling of distance. This occurs as the sound waves are no longer allowed to dissipate uniformly in all directions and propagate in a cylindrical manner (Lawson *et al.* 2000; NRC 2003). Figure 7.6 illustrates spherical and cylindrical propogation as well as the intermediary stage where one boundary layer exists.



Source: Lawson *et al.* (2000)

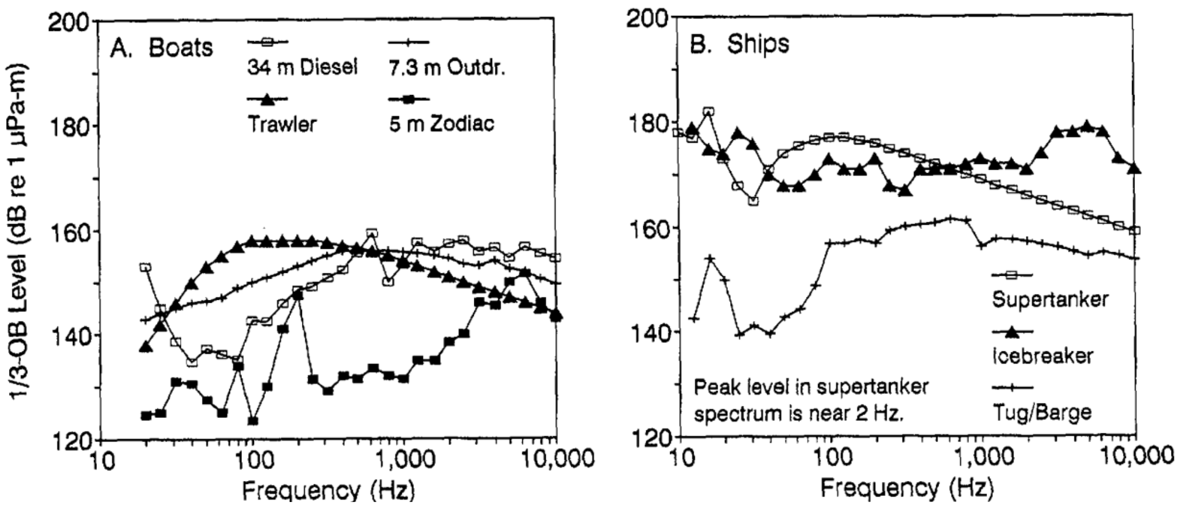
Figure 7.6 General Sound Pressure Propogation in the Marine Environment

7.1.5.2 Sound Associated with Support Vessels

Support vessels can be characterized essentially as continuous noise sources with helicopter overflight considered a transient noise source due to the limited angle of propagation of the airborne sound into the water column. The vessels involved in offshore oil and gas operations span a wide range of sizes, power ratings and applications and, consequently, generate widely different levels of underwater sound. Vessel and helicopter noise are a combination of tonal and broadband sounds, which in the case of vessels, is dependent on their size, design and speed (Richardson *et al.* 1995).

Boat (e.g., trawler, zodiac) and ship (tanker, barge) noise is attributable mainly to propeller cavitation, propeller singing, propulsion engines (noise transmitted through the vessel's hull) or other machinery. Cavitation is usually the dominant noise source (Ross 1976, in Richardson *et al.* 1995). The frequency spectrum of cavitation noise has been observed to be a broadband noise consisting of sharp pulses that correspond with the propeller rotation frequency times the number of blades (Erbe and Farmer 2000). Noise from older, medium to high-speed diesel engines built with simple connecting rods is strong enough to potentially overshadow cavitation (Ross 1976). Modern diesels built with articulated connecting rods (mostly found in tankers, freighters and container ships) are slow speed (<250 rpm) and relatively quiet, with cavitation being the dominant noise source (Richardson *et al.* 1995).

Generally, the larger the vessel, the greater the level and lower the frequency of sound emitted. A comparison of 1/3 octave bands associated with both small and medium to large vessels is provided in Figure 7.7. In an operation involving diverse vessel sizes, noise will be mainly due to medium and large vessels. When operating at relatively close range, small vessels with outboard engines, such as zodiacs, may also contribute considerable underwater noise levels (Erbe 2002).



Note: The icebreaker noise is from the Robert Lemeur (studied by Greene 1987) pushing on ice at full power (7.2 MW) and zero speed. This is estimated to be louder than that generated by an ocean-going tug pulling a load at low speed.Source: Richardson *et al.* 1995.

Figure 7.7 Estimated One-third Octave Sound Levels of Underwater Noise at 1 m for A) Boats; and B) Ships

The exploration well will be drilled in the Laurentian Channel, which is a major shipping channel subject to a high level of ship noise (DFO 2012c). On a long term average, in close proximity to the well, the incremental increase in noise created by support vessel activity as a fraction of the pre-existing ambient background should be less than similar operations conducted in areas further removed from the shipping lanes (DFO 2012c).

7.1.5.3 Biological Effects

If one examines sounds based on a hierarchal effect, then the most intense sounds associated with the proposed undertaking would most likely be associated with the seismic sources used in the VSP survey, followed by the drill platform and related operations, support vessels and helicopters. Much of the information presented on sound in subsequent sections will be related to seismic sources, as seismic sound will be the most probable source of the most intense sounds undertaken as part of the exploration drilling activities (VSP surveys). A VSP survey may be undertaken as part of the exploration drilling program. This type of seismic survey produces a lower intensity sound than that associated with the 2-D or 3-D seismic surveys.

Fish

There is a paucity of experimental data on the effects of drilling sounds on fish. A concern is that anthropogenic sounds affect communication and detection of the acoustic scene. There is a broad range of other potential effects of anthropogenic sounds (Popper and Hastings 2009). The contrast between the two sound types can be characterized as follows: exposure to intense intermittent sound sources is relatively brief because the sounds are in a localized area and the sources are often moving (*i.e.*, sonars and seismic equipment) and pass by the fish, or they are stationary (*i.e.*, pile driving) and the fish swim by the structure. In contrast, the long-lasting sounds, such as might be found in a harbour with heavy shipping, are pervasive throughout a large region and cannot easily be avoided.

There are over 50 families of fish with sound-producing species (Myrberg 1981). Fish sounds are normally generated in the range of 50 to 3,000 Hz. Fish use sound for communication, navigation and sensing of prey and predators. Sound transmission is thought to play an important role in cod and haddock mating (Engen and Folstad 1999; Hawkins and Amorin 2000). Seismic signals have peak pressures in the range of 5-300 Hz, with some energy emitted in the 500-1000 Hz range (DFO 2011r; Hurley 2009) and will therefore overlap slightly with signals produced by fish. However, detecting a signal does not mean the fish will have any measurable reaction to the noise. The hearing ability of fish varies considerably by species as will the effects of seismic exploration. Variability in effect may also vary within a species because seismic signals have a more pronounced effect on larger fish than on smaller fish of the same species (Engås *et al.* 1996).

Studies on effects of anthropogenic sounds have shown varying results ranging from no measureable effect to small and temporary shifts in behaviour, and in some cases, mortality. All fish studied to date are able to hear sounds (Fay and Popper 2000; Kasumyan 2005; Popper and Fay 2010) and they have two sensory systems for detection of water motions: the inner ear (there is no outer or middle ear) and the lateral line system. The ear serves to detect sound up to hundreds or even thousands of Hz (depending on the species), whereas the lateral line detects low-frequency sound (*e.g.*, <100 Hz), but is generally considered to be primarily a detector of water motion relative to the body (Slabbekoorn *et al.* 2010).

Fish with swim bladders and specialized auditory couplings to the inner ear (*e.g.*, herring) are highly sensitive to sound pressure. Fish with a swim bladder but without a specialized auditory coupling (*e.g.*, cod and redfish) are moderately sensitive, while fish with a reduced or absent swim bladder (*e.g.*, mackerel and flounder) have low sensitivity (Fay 1988). Fay (1988) has developed an approximate threshold for each of these three classifications of hearing sensitivity. The highly sensitive group has a hearing threshold of less than 80 dB re 1 µPa. The moderately sensitive threshold is between 80 and 100 dB re 1 µPa and those fish with a low threshold have a sensitivity of greater than 100 dB re 1 µPa. These sensitivity thresholds were derived under quiet laboratory conditions, so thresholds to seismic sound pressure in the ocean are thought to be 40 dB higher due to ambient noise and the start and stop nature of the seismic signal. Source levels during seismic surveys are usually in excess of the noise levels that elicit a response in fish, so the area in which fish react to the noise may extend several kilometres in the open ocean. By comparison, underwater ambient noise in bad weather is in the range of 90 to 100 dB re 1 μPa. In comparison, large tankers may have a source noise level of 170 dB re 1 μPa @ 1 m.

The expected distance for fish to react to a typical peak source level of 250 to 255 dB re 1 μPa @ 1 m is from 3 to 10 km (Engås *et al.* 1996). A reaction may simply mean a change in swimming direction. The spatial range of response in fish will vary greatly with changes in the physical environment in which the sounds are emitted. In one environment, fish distribution has been shown to change in an area of 74 x 74 km (40 x 40 nautical miles) and 250 to 280 m deep for more than five days after shooting ended, with fish larger than 60 cm being affected to a greater extent than smaller fish (Engås *et al.* 1996).

The first time that sound was used by humans to locate objects underwater was shortly after the Titanic sank in 1912. After that, the use of mid- and later low-frequency sonar has become widespread for navigation and localization of submarines and other objects (Slabbekoorn *et al.* 2010). Effects of sonar sound were studied by Popper *et al.* (2007) and Halversen *et al.* (2006) with the exposure of several different species of fish, including rainbow trout (*Oncorhyncus mykiss*) and channel catfish (*Ictalurus punctatus*) to sound emissions from a SURTASS LFA sonar. These studies were conducted using a sonar transducer and exposing fish to received sounds as high as 193 dB re 1 μPa (rms) continuously for up to 216 seconds. The results indicated no mortality and no damage to auditory and non-auditory tissues but demonstrated temporary threshold shift (TSS) in both species. Hearing loss recovered within 48 hours in channel catfish, and there were not enough data to determine recovery in rainbow trout. Data for other marine fish have demonstrated that exposure to moderately loud noises can result in TTS in a few species that have been studied, including goldfish (*Carassius auratus*) and other fish specialized for hearing (Scholik and Yan 2001 2002; Amoser and Ladich 2003; Amoser *et al.* 2004; Smith *et al.* 2004). Three studies using higher intensity sounds have also shown damage to the sensory hair cells of the inner ear, the cells responsible for transducing sound into neural impulses (Hastings *et al.* 1996; McCauley *et al.* 2003).

Popper *et al.* (2005) exposed several different species of fish to shots from a small seismic air source array in a river and found no damage to sensory hair cells of the ear (Song *et al.* 2008). Two of the three species tested showed some hearing loss compared to control animals with complete recovery of hearing within 18 to 24 hours after exposure.

There have been several studies that have examined the effects of long-term noise exposure on fish (Scholick and Yan 2001 2002; Amoser and Ladich 2003; Amoser *et al.* 2004; Smith *et al.* 2004, 2006; Wysocki *et al.* 2006). These studies show that fish that have anatomical specializations that make them better able to detect lower levels of sound pressure (known as hearing specialists) and demonstrate temporary hearing loss when exposed to increased background noise levels for 24 hours or more, whereas fishes without such specializations (known as hearing generalists) may not demonstrate hearing loss. Smith *et al.* (2004) studied hearing loss after over 20 days of exposure to a broadband noise of 170 dB re 1 μPa (rms) and found that substantial hearing loss in goldfish (hearing specialist), but not in the Nile tilapia (*Oreochromis niloticus*), a hearing generalist. Similar findings for hearing specialists and generalists have been reported by others. The results of these studies suggest that the amount of hearing loss that occurs in fish might be correlated with the sound pressure level of the noise relative to the hearing threshold of the fish.

Fish have been observed to congregate, seek shelter or food, at places with artificially high sound levels. Several studies in captive fish have shown an increase in secretion of the stress hormone cortisol during exposure to white noise or simulated boat noise (Smith *et al.* 2004; Wysocki *et al.* 2006, 2007). Other recent studies on potential indicators of stress in captive fish report noise-related rises in heart rate (Graham and Cooke 2008) and increased motility related to several blood parameters reflecting increased muscle metabolism (Buscaino *et al.* 2010). Population productivity of noisy areas might not only be affected by lower numbers or lower-quality individuals, but might also decline due to lowered reproductive efficiency. A study reports on actual interruption of spawning in roach (*Rutilus rutilus*) and rudd (*Scardinius erythrophthalmus*) by an approaching fast-moving powerboat (Boussard 1981). These studies suggest that anthropogenic sound could be a stressor in natural water bodies.

The response to sound by fish might range from no overt change in behaviour to the fish exhibiting an awareness of the sound or a startle response but otherwise no change in behaviour (Wardle *et al.* 2001), to small temporary movements for the duration of the sound, to larger movements that might displace fish from their normal locations (Slotte *et al.* 2004) for short or long periods of time.

Kosheleva (1992) reports no obvious physiological effects beyond 1 m from a source of 220 to 240 dB re 1µPa. Hastings (1990) reports the lethal threshold for fish beginning at 229 dB and a stunning effect in the 192 to 198 dB range. Auditory damage starts at 180 dB, transient stunning at 192 dB and internal injuries at 220 dB.

A specific noise impact that could potentially result in lower reproductive efficiency for fish is masking of communicative sounds. Over 800 species are known to produce sounds and the sounds they produce are in general broadband signals with most energy <500 Hz. Distinct variation in spectral and temporal characteristics can be related to species, populations, and gender (Slabbekoorn *et al.* 2010) and suggests that acoustic variation means that sounds can serve as information carriers in acoustic communication among fish (Tavolga 1971; Ladich 2004; Myrberg 1981).

Fish are known to produce sounds in spawning aggregations (Saucier and Baltz 1993; Aalbers 2008) and courtship interactions (Myrberg *et al.* 1986; McKibben and Bass 1998). Sounds could serve in aggregating reproductive groups, in which they may contribute to synchronization of male and female gamete release (Myrberg and Lugli 2006). Recent experimental evidence has unequivocally shown that sounds can modify mate choice decisions in fish. Female haplochromine cichlids (*Pundamilia nyererei*) provided with a choice between two males, matched in size and colour, preferred to interact with the male associated with playback of conspecific sounds (Verzijden *et al.* 2010). An acoustic impact on sexual preferences was also inferred for Atlantic cod in which the male drumming muscle mass was correlated with mating success (Rowe *et al.* 2008).

Masking leading to a reduction in detection distance, can potentially lead to failure in mate attraction. Currently there is a lack of empirical evidence demonstrating this effect for fish. It is not only essential to assess signal-to-noise threshold levels for an impact of anthropogenic noise on detection and recognition of relevant sounds, insight is also required into the potential scale of impact of such masking effects under natural conditions (Slabbekoorn *et al.* 2010).

Hearing and localizing of sounds can also be used for prey location and predator avoidance. Although sharks and other cartilaginous fish have relatively poor hearing sensitivity as compared to other fishes, they were reported to approach irregularly pulsed broadband sounds, which could be indicative for the presence of struggling prey (Myrberg 2001). Surface-feeding fish can localize prey accurately by listening to the surface waves produced when prey fall into the water (Hoin-Radkovsky *et al.* 1984). Peacock cichlids (Aulonocara) are even able to sense the sound of prey submerged in the sediment (Konings 2001). In other species, broad hearing bandwidths have been correlated with predator avoidance. Herring species (Clupeidae) of the genus *Alosa* are capable of detecting ultrasound (up to 180 kHz), which could allow detection and avoidance of echo-locating whales (Popper at al. 2004; Doksæter *et al.* 2009). While data are lacking in fish, it has been suggested that anthropogenic masking effects on predator-prey relationships could be widespread (Slabbekoorn *et al.* 2010).

Slabbekoorn *et al.* (2010) note that sound is important to fish and that a rise in artificial noise levels underwater may have negative consequences for individuals as well as populations. They also note that sonar, piling and explosions typically attract the most attention. It is reasonable to argue that the greater impact on fish will be from less intense sounds that are of longer duration and that can potentially affect whole ecosystems.

Plankton

Planktonic species and life stages of fish and invertebrates in the immediate vicinity of seismic air sleeves are probably the most vulnerable to seismic activities simply because they cannot move away. Several studies have concluded that direct physical damage of eggs and larvae is caused by air sleeve levels exceeding 220 dB re 1 µPa (see Table 7.6). From existing evidence, physical damage is therefore restricted to within a few metres of the air sleeve (Gausland 1992). Studies on the effects of seismic exposure on fish eggs and larvae (*i.e.*, Kostyuchenko 1973; Dalen and Knutsen 1987; Holliday *et al.* 1987; Matishov 1992; Booman *et al.* 1996; Dalen *et al.* 1996, in Dalen *et al.* 2007) have found that effects appeared to be minimal and any mortality effect was generally not significantly different from experimental controls. Generally, any observed larval mortality occurred after exposures within 0.5 to 3 m of the air sleeve source. For example, some retinal tissue damage was observed in cod larvae exposed at 1 m from an air sleeve source (Matishov 1992). One study concluded potential pathological effects on eggs and larvae at 5 m from the source (Kostyuchenko 1973). Application of a “worst-case scenario” mathematical model to investigate the effects of seismic energy on fish eggs and larvae, concluded that mortality rates caused by exposure to seismic are so low compared to natural mortality, the impact of seismic activity on recruitment to a fish stock would be insignificant (Saetre and Ona 1996).

Table 7.6 Observations from Exposures of Marine Plankton Life Stages to Air Sleeves at Close Range

Organism	Life Stage	Exposure Distance from Air Sleeve (m)	Estimated Exposure Level (dB re 1 µ pA)	Observed Response	Reference
Pollock	Egg	0.75	242	Some delayed mortality	Booman *et al.* 1996
Cod	Larvae	5	220	Immediate mortality	Booman *et al.* 1996
	Fry	1.3	234	Immediate mortality	
	5-day-old larvae	1	250	Delamination of retina	Matishov 1992
	Eggs	1 to 10	202 to 220	No signs of injury	Dalen and Knutsen 1987
Plaice (*Pleuronectes platessa*)	Eggs & larvae	1	220	High mortality (unspecified)	Kosheleva 1992
		2	214	No effect	
Anchovy (*Engraulis mordax*)	Eggs	unknown	223	8.2% mortality	Holiday *et al.* in Turnpenny and Nedwell 1994
	2-day-old larvae	3	238	Swimbladder rupture	
Red Mullet (*Mullus surmuletus*)	Eggs	1	230	7.8% of eggs injured	Kostyuchenko 1973
		10	210	No injuries	
Fish (various spp.)	Eggs	0.5	236	17% dead in 24 hr	Kostyuchenko 1973
		10	210	2.1% dead in 24 hr	
Dungeness Crab (*Cancer magister*)	Larvae	1	231	No observed effect on time to molt or long-term survival	Pearson *et al.* 1994

Shellfish

No physical structures have been discovered in aquatic invertebrates that are stimulated by the pressure component of sound. However, vibrations (*i.e.*, mechanical disturbances of the water) are also characteristic of sound waves. Rather than being pressure sensitive, aquatic invertebrates appear to be most sensitive to the vibrational component of sound (Breithaupt 2002). Statocyst organs may provide one means of vibration detection for aquatic invertebrates.

A limited number of studies have been conducted on the sensitivity of certain invertebrate species to underwater sound. Available data suggest that they are capable of detecting vibrations. Many invertebrates are capable of producing sound, including barnacles, amphipods, shrimp, crabs, and lobsters (Au and Banks 1998; Tolstoganova 2002). Invertebrates typically produce sound by scraping or rubbing various parts of their bodies, although they also produce sound in other ways. Examples of these sound-producing capabilities include lobsters vibrating their antennae, crabs stridulating, crayfish squeaking their abdomens, and shrimp creating rumbling noise using muscles in their abdomen (Patek *et al.* 2009). Sounds made by marine invertebrates may be associated with territorial behaviour, mating, courtship, and aggression.

The acoustic detection capabilities in decapod crustaceans is the best understood and studied of the invertebrate group. Crustaceans appear to be most sensitive to sounds of low frequencies (*i.e.*, <3,000 Hz) (Budelmann 1992; Popper *et al.* 2001). A study by Lovell *et al.* (2005) suggests greater sensitivity of the prawn (*Palaemon serratus)* to low-frequency sound than previously thought. Lovell *et al.* (2006) showed that *Palaemon serratus* is capable of detecting a 500 Hz tone regardless of the prawn's body size and the related number and size of statocyst hair cells. Studies of American lobsters suggest that these crustaceans are more sensitive to higher frequency sounds than previously realized (Pye and Watson III 2004).

There are a limited number of studies assessing the potential for effects on invertebrates from exposure to seismic sound. A pilot study on snow crab (*Chionoecetes opilio*) under controlled field experimental conditions on captive adult male snow crab, egg-carrying female snow crabs, and fertilized snow crab eggs exposed to variable sound pressure levels (191 to 221 dB re 1 μPa) and sound energy levels (<130 to 187 dB re 1 μPa^2 Hz) was conducted (Christian *et al.* 2003, 2004). Neither acute nor chronic (12 weeks post-exposure) mortality was observed for the adult crabs. However, a significant difference in development rate was noted between the exposed and unexposed fertilized eggs / embryos. The egg mass exposed to seismic energy had a higher proportion of less-developed eggs than did the unexposed mass. It should be noted that both egg masses came from a single female and as such there is no measure of natural variability associated with this study (Christian *et al.* 2003, 2004). Stress indicators in the haemolymph of adult male snow crabs were monitored immediately after exposure of the animals to seismic survey sound (Christian *et al.* 2003, 2004) and at various intervals after exposure. No significant acute or chronic differences were found between exposed and unexposed animals in which various stress indicators (*e.g.*, proteins, enzymes, cell type count) were measured.

Benthic macroinvertebrates are less likely to be impacted by seismic activity because few invertebrates have gas-filled spaces and benthic species are usually more than 20 m away from the seismic source. The resilience of various macroinvertebrates has been tested by exposing them at a short distance to an active air sleeve (Table 7.7). The rate of injury experienced by macroinvertebrates due to the passage of a seismic survey should be less than indicated for planktonic organisms and fish. Lobsters are similar to crab in that they are thought to be resilient to seismic activity because decapods lack the gas-filled voids that would make them sensitive to changes in pressure (Payne *et al.* 2007). Mortality and development rates of Stage II Dungeness crab larvae exposed to single discharges from a seismic array were compared with those of unexposed larvae. No statistically significant differences between the exposed and unexposed larvae were observed with respect to immediate and long-term survival and time to molt, even for those exposed larvae within 1 m of the seismic source (Pearson *et al.* 1994).

Table 7.7 Observation from Exposures of Marine Macroinvertebrates to Air Sleeves at Close Range

Organism	Exposure Distance from Air Sleeve (m)	Estimated Exposure Level (dB re 1 µ Pa)	Observed Response	Reference
Iceland scallop (*Acequipecten irradians*)	2	217	Shell split in 1 of 3 tested	Matishov 1992
Sea urchin (*Strongylocentrotus droebachiensis*)	2	217	15% of spines fell off	Matishov 1992
Mussel (*Mytilus edulis*)	0.5	229	No detectable effect within 30 days	Kosheleva 1992
Periwinkle (*Littorina* spp.)	0.5	229	No detectable effect within 30 days	Kosheleva 1992
Amphipod (*Gammarus locusta*)	0.5	229	No detectable effect within 30 days	Kosheleva1992
Brown shrimp (*Cragnon cragnon*)	1	190	No mortality	Webb and Kempf 1998

A collaborative study was conducted in the southern Gulf to investigate the effects of exposure to sound from a commercial seismic survey on egg-bearing female snow crab (DFO 2004d). This study had design problems that impacted interpretation of some of the results (Chadwick 2004). Caged animals were placed on the ocean bottom at a location within the survey area and at a location outside of the survey area. The maximum received sound pressure level was approximately 195 dB re 1 µPa0-p. The crab were exposed for 132 hours of the survey, equivalent to thousands of seismic shots of varying received sound pressure level. The animals were retrieved and transferred to laboratories for analyses. Neither acute nor chronic lethal or sub-lethal injury to the female crab or crab embryos was indicated. DFO (2004d) reported that some exposed individuals had short-term soiling of gills, antennules and statocysts, bruising of the hepatopancreas and ovary, and detached outer membranes of oocytes.

Payne *et al.* (2007) conducted a pilot study on the effects of seismic sound on lobster (*Homarus americanus*) assessing several physiological endpoints in animals exposed to a “low level” exposure of approximately 202 dB peak-to-peak and a “high level” exposure of approximately 227 dB peak-to-peak. The endpoints included lobster survival, food consumption, turnover rate, serum protein, serum enzymes, and serum calcium. A limited histopathological study was also conducted on lobsters from one of the five trials. Observations were conducted over a period of a few days to several months.

Exposure of lobster to high and low seismic sound levels had no effect on delayed mortality or damage to mechano-sensory systems associated with animal equilibrium and posture, as assessed by turnover rates (Payne *et al.* 2007). There was no evidence for loss of legs or other appendages. Sub-lethal effects were observed with respect to feeding and serum biochemistry with effects sometimes being observed weeks to months after exposure. A histochemical change was also noted in the hepatopancreata of animals previously exposed to seismic sound (four months prior), which may be linked to organ "stress". While these initial studies were exploratory in nature, the scientists indicate the need for comprehensive studies regarding the potential for seismic surveys to affect lobster (Payne *et al.* 2007).

Price (2007) found that blue mussels (*Mytilus edulis*) responded to a 10 kHz pure tone continuous signal by decreasing respiration. Smaller mussels did not appear to react until exposed for 30 minutes, whereas larger mussels responded after 10 minutes of exposure. The oxygen uptake rate tended to be reduced to a greater degree in the larger mussels than in the smaller animals.

Marine Birds

Birds have good hearing abilities in air (Fay 1988), but information on their underwater hearing is unknown and is generally lacking. Investigations into the effects of airguns and other sounds associated with offshore oil and gas activities on seabirds are extremely limited. The lack of data regarding seabirds and seismic activity (as well as sounds associated with other offshore oil and gas activities) may be a reflection of the fact that there is little evidence that problems occur (Davis *et al.* 1998) or maybe as a result of the paucity of data. As such, it is acknowledged that dedicated studies are required to elucidate potential effects and generate relevant data. Corridor is committed to conducting pelagic marine bird monitoring with Environment Canada-Canadian Wildlife protocols during the drilling program.

The sound created by seismic air source arrays is focused downward below the surface of the water and sound levels at and immediately below the surface are likely greatly reduced compared to levels deeper in the water (LGL 2002). Above the water, the sound is muffled and should have little or no effect on birds that have their heads above water or are in flight. It is possible that birds on the water at close range would be startled by the sound. However, the presence of the ships and other related oil and gas platforms should have already warned the bird of unnatural visual and auditory stimuli (LGL 2005b).

Observations made during a seismic program in the Davis Strait area showed no evidence of mortality or distributional effects on marine birds (Stemp 1985). Parsons (in Stemp 1985) reported that shearwaters with their heads under water were observed within 30 m of seismic sources (explosives) and did not respond. Similarly, trained observers reported no ill effects on guillemot, fulmar and kittiwake species that were monitored during air source seismic surveys in the North Sea (Turnpenny and Nedwell 1994). Evans *et al.* (1993) noted that there was no evidence to suggest that seabirds were either attracted to or repelled by seismic testing in the Irish Sea.

Most species of marine birds that are expected to regularly occur in the Study Area feed at less than 1 m from the surface of the ocean and this would include members of Procellariidae, Hydrobatidae, Phalaropodinae and Laridae. The only group of marine birds that spends considerable time submerged underwater is the Alcidae (Dovekie, Common Murre, Thick-billed Murre, Razorbill, Black Guillemot and Atlantic Puffin). Alcids secure food by diving under the water and propelling their bodies rapidly through the water with their wings. All are capable of reaching considerable depths and spending prolonged periods of time submerged (Gaston and Jones 1998). Murres regularly dive to a maximum depth of 100 m and have been recorded underwater for up to 202 seconds (Gaston and Jones 1998). The effects of seismic sounds on Alcidae are unknown but sounds are probably not important to Alcidae in securing food. However, all six species are quite vocal at breeding sites, indicating auditory capabilities are important in that part of the life cycle of Alcidae.

A study of the effects of seismic surveys on moulting long-tailed ducks in the Beaufort Sea found no effects on movement or diving behaviour, although the authors cautioned that they had limited ability to detect subtle disturbance effects (Lacroix *et al.* 2003). Northern Gannet plunge dive to a depth of 10 m, but animals remain submerged for only a few seconds in total, so would have minimal chance to receive underwater sound.

Marine Mammals

Marine mammals rely heavily on the use of underwater sounds to communicate and to gain information about their surroundings. Studies also show that marine mammals hear and react to many anthropogenic sounds, including sounds made during seismic exploration (Richardson *et al.* 1995; Gordon *et al.* 2004; Nowacek *et al.* 2007; Tyack 2008). Marine mammals are highly dependent on sound for communicating, detecting predators, locating prey and in toothed whales, echolocation.

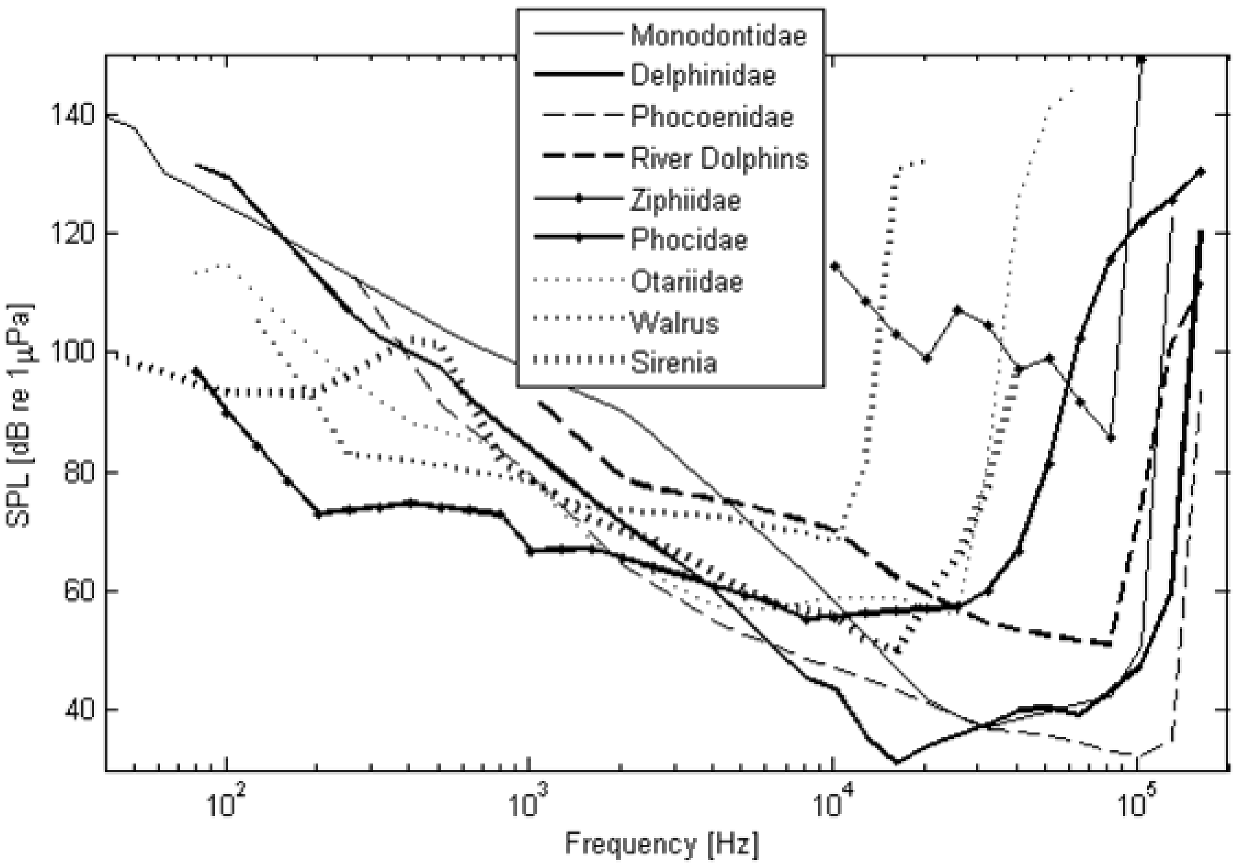
The hearing abilities for some toothed whales have been studied in detail (Richardson *et al.* 1995; Au *et al.* 2000), with the hearing sensitivity for several species having been determined as a function of frequency. The small to moderate-sized toothed whales hearing that have been studied showed relatively poor hearing sensitivity at frequencies below 1 kHz and extremely good sensitivity at, and above, several kHz.

There are very few data on the absolute hearing thresholds of most of the larger, deep-diving toothed whales, such as the sperm and beaked whales. Cook *et al.* (2006) found that a stranded juvenile Gervais' beaked whale showed evoked potentials from 5 kHz up to 80 kHz (the entire frequency range that was tested), with best sensitivity at 40 to 80 kHz. An adult Gervais' beaked whale had a similar upper cutoff frequency of 80 to 90 kHz (Finneran *et al.* 2009).

Most of the toothed whale species have been classified as belonging to the "mid-frequency" hearing group, and the mid-frequency odontocetes (collectively) have functional hearing from about 150 Hz to 160 kHz (Southall *et al.* 2007). The porpoises, river dolphins, and members of the genera Cephalorhynchus and Kogia of the toothed whales are classified as "high frequency" hearing group with functional hearing from about 200 Hz to 180 kHz (Southall *et al.* 2007).

Sound levels decrease with range due to propagation losses. Audibility is limited by the sound dropping either below the animal's hearing curve (audiogram) or below ambient noise levels. An audiogram is a graph showing hearing thresholds of pure tones as a function of frequency. Audiograms have been measured from only approximately 20 marine mammal species and from only a few individuals. Audiogram variability on an individual (let alone species or genus) level is barely understood. The reported threshold is a statistical quantity (*i.e.*, depending on the method used, the level at which the tone was heard 50 percent of the time).

Marine mammal audiograms, grouped into families, are shown in Figure 7.8. Published audiograms were assembled and interpolated for the centre frequencies of 1/3 octave bands between 40 Hz and 200 kHz. Within each family, the lowest threshold of all species and individuals was plotted at each frequency. The computation of 1/3 octave band levels (commonly used for marine mammal impact assessment) provide a convenient way of averaging individual audiograms and smoothing audiograms for different species (Figure 7.8).



Note: Shows the minimum thresholds over all species belonging to the same family.
Source: Au and Hastings 2008

Figure 7.8 Underwater Audiograms of Marine Mammals

There are no direct measurements of underwater audiograms of sea otters, sperm whales and baleen whales. It is expected that their frequencies of best sensitivity overlap to some degree with the frequencies of their calls. Other indicators for what these animals can hear come from controlled exposure experiments looking for responses of animals to sound. Anatomical studies of baleen ears have suggested good hearing sensitivity between 10 Hz and 30 kHz (Ketten 2000). Although the hearing abilities of baleen whales (mysticetes) have not been studied directly, behavioural and anatomical evidence indicates that they may hear well at frequencies below 1 kHz (Richardson *et al.* 1995; Ketten 2000). It has been noted that some baleen whales react to pinger sounds up to 28 kHz, but not to pingers or sonars emitting sounds at 36 kHz or above (Watkins 1986). Baleen whales have been observed to produce sounds at frequencies up to 8 kHz and, for humpbacks, with components to >24 kHz (Au *et al.* 2006). Frankel (2005) noted that gray whales reacted to a 21 to 25 kHz whale-finding sonar.

The anatomy of the baleen whale inner ear indicates that it may be well adapted for detection of low-frequency sounds (Ketten 1991, 1992, 1994, 2000; Parks *et al.* 2007). However, humpbacks and minke whales (Berta *et al.* 2009) may have some auditory sensitivity to frequencies above 22 kHz. Baleen whales as a group have a functional hearing range that is thought to be about 7 Hz to 22 kHz and are considered to be represent “low-frequency” hearing group (Southall *et al.* 2007). The absolute sound levels that they can detect below 1 kHz are probably limited by increasing levels of natural ambient sound at decreasing frequencies (Clark and Ellison 2004). Ambient sound levels are higher at low frequencies than at mid frequencies. At frequencies below 1 kHz, natural ambient levels tend to increase with decreasing frequency.

The hearing systems of baleen whales are thought to be more sensitive to low-frequency sounds than are the ears of the small toothed whales that have been studied directly. Therefore, baleen whales are likely to hear seismic air source pulses farther away than small toothed whales and, at closer distances, air source sounds may seem more prominent to baleen than to toothed whales. However, baleen whales have commonly been seen well within the distances where seismic (or other source) sounds would be detectable and often show no overt reaction to those sounds.

The functional hearing range for pinnipeds in water is considered to extend from 75 Hz to 75 kHz (Southall *et al.* 2007), although some species, in particular the eared seals, do not have as broad an auditory range (Richardson *et al.* 1995). In comparison with toothed whales, pinnipeds tend to have lower best frequencies, lower high-frequency cutoffs, better auditory sensitivity at low frequencies, and poorer sensitivity at the best frequency.

Some of the phocid seals have better sensitivity at low frequencies (≤1 kHz) than do toothed whales. Below 30 to 50 kHz, the hearing thresholds of most pinniped species tested are essentially flat down to approximately1 kHz, and range between 60 and 85 dB re 1 μPa. Measurements for harbour seals indicate that, below 1 kHz, their thresholds under quiet background conditions deteriorate gradually with decreasing frequency to approximately 75 dB re 1 μPa at 125 Hz (Kastelein *et al.* 2009). For the eared seals, the high frequency cutoff is lower than for phocinids, and sensitivity at low frequencies (*e.g.*, 100 Hz) is poorer than for harbour seals.

Underwater ambient or anthropomorphic sounds may prevent an animal from detecting another sound through a process known as masking. Masking is the obscuring of sounds of interest by interfering sounds, generally at similar frequencies (Richardson *et al.* 1995). Introduced underwater sound will, through masking, reduce the effective communication distance of a marine mammal species if the frequency of the source is close to that used as a signal by the marine mammal, and if the anthropogenic sound is present for a significant fraction of the time (Richardson *et al.* 1995). Masking can occur as a result of either natural sounds (*e.g.*, periods of strong winds or heavy rainfall) or anthropogenic sounds (*e.g.*, ship propeller sound). The sea is a naturally noisy environment and even in the absence of anthropogenic sounds, this natural sound can “drown out” or mask weak signals from distant sources. Signals that might be masked include social sounds, communication sounds, predator sounds, prey sounds, echolocation sounds and environmental sounds (*e.g.*, the sound of surf) that animals might listen to for navigation. If little or no overlap occurs between the introduced sound and the frequencies used by the species, communication is not expected to be disrupted.

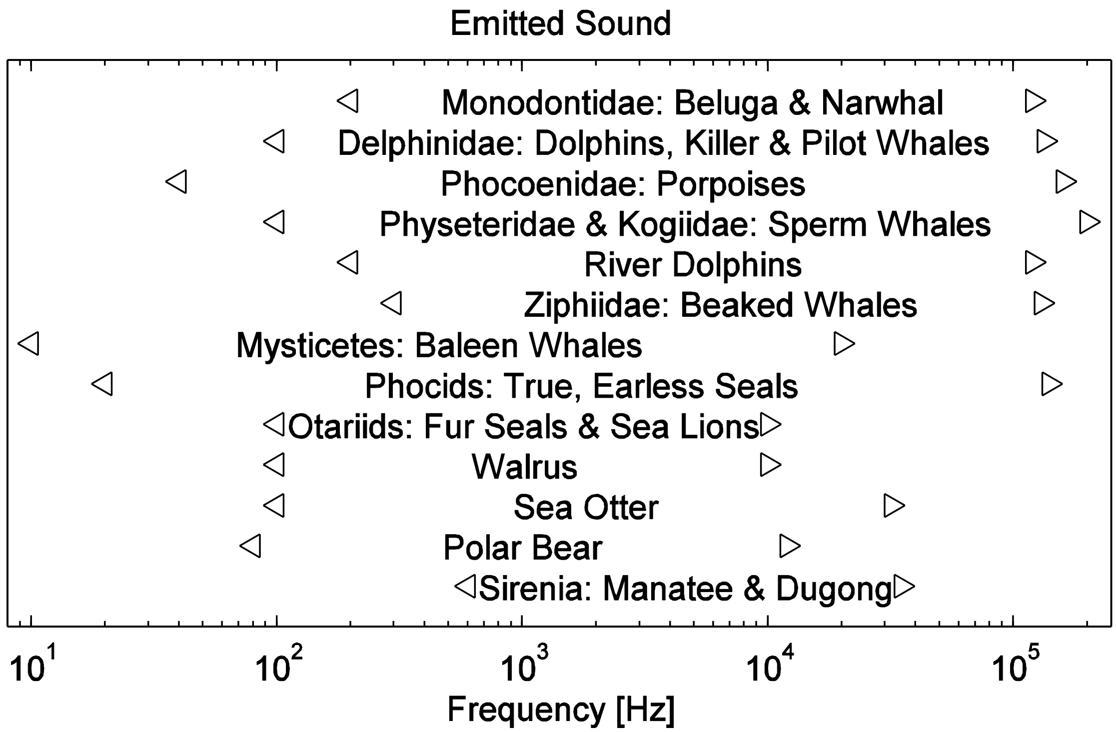
All marine mammals emit sound that is produced internally. Other sounds, that may also take a social or communicative role, are generated when an animal strikes an object or the water surface. Toothed whales (*e.g.*, dolphins, pilot whale, and sperm whale) sounds are generated within the nasal system, not the larynx. They can be classified into three categories: tonal whistles, burst-pulse sounds and echolocation clicks. Whistles and burst-pulse sounds have a social function. Some toothed whales do not whistle (*e.g.*, Phocoenidae, *Cephalorhynchus* sp., *Kogia* sp., *Physeter macrocephalus*). Whistles have a fundamental frequency below 20 to 30 kHz plus higher harmonics. Whistles may be categorized according to the shape of the fundamental frequency with time: constant frequency, upsweep, downsweep, concave (hill), convex (valley), sinusoidal. Burst-pulse sounds are a series of broadband pulses with substantial ultrasonic energy. Echolocation clicks are broadband and mostly in the ultrasonic range. Burst-pulse sounds have lower source levels and lower interclick intervals than echolocation click trains. Both have highly directional beam-patterns.

Toothed whales (*e.g.*, dolphins, pilot whale, and sperm whale) communicate using two types of sounds: 1) continuous, narrowband, frequency-modulated signals which range in duration from several tenths of a second to several seconds and range in frequency from approximately 2 to 25 kHz (Tyack and Clark 2000); and 2) broadband click trains with peak frequencies that vary from tens of kilohertz to well over 100 kHz (Norris and Evans 1966; Au 1980). Click trains contain few to hundreds of clicks and are used for communication, navigation and object detection and discrimination (Au 1993). The low frequency spectrum of industrial sound generally will not overlap with the high frequency echolocation of toothed whales. The side-scan sonar emits pulses of sound in narrow beams at 105 and 390 kHz. The echo-sounder emits pulses at 24, 200 and 240 kHz. The 105 kHz pulse from the side-scan sonar and the 24 kHz pulse from the echo-sounder are likely audible to toothed whales, but significant masking of communication signals is improbable due to the fact that the pulses are short and have narrow band widths.

The sound production mechanism of baleen whale (*e.g.*, minke, humpback and fin whales) sounds is unclear. Sounds can be classified into calls and songs. Calls have been categorized further into simple calls (low frequency <1 kHz, narrow band, frequency and amplitude modulated), complex calls (broadband, 500 to 5,000 Hz, frequency and amplitude modulated), grunts and knocks (<0.1 s duration, 100 to 1,000 Hz), and clicks and pulses (short duration <2 milliseconds, 3 to 30 kHz) (Clark 1990). Songs have been recorded from humpback, bowhead, blue and fin whales. Humpback song can be broken down into themes, which consist of repetitions of phrases, which are made up of patterns of units (with energy up to 30 kHz). Baleen whales communicate using low frequency sounds (generally between 10 Hz and 4 kHz (Richardson *et al.* 1995; Erbe 2002)) that can propagate for long distances. These sounds range in duration from 50 msec thumps produced by minke whales (Winn and Perkins 1976; Thompson *et al.* 1979) to moans produced by blue whales, which can have durations up to 36 sec (Cummings and Thompson 1971).

Pinniped sounds occur in air and underwater, and are often described as grunts, snorts, buzzes, barks, yelps, roars, groans, creaks, growls, whinnies, clicks (Richardson *et al.* 1995; Au and Hastings 2008).

The frequency bands of sounds emitted by marine mammals (including echolocation) are illustrated in Figure 7.9.



Source: Au and Hastings 2008

Figure 7.9 Frequency Bands of Marine Mammal Sounds

Marine animals themselves also contribute to the level of natural ambient noise. The calls of a blue whale have been recorded for 600 km (Stafford *et al.* 1998). A sperm whale call can be as loud as 232 dB re 1µPa at 1 m (rms) (Møhl *et al.* 2003) and a species of shrimp has been recorded at 185 to 188 dB re 1µPa at 1 m (Au and Banks 1998). In areas where natural background noise is relatively high, such as near a shelf break or high surf, anthropogenic noise itself can be masked and reduce the area in which it is detectable. The anthropogenic noise is undetectable for marine mammals once it falls below ambient noise level or the hearing threshold of the animal. Given this, and the fact that mammal response will vary by species and between individuals, the zone of potential influence of noise on marine mammals is highly variable.

Marine mammals have evolved in an environment that contains a variety of natural sounds and as such, some degree of masking occurs; thus, marine mammals have evolved systems and behaviour to reduce the impacts of masking (NRC 2003). Since little is known about the importance of how a temporary interruption in sound detection affects mammals (Richardson *et al.* 1995), it is very difficult to assess the environmental effect. In general, the environmental effect of both natural and anthropogenic noise is less severe when it is intermittent than continuous (NRC 2003). The level of masking may be significantly reduced if the anthropogenic noise originates from a different direction than the mammal vocalization (NRC 2003). While marine mammals may adapt behaviour changes to reduce masking, the physiological costs associated with the behavioural changes cannot be estimated at this time (NRC 2003).

Acoustic energy in the sound pulses produced by seismic air sources and sub-bottom profilers overlaps with frequencies used by baleen whales, but the discontinuous, short duration nature of these pulses is expected to result in limited masking of baleen whale calls at short distances. Periods of silence between intermittent pulses are reduced as one moves away from the source by the reflection of sound, which increases the potential for masking. Several studes have shown that the propagation effects by multipath have the effect of producing multiple replicas of the pulses, thus increasing the risk of masking over long distances (Madsen *et al.* 2006). Side-scan sonar and echosounder signals do not overlap with the predominant frequencies of baleen whale calls, which limits significant masking. Several species of baleen whales have been observed to continue calling in the presence of seismic pulses, including bowhead whales (Richardson *et al.* 1986), blue whales and fin whales (McDonald *et al.* 1995). This, however, does not imply a lack of masking, since animals may not be able to be heard by other animals in the vicinity during seismic activities.

The low frequency spectrum of industrial noise will not overlap with the high frequency echolocation of belugas, dolphins, or pilot whales, for example. Because seismic and sub-bottom profiler pulses are intermittent and predominantly low frequency, masking effects are expected to be negligible for toothed whales. However, while Madsen *et al.* (2002) reported that sperm whales off northern Norway continued calling in the presence of seismic pulses, Bowles *et al.* (1994) reported that sperm whales ceased calling when exposed to pulses from a distant seismic ship. Some pulses emitted by side-scan sonars and echo-sounders are likely audible to toothed whales, but significant masking of communication signals is improbable, at least in proximity to the sound sources, due to the fact that the pulses are short and have narrow beam widths.

Anthropogenic sounds have the potential to disturb behaviour and/or interfere with important functions (Richardson *et al.* 1995; NRC 2003). The zone of behavioural response is mostly going to be smaller than the zone of audibility. Richardson *et al.* (1995) reported that marine mammals tend not to respond overtly to barely audible man-made sounds. Indicators of “disturbance” include changes in swim direction, swim speed, dive duration, surfacing duration, respiration (blow rate), movement towards or away from the noise, changes in acoustic behaviour. Marine mammals are generally more tolerant of stationary sources of noise than moving sources. This seems especially true for seals which will approach a stationary vessel or fixed platform (LGL *et al.* 2000). Dolphins and other toothed whale species have also reportedly approached offshore drilling platforms (Richardson *et al.* 1995).

Available detailed data on reactions of marine mammals to seismic sounds (as well as other anthropogenic sounds including those associated with exploratory drilling) are limited to a few species and limited documented situations (Richardson *et al.* 1995; Gordon *et al.* 2004; Nowacek *et al.* 2007; Southall *et al.* 2007). Behavioural reactions of marine mammals to sound are difficult to predict in the absence of site- and context-specific data. Reactions to sound would depend on species, state of maturity, experience, current activity, reproductive state, time of day, as well as other factors (Richardson *et al.* 1995; Wartzok *et al.* 2004; Southall *et al.* 2007; Weilgart 2007). The data and studies summarized below present a flavour for the type of reactions to sound exhibited by marine mammals. As indicated earlier, the majority of current scientific information on the effects of sound on marine mammals is based on seismic sound, which has been the primary focus of research studies. For an exploration drilling program, seismic-based activities would likely produce the largest sound source. Other sound sources would produce lower levels of sound than seismic sources and as such marine mammals may exhibit similar responses but within a potentially smaller zone of influence.

Behavioural responses of marine mammals to noise are highly variable and dependent on a suite of internal and external factors (NRC 2003). Internal factors include:

- individual hearing sensitivity, activity pattern and motivational and behavioural state at time of exposure;
- past exposure of the animal to the noise, which may have led to habituation or sensitization;
- individual noise tolerance; and
- demographic factors such as age, sex and presence of dependent offspring.

External factors include:

- non-acoustic characteristics of the sound source, such as whether it is stationary or moving;
- environmental factors that influence sound transmission;
- habitat characteristics, such as being in a confined location; and
- location, such as proximity to a shoreline.

Behavioural responses by marine mammals such as moving a short distance in reaction to sound is unlikely to result in significant impacts to the individual, let alone the stock or population. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on individuals and populations could be significant (*e.g.*, Lusseau and Bejder 2007; Weilgart 2007). It has been noted in some studies that some marine mammals that have shown no obvious avoidance or behavioural changes may still be adversely affected by noise (Brodie 1981; Richardson *et al.* 1995: Romano *et al.* 2004; Weilgart 2007; Wright *et al.* 2009). Some research suggests that animals in poor condition or in an already stressed state may not react as strongly to human disturbance as would more robust animals (*e.g.*, Beale and Monaghan 2004).

Baleen whales generally tend to avoid intense sound sources with the avoidance zone being variable among species, locations, whale activities and oceanographic conditions affecting sound propagation (Richardson *et al.* 1995; Gordon *et al.* 2004). Baleen whales, like the fin and blue whales, exposed to strong sound pulses from seismic sources have been observed to react by deviating from their normal migration route and/or interrupting their feeding and moving away (Malme *et al.* 1984, 1985, 1988; Richardson *et al.* 1986, 1995, 1999; Ljungblad *et al.* 1988; Richardson and Malme 1993; McCauley *et al.* 1998, 2000a, 2000b; Miller *et al.* 2005; Gordon *et al.* 2004; Moulton and Miller 2005; Stone and Tasker 2006; Johnson *et al.* 2007;

Nowacek *et al.* 2007; Weir 2008). Reactions of baleen whales to vessels have been studied directly for species such as gray whales, humpback whales, and bowhead whales. Reactions have been found to vary from approach to avoidance. In general, baleen whales tend to change their behaviour in response to strong or rapidly changing vessel noise (Watkins 1986; Beach and Weinrich 1989). Behavioural changes include course changes, changes in surfacing and respiration patterns, and displays such as breaching, flipper slapping, and tail slapping (Wyrick 1954; Edds and Macfarlane 1987; Stone *et al.* 1992).

Limited information is available with respect to reactions of toothed whales to sound pulses. There are relatively few studies similar to the more extensive baleen studies that have been previously summarized. The sounds produced by seismic air sources are in the frequency range of low hearing sensitivity for toothed whales. However, they are high intensity sounds and their received levels can sometimes remain above the hearing thresholds of toothed whales for distances out to several tens of kilometres (Richardson and Würsig 1997). Based on the literature reviewed in Richardson *et al.* (1995), it is apparent that most small and medium-sized toothed whales (harbour porpoise) exposed to prolonged or repeated underwater sounds are unlikely to be displaced unless the overall received level is at least 140 dB re 1 µPa. There have been dolphins observed to be attracted to the seismic vessel and related gear, with some riding the bow wave of the seismic vessel even when a large air source array was firing (Moulton and Miller 2005). However, small toothed whales do tend to move away, or to maintain a somewhat greater distance from the vessel, when a large air source array is operating than when it is silent (Stone 2003; Moulton and Miller 2005; Holst *et al.* 2006; Stone and Tasker 2006; Weir 2008; Richardson *et al.* 2009). The avoidance zone appears to be small, on the order of 1 km or less, with some individuals showing no apparent avoidance. Responses of toothed whales to vessels vary within and among species and range from avoidance to approach and bowriding (Baird and Stacey 1991a, 1991b; Stacey and Baird 1991; Mullin *et al.* 1994a, 1994b).

Very little information exists on the reactions of pinnipeds to sounds from seismic exploration in open water (Richardson *et al.* 1995). Visual monitoring from seismic vessels has shown that pinnipeds frequently do not avoid the area within a few hundred metres of an operating air source array (Harris *et al.* 2001). However, the telemetry research of Thompson *et al.* (1998) suggests that reactions may be stronger than has been evident from visual studies. Based on anecdotal evidence, pinnipeds appear to show little reaction to vessels in open water (Richardson *et al.* 1995). However, there are few studies that describe the responses of pinnipeds in the water to vessel traffic.

Moulton and Holst (2010) summarized marine mammals monitoring results from eight seismic programs off eastern Canada during 2003 to 2008. Marine mammal observations were recorded for 9,180 hours from seismic vessels. During these seismic surveys, it was found that mysticetes exhibited localized avoidance of the active air source array. Sighting rates were significantly lower during operations with the full air source array compared with non-seismic periods and these reduced sighting rates suggest that some baleen whales avoided the source vessel by several kilometres. Mysticetes were also observed significantly further from the source vessel during seismic as compared to non-seismic periods. On average, it was found that baleen whales were observed approximately 200 m further from the vessel during seismic operations. Mysticetes were also noted to swim away from the vessel more often during seismic compared with non-seismic periods. Delphinids were initially detected significantly farther away during air source activity (by approximately 200 m) compared with non-seismic periods, but there was no significant difference between sighting rates. For large toothed whales such as sperm whales and beaked whales the sighting rates and distances were similar during periods when seismic sources were active versus silent.

Behavioural responses by baleen whales to seismic pulses have been documented; however, the received level of pulsed sounds necessary to elicit these reactions are typically well above the minimum detectable levels (Richardson *et al.* 1986, 1995, 1999). In addition, baleen whales have often been seen well within distances where seismic sounds would be audible and yet show no obvious reaction to those sounds (LGL 2005b). Little is known about the significance of how a temporary interruption in sound detection affects mammals (Richardson *et al.* 1995). In general though, the impact of both natural and man-made noise is less severe when it is intermittent rather than continuous (NRC 2003).

Little is known about the potential for the sounds produced during geohazard surveys to cause auditory threshold shifts or other effects in marine mammals. Data suggests that if these effects do occur, they would only occur in close proximity to the sound sources. Thus, species that show behavioural avoidance of noise, including most baleen whales, some toothed whales and some pinnipeds, would not likely experience threshold shifts or other physical effects (LGL 2005b).

Sea Turtles

Very little is known about the importance of hearing to sea turtles. It has been suggested that sound may play a role in navigation, but recent studies suggest that visual, wave and magnetic cues are the main navigational cues used by hatchling and juvenile sea turtles (Lohmann and Lohmann 1998; Lohmann *et al.* 2001). Sea turtles are likely to avoid underwater sound (McCauley *et al.* 2000a, 2000b). Avoidance may reduce the risk of potential physiological effects of sound exposure. Sea turtles are not believed to use hearing for prey detection or navigation; therefore, masking is unlikely to be an important issue for sea turtles.

The limited available information indicates that turtles hear at low frequency (100 to 500 Hz (Office of Naval Research website 2002); 100 to 700 Hz (Environment Australia 2003)) range and are therefore more like seals than other marine mammals. Sea turtle auditory perception occurs through a combination of bone and water conduction rather than air conduction (Lenhardt 1982; Lenhardt and Harkins 1983). Detailed descriptions of sea turtle ear anatomy are found in Ridgway *et al.* (1969), Lenhardt *et al.* (1985), and Bartol and Musick (2003). The ear arrangement of sea turtles comprise fat deposits and bone that enables sea turtles to hear low-frequency sounds while underwater and makes them relatively insensitive to sound above water. Sound vibrations can also be conducted through the bones of the carapace to reach the middle ear. The limited available data indicate that the frequency range of hearing sensitivity of sea turtles extends from approximately 200 to 700 Hz. Sensitivity deteriorates as one moves away from this range to either lower or higher frequencies.

O'Hara and Wilcox (1990) tested the reactions to airguns by loggerhead sea turtles held in a 300 × 45 m area of a canal in Florida with a bottom depth of 10 m. The sound source consisted of one 10 inch air source plus two 0.8 inch “poppers” operating at 2,000 psi and an air source depth of 2 m for prolonged periods of 20 to 36 hours. The turtles maintained a standoff range of approximately 30 m when exposed to seismic pulses every 15 or 7.5 seconds. Some turtles may have remained on the bottom of the enclosure when exposed to seismic pulses.

Lenhardt (2002) exposed loggerhead turtles while they were near the bottom of holding tanks at a depth of 1 m to tones from 35 to 1000 Hz. The turtles exhibited startle responses (neck contractions) to these tones. The lowest thresholds were in the 400 to 500 Hz range (106 dB sound pressure level re 1 µPa), and thresholds in the 100 to 200 Hz range were approximately 124 dB (Lenhardt 2002). Diving behaviour was exhibited at 30 Hz and 164 dB. Lenhardt (2002) suggested that exposure of sea turtles to seismic sources at water depths >10 m may result in exposure to more energy in the low frequencies with unknown biological effects.

Moein *et al.* (1994) investigated the avoidance behaviour and physiological responses of loggerhead turtles exposed to an operating air source. The turtles were held in a netted enclosure approximately 18 m by 61 m by 3.6 m deep, with an air source of unspecified size at each end. Only one source was operated at any one time; the firing rate was one pulse every five to six seconds. The air source was initially discharged when the turtles were near the center of the enclosure and the subsequent movements of the turtles were documented. The turtles exhibited avoidance during the first presentation of seismic sounds at a mean range of 24 m, but the avoidance response waned quickly, which suggested that the turtles had become habituated to the sound.

Data on sea turtle behaviour during seismic operations have also been collected during marine mammal and sea turtle monitoring and mitigation programs associated with various seismic operations worldwide. Results suggest that some sea turtles exhibit behavioural changes and/or avoidance within an area of unknown size near a seismic vessel. However, avoidance of approaching seismic vessels is sufficiently limited and small-scale such that sea turtles are often seen from operating seismic vessels.

Weir (2007) reported on the behaviour of sea turtles near seismic exploration operations off Angola, West Africa. A total of 240 sea turtles were seen during 676 hours of vessel-based monitoring. Seismic arrays with total volumes of 5085 and 3147 in^3 were used at different times during the seismic program. Sea turtles tended to be seen slightly closer to the seismic source, with the sighting rates twice as high, during non-seismic versus seismic periods (Weir 2007). There was no significant difference in the median distance of turtle sightings from the arrays during non-seismic versus seismic periods, with means of 743 m and 779 m respectively.

Based on experimental studies (primarily) and field observations, sea turtles generally respond to seismic sound (loudest sound anticipated to be associated with an exploratory drilling program) by startling, increasing swimming speed, and/or swimming away from the sound source. The paucity of data precludes clear predictions of sea turtle responses to seismic sound and other sounds related to exploration drilling. Available evidence suggests that localized behavioural and distributional effects on sea turtles are likely during seismic operations, including responses to the seismic vessel, seismic sources, and gear (McCauley 1994; Pendoley 1997; Weir 2007).

Commercial Fisheries

Collins *et al.* (2002) looked at potential effects on fish catches during and after two independent inshore and nearshore seismic surveys undertaken in the Bay St. George and Port au Port areas of western Newfoundland. While not statistically conclusive, their analyses suggested no observable effects on overall fish catches including snow crab, during or in the years following the seismic surveys. This indicates that fish behaviour was not measurably affected. Turnpenny and Nedwell's (1994) general conclusion is that seismic activity has a reduced affect on fish behaviour inshore, in shallow water because attenuation of the sound is more rapid.

Recent studies using a number of methods to estimate fish distribution in open sea fisheries showed a decrease in gadoid abundance during seismic surveys (Løkkeborg and Soldal 1993; Engås *et al.* 1996). The areas apparently affected extended up to 33 km from the survey centre, but the most pronounced reduction in catch occurred within the seismic survey area (Engås *et al.* 1996). Dalen and Raknes (1985, in Engås *et al.* 1996) suggested that cod may swim toward the bottom and remain immobile during disturbance by sound and Løkkeborg and Soldal (1993) have suggested that this change in behaviour could explain increases in catch rates of cod in saithe trawls during seismic activity. Chapman and Hawkins (1969) illustrated how whiting in mid-water schools moved deeper below air sleeves. Pearson *et al.* (1992) showed rock fish catches declined, mainly due to changes in fish depth rather than to dispersal of the shoals.

McCauley *et al.* (2000a, 2000b) reported that many finfish species and squid display an alarm response of increased swimming speed, tightening schools and moving towards the sea floor at levels between 156 to 168 dB re 1m. A level of 156 dB re 1 m can be expected between 3 and 5 km from a 3-D array (2,678 in^3 100 to 120 m of water) and, therefore, it is the distance at which swimming speed may begin to increase. Active avoidance behaviour may begin at distances of 1 to 2 km from a source of this level. In water less than 50 m in depth, the affected area is 0.01 percent of the area affected by seismic activity in deep water (Turnpenny and Nedwell 1994).

Davis *et al.* (1998) summarized that most schools of fish will not show avoidance if they are not in the path of the approaching vessel. Schools that the vessel passes over may show lateral avoidance or compress towards the bottom. Observed responses indicate that the fish schools are quite variable and depend on species, life history stage, current behaviour, time of day, whether the fish have fed and how the sound propagates in a particular setting. Fish moving to the bottom appears to be a common response to seismic activity, especially for demersal or benthic species (see Davis *et al.* 1998). Seismic activity has also been demonstrated to reduce the density of demersal species several kilometres from the source, in up to 250 m of water (Engås *et al.* 1996).

There are studies that have reported an effect of vessel noise on fish flight behaviour in the context of population assessments and catch rates for commercially important fish stocks. Horizontal and vertical movements away from vessels have been reported for Atlantic herring and Atlantic cod (Vabø *et al.* 2002; Handegard *et al.* 2003) presumably in response to ship noise. Another example concerns effects of nearby boating noise on bluefin tuna in large oceanic pens. In the presence of boat noise, tuna schools were less coherent than when the noise was not present and individual fish often swam independently towards the surface or the bottom (Sarà *et al.* 2007). Fish have also been reported to flee from seismic survey areas as inferred from decreased catches.

Studies have shown a startle response to received sounds as low as 160 dB, but this level sound did not appear to elicit a decline in catch (Pearson *et al.* 1987, 1992; Skalski *et al.* 1992). The basis for the decrease in catch is not clear, and it should be noted that, for the most part, there was no actual visual observation of the behaviour of the fish during sesimic source exposure.

Engås *et al.* (1996) and Engås and Løkkeborg (2002) examined the effects of seismic exploration on fishing success for haddock and Atlantic cod. They found that, compared to pre-seismic catches, there was a significant decline in the long-line catch rate during and after the seismic study. The catch rate did not return to normal for at least five days after the end of the seismic study. More recently, the same group used sonar to observe the behaviour of blue whiting and Norwegian spring spawning herring during a seismic operation and observed that fish would move away from the seismic source and not return until after the activity had stopped (Slotte *et al.* 2004).

The often contradictory results of these studies demonstrate the paucity of scientific data, the general lack of understanding of hearing in fish, and may represent the differences in the effects of sound of fish that are hearing specialist versus hearing generalist. There is evidence that suggests that sounds associated with research and fish vessels may affect study results (Mitson 1995; Handegard *et al.* 2003; Mitson and Knudsen 2003), while other data suggest less of an effect from “quieted” ships (Ona *et al.* 2007; De Robertis *et al.* 2008). Therefore, studying responses of fish from a vessel might in actuality provide results that do not reflect the fish behaviour that would occur if the research vessel were not present.

The lack of swim bladder in shrimp, crab and lobster should also make these species less sensitive to sound. Large displacements of macroinvertebrates through avoidance behaviour are very unlikely (Turnpenny and Nedwell 1994). Christian *et al.* (2003) reported no drastic decrease in catch rate for snow crab during an experimental commercial fishery conducted before and after an area was exposed to seismic shooting. However, study limitations were noted including variability in set durations and a relatively low number of sets conducted.

7.1.6 Atmospheric Emissions

Atmospheric emissions will occur from the drilling rig during exploration drilling. However, all equipment is designed to meet regulatory requirements for emissions and regular maintenance plans ensure equipment operates as efficiently as possible. There is ample assimilative capacity for emissions resulting from Project activities because of the strong average winds at the site. There will be negligible environmental effects to air quality beyond the safety exclusion zone.

7.1.7 Well Abandonment / Suspension

When the well is eventually abandoned, well abandonment procedures will follow industry standard practices, in accordance with C-NLOPB regulations.

The typical abandonment process for a well consists of placing mechanical and cement plugs at strategic depths in the wellbore to separate and permanently seal off zones of varying ages and pressures. This process isolates these zones from each other and prevents any subsurface fluids (including oil, natural gas and brine) escaping from the wellbore in the future.

For this Project, depending on the preliminary information received during drilling, the exploration well may be suspended for future re-entry. The wellbore would be plugged below the seafloor using mechanical and/or cement plugs in accordance with the Drilling and Production Guidelines (C-NLOPB and CNSOPB 2011b). A suspension cap would be installed to protect the wellhead connector for potential future re-use.

If the offshore well is abandoned, the wellhead may be removed, or in some cases, approval may be granted for leaving the wellhead in place. When the wellhead is removed, the wellhead and associated equipment are removed to at least 1 m BSF. This is typically performed using mechanical cutters from the drilling unit. However, there are cases that require subsea cutting involving the use of shaped explosive charges. This option is employed only in instances where mechanical removal has failed. It is a requirement that operators have authorization from C-NLOPB before shaped charges are used. If approval is granted for leaving a wellhead in place, several factors are considered, including the occurrence and type of fishery in the area, as well as water depth at the location of the wellhead.

Typical effects associated with well abandonment and suspension are noise (Section 7.1.5.3) and physical disturbance of the bottom in the immediate area surrounding the wellhead.

7.2 Species at Risk

Species at Risk are considered a VEC in this EA because certain bird, fish, marine mammal and turtle species that may occur within the Study Area have been assessed as species at risk listed under Schedule 1 of the SARA, the official list of wildlife and plant species at risk in Canada. It legally protects those species classified as Extirpated, Endangered, Threatened, or of Special Concern. Once a species is listed on Schedule 1, measures to protect it and its critical habitat and help its recovery are implemented. Section 32 of SARA prohibits harming, harassing, killing, capturing, or collecting and selling those species listed on Schedule 1 as Extirpated, Endangered and Threatened. Species designated by COSEWIC, but not listed under SARA are also considered in this VEC.

Potential interactions, between species at risk and routine Project activities include:

- environmental effects associated with the presence of drilling platform and related lights;
- environmental effects associated with discharge of drill mud and cuttings;
- environmental effects associated with the discharge of waste and wastewater;
- environmental effects of sound from all routine exploration drilling activities (including support vessels and VSPsurveys); and
- environmental effect from collisions with vessels.

The effects of accidental events are assessed in Section 8. Cumulative environmental effects in consideration with other projects and/or activities are assessed in Section 9.

7.2.1 Residual Environmental Effects Significance Criteria

A significant adverse residual environmental effect on Species at Risk is one that:

- jeopardizes the achievement of self-sustaining population objectives or recovery goals;
- is not consistent with applicable allowable harm assessments;
- results in permanent loss of critical habitat as defined in a recovery plan or an action strategy; or
- an effect for which an incidental harm permit would not likely be issued.

Due to the sensitive nature of Species at Risk, residual adverse environmental effects on one individual may be considered significant. An adverse environmental effect that does not meet the above criteria is considered to be not significant.

7.2.2 Effects Assessment

The primary interactions between Species at Risk and routine Project activities will result from drill cuttings and sound associated with the drilling platform and VSP surveys. As many Project-related activities are limited to the Project Area, they would only interact with species likely to occur in and or within close proximity to EL 1105. Species which occur in the nearshore of the Study Area would only interact with supply vessel and helicopter traffic. These distinctions are identified and characterized below.

7.2.2.1 Presence of the Drill Platform

Marine Fish Species at Risk

Water depths at the wellsite are approximately 470 m which influence the marine fish species at risk likely to occur in the Project Area. Species with a moderate to high potential to occur in the Project Area include Atlantic cod, redfish, and American plaice. Other marine fish species identified in Tables 5.1 and 5.2 are considered to have a lower potential for occurrence in the Study Area. This includes winter skate, roundnose grenadier, porbeagle shark, white shark, Atlantic salmon, shortfin mako, striped bass, cusk, roughead grenadier, spiny dogfish, blue shark, basking shark, American eel, Atlantic (striped) wolffish, Northern wolffish, spotted wolffish, Atlantic bluefin tuna, striped bass, and Atlantic Sturgeon. The occurrence of these species in the Project Area or Study Area would be a more transient and infrequent occurrence.

Since cod and plaice are benthic species, they are not expected to be attracted to the surface by increased illumination due to the rig and vessel lights or flares. Redfish are also benthic, but are pelagic or bathypelagic feeders, rising off the bottom at night to feed and could therefore be attracted to the platform’s lights. Other species with low potential for occurrence in the Project Area could also occasionally be attracted to the rig site from light or the artificial reef effect.

Existing knowledge related to the effects of the presence of the drill platform, safety zone, lights and flaring are discussed in Section 7.2.1, including information applicable to marine fish species at risk. If individuals are attracted to the rig, this would represent a temporary refuge due to the FEZ. Since the rig would be present for 20 to 50 days, the above effects would be localized, short-term and reversible. No significant residual adverse environmental effects are predicted.

Marine Bird Species at Risk

The Ivory Gull is an unlikely visitor in the Project Area, except on those occasions where the pack ice extends into the Project Area. Due to the potential timing of the Project activities (*i.e.*, drilling would occur during ice free periods) and the unlikelihood of the Ivory Gull being in the Project Area, it is also unlikely that light attraction would be an issue for this Species at Risk. All other marine birds considered within this VEC would occur in nearshore / coastal waters of the Study Area and would therefore not interact with the presence of the drilling platform.

However, effects during migration are somewhat unknown given given that migratory spatial patterns are poorly understood for many avian species, including Species at Risk. Therefore, there is also some potential for interaction during migratory movements over ocean expanses.

Marine Mammal and Sea Turtle Species at Risk

The potential interaction between the presence of the drilling platform and marine mammals and sea turtle species at risk is limited. Artificial light might attract prey species of marine mammal and sea turtle Species at Risk and result in a positive environmental effect on its habitat use; however, the sound emission associated with the VSP and drilling noise would result in avoidance or temporary displacement, negating any potential positive effect. The Project Area does not represent any known critical habitat for any of the species that may pass through the area. The MODU is not expected to present any physical obstruction as marine mammals / sea turtles will avoid collision with stationary structures of this size (the risk of collision with vessels is assessed separately below in Section 7.2.2.4). The residual adverse environmental effects are therefore assessed as not significant.

7.2.2.2 Drill Muds and Cuttings

Marine Fish Species at Risk

The primary effect of SBM and WBM discharges on marine fish Species at Risk is the physical disturbance near the drill site. Contamination of the fish or their prey is of limited concern due to the spatial extent of the drilling discharge deposition and related potential effects. Potential effects to marine fish Species at Risk include avoidance of the area of drilling discharge deposition and smothering of potential prey of marine Species at Risk. The smothering effect is a localized effect that is restricted generally to 100 m or less from the drilling platform (more information on smothering is provided in Section 7.1.2). The Project Area does not represent any important habitat for these species with the exception of redfish (further assessed in Section 7.7) and, therefore, any temporary avoidance of the wellsite would not result in any significant effects.

Marine Bird Species at Risk

There is no interaction expected between the drill muds and cuttings and marine bird Species at Risk. As identified above, the Ivory Gull is the only species that may occur in the Project Area (with the possible exception of migratory movement of other species) and this rare occurrence is unlikely to overlap temporally with the Project. The effects associated with drill muds and cuttings are mostly associated with the benthic environment and unlikely to contaminate food for marine birds.

Marine Mammal and Sea Turtle Species at Risk

The discharge of drill muds and cuttings are not expected to interact with marine mammal Species at Risk directly, since mammals will likely avoid the immediate areas of discharge due to sound avoidance. Any potential of an indirect effect on these species would be as a result of an impact on their food supply, which is also unlikely since the drilling waste disposal to the seafloor will be localized near the rig. Fin, right and blue whales feed on plankton and on small schooling fish, like capelin, from the water column, which will not be affected by the discharge of drill waste. As well, harbour porpoise feed primarily on schooling fish from the water column.

As with the mammal Species at Risk, the sea turtles will not likely be affected by the discharge of drilling mud and cuttings due to avoidance of the immediate area and because they feed primarily on jellyfish. The residual environmental effects are predicted to be not significant.

7.2.2.3 Routine Discharges

Marine Fish Species at Risk

Existing knowledge related to the effects of routine discharges have been discussed in Section 7.1.3 and would be applicable to marine fish, including species at risk. Routine discharges will be of limited duration and frequency over the drilling period and will comply with applicable regulations. Any discharge with potential for toxicity to the marine environment is regulated and monitored for compliance, so the risk of contamination of biota is limited. Organic matter associated with discharges will disperse quickly in an open ocean environment and be degraded by bacteria. The effects of this relatively small amount of waste and wastewater on marine fish Species at Risk over a limited time period are considered not significant.

Marine Bird Species at Risk

While gulls can be attracted to discharges of sanitary and food waste, the potential for interaction between routine discharges and marine bird Species at Risk would again be limited to the Ivory Gull and interaction is considered unlikely given the rarity of the occurrence of this species in the Project Area and the potential timing of this occurrence (*i.e.*, associated with presence of pack ice). Should the Ivory Gull interact with routine discharges, the adverse residual effect is predicted to be not significant. Minimal effects of cooling water are expected due to low use concentrations, large dilution factors and the small area of any thermal effect. Residual hydrocarbons in discharges are generally not associated with the formation of a slick, as discharges will comply with the OWTG and ship operations will adhere to Annex I of the

International Convention for the Prevention of Pollution from Ships (MARPOL 73/78). The waste generated by the Project (including any recyclables) will be limited due to the length of the drilling program and will be brought back to shore.

Marine Mammal and Sea Turtle Species at Risk

Marine mammals and sea turtle Species at Risk are unlikely to be directly or indirectly affected by the waste discharges from the rig as they are likely to avoid the noise from rigs and, therefore, the associated discharges. Any contact with the rig discharges will likely be short-term. All drilling discharges will meet the OWTG which were established to protect the environment. Rig discharges are expected to be temporary, non-bioaccumulating, non-toxic in nature, and subject to high dilution in the open ocean. Thus, the residual adverse environmental effect of waste and wastewater from routine Project activities on marine mammals and sea turtles Species at Risk is predicted to be not significant.

7.2.2.4 Supply Vessels

Marine Fish Species at Risk

Potential interactions between support vessels and this marine fish Species at Risk are mostly related to noise generated by the vessels. The effects of ship lights would be the same as for the drilling platform, assessed in Section 7.4.2.1. Most available literature indicates that the effects of noise on fish are transitory and if short-lived and outside a critical period, are expected not to translate into biological or physical effects. In most cases, it appears that behavioural effects on fish as a result of noise should result in negligible effects on individuals and populations. Existing knowledge related to the biological effects of noise (including vessel traffic) on marine fish is described in detail in Section 7.1.5.3. The effects of noise on marine fish Species at Risk are also further assessed below in Section 7.2.2.5. As vessel traffic would be a less intense noise source than VSP surveys, the effects would also be less. All vessels will comply with Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and the *Canada Shipping Act*. The residual environmental effect associated with the short-term and slight increase in vessel traffic within the Study Area as a result of this Project is predicted to be not significant.

Marine Bird Species at Risk

As supply vessels and helicopter traffic will travel between the Project Area and Newfoundland, there is potential for this routine Project activity to interact with any of the marine bird Species at Risk that occur within the Study Area (any support vessels that may come from St. John's, Newfoundland, will use the recognized shipping lane through the Laurentian Channel). This includes the following species protected under SARA: Ivory Gull, Piping Plover, Barrow's Goldeneye, and Harlequin Duck. Some species listed under SARA (*i.e.*, Eskimo Curlew and Roseate Tern) are considered unlikely to occur in the Study Area so the potential for interaction with supply vessels or helicopters are also considered unlikely.

Marine birds in the Study Area should be habituated to vessel activity and direct effects are not anticipated as these species are highly mobile and can avoid vessels by flying or diving. Energy expended during these events would be minimal and have no physiological effect on the birds.

With respect to helicopter traffic, research has shown that seabirds react most strongly to low-level flights and the effects of these responses tend to be short-lived. Helicopter overflights at 300 m failed to cause a visible reaction among moulting sea ducks in the North Sea, while overflights at 100 m resulted in short-term avoidance reactions (Ward and Sharp 1974). Helicopters servicing the Project will avoid major colonies and known nesting sites for Species at Risk, and will fly at a minimum of 600 m above sea surface whenever possible, limiting potential for disturbance. When taking off and landing on the drilling platform, marine bird Species at Risk in the vicinity may be disturbed; however, this issue would be limited to the Ivory Gull, which is considered an unlikely to occur during the Project timeframe.

Supply vessels travelling from Newfoundland to the Project site will follow established shipping lanes and will comply with applicable pollution prevention regulations. The volume of increased vessel traffic as a result of the Project will be minimal and short-term. Residual adverse environmental effects of ship and helicopter traffic on marine bird Species at Risk is predicted to be not significant.

Marine Mammal and Sea Turtle Species at Risk

As indicated by the existing knowledge presented in Section 7.1.4, toothed whales and pinnipeds are rarely struck by vessels as they are fast swimming and agile, enabling them to avoid approaching vessels. The most commonly struck of all marine mammals are the baleen whales, which are large, slow-moving animals often unable to react fast enough to avoid approaching vessels, particularly vessels traveling at more than 14 knots. If a mammal is in the path of a vessel, every safe effort will be made by the vessel operator to avoid collision, if the mammals has not moved upon approach. By nature of the slow and steady movement of each vessel during this Project, and the practice of avoiding concentrations of marine mammals, the risk of collision is low.

There is limited information pertaining to the potential effects of vessel traffic on sea turtles. Studies, as described in Section 7.1.4, suggest that some sea turtles exhibit behavioural changes and/or avoidance within an area of unknown size near a seismic vessel. However, avoidance of approaching supply vessels is sufficiently limited and small-scale such that sea turtles are often seen from operating supply vessels. Therefore, the most likely effect on sea turtles is that they will temporarily avoid an area due to noise, with the spatial extent of any such temporary disturbance from an approaching supply vessel likely being small.

Helicopter traffic noise may elicit diving behaviour in many marine species. Minke whales have changed course or gone into a slow dive in response to helicopters flying at an altitude of 230 m (Leatherwood *et al.* 1982) and seals may also dive in response to low-flying aircraft. However, the effect is temporary.

Given the temporary and reversible nature of any disturbance and behavioural effects and the mitigation in place to avoid the potential for collisions, the environmental effect of vessel and helicopter traffic on marine mammals and sea turtle species at risk is predicted to be not significant.

7.2.2.5 Drilling Noise / Vertical Seismic Profiles

If one examines sounds based on a hierarchal effect, then the most intense sounds associated with the proposed undertaking would most likely be associated with the seismic sources used in the VSP survey, followed by the drill platform and related operations, support vessels and helicopters. Much of the information presented on sound in subsequent sections will be related to seismic sources, as seismic sound sources using a risk management process has the potential to produce the more pronounced responses as it will be the most probable source of the most intense sounds undertaken as part of the exploration drilling activities. The information presented on sound is based on the traditional 2-D or 3-D seismic surveys and not the lower intensity sounds associated with VSP surveys.

Marine Fish Species at Risk

Sound likely to be generated by Project activities (including drilling and VSP surveys) and the likely biological effects of this sound is presented in detail in Section 7.1.5 and related subsections. Specifically, existing knowledge regarding the biological effects of sound on fish is presented in Section 7.1.5.3 and would be considered applicable to Species at Risk. Where specific information is available for the species at risk that may occur in the Project Area, it has been included below.

The *Recovery Strategy for Northern Wolffish and Spotted Wolffish and Management Plan for Atlantic Wolffish in Canada* (Kulka *et al.* 2007) specifically addresses the potential effects of seismic activity (not VSP surveys in particular) on wolffish. While the report concludes that the effect of seismic activity needs to be quantified with respect to wolffish and their habitat and little is known about the possible effect on wolffish species at any stage of their life history, it is acknowledged that there are no documented cases of mortality of any fish species upon exposure to seismic sound under field operating conditions (DFO 2004e). Kulka *et al.* (2007) speculate that it is possible that wolffish adults guarding nests could leave the area of disturbance to the detriment of the egg cluster, although there is no information to confirm potential effects for wolffish. There are no reports of either of the wolffish species spawning within the Project Area. A study by DFO (2004e) determined that oil and gas exploration activities are considered to have negligible effects on the ability of both northern and spotted wolffish to survive and recover.

Atlantic cod may also occur within the Project Area. Compared to other species, cod is considered a moderately sensitive species in terms of hearing. A measurable behavioural response is anticipated in the range of 160 to 188 dB re 1 μPa (Turnpenny and Nedwell 1994), which may be expected from this Project; temporary avoidance of the immediate area around the sound may be a result. DFO (2004a) concludes that some fish exposed to seismic sounds are likely to exhibit a startle response, a change in swimming pattern and/or a change in vertical distribution. However, these effects are expected to be short-term and of low ecological significance except where fish reproductive activity may be affected. The greatest risk from sound would also apply to cod eggs and larvae near the surface. No measurable effect of sound on cod is expected due to the low probability of spatial and temporal overlap between the VSP survey of two to three days and the presence of cod eggs and larvae near the source.

Because of their long lifespan, slow growth rate and late maturity, redfish are considered to have low resilience, with the principal threats identified as directed fisheries and bycatch (COSEWIC 2010b).

Sarà *et al.* (2007) studied the response of bluefin tuna in the Mediterranean Sea to noise from vessels. They studied semi-captive fish and their response to sound generated by hydrofoil passenger ferries, small boats and large car ferries. Authors reported that in response to approaching vessels, tuna changed swimming direction and increased their vertical movement toward surface or bottom, with the school exhibiting an unconcentrated structure and uncoordinated swimming behaviour. Hydrofoils appeared to elicit a similar response, but for shorter periods. As schooling enhances tuna homing accuracy during their spawning migration, alteration in this behaviour can affect the accuracy of their migration to spawning and feeding grounds. Iversen (1967, in Sarà *et al.* 2007) tested yellowfin tuna (*Thunnus albacares*) and determined that the greatest sensitivity occurs between 200 and 800 Hz, where the mean thresholds ranged from 89 to 100 dB re 1 μPa. This evidence concurs with that of the vast majority of fish studied to date which appear to have a relatively narrow audible frequency range (Popper 2000).

Noise from a seismic source array used in VSP may cause mortality of fish eggs and larvae within a few metres, if they come near the source. Physical effects on fish may occur within a few hundred meters of this magnitude sound source, but no mortality of fish is expected. Fish will likely be startled and avoid the area temporarily within a few kilometres. Due to the spatial limits of mortality and potential physical effects, and due to the temporary nature of behavioural effects, noise is considered a not significant environmental effect on marine fish Species at Risk.

Marine Bird Species at Risk

The Ivory Gull is an unlikely visitor in the Project Area except on those occasions where the pack ice extends into the Project Area. However, drilling will occur during an ice free period; therefore, interaction between the Ivory Gull and the Project is unlikely. The risk of hearing impairment to Ivory Gull from VSP surveys is low as this species would not spend considerable amounts of time below the surface of the water or in close proximity to seismic pulses. It is also unlikely that the Ivory Gull would be feeding beneath the surface at the same time a seismic source is activated. Other bird Species at Risk that could potentially be migrating through the area are not expected to be affected by Project-related noise. The residual adverse environmental effect of sound sources on marine bird Species at Risk is predicted to be not significant.

Marine Mammal and Sea Turtle Species at Risk

In general, avoidance of the Project Area by marine mammal Species at Risk is not expected for prolonged periods as the exploration drilling is anticipated to be undertaken over a period of 20 to 50 days. Project activities may illicit a startle response, causing increased heart rate and breathing or a change in swimming path, but these responses are not considered biologically critical (Erbe 2000). If the opportunity for feeding is presented to marine mammal Species at Risk within the Project Area, they may tolerate sound they may otherwise avoid while feeding (Wartzok *et al.* 2004) and then move out of the Project Area.

The spatial extent of any such avoidance behaviour by humpback and minke whales can be expected to be 0.5 to 1 km. Humpbacks exhibited no avoidance when exposed to simulated semi-submersible and drill platform sounds (Malme *et al.* 1985). Whales known to exhibit long distance avoidance, such as Northern Atlantic right and bowhead (*Balaena mysticetus*) whales, are not known to occur within the Project Area. Under typical ambient sound conditions, low frequency sound from a drilling platform might be detectable no more than 2 km away near a shelf break (Richarson and Malme 1995). The effect of sound on marine mammals is considered highly reversible; therefore, once the source is removed, marine mammals are expected to return to the area (Davis *et al.* 1987).

It is probable that any behavioural changes in baleen whales, toothed whales, pinnipeds and sea turtles (including species at risk) triggered by a MODU and its support vessels will be temporary. The proposed surveys(s) are of short duration and will occur over a relatively small area within the Project Area boundary. Thus, disturbance from vessel traffic is expected to be low.

Avoidance of the Project Area by sea turtles as a result of sound is also not expected to cause any adverse biological effects given that the area is not known to congregate jellyfish, a primary prey item. Jellyfish are transitory, with distributions changing within and between years, so there is no more reason to expect jellyfish within the Project Area than any other area of the Gulf. Furthermore, the Project Area is not an area that would be used for nesting or hatching. Any negative effects such as avoidance would be temporary in time and space.

Overall, the residual adverse effects of Project-related noise from drilling, ships and VSPs is not predicted to result in any significant residual adverse environmental effects.

7.2.2.6 Atmospheric Emissions

Atmospheric emissions will occur from the drilling rig during exploration drilling and could interact with marine bird Species at Risk that are present in the Project Area (*e.g.*, Piping Plover). All equipment is designed to meet regulatory requirements for emissions and regular maintenance plans ensure equipment operates as efficiently as possible. There is ample assimilative capacity for emissions resulting from Project activities because of the strong average winds at the site. There will be negligible environmental effects to air quality beyond the safety exclusion zone. Therefore, the effects of atmospheric emissions on marine birds including Species at Risk will be not significant.

7.2.2.7 Well Abandonment / Suspension

During well abandonment / suspension, any noise would be similar to the noise associated with drilling and would be temporary and localized. Permanent alteration of habitat would be localized to the immediate area of the wellhead. No significant adverse environmental effects are predicted on any Species at Risk as a result of this activity.

7.2.3 Mitigation

Based on the potential interactions identified above and existing knowledge regarding these interactions, the following technically and economically feasible mitigation measures to reduce or eliminate potential adverse effects of the Project on Species at Risk have been identified:

- the vessel will be monitored for stranded marine bird Species at Risk;
- use of a trained marine mammal observer during VSP activities;
- adherence to all relevant mitigation standards as outlined in the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2012) (including the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*) during any VSP activities;
- use of non-toxic or low toxicity chemicals and muds, and treating synthetic oil-contaminated cuttings as per the OWTG;
- all wastewater discharges to comply with the OWTG and ship operations will adhere to Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and *Pollution Prevention Regulations* of the *Canada Shipping Act*;
- solid waste transported to shore and recycled where feasible; and
- all equipment designed to meet regulatory requirements for emissions and regular maintenance plans to ensure equipment operates as efficiently as possible.

7.2.4 Residual Environmental Effects

A summary of potential environmental effects on Species at Risk is provided in Table 7.8. Based on existing knowledge of the effects of exploration drilling program activities on Species at Risk and with the mitigation that will be implemented, routine Project activities are predicted to have only minor environmental effects on Species at Risk. As no non-permitted contravention of any of the prohibitions stated in Sections 32 to 36 of *SARA* will occur, the residual adverse environmental effects of the Project on Species at Risk is predicted to be not significant.

Table 7.8 Potential Environmental Effects Assessment Summary – Species at Risk

Project Components / Activities	Potential Interactions/ Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Presence of Drilling Platform (including safety zone, lights, flaring)	Behavioural effects (A) Artificial reef effect, increased food and shelter (P) Attraction/stranding (A)	Proper equipment inspection / maintenance practices	1	2	6	2	R	1
Drill Mud and Cuttings	Loss of habitat (A) Contamination (A)	Treatment of mud and compliance with OWTG	1	1	6	4	R	1
Routine Discharges (*e.g.*, deck discharge, bilge water, sanitary or domestic waste water)	Nutrient enrichment (A/P); Contamination (A)	Solid waste transported to shore; Adherence to MARPOL 73/78 and *Pollution Prevention Regulations* Compliance with OWTG	1	1	6	2	R	1
Support Vessels (supply boat and helicopter)	Attraction or Avoidance (A); Collision resulting in injury or mortality(A)	Proper equipment inspection / maintenance practices	1	2	6	2	R	1
VSP Survey / Drilling Noise	Mortality (eggs and larvae) (A) Behavioural and Physiological Effects (A); Avoidance (A)	Adherence to *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*	1	1	6	1	R	1
Routine Air Emissions	Avoidance (A)	Proper equipment inspection / maintenance practices	1	1	6	2	R	1
Well Abandonment / Suspension	Behavioural effects (A)		1	1	1	1	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius
3 = 11-100 km radius
4 = 101-1,000 km radius
5 = 1,001-10,000 km radius
6 = >10,000 km radius

Frequency
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200events/yr
5 = >200 events/yr
6 = continuous

Duration
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

n/a = Not applicable

7.3 Marine Ecosystem

A healthy marine ecosystem supports the biological communities and socio-economic uses of the marine environment. In the context of this VEC, the Marine Ecosystem encompasses water (including plankton) and benthic (including coral) communities. It is identified as a VEC as effects to the Marine Ecosystem can in turn affect other marine components including fish and fish habitat, marine mammals and marine birds. The Marine Ecosystem was also identified for consideration in the Scoping Document (C-NLOPB 2011a). This assessment focuses in particular on potential Project effects on corals and plankton. Assessment of Project effects on pelagic and benthic fish species is provided in Section 7.4. As stated in Section 5.3.3, sea pens are present but not common in the Project Area; deep-water corals and sponges are not considered likely in this area.

Kelp forests were also identified in the Scoping Document (C-NLOPB 2011a) as an important component of marine ecosystems. Kelp forests occur in nearshore areas and, therefore, the only potential interactions with routine Project effects would be supply vessel traffic to and from the Project site. Vessels will follow existing shipping routes and will adhere to Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and Pollution Prevention Regulations of the *Canada Shipping Act.* Therefore, any routine interactions between supply vessels and kelp forests would be limited in nature and have not been further assessed.

In this section, the potential effects of routine Project activities on the Marine Ecosystem are evaluated. The effects of accidental events are assessed in Section 8. Cumulative environmental effects in consideration with other projects and/or activities are assessed in Section 9.

7.3.1 Residual Environmental Effects Significance Criteria

A significant adverse environmental effect on the Marine Ecosystem is defined as one that affects the marine ecosystem physically, chemically, or biologically, in quality or extent, to such a degree that there is a decline or change in abundance and/or distribution of marine populations in the Study Area and natural recruitment (reproduction and in-migration from unaffected areas) may not re-establish these populations to their original (*i.e.*, pre-Project) level within several generations or avoidance of the area becomes permanent.

An adverse effect that does not meet the above criteria is considered to be not significant.

7.3.2 Effects Assessment

7.3.2.1 Presence of Platform

During drilling, the seafloor will be affected by physical disturbances, including the drilling of one well in the seafloor, placing the drill plate on the seafloor, placing anchors, retrieving anchors, and removing the drill plate. Effects may include direct smothering, increased turbidity, physical disturbance, and elevated levels of metals on the seafloor and water column. Physical disturbances on the soft seafloor are expected to cause temporary changes in species abundance or composition. The infaunal community in these habitats is expected to rapidly repopulate or recolonize and changes are likely well within natural variability from the natural disturbance regime (*i.e.*, sediment transport during severe storms).

Deepwater corals are susceptible to physical damage and consequential reductions in their populations in many areas through human activities such as bottom trawling (Dayton *et al.* 2002). The very long growth period required for large corals makes them of particular concern. As described above, sea pens are known to occur in the Project Area and can be sensitive to anthropogenic activities (OSPAR Commission 2010). The highest threat was identified as habitat degradation through physical disturbance as a result of bottom trawling. Large, slow-growing species such as sea pens were found to be particularly vulnerable to trawling disturbance, while smaller individuals and species suffer lower mortality rates (Dinmore *et al.* 2003).

The direct footprint of exploratory or production drilling for oil and natural gas has the potential to damage or destroy cold-water corals and sponges, if sited atop or in close proximity to cold-water coral or sponge communities. Physical damage in the form of breakage and dislodgement of organisms and hard substrate, and/or crushing of cold-water corals and sponges can result from anchoring of support and transport vessels, anchoring of semi-submersible drilling units, platform installation and chains associated with moorings (Cimberg *et al.* 1981; Raimondi *et al.* 1997; Freiwald *et al.* 2004; Lophelia 2010).

Based on a review of seafloor video taken at the Old Harry Site as part of the Geohazard Survey (see Section 5.4.1), physical disturbance of corals as a result of the platform placement will be minimal. Due to the relatively small size of potential disturbance, and the fact that corals, other than small numbers of sea pens, are not likely to occur in the Project Area as per the seabed video, residual effects will be not significant.

The presence of lights on the platform may also affect plankton and other pelagic organisms. Many planktonic species and life stages are phototaxic, floating to near surface during the day and settling to deeper water at night. Any lights on the water at night may attract nekton that have active swimming ability. This affect would be localized and temporary, reversing once the drilling period is over.

7.3.2.2 Drill Muds and Cuttings

As discussed in Section 7.1.2 in detail, the effects of WBM, SBM and associated cuttings have been well studied. While the discharge of WBM may increase metals in sediments, these increases are generally limited to within 250 to 500 m of the drill site and few if any biological effects have been associated with these increases (CAPP 2001b; Neff 2005). Most microcosm and field studies (Neff 2010) on the effects of WBM cuttings have shown no or minimal short-term effects on zooplankton communities, and minimal effects on benthic macro- and mega-faunal communities (effects are generally restricted to within 100 m).

In comparing WBM and SBM discharges, the effects of SBM discharges (meeting the OWTG) are limited to benthic organisms. The water column effects (OGP 2003) from discharging SBM cuttings are considered to be negligible due to the low solubility of base fluid of the SBM in seawater, low water column dispersion and residence time due to rapid settling rate, and the fact that drilling discharges are intermittent and transient. Biological effects of SBM cuttings on the benthos are expected to be similar to or greater than those of WBM, with benthic communities taking longer to recover from SBM releases than WBM releases.

Corals and other hydrozoa, as well as sponges, have been shown in many areas to be sensitive to elevated suspended sediment concentrations (Moore 1977). Settling WBM and cuttings could lead to short-term elevated suspended particulate matter concentrations in near-seabed zones, and at high levels could impact particle-feeding organisms (*e.g.*, corals, sponges and anemones). While it was recognized that offshore oil rigs and other oil installations can cause a variety of disturbance effects, such as smothering due to disposal of drill cuttings, the OSPAR Commission (2010) considered threats to sea pens in the North Sea and ranked potential alteration or loss of habitat due to oil and gas activities as low. Re-suspension of fine mud particles by bottom trawling and the resulting sedimentary modification was identified as a main threat. Any effects on sea pens as a result of drilling for this Project would likely be limited to within 500 m of the drill site.

Given both the short-term and localized nature of predicted effects, the residual effects of drill muds and cuttings on the marine ecosystem are predicted to be not significant.

7.3.2.3 Routine Discharges

All routine discharges associated with the exploratory drilling program will be discharged in accordance with the OWTG (NEB *et al.* 2010), including sanitary and waste water. Organic matter associated with discharges will disperse quickly in an open ocean environment and be quickly degraded by bacteria. The effects of this relatively small amount of organic matter and nutrients on the offshore marine environment will be negligible and not significant. Drilling will require seawater, most of which will be used as cooling water (non-chlorinated). The volume of entrainment will be low and the area of thermal effects will be small. Any discharge with potential for toxicity to the marine environment is regulated and monitored for compliance, so the risk of contamination of biota is limited.

7.3.2.4 Support Vessels

The aspects of the marine ecosystem being assessed as part of this VEC will have limited interactions with support vessels and helicopters and therefore this interaction is not assessed further.

7.3.2.5 Drilling Noise / Vertical Seismic Profiles

Existing knowledge related to the biological effects of sound on plankton and benthic organisms is presented in Section 7.1.5.3.

The US Minerals Management Service's environmental assessment of geophysical exploration in the Gulf of Mexico supports the conclusion that there is no documented evidence of a measurable impact to benthic communities from seismic surveys, vertical seismic profile surveys or remote sensing surveys (MMS 2004). Vertical seismic profile impulses may cause mortality in plankton and ichthyoplankton near the source, but the spatial (metres) and temporal (two to three days per well) scales are considered to result in not significant residual environmental effects.

7.3.2.6 Atmospheric Emissions

Air emissions are not expected to interact with or affect the aspects of the marine ecosystem being assessed in this VEC and, therefore, this activity is not assessed further.

7.3.2.7 Well Abandonment / Suspension

During well abandonment/suspension, any physical disturbance to the seafloor would be limited to the areas already disturbed during drilling. The immediate area of the wellhead will remain permanently altered. Noise would be temporary and localized.

7.3.3 Mitigation

The following technically and economically feasible mitigation measures to reduce or eliminate potential adverse effects of the Project on the Marine Ecosystem have been identified:

- use of non-toxic or low toxicity chemicals and muds, and treating synthetic oil-contaminated cuttings as per the OWTG;
- all wastewater discharges to comply with the OWTG and ship operations will adhere to Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and *Pollution Prevention Regulations* of the *Canada Shipping Act*;
- solid waste transported to shore and recycled where feasible;
- adherence to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*; and
- proper equipment inspection / maintenance practices to be in place to minimize emissions and discharges.

7.3.4 Residual Environmental Effect

A summary of potential environmental effects on the Marine Ecosystem is provided in Table 7.9. Given that predicted effects are short-term, localized and reversible, the residual environmental effects on the Marine Ecosystem are predicted to be not significant. Note that an irreversible change in benthic habitat is predicted for the immediate location of the wellhead, but this effect is localized.

Table 7.9 Potential Environmental Effects Assessment Summary – Marine Ecosystem

Project Components / Activities	Potential Interactions/ Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Presence of Platform	Physical disturbance (A)	Proper equipment inspection / maintenance practices	1	1	6	2	R	1
Drill Mud and Cuttings	Smothering, contamination (A)	Use of non-toxic or low toxicity chemicals and muds, and treating SBM cuttings as per the OWTG	1	1	6	3	R	1
Routine Discharges (*e.g.*, deck discharge, bilge water, sanitary or domestic waste water)	Nutrient enrichment, contamination (A)	Transport of solid waste to shore; Adherence to the Pollution Prevention Regulations and OWTG	1	1	6	2	R	1
VSP / Drilling Noise	Mortality (A)	Adherence to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*	1	1	6	1	R	1
Well Abandonment / Suspension	Physical Disturbance (A)	Well abandonment to follow industry standard practices, in accordance with C-NLOPB regulations	1	1	1	1	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius
3 = 11-100 km radius
4 = 101-1,000 km radius
5 = 1,001-10,000 km radius
6 = >10,000 km radius

Frequency
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Duration
1 = <1 month
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4 = 37-72 months
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Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

n/a = Not applicable

7.4 Marine Fish, Shellfish and Habitat

Marine Fish, Shellfish and Habitat includes the physical (*e.g.*, substrate, temperature, water depth), chemical (*e.g.*, nutrients), and biological (*e.g.*, benthic invertebrates, marine plants) attributes of the environment that are required by marine fish to carry out life cycle processes (*e.g.*, spawning, rearing, feeding, overwintering, migration). Several commercial species of fish and shellfish have spawning, feeding and nursery habitats within the Gulf. Environmental effects of the routine Project activities on fish and fish habitat resulting from an exploration well are assessed in this section. Marine Fish, Shellfish and Habitat is selected as a VEC because of the potential for direct interaction with the Project. Specifically, it was selected as a VEC because of:

- specific regulatory requirements of the *Fisheries Act*;
- the direct interaction between marine habitat and routine Project activities; and
- the ecological, recreational and commercial importance of marine habitat to the public.

The environmental impact assessment focuses on relevant aspects of fish, shellfish and fish habitat. Potential interactions with routine Project activities include:

- environmental effects associated with the presence of drilling platform and related lights;
- environmental effects associated with discharge of drill mud and cuttings;
- environmental effects associated with the discharge of waste and wastewater; and
- environmental effects of sound from all routine exploration drilling activities (including support vessels and VSP surveys).

A detailed list of the potential interactions between the Project and Marine Fish, Shellfish and Habitat is provided in Table 7.1. In this section, the potential effects of routine Project activities are evaluated. Species of Marine Fish listed under SARA or considered at risk by COSEWIC are assessed within the Species at Risk VEC (Section 7.2). The effects of accidental events are assessed in Section 8. Cumulative environmental effects in consideration with other projects and/or activities are assessed in Section 9.

7.4.1 Residual Environmental Effects Significance Criteria

A significant adverse environmental effect on Marine Fish, Shellfish and Habitat is defined as one that affects fish and/or shellfish populations, or a portion thereof, in such a way as to cause a decline or change in abundance and/or distribution of the population over one or more generations. Natural recruitment (reproduction and in-migration from unaffected areas) may not re-establish the population to its original (*i.e.*, pre-Project) level within several generations or avoidance of the area becomes permanent.

For potential environmental effects on fish habitat, a significant adverse residual environmental effect would be one that results in an unmitigated or non-compensated net loss of fish habitat as required in a *Fisheries Act* harmful alteration, disruption or destruction authorization (HADD).

An adverse environmental effect that does not meet the above criteria is considered to be not significant.

A positive effect is defined as one that results in a measurable population increase and/or enhances the quality of habitat for fish and/or shellfish.

7.4.2 Effects Assessment

7.4.2.1 Presence of Platform

Existing knowledge related to the effects of the presence of the drill platform, safety zone, lights and flaring have been discussed in Section 7.1.1, including information applicable to fish, shellfish and fish habitat. As stated earlier, the presence of the drill platform may result in an artificial reef effect, where the drill platform provides shelter for species of fish and shellfish, especially juveniles. In the short-term, this could alter the local abundance and distribution of fish, thereby concentrating food sources that may attract marine mammals, sea turtles and marine birds to the drill platform. The FEZ may also serve as a refuge for some fish species, including commercially-fished species.

There is some evidence that lights on the water may attract some fish species, including pelagic migratory fish species. This could make species more vulnerable to predation by marine mammals and marine birds that might also be attracted by the vessel lighting. Studies from the Pacific Coast report changes in juvenile herring and sand lance distribution at night, in artificially lighted areas (Nightingale and Simenstad 2002). Predators of these species may also have been attracted by the increase in juveniles under the lights (Nightingale and Simenstad 2002).

Since the rig would be present for 20 to 50 days, the above effects would be localized, short-term and reversible. No significant residual adverse environmental effects are predicted.

7.4.2.2 Drill Muds and Cuttings

Existing knowledge related to the effects of drill muds and cuttings are discussed in detail in Section 7.1.2, including toxicity of WBM and SBM and the results of field studies conducted on the fate of drill muds and cuttings in the environment. As described in Section 7.1.2.4, field studies (Neff 2010) found no evidence of ecologically significant bioaccumulation of metals and petroleum hydrocarbons by marine organisms residing or deployed in cages near WBM discharges and no evidence of toxicity effects associated with WBM constituents. Ecological effects are due to physical disturbances of water column and the benthic environment (a startle response and avoidance of the area of deposition may be elicited in motile benthic species and smothering of sessile organisms). The effects of SBM discharges are considered to be limited to the benthic environment. Therefore, additional information on the effects of drill muds and cuttings on shellfish is provided below.

The deposition of WBM and SBM cuttings may result in physical smothering of benthic organisms. The initial deposition of cuttings may also impact bottom-dwelling animals by altering the sediment particle size distribution of the substrate (OGP 2003). Since SBMs are biodegradable organic compounds, their presence with the cuttings on the sediments may increase the oxygen demand in the sediments. The organic enrichment of sediment can lead to anoxic/anaerobic conditions as biodegradation of the organic material occurs. Anoxic conditions may also result from burial of organic matter by sediment redistribution. If anoxia is induced, benthic organisms that require oxygen for survival may not be able to compete with bacteria for oxygen. As a consequence, rapid biodegradation of SBM may indirectly result in sediment toxicity (OGP 2003). Furthermore, if the concentration of hydrogen sulphide becomes elevated in the sediments, it may also impact benthic populations. As a result of these factors, benthic populations may be altered in the affected sediments until the SBM has undergone sufficient degradation to mitigate the organic enrichment and organisms are able to recolonize the sediments.

A number of field and monitoring studies have been conducted that assessed the degradation rates of SBM and the recovery rates of benthos (Jensen *et al.* 1999; Neff *et al.* 2000; OGP 2003; Roberts and Nguyen 2006). Ester-based fluids generally biodegrade rapidly and the benthos is mostly recovered within 11 months. Studies on olefin-based fluids have been conducted under a wide variety of conditions with varying results but degradation and benthic recovery may take from several months to several years depending upon a wide variety of factors. In general, benthos may require as many as three to five years to fully recover after discharge of SBM (Neff *et al.* 2000; Okoro Chuma 2011; American Chemistry Council 2006).

The potential risk of drill cuttings discharges settling onto the seabed is the temporary effects of physical burial of benthic fauna (Daan and Mulder 1993). The effect of burial mainly depends on the mobility of organisms in the sediment matrix and on the settling rate of particles. Sedentary organisms, which have no or very limited abilities to move, such as attached barnacles or mussels, are very sensitive. Other species with a low capability to move through the sediment, such as certain bivalve species, may eventually suffer from low oxygen concentrations in the sediment (Essink 1999). Most species present in muddy sediments or in high-energy, dynamic sediments are, however, well adapted to changes in their substrate. Especially species with burying behaviour, experience hardly any effect (Bijkerk 1988, in Kjeilen-Eilertsen *et al.* 2004).

Although changes in benthic density and diversity from drilling muds have been detected within 1,000 m of drill sites, most of these effects are found within the 50 to 500 m range and are of short duration (Hurley and Ellis 2004). Additives to WBM are selected for use in accordance with the Offshore Chemical Selection Guidelines (NEB *et al.* 2009), which ensures that the additives selected have an acceptable risk to the environment. Metals from WBM and cuttings have not been demonstrated to cause biological effects (CAPP 2001a; Hurley and Ellis 2004).

Research indicates that sessile organisms are likely to be smothered in areas where cuttings are greater than 1 cm thick (Bakke *et al.* 1989). Since most sessile benthic species have short generation times, benthic communities are expected to recover within one year after drilling (Hurley and Ellis 2004; Neff 2005). Sessile, and slow moving epifauna such as bryozoans, barnacles, brittlestars and urchins will be smothered at various depths. Infauna such as most polychaetes, amphipods and clams are burrowing species and can be expected to resurface from a covering of several centimetres.

The direct footprint of exploratory drilling for oil and natural gas has the potential to damage or destroy cold-water corals and sponges, if sited atop or in close proximity to cold-water coral or sponge communities. Physical damage in the form of breakage and dislodgement of organisms and hard substrate, and/or crushing of cold-water corals and sponges can result from anchoring of support and transport vessels, anchoring of semi-submersible drilling units, platform installation and chains associated with moorings (Cimberg *et al.* 1981; Raimondi *et al.* 1997; Freiwald *et al.* 2004; Lophelia 2010). Discharges of drill cuttings, drilling mud and chemicals could smother, stress or physically damage the corals and their inhabitants (Freiwald *et al.* 2004; Lophelia 2010).

Any drill cutting and drilling mud released near cold-water corals and sponges has the potential to damage these organisms as a result of burial or smothering or due to increased levels of suspended sediments in the waters surrounding a drilling site. Relatively coarse-grained sediments and barite crystals trapped in coral polyps approximately 500 m down-current from a drilling site in the Træna Deep (Norway) have been observed (Lepland and Mortensen 2008). Corals use a number of mechanisms to remove sediments; ciliary movements, mucus production, tissue expansion and movements of tentacles and sediment ingestion (Stafford-Smith and Ormond 1992; Riegl 1995). These are all energetically costly mechanisms and the energy investment may ultimately affect processes such as growth, reproduction and resistance to disease (Krone and Biggs 1980; Dallmeyer *et al.* 1982; Riegl and Branch 1995).

Several field and laboratory studies have been conducted on possible effects of sedimentation and drilling mud in corals. The majority of these studies have focused on sediment exposure and most of the studied species were tropical corals. There have been relatively few studies published on cold water corals, such as *Lophelia pertusa* (Gass 2006; Gass and Roberts 2006; Lepland and Mortensen 2008; Brooke *et al.* 2009). Polyp mortality and increased mucus production / secretion seem to be the most reported effects / responses.

Results from laboratory studies have suggested an apparent weight loss of sea scallop somatic and reproductive tissues when exposed to ParaDrill IA (SBM type typically used for drill programs on the Grand Banks) at concentrations of 1.5 mg/L; however, the effects were reversed after exposure ceased and little effect was noted at lower concentrations (Armsworthy *et al.* 2005). The authors also concluded that the fine particles of bentonite and barite found in drill mud is most likely the primary cause of effects on scallop tissue growth. Hamoutene *et al.* (2004) exposed lobsters to the SBM (IPAR) over a 20-day period and concluded that there was little or no potential for negative effects.

The primary effect of drilling mud discharges will be the smothering of benthos near the drill site. Effects will range from eliciting a startle response (avoidance of the area of deposition) in motile benthic fish and shellfish to smothering of sessile invertebrates. Effects will localized to within 500 m of the drill site and the benthic environment is expected to recover within three to five years. No significant residual effects are predicted.

7.4.2.3 Routine Discharges

The effects related to routine discharges have been discussed in Section 7.1.3. Routine discharges will be of limited duration and frequency over the drilling period and will comply with applicable regulations. Any discharge with potential for toxicity to the marine environment is regulated and monitored for compliance, so the risk of contamination of biota is limited. Organic matter associated with discharges will disperse quickly in an open ocean environment and will be degraded by bacteria. The effects of this relatively small amount of waste and wastewater on Marine Fish, Shellfish and Fish Habitat are considered not significant.

7.4.2.4 Support Vessels

Potential interactions between support vessels and this VEC are related to noise generated by the vessels. This interaction is assessed in Section 7.4.2.5. The effects of ship lights would be the same as for the platform, assessed in Section 7.4.2.1.

7.4.2.5 Drilling Noise / Vertical Seismic Profiles (VSP)

Sound likely to be generated by Project activities (including drilling and VSP surveys) and the likely biological effects of this sound is presented in detail in Section 7.1.5 and related subsections. Specifically, existing knowledge regarding the biological effects of sound on fish and shellfish is presented in Section 7.1.5.3.

Most available literature indicates that the effects of noise on fish are transitory and if short-lived and outside a critical period, are expected not to translate into biological or physical effects. In most cases, it appears that behavioural effects on fish as a result of noise should result in negligible effects on individuals and populations.

Noise from a seismic source array used in VSP may cause mortality of fish and shellfish eggs and larvae within a few metres, if they come near the source. Physical effects on fish may occur within a few hundred metres of this magnitude sound source, but no mortality of fish or shellfish is expected. Fish will likely be startled and avoid the area temporarily within a few kilometres.

Other sources of noise during the Project will be less in magnitude and each of limited duration, with little potential for overlap. Due to the spatial limits of mortality and potential physical effects, and due to the temporary nature of behavioural effects, noise is considered a not significant environmental effect on Marine Fish, Shellfish and Fish Habitat.

7.4.2.6 Atmospheric Emissions

Potential interactions between atmospheric emissions and Marine Fish, Shellfish and Habitat will be limited and therefore further assessment is not warranted.

7.4.2.7 Well Abandonment / Suspension

During well abandonment / suspension, any physical disturbance to the benthic environment would be limited to the areas already disturbed during drilling. Noise would be temporary and localized. No significant adverse effects on fish and shellfish populations are expected. Permanent alteration of habitat would be localized to the immediate area of the wellhead.

7.4.3 Mitigation

In addition to the above commitments and based on the potential interactions identified and existing knowledge regarding these interactions, the following technically and economically feasible mitigation measures to reduce or eliminate potential adverse effects of the Project on Fish, Shellfish and Habitat have been identified:

- use of non-toxic or low toxicity chemicals and muds, and treating synthetic oil-contaminated cuttings as per the OWTG;
- all wastewater discharges to comply with the OWTG and ship operations will adhere to Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and *Pollution Prevention Regulations* of the *Canada Shipping Act*;
- solid waste transported to shore and recycled where feasible;
- adherence to the Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment; and
- proper equipment inspection / maintenance practices to be in place to minimize emissions and discharges.

7.4.4 Residual Environmental Effect

The assessment of potential environmental effects on Marine Fish, Shellfish and Habitat focused on key Project components, including presence of the MODU and support vessel(s), drill muds and cuttings, routine marine discharges and Project-related noise. A key Project-specific consideration of the effects assessment is the short duration of the proposed activities (*i.e.*, 20 to 50 days). Given that predicted effects are short-term, localized and reversible, the residual environmental effects on Marine Fish, Shellfish and Habitat are predicted to be not significant. Note that an irreversible change in fish habitat is predicted for the immediate location of the wellhead, but this effect is localized. A summary of potential environmental effects on Marine Fish, Shellfish and Habitat is provided in Table 7.10.

Table 7.10 Potential Environmental Effects Assessment Summary – Marine Fish, Shellfish and Habitat

Project Components/ Activities	Potential Interactions / Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Presence of Drilling Platform (including safety zone, lights, flaring)	Behavioural effects (A) Artificial reef effect, increased food and shelter (P)	Proper equipment inspection / maintenance practices	1	2	6	2	R	1
Drill Mud and Cuttings	Direct mortality caused by smothering (A) Loss of habitat (A) Contamination (A)	Treatment of mud and compliance with OWTG	1	1	6	4	R	1

Table 7.10 Potential Environmental Effects Assessment Summary – Marine Fish, Shellfish and Habitat

Project Components/ Activities	Potential Interactions / Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Routine Discharges (*e.g.*, deck discharge, bilge water, sanitary or domestic waste water)	Nutrient enrichment (A / P); Contamination (A)	Solid waste transported to shore; Adherence to MARPOL 73/78 and *Pollution Prevention Regulations* Compliance with OWTG	1	1	6	2	R	1
Support Vessels (supply boat and helicopter)	Fish Attraction or Avoidance (A)	Proper equipment inspection / maintenance practices	1	2	6	2	R	1
VSP Survey / Drilling Noise	Mortality (eggs and larvae) (A) Behavioural and physiological effects (A)	Adherence to DFO's *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*	1	1	6	1	R	1
Well Abandonment / Suspension	Avoidance (A)		1	1	1	1	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius
3 = 11-100 km radius
4 = 101-1,000 km radius
5 = 1,001-10,000 km radius
6 = >10,000 km radius

Frequency
1 = <11 events/yr
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Duration
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Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

n/a = Not applicable

7.5 Marine Birds

Marine birds were selected as a VEC because of the potential interactions with Project activities that could affect their habitat, behaviour, breeding success and ecological role. Marine birds are protected under the *Migratory Bird Convention Act*, *1994* administered by Environment Canada. Marine Birds are also considered a VEC because of regulatory concern (C-NLOPB 2012) and their sensitivity to oil in the marine environment. The following families of marine birds occur within the Study Area and could potentially be affected: Procellariidae (fulmars and shearwaters), Hydrobaridae (storm-petrels), Sulidae (gannets), Phalaropodinae (phararopes), Laridae (gulls, terns, kittiwakes, jaegers, skuas) and Alcidae (Dovekie, murres, Razorbills, puffins). Additionally, there is potential for certain migratory land birds to be affected, depending on the timing of Project activities.

Pelagic seabirds in particular spend the majority of their lives on the open ocean, only coming to shore to breed, and are therefore most likely to be affected by Project activities. As this assessment also considers helicopter and support vessel traffic associated with this Project, there is potential for Project interaction with nearshore birds.

The Study Area extends to the coastal areas of western Newfoundland, with this area being included to encompass the transit routes of helicopters and supply vessels (any support vessels that may come from St. John's, Newfoundland, will use the recognized shipping lane through the Laurentian Channel). The zones of influence of other routine Project activities are generally limited to the Project Area. The key concern with respect to coastal areas and marine birds will, therefore, be disturbance to vulnerable seabird nesting sites by passing ships or helicopters.

Recent survey data (EC-CWS 2013b) indicate that that there are 20 seabird colonies distributed within the portion of the west coast of Newfoundland that fall within the boundaries of the Project Study Area. These colonies are known to support nesting Black-legged Kittiwakes, cormorants, Common terns, and gulls (including Herring Gull, Greater Black-backed Gull, Black-headed Gull, and Ring-billed Gull). The two largest of these colonies (both located at Cape St. George) support Black-legged Kittiwakes (one was estimated to support more than a thousand pairs and the other between 500 and 1000) which are generally considered to be amongst the most vulnerable seabirds to oil spills (Lock *et al.* 1994). Cormorants, which are also considered vulnerable but more resilient (Lock *et al.* 1994), are present at five of the colonies, with four of these being estimated to contain less than a hundred pairs and one between 100 and 500. Common Terns nest at six of the sites, with the number of breeding pairs ranging from two to 240. Gulls were present at nine locations, with the number of estimated breeding pairs for a particular species being either less than one hundred or between 100 and 500 (EC-CWS 2013b). Furthermore, older colony data from Lock *et al.* (1994) identified six colonies of "vulnerable" seabirds within the study area of the west coast of Newfoundland which cumulatively supported 39 Great Cormorant, two Double-crested Cormorant, 501 Black-legged Kittiwake, and 20 Black Guillemot breeding pairs. In addition to direct affects on such colonies, there is potential for those outside of the Project Area (*e.g.*, in association with the Magdalen Islands) to interact with the Project activities if their members forage in the area or pass through during migration.

In this section, the potential effects of routine Project activities on marine birds are evaluated. Species of marine birds listed under SARA or considered at risk by COSEWIC are assessed within the Species at Risk VEC (Section 7.2). The effects of accidental events on Marine Birds are assessed in Chapter 8. Cumulative environmental effects in consideration with other projects and/or activities are assessed in Section 9.

7.5.1 Residual Environmental Effects Significant Criteria

A significant adverse residual environmental effect on Marine Birds is one that affects marine bird populations (*e.g.*, direct mortality, change in migratory patterns, habitat avoidance) in a way that causes a decline in abundance or change in distribution of population(s) of indicator / representative species within the Study Area. Natural recruitment may not re-establish the population(s) to its original level within one generation.

An adverse effect that does not meet the above criteria is considered to be not significant.

A positive effect is defined as one that results in a measurable population increase and/or enhances the quality of habitat for Marine Birds.

7.5.2 Effects Assessment

7.5.2.1 Presence of Platform

Existing knowledge related to marine birds and lighting on the platform is provided in Section 7.1.1. Birds may be attracted to rigs due to the increased presence of fish in the vicinity of the rig or to vessel lighting, particularly night flying birds such as storm-petrels. Birds may become disoriented and fly into vessel lights or infrastructure, injuring themselves and becoming stranded. While the drill rig could attract marine birds (and possibly migrating land birds) to the area, its presence is expected to have negligible effects on gulls and other species that may be attracted to the Project site. There is an increased risk of predation by these species on smaller birds such as storm-petrels; however, no significant change in regional bird populations are expected due to the presence of the drilling rig for a short period.

While all vessels and offshore structures have navigation and warning lights that may attract marine birds (and also potentially migrating land birds), lighting on supply vessels and drilling rigs may attract birds more readily than other vessels as the illuminated areas will be larger and more intense. Storm-petrels are particularly susceptible to light attraction because of their nocturnal feeding habits. For this Project, lighting will be used as required for navigational purposes, on the back deck for safe operations and equipment monitoring. Since lighting is required at night for safety purposes, mitigation will include routine checks for stranded birds and implementation of appropriate procedures for release that will minimize the effects of vessel lighting on birds in the Study Area.

There may be some short-duration flaring by the drill rig during testing and the light produced from this has potential to attract marine birds (as well as migrating land birds). Whereas flaring activities have potential to result in bird mortalities, the effects of such are likely minimal given their limited duration. Furthermore, heat and noise generated by the flare may also deter birds from the immediate area, although there is a paucity of research on this subject. As all of the above effects will be short-term and with appropriate mitigation in place, the residual adverse environmental effect is the predicted to be not significant.

7.5.2.2 Drill Muds and Cuttings

As drill muds and cuttings are discarded and accumulate at the seafloor, no interactions with or effects on Marine Birds are anticipated.

7.5.2.3 Routine Discharges

There are several types of discharges that marine birds may interact with during drilling of the well. The release of any blowout preventer fluid by a drill rig will have minimal effects on marine birds because low-toxicity glycol-water mixes will be used and the periodic near-bottom releases will be low volume. Drilling will require seawater, most of which will be chlorinated for anti-fouling purposes and used as cooling water. Minimal effects of cooling water on marine birds are expected due to low use concentrations, large dilution factors and the small area of any thermal effect.

Other waste materials, such as deck drainage and bilge waters, may negatively affect marine bird health due to the presence of residual hydrocarbons. The attraction of gulls to platforms as a result of discharges of sanitary and domestic waste may increase the potential for predation of smaller marine birds such as Leach's Storm-Petrels.

Limited amounts of hydrocarbons may enter the marine environment as a result of routine discharges (*e.g.*, deck drainage, gray water, black water). Ship operations will adhere to Annex I of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78). Any MODU discharges will comply with the OWTG. Hydrocarbon concentrations associated with these discharges are not generally associated with formation of a surface slick. They are, therefore, not likely to have a measurable effect on marine birds. The waste generated by the Project will be limited due to the length of the drilling program.

Given the short duration of the drilling program and compliance with applicable regulations and guidelines related to discharges, residual environmental effects on Marine Birds are predicted to be not significant.

7.5.2.4 Support Vessels

Support vessels may affect marine birds through discharges, lighting, the physical presence of the structure and noise. Marine birds in the Study Area are habituated to vessel activity and some birds such as gull species and Northern Fulmar are actually attracted to ships and often stay with them for extended periods (Montevecchi *et al.* 1999; Wahl and Heinemann 1979; Brown 1986). Direct effects to marine birds are not anticipated because these species are highly mobile and can avoid vessels by flying or diving. Energy expended during these events would be minimal and have no physiological effect on the birds.

With respect to helicopter traffic, research has shown that seabirds react most strongly to low-level flights and the effects of these responses tend to be short-lived. Helicopter overflights at 300 m failed to cause a visible reaction among moulting sea ducks in the North Sea, while overflights at 100 m resulted in short-term avoidance reactions (Ward and Sharp 1974). As with their response to vessel traffic, seabirds may habituate to air traffic over time.

Helicopters servicing the Project will avoid major colonies and will avoid flying at low altitudes above sea surface whenever feasible. When taking off and landing on platforms, marine birds in the vicinity may be disturbed. However, birds will likely become habituated to the activity and potential residual adverse effects are considered not significant.

Supply vessels travelling from Newfoundland to the Project site will follow established shipping lanes, particularly in proximity to shore and the potential for disturbance to colonies will be minimal.

7.5.2.5 Drilling Noise / Vertical Seismic Profiles

Sources of noise associated with the Project VSP include surveys, drilling activities, and marine and air traffic. The atmospheric noise generated by this Project is of little concern for seabirds, the loudest source being from a helicopter, which will likely be avoided by seabirds. The most intense sound source from this Project would occur during a potential VSP survey. The VSP array is not as intense and is more localized compared to a 2-D or 3-D seismic survey, so the potential effects would also be less. Section 7.1.5.3 describes existing knowledge related to marine birds and seismic noise.

Existing knowledge indicates that marine birds diving in close proximity to a loud underwater sound could be injured. Only the Alcidae (Dovekie, Common Murre, Thick-billed Murre, Razorbill, Black Guillemot and Atlantic Puffin) spend measurable time underwater during forage dives. Most species of seabirds that may be present in the Study Area spend only a few seconds underwater during a foraging dive; therefore, there would be minimal opportunity for exposure. It is thought that the presence of an approaching supply vessel may potentially alert alcids (and other seabirds on the water), thereby flushing animals from the area (prior to being exposed to any sounds or occurring in close proximity to operating VSP sound sources.

Given the short-term and localized nature of the potential effects, the potential for any injury to birds would be minimal. The residual environmental effects are predicted to be not significant.

7.5.2.6 Atmospheric Emissions

There is ample assimilative capacity for emissions resulting from Project activities because of the strong average winds at the site. There will be negligible environmental effects to air quality beyond the safety exclusion zone. Given the short-term nature of this Project and the limited numbers of individuals that may be affected, no residual adverse significant environmental effects are predicted.

7.5.2.7 Well Abandonment / Suspension

During well abandonment / suspension, any noise would be similar to the noise associated with drilling. No significant adverse environmental effects are predicted on Marine Birds as a result of this activity. Noise would be temporary and localized.

7.5.3 Mitigation

Based on the potential interactions identified and existing knowledge regarding these interactions, the following technically and economically feasible mitigation measures to reduce or eliminate potential adverse effects of the Project on Marine Birds have been identified:

- avoidance of seabird colonies by the MODU support vessel(s) and helicopters;
- routine checks for stranded birds and implementation of appropriate procedures for release that will minimize the effects of vessel lighting on birds;

- adherence to "The Leach's Storm-Petrel: General Information and Handling Instructions" in the event that this species becomes stranded on the survey vessel (which involves the pre-submission of a permit application to the CWS);
- a pelagic marine bird monitoring program with EC-CWS (ECSAS) protocols will be implemented and Corridor will include trained observer(s) among their staff;
- Corridor will have a Bird Handling Permit and will comply with the requirements for documenting and reporting any stranded birds (or bird mortalities) to the CWS during the 20 to 50 day drilling program; to differentiate between Wilson's Storm-Petrel and Leach's Storm-Petrel, photographs depicting their differences will be provided to trained observers;
- compliance with the *Migratory Birds Convention Act, 1994* and regulations;
- all wastewater discharges to comply with the OWTG and ship operations will adhere to Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and *Pollution Prevention Regulations* of the *Canada Shipping Act*;
- solid waste transported to shore and recycled where feasible; and
- equipment will be designed to meet regulatory requirements for emissions and regular maintenance plans will allow equipment to operate as efficiently as possible.

7.5.4 Residual Environmental Effects

A summary of the potential environmental effects on Marine Birds is provided in Table 7.11. Effects on Marine Birds are anticipated to be short-term, localized and reversible at a population level. Appropriate mitigation will be in place including routine checks for stranded birds. Therefore, the effects of routine Project activities on Marine Birds are predicted to be not significant.

Table 7.11 Potential Environmental Effects Assessment Summary – Marine Birds

Project Components/ Activities	Potential Interactions/ Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Presence of Drilling Platform (including safety zone, lights, flaring)	Attraction to vessel resulting in stranding, injury or mortality (A);	Routine checks for stranded birds and appropriate handling procedures; Adherence to MARPOL 73/78 and OWTG	1	1	6	2	R	1
Routine Discharges (*e.g.*, deck discharge, bilge water, sanitary or domestic waste water)	Attraction to vessel (A); Contamination (A); Oiling of Feathers (A)	Adhere to Annex I of the International Convention for the Prevention of Pollution from Ships and OWTG; Equipment inspections and communication	1	1	6	2	R	1
Support Vessels (supply boat and helicopter)	Attraction to vessel resulting in stranding, injury or mortality (A); Disturbance due to overflights (A)	Routine checks for stranded birds and appropriate handling procedures; Bird observations by a qualified observer(s); Avoidance of seabird colonies	1	1	6	2	R	1

Table 7.11 Potential Environmental Effects Assessment Summary – Marine Birds

Project Components/ Activities	Potential Interactions/ Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
VSP Survey / Drilling Noise	Disturbance (A); Behavioural or physiological effects (A)	Adherence to DFO's *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*	1	1	6	2	R	1
Routine Air Emissions	Contamination (A)	Equipment will be designed to meet regulatory requirements for emissions and regular maintenance plans will allow equipment to operate as efficiently as possible.	1	1	6	2	R	1
Well Abandonment / Suspension	Disturbance (A)		1	1	6	1	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius
3 = 11-100 km radius
4 = 101-1,000 km radius
5 = 1,001-10,000 km radius
6 = >10,000 km radius

Frequency
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200events/yr
5 = >200 events/yr
6 = continuous

Duration
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

n/a = Not applicable

7.6 Marine Mammals and Sea Turtles

Marine mammals and Sea Turtles were selected as a VEC for several reasons. They play a critical role in the marine ecosystem, the significance of which is manifested in regulatory protection, scientific study and public concern. Specifically, marine mammals were included as a VEC because of:

- specific regulatory requirements of the *Fisheries Act* and SARA;
- requirements of the Project-specific Scoping Document (C-NLOPB 2011a);
- the direct interaction between marine mammals and routine Project activities, as well as accidents and malfunctions; and
- the ecological, recreational and commercial importance of marine mammals to the public.

The environmental impact assessment focuses on relevant aspects of Marine Mammals and Sea Turtles and potential interactions with routine Project activities, which include:

- effects associated with the presence of drilling platform and related lights;
- effects of noise from all routine activities (including VSPs and abandonment);
- effect from collisions with vessels;
- effects associated with discharge of drill mud and cuttings; and
- effects associated with the discharge of waste and wastewater.

The assessment of marine mammals includes baleen whales (Mysticetes), toothed whales (Odontocetes), dolphins (Delphinids), and seals (Pinnipeds). Species of marine mammals and sea turtles listed under SARA or considered at risk by COSEWIC, are assessed separately as Species at Risk (Section 7.2). Those species that are not considered at risk and may interact with the Project are considered within this VEC. The effects of all accidental events except collision between marine mammals / sea turtles and vessels are assessed in Section 8. Cumulative environmental effects on marine mammals in consideration with other Projects and/or activities are assessed in Section 9.

7.6.1 Residual Environmental Effects Significance Criteria

A significant adverse environmental effect on Marine Mammals and Sea Turtles is defined as one that affects a marine mammal or sea turtle population or portion thereof or their associated habitat in such a way as to cause a decline or change in abundance and/or distribution of the population over one or more generations. Natural recruitment (reproduction and in-migration from unaffected areas) may not re-establish the population to its original (*i.e.*, pre-Project) level within several generations or avoidance of the area becomes permanent.

An adverse effect that does not meet the above criteria is considered to be not significant.

A positive effect is defined as one that results in a measurable population increase and/or enhances the quality of habitat for Marine Mammals and Sea Turtles.

7.6.2 Effects Assessment

7.6.2.1 Presence of Platform

Marine mammals and sea turtles would most likely avoid the immediate area around drilling activities due to physical activities and underwater sound generated by equipment. It is possible that marine mammals may be attracted to subsea structures if the artificial reef effect occurs and availability of prey increases.

The potential interaction between the presence of the platform and marine mammals / sea turtles is limited. The MODU is not expected to present any physical obstruction as marine mammals / sea turtles will avoid collision with stationary structures of this size (the risk of collision with vessels is assessed separately below in Section 7.6.2.4). The limited potential of attraction may be offset by a more likely avoidance of noise from the structure. The residual adverse environmental effects are therefore assessed as not significant.

7.6.2.2 Drill Muds and Cuttings

The potential effect of drill mud and cuttings on marine mammals and sea turtles is essentially limited to the degree that their food supply is affected. Contamination of the marine mammals and sea turtle food supply is of limited concern. Baleen whales feed on plankton and on small schooling fish, like capelin, from the water column. Toothed whales (*e.g.*, dolphins) feed primarily on fish and squid, some of which may be benthic species. Seals are known to feed on fish from the water column as well as from benthic habitats. The area where benthic species are potentially affected is limited to within 500 m of the well being drilled, so drill cuttings are unlikely to affect marine mammal prey or the food chain for sea turtles.

7.6.2.3 Routine Discharges

Marine mammals may not be directly or indirectly affected by the waste discharges from the rig because they are likely to avoid the noise from rigs and therefore the associated discharges. Any contact with the rig discharges will likely be short-term. All drilling discharges will meet the OWTG which were established to protect the environment. Rig discharges are expected to be temporary, non-bioaccumulating, non-toxic in nature, and subject to high dilution in the open ocean. Thus, measurable effects on marine mammals are not expected as a result of this Project. The residual adverse environmental effect of waste and wastewater from routine Project activities on marine mammals and sea turtles is predicted to be not significant.

7.6.2.4 Supply Vessels

Collisions of vessels with marine mammals during routine Project activities are considered unlikely, but possible. Habituation is possible when the same boats regularly visit a site (Bonner 1982). The current level of commercial and industrial activity within the area may have habituated repeat visitors.

When approached by a vessel, whales usually dive or make changes in swimming speed or direction (Watkins 1986), but the reaction can be quite variable between species and even within a species. There are several biotic and abiotic factors which may influence the reaction, such as whether or not the animal is feeding or the speed and size of the approaching vessel.

There is limited information pertaining to the potential effects of vessel traffic on sea turtles. Studies, as described in Section 7.1.4, suggest that some sea turtles exhibit behavioural changes and/or avoidance within an area of unknown size near a supply vessel. However, avoidance of approaching supply vessels is sufficiently limited and small-scale such that sea turtles are often seen from operating supply vessels. Therefore, the most likely effect on sea turtles is that they will temporarily avoid an area due to noise, with the spatial extent of any such temporary disturbance from an approaching vessel likely being small.

As indicated by the existing knowledge presented in Section 7.1.4, toothed whales and pinnipeds are rarely struck by vessels as they are fast swimming and agile, enabling them to avoid approaching vessels. The most commonly struck of all marine mammals are the baleen whales, which are large, slow-moving animals often unable to react fast enough to avoid approaching vessels, particularly vessels traveling at more than 14 knots. If a mammal is in the path of a vessel, every safe effort will be made by the vessel operator to avoid collision, if the mammals has not moved upon approach. By nature of the slow and steady movement of each vessel during this Project, and the practice of avoiding concentrations of marine mammals, the risk of collision is low.

It is probable that any behavioural changes in baleen whales, toothed whales, pinnipeds and sea turtles (including species at risk) triggered by a MODU and its support vessels will be temporary. The proposed surveys(s) are of short duration and will occur over a relatively small area within the Project Area boundary. Thus, disturbance from vessel traffic is expected to be low.

Helicopter traffic noise may elicit diving behaviour in many marine species. Minke whales have changed course or gone into a slow dive in response to helicopters flying at an altitude of 230 m (Leatherwood *et al.* 1982) and seals may also dive in response to low-flying aircraft. However, the effect is temporary.

Given the temporary and reversible nature of any disturbance and behavioural effects and the mitigation in place to avoid the potential for collisions, the environmental effect of vessel and helicopter traffic on marine mammals and sea turtles is predicted to be not significant.

7.6.2.5 Drilling Noise / Vertical Seismic Profiles

Existing knowledge related to the effects of noise on marine mammals and sea turtles is described in detail in Section 7.1.5.3. Temporary avoidance of an area due to noise is the most likely effect from a drilling project on marine mammals and seas turtles. Most of the noise generated from this Project will be intermittent. However, the drilling unit emits some noise continuously during operation. A broadband received sound pressure level of 160 dB re 1 µPa (rms) or greater is currently the best estimate available to indicate potential concern for disruption of marine mammals behavioural patterns (NMFS 2000), however, noise levels below 160 dB re 1µPa have also been known to elicit behavioural disturbances in marine mammals (NRC 2005). The spatial extent of any such avoidance behaviour by most common species in the area (*e.g.*, humpback and minke whales) can be expected to be 0.5 to 1 km.

The most likely activity of marine mammals in the Study Area is feeding, and some communications may occur between some whales during this activity. If mammals are discouraged from this area by noise or if their feeding efficiency is diminished as a result of masking, the effect would be of limited spatial extent and duration. Marine mammals will avoid an area of noise, especially if there are sudden changes in frequency or intensity. Marine mammals are generally more tolerant of stationary sources of noise than moving sources.

The effect of noise on marine mammals is considered highly reversible therefore, once the source is removed, marine mammals are expected to return to the area (Davis *et al.* 1987). Each activity, except supply vessels and personnel flights, will likely occur in sequence with little chance for more than one activity at a time. The Project Area offers no unique habitat or feeding areas for marine mammals. Similar alternate sites are available in the immediate area, so the fitness of any species of marine mammals will not be affected. The residual environmental effects on marine mammals are therefore predicted to be not significant.

The possible responses of sea turtles to sound associated with VSP surveys (seismic) and other exploratory drilling activities could include:

- avoiding the Project Area where seismic sounds (and other related exploratory drilling sounds) occur to the extent that turtles move to less preferred habitat (more likely to occur in nearshore shallow water areas during nesting, hatching or foraging as compared to the Old Harry Project Area, with 470 m water depth);
- avoiding only the immediate area around the active sound source (local avoidance of the source vessel but remain in the general area); and
- exhibiting no appreciable avoidance, although short-term behavioural reactions are likely.

Sea turtles might be excluded from the area for the duration of the VSP survey, or they might remain, but exhibit abnormal behavioural patterns such as lingering longer than normal at the surface where received sound levels are lower. Whether those that were displaced would return quickly after the VSP survey ended is unknown but monitoring evidence suggests this could occur (Holst *et al.* 2006; Hauser *et al.* 2008; Holst and Smultea 2008). The Project Area offers no unique habitat or feeding areas for sea turtles. Similar alternate sites are available in the immediate area, so the fitness of any species of sea turtles will not be affected. The residual environmental effects on sea turtles are therefore predicted to be not significant.

7.6.2.6 Atmospheric Emissions

Potential interactions between atmospheric emissions and marine mammals / sea turtles will be limited and, therefore, further assessment is not warranted.

7.6.2.7 Well Suspension / Abandonment

Noise generated during the removal of the wellhead will be of short duration and localized. The disturbance associated with well suspension and abandonment activities (primarily associated with noise generated during removal of the wellhead) will be of short duration and occur directly at the wellsite. The level of vessel traffic would be similar to that currently experienced in the area. The residual adverse environmental effects of well suspension / abandonment activities on Marine Mammals and Sea Turtles are predicted to be not significant.

7.6.3 Mitigation

Based on the potential interactions identified and existing knowledge regarding these interactions, the following technically and economically feasible mitigation measures to reduce or eliminate potential adverse effects of the Project on Marine Mammals and Sea Turtles have been identified:

- use of a Marine Mammal Observer;
- adherence to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*;
- all wastewater discharges to comply with the OWTG and ship operations will adhere to Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and *Pollution Prevention Regulations* of the *Canada Shipping Act*;

- solid waste transported to shore and recycled where feasible; and
- equipment will be designed to meet regulatory requirements for emissions and regular maintenance plans will allow equipment to operate as efficiently as possible.

7.6.4 Residual Environmental Effects

A summary of the potential environmental effects on Marine Mammals and Sea Turtles is provided in Table 7.12. Residual effects on Marine Mammals and Sea Turtles will be greatly influenced by the short-term nature of the Project and reversibility of any physical and behavioural effects once sound sources are removed. With the mitigation in place to minimize potential for collision, the effect of routine Project activities on Marine Mammals and Sea Turtles are predicted to be not significant.

Table 7.12 Potential Environmental Effects Assessment Summary – Marine Mammals and Sea Turtles

Project Components/ Activities	Potential Interactions / Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Presence of Drilling Platform (including safety zone, lights, flaring)	Attraction due to reef effect or possible avoidance due to noise (A)	Observer(s) for marine mammals and sea turtles	1	2	6	2	R	1
Routine Discharges	Contamination of food sources (A)	Adhere to Annex I of the International Convention for the Prevention of Pollution from Ships and OWTG; Equipment inspections and communication	1	1	6	2	R	1
Support Vessels (supply boat and helicopter)	Disturbance / avoidance (A); Collision resulting in injury or mortality(A)	Observer(s) for marine mammals and sea turtles; Slow vessel speed	1	1	6	2	R	1
VSP Survey / Drilling Noise	Physical and/or behavioural effects (A); Avoidance (A)	Adherence to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*;	1	2	6	2	R	1
Well Suspension / Abandonment	Physical and/or behavioural effects (A); Disturbance / avoidance (A)		1	1	1	1	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent

Frequency
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200events/yr
5 = >200 events/yr
6 = continuous

Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity

Table 7.12 Potential Environmental Effects Assessment Summary – Marine Mammals and Sea Turtles

Project Components/ Activities	Potential Interactions / Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context

1 = <1 km radius 2 = 1-10 km radius 3 = 11-100 km radius 4 = 101-1,000 km radius 5 = 1,001-10,000 km radius 6 = >10,000 km radius	Duration 1 = <1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = >72 months	2 = Evidence of existing adverse activity 3 = High level of existing adverse activity n/a = Not applicable

7.7 Sensitive Areas

Sensitive Areas are often associated with rare or unique marine habitat features, habitat that supports sensitive life stages of valued marine resources, and/or critical habitat for species at risk. Sensitive areas were selected as a VEC due to their importance as unique or critical habitat for various species or species assemblages. Sensitive areas are important socially, culturally, aesthetically, ecologically and scientifically.

As per the Scoping Document (Appendix A), Sensitive Areas in the Study Area include any EBSAs identified within the Gulf (and some consider the Gulf as a whole a sensitive area). With the Study Area, this includes the following EBSAs: the southern fringe of the Laurentian Channel (the Study Area has a small overlap with the eastern fringe of this EBSA) and the west coast of Newfoundland which crosses the Study Area between the Project Area and the western coastline of Newfoundland. The Project Area overlaps with a potential redfish (a COSEWIC-designated species) mating area and the Study Area overlaps with a potential redfish larvae extrusion area and a cod (a COSEWIC-designated species) spawning area. These five areas are considered in this VEC.

As many of the sensitive areas being considered here were created in relation to Species at Risk and other marine resources, such as marine mammals and marine fish, this assessment is closely linked to the assessment of other VECs. The effects of accidental events on Sensitive Areas are assessed in Section 8. Cumulative environmental effects on Sensitive Areas in consideration with other Projects and/or activities are assessed in Section 9.

7.7.1 Residual Environmental Effects Significance Criteria

A significant adverse residual environmental effect on Sensitive Areas is one that alters the valued habitat of the identified Sensitive Areas physically, chemically or biologically, in quality or extent, to such a degree that there is a decline in abundance of key species or species at risk or a change in community structure, beyond which natural recruitment (reproduction and immigration from unaffected areas) would not return the population or community to its former level within several generations.

An adverse environmental effect that does not meet the above criteria is considered to be not significant.

7.7.2 Effects Assessment

While all five of the sensitive areas considered within this VEC overlap with the Study Area, not all of these areas will interact with all routine Project activities. Many Project activities and their potential zones of influence are localized within the Project Area. Within the following assessment, the specific Project activities that may interact with each sensitive area will be identified and assessed.

7.7.2.1 Presence of Platform

As potential effects related to the presence of the drilling platform would be limited to the Project Area. This interaction is only a consideration for the potential redfish mating area (September-December), which could overlap with the Project both spatially and temporally.

While redfish are a benthic species, limiting their potential to be attracted by lights or flares on the rig, feeding is believed to occur at night, when redfish rise off the bottom and feed on pelagic organisms (primarily zooplankton) in the water column (Scott and Scott 1988; DFO 2010n; DFO 2011q). Fish and crustaceans become more important in the diet as redfish increase in size. Thus, there is potential for redfish to be attracted to the rig and be affected by the lights at night. Given the localized and temporary nature of this effect and the reversibility once the drilling platform is removed, this effect will not be measurable at the population level.

7.7.2.2 Drill Muds and Cuttings

Similar to the presence of the drilling platform, the biological effects of drill muds and cuttings is limited to the Project Area and, therefore, would only be a consideration for the potential redfish mating (September-December), which could overlap with the Project both spatially and temporally. As discussed in Section 7.1.2, most microcosm and field studies (Neff 2010) on the effects of WBM cuttings have shown no or minimal short-term effects on zooplankton communities, and minimal effects on benthic macro- and mega-faunal communities (effects are generally restricted to within 100 m). In comparing WBM and SBM discharges, the effects of SBM discharges are limited to benthic organisms.

For fish species, such as redfish, there would be minimal behavioural effects from cuttings discharges (*i.e.*, startle effect), no potential for smothering and minimal potential for physiological effects. The residual environmental effects are predicted to be not significant.

7.7.2.3 Routine Discharges

The effects related to routine discharges have been discussed in Section 7.1.3. Routine discharges will be of limited duration and frequency over the drilling period and will comply with applicable regulations. Any discharge with potential for toxicity to the marine environment is regulated and monitored for compliance, so the risk of contamination of biota is limited. Organic matter associated with discharges will disperse quickly in an open ocean environment and will be degraded by bacteria. The effects of this relatively small amount of waste and wastewater would be limited to the Project Area and, therefore, only a potential influence on the potential redfish mating area. The residual environmental effects are considered not significant.

7.7.2.4 Support Vessels

Potential interactions between support vessels and this VEC are related to noise and lights generated by the vessels. Because of vessel traffic to and from western Newfoundland, this activity could interact with the cod spawning area, potential redfish mating area and the West Coast of Newfoundland EBSA. The vessel traffic associated with this Project will occur over a short period and will consist of approximately two to three vessel trips per week. Vessel operations will adhere to Annex I of the International Convention for the Prevention of Pollution from Ships and the *Canada Shipping Act*. The temporary interactions associated with limited vessel traffic will not result in any residual adverse significant effects on any of the identified Sensitive Areas.

7.7.2.5 Drilling Noise / Vertical Seismic Profiles

Sound likely to be generated by Project activities (including drilling and VSP surveys) and the likely biological effects of this sound is presented in detail in Section 7.1.5 and related subsections. As the zones of influence of the noise produced by these activities are likely to be contained within the Project Area and immediate vicinity, this interaction is of most concern for the potential redfish mating area. Existing knowledge regarding the biological effects of sound on fish is presented in Section 7.1.5.3.

Most available literature indicates that the effects of noise on fish are transitory and if short-lived and outside a critical period, are expected not to translate into biological or physical effects. In most cases, it appears that behavioural effects on fish as a result of noise should result in negligible effects on individuals and populations.

Noise from a seismic source array used in VSP may cause mortality of fish and shellfish eggs and larvae within approximately 10 m, if they come near the source. Physical effects on fish may occur within a few hundred metres of this magnitude sound source, but no mortality of fish or shellfish is expected. Fish will likely be startled and avoid the area temporarily within a few kilometres. This may result in temporary disturbances to redfish mating activity, and possible injury to fish in the immediate area. Given the localized and mostly temporary nature of these disturbances, no residual adverse environment effect on redfish mating is anticipated.

Other sources of noise during the Project will be less in magnitude and each of limited duration. Due to the spatial limits of mortality and potential physical effects, and due to the temporary nature of behavioural effects, noise is considered to have a not significant environmental effect on Sensitive Areas.

7.7.2.6 Atmospheric Emissions

Air emissions are not expected to interact with this VEC and, therefore, this activity is not assessed further.

7.7.2.7 Well Abandonment / Suspension

The abandonment / suspension of the well will cause a permanent alteration in benthic habitat in the immediate area of the wellsite. This is not anticipated to result in any significant adverse residual effects on Sensitive Areas.

7.7.3 Mitigation

The following technically and economically feasible mitigation measures to reduce or eliminate potential adverse effects of the Project on Sensitive Areas have been identified:

- use of non-toxic or low toxicity chemicals and muds, and treating SBM and cuttings as per the OWTG;
- all wastewater discharges to comply with the OWTG and ship operations will adhere to Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and *Pollution Prevention Regulations* of the *Canada Shipping Act*;
- solid waste transported to shore and recycled where feasible;
- adherence to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*; and
- proper equipment inspection / maintenance practices to be in place to minimize emissions and discharges.

7.7.4 Residual Environmental Effect

The assessment of potential environmental effects on Sensitive Areas focused on key Project components, including presence of the MODU and support vessel(s), drill muds and cuttings, routine marine discharges and Project-related noise. Most of the potential disturbances related to routine activities are limited to the Project Area and are, therefore, only a potential concern for the potential redfish mating areas. Interactions with other Sensitive Areas would be limited to supply vessel and helicopter traffic to and from Newfoundland.

Due to the short duration of the proposed Project (*i.e.*, 20 to 50 days), and the implementation of the proposed mitigation measures, the potential adverse environmental effects of the Project on the potential redfish mating area are predicted to be not significant. A summary of potential environmental effects on Sensitive Areas is provided in Table 7.13.

Table 7.13 Potential Environmental Effects Assessment Summary – Sensitive Areas

Project Components/ Activities	Potential Interactions / Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Presence of Drilling Platform (including safety zone, lights, flaring)	Behavioural effects (A) Artificial reef effect, increased food and shelter (P)	Proper equipment inspection / maintenance practices	1	2	6	2	R	1
Routine Discharges (*e.g.*, deck discharge, bilge water, sanitary or domestic waste water)	Nutrient enrichment (A / P); Contamination (A)	Solid waste transported to shore; Adherence to MARPOL 73/78 and *Pollution Prevention Regulations* Compliance with OWTG	1	1	6	2	R	1
Support Vessels (supply boat and helicopter)	Fish Attraction or Avoidance (A)	Proper equipment inspection / maintenance practices	1	2	6	2	R	1
VSP Survey / Drilling Noise	Mortality (eggs and larvae), Behavioural and Physiological Effects (A)	Adherence to the *Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment*	1	1	6	1	R	1
Well Abandonment / Suspension	Avoidance (A)		1	1	1	1	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius
3 = 11-100 km radius
4 = 101-1,000 km radius
5 = 1,001-10,000 km radius
6 = >10,000 km radius

Frequency
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200events/yr
5 = >200 events/yr
6 = continuous

Duration
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

n/a = Not applicable

7.8 Commercial Fisheries and Other Users

Historically, the fishery has played an important role in the economy and social fabric of various communities that border the Gulf including those in Newfoundland and Labrador, and has helped to define much of the region's character. The fishery remains an integral component of the economy of the region as well as Newfoundland and Labrador. Research and sentinel fisheries are undertaken to monitor the status and health of underutilized species, species under moratoria and listed species at risk and, for the purpose of this environmental assessment are considered part of commercial fisheries. Commercial fisheries was selected as a VEC because of the potential for direct interaction with the Project. Specifically, commercial fisheries was selected as a VEC because of:

- specific regulatory requirements of the *Fisheries Act*;
- the direct interaction between commercial fish and routine Project activities;
- the potential interaction between commercial fish and the Project as a result of accidents or malfunctions; and
- the commercial importance and historic relevancy of the commercial fisheries to the region.

The environmental impact assessment focuses on relevant aspects of Commercial Fish. Potential interactions, between commercial fish and routine Project activities include:

- environmental effects of sound from all routine exploration drilling activities (including support vessels and VSP profiling);
- conflict with harvesting activities and fishing gear;
- impacts on fish catchability;
- interference with DFO surveys;
- environmental effects associated with discharge of drill mud and cuttings;
- environmental effects associated with the discharge of waste and wastewater; and
- environmental effects associated with the presence of drilling platform and related lights.

As described in Section 5.8.3, the Project Area is adjacent to a major shipping route, with traffic density in the vicinity estimated at four to eight ships per day. As well, DFO carries out stock assessment surveys and research activities throughout the maritime marine environment, which may overlap with proposed Project activities. The effects of the Project on these other users will also be assessed.

The effects of all accidental events on Commercial Fisheries and Other Users are assessed in Section 8. Cumulative environmental effects in consideration with other Projects and/or activities are assessed in Section 9.

7.8.1 Residual Environmental Effects Significance Criteria

7.8.1.1 Commercial Fisheries

A significant adverse residual environmental effect on Commercial Fisheries is one that has a measurable and sustained adverse effect on commercial fishing incomes.

An adverse environmental effect that does not meet the above criteria is considered to be not significant.

A positive effect is defined as one that results in a measurable increase in fisher income.

7.8.1.2 Other Users

Other users include Aboriginal fisheries, recreational fisheries, aquaculture, seal and bird hunting, military use, marine traffic and tourism and recreation. Marine traffic and military use is the primary other user that could interact with the Project. Aboriginal and recreational fisheries, aquaculture, sealing and bird hunting and tourism and recreational are activities that normally occur nearshore and are not expected to interact with the Project Area. Therefore, the focus will be on marine traffic and military use in this section. Other users are discussed under accidental events (Section 8.7.7).

A significant effect is one that has a detrimental effect on the use of the Cabot Strait by marine traffic and military use for a duration of time sufficient to affect a long-term change in the established traffic patterns.

An adverse environmental effect that does not meet the above criteria is considered to be not significant.

A positive effect is defined as one that enhances marine traffic and military use activities.

7.8.2 Effects Assessment

Fishers elsewhere in the world have expressed concerns with respect to offshore oil exploration and development. Lam (2001) provides a good review of fisheries-related issues in the United Kingdom over more than three decades of offshore oil and gas development. Issues and concerns relevant to this environmental assessment include loss of access, damage to gear and compensation for damage, and communication between the two industries. Similarly, issues identified off California (MMS 2001) have included space use conflicts and reduced catch due to seismic activity and related noise. Peterson (2004) draws on Canada's east coast experience to describe potential interaction between seismic testing activities and fisheries on the west coast of Canada (British Columbia). Issues identified in that report include reduced fish catch and space use conflict. Numerous other such reports exist, all of which highlight the importance of communication between the fishing (including DFO, with respect to research activities) and oil industries, often through the establishment of formal liaison mechanisms to deal with specific issues.

7.8.2.1 Presence of the Drill Platform

A FEZ is a temporary exclusion zone typically established around a drilling platform for the duration of the 20 to 50 day drilling program; fishing is not permitted within a FEZ. Input into the development of the FEZ is solicited from stakeholders during public and fisheries consultation as part of the EA process. The FEZ around drilling operations is relatively small. If the drilling platform is an anchored rig (such as a semi-submersible), then the FEZ typically extends 500 m beyond the anchor points (which can extend up to approximately 1,000 m from the centre of the drilling platform). If the drilling platform is not anchored, then the FEZ is established 500 m from the edge of the drilling platform.

The FEZ is enforced by the Offshore Installation Manager through the authority granted by the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act*. Reasonable measures will be taken to warn persons in charge of vessels of the FEZ boundaries and related potential hazards Information on the FEZ is usually provided via the Fisheries Broadcast and through the Notice to Shippers. Because fishing will not be safe within the designated safety zones, the effect of exclusion has the potential to interact with commercial fisheries (including research and sentinel fisheries). However, since the zones will be located in areas where very little commercial fishing has occurred in recent years (as described in Section 5.8.1, no harvesting locations were recorded within the Project Area, with the closest harvest location being approximately 10 km to the southwest), the safety zone area is expected to have little operational or economic impact on fish harvesters.

If sites selected for DFO science surveys happen to be within an active safety zone, alternative sites can be used (DFO typically selects equivalent alternative sites, for example, for random stratified surveys).

7.8.2.2 Drill Muds and Cuttings

The effect of drill muds and cuttings on commercial fisheries would be limited to the extent to which these discharges affect fish resources in the area. As shown in Section 7.4.2.2, effects of drill muds and cuttings on fish, shellfish and fish habitat will generally be limited to within 500 m of the wellsite with expected recovery within three to five years. Given the localized area of the effect and the current low level of harvesting in the Project Area, these discharges are predicted to have no residual adverse environmental effects on fish harvesters or other marine users.

7.8.2.3 Routine Discharges

Similar to the effect of drill muds and cuttings, routine discharges could affect commercial fisheries indirectly through effects on fisheries resources or directly through fouling of gear. All routine discharges from the MODU and supply vessel(s) will comply with the OWTG and will meet the *Pollution Prevention Regulations* of the *Canada Shipping Act*. Sewage and food wastes would be macerated before discharge.

As routine discharges will be of limited duration and frequency over the drilling period, will comply with applicable regulations and will disperse rapidly in an open ocean environment, no measurable effects on fish resources are anticipated. With the FEZs in place, the potential for fouling of gear is also limited. As such, the adverse residual effects on Commercial Fisheries and Other Users is predicted to be not significant.

7.8.2.4 Supply Vessels

Supply vessels associated with the Project could interfere with fish harvesting activities if they interfere with the operation of fishing vessels or fishing gear. Such conflicts are more likely to involve fixed fishing gear (*e.g.*, crab pots), and might result in gear damage, gear loss, loss of catch and increased operational expenses for harvesters. While supply vessels pose minimal risk to fishing gear (*i.e.,*no more than other ocean-going ships or other fishing vessels in the area), surveys such as VSP during drilling do pose more of a specific risk if the seismic equipment is towed through the water. Seismic survey/fishing gear conflicts do occur sometimes once or twice a year in Atlantic Canada, though not usually as the result of localized VSP surveys, which are very small scale (*i.e.*, on the order of a few kilometres). As the Project Area is characterized by low existing harvesting activity, conflicts are expected to be minimal.

In the event that DFO research activities or stock assessments are underway in the vicinity of the Project Area during the proposed exploration drilling program, interactions and potential effects could occur either as a result of behaviour responses, fishing interference or displacements (LGL 2005b). The DFO Science Advisory Schedule can be accessed online to determine if there are any DFO activities scheduled to overlap with the Project. This online resource included activities scheduled through the month of March 2013, but no later, at the time of writing this report. This online resource will be accessed to check for conflicts prior to the Project and communication with DFO will be used to resolve any potential issues should they occur.

During the proposed exploration drilling program, it is expected that commercial traffic will be passing in the vicinity of the Project Area. Therefore, the mobilization and logistic support for an exploration drilling program may interact with marine traffic and military use in the Cabot Strait, which includes the Laurentian Channel. The incremental amount of vessel traffic as a result of this Project is anticipated to be negligible compared to existing vessel traffic in the area and interactions will be minimal.

Overall, the residual adverse environmental effect of potential conflicts with supply vessels is predicted to be not significant for Commercial Fisheries and Other Users.

7.8.2.5 Drilling Noise / Vertical Seismic Profiles

Sound and the effects of sound that are applicable to commercial fish are presented in detail in Sections 7.1.5.3. As described in this section, if one examines sounds based on a hierarchal effect, then the most intense sounds associated with the proposed undertaking would most likely be associated with the seismic sources used in the VSP survey, followed by the drill platform and related operations, support vessels and helicopters. Much of the information presented on sound in subsequent sections will be related to seismic sources, as seismic sound sources using a risk management process has the potential to produce the more pronounced responses as it will be the most probable source of the most intense sounds undertaken as part of the exploration activities. VSP surveys may be conducted as part of the exploration drilling program. VSP surveys use a seismic source with a lower intensity and duration than those associated with seismic surveys.

Fisheries industry representatives have registered concerns in the past that seismic survey sound sources, in particular, may scare finfish from their fishing locations, or discourage benthic species (such as snow crab) from entering fixed fishing gear. There are also scientific reports of decreases in finfish catch rates near seismic arrays. There is debate on the duration and geographic extent of the effect, however. Reports range from fish quickly returning to the area after source arrays were activated, to finfish catch rates several kilometres away taking days to return to normal (Løkkeborg 1991; Skalski *et al.* 1992; Engås *et al.* 1996). In any case, compared to a conventional 2-D or 3-D geophysical survey, a very small area would be affected by VSP sound, since the area where the activities would take place will be quite small (*i.e.*, in the immediate area of the drilling location). Also, the VSP sound source is typically smaller, the noise generated is lower than typical seismic arrays and the surveys would occur over a shorter timeframe.

Given the nature of the surveys to be conducted, the limited effects on fish resources and the lack of harvesting activity within the immediate Project Area, the residual environmental effect of noise sources on Commercial Fisheries and Other Users is predicted to be not significant.

7.8.2.6 Atmospheric Emissions

Potential interactions between atmospheric emissions and Commercial Fisheries and Other Users will be limited and, therefore, further assessment is not warranted.

7.8.2.7 Well Suspension / Abandonment

Noise generated during the removal of the wellhead will be of short duration and localized. The disturbance associated with well suspension and abandonment activities (primarily associated with noise generated during removal of the wellhead) will be of short duration and occur directly at the wellsite. The level of vessel traffic would be similar to that currently experienced in the area.

If the wellhead is removed, the wellhead and associated equipment would be removed to at least 1 m BSF, so as not to pose any obstruction. If approval is granted for leaving a wellhead in place, several factors are considered, including the occurrence and type of fishery in the area, as well as water depth at the location of the wellhead. Thus, it would not be left in place if it is deemed to be a major obstacle for fishing activities.

The residual adverse environmental effects of well suspension / abandonment activities on Commercial Fisheries are predicted to be not significant.

7.8.3 Mitigation

7.8.3.1 Commercial Fisheries

The C-NLOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (CNLOPB 2012) provide guidance aimed at minimizing any impacts of VSP surveys on commercial fish harvesting. These Guidelines were developed based on best practices during previous years' surveys in Atlantic Canada, and on guidelines from other national jurisdictions. The relevant Guidelines state (Appendix 2, Environmental Mitigative Measures):

> *a) The operator should implement operational arrangements to ensure that the operator and/or its survey contractor and the local fishing interests are informed of each other's*

planned activities. Communication throughout survey operations with fishing interests in the area should be maintained.

b) The operator should publish a Canadian Coast Guard "Notice to Mariners" and a "Notice to Fishers" via the CBC Radio program Fisheries Broadcast.

c) Operators should implement a gear and/or vessel damage compensation program, to promptly settle claims for loss and/or damage that may be caused by survey operations. The scope of the compensation program should include replacement costs for lost or damaged gear and any additional financial loss that is demonstrated to be associated with the incident. The operator should report on the details of any compensation awarded under such a program.

d) Procedures must be in place on the survey vessel(s) to ensure that any incidents of contact with fishing gear are clearly detected and documented (e.g., time, location of contact, loss of contact, and description of any identifying markings observed on affected gear). As per Section 5.2 of these Guidelines, any incident should be reported immediately as per the C-NLOPB / CNSOPB Guideline for the Reporting and Investigation of Incidents.

Corridor will also use qualified fishing observer(s) / Fisheries Liaison Officer. These mitigative measures will be in place for any such surveys required for the Project.

Section 4.9 of the C-NLOPB's *Guidelines Respecting Drilling Programs in the Newfoundland Offshore Area* state: "the operator should provide for the advance notification of persons engaged in fishing activities in the proposed area of operations and the measures to be put in place to eliminate any potential mutual interference."

The locations of the FEZs will be well publicized and communicated to fishers and DFO, and Corridor will continue to communicate with fishers and DFO about fishing and survey activities in these areas. The general timing and locations of planned Project activities will be provided to fishers who may be operating in the vicinity of the Project Area via a Canadian Coast Guard "Notice to Mariners" and a CBC Radio Fisheries Broadcast "Notice to Fishers".

Harvesting locations for each species can vary between years, as well as within the same season, due to migration patterns, catch rates, quotas, resource issues, weather, technology, and fuel costs. Effective communication of all operations in the Project Area is imperative.

7.8.3.2 Other Users

Representative(s) from DFO will be contacted prior to commencement of the Project to confirm the presence or absence of DFO vessels in the vicinity of the Project Area during the 20 to 50day exploration drilling program. Scheduling will be coordinated with DFO, as required, to avoid or minimize disruption to existing DFO research activities or stock assessments being carried out in the Old Harry Prospect Area.

7.8.4 Residual Environmental Effects

A summary of potential environmental effects on Commercial Fisheries and Other Users is provided in Table 7.14. With the above mitigations in place (including compensation if a conflict with gear were to occur), and in light of the localized nature of VSP surveys, their small footprint, short duration, and the lack of past harvesting activities in the Project Area, the residual environmental effects of the Project on Commercial Fisheries and Other Users is predicted to be not significant.

Table 7.14 Potential Environmental Effects Assessment Summary – Commercial Fisheries and Other Users

Project Components / Activities	Potential Interactions/ Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
Presence of Drill Platform (including safety zone, lights, flares)	Change in fish catch (A); Interference with marine traffic and military use (A)	Coordination and communication with fishing industry and DFO; Use of a qualified observer(s) / Fisheries Liaison Officer; Awareness of shipping lanes; Notice to Shipping	1	2	6	2	R	1
Routine Discharges	Change in fish catch (A); Fouling of Gear (A)	Adhere to Annex I of the *International Convention for the Prevention of Pollution from Ships* and OWTG	1	1	6	2	R	1
Supply Vessels (supply boat and helicopter)	Change in fish catch (A); Interference with marine traffic, military use, DFO surveys, and other users (A)	Coordination and communication with fishing industry and DFO; Use of a qualified observer(s) / Fisheries Liaison Officer; Awareness of shipping lanes; Notice to Shipping	1	1	6	2	R	1
VSP Surveys/ Drilling Noise	Change in fish catch (A); Interference with marine traffic and DFO Surveys (A)	Compliance with the C-NLOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines*; Use of a qualified observer(s) / Fisheries Liaison Officer; Awareness of shipping lanes; Notice to Shipping	1	2	6	2	R	1
Well Abandonment / Suspension	Interference with marine traffic, fishing gear and DFO Surveys (A)	Compliance with C-NLOPB requirements	1	1	1	1	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius

Frequency
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200events/yr
5 = >200 events/yr
6 = continuous

Duration

Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

Table 7.14 Potential Environmental Effects Assessment Summary – Commercial Fisheries and Other Users

Project Components / Activities	Potential Interactions/ Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-Economic Context
3 = 11-100 km radius 4 = 101-1,000 km radius 5 = 1,001-10,000 km radius 6 = >10,000 km radius	1 = <1 month 2 = 1-12 months 3 = 13-36 months 4 = 37-72 months 5 = >72 months	n/a = Not applicable						

8.0 ACCIDENTAL EVENTS

The two main types of accidental events that could occur during the proposed exploration drilling program are blowouts and "batch" spills. Blowouts are continuous spills lasting hours, days or weeks that could involve the discharge of natural gas and/or crude oil into the environment. Batch spills are instantaneous or short-duration discharges of petroleum hydrocarbons that could occur from accidental events on the drilling rig where fuel oil and other petroleum products are stored and handled.

Based on modelling conducted by SL Ross (2011a, updated 2012; see Section 2.12 for summary), the maximum extent of an oil spill that originates at the wellsite could extend up to 20 km from the point of origin of the spill, which is approximately 50 km away from the closest Newfoundland coast, approximately 70 km from the closest Nova Scotia coast and approximately 75 km away from the closest Magdalen Islands coast (Figure 2.23). As the Study Area was delineated to incorporate supply vessel and helicopter routing to and from Newfoundland, there is also potential for a batch spill to originate from a supply vessel at any point along the route. The worst case-scenario would be a collision / sinking close to shore that resulted in the loss of oil and diesel fuel.

Estimates on the probability of these spills and the results of trajectory modelling are provided in Sections 8.4 and 2.12.2, respectively. The information in these sections is from supporting documents prepared by SL Ross Environmental Research Ltd. (SL Ross 2011a, updated 2012). An assessment of the environmental effects of an accidental event on the VECs is provided in Section 8.0.

8.1 Relief Well Planning

Corridor will prepare a relief well strategy that will ensure the following items are addressed in the Approval to Drill process with the C-NLOPB:

- a relief well drilling rig contracting plan;
- suitable quantity and type of tangible items are readily available for deployment (*e.g.*, wellheads, tubular); and
- suitable relief well locations will be pre-determined prior to initiation of operations at Old Harry; these locations will consider expected wind, wave and current directions as well as maintaining a safe distance from the blowing well.

It is assumed that if a relief well were to be drilled, a drilling rig would have to be mobilized from Newfoundland, the Gulf of Mexico or the North Sea with mobilization time varying from 7 to 45 days (depending on location). Upon rig mobilization, it would take approximately 20 to 45 days to drill the relief well.

8.2 Well Cap and Containment System

Corridor will adhere to industry standards as well as the C-NLOPB's Guidelines and Regulations in place at the time of operations at Old Harry.

In conjunction with CAPP, the C-NLOPB, other Newfoundland operators and industry companies, Corridor will continue work to ensure that the most suitable cap and containment system available in Eastern Canada is also available for use on this well should the need arise.

The Subsea Well Response Project (SWRP) is a joint initiative of experts from nine of the world's major oil and gas companies who work together practively and cooperatively to build on existing capabilities and develop enhanced oil response equipment and methods. Oil Spill Response Ltd. (OSRL) and SWRP are collaborating to make the new integrated intervention system available to the industry and to ehance interational capabilities to respond to subsea well incidents. This group makes available, based on a fee structure, equipment to oil and gas companies operating around the world. The equipment includes capping toolboxes, capability for subsea dispersant use, and deployment services. For drilling in the 2014/15 timeframe, Corridor will enter into an arrangement with this group for access to this enhanced spill response equipment. Corridor's first priority, as with all operators, is prevention. In the unlikely event of a uncontrolled blowout, Corridor will have access to the same equipment as all operators active on the Grand Banks.

8.3 Spill Response Technologies

The general awareness of drill rig personnel will be increased through training and safety meetings. Personnel will be encouraged to report potential problems and "near miss" incidents in an attempt to avoid an occurrence that could result in a loss of containment or other release of petroleum or other hydrocarbons.

Standard Operating Procedures to reduce or eliminate the chance of a spill, even in the case of equipment failure, will be instituted for all hydrocarbon handling operations. Prior to drilling, practices for operating in poor weather and/or high sea state conditions will be established. Good communications and sound marine practices for all vessels will also improve the ability to prevent spills.

The emergency oil spill program should consider a range of offshore spill response options as well as training and Standard Operating Procedures. The decision when to use each of these is based on an evaluation of operating conditions, the anticipated characteristics of the hydrocarbon, the effectiveness of the option and effects on the environment. There are environmental and technological constraints to response and cleanup. High sea states and visibility are examples of typical environmental constraints, while technological constraints include pumping capacity of oil recovery devices and effectiveness of chemical dispersants. These kinds of limitations apply in all environments and jurisdictions.

Cleanup and recovery from an oil spill is difficult and depends upon many factors, including the type of oil spilled, the temperature of the water (affecting evaporation and biodegradation) and the types of shorelines and beaches that may be involved.

Some examples of methods for cleanup and recovery include the following:

- Surveillance, tracking and detection are critical. Information about the location, movement and characteristics of the oil spill must be considered. Selection and application of response technologies depends on the location and movement of the oil, surface layer thickness and the nature and extent of weathering. Technologies for surveillance, tracking and detection include tracking buoys (used to follow the movement of the oil slick in response to winds, surface currents and ice movements), satellite imagery, airborne reconnaissance, vessel reconnaissance, trajectory modelling and optical tracking.
- Mechanical recovery involves the physical containment of the oil within natural or artificial barriers and the subsequent removal of the oil from the surface. Containment barriers are used to intercept, control, contain and concentrate spreading oil. Recovery of oil contained or concentrated with boom or natural barriers is accomplished using a skimming or recovery system that removes oil and water from the surface.
- Natural dispersion and/or degradation is the natural weathering of hydrocarbon as it breaks into small droplets by wave action that are metabolized by micro-organisms.
- Mechanical dispersion is the mechanical breakup of small spills by the use of readily available tools such as vessels (propeller wash) and sprayed water.
- Chemical dispersion or dispersants are a group of chemicals sprayed or applied onto oil slicks to accelerate the process of natural dispersion. They are usually used in oil spill response when it is desirable to reduce the amount of floating oil to minimize damage to shorelines, wildlife, and other sensitive resources. These must be authorized by the C-NLOPB before application.
- Controlled burning can effectively reduce the amount of oil in water, if done properly, but it can only be done in low wind, and can cause air pollution. *In situ* burning is undertaken by collecting and thickening the oil with a fire resistant boom, ignite it burning the oil in place in the water.
- Blowout control is an important response strategy, as it would be the primary method to control and minimize the environmental effects of a well blowout.

An Oil Spill Response Plan will be developed in advance of operations and submitted to the C-NLOPB for review and approval as part of the Operations Authorization application. This Plan will describe in detail the oil spill response strategies to be utilized in the unlikely event of an accidental release.

8.4 Spill Probabilities

Because the SL Ross study (2011b) derives spill and blowout statistics for the Project from worldwide statistics, it is assumed that the practices and technologies that will be used by Corridor will be at least as safe as those used in other offshore oil and gas operations around the world and will be in accordance with the accepted practices of the international petroleum industry.

8.4.1 General Oil Pollution Record of the Offshore Oil and Gas Industry

Compared with other industries that have potential for discharging petroleum oil into the marine environment, the industry of exploring, developing and producing offshore oil and gas (the offshore E&P industry) has a very good record. A study on marine oil pollution by the US

National Research Council (NRC 2002) indicates that accidental petroleum discharges from platforms contribute only 0.07 percent of the total petroleum input to the world's oceans (0.86 thousand tonnes per year versus 1,300 thousand tonnes per year - see Table 8.1).

Table 8.1 Best Estimate of Annual Releases [1990 to 1999] of Petroleum by Source

Petroleum Source	North America (in thousands of tonnes)	Worldwide (in thousands of tonnes)
Natural Seeps	**160**	**600**
Extraction of Petroleum	**3.0**	**38**
Platforms	0.16	0.86
Atmospheric Deposition	0.12	1.3
Produced waters	2.7	36
Transportation of Petroleum	**9.1**	**150**
Pipeline Spills	1.9	12
Tank Vessel Spills	5.3	100
Operational Discharges [Cargo Washings]	Na[A]	36
Coastal Facility Spills	1.9	4.9
Atmospheric Deposition	0.01	0.4
Consumption of Petroleum	**84**	**480**
Land-Based [River and Runoff]	54	140
Recreational Marine Vessel	5.6	Nd[B]
Spills [Non-Tank Vessels]	1.2	7.1
Operational Discharges [Vessels 100 GT]	0.10	270
Operational Discharges [Vessels <100 GT]	0.12	Nd[C]
Atmospheric Deposition	21	52
Jettisoned Aircraft Fuel	1.5	7.5
TOTAL	**260**	**1,300**

Source: NRC 2002. This 2002 report is the third (and most recent) in a series of reports updated periodically by NRC.
[A] Cargo washing is not allowed in US waters, but is not restricted in international waters. Thus, it was assumed that this practice does not occur frequently in US waters.
[B] World-wide populations of recreational vessels were not available.
[C] Insufficient data was available to develop estimates for this class of vessels.

8.4.2 Historical Large Spills from Offshore Oil Well Blowouts

The main concern is the possibility of a well blowout occurring and discharging large quantities of oil into the marine environment. In Canada, only one small condensate blowout has occurred on the Scotian Shelf. In the US, only three oil-well blowouts (including the recent BP Deepwater Horizon blowout in the Gulf of Mexico) involving oil spills larger than 50,000 barrels have occurred since offshore drilling began in the mid-1950s. One must, therefore, look beyond North America to find a reasonable database on very large and extremely large oil-well blowouts (see Table 8.2 for a definition of hydrocarbon spill sizes). All worldwide blowouts involving spills of more than 10,000 barrels each are provided in Table 8.3.

Table 8.2 Definition of Hydrocarbon Spill Sizes

Hydrocarbon Spill Type	Spill Size	
	bbl	m^3
Extremely Large	>150,000	>23,850
Very Large	>10,000	>1,590
Large	>1,000	>159
Small	<1	<0.159

Note: The top three categories are cumulative; for example, the large-spill category (>1,000 bbl) includes the very large and extremely large spills, and the very large category includes extremely large spills. This follows the approach used by BOEMRE statisticians upon which the "large" spill frequencies are derived.

Table 8.3 Historical Large Spills from Offshore Oil Well Blowouts

Area	Reported Spill Size (bbl)	Date	Operation Underway
US, Santa Barbara	77,000	1969	Production
US, S. Timbalier 26	53,000	1970	Wireline
US, Main Pass 41	30,000	1970	Production
Trinidad	10,000	1973	Development drilling
North Sea / Norway	158,000	1977	Workover
Mexico (*Ixtoc 1*)[A]	3,000,000	1979	Exploratory drilling
Nigeria	200,000	1980	Development drilling
Iran	100,000	1980	Development drilling
Saudi Arabia	60,000	1980	Exploratory drilling
Iran[B]	see note	1983	Production
Mexico	247,000	1986	Workover
Mexico	56,000	1987	Exploratory drilling
US, Timbalier Bay / Greenhill	11,500	1992	Production
Australia[C]	30,000	2009	Development drilling
US, GOM[C]	4,000,000	2010	Exploratory drilling

[A] Spill volume widely believed to be underestimated.
[B] The Iranian Norwuz oil-well blowouts in the Gulf of Arabia, which started in February 1983, were not caused by exploration or drilling accidents but were a result of military actions during the Iraq / Iran war.
[C] Currently under investigation. Spill volume is best estimate and may be subject to revision.

8.4.3 Spill Probabilities from Historical Statistics

Spill frequencies are best expressed in terms of a risk exposure factor such as number of wells drilled. As of May 2010, approximately 50,433 offshore exploration and delineation wells have been drilled (Deloitte Petroleum Services 2010). Therefore, based on two extremely large spills (>150,000 barrel) during offshore exploration drilling the historical frequency is 3.97×10^{-5} (2 / 50,433).

A similar calculation can be done for “very large” spills, that is, those larger than 10,000 barrels. Referring again to Table 8.2, it is seen that four exploration drilling blowouts have produced spills in the “very large” spill category (including Ixtoc 1 and Macondo), so the spill frequency for these becomes 7.93×10^{-5} spills per well drilled (4 / 50,433).

In the entire history of operations in Canadian waters, the US outer continental shelf (OCS), and the North Sea, there have been no large (>1,000 barrel) spills during exploration drilling, other than those listed above including the recent Macondo incident. Only one exploration drilling blowout that resulted in a large oil spill, other than the spills listed in Table 8.2 (again noting that the category of large spills includes very large spills and extremely large spills). This occurred in the offshore Ankleshwar field in Gujarat, India, in 1998. The operator was the state-owned Oil and Natural Gas Corporation and the spill size was 100,000 gallons or 2,380 barrels. If it is assumed that this was the only large-spill blowout to occur after the ones accounted for above (and this may be a weak assumption), then the spill frequency for large (>1,000 barrel) spills from exploration drilling becomes 5 / 50,433 = 9.91×10^{-5} spills per well drilled.

8.4.4 Blowout Frequency Trends

It must be noted that the above spill frequency calculations are based on the entire offshore experience from 1955 to the present. Most of the spills noted in Table 8.3 occurred over 20 years ago, and, as noted earlier, only one large spill from exploration operations (the recent Macondo incident in the US GOM) has ever occurred in North American or North Sea waters. There is an obvious trend over time toward fewer blowouts. Looking at only the drilling related blowouts and comparing these against the number of wells drilled in the corresponding periods, the historical frequency can be calculated (Table 8.4). There is a clear downward trend from the 1970s to 1980s to 1990s, but then an increase in the most recent 10 year period.

Table 8.4 Large Offshore Drilling-related Blowouts, Historical Frequency by Decade

Period	Incidents	Wells Drilled Worldwide[A]	Frequency	Return Period
1971 to 1980	5	20,116	2.49×10^{-4}	One in 4,020
1981 to 1990	1	29,527	3.39×10^{-5}	One in 29,500
1991 to 2000	0	28,118	0	--
2001 to present	2	26,732	7.48×10^{-5}	One in 13,400

Source: Deloitte Petroleum Services. 2010. List of offshore petroleum wells to May 31, 2010. Report generated on request from Deloitte LLP. London, England.
[A] Includes all offshore wells.

8.4.5 Calculated Blowout Frequencies for the Old Harry Project

Based on a drilling program of one exploration well:

- Predicted annual frequency of extremely large oil spills (>150,000 barrel) from blowouts during an exploration drilling operation, based on an exposure of wells drilled is simply, for a base case of one well, (1 well drilled/year) x (3.97×10^{-5} spills/well drilled) = 3.97×10^{-5} spills per year. This represents an annual probability of one in 25,000. Another way of expressing this would be to say that, if this drilling rate of one well per year were to continue forever, one could expect an oil spill larger than 150,000 barrels once every 25,000 years.

- Predicted annual frequency of very large oil spills (>10,000 barrel) from exploration drilling blowouts based on an exposure of wells drilled is 7.93×10^{-5}, or a probability of one in 13,000.
- Predicted annual frequency of large oil spills (>1,000 barrel) from exploration drilling blowouts based on an exposure of one well drilled is 9.91×10^{-5}, or a probability of one in 10,000.

8.4.6 Exploration Drilling Blowouts Involving Primarily Gas

Gas blowouts from offshore wells that do not involve a discharge of liquid petroleum are generally believed to be harmless to the marine environment. However, such blowouts do represent a threat to human life and property because of the possibility of explosion and fire.

US OCS data representing the 30 year period from 1980 to 2010 are provided in Table 8.5. The drilling and blowout experience in operations off Newfoundland and Nova Scotia are summarized in Table 8.6. The total number of exploration wells drilled in the U.S. Federal OCS from 1980 to 2010 is not shown in Table 8.5, but it is derived from Deloitte (2010); the number is approximately 12,000. The number of blowouts from exploration drilling is shown to be 45; therefore, the blowout frequency is 45/12,000 or 3.75×10^{-3} blowouts per well drilled, or one blowout for every 267 wells drilled. Five of the blowouts involved oil spills, one of size 200 barrels, one was 100 barrels, one was 11 barrels, one was 5 barrels and the recent Macondo spill of 4×10^{6} barrels. The frequencies in Table 8.5 are consistent with the values derived from Table 8.6 (2.8×10^{-3} versus 3.75×10^{-3}). It is important to note that blowout frequencies in the North Sea and in the GOM declined significantly over the most recent years of the study period, as shown in Table 8.7.

Table 8.5 Blowouts and Spillage from U.S. Federal Offshore Wells, 1980 to 2010

Year	Well Starts	Drilling Blowouts				Non-drilling Blowouts								OCS Production
		Exploration		Development		Production		Workover		Completion		Total Blowouts		
		No.	bbl	No.	bbl	No.	bbl	No.	bbl	No.	bbl	No.	bbl	MMbbl
1980s	11,071	19	0	21	0	7	0	19	113	6	60	72	173	3,407.3
1990s	8,765	17	300	16	0	2	0	5	0	3	0	44	302	4,292.4
2000s	8,390[A]	9	4 E6[B] + 16	9	1	8	378	7	12	1	0	29	380	5,389.64
Total	28,226	45	4 E6[B]	46	1	17	378	31	125	10	60	145	855	13,089.34

[A] Most recent three years estimated.
[B] Total includes 4,000,000 barrel Macondo spill plus 316 barrels in 44 other incidents.

Table 8.6 Exploration and Development Wells and Blowouts in the Eastern Canada

Region	No. of Exploratory Wells	No. of Development Wells	No. of Blowouts	Exploration Blowout Frequency	Overall Blowout Frequency
Newfoundland	198	164	0	0	0
Nova Scotia	154	53	1 (exploration)	6.5×10^{-3}	4.8×10^{-3}
TOTAL	352	217	1 (exploration)	2.8×10^{-3}	1.8×10^{-3}
Valid to January 2011 for Newfoundland, March 2010 for Nova Scotia.					

Table 8.7 Exploration and Development Drilling Blowout Frequencies over Time

Time Period	Number of Blowouts	Number of Exploration and Development Wells Drilled	Blowout Frequency
18 years (1980 to 1997)	53	22,084	24.0×10^{-4}
10 years (1988 to 1997)	23	13,870	16.6×10^{-4}
5 years (1993 to 1997)	5	7,581	6.6×10^{-4}
3 years (1995 to 1997)	1	4,924	2.0×10^{-4}
Source: Scandpower 2000			

A more recent analysis by Scandpower (2006), summarized in IAOGP (2010), confirms the reduced frequencies in recent years. The data, based on the 20 year record to 2005, indicate a subsea blowout frequency of 2.1×10^{-4}, based on two incidents in 9,744 wells drilled, which is comparable to the most recent three-year period included in the Scandpower (2000) report. A subsea blowout frequency of 2.1×10^{-4} is equivalent to a probability of one blowout for every 4,800 wells drilled. The more recent analysis also indicates a shallow gas blowout frequency of 2.8×10^{-3}, based on 26 incidents in 9,172 wells drilled.

8.4.7 Calculated Blowout Frequencies for the Old Harry Project

Considering again an exploration program of one well, the blowout frequency becomes 1 well x 2.1×10^{-4} blowout/well drilled = 2.1×10^{-4} blowout per year, or a one in 4,800 chance of a subsea blowout occurring over the drilling program.

8.4.8 Smaller Non-blowout Spills

Oil spills other than from blowouts can occur during drilling and production activities. These include spills of diesel oil or lubricating oil on the drilling installation, spills from transfer operations, spills of drilling muds, and spills from similar incidents involving the handling of oil that is needed to run operations. The overwhelming majority of these spills are very small.

As there have been very few large spills related to exploration and development in Canadian waters, US and world-wide statistics are used. However, there is a reasonably-sized database on small spill incidents in Newfoundland and Labrador waters. Spill statistics are maintained and reported by the C-NLOPB (2011c).

Offshore drilling in Newfoundland and Labrador waters commenced in 1966 with 362 wells drilled to date. Spill incident data, published by the C-NLOPB, is available from 1997 when production began (C-NLOPB 2011b). Since 1997, 219 wells have been drilled. The spill incidents involving 1 barrel or more of hydrocarbon during that period are listed in Table 8.8. These spills include spills of crude, diesel and other hydrocarbons resulting from production and loading operations. As noted above, there was one spill of greater than 1,000 barrel, in 2004.

Table 8.8 Frequency of Spills in the Ranges of 1 to 49.9 Barrels and 50 to 999 Barrels (Newfoundland and Labrador Waters, 1997 to 2010)

Spill Size Range	Number of Spills
1 to 49.9 barrels	12
50 to 999 barrels	0

A disproportionate number (7 of 12) of these spills occurred in the first three years of operations, so it is reasonable to focus on the more recent years (Table 8.9). For the years 2000 to 2010, some 183 wells were drilled.

Table 8.9 Frequency of Spills in the Ranges of 1 to 49.9 Barrels and 50 to 999 Barrels (Newfoundland and Labrador Waters, 2000 to 2010)

Spill Size Range	Number of Spills
1 to 49.9 barrels	5
50 to 999 barrels	0

For the smallest size range, statistics from Newfoundland and Labrador operations can be used, but as there have been zero spills in the second category, US GOM statistics will be used. Based on this, the frequency of spills in the range of 1 to 49.9 barrel is 2.7×10^{-2} (5 / 183) per well drilled and for the range 50 to 999 barrel is 1.8×10^{-3} (104 incidents / 56,500 total wells).

The C-NLOPB also provides a statistical record of spills of greater than 1 L but less than 159 L (1 barrel), and of spills of 1 L and less (Table 8.10). As in the previous category of spill size, a disproportionate number of these spills occurred in the first three years of operations, so it is reasonable to focus on the more recent years of the record, 2000 to 2010. For these years (2000 to 2010), there were a total of 183 wells drilled, with 87 spills in the 1 to 159 L category, and 201 spills less than 1 L. Note that the totals in Table 8.10 indicate all spills from 1997 to 2010. The total number of recorded spills less than 159 L (1 barrel) results in a historical frequency of 1.69 spills per well drilled (141 + 230 / 219 wells).

Table 8.10 Record of Very Small Spills in Newfoundland Waters, 1997 to 2010

Year	Spills Greater Than 1 L and Less Than 159 L (1 barrel)		Spills of 1 L and Less	
	Number	Total Volume (L)	Number	Total volume (L)
1997	7	123	0	0
1998	20	640	3	1.6

Table 8.10 Record of Very Small Spills in Newfoundland Waters, 1997 to 2010

Year	Spills Greater Than 1 L and Less Than 159 L (1 barrel)		Spills of 1 L and Less	
	Number	Total Volume (L)	Number	Total volume (L)
1999	24	1,193	9	4.72
2000	2	62	2	1.1
2001	7	26	8	4.21
2002	5	16	19	5.2
2003	10	186	9	2.48
2004	21	193	30	8.97
2005	11	181	28	8.96
2006	5	20	27	9.24
2007	3	93	34	4.28
2008	12	337	22	2.89
2009	11	215.8	22	4.97
2010	3	20.3	17	4.21
Total	**141**	**3,306.1**	**230**	**62.83**

8.4.9 Calculated Frequencies for the Old Harry Project

Three spill size classifications are considered: spills of less than one barrel (termed very small spills for this report), small spills defined as spills between 1 and 50 barrels, and medium spills, 50 to 999 barrels.

8.4.9.1 Spills (Less Than 1 Barrel)

The statistics in Table 8.10 are used to derive an estimated spill frequency for this spill size range. Considering a base case of one well drilled:

- The predicted frequency of spills less than 1 barrel during drilling operations is 1.69 spills/well.

8.4.9.2 Small Spills (1 to 10 Barrel)

The statistics in Table 8.10 are used to derive an estimated spill frequency for this spill size range. Considering that one well will be drilled:

- The predicted frequency of spills of size 1 to 50 barrels during drilling operations is 2.7×10^{-2} spills/well, or one spill every 37 wells.

8.4.9.3 Medium Spills (50 to 999 Barrel)

No medium spills or larger spills have occurred in Newfoundland waters since records began in 1997, therefore, US data is used:

- Based on US OCS experience, the predicted frequency of medium spills (50 to 999 barrels) during exploration drilling is 1.8×10^{-3} spills/well, or one spill every 540 wells.

8.4.10 Summary of Spill Frequencies

The calculated oil spill frequencies for the Old Harry Project are summarized in Table 8.11. The highest frequencies are obviously for the smaller, operational spills. Spills less than one barrel in size may occur one to two times per well, based on recent petroleum development experience off Newfoundland. Although they may occur with some regularity, they are likely to be quite small, with a median volume of 4 L. Oil spills during exploration that are larger than one barrel but less than 50 barrels have about a 1-in-37 chance of occurring per well. Oil spills of all types in the 50 to 999 barrel range may have about a 1-in-540 chance of occurring per well, based on experience in the US OCS.

There is about a 1-in-4,800 chance per well of having any sort of subsea blowout. Shallow gas blowouts may occur and are up to 10 times more probable than ones that occur at depth, but these would involve only natural gas and not oil.

The chances of an extremely large (>150,000 barrels), very large (>10,000 barrels), and large (>1,000 barrels) oil well blowout from exploration drilling are very small: about a 1-in-25,000, 1-in-13,000 and 1-in-10,000 chance per well, respectively. These predictions are based on worldwide blowout data and are strongly influenced by blowouts that occurred in parts of the world where drilling regulations may be less rigorous.

Table 8.11 Predicted Number of Blowouts and Other Spills for Old Harry Project (assuming one well)

Event	Historical Frequency (per well drilled)[A]	Probability
Subsea blowout during exploration drilling	2.1×10^{-4}	One every 4,800 wells
Exploration drilling blowout with oil spill >1,000 barrels	9.91×10^{-5}	One every 10,000 wells
Exploration drilling blowout with oil spill >10,000 barrels	7.93×10^{-5}	One every 13,000 wells
Exploration drilling blowout with oil spill >150,000 barrels	3.97×10^{-5}	One every 25,000 wells
Non-blowout oil spill, 50 to 999 barrels	1.8×10^{-3}	One every 540 wells
Non-blowout oil spill, 1 to 50 barrels	2.7×10^{-2}	One every 37 wells
Non-blowout oil spill, 1 L to 1.0 barrel	1.69	One every 0.59 wells

[A] Blowout spills (first four rows of data) are based on worldwide, US OCS and North Sea experience; Non-blowout - oil spills (last two rows of data) are based on Newfoundland experience, 2000 to 2010.

8.4.11 Spills of Synthetic-based Muds

The C-NLOPB records spills of SBM, and these are summarized in Table 8.12 for the years 1997 through 2010. In the largest such spill to date, in 2004, approximately 96,600 L (608 barrels) of SBM were spilled from the diverter line of the *GSF Grand Banks* at the White Rose location. The spill frequency is calculated based on the 219 wells spudded during this period.

Table 8.12 Spills of Synthetic-based Muds, 1997 to 2010

Spill Size Range	Number of Spills	Frequency, per well
>1 L	36	0.16
159 to 7,934 L (1 to 49.9 barrels)	18	0.082
7,935 to 159,000 L (50 to 999 barrels)	5	0.023
>159,000 L (1,000 barrels)	0	0

8.5 Nearshore Spills

The assessment of this Project includes helicopter and supply vessel transit to and from Newfoundland. Any support vessels that may come from St. John's, Newfoundland, will use the recognized shipping lane through the Laurentian Channel. Once the supply vessels leave the Project Area, they must adhere to general marine shipping rules and conventions, but there is a risk that an accident or collision could result in the release of hydrocarbons (likely diesel fuel and lubricants) into the marine environment. As the exact routing of these vessels has not yet been determined, it was not feasible to conduct modelling for these events. For the purposes of the assessment, it is assumed that the spill could occur anywhere within the Study Area and in a worst case-scenario, reach the shoreline. These potential effects are discussed here generically.

The United States Coast Guard (2005) published a fact sheet on small diesel fuel spills (approximately 1,900 to 19,000 L (500 to 5,000 gallons)), indicating that diesel fuel is a light, refined petroleum product and when spilled on water, most of the oil will evaporate or naturally disperse within a few days or less, seldom leaving any oil on the surface for responders to recover. It quickly spreads to a thin film; even when described as a heavy sheen, it is approximately 0.01 mm (0.0004 inches) thick. Due to low viscosity, it is readily dispersed into the water column; it does not sink and accumulate on the sea floor as pooled or free oil, but can be physically mixed into the water column by wave action, forming small droplets carried and kept in suspension by the currents.

Oil dispersed in the water column can adhere to fine-grained suspended sediments, which then settle out and are deposited on the sea floor (NOAA 2006), with this process more likely to occur near river mouths and less likely in open marine settings. For small spills, it is not likely to result in measurable sediment contamination. Because of its low viscosity, when small spills strand on the shoreline, the oil tends to penetrate porous sediments quickly, but also to be washed off quickly by waves and tidal flushing. Thus, shoreline cleanup is usually not needed. It can be expected to be fully degraded by naturally occurring microbes within one to two months or less.

Within any shoreline type, environmental effects are expected to be proportional to the nature and amount of oil stranded. The level of environmental effects of oil spills on shorelines is closely related to the relative degree of exposure of the affected habitat (Hayes and Gundlach 1975; Gundlach and Hayes 1978; Gundlach *et al.* 1978; Michel *et al.* 1978). Two physical factors, wave energy flux and tidal-energy flux, primarily determine the degree of exposure for shorelines (NOAA 2002).

Shorelines can be classified as high, medium and low energy (NOAA 2002). High-energy shorelines are exposed year round to large waves and/or strong tidal currents. They occur along the outermost coastline of a region that is subjected to dominant winds causing waves to strike the shoreline directly or by wave refraction. Medium-energy shorelines are subjected to seasonal patterns of influences resulting from storm frequencies and wave size (*i.e.*, they are more sheltered than high-energy shorelines but storm events result in similar patterns as high energy shorelines on a seasonal cycle). Low-energy shorelines are sheltered from wave and tidal energy, except during unusual or infrequent events.

Inherent in the energy classifications are inferences to the persistence of stranded oil. High energy shorelines exhibit rapid natural removal, usually within days to weeks. Low energy shorelines are characterized by slow, natural removal, usually within years. Medium energy shorelines have stranded oil that will be removed when the next high-energy event occurs, which could be days or months after the spill.

The tidal-energy flux (NOAA 2002) is also important in determining the potential of oil-spill effects on coastal habitats, as strong tidal currents can remove stranded oil as well as build and move inter-tidal sand and/or gravel that bury oil.

Substrate types (NOAA 2002) are important considerations with respect to persistence and effects of oil on shoreline types. The substrate type distinctions of primary importance are between bedrock and unconsolidated sediment, as with unconsolidated sediment there is the potential for penetration and burial of oil. Penetration and burial are different, but these mechanisms lead to the increased persistence of oil and as a result may lead to long-term biological effects, as well as making cleanup more difficult and intrusive. Environmental effects are expected to be greater where the oil penetrates permeable substrates and tends to persist in sheltered habitats. Studies have shown that heavy oils can penetrate up to 1 m on gravel beaches. The oil from Old Harry is anticipated to be light (45to 56 ºAPI). Mixed sand and gravel beaches usually have heavy oil penetration of less than 50 cm.

Beaches may have different permeabilities depending upon grain size, with muddy sediment have the lowest permeability and the least amount of penetration. However, the infaunal burrows provide a mechanism for oil penetration into an often impermeable substrate.

Biological resources (NOAA 2002) along shorelines are most at risk from oil spills when:

- large numbers of individuals are concentrated in a relatively small area;
- marine or aquatic species come ashore during special life stages or activities, such as nesting, birthing, resting, or molting;
- early life stages or important reproductive activities occur in sheltered, near-shore environments where oil may tend to accumulate;
- a species is threatened, endangered, or rare; or
- a large percentage of the population is likely to be exposed to oil.

In high-energy environments (NOAA 2000), oil is generally held offshore by wave reflection, and any oil that is deposited is rapidly removed by wave action. Environmental effects to inter-tidal communities are expected be short-term. In medium-energy environments, which are essentially an intermediate stage between high-energy and low-energy environments with tide pools, there is usually a small accumulation of soil sediment at high tide mark coexisting with gravel beaches. Depending upon the substrate type and energy / tidal flux, medium-energy environments often have varying species density and diversity. Barnacles, snails, mussels and macro-algae are present and may be dominant species.

The effects of oil in low-energy environments (NOAA 2000) may vary considerably, depending upon substrate type. Beach-type fauna will vary with sand beaches used by birds, turtles, crabs, amphipods and other sediment crustaceans. Tidal flats are often the most diverse productive type of low-energy environments, with large concentrations of bivalves, worms and other invertebrates. They are often critical habitat for feeding birds. If there is the presence of sea grasses, these low-energy environments may be important fish and shellfish nurseries. Under worst case scenarios, environmental effects in low-energy environments can be severe, with smothering and lethal toxicity associated with interstitial waters. Sea grass communities maybe become defoliated. Temporary declines in infauna may occur, which in turn may affect shorebirds, as low-energy environments are often critical forage habitats.

Several diesel oil spills have been studied in the past, focusing on the physical properties and movement of diesel, along with the biological effects of diesel in the marine environment (Hooper and Morgan 1999). Diesel has been found to have an immediate toxic effect on many intertidal organisms, including periwinkles, limpets, gastropods, amphipods and most meiofaunal organisms within several kilometres of the original spill (Pople *et al.* 1995; Stirling 1977; Wormald 1976; Cripps and Shears 1997). One such spill was found to have contaminated the water and shoreline with diesel within a 2 km radius of the original spill. Intertidal areas were most directly affected, but all components of the surrounding ecosystem were contaminated during the first weeks after the spill. Hydrocarbons were detected in tissues from birds, limpets, algae, calms, fish and crustaceans in harbours a couple of kilometres away up to one year after the incident (although continued chronic leakage from the ship was suggested as a possible source) (Kennicutt *et al.* 1991). Subtidally, there were no measurable effects of the *Bahia Paraiso* oil spill two months after the incident, nor was there any major contamination of the subtidal sediments (Hyland *et al.* 1994). Marine resources unable to avoid a spill, such as eggs and larvae, would be more at risk from the harmful physiological effects of a spill.

8.6 Spills of Whole Muds

SBM are drilling muds that consist of a synthetic base fluid chemical that is in continuous phase with water as the dispersed phase (Neff *et al.* 2005). As such, SBM are largely immiscible in water (Hart *et al.* 2007). When accidently released into seawater, SBM breaks into individual droplets. Due to the presence of barite in emulsion, SBM are denser than seawater and will sink when released. Dispersal, size and fall velocity of droplets depend on the conditions of release and mixing during descent through the water column (Hart *et al.* 2007). The contrasting physical/chemical properties of WBM versus SBM emulsions leads to different responses to dilution in seawater and, subsequently, different behaviours in the marine environment. These differences are fundamental and are possibly best described in terms of a comparison of the general behaviour of WBM and SBM releases in seawater.

In the case of WBM, seawater dilutes an emulsion that is already water-based (JW 2004). As a result, individual particles in the emulsion are separated by larger and larger distances such that they can be eventually treated as independent particles falling under the force of gravity. After sufficient dilution, these particles simply ‘rain’ down toward the seabed. The particles may coalesce (flocculate) and their behaviour in the benthic boundary layer (overlying water column and uppermost centimetres of sediment) may be complex, but, in any case, the original properties of the emulsion are lost. In the case of WBM, the effect of dilution is invariably to break the emulsion.

SBM emulsions behave quite differently (JW 2004). While the initial phase of dilution follows the same overall physical processes as does WBM (mainly mixing during momentum loss and turbulent decent), the entrained seawater does not dilute the emulsion constituents homogeneously and does not “break” the emulsion. Instead, the emulsion forms droplets that retain the properties of the original emulsion. These droplets can subsequently coalesce under conditions of reduced turbulence to regenerate the original bulk emulsion. The regenerated emulsion may be wetter than the original, due to water adsorbed by excess emulsifiers or due to the swelling of the water pockets within the emulsion. If wet enough and subject to shearing over a sufficiently long period of time, a thickened mousse may form. However, only under conditions of very high shear will the emulsion break with the separation of the synthetic base fluid phase from the emulsified constituents. This circumstance would be a very rare event, but if it were to occur, the buoyant base fluid phase of the emulsion will tend to rise in the water column while the heavier particles would tend to floc and sink toward the sea floor. Only in this unlikely case would the weighting particles tend to behave like diluted WBM particles. Most releases likely involve formation of droplets or streams of the SBM emulsion. The main environmental parameters affecting SBM plume behaviour are density and current.

8.7 Environmental Effects Assessment

An accidental release of oil could affect marine fish habitat and marine ecosystems (especially a subsea blowout), marine fish and shellfish (and the resulting affect on commercial fisheries), marine birds (especially a surface blowout or batch spill), marine mammals and sea turtles that come into contact with a slick (although they can usually avoid a slick), species at risk (for same reasons as the not at-risk species) and sensitive areas.

The following assessment assumes that the Study Area / Affected Area for each of the VECs would be equivalent to the cumulative predicted zones of influence from the spill scenarios described in Section 2.12.2 (and illustrated in Figures 2.12, 2.13, 2.18 and 2.19 and reported in SL Ross (2011a, updated 2012) for blowouts. As described in the introduction, there is also a possibility that spills of diesel fuel could occur from vessels enroute to site from Newfoundland (any support vessels that may come from St. John’s, Newfoundland, will use the recognized shipping lane through the Laurentian Channel.).

The same significance criteria are used as for routine Project activities (see Sections 7.2.1 to 7.8.1).

8.7.1 Species at Risk

The species at risk that may occur within the Study Area are identified in Tables 5.1 and 5.2 and include marine fish, marine birds, marine mammals and sea turtles.

8.7.1.1 Marine Fish Species at Risk

Fish have the potential to interact with material discharged during a spill event. Spilled substances can adhere to physical habitat structures or influence chemical habitat parameters (*e.g.*, water quality). The risk of exposure of marine fish to an oil spill is dependent on the habitat they occupy and their behaviour (Yender *et al.* 2002):

- Adult pelagic and benthic fish, occurring in relatively deep waters have low exposure risk because they are highly mobile and able to avoid oiled areas (Irwin 1997) and oil concentrations in the water column are usually low and declining;
- larval and juvenile pelagic and benthic fish species may be at a greater risk to avoiding oiled areas as, they may be less mobile than adults;
- fish that spawn or occur in nearshore intertidal and subtidal zones and in shallow reef zones are at higher risk of exposure due to shoreline oiling;
- shellfish have a moderate risk of exposure because they have some mobility, but utilize benthic habitats in shallow nearshore and estuarine areas. Species that burrow into contaminated sediments are at higher risk of exposure;
- molluscs, especially bivalves, are at high risk of contamination because they are sessile and unable to avoid exposure. They can ingest dispersed oil and oil attached to suspended sediments.

All marine fish species at risk within the Study Area are finfish with low exposure risk. A hydrocarbon spill can affect local abundance and availability of phytoplankton and zooplankton to fish, but fish are not expected to remain within the area affected by the spill. If fish eat contaminated zooplankton, they will accumulate hydrocarbons themselves. However, fish are also able to metabolize hydrocarbons and there is no potential for bio-magnification (LGL 2005c).

Perhaps the species of greatest concern would be redfish as the Project Area overlaps a potential redfish mating area. Redfish typically mate in the fall; however, eggs are hatched within the female and are not extruded until the following April to July (Section 5.2.1.7). An oil spill would not affect redfish larvae, as the potential larvae extrusion area is outside (to the north, in the Cabot Strait) of the Study Area (LGL 2007) (Figure 5.65).

Effects of an oil spill resulting from an accidental release associated with this Project are, therefore, expected to be minimal and not significant on juvenile and adult fish species at risk.

8.7.1.2 Marine Bird Species at Risk

The oil spill modelling of the diesel and oil (condensate) spills at the wellsite (reported in SL Ross (2011a, updated 2012) and summarized in Section 2.12.2) indicate that there would be no fuel remaining after 30 days and it would not reach any shorelines. The only bird species at risk (Ivory Gull) which is expected to occur within the Project Area is an infrequent visitor and travels with the pack ice. As Corridor plans on drilling in an ice-free period only, there is a low probability that any Ivory Gull would be affected by an oil spill at the exploration well. Spills of diesel fuel from the supply vessels could interact with the coastline, and, thus, could affect Piping Plover, Barrow's Goldeneye and Harlequin Duck. This risk would be no different or greater than the risk associated with any other marine shipping activity in the Gulf.

Oil spills can affect marine bird species at risk in a number of ways. Nesting seabirds that have survived oil contamination generally exhibit decreased reproductive success. Breeding birds that ingest oil generally exhibit a decrease in fertilization (Holmes *et al.* 1978), egg laying and hatching (Hartung 1965; Ainley *et al.* 1981), chick growth (Szaro *et al.* 1978), and survival (adults and offspring) (Vangilder and Peterle 1980b; Trivelpiece *et al.* 1984), as well as a reduction in mean eggshell thickness and strength (Stubblefield *et al.* 1995).

A spill that occurs during the reproductive period could cause mortality of young even if the adults survived the exposure to oil by affecting prey availability of species with low seasonal dietary variation (Velando *et al.* 2005), changes in normal parental behaviour (Eppley and Rubega 1990), or abandonment of nests (Butler *et al.* 1988).

There are possible changes in habitat use of oiled areas by both oiled and un-oiled birds, with the greatest decrease in use of contaminated habitats immediately following a spill occurring in species that feed on or close to shore and that either breed along the coast or are full-year residents (Wiens *et al.* 1996). Day *et al.* (1995) showed that species lacking clear evidence of recovery tended to be intertidal feeders and residents. However, they also found that other ecologically similar species did not show signs of initial impact or showed rapid recovery.

Exposure to oil causes thermal and buoyancy deficiencies that typically lead to the deaths of affected seabirds. External exposure to oil occurs when flying birds land in oil slicks, diving birds surface from beneath oil slicks, and swimming birds swim into slicks. Although some may survive these immediate effects, long-term physiological changes may eventually result in death (Ainley *et al.* 1981; Williams 1985; Frink and White 1990; Fry 1990). Reported effects vary with bird species, type of oil (Gorsline *et al.* 1981), weather conditions, time of year, and duration of the spill or blowout. Although oil spills at sea have the potential to kill tens of thousands of seabirds (Clark 1984; Piatt *et al.* 1990), some studies suggest that even very large spills may not have long-term effects on certain seabird populations (Clark 1984; Wiens 1995). Most mortality occurs during the initial phase of oil spills when large numbers of birds are exposed to floating oil (Hartung 1995). There is no clear correlation between the size of an oil spill and numbers of seabirds killed, because the density of birds in a spill area, wind velocity and direction, wave action, and distance to shore can have a greater bearing on mortality than the size of the spill (Burger 1993). A major spill that persists for several days near a nesting colony could kill a high proportion of pursuit-diving birds (*e.g.*, murres) within the colony (Cairns and Elliot 1987). As stated above for diesel spills and the predicted crude oil, most of the oil will evaporate or naturally disperse within a few days or less, limiting the potential for oiling of marine bird species at risk in the Study Area.

Oiled birds that escape death can ingest oil from excessive preening (Hunt 1957, in Hartung 1995). The preening leads to the ingestion of significant quantities of oil that, although apparently only partially absorbed (McEwan and Whitehead 1980) can cause lethal effects.

Birds exposed to oil are also at risk of starvation (Hartung 1995). For example, oiled Common Eiders generally deplete all of their fat reserves and much of their muscle protein (Gorman and Milne 1970). In addition, energy demands are higher because the metabolic rate of oiled birds increases to compensate for the heat loss caused by the reduced insulating capacity of their plumage. This can expedite starvation (Hartung 1967; McEwan and Koelink 1973).

It appears that direct, long-term sublethal toxic effects on seabirds are unlikely (Hartung 1995). The extent of bioaccumulation of the chemical components of oil in birds is limited because vertebrate species are capable of metabolizing them at rates that minimize bioaccumulation (Neff 1985, in Hartung 1995). Birds generally excrete much of the hydrocarbons within a short time period (McEwan and Whitehead 1980).

Piping Plover are known to breed in the Magdalen Islands, western Newfoundland and elsewhere in the Gulf of St. Lawrence. As a shorebird, this species would be most at risk from spills that extend onto shore. As stated above, when small spills of diesel fuel strand on the shoreline, the oil tends to penetrate porous sediments quickly, but also to be washed off quickly by waves and tidal flushing. As diesel spill disperses rapidly, this would only be a concern for spills that originate close to shore from support vessels.

Harlequin Ducks breed and overwinter on the west coast of Newfoundland. Breeding sites are in inland rivers and in later summer, birds return to the ocean and spend most of the year in coastal marine environments. Distribution maps for these species shows a greater occurrence on the southern and northern coasts of Newfoundland. While Harlequin Duck may be affected by a spill, this species is expected to occur off the west coast in low densities and it is, therefore, unlikely for a localized spill of diesel fuel to affect more than a few birds in a worst-case scenario.

Barrow’s Goldeneye is a diving duck that winters in marine habitats. During late fall, winter and early spring, the majority of the Eastern population occurs in the St. Lawrence corridor, an area subject to heavy shipping activity. A provincial management plan considered that the risks to this species on the wintering grounds within Newfoundland from an oil spill would be minimal. As there are only a small number of birds documented at six sites (mostly off eastern and northern Newfoundland), any individual oil spill was considered to have a negligible overall effect on the Barrow’s population (Schmelzer 2006).

Depending on the timing, location, and environmental conditions of any accidental events, there could be oiling of marine bird species at risk. Given the location of the Project, the non-persistence of both diesel and predicted Old Harry crude oil, and potential supply vessel route from Newfoundland (any support vessels that may come from St. John’s, Newfoundland, will use the recognized shipping lane through the Laurentian Channel), it is unlikely that an accidental spill would affect a large number of birds or that the effects would be measurable at a population level. However, as even minute amounts of oil have the potential to affect marine birds, and the mortality of an individual bird species at risk is significant, the residual environmental effect is predicted to be significant, but unlikely given predicted limited Project interaction with bird species at risk.

8.7.1.3 Marine Mammal and Sea Turtle Species at Risk

Marine mammals or turtles could ingest oil with water, contaminated food, or oil could be absorbed through the respiratory tract; absorbed oil could cause toxic effects (Geraci 1990). Inhalation of vapours from volatile fractions of oil from a spill or blowout could potentially irritate respiratory membranes and hydrocarbons could be absorbed into the bloodstream (Geraci 1990). Species like the humpback whale, right whale, beluga and harbour porpoise that feed in restricted areas may be at greater risk of ingesting oil (Würsig 1990). Absorbed oil can cause toxic effects such as minor kidney, liver, and brain lesions (Geraci and Smith 1976; Spraker *et al.* 1994). Some of the ingested oil is voided in vomit or feces, but some is absorbed and could cause toxic effects (Geraci 1990). When returned to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982). Whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage (Geraci and St. Aubin 1980, 1982). In baleen whales, crude oil could coat the baleen and reduce filtration efficiency, but these effects are considered to be reversible (Geraci 1990).

Gross histologic lesions developed in loggerhead sea turtles experimentally exposed to oil, but most effects were apparently reversed by the tenth day after exposure (Bossart *et al.* 1995). Oil may also reduce lung diffusion capacity, decrease oxygen consumption or digestion efficiency, or damage nasal and eyelid tissue (Lutz *et al.* 1989).

Several species of cetaceans and seals have been documented behaving normally in the presence of oil (St. Aubin 1990; Harvey and Dahlheim 1994; Matkin *et al.* 1994). It is possible that cetaceans swim through oil because of an overriding behavioural motivation (for example, feeding). Studies of both captive and wild cetaceans indicate that they can detect oil spills. Captive bottlenose dolphins (*Tursiops truncatus*) avoided most oil conditions during daylight and darkness, but had difficulty detecting a thin sheen of oil (St. Aubin *et al.* 1985). Wild bottlenose dolphins exposed to the Mega Borg oil spill in 1990 appeared to detect, but did not consistently avoid contact with, most oil types (Smultea and Würsig 1995). It is unknown whether sea turtles can detect and avoid oil slicks. Gramentz (1988) reported that sea turtles did not avoid oil at sea, and sea turtles experimentally exposed to oil showed a limited ability to avoid oil (Vargo *et al.* 1986).

There is no clear evidence implicating oil spills with the mortality of cetaceans (Geraci 1990), although there was a significant decrease and lack of recovery in the population size of a fish-eating killer whale pod that uses the area of the Exxon Valdez oil spill (Dahlheim and Matkin 1994). Continued monitoring over sixteen years indicates that the killer whale pod had still not returned to its pre-spill population abundance, and the population's rate of increase was significantly less than other fish-eating pods in the area (Matkin *et al.* 2008).

Hall *et al.* (1983) observed seven live and three dead sea turtles following an oil well blowout in 1979; two of the carcasses had oil in the gut but no lesions, and there was no evidence of aspirated oil in the lungs. However, hydrocarbon residues were found in kidney, liver, and muscle tissue of all three dead turtles, and prolonged exposure to oil may have disrupted feeding behaviour and weakened the turtles.

Stressed individuals or those that could not escape a contaminated area would be most at risk to potentially deleterious effects. Animals exposed to heavy doses of oil for prolonged periods could experience mortality. It is difficult to predict with precision the effects of accidental events on biota, especially as they relate to the geographic extent of the effects. Numerous parameters (*e.g.*, chemical composition of the hydrocarbon, behaviour of spilled substance at different times of year) influence hydrocarbon spill characteristics and there are many unknowns concerning specific effects on different marine mammal and sea turtle species at risk. Therefore, the emphasis will be on accident prevention at all phases of the Project.

Marine mammals and sea turtles are not considered to be at high risk from the effects of oil exposure, and it is probable that only small proportions of populations at risk would be in the Project Area or Study Area at any one time. Oil spill prevention measures, along with typical oil spill countermeasures (creating an oil spill response plan, training, preparation, an equipment inventory, and conducting emergency response drills) will serve to reduce the likelihood and consequences of an oil spill. Depending on the time of year, location of animals within the affected area, and type of oil spill or blowout, the effects of an accidental release on the health of cetaceans and sea turtles is predicted to be negligible to low. Based on modelling exercises, and on past monitoring experience with large spills with much worse scenarios than for this Project (*e.g.*, Exxon Valdez, Arrow and others), any residual environmental effects on marine mammal or sea turtle species at risk in the Study Area are predicted to be not significant.

8.7.2 Marine Ecosystem

Based on modelling conducted by SL Ross (2011a, updated 2012; see Section 2.12.2 for summary), there will be no interaction between a spill at the wellsite and coastal ecosystems (algal, eelgrass and saltmarsh communities) (Figure 2.23). A diesel spill from a vessel accident could potentially affect the coastline and this is discussed below.

There is also potential for interaction between a spill event at the wellsite and the marine ecosystems (benthic fauna and plankton). As light oil from a surface spill would form a thin slick on the ocean surface and only disperse into the top 30 m of the water column (Section 2.12.2.4), it is unlikely that there would be an interaction between a surface spill and deep-water corals and sponges. However, it is within this upper zone of the water column where the highest proportion of available prey for marine birds is concentrated.

There is potential for interaction in the event of a subsea blowout. Oil released from an offshore blowout should quickly rise to the surface, with little oil loss to the surrounding waters. As fluids erupt from the seabed, the turbulent flow breaks the crude oil up into small droplets. These droplets are then quickly carried to the surface by the water being pumped to the surface by the gas bubble plume. Drilling will occur in open water and because of the depths involved (greater than 400 m), there is a low likelihood of oil adhering to suspended sediments and being deposited on the bottom.

Effects of crude oil spills on plankton are brief, with zooplankton being more sensitive than phytoplankton. Zooplankon accumulate hydrocarbons in their bodies which may be metabolized and depurated (Trudel 1985). After a spill, accumulated hydrocarbons would be depurated within a few days after a return to clean water, and, thus, there is limited potential for transfer of hydrocarbons up the food chain (Trudel 1985). There is a potential for transfer of hydrocarbons up the food chain in an environment subject to chronic inputs of hydrocarbons, but there is no potential for biomagnification.

Diesel oil (39 to 43 ºAPI), which has similar characteristics to the light oil expected at the Old Harry field, is much more toxic than heavy crude oil, but is shorter-lived in the open ocean than crude oil and there is great variability among species and some species are relatively insensitive. For example, the 96-h LC50 of crude oil for *Calanus hyperboreus*, a common cold water copepod, was 73,000 ppm (Foy 1982). Complete narcotization of copepods can occur after a 15-minute exposure to 1,800 ppm of aromatic heating oil (No. 2 fuel oil) and mortality can occur after a 6-hour exposure (Berdugo *et al.* 1979). Exposure to concentrations of 1,000 ppm of aromatic heating oil for three days had no apparent effect on mobility, but exposure for as little as 10 minutes shortened life span and total egg production (Berdugo *et al.* 1979). No. 2 fuel (33.7ºAPI) oil at concentrations of 250 to 1,000 ppm completely inhibited, or modified, copepod feeding behaviour, while concentrations of 70 ppm or lower may not affect feeding behaviour (Berman and Heinle 1980). Exposure to naphthalene at concentrations of 10 to 50 ppm for 10 days did not affect feeding behaviour or reproductive potential of copepods, although egg development was not examined (Berdugo *et al.* 1979).

Although individual zooplankton could be affected by a blowout or spill through mortality, sublethal effects, or hydrocarbon accumulation, the predicted maximum concentrations for batch and blowouts are well below those known to cause effects.

If a diesel spill were to occur in the nearshore environment, it could affect sensitive habitats such as eelgrass beds and kelp forests. Sea grasses are sensitive to hydrocarbon uptake and oiling. Direct contact with oil causes eelgrass plants to lose their leaves. As eelgrass leaves are rough and without a mucous layer like many seaweeds, oil will readily stick.

Direct oiling can occur where eelgrass beds occurs in very shallow water and form a canopy layer on the water surface, allowing oiling of the floating eelgrass tops. However, direct oiling is uncommon, with uptake of hydrocarbon from the water column being the main concern. Moderate hydrocarbon concentrations in the water column for a few hours or low concentrations for a few days will result in mortality of individual plants, with a bed of eelgrass possibly taking several years to recover from die-off resulting from oiling (Fingas 2001).

The effects of oil spills can be more pronounced for eelgrass beds growing in sheltered bays that are poorly flushed, as oil will tend to persist for longer periods resulting in chronic contamination (Dean and Jewett 2001). The timing of a spill will also influence the nature of the effects. In the spring, seed production and viability could be affected (Beak Consultants 1975), while a spill in late summer or winter when leaf sloughing is at its peak, may encounter mats of drift blades which will tend to catch and retain oil for later decomposition in the intertidal zone. Hatcher and Larkum (1982) also indicate that the surfactants applied to mitigate oil spills could have a permanent and more significant detrimental effect on eelgrass than the spill itself.

Studies of the effects of oil spills on eelgrass communities have been conducted in association with the *Exxon Valdez* oil spill in Prince William Sound, Alaska (Dean *et al.* 1998; Jewett and Dean 1997), and the Amoco Cadiz spill near Roscoff, France (Den Hartog and Jacobs 1980).

The results of both case studies indicate that recovery of the eelgrass beds can occur within a couple of years, although there may be a longer effect for some components of the benthic communities. Thus, it is the associated faunal communities that tend to be more sensitive to hydrocarbon pollution than the eelgrass plants themselves. There is very little information on the effect of diesel oil on eelgrass in particular. Even though diesel can be more toxic than crude oil initially, these studies are useful in assessing the longer term effects of polycyclic aromatic hydrocarbons (PAHs) in the sediment of an eelgrass bed.

Bokn *et al.* (1993) discussed the effects of the water-accommodated fractions of diesel on rock shore populations. In a rocky littoral, diesel oil spills usually result in extensive animal mortalities, and variable, but less severe impacts on seaweeds (*e.g.*, Blumer *et al.* 1971; Pople *et al.* 1990). Data for the Solbergstrand mesocosms suggest that animal populations were most affected by oil treatments and indicate that a chronic low-level exposure to water-accommodated fractions of diesel oil may have only limited direct effect on seaweed stocks (Bokn *et al.* 1993).

Should an accidental spill of diesel hydrocarbons occur in the nearshore environment as a result of this Project, experience from the sites of other spills indicates that there could be a change in the composition of mobile benthic communities associated with any contaminated eelgrass beds. While most components are likely to recover within several years following a spill, some taxa such as Amphipoda and some families of Polychaeta, may take longer to return.

Marine wetlands (*e.g.*, salt marshes) are vulnerable to oil spills because their inherently low wave energy limits the effective physical removal of oil. They are flooded at high tide and their complex surface can trap large amounts of oil (Zhu *et al.* 2004). Oil spills can cause reduction in population and growth rate or abnormal growth and regrowth after initial impact, with effects depending on factors, including the type and amount of oil, the extent of oil coverage, the plant species, the season of the spill, the soil composition, and the flushing rate (Zhu *et al.* 2004). Oil generally remains longer in soils with higher organic matter, resulting in greater impact on resident plants. Heavy contamination by light oil can lead to widespread mortality, and plants may require a decade or more to recover. Plants are also more sensitive to oiling during the growing season than other periods (Pezeshki *et al.* 2000).

The risk of any diesel spill in association with this Project is low and no greater than from any other marine shipping activity in this region. Supply ships will follow standard shipping rules and conventions and pollution prevention measures will be in place. As discussed above, a diesel spill will disperse quickly in open waters and the above effects would be of most concern if a spill occurred in the vicinity of sheltered bays which also support sensitive habitats such as eelgrass beds or salt marshes. As worst-case scenario effects are predicted to be reversible and localized, the residual adverse environmental effect of an accidental spill on the Marine Ecosystem is predicted to be not significant.

8.7.3 Marine Fish, Shellfish and Habitat

Shellfish have limited potential to interact with material discharged during a spill event. Spilled substances can adhere to physical habitat structures or influence chemical habitat parameters (*e.g.*, water quality). Shellfish (with the exception of northern shrimp) present in the Study Area inhabit the seabed for the majority of their life. Only the subsea blowout scenario has potential to interact with adult benthic shellfish; howevere, the oil is expected to move quickly to the surface in the strong gas bubble driven plume, with little loss of oil to the surrounding waters. Shellfish past the egg and larval stage will likely actively avoid any hydrocarbon spill by swimming away and would not be affected (Irwin 1997).

Eggs and larvae are more subject to harmful physiological effects from a fuel spill because they cannot actively avoid the spill and they have not developed any detoxification mechanisms. Recruitment to a population would not be affected unless more than 50 percent of the larvae in a large portion of the spawning area were lost (Rice 1985). When the survival of herring larvae was reduced by 58 percent as a result of the *Exxon Valdez* spill, no effect was detected at the population level (Hose *et al.* 1996). Thus, the effect of a localized spill on egg and larval survival would likely be undetectable from the high rate of natural mortality.

As described in Section 8.7.1.1, marine fish would likely avoid any slick that might form. Given the limited aerial extent of a modelled accidental event, the residual adverse environmental effect of an accidental spill on Marine Fish and Shellfish is predicted to be not significant on adult and juvenile fish and shellfish.

8.7.4 Marine Birds

The potential effects of oil on marine bird species at risk are discussed in Section 8.7.1.2, but is also applicable to non-listed species. It is clear that truly aquatic and marine species of birds are most vulnerable and most often affected by exposure to marine oil spills. Diving species such as Black Guillemot, murres, Atlantic Puffin, Dovekie, eiders, Long-tailed Duck, scoters, Red-breasted Merganser (*Mergus serrator*), loons, and grebes are considered to be the most susceptible to the immediate effects of surface slicks (Leighton *et al.* 1985; Chardine 1995; Wiese and Ryan 1999; Irons *et al.* 2000; EC-CWS, pers. comm. 2012). Alcids, especially Common and Thick-billed Murres, often have the highest oiling rate of seabirds recovered from beaches along the south and east coasts of the Avalon Peninsula, Newfoundland (Wiese and Ryan 2003). Those were the only group of seabirds to show an annual increase over a 13 year period (2.7 percent) in the proportion of oiled to stranded birds (Wiese and Ryan 1999). There also appears to be a strong seasonal effect, as significantly higher proportions of alcids (along with other seabird groups) are oiled in winter versus summer (Wiese and Ryan 1999). Such seasonal effects reflect the location, size, and importance (*i.e.*, percentage of a population) of bird congregations (*i.e.*, breeding colonies and their seaward extensions, migration staging areas, and wintering areas).

Other birds such as Northern Fulmar, shearwaters, storm-petrels, gulls, phalaropes, and terns are vulnerable to contact with oil because they feed over wide areas and make frequent contact with the water's surface. They are also vulnerable to the disturbance and habitat damage associated with oil spill cleanup (Lock *et al.* 1994). Shorebirds and phalaropes may be more affected by oil spills than has been suggested by carcass counts.

The 1984 blowout at the Uniacke G-72 well (near Sable Island) resulted in a spill of 240 m^3 (1,510 barrels) of condensate, not unlike the crude oil expected at Old Harry. A survey of an extensive area around the well after the well was capped (11 days after the blow-out) observed a total of seven oiled marine birds (three Dovekies and four murres), with no obvious oiling of gulls, kittiwakes and fulmars (Martec Ltd. 1984, in Hurley and Ellis 2004). However, many oiled birds are never recovered and oiled carcasses can disappear quickly in the marine environment, therefore mortalities can be under-reported.

Some studies have suggested that oil pollution is unlikely to have major long-term effects on bird productivity or population dynamics (Clark 1984; Butler *et al.* 1988; Boersma *et al.* 1995; Erikson 1995; Stubblefield *et al.* 1995; White *et al.* 1995; Wiens 1995, 1996; Seiser *et al.* 2000). Conversely, others (Harvey *et al.* 1982; Leighton 1993) do show long-term effects of oil pollution on birds (*e.g.*, birds having ingested oil no longer contribute to the reproductive output of a species).

On a broader geographical scale, estimates of the number of birds that die annually from operational spills range from 21,000 on the Atlantic coast of Canada, and 72,000 in all of Canada (Thomson *et al.* 1991), to 315,000 ±65,000 Common Murres, Thick-billed Murres and Dovekies annually in southeastern Newfoundland alone due to illegal oil discharges from ships (Wiese and Robertson 2004). Clark (1984) estimated that 150,000 to 450,000 birds die annually in the North Sea and North Atlantic from oil pollution from all sources.

The modelling results indicated that no slicks would reach a coastline from an above-sea spill in the Project Area (see Section 2.12.2). As a result, none of the coastal colonies would be directly influenced by a spill at the well site. As described above for marine bird species at risk, an accidental spill of diesel fuel from a supply ship could occur anywhere along the route. Recent survey data (EC-CWS 2013b) indicate that that there are 20 seabird colonies distributed within the portion of the west coast of Newfoundland that fall within the boundaries of the Project Study Area. These colonies are known to support nesting Black-legged Kittiwakes, cormorants, Common terns, and gulls (including Herring Gull, Greater Black-backed Gull, Black-headed Gull, and Ring-billed Gull). The two largest of these colonies (both located at Cape St. George) support Black-legged Kittiwakes (one was estimated to support more than a thousand pairs and the other between 500 and 1000) which are generally considered to be amongst the most vulnerable seabirds to oil spills (Lock *et al.* 1994). Cormorants, which are also considered vulnerable but more resilient (Lock *et al.* 1994), are present at five of the colonies, with four of these being estimated to contain less than 100 pairs and one between 100 and 500. Common Terns nest at six of the sites, with the number of breeding pairs ranging from 2 to 240. Gulls were present at nine locations, with the number of estimated breeding pairs for a particular species being either less than 100 or between 100 and 500 (EC-CWS 2013b). Furthermore, older colony data from Lock *et al.* (1994) identified six colonies of “vulnerable” seabirds within the study area of the west coast of Newfoundland which cumulatively supported 39 Great Cormorant, two Double-crested Cormorant, 501 Black-legged Kittiwake, and 20 Black Guillemot breeding pairs. The numbers of breeding pairs identified for these colonies represent a small component of the populations within the Gulf; for example, Lock *et al.* (1994) indicate the Gulf supported approximately 2,540 Great Cormorant, 28,065 Double-crested Cormorant, 85,906 Black-legged Kittiwake, and 4,939 Black Guillemot breeding pairs, with many more being found outside this region (*e.g.*, along the Atlantic coasts of Newfoundland and Nova Scotia).

Depending on the timing, location, and environmental conditions of any accidental events, there could be oiling of marine birds. It is recognized that even a small spill can result in significant adverse environmental effects on marine birds. However, given the location of the Project, the non-persistence of both diesel and expected Old Harry light crude oil, and potential supply vessel route from Newfoundland (any support vessels that may come from St. John's, Newfoundland, will use the recognized shipping lane through the Laurentian Channel), this significant adverse effect is unlikely to occur.

8.7.5 Marine Mammals and Sea Turtles

The effects of hydrocarbon spills on marine mammal and sea turtle species at risk is described in Section 8.7.1.3 and would also be applicable to non-listed species. As described in this section, marine mammals and sea turtles would likely avoid any slick that might form.

Marine mammals and sea turtles are not considered to be at high risk from the effects of oil exposure, but some evidence implicates oil spills with seal mortality, particularly young seals. For marine mammals and sea turtles, it is probable that only small proportions of populations are at risk at any one time in either the Project or Study Area. Oil spill prevention measures, along with typical oil spill countermeasures (creating an oil spill response plan, training, preparation, an equipment inventory, and conducting emergency response drills) will serve to reduce the number of animals exposed to oil in the unlikely event of a spill.

Depending on the time of year, location of animals within the affected area, and type of oil spill or blowout, the effects of an oil release on the health of cetaceans is predicted to range from negligible to low magnitude over varying geographic extents. Based on the modelling exercises, and on past monitoring experience with large spills with much worse scenarios than likely for this Project (*e.g.*, Exxon Valdez, Arrow and others), it can be predicted with confidence that an oil spill associated with the Project will not result in any significant residual effects to marine mammals or sea turtles in the Study Area.

8.7.6 Sensitive Areas

The Study Area overlaps with the following EBSAs: the southern fringe of the Laurentian Channel (the Study Area has a small overlap with the eastern fringe of this EBSA) and the west coast of Newfoundland which crosses the Study Area between the Project Area and the western coastline of Newfoundland. The Project Area also overlaps with a potential redfish (a COSEWIC-designated species) mating area and the Study Area overlaps with a potential redfish larvae extrusion area and a cod (a COSEWIC-designated species) spawning area.

The oil spill modelling indicates that the furthest extent of a blow-out or spill from the Project site would extend approximately 20 km from the well location (not much beyond the borders of EL 1105), overlapping with the redfish mating area. As stated in Section 8.4.1.1, life history of the redfish and the Project's distance from the potential redfish larvae extrusion area, would limit the extent of any effects of a spill of redfish eggs and larvae.

Spills of diesel fuel from a supply vessel could overlap a number of these Sensitive Areas depending on the final routing of the vessels. As stated earlier in Section 8.2, spills of diesel fuel in open water are expected to disperse rapidly. While diesel is more toxic than heavy crude oil, it is shorter-lived in the open ocean and there is great variability among species and some species are relatively insensitive. There is no greater risk of a spill from a supply vessel in transit than any other marine vessel activity. A spill of this nature would not have a long-term effect on any of the identified sensitive areas. Effects would be short-lived and relatively localized. No significant adverse residual effects are predicted.

8.7.7 Commercial Fisheries and Other Users

The 1984 blowout at the Uniacke G-72 well (near Sable Island) resulted in a spill of 240 m^3 (1,510 barrels) of condensate. No taint was observed in fish caught in the condensate drift zone (Gill *et al.* 1985, in Hurley and Ellis 2004). Diesel fuel is considered to result in a moderate to high risk of seafood contamination because of the relatively high content of low molecular weight, water-soluble aromatic hydrocarbons, which are semi-volatile and evaporate slowly (Yender *et al.* 2002). Dispersed droplets are also bio-available. Crude from the Old Harry Project is considered a light crude and would behave in a similar fashion to diesel.

An accidental spill could potentially affect Commercial Fisheries (including sentinel and research fisheries) and Other Users (Aboriginal fisheries, recreational fisheries, aquaculture, seal and bird hunting, military use, marine traffic and tourism and recreational activities). Accidental spills could result in fishing gear fouling and potential loss of income through reduced catch value, food safety concerns (*e.g.*, tainting), loss of reputation or suspended fishing. However, the likelihood of such an event is extremely low. As well as described in Section 5.8.1, there is likely no commercial fishing occurring within the Project Area. Commercial fishers could be affected by a spill of diesel from a supply ship, with the likely effects depending on the location of the spill in relation to harvesting activities. As noted above, the risk of a spill from a supply ship would be no different than the risk of spills from any marine shipping activity. The loss of fuel during an accidental event is not expected to have an effect on other users. Given the low level of commercial harvesting activities within the Project Area and the mitigation which will be in place to compensate fishers for any loss or fouling of gear, the residual adverse environmental effect of an accidental release of diesel or oil (condensate) on Commercial Fisheries and Other Users is rated not significant.

8.8 Summary

As described in Section 8.1.10, spills and blowouts are considered unlikely from exploration drilling activities, and Corridor's Emergency Response Plan and Oil Spill Response Plan (which will be based on Corridor's Corporate Emergency Response Manual (and experience of other offshore operators)) would ensure that any such effects are minimized. The drilling platform will have response equipment on board (and personnel trained in their use) and Corridor will enter into an agreement with the Subsea Well Response Project and and Oil Spill Response Ltd. for access to enhanced spill response equipment. Corridor's emphasis, however, will be on safe operations to prevent the risk of spills.

The potential environmental effects associated with an accidental event on Species at Risk, Marine Ecosystem, Marine Fish, Shellfish and Habitat, Marine Birds, Marine Mammals and Sea Turtles, Sensitive Areas and Commercial Fisheries and Other Users are summarized in Table

8.13. As the likely effects of any accidental event are largely dependent on a number of variables including time of year, spilled material, amount of material spilled, the rankings in Table 8.13 represent the worst case scenario. With the exception of marine birds (including at-risk species), residual environmental effects are predicted to be not significant.

Table 8.13 Potential Environmental Effects Assessment Summary – Accidental Events

Project Components / Activities	Potential Interactions / Environmental Effects (positive (P) or adverse (A))	Mitigation	Potential Environmental Effects Summary					
			Magnitude	Geographic Extent	Frequency	Duration	Reversibility	Ecological and Socio-economic Context
Species at Risk	Oiling (A) Avoidance of Habitat (A) Mortality (marine birds) (A)	Spill Response Plan Equipment inspections Adherence to pollution prevention protocols Drilling in Ice-free season only	3	3	1	2	R	1
Marine Ecosystems	Contamination / Health Effects (A) Mortality (plankton) (A)	Spill Response Plan Equipment inspections Adherence to pollution prevention protocols	1	3	1	3	R	1
Marine Fish and Fish Habitat	Oiling (A) Avoidance of Habitat (A)	Spill Response Plan Equipment inspections Adherence to pollution prevention protocols Drilling in Ice-free season only	1	3	1	2	R	1
Marine Birds	Oiling (A) Avoidance of Habitat (A) Mortality (A)	Spill Response Plan Equipment inspections Adherence to pollution prevention protocols Drilling in Ice-free season only	2	3	1	2	R	1
Marine Mammals and Sea Turtles	Oiling (A) Avoidance of Habitat (A)	Spill Response Plan Equipment inspections Adherence to pollution prevention protocols Drilling in Ice-free season only	1	3	1	2	R	1
Sensitive Areas	Avoidance of Habitat (A)	Spill Response Plan Equipment inspections Adherence to pollution prevention protocols Drilling in Ice-free season only	1	3	1	2	R	1
Commercial Fisheries	Reduced fish catch (A) Suspended fishing (A) Tainting (real or perceived) (A)	Spill Response Plan Equipment inspections Adherence to pollution prevention protocols Drilling in Ice-free season only	1	3	1	2	R	1

KEY:

Magnitude Context
0 = Negligible (essentially no effect)
1 = Low effects
2 = Medium effects
3 = High effects

Geographic Extent
1 = <1 km radius
2 = 1-10 km radius
3 = 11-100 km radius
4 = 101-1,000 km radius
5 = 1,001-10,000 km radius
6 = >10,000 km radius

Frequency
1 = <11 events/yr
2 = 11-50 events/yr
3 = 51-100 events/yr
4 = 101-200events/yr
5 = >200 events/yr
6 = continuous

Duration
1 = <1 month
2 = 1-12 months
3 = 13-36 months
4 = 37-72 months
5 = >72 months

Reversibility
R = Reversible
I = Irreversible (Refers to population)

Ecological and Socio-economic Context
1 = Relatively pristine area not affected by human activity
2 = Evidence of existing adverse activity
3 = High level of existing adverse activity

n/a = Not applicable

9.0 CUMULATIVE ENVIRONMENTAL EFFECTS ASSESSMENT

Potential cumulative environmental effects external to the Project include marine transportation (see Section 5.8.2.7), commercial fishing (see Section 5.8.1), oil and gas exploration including seismic activity and research surveys (see Sections 5.8.1.4 and 5.8.1.5). There is little potential for environmental effects resulting from the proposed exploration well to overlap with other existing exploration drilling programs either temporally or spatially. There is potential for seismic surveys to be conducted along western Newfoundland between 2012 and 2014. The recent (November 16, 2011) land sale resulted in the sale of the two parcels in Western Newfoundland (NL-11-01-01 (west of EL 1120) and NL-11-01-02 (west of EL 1097, EL 1098 and EL 1103)). DFO conducts annual multi-species research surveys in the Gulf, usually in August and September. During the exploration drilling program, it is expected that some commercial traffic will be passing in the vicinity of the Project Area. As well, commercial fishing vessels may be transiting in the vicinity of the Project Area. The increase in vessel traffic resulting from supply vessels will be minimal with respect to the traffic currently associated with marine traffic and fishing activities.

A summary of the potential cumulative environmental effects on species at risk, marine ecosystems, marine fish and shellfish, marine birds, marine mammals and sea turtles, sensitive areas and commercial fisheries and other users is described in the following sections.

9.1 Species at Risk

By definition of their nature or life history, species at risk often have lower tolerance to disturbance or are less resilient than non-listed species. For most species at risk, various anthropogenic activities have been identified as major threats to the recovery of the population. For most marine fish species, direct and indirect fishing, both historically and current, are identified as one of the key threats. Marine mammals are vulnerable to ship strikes and marine pollution. The latter is also a major consideration for marine birds.

The potential for cumulative effects on these species is essentially the same as the potential cumulative effects on non-listed species, although it is acknowledged that due to the status of these populations, they may be more vulnerable to even limited Project effects compared to more stable populations. In general, the proposed Project's contribution to any cumulative effects is limited in comparison to the influences on these species throughout their range that have caused these species to reach their current population levels.

A key consideration for this Project is that its environmental effects are localized, short-term and reversible. This limits the potential for temporal and spatial overlap with other projects and activities and therefore, the potential for cumulative environmental effects. As described in Section 7.1.5, noise associated with the Project would cause most species to avoid the immediate Project Area, limiting any further exposure to Project effects. If there was a lack of alternate habitat in the area due to other activities, this would be a concern. However, during this period, there would likely be only commercial vessel traffic in the area. As shown in Section 5.8.1, the level of commercial harvesting activities in the vicinity of the Project Area is low and this trend is expected to continue into the proposed exploration period. Due to both logistical conflicts and validity of research results, any other seismic surveys or research surveys would need to be co-ordinated to avoid temporal and spatial overlap, thereby negating the potential for cumulative effects.

Given the mitigation measures in place, the limited nature of the Project's residual effects and the nature of the other projects and activities in the area, the cumulative environmental effects of the Project in combination with other projects and activities on Species at Risk are rated as not significant.

9.2 Marine Ecosystem

As described in Section 7, the majority of Project-related effects are limited geographically to the Project Area. The exception is vessel and helicopter traffic and any associated accidental events. Within the Project Area, the Marine Ecosystem VEC includes consideration of plankton and coral. As stated in Section 5.3.3, sea pens are present but not common in the Project Area and deep-water corals and sponges are not considered likely in this area. While corals can be affected by commercial fishing practices, there is limited activity in the Project Area and vicinity. The residual environmental effects of the Project on coral are predicted to be not significant and given the limited potential for both corals and fishing activity in the Project Area, no cumulative effects are predicted.

Plankton within the Project Area can be affected by seismic noise, but the noise associated with a VSP survey is short-term and of less strength than that associated with 2-D and 3-D surveys. There is potential for cumulative effects if other surveys were to occur in the same area, but this potential is limited by the logistical need to maintain temporal and geographic separation between any surveys. As indicated in Section 7.3.2.5, mortality in plankton and ichthyoplankton caused by a VSP would occur near the source, but the spatial (metres) and temporal (two to three days per well) scales would be so limited that the effects are considered not significant and any potential cumulative effects would also be negligible.

Coastal ecosystems, including algal, eelgrass and saltmarsh communities, can be susceptible to both marine and on-land development and activities. While coastal areas in western Newfoundland are likely subject to cumulative pressures, the contribution of this Project to these effects is limited to a small amount of vessel traffic over less than a two month period (*i.e.*, two to three vessel trips/week). Vessel traffic has limited potential for interaction with these resources, as it will be required to follow standard shipping routes, rules and conventions.

The cumulative effects of the Project on the Marine Ecosystem in the Study Area are predicted to be not significant.

9.3 Marine Fish, Shellfish and Habitat

Sources of cumulative effects on Marine Fish, Shellfish and Habitat in the Study Area include marine shipping, commercial harvesting and seismic and research surveys. Overfishing, habitat degradation, pollution and natural variability of the population cause adverse effects to fish species and habitat. Fishing pressure and subsequent bottom dragging techniques are significant stresses on some fish resources. Bottom dragging fish gear impacts fish habitat by removing plants, corals, sessile food items, overturning rocks, levelling rock outcrops and re-suspending sediments, ultimately homogenizing the habitat. While commercial fisheries can have an impact on marine invertebrates and fish, the current level of commercial exploitation within the Project Area is limited and DFO's fisheries management is intended to keep populations at sustainable levels.

As stated in Section 7, the majority of Project effects will be limited to the immediate vicinity of the wellsite. Fish may either be attracted by the artificial reef effect or be temporarily displaced by noise. The effects of drill mud and cuttings deposition in the area immediately adjacent to a well lessen considerably one to two years after drilling cessation (Kingston 1987; Gray *et al.* 1990). Fish habitat, as measured by changes in benthic community structure around single exploration wells, returned to baseline conditions within one year after cessation of drilling (Hurley and Ellis 2004).

All predicted effects on Marine Fish, Shellfish and Habitat are temporary and reversible. This limits the potential for these effects to act in a cumulative fashion with any other project and activities. Commercial harvesting levels in the Project Area are negligible, further limiting any potential for cumulative effects.

Areas along major shipping routes, such as the Project Area, are potentially subject to chronic oiling from bilge pumping and de-ballasting by vessel traffic, resulting in resident (non-migratory) biota having accumulated hydrocarbons; however, in a non-coastal area such as the Project Area, resident species within an area affected by a spill would be benthic for the most part (*e.g.*, scallop, clams, sculpins) and the least likely to have accumulated hydrocarbons from chronic oil pollution.

Discharges from the Project will comply with the OWTG and ship operations will comply with Annex 1 of the *International Convention for the Prevention of Pollution from Ships* (MARPOL 73/78) and *Pollution Prevention Regulations* of the *Canada Shipping Act.* Overall, the cumulative environmental effects of the Project in combination with other projects and activities on Marine Fish,Shellfish and Habitat are rated not significant.

9.4 Marine Birds

Other oil and gas exploration programs, commercial fishing, research surveys and commercial shipping may result in cumulative environmental effects on seabirds. Marine birds may also be affected by projects and activities that occur outside the Study Area, but within their migratory ranges. As well, changes in prey and predator populations may affect marine bird populations.

Vessel traffic may affect marine birds through vessel lighting, oily discharges and sound. Chronic routine discharges, such as deck drainage and ballast and accidental releases of hydrocarbons, can expose birds to oil. Chronic releases may be equally or more important to long-term population dynamics of seabirds. All routine drilling platform discharges and supply vessel discharges will comply with the OWTG.

The incremental amount of vessel traffic as a result of this Project will be negligible compared to existing vessel traffic in the area. Routine Project activities are predicted to have minor, temporary and reversible environmental effects on Marine Birds; therefore, the cumulative environmental effects of Project activities on Marine Birds within the Study Area are predicted to be not significant.

9.5 Marine Mammals and Sea Turtles

Marine mammals may be vulnerable to cumulative effects from the Project in combination with marine transportation, commercial fishing and other seismic and research surveys. The main effects of the Project on marine mammals are associated with noise disturbances, potential for injury and mortality due to vessel collisions and contamination or change in distribution of food source.

While other seismic programs may occur in the Project Area, activities will not overlap spatially and temporally, as this may interfere with data collection. Given the localized nature of the surveys associated with this Project, the zone of influence is spatially limited. In addition, all surveys conducted within the Project Area would be required to comply with the C-NLOPB *Geophysical, Geological, Environmental and Geotechnical Program Guidelines* (C-NLOPB 2012), thereby reducing the potential for cumulative effects from this activity.

Ship strikes and noise are among the most frequently identified stressors of marine mammals in the Gulf of St. Lawrence (DFO 2012c). Marine mammal reaction to the Project is likely temporary avoidance behaviour. Vessel traffic associated with the proposed Project would contribute to only a slight increase over current levels. No cumulative effects are expected with helicopter traffic due to the localized and temporary disturbance.

Marine mammals may be vulnerable to vessel collisions. Most marine mammal-vessel collisions occur near the surface where acoustical reflection and propagation can limit the ability of marine mammals to hear and locate approaching vessels (Gerstein and Blue 2005). Injuries on stranded ship-struck marine mammals suggest that large vessels are the principal source of injury with most marine mammals not observed prior to the collision or at the last moment. Research suggests that one of the best ways to reduce lethal vessel-strikes to right whatles in the Bay of Fundy is by limiting vessel speed to 10 knots (18.5km h^{-1}) (Vanderlaan *et al.* 2008)The typical speed of vessels within the Project Area may assist in the avoidance of marine mammal collisions.

Based on the speed of the vessel movement associated with offshore activities and the limited incremental number of vessels associated with the Project, the predicted cumulative adverse effect on marine mammals is not significant.

Sea turtles feeding in the Study Area may be affected by entanglement in and ingestion of debris. Entanglements in fishing lines, lobster pot lines, nets and other fishing gear have been reported. Sea turtles either ingest baited hooks or become entangled or hooked externally or both (Witzell 1999; Smith 2001). Sea turtles have also been in trawling gear in other parts of the Atlantic, Pacific and Gulf of Mexico (Magnuson *et al.* 1990). There is no known directed take of sea turtles in Canadian waters. The take of sea turtles at sea or on nesting beaches in other areas is seen as a threat to all species of sea turtles. Few studies have been undertaken on the effects of anthropogenic noise on sea turtles; however, it is assumed that noise from the various offshore sources could result in temporary disturbance to individuals. Although the effects of noise from this Project are not expected to be significant, it will add to cumulative noise and disturbance levels that sea turtles are exposed to in the Study Area. Sea turtle densities are low in the area and there is no evidence to suggest that the Project's oil and gas activities and increased support vessel traffic will add measurably to cumulative impacts on sea turtles.

9.6 Sensitive Areas

The Study Area overlaps with the following EBSAs: the southern fringe of the Laurentian Channel (the Study Area has a small overlap with the eastern fringe of this EBSA) and the west coast of Newfoundland which crosses the Study Area between the Project Area and the western coastline of Newfoundland. The Project Area also overlaps with a potential redfish (a COSEWIC-designated species) mating area and the Study Area overlaps with a potential redfish larvae extrusion area and a cod (a COSEWIC-designated species) spawning area.

As described in Section 7.7, potential Project effects on all of these areas, except for the potential redfish mating area, would be limited to the additional supply vessel traffic, which represents a short term, slight increase in the existing levels of marine traffic in the Study Area. The potential for Project-related cumulative environmental effects on the various species that may use these Sensitive Areas is considered and assessed in the respective VECs above. None of the potential effects related to supply vessel traffic would result in a long term or permanent change in habitat quality or quantity within the Sensitive Areas. Therefore, there is no potential for the Project to result in significant cumulative effects to these areas.

With respect to the potential redfish mating area, the Project will not cause any long term or irreversible effects to fish habitat in the Project Area. There may be short term and localized disturbances to mating activities which could act in a cumulative manner with other sources of disturbance in the area, but these are not considered to be at a level to result in significant cumulative environmental effects on this Sensitive Area or this species.

9.7 Commercial Fisheries and Other Users

Cumulative environmental effects on commercial fisheries are related to the space-use conflicts and sound associated with other users of the offshore resources. Drilling MODU support vessel activity is a minor component of total marine transportation in the vicinity of the Study Area. The additional vessel activity from support of the exploration drilling program is negligible compared to the existing vessels in the area. As well, as discussed in Section 5.8.1, no commercial fishing efforts have overlapped with the Study Area during the years assessed (2004 to 2009).

In general, a drilling program will constitute a minor incremental contribution to the overall sound generated by other such sources and space-user conflict, and will be of short duration in local areas. Based on current knowledge, and especially with the proposed mitigation procedures in place, the proposed Project is not expected to result in or contribute to any significant cumulative environmental effects on commercial fisheries.

9.8 Summary

Based on the short term and localized nature of the predicted environmental effects of routine Project activities and the limited occurrence of other projects and activities in the Project Area, there are no significant cumulative environmental effects predicted for any of the assessed VECs.

10.0 RESIDUAL ADVERSE ENVIRONMENTAL EFFECTS SUMMARY

Given the short duration (20 to 50 days) and limited geographic extent (1 to 5 km^2) of a typical exploration drilling program proposed to occur within the Project Area and with the application of mitigation measures, the residual environmental effects of routine activities of the Project, including cumulative environmental effects, is predicted to be not significant. In the unlikely event of an accidental release of hydrocarbons, short-term residual adverse environmental effects could result from the Project.

A summary of the residual adverse environmental effects for Species at Risk, Marine Ecosystem, Marine Fish, Shellfish and Habitat, Marine Birds, Marine Mammals and Sea Turtles, Sensitive Areas, and Commercial Fisheries and Other Users is presented in Table 10.1.

Table 10.1 Residual Adverse Environmental Effects

VEC		Project Activities							Accidental Event (surface or subsea oil spill)
		Presence of Drilling Platform	Drill Muds and Cuttings	Routine Discharges	Support Vessels	VSP Survey / Drilling Noise	Routine Air Emissions	Well Abandonment / Suspension	
Species at Risk	Significance	NS	NS	NS	NS	NS	NS	NS	S[A]
	Level of Confidence	3	3	3	3	3	3	3	3
	Likelihood*								1
Marine Ecosystem	Significance	NS	NS	NS	n/a	NS	n/a	NS	NS
	Level of Confidence	3	3	3		3		3	3
	Likelihood*								
Marine Fish, Shellfish, and Habitat	Significance	NS	NS	NS	NS	NS	NS	NS	NS
	Level of Confidence	3	3	3	3	3	3	3	3
	Likelihood*								
Marine Birds	Significance	NS	n/a	NS	NS	NS	NS	NS	S
	Level of Confidence	3		3	3	3	3	3	3
	Likelihood*								1
Marine Mammals and Sea Turtles	Significance	NS	n/a	NS	NS	NS	n/a	NS	NS
	Level of Confidence	3		3	3	3		3	3
	Likelihood*								
Sensitive Areas	Significance	NS	n/a	NS	NS	NS	n/a	n/a	NS
	Level of Confidence	3		3	3	3			2
	Likelihood*								
Commercial Fisheries and Other Users	Significance	NS	NS	NS	NS	NS	NS	n/a	NS
	Level of Confidence	3	3	3	3	3	3		3
	Likelihood*								

Key:

Significance:
S = Significant Adverse Effect
NS = Not Significant Adverse Effect
P = Positive Effect

Level of Confidence:
1 = Low
2 = Medium
3 = High

Likelihood*:
1 = Low Probability
2 = Medium Probability
3 =High Probability
* Likelihood defined only for effects that are evaluated as significant (CEA Agency 1994)

n/a = Not Applicable
A refers specifically to marine bird Species at Risk

11.0 FOLLOW-UP AND MONITORING

A follow-up program is discretionary, not mandatory, for a screening-level environmental assessment. Potential follow-up and monitoring that will be applied to this Project include the following:

- There is no follow-up and monitoring recommended for marine fish (at-risk and not-at-risk), shellfish and fish habitat.
- Routine checks will be done by a seabird observer for stranded birds that may have been attracted to vessel lighting in accordance with pre-determined protocol established with EC-CWS (ECSAS)
- Corridor will use a Marine Mammal Observer during the drilling program.
- In the unlikely event of an oil spill, an EEM program will be designed as part of Corridor's Emergency Response Plan.
- During the VSP program, a qualified observer will be used, who will be capable of liaising with the fishing industry.
- Any fluid losses will be reported to the C-NLOPB and the Canadian Coast Guard and any seabird mortalities will be recorded by the on-board observer(s).

Any suspected unexploded ordnances will be reported immediately to the Coast Guard.

12.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

The effects of the environment on an exploration drilling program are considered during the planning and environmental assessment stages of program development. Effects of the physical environment on the Project include those caused by wind, ice, waves, and currents (discussed in Section 4). These effects may differ somewhat by equipment type, with bottom-founded equipment stable under all conditions whereas floating systems are subject to heaving due to wave action. Successful exploration drilling programs have been executed in offshore Newfoundland waters for more than three decades. The potential effects of the environment on the program include:

- meteorology and oceanography (extreme conditions may affect schedule and program operations);
- sea ice and icebergs (drilling will be conducted during ice-free periods);
- superstructure icing; and
- biofouling.

12.1 Potential Effects of the Physical Environment on the Project

Weather, fog, ice and icing, and wave conditions affect every offshore oil and gas project in eastern Canadian waters. These effects will be mitigated by using rigs, vessels and equipment that are certified by the appropriate authorities (*e.g.*, DNV, Transport Canada, Coast Guard, C-NLOPB, and others) for use in eastern Canadian waters, by detailed project planning, by design in accordance with recognized and appropriate national and international standards, by operational scheduling, and by monitoring government and industry 24-hour forecasts. The residual effects of physical environmental factors have the potential to be adverse on the Project because they can cause delays, damage to equipment and thus economic losses, or because they can be a contributing factor to accidents. Accidental effects are discussed in detail in Section 8.

Wind and wave conditions result in most environmental constraints on exploration drilling programs. Sea ice should have no effect on the Project given the Project time frame (during open waters). There is a potential that spring / early summer sea ice may cause some delays.

Fog is often present in the Gulf of St. Lawerence. Impacts of fog on exploration activities pertain primarily to aviation delays due to poor visibility.

Ice accumulations (superstructure icing) may cause delays while operations are slowed or suspended and ice accumulation is avoided or removed. Any delays are anticipated to be relatively short-lived, particularly with respect to the short duration of the Project's timeline. As stated above, all drilling for the Project will be conducted only during ice-free periods. The effects of ice on the Project will be minimal because the Project Area is free of sea ice for most of the year and subject to relatively few icebergs. Any potential effects on the Project from icebergs can be mitigated by the Ice Management Plan and project scheduling such that residual effects will be minimal.

Vessels operating in Canadian waters in late fall and winter are likely to experience some degree of icing. Icing can hinder shipboard activity and, in extreme cases, it can seriously impair vessel operations and stability. The accumulation of ice on a ship's superstructure can raise the centre of gravity, lower the speed and produce difficulty in manoeuvring (DFO 1999a).

Icing on vessels and related structures can result from freshwater moisture such as fog, freezing rain, drizzle and wet snow, or from salt-water including freezing spray and wave wash. Of the various forms of superstructure icing, freezing spray is the most common, and is the most severe cause of ice build-up. It occurs when the air temperature falls below the freezing temperature of sea-water and when sea-surface temperatures are below 6°C (DFO 1999a).

In the Gulf, freezing spray is the most frequently reported cause of vessel icing and may be encountered any time from November to April, although it is most frequently reported from December to February. During January, potential spray icing conditions are encountered more than 50 percent of the time (DFO 1999a). Freezing spray conditions in the Gulf are usually produced as a result of intense winter storms situated off the Canadian east coast. These storms may result in a strong northwesterly flow of cold Arctic air over the Gulf area, which produces snow showers and squalls over open water. During spray icing events, the air temperature is typically around -10°C with 55.6 km/hr (30-knot) northwesterly winds and 2 to 3 m waves (DFO 1999a).

With respect to geological seismic activity (e.g., earthquakes) there has been no seismic activity reported in the Study Area in approximately 400 years and the Project is in Zone 1, which is the lowest seismic zone. Therefore, there is little risk of seismic activity in the Project Area.

Mitigation measures applied to potential effects of the physical environment on the Project include the following:

- Ice Management Plan;
- Project scheduling;
- Use of rigs, vessels and equipment that are all certified by the appropriate authorities;
- Detailed Project planning;
- Design in accordance with recognized and appropriate national and international standards;
- Monitoring government and industry 24-hour forecasts; and
- the exploration well will be drilled during an ice-free period.

With this mitigation in place and given the timing of the Project, effects of the physical environment on the Project are, therefore, unlikely.

12.2 Potential Effects of the Biological Environment on the Project

Effects of the biological environment on the Project are unlikely with biofouling being the main potential effect. Biofouling may affect rig stability and encourage corrosion by establishing itself on exposed support structures or hulls and may also have a similar effect on the interior of pipes as well as water intakes and outlets and tankage used for waste water storage and treatment, and possibly drill mud tankage.

Mitigation measures applied to potential effects of the biological environment on the Project include the following:

- Use of rigs, vessels and equipment that are all certified by the appropriate authorities;
- Detailed project planning;
- Design in accordance with recognized and appropriate national and international standards; and
- Preventative maintenance programs instituted by the drill platform and vessel owners.

With the appropriate mitigation in place, effects of the biological environment on the Project are predicted to be unlikely and not significant.

13.0 ENVIRONMENTAL MANAGEMENT

Corridor will act as the Program Operator for the exploration well. Corridor's policies and procedures would apply as well as those of the exploration MODU contractor and other subcontractors. If Corridor enters into a partnership with another company, that company's policies and procedures will be compared with Corridor's and those policies and procedures that provide the best level of safety, health and environmental protection will be implemented. These policies and procedures will be bridged so that there is clear direction on the requirements for the Project. Such policies and procedures will include:

- fisheries liaison / interaction policies and procedures, such as routine advisories, where appropriate and continued participation with One Ocean;
- use of a qualified observer(s), who will be capable of liaising with the fishing industry during the VSP surveys;
- species at risk and other marine mammal, sea turtle and marine bird monitoring through the use of a qualified observer(s) during drilling activities, including VSP surveys;
- waste management;
- spill response;
- compensation of affected parties, including fisheries interests, for accidental damage resulting from Project activities, in keeping with the *Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity* (C-NLOPB 2002); and
- Project-specific Quality, Health Safety and Environment (QHSE) Plan. Corridor is committed to conducting all Project activities in an environmentally responsible manner and promoting employee, contractor and public awareness of environmental issues. Corridor has and will continue to integrate environmental considerations into early decision making in order to identify and wherever practical, mitigate potentially negative consequences of their proposed activities. Corridor intends to implement progressive industry standards, codes and practices, and government policies and guidelines for environmental protection in assessing, planning, constructing and operating all proposed projects as well as preventing and minimizing waste and emissions through throughout the life cycle of their Project.

14.0 SUMMARY AND CONCLUSION

This environmental assessment presents information on the exploration drilling program, as proposed by Corridor, and the results of the environmental effects assessment. The proposed program would be conducted offshore over the Old Harry prospect in the Gulf in Newfoundland waters. The VECs selected for this assessment were:

- Species at Risk;
- Marine Ecosystem;
- Marine Fish, Shellfish, and Habitat;
- Marine Birds;
- Marine Mammals and Sea Turtles;
- Sensitive Areas; and
- Commercial Fisheries and Other Users.

In the unlikely event of an accidental release of hydrocarbons, significant environmental effects are predicted to occur for marine birds (both at risk and not at risk species), but not at a population level. With respect to routine activities associated with drilling one exploration well, the results of the Environmental Assessment predict that no significant adverse environmental effects, including cumulative environmental effects, will occur as a result of the Project.

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APPENDIX A

Corridor Resources Inc. Old Harry Prospect Exploration Drilling Scoping Document

Corridor Resources Inc. Exploratory Drilling Program on the Old Harry Prospect, Exploration Licence 1105

Scoping Document

Prepared by:
Canada-Newfoundland and Labrador Offshore Petroleum Board
Environmental Affairs Department
St. John's, NL
For further information contact:

C-NLOPB

5th Floor, TD Place, 140 Water Street
St. John's NL, A1C 6H6
Tel: (709) 778-1400
Fax: (709) 778-1473
ISBN: 978-1-927098-02-8

1 Purpose

This document provides scoping information for the environmental assessment of the proposed exploration drilling program (the Project) in the Gulf of Saint Lawrence on EL 1105 over the period 2012 through 2014. Corridor Resources Inc. (Corridor) is the project proponent. A Project Description was submitted to the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) on February 21, 2011. The proposed project is located offshore western Newfoundland, approximately 80 kilometres west-northwest of Cape Anguille, Newfoundland and Labrador.

Included in this document is a description of the scope of the project that will be assessed, the factors to be considered in the assessment, and the scope of those factors.

The document has been developed by the C-NLOPB in consultation with the federal and provincial fisheries and environment departments, and the public.

2 CEA Act Regulatory Considerations

The Project will require authorizations pursuant to Section 138 (1) (b) of the *Canada-Newfoundland Atlantic Accord Implementation Act* and Section 134(1) (b) of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act.*

The C-NLOPB has determined, in accordance with paragraph 3(1)(a) of the *Regulations Respecting the Coordination by Federal Authorities of Environmental Assessment Procedures and Requirements* (FCR), that an environmental assessment (EA) of the project under Section 5 of the *Canadian Environmental Assessment Act* (CEA Act) is required.

Pursuant to paragraph 12.4 (2) of the CEA Act, the C-NLOPB will be assuming the role of the Federal Environmental Assessment Coordinator (FEAC) for this screening and in this role will be responsible for coordinating the review activities by the expert government departments and agencies that participate in the review.

The C-NLOPB intends that the environmental assessment submitted with any supporting documents, as may be necessary, will fulfill the requirements for a Screening. The C-NLOPB, therefore, pursuant to paragraph 17(1) of the CEA Act, formally delegate the responsibility for preparation of an acceptable Screening environmental assessment report to Corridor Resources Inc., the project proponent. The C-NLOPB will prepare the Screening Report, which will include the determination of significance.

3 Scope of the Project

The project to be assessed consists of the following components.

3.1 Drilling of a single exploration well, inclusive of routine activities such as pre-setting of anchors, vertical seismic profiling (VSP), geotechnical borehole drilling, and seabed sampling (coring, grabs, ROV surveying).

3.2 Operation of support craft associated with the above activities, including but not limited to mobile offshore drilling units (MODU), anchor handling tug supply (AHTS) vessels, supply/standby vessels, and helicopters.

3.3 Drilling activities are likely to commence in 2012, are scheduled to last between 20 to 50 days, and may occur year-round depending on ice conditions. Well testing activities, if conducted, will require several additional weeks. Depending on the type of drilling unit used (*i.e.*, semi-submersible, drill ship), drilling activities may occur throughout the year up to 2014. The well will either be suspended or abandoned by the end of 2014.

4 Factors to be Considered

The environmental assessment shall include a consideration of the following factors in accordance with Section 16 of the CEA Act.

4.1 The purpose of the project.

4.2 The environmental effects[1] of the Project, including those due to malfunctions or accidents that may occur in connection with the Project, and any change to the Project that may be caused by the environment.

4.3 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.

4.4 The significance of the environmental effects described in 4.2 and 4.3.

4.5 Comments from the public that are received in accordance with the CEA Act and the regulations.

4.6 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.

4.7 The significance of adverse environmental effects following the employment of mitigative measures, including the feasibility of additional or augmented mitigative measures.

4.8 The need for, and the requirements of, any follow-up program in respect of the Project consistent with the requirements of the CEA Act and the *Species at Risk Act* (SARA).

4.9 Report on consultations undertaken by Corridor Resources with interested parties who may be affected by program activities and/or the public respecting any of the matters described above.

5 Scope of the Factors to be Considered

Corridor will prepare and submit to the C-NLOPB an EA for the physical activities as described in the project description "*Project Description for the Drilling of an*

[1] The term "environmental effects" is defined in Section 2 of the *CEA Act*, and Section 137 of the *Species at Risk Act*.

Exploration Well on the Old Harry Prospect – EL 1105" (Corridor Resources Inc. February 2011), and as described above.

In preparing its EA, the Proponent shall consult with potentially affected groups and individuals, in consideration of comments submitted during the public consultation period for the February 25, 2011 draft scoping document. The EA will describe the results of these consultations and how they are to be addressed; address the factors listed in Section 4; and address the issues identified in Section 5.2..

Program activities are proposed for the Old Harry area, which has been studied in recent environmental assessments and the Western Newfoundland Strategic Environmental Assessment (LGL 2005) and Amendment (LGL 2007). For the purposes of the present assessment, the information provided in these environmental assessment documents for offshore oil and gas activities in this area can be used and/or referenced as supporting information, where applicable.

If the "valued ecosystem component" (VEC) approach is used to focus its analysis, a definition of each VEC (including components or subsets thereof) identified for the purposes of environmental assessment, and the rationale for its selection, shall be provided.

The scope of the factors to be considered in the environmental assessment includes the components identified in Section 5.2, "Summary of Potential Issues", setting out the specific matters to be considered in assessing the environmental effects of the project and in developing environmental plans for the project and the defined "Boundaries" (see below). Considerations relating to definition of "significance" of environmental effects are provided in the following sections.

Discussion of the biological and physical environments should consider the data available for the project and Affected area. Where data gaps exist, the EA should clearly identify the lack of data available.

5.1. Boundaries

The EA will consider the potential effects of the proposed drilling program activities within spatial and temporal boundaries that encompass the periods and areas during and within which the project may potentially interact with, and have an effect on, one or more VEC. These boundaries may vary with each VEC and the factors considered, and should reflect a consideration of:

- the proposed schedule/timing of the drilling program and its additional activities;
- the natural variation of a VEC or subset thereof;
- the timing of sensitive life cycle phases in relation to the scheduling of proposed physical activities;
- interrelationships/interactions between and within VECs;
- the time required for recovery from an effect and/or return to a pre-effect condition, including the estimated proportion, level, or amount of recovery; and

- the area within which a VEC functions and within which a project effect may be felt.

The Proponent shall clearly define and provide the rationale for the spatial and temporal boundaries used. The EA report shall clearly describe the spatial boundaries (i.e. Affected Area, Project Area), and shall include figures, maps and the corner-point coordinates.

Boundaries should be flexible and adaptive to enable adjustment or alteration based on field data and/or modeling results. The Affected Area and associated boundaries will be described based on consideration of potential areas of effects as determined by modeling (spill trajectory and cuttings dispersion), the scientific literature, and project-environment interactions (including transportation corridors). A suggested categorization of spatial boundaries follows.

5.1.1. Spatial Boundaries

Defining the spatial boundaries should take into consideration the potential for project activities, including accidental hydrocarbon spill events, which could affect sensitive areas, including coastlines.

<u>Project Area</u>
The area in which Project activities are to occur.

<u>Affected Area</u>
The area which could potentially be affected by project activities beyond the “Project Area”.

<u>Regional Area</u>
The area extending beyond the “Affected Area” boundary. The “Regional Area” boundary will also vary with the component being considered (e.g., boundaries suggested by bathymetric and/or oceanographic considerations).

5.1.2. Temporal Boundaries.

The temporal scope should describe the timing of project activities. Scheduling of project activities should consider the timing of sensitive life cycle phases of the VECs in relation to physical activities.

5.2. Summary of Potential Issues

The EA report for the proposed drilling program should contain descriptions of the physical and biological environments, as identified below. Where applicable, information may be summarized from existing environmental assessment reports. However, where new information is available, (e.g., fisheries data) the new information should be provided. Where information is summarized from existing environmental assessment reports, the environmental assessment reports should be properly referenced and the EA report should specifically reference the section of the completed EA report summarized.

The EA will contain descriptions and definitions of EA methodologies employed in the assessment of effects. Where information is summarized from existing EA reports, the sections referenced should be clearly indicated. Effects of relevant project activities on those VECs most likely to be in the Affected Area will be assessed. Discussion of cumulative effects within the Project and with other relevant marine projects will be included. Issues to be considered in the EA will include, but not be limited to, the following.

5.2.1. Physical Environment

Provide a summary description of the following:

- Meteorological and oceanographic characteristics in the Affected Area, including extreme conditions;
- Circulation and the factors influencing it;
- Summary of sea ice and iceberg conditions, including iceberg scour of the seabed;
- Overview of physical environmental monitoring, observation and forecasting programs that will be in place during the project;
- Magnitude and frequency of earthquakes;
- Evidence for and consequences of climate change for meteorology and oceanography;
- Summary of natural hazards affecting the seafloor (e.g., submarine landsliding) including events occurring outside the affected area that may affect the affected area;
- Ice management/mitigation procedures to be implemented, and any change to the Project that may be caused by the environment; and
- Effects of the environment on the Project (e.g., vessel and drilling platform icing, helicopter icing, turbulence, and cloud ceiling heights), including cumulative effects. The effects assessment should pay specific attention to effects of environmental factors on deep water rigsand mitigations that may be implemented to reduce these effects.

Marine Resources

5.2.2 Marine and/or Migratory Birds using the Affected Area

Provide a summary description of the following:

- Spatial and temporal species distributions (observation/monitoring data collected during ongoing petroleum activities should be included);
- Species habitat, feeding, breeding, and migratory characteristics of relevance to the Affected Area;
- Physical displacement as a result of vessel presence (e.g. disruption of foraging activities);
- Exposure to contaminants from accidental spills (e.g., fuel, oils) and operational discharges (e.g., deck drainage, grey water, black water);
- Attraction of birds to vessel lighting and flares and potential effects and mitigations;
- Noise disturbance from equipment including both direct effects (physiological), or indirect effects (foraging behaviour or prey species);
- Attraction of, and increase in, predator species as a result of waste disposal practices (i.e., sanitary and food waste);
- Procedures for handling birds that may become stranded on drill rigs or support vessels;

- Means by which bird mortalities associated with project operations may be documented and assessed;
- Means by which potentially significant effects upon birds may be mitigated through design and/or operational procedures;
- Effects of hydrocarbon spills from accidental events; and
- Environmental effects due to the Project, including cumulative effects (e.g., hunting, fishing (long line by-catch), shipping).

5.2.3 Marine Ecosystem

Provide a summary description of the following:

- Description of coral communities likely present in the Affected Area, and potential for coral communities to exist based on local habitat conditions;
- Characterization, including quantification to the degree possible, of the spatial area of seabed that is predicted to be affected by drill cuttings and other discharges, and subsea structures and the extent of impact on benthic communities (e.g., fish, shellfish, corals);
- Water column biota and their productivity including seasonality;
- Description of plankton communities, in particular zooplankton accumulation and aggregation zones that can be important for higher trophic level species (e.g., fish, marine mammals);
- Characterization of potential effects of the project on pelagic community and mitigation options;
- Means by which potentially significant effects upon benthic communities, (eg. corals and kelp forests), may be mitigated through design and/or operational procedures;
- Effects of hydrocarbon spills from accidental events; and
- Assessment of effects, including cumulative effects (e.g., bioaccumulation).

5.2.4 Marine Fish and Fish Habitat

Provide a summary description of the following:

- Distribution and abundance of marine fish and invertebrate species utilizing the Affected Area with consideration of critical life stages (e.g., spawning areas, overwintering, juvenile distribution, migration);
- Description, to the extent possible, of location, type, diversity and areal extent of marine fish habitat in the Affected Area. In particular, those indirectly or directly supporting traditional, aboriginal, historical, present or potential fishing activity, and including any essential habitats(e.g. spawning, feeding, overwintering);
- Description of benthic and pelagic habitat in the region and the affected area;
- Critical seasons and timing of habitat occupation;
- The means by which potentially significant effects upon fish and fish habitat (including critical life stages) may be mitigated through design, scheduling, and/or operational procedures;
- Effects of hydrocarbon spills from accidental events; and
- Environmental effects due to the Project, including cumulative effects.

5.2.5 Marine Mammals and Sea Turtles

Provide a summary description of the following:

- Spatial and temporal descriptions (observation and monitoring data collected during exploration activities operated by Corridor Resources should be discussed);
- Description of marine mammal and sea turtle lifestyles/life histories relevant to Affected Area;
- Means by which potentially significant effects upon marine mammals and sea turtles (including critical life stages) may be mitigated through design, scheduling, and/or operational procedures;
- Effects of hydrocarbon spills from accidental events; and
- Environmental effects due to the Project, including cumulative effects.

5.2.6 Species at Risk (SAR):

Provide a summary description of the following:

- A description, to the extent possible, of SAR and their habitat as listed in Schedule 1 of the *Species at Risk Act (SARA)*, and those under consideration by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in the Affected Area, including fish, marine mammals, sea turtles and seabird species. It is advised that the SARA Registry and COSEWIC website be referred to for the most recent information;
- A description of critical habitat (as defined under SARA), if applicable, to the Affected Area;
- Monitoring and mitigation, consistent with recovery strategies/action plans (endangered/threatened) and management plans (special concern);
- A summary statement stating whether project effects are expected to contravene the prohibitions of SARA (Sections 32 (1), 33, 58(1));
- Means by which adverse effects upon SAR and their critical habitat may be mitigated through design, scheduling, and/or operational procedures;
- Effects of hydrocarbon spills from accidental events; and
- Assessment of effects (adverse and significant) on species and critical habitat, including cumulative effects summary statement stating whether project effects are expected to contravene the prohibitions of SARA (Sections 32 (1), 33, 58 (1).

5.2.7 Sensitive Areas

The information should include:

- A description, to the extent possible, of any "Sensitive" Areas in the Affected Area, including coastal areas, deemed important or essential habitat to support any of the marine resources identified;
- Effects of hydrocarbon spills from accidental events;
- Environmental effects due to the project, including cumulative effects, on those "Sensitive" Areas identified; and
- Means by which adverse effects upon "Sensitive" Areas may be mitigated through design, scheduling, and/or operational procedures.

Marine Use

5.2.8 Noise/Acoustic Environment

Provide a description of the following:

- Noise and acoustic issues in the marine environment that may be generated from drilling operations (drill rig, thrusters-equipped vessels, VSP, and geohazard/wellsite

survey programs) and abandonment (wellhead severance), including the geographical extent of elevated noise levels;
- Disturbance/displacement of VECs and SAR associated with drilling activities;
- Means by which potentially significant effects may be mitigated through design and/or operational procedures; and
- Assessment of effects of noise/disturbance on the VECs and SAR, including cumulative effects.

5.2.9 Presence of Structures and/or Operations:

Provide a description of the following:
- Size and location of temporary or project-life exclusion zones;
- Description of project-related traffic (e.g., support aircraft and vessels), including routings, volumes, scheduling and vessel types;
- Effects upon access to fishing grounds;
- Means by which potentially significant effects may be mitigated through design, scheduling and/or operational procedures; and
- Effects of physical presence of structures upon access to fishing grounds, fish research surveys and upon general marine traffic/navigation; including cumulative effects.

5.2.10 Discharges and Emissions

Provide a description of planned project discharges to the marine environment, including:
- Drilling muds, fluids, and cuttings, bilge water, grey water, black water, cooling water, deck drainage, blow out preventer fluid, ballast water;
- Characterization, quantification and modelling of expected discharges and the timing of discharges, including a description of the trajectory models employed; and
- Environmental effects of discharges, including cumulative effects.

5.2.11 Air Quality

Provide a description of the following:
- Annual estimates of rates and quantities of emissions (e.g. as reported through Environment Canada's National Pollutant Release Inventory and the Board's *Offshore Waste Treatment Guidelines*), and a description of potential means for their reduction and reporting;
- Implications for health and safety of workers that may be exposed to them;
- Implications for health and safety of other marine users (e.g., fishers) that may be exposed;
- Implications for health and safety of coastal communities;
- Mitigation and monitoring; and
- Assessment of effects, including cumulative effects.

5.2.12 Commercial Fisheries

Provide a description of commercial fisheries in the Affected Area. The most recent data should be included, if available. The information should include:
- A description of fishery activities (including traditional, existing and potential commercial, recreational and aboriginal/subsistence and foreign fisheries) in the Affected Area;

- Consideration of underutilized species and species under moratoria that may be found in the Affected Area as determined by analyses of past DFO research surveys and Industry GEAC survey data, with emphasis on those species being considered for future potential fisheries, and species under moratoria;
- An analysis of the effects of Project operations and accidental events upon the foregoing;
- Fisheries liaison/interaction policies and procedures;
- Program(s) for compensation of affected parties, including fisheries interests, for accidental damage resulting from project activities;
- Effects of hydrocarbon spills from accidental events;
- Means by which adverse effects upon commercial fisheries may be mitigated through design and/or operational procedures; and
- Environmental effects of the Project, including cumulative effects.

5.2.13 Accidental Events

The discussion should not be limited to crude oil or condensate, but should consider accidental releases of drilling fluids, drilling muds, and other hydrocarbons. The information should include:

- Quantification of blowout risk;
- Quantification of risk of petroleum/chemical spills of all volumes associated with the Project;
- Discussion of the potential for spill events from drilling activities to enter the marine environment;
- Modelled physical fate of hydrocarbon spills, including descriptions of models and/or analyses that are employed and the physical data (e.g. circulation) upon which they are based;
- The effect of the physical environment on spills (e.g., ice)
- Description of the marine area likely to be affected by hydrocarbons from a spill event that enters the marine environment;
- Mitigations to reduce or prevent such events from occurring;
- Contingency plans, including relief wells and subsea intervention to shut in or cap well, to be implemented in the event of an accidental release;
- Description of activities associated with emergency response (e.g., dispersant use, burning or cleaning operations); and
- Environmental effects of any accidental events on all VECs identified, including those listed above. Cumulative effects should be included.

5.2.14 Environmental Management

Provide a general overall description of Corridor Resources' environmental management system and its components. It should include, but not be limited to:

- Pollution prevention policies and procedures;
- Fisheries liaison/interaction policies and procedures;
- Program(s) for compensation of affected parties, including fisheries interests, for accidental damage resulting from project activities; and
- Emergency response plan(s).

5.2.15 Biological and Follow-up Monitoring

Discuss the need for and requirements of a follow-up program (as defined in Section 2 of CEAA) and pursuant to the SARA. The discussion should also include any requirement for compensation monitoring (compensation is considered mitigation).

Detailed description of the monitoring and observation procedures to be implemented regarding marine mammals, sea turtles, and seabirds (observation protocols should be consistent with those described in Appendix 2 of the C-NLOPB "*Geophysical, Geological, Environmental and Geotechnical Program Guidelines"* (2011)).

5.2.16 Abandonment/Decommissioning

Plans for abandonment and/or decommissioning of the Project area and associated facilities following termination of drilling, including any anticipated requirement for post-abandonment monitoring.

5.3 Significance of Adverse Environmental Effects

The Proponent shall clearly describe the criteria by which it proposes to define the "significance" of any residual adverse effects that are predicted by the EA. This definition should be consistent with the May 2007 CEAA reference guide "*Determining Whether a Project is Likely to Cause Significant Adverse Environmental Effects"*, and be relevant to consideration of each VEC (including components or subsets thereof) that is identified. SARA species shall be assessed independent of non-SARA species. The effects assessment methodology should clearly describe how data gaps are considered in the determination of significance of effects.

5.4 Cumulative Effects

The assessment of cumulative environmental effects should be consistent with the principles described in the February 1999 CEAA "*Cumulative Effects Assessment Practitioners Guide*" and in the November 2007 CEAA operational policy statement "*Addressing Cumulative Environmental Effects under the Canadian Environmental Assessment Act*". It should include a consideration of environmental effects that are likely to result from the proposed project in combination with other projects or activities that have been or will be carried out. These include, but are not limited to:

- Proposed and potential oil and gas activities under EA review (listed on the C-NLOPB Public registry at www.cnlopb.nl.ca);
- Seismic activities;
- Marine management and protected areas;
- Commercial tourist activities;
- Fishing activities, including Aboriginal fisheries; and
- Marine transportation.

6 Projected Timelines for the Environmental Assessment Process

The following are estimated timelines for completing the EA process. The timelines are offered based on experience with recent environmental assessments of similar project activities and do not include proponent time.

ACTIVITY	TARGET	RESPONSIBILITY
Proponent submits EA to C-NLOPB	-	N.A.
C-NLOPB assess completeness of EA and requests further information from proponent [*if required*]	2 weeks	C-NLOPB
Proponent submits additional information [if required]		*Proponent*
C-NLOPB files EA documents with Independent Reviewer	0.5 weeks	C-NLOPB
Technical review of EA	8 weeks	C-NLOPB, Government Agencies, Public
Compile comments on EA and provide to Proponent	2 weeks	C-NLOPB
Submission of EA Addendum/Response to EA Comments		*Proponent*
Review of EA Addendum/Response Document	3 weeks	C-NLOPB & Government Agencies
Preparation of Draft Screening Report	3 weeks following submission of Independent Reviewer's report	C-NLOPB
Review of Draft Screening Report	4 weeks	Public
Finalize Screening Report (Determination of Significance of Project Effects)	2 weeks	C-NLOPB

APPENDIX B

Disposition Table of Regulatory Information Requests and Responses

Total Comment #	Agency/ Company Comment #	Government Department / Company	Section of EIS	Comment /Information Request	Response
1	1	CNLOPB	General	The EA report does not appear to have undergone appropriate quality control. Inconsistencies appear throughout the report in text, figures and tables.	The EA Report has been revised substantially and has been subject to quality review.
2	2	CNLOPB	Section 1.3 Page 4	Environment Canada has not been identified as a Responsible Authority.	Comment noted and this reference has been removed. Section 1.3 has also been revised to include information on CEAA, 2012.
3	3	CNLOPB	Section 2.6 Page 14	Please provide more detailed information on how this proposed project can be executed in as little as 20 days. Has the time required for Well Testing been included in the overall schedule and included in the assessment of effects on VECs	The estimated project time is from 20 to 50 days. The 20 days refers to drilling time for a 2000 m well. The 20 days does not include rig mobilization and demobilization, non-productive time or any time associated with waiting on weather. The time for well testing has not been included in the 20 to 50 day time period. Currently, testing is not planned to be completed during the drilling of the well; however, depending on approval times and rig availability, testing may be completed immediately after drilling or at a later date.
4	4	CNLOPB	Section 2.6 Page 14	The report touches briefly on the concept of operational windows around ice in the Gulf but it does not elaborate on the concept of establishing the timeframe of a seasonal window of operation and on actually limiting drilling activities within the Gulf to such a seasonal window. It also does not talk to the concept of limiting the drilling season to a timeframe that would also allow relief well drilling within the seasonal window (much the same concept as has been applied for drilling operations off the coast of Labrador). The "confined" nature of the Gulf (as opposed to the "unconfined" nature of other areas such as the Jeanne d'arc Basin) and also the potential for pack ice should be discussed to a greater extent and should probably drive towards at least considering a seasonal window that also allows for drilling of a relief well (if necessary).	The timeframe included in the Environmental Assessment was chosen to allow for any month of the year that might be icefree, taking into account that some years there may not be ice during any of the months that would hinder operations. The spud date for the well would likely be between March and November.
5	5	CNLOPB	Section 2.8 Mobil Offshore Drilling Units, pg 14	Should be Mobile Offshore Drilling Units.	Text has been updated as noted.
6	6	CNLOPB	Section 2.8 page 14	The report makes note of the various Mobile Offshore Drilling Unit (MODU) types (i.e.. Drillship versus Semi-submersible) and of the options of Moored units versus Dynamically Positioned units. However, the report does not talk to the pros and cons of these various options, especially in the context of the water depth for this prospect, and the potential impacts on operational risk and therefore the potential impact on environmental risk. Also, the report does not advise of the preferred option and the associated rationale for such a preferred option.	Both drillship and semi-submersibles in DP or moored mode can operate at the Old Harry location. Criteria for rig selection will be determined by availability and market conditions.
7	7	CNLOPB	Section 2.8 page 15	The OWTG expresses performance targets (OWTG, page 7). The operator's EPP expresses the discharge limits which apply to the project. The operator must submit an EPP, which describes every discharge and the associated limits, with the application for an OA.	Comment noted.
8	8	CNLOPB	Section 2.9.3 page 16 Helicopter Support, pg 16	The EA report does not identify shore-based facilities. This makes it difficult to assess, particularly in terms of assessing potential effects on VECs.	For a single exploration well, the main shorebase will be St. John's, NL. Supply vessels will mobilize from there. There may be minor vessel traffic into Port aux Basques and refuelling in Stephenville. The helicopter base will be in St. John's NL, with potential refueling at a location in Western NL. Text has been updated in Sections 2.91 and 2.93 to reflect this information.
9	9	CNLOPB	Section 2.10.3 Vertical Seismic Profiling, pg 18	The Geophysical, Geological, Environmental and Geotechnical Program Guidelines were revised in January 2012.	Text updated to reflect the new regulations.
10	10	CNLOPB	Section 2.10.4 Well Testing, pg 18	– "A Well Data Acquisition Program will be submitted to the C-NLOPB in support of the well approval at least 21 days prior to the anticipated spud date. There is no regulatory requirement to test the exploration well." Other than declaring a significant discovery, any testing program that involves flowing the well will require its own approval.	Text updated to include the information provided. Other than declaring a significant discovery, any testing program that involves flowing the well will require its own approval.
11	11	CNLOPB	Section 2.10.4 Well Testing, pg 18	"If produced water occurs, it will either be flared or treated in accordance with the Offshore Waste Treatment Guidelines (OWTG) (National Energy Board (NEB) et al. 2010) prior to ocean discharge." Water brought to the surface as part of reservoir fluids during a testing program, and which is not discharged via the flare, is typically transported to shore.	Text has been updated to state that wastewater is typically transported to shore and treated.
12	12	CNLOPB	Section 2.11.1 Drill Mud and Cuttings, pg 20	"Discharged drill cuttings are required to meet the limits outlined in the OWTG for the disposal of drill solids (no limit for WBM cuttings, 6.9 g of mud or less/100 g of cuttings for SBM cuttings overboard discharge)." See general comment on discharge limits. A discussion by Corridor regarding their plans if they cannot achieve this concentration of synthetic-on-cuttings is warranted.	Corridor will use best available technology to meet the requirements of the OWTG. Corridor will follow the practices established by other operators within the juristiction of the C-NLOPB if the conditions of the OWTG cannot be met.

Total Comment #	Agency/ Company Comment #	Government Department / Company	Section of EIS	Comment /Information Request	Response
13	13	CNLOPB	Section 2.11.1.2	Synthetic-based Muds "SBM cuttings may be discharged provided they do not exceed 6.9 g/100 g time weighted average of oil on wet solids (see Section 2.4 of the OWTG)". See general comment on discharge limits. A discussion by Corridor regarding their plans if they cannot achieve this concentration of synthetic-on-cuttings is warranted.	Corridor will use best available technology to meet the requirements of the OWTG. Corridor will follow the practices established by other operators within the juristiction of the C-NLOPB if the conditions of the OWTG cannot be met.
14	14	CNLOPB	Section 2.11.3 Produced Water, pg 23	Water brought to the surface as part of reservoir fluids during a testing program, and which is not discharged via the flare, is typically transported to shore.	Text has been updated to remove the reference to ocean disposal.
15	15	CNLOPB	Section 2.11.5 Machinery Space Discharges, pg 23	If this refers to bilge drainage from machinery spaces then where machinery leaks oil to a dedicated collection system, these discharges are normally collected and sent ashore for disposal.	This section has been updated as suggested.
16	16	CNLOPB	Section 2.11.9 Cooling Water, pg 24	The operator's EPP must describe the proposed biocide system and its management. If any form of biocide (chlorine or other) is to be used, it must be screened through the operator's chemical management system.	Text has been updated to include the commitment to address the management of the biocide system in the EPP and to acknowledge that if any form of biocide (chlorine or other) is to be used, it must be screened through the operator's chemical management system.
17	17	CNLOPB	Section 2.11.12 Miscellaneous, pg 24	The operator's EPP must describe all proposed discharges. Any chemical to be released to the environment must be screened through the operator's chemical management system.	Text has been updated to include commitments as stated by the reviewer.
18	18	CNLOPB	Section 3.6 Issues, Table 3.1, pg 68	please identify the section(s) in SL Ross 2011 Supporting Document that answers the question, "Is the spill model 2-D or 3-D?"	The SL Ross report utilized 2-D modeling. Table 3.1 has been updated with this information.
19	19	CNLOPB	Section §3.6 Issues, Table 3.1, pg 68	please identify the section(s) in SL Ross 2011 Supporting Document and the EA Report, if applicable, that addresses the comment, "The Gulf of Mexico spill occurred during exploration."	Table 3.1 has been updated to direct readers to Section 8.4.2 which addresses Large Spills from Offshore Well Blowouts.
20	20	CNLOPB	Section 7.1.5.3 Biological Effects, sub-section Shellfish, paragraph 1, line 6, pg 327	please explain how "they (shellfish)" produce sound in other ways.	The text has been updated to reflect the following: Shellfish are known to produce anti-predatory sounds. Examples include: lobsters vibrating antennae muscles, crabs stridulating, crayfish squeaking abdomen muscles and shrimp creating rumbling noises using their abdomen (Patek et al. 2009).
21	21	CNLOPB	Section 7.1.5.3 Biological Effects, sub-section Shellfish, Table 7.7, pg 328	The observed response of Iceland scallop (*Acequipecten irradians*) should be 1 of 3, not 14 of 3.	This correction has been made.
22	22	CNLOPB	Section 7.1.7 Well Abandonment/ Suspension, pg 341	Only one exploratory well is proposed and assessed. Production is outside the scope of this project.	Text has been revised to remove references to "wells" and "production" which are not part of the scope of this EA.
23	23	CNLOPB	Section 7.4.2.1 Presence of Platform, paragraph 1, line 2, pg 358	the presence of the drill platform, safety zone, lights and flaring is not discussed in Section 7.4.1. Please address.	The text has been updated to include cross-reference to Section 7.1.1.
24	24	CNLOPB	Section 7.4.2.2 Drill Muds and Cuttings, paragraph 5, line 5, pg 360	please identify the location of Traena Deep.	Traena Deep is located in the deep northeastern Atlantic Ocean off the coast of Norway.
25	25	CNLOPB	Section 7.7.2.1 Presence of Platform, paragraph 2, line 3, pg 376	Is there any research more recently published than Scott and Scott 1988. If so, please use in this section as the reference seems to be dated, 22 years old.	The references were updated to include: DFO (Fisheries and Oceans Canada). 2010n. Assessment of redfish stocks (Sebastes fasciatus and S. mentella) in Units 1 and 2 in 2009. Canadian Science Advisory Secretariat Science Advisory Report, 2010/037: 20 pp. DFO (Fisheries and Oceans Canada). 2011q. Recovery Potential assessment of redfish (Sebates fasciatus and S. mentella) in the northwest Atlantic. DFO Can. Sci. Advis. Sec., Sci. Advis. Rep. 2011/044.
26	26	CNLOPB	Section 7.8.3.1 Commercial Fisheries, 2nd bullet, pg 384	what does section 2(e) say?	This section was updated to reflect the latest version of the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (CNLOPB 2012).

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27	27	CNLOPB	Section 8.1 Relief Well Planning, pg 387	Blow-outs can last for months and in the Newfoundland and Labrador offshore, mobilization of a drilling unit can likely take weeks to arrive and begin drilling. How long it may take to drill a relief well and the time required to mobilize a rig should be considered. If a drill rig is not available locally then the proponent should address the time it would take to secure the rig and for the rig to arrive at location and begin drilling a relief well.	The relief well rig would have to be mobilized from NL, the Gulf of Mexico or the North Sea. If a rig is mobilized from NL, it would take 7 to 14 days for the rig to be ready to drill. A relief well would take a timeframe comparable to the estimate for the drilling of the original well. Therefore, it would take approximately 20 to 45 days to kill the well, in addition to the mobilization time. If a rig had to be mobilized from the North Sea, it would take approximtely 15 to 45 days for mobilization, plus 20 to 45 days to kill the well. Text has been added to Section 8.1 to acknowledge these timeframes.
28	28	CNLOPB	Section 8.2 Well Cap and Containment System, pg 387	The report makes a very high level comment to industry efforts regarding capping and containment; however, it does not articulate the risk mitigation associated with such technology nor does it provide a clear understanding of the current global state of play for availability for such technology. The EA report should have provided better clarity regarding the level of risk mitigation that can be gained from such technology and better clarity on the reality of having access to such technology in the operational timeframe being addressed by the EA. Also, in conjunction with this, the EA report does not provide any real commitment on having access to such technology.	The Subsea Well Response Project (SWRP) is a joint initiative of experts from nine of the world's major oil and gas companies who work together practively and cooperatively to build on existing capabilities and develop enhanced oil response equipment and methods. Oil Spill Response Ltd. (OSRL) and SWRP are collaborating to make the new integrated intervention system available to the industry and to ehance interational capabilities to respond to subsea well incidents. This group makes available, based on a fee structure, equipment to oil and gas companies operating around the world. The equipment includes capping toolboxes, capability for subsea dispersant use, and deployment services. For drilling in the 2014/15 timeframe, Corridor will enter into an arrangement with this group for access to this enhanced spill response equipment. Corridor's first priority, as with all operators, is prevention. In the unlikely event of a uncontrolled blowout, Corridor will have access to the same equipment as all operators active on the Grand Banks. This text has been added to Section 8.2 of the EA Report.
29	29	CNLOPB	Section 8.4.5 Calculated Blowout Frequencies for the Old Harry Project, pg 392–	This should probably be reworded. The impression that the reader is left with is that an extremely large spill probably won't occur for 25,000 years. The following wording should be considered. The likelihood of an extremely large oil spill (>150,000 barrel) from a blowout during drilling of an exploration well, may be calculated as (1 well drilled) x (3.97 x 10-5 spills/well drilled) = 3.97 x 10-5. The likelihood of a very large oil spill (>10,000 barrel) from a blowout during drilling of an exploration well is 7.93 x 10-5. The likelihood of a large oil spill (>1,000 barrel) from a blowout during drilling of an exploration well is 9.91 x 10-5.	Report has since been revised to address this concern.
30	30	CNLOPB	Section 8.4.7 Calculated Blowout Frequencies for the Old Harry Project, pg 395	The most recent analysis indicates 2.8×10^{-3} not 2.1×10^{-4}.	The more recent analysis of 2.8 x 10-3 refers to the shallow gas blowout frequency, and should not be confused with the deep blowout frequency of 2.1 x 10-4. In this chapter on spill probability, a shallow gas blowout is defined as a release of gas prior to the BOP being set and should not be confused with shallow-water blowouts discussed in the spill behaviour chapter. Shallow gas blowouts are more likely to occur than deep blowouts, but they do not involve a discharge of oil, and are not discussed further in this chapter.
31	31	CNLOPB	Section §8.4.10 Summary of Spill Frequencies, Table 8.1, pg 397	what is the heading of the second column supposed to read?	The table has been formatted to improve readability.
32	32	CNLOPB	Section8.7.1.2 Marine Bird Species at Risk, pg 402	Assuming that the risk of spills from supply vessels is consistent with other shipping, it is still an incremental increase in risk. In addition, since no risk statistics have been provided for marine shipping activity in the Gulf, this statement cannot be assessed in a quantitative manner.	Although an incremental risk is acknowledged, it remains a low risk and a quantitative analysis is not considered necessary for this discussion
33	33	CNLOPB	Section 8.7.2 Marine Ecosystems, pg 405	Since no risk statistics have been provided for marine shipping activity in the Gulf, this statement cannot be assessed in a quantitative manner. Also, "low" has not been defined.	Refer to response provided for CNLOPB-32.

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34	34	CNLOPB	Section 8.7.7 Commercial Fisheries and Other Users, pg 410	"low" has not been defined.	"Low" in this case is referring to the low level of commercial harvesting activities within the Project Area which was defined in Section 5.8.1 by the following text - "there is minimal fishing effort within and surrounding the Project. No harvesting locations were recorded within EL 1105. The closest harvest location to the Project is located just less than 10 km to the southwest of EL 1105, and was recorded for redfish. Between 10 and 12 km from the EL 1105, a couple of harvest locations were recorded for redfish and one for each cod and white hake. However, in general, the fishing effort can be summarized in the immediate vicinity of the Project as low".
35	35	CNLOPB	Section 11.0 Follow-up and Monitoring, pg 421	It is not clear whether they are commitments or not? The bulleted list say "will" but they are introduced as "could".	Text has been revise to remove "could" and replaced with "will".
36	36	CNLOPB	Section 12.1 Potential Effects of the Physical Environment on the Project, para. 1, pg 422	"These effects will be mitigated by using… state-of-the-art forecasting." Details should be provided on the "state-of-the-art" forecasting.	Text has been revised to "monitoring government and industry 24-hour forecasts".
37	37	CNLOPB	Section 13.0 Environmental Management, 7th Bullet, pg 425	The *Drilling and Production Regulations* require an Operator to submit a Safety Plan and an Environmental Protection Plan with the application for an authorization. One document may be used to satisfy the requirements if it meets the requirements laid out in Sections 8 and 9, of the regulation.	Comment noted.
38	38	CNLOPB	Section 14.0 Summary and Conclusion, pg 426	"Significant environmental effects are predicted" however not at a population level.	Text has been updated as indicated.
39	1	DFO	General	The quality of French in the French version of the environmental assessment report is lacking and many sentences are difficult to understand. For example, the French translation is sometimes technically inaccurate, even truncated compared to the English version, making the text incomprehensible. Incomprehensible paragraphs should therefore be reviewed for content or edited by an individual fluent in French and with scientific knowledge.	Translation edits will be addressed as relevant during translation of the revised EA Report.
40	2	DFO	General	Overall, the quality of scientific content presented in the environmental assessment (EA) varies across the sections. While the potential environmental impacts of exploratory drilling regarding drilling fluids and cuttings is well-covered and conclusions are in line with many reviews and individual studies dealing with the effects, much of the preceding content relating to Valued Ecosystem Components (VECs) is inconsistent among the various sections. Substantial inaccuracies and omissions here can threaten the ability to properly assess potential effects.	Comment noted. Significant effort has been made to address reviewer comments and the report has been revised substantially. Although it is recognized, in spite of this additional work, the original impact analysis, mitigation, and conclusions remained valid for environmental assessment and decision-making.
41	3	DFO	General	The environmental assessment does not indicate what time of year the project will occur. While the duration is identified, the season of activity is not. This information is particularly important in terms of assessing potential impacts on the ecosystem and its components.	The Environmental Assessment included the possibility of drilling in any month of the year that is ice free. The spud date of the well would likely be no earlier than March and no later than November.
42	4	DFO	General	In general, modeling pertaining to assessing the behavior and trajectory of oil spills that might occur during exploration drilling activities requires significant reconsideration of many of the inputs (e.g. currents, winds, tides, outflows, timing, etc.), as well as the models in some cases. Scenarios were also often not clearly described (e.g. for blowouts), and overall, modeling results were not clearly presented. Information gained from the Gulf of Mexico spill should also be considered for informing this exercise.	These general concerns are addressed in the specific questions / concerns of DFO below.
43	5	DFO	General	The environmental assessment should undergo appropriate and specialized quality control of content for translation, relevancy, agreement between text and figures and tables, and the appropriate use of up-to-date information and references.	Comment noted. The report has been edited substantially to address reviewers' comments.

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44	6	DFO	General	The Study Area, the area that could be potentially affected by Project activities, has been defined by the furthest extent of the drill cutting deposition modeling, oil spill trajectory modeling results and supply vessel/helicopter activity to coastal Newfoundland. The parameters of these activities limit the spatial scope (i.e. geographical area) of the assessment. For example Cohasset oil (i.e. light oil), was used as a surrogate for spill modeling purposes. This directly impacts the spatial extent of any accidental spill event modeling and in turn the assessment of impacts on the VECs, in particular fish, fisheries, sensitive areas, marine ecosystem and coastal areas. Should the nature of the oil discovered be different (i.e. heavier) than that used in modeling the potential impacts and significance of the impacts to the VECs may be different than what has currently been assessed. It may have been more appropriate to consider other oil heavier types during modeling.	The justification for the selection of Cohassett condensate as a surrogate for the oil likely to be found at this location has been provided in Appendix A of the SL Ross report "Oil Spill Fate and Behaviour Modelling in Support of Corridor Resources Old Harry Exploratory Drilling Environmental Assessment" (SL Ross 2011a, updated 2012). The type of oil selected for oil spill modeling was based upon detailed scientific work completed by a world renowned geochemist with Global Geoenergy Research Ltd. The work involved assessing the organic material in the shale source rocks at the Brion Island No.1 well, the closest well to Old Harry. These studies identified the source rocks to be derived mainly from a mixed lacustrine or fluvial oil prone amorphous lipids or terrestrial liptinite (plant suberin, resin, and cuticle) rich organic matter. These organic rich zones contain oil and gas prone Type II-III kerogen that generate hydrocarbons (mainly oil) at an early stage of thermal maturation. During later stages, they will generate mainly natural gas. Petroleum system modeling was conducted to determine the type of oil likely to be produced from the source rocks; the models predict the presence of hydrocarbons in the liquid (oil) and vapour (natural gas) phases. No oils were identified that were heavier than 50 degrees API. Therefore, Corridor asserts that the selection of a Cohassett-Panuke oil with an API gravity of 47 degrees API is conservative selection of a surrogate oil. Finally, the Carboniferous Magdalen Basin is generally a gas prone basin. Natural gas has been encountered in those wells that contain hydrocarbons. In fact, the only discovery to date in the Gulf of St. Lawrence (East Point E-49) is a natural gas discovery. Based upon a scientific evaluation, Corridor's view is that the Old Harry structure is not likely to contain a heavier oil.
45	7	DFO	1.3 Regulatory Context, p. 4, 1st paragraph	Fisheries and Oceans Canada (DFO) has been identified as a Responsible Authority in this section. Please note DFO is not a Responsible Authority for this environmental assessment as an Authorization under the *Fisheries Act* is not required for this project. Rather DFO is a Federal Authority offering expert specialist advice during the environmental assessment review.	Section 1.3 has been edited substantially and DFO's role has been corrected as a federal authority.
46	8	DFO	2.6	While the anticipated duration of work is indicated (20-50 days) the season is not. This is information is particularly important in terms of assessing potential impacts on the ecosystem and its components (i.e. fish, marine mammals etc…).	The Environmental Assessment included the possibility of drilling in any month of the year that is ice free. The spud date of the well would likely be no earlier than March and no later than November.
47	9	DFO	Section 2.6	It is advised that the proponent should plan the activity around important and sensitive time periods for fish, marine mammals and species at risk.	Drilling will not occur earlier than March or later than November. Specific timing will depend on a variety of variables including but not limited to rig availability and regulatory approvals. Mitigation measures, including wildlife observers and adherence to regulatory guidelines (e.g., Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment, Offshore Waste Treatment Guidelines) will reduce effects on marine species.
48	10	DFO	2.12.2	The parameters used in the models take into account the seasonal averages of oceanographic and atmospheric conditions recorded for the Gulf of St. Lawrence as well as the properties associated with light hydrocarbons. Should characteristics of the hydrocarbons found differ (i.e. heavier crude oil) from those expected, modeling and assessment of potential impacts may be different.	Corridor Resources experts identified that the oil from this operation would most likely match the Cohassett light oil/condensate product (see response provided for DFO-6). Known physical properties of this oil were used in the spill fate modelling.

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49	11	DFO	3.0 Stakeholder Consultation	A key concern that has been raised repeatedly by stakeholders to DFO is the need for additional consultation with fishery stakeholders including the commercial, recreational, Aboriginal Fisheries and the Aquaculture sector within the Gulf Region. The consultation program focused primarily on the "geographic region", most likely to be affected by the project and included Western Newfoundland and the Magdellan Islands. It should be noted that the proposed exploratory well is near the border of NAFOzones 4R, 4S, 4T and 4VN, where Gulf Region fish harvesters participate in fisheries within close proximity to the proposed well location.	A summary of Corridor's public consultation is included in the Environmental Assessment document. Corridor conducted consultations in NL and the Magdalen Islands with key stakeholders, including fisheries groups. Corridor also obtained fisheries information from DFO. Any information on fisheries data that arose from the consultations conducted by Corridor and its consultants was included in the draft EA document. Consultation appropriate for a screening level EA of a single, short duration exploration well has already been conducted. Additional consultation is unlikely to result in information that would enhance the Old Harry EA or that would substantively change its conclusions. Fisheries effort in the vicinity of the proposed Old Harry well location show that minimal to no fishing activities are conducted within 30 km of the proposed well (see Figures 5.67-5.70 in the EA). In addition, the C-NLOPB has undertaken a public consultation process for the Strategic Environmental Assessment (SEA) update of the Western Newfoundland offshore area and fisheries stakeholders will be able to provide input on their activities in relation to proposed drilling activities in the Gulf of St. Lawrence. The updated regional fisheries information will be included in the SEA Update.
50	12	DFO	3.1, p. 64 par 1	The focus on western Newfoundland and Magdellen Islands implies that fish harvesters from other areas of the Gulf are not participating in fisheries in areas close to the proposed well, which is not the case. The C-NLOPB was provided a list of Gulf and Quebec region stakeholders in April 2011 to assist in consultations.	Consultation appropriate to a screening level EA has been conducted. The Project is one exploration well and it will be completed within 50 days. Fisheries effort in the vicinity of the proposed Old Harry well location show that minimal to no fishing activities are conducted within 30 km of the proposed well (see Figures 5.67-5.70 in the EA).
51	13	DFO	3.4, p. 66, bullet 1	DFO attendees at the meeting included: -A/Regional Manager - Environmental Assessment and Major Projects NL Region - Environmental Assessment Analyst - Environmental Assessment and Major Projects NL Region -Regional Manager - Environmental Assessment and Major Projects Gulf Region -Senior Advisor for Oil and Gas, Ecosystem Management Branch – Gulf Region - Analyste principale, Évaluation environnementale – Québec Région	Section 3.4 has been updated to reflect DFO attendees as indicated.
52	14	DFO	4.1.5	Although the volume measure (3,553 km^3) is from Dufour and Ouellet (2007), it is incorrect. The volume is about 35 000 km^3 (see for example Dufour et al. 2009).	Text revised to include the volume listed as per Dufour et al. 2010.
53	15	DFO	4.1.7	While the EA acknowledges that *"Knowledge of ocean currents is essential to the planning of oil and gas related operations in any area",* the section on ocean currents simply states broad facts and shows maps from different sources without any proper interpretation or comparison. The currents that the EA uses in the report are cited but are never shown (i.e. *Surface water current fields developed by the Ocean Sciences Division, Maritimes Region of DFO (Tang et al. 2008) were used in the spill trajectory modeling*).	The section on ocean currents properly describes the currents of the Gulf. The currents are shown in Figures 4.13, 4.14, and 4.16-4.19 with citations (SLGO 2011; Galbraith et al. 2011; LGL 2005b). Tang et al. 2008 was not referenced in Section 4.1.7. For more information on oil spill modeling, trajectories and the currents used to create these, please refer to the stand alone report conducted by SL Ross.
54	16	DFO	4.1.7	The statement, *"Driven by wave and tidal movement, cold, dense water flows into the Gulf through the Strait of Belle Isle from the Arctic via the Labrador Current."* is incorrect. The inflow through the Strait of Belle Isle is not driven by waves or tides and it isn't from the Arctic (although contains some dilution of Arctic waters) or from the (deep) Labrador Current. It is noted that this text is out of context in the Ocean Currents section.	Comment noted and incorporated into the EA.
55	17	DFO	4.1.7	Figure 4.13 – panels for M2 and K1 are not identified.	Unclear what is being referred to in this comment.
56	18	DFO	4.1.7	Figure 4.19 – surface currents in the Gulf of St. Lawrence (top: February 4, 2011@ 1100 hours and bottom: September 29, 2011 @ 0800 hours) - there is no bottom panel in the EA	The bottom panel has been added to the EA.
57	19	DFO	4.1.7	Figure 4.12 – the caption indicates two panels; only one panel shown (French version).	Translation edits will be addressed as relevant during translation of the revised EA Report.

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58	20	DFO	4.1.8	It is not evident that tides were used in spill trajectory modeling within the EA. If this is the case, why not?	Tides were not used in the modelling because their inclusion would not have significantly altered the overall spatial footprint of the oil from the spill scenarios modelled.
59	21	DFO	4.1.8	Sources of water current estimates are included (p.101) in the EA, but are out of context here. This information should appear in Section 4.1.7 and be compared with other results shown.	The section on Tides (previously 4.18) has been edited in the revised EA Report.
60	22	DFO	4.1.11	Fig. 4.23 – this is unreadable with insufficient resolution.	Figure 4.23 has been split into four different Figures (25-28) to improve resolution.
61	23	DFO	4.1.11	Fig. 4.34 – legend = 2009; figure shows 2010 and not 2009.	Figure 4.34 caption has been updated to 2010.
62	24	DFO	4.1.11	Regarding the statement, "*All sea ice in EL1105 is first-year ice, ranging in its un-deformed thickness from 30 to 120 cm (SLGO 2011; Figure 4.20).*" Figure 4.20 does not actually show ice. It is not obvious what is meant by *un-deformed thickness* here, but ice thickness in the Gulf has been known to exceed 2 m in places by rafting during heavy ice years. Ridges can be much thicker still (> 10 m). As such, these extremes should be mentioned in the assessment rather than showing median quantities such as average thickness. Based on the above, the reader might surmise that since bathymetry, currents and tides are very predictable, then so is ice cover. However, the premise of the initial statement is misleading: the thermodynamics of the ocean surface layer are not even mentioned here. To produce ice, the winter mixed layer must first be cooled to the freezing point over a large layer (a typical thickness of 75 m was mentioned on Page 92).	The section on Ice has been rewritten with reviewer comments in mind.
63	25	DFO	4.1.11	The EA states (p.108), "*The Project Area is located in an area that ranges from 51 to 84 percent 30-Year frequency for the presence of sea ice (green and purple color bands) depending upon the month.*" However, Figures 1.27 to 4.28 do not have any green as mentioned. Caution should also be used in interpreting these three figures. For example, the March figure shows the average probability of encountering sea ice over the entire month, and not the probability of encountering ice at least once during the month.	Refer to response provided for DFO-24.
64	26	DFO	4.1.11	The EA states, "*EL1105 is located in the area that has an average ice freeze up date of January 29 (Figure 4.31). The normal ice free period for EL1105 extends from April 9th to February 12th of the following winter…*" However, this seems in contradiction. If the average ice freezup date is January 29, then the area cannot be ice-free after break-up until the following February 12th.	Refer to response provided for DFO-24.
65	27	DFO	4.2	For the circulation subsection, Han et al. (1999, Journal of Physical Oceanography) provided detailed seasonal mean circulation fields in the Gulf of St. Lawrence, especially in terms of the gulf-shelf interactions, including the inflow from the Labrador Shelf through the Strait of Belle Isle, as well as the outflow on to the Scotian Shelf and the inflow from the Newfoundland Shelf, both through Cabot Strait. This paper should be included in the review under 4.2.2 (p.55).	Galbraith 2006, Dufour and Ouellet 2007, Galbraith et al. 2011, Saucier et al. 2003, provide detailed and up-to-date information as seasonal mean circulation fields in the Gulf of St. Lawrence including the inflow from the Labrador Shelf through the Strait of Belle Isle, as well as the outflow onto the Scotian Self and the inflow from the Newfoundland Shelf, both through the Cabot Strait. Figures 4.16-4.18 taken from Galbraith et al. 2011 depict seasonal ocean currents during 2010, which closely mimic the mean currents found in Han et al. 1999 (Figure 11). The description of the circulation found in Section 4.2 of the Environmental Assessment portrays the same message as Han et al. 1999, with more up to date information.
66	28	DFO	4.2.1	Average daily temperatures in the vicinity of EL1105 could be misinterpreted. Those presented are not the true range of observations, but rather the 30-year monthly average temperature minimum and maximum. Far colder and warmer temperatures have been recorded. Therefore variability is missing on the monthly scale, and also at the inter-annual scale.	Comment noted and extreme maximum and minimum temperatures have been added to showcase variability on a monthly scale.
67	29	DFO	4.2.1	Reference in the EA to "*…average monthly air temperatures for several land-based weather stations surrounding the Gulf…*" does not add much long term context. Instead, Galbraith et al (2011) show mean winter air temperatures at these land stations since 1971, which should be used to describe interannual variability.	Interannual variability and historical climate of EL1105 is described in section 4.2.1 in regards to the Port Aux Basques weather station (closest station to EL1105). Galbraith et al. 2011, is used to describe the recent trends in variability and climate compared to historical data for the area.
68	30	DFO	4.2.1	The EA describes (p.114) sea surface temperatures such that "*…the minimum mean temperatures for February and March are approximately -0.8°C.*" However, in years of maximum ice year such as 1993, the winter mixed layer was near-freezing at -1.7°C in the area of EL1105. The area also borders the warm waters (T > 0°C) seen in many winters entering the Gulf on the Newfoundland side of Cabot Strait (see Galbraith 2006).	Comment noted. This is logical, in years of maximum ice it would be expected that the surface ocean temperatures would be colder than years with less ice. It is possible to have mean minimum temperatures of -0.8 °C, and years with maximum ice with temperatures of -1.7 °C.

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69	31	DFO	4.2.2	It is unusual that the MSC50 reanalysis shows no winds above 20 m/s (90 km/h) between June and November, and extremely rarely in other months. The EA presents that the highest winds are less than 2% in winter; however winter interpreted as Dec-Jan-Feb is in fact 0.02%, and the highest as occurring in spring (Mar-Apr-May) at less than 0.2%.	Wind speeds over 90 km/h during the summer months would be rare and would still be rare during the winter months. During the months of June to November average wind speeds at Port Aux Basques range from 17.5 km/h to 27.4 km/h. The number of days with winds > = 63 km/h range from 0.2 to 4.1. As a result we can see that wind speeds are relatively low during the summer months as indicated by the MSC50 results.
70	32	DFO	4.2.2, page 100	Habituellement, le mouvement de l'eau suit le détroit de Cabot, coulant dans le sens trigonométrique autour du Golfe […]. Incorrect translation of "counterclockwise"	Translation edits will be addressed as relevant during translation of the revised EA Report.
71	33	DFO	4.2.2, page 100	Incomprehensible translation – French version Le courant de débordement du fleuve Saint-Laurent produit un fort courant côtier qui coule le long de la péninsule gaspésienne (le courant de Gaspésie), en direction de la mer et dispersant l'écoulement de surface du Saint-Laurent en direction nord-ouest et du sud du Golfe (Dufour et Ouellet 2007). This excerpt of the document comes from an article by Dufour and Ouellet 2007, which reads as follows: La caractéristique principale du débit sortant du Saint-Laurent est un courant côtier fort le long de la péninsule gaspésienne (courant de Gaspé) qui disperse l'eau du Saint-Laurent dans le nord-ouest et le sud du golfe. (original text)	Translation edits will be addressed as relevant during translation of the revised EA Report.
72	34	DFO	4.2.2, page 107	*Incorrect Translation – French version* *Les marées se propageant au-dessus des filons-couches à la tête du chenal Laurentien […].* *Incorrect translation of "sill"*	Translation edits will be addressed as relevant during translation of the revised EA Report.
73	35	DFO	4.2.6, page 118	Incomprehensible translation – French version Le PP 1105 est situé dans le secteur dont la date moyenne de congélation de la glace est le 29 janvier (Figure 4.25).	Translation edits will be addressed as relevant during translation of the revised EA Report.
74	36	DFO	5.1, page 131	Incomprehensible translation – French version Cela en raison du fait que le Golfe est séparé partiellement de l'Atlantique Nord, recevant un apport en eau douce de la part de rivières importantes, et aussi par un chenal orienté sur toute sa longueur, une saison des glaces, plusieurs types de masses d'eau, incluant une couche intermédiaire froide, des zones a plateaux et d'eaux peu profondes ainsi qu'une productivité et une diversité biologique élevées (MPO, 2005a). Ces zones biologiques bonifiées sont le résultat de facteurs physiques reliés à la topographie particulière du plancher océanique, des vents et courants océanographiques, laquelle, combinée a des facteurs chimiques tels des eaux riches en nutriment, donne naissance a des processus physiques comme une remontée des eaux de fond, des fronts horizontaux ou verticaux entre deux schémas de circulation distincts et des masses d'eau, ainsi que des zones de convergence et des gyres.	Translation edits will be addressed as relevant during translation of the revised EA Report.
75	37	DFO	5.1	This section indicates that Section 5.2 will cover species at risk from both the St. Lawrence Estuary and the Gulf of St. Lawrence. Section 5.2 states that Table 5.2 covers all species in the Gulf that are designated at risk by COSEWIC. The following Atlantic salmon populations are assessed as at risk by COSEWIC (2010), but are treated neither in the text of Section 5.2 nor in Table 5.2: Quebec Eastern North Shore population - special concern; Quebec Western North Shore population - special concern; Inner St. Lawrence population - special concern. In general, the migration routes of these populations are unlikely to take them close to EL1105 for an extended period of time. However, if it is the intent of the assessment to exclude these populations from consideration, it should be explicitly stated why.	The Quebec Eastern North Shore Atlantic salmon population has been addressed in the text. The Quebec Western North Shore population as well as the Inner St. Lawrence population has been added to Table 5.2.
76	38	DFO	5.2	The data on which many of juvenile/adult fish distribution figures are based is often dated – and only a single or several years of RV data compiled into figures is also common. As such, updated and additional years are required indicate the current distribution of these species as RV surveys referenced are likely stratified-random surveys and any one year may not yield any sets within the Old Harry project area. Figures are also lacking the location of the exploration licenses covering the Old Harry area superimposed on distribution maps for reference. Information on the size and/or age of juvenile fish should be included with figures and descriptions.	Species distribution maps have been extracted from primary and/or secondary literature and without georeferenced digital data files that can be easily manipulated to include the Project Area, the EL1105 area cannot be easily overlaid onto distribution maps. For the purpose of environmental assessment, the level of detail presented is sufficient to make a determination of species presence/absence in the general Study Area.
78	39	DFO	5.2, Table 5.1, p. 122-123	For the 3 wolffish species the table indicates that there is a low potential for occurrence in EL1105, yet in the first paragraph of Section 7.2.2.1, p.343, it is indicated that wolffish are included with the species which have a moderate to high potential to occur in the project area (same as EL1105?). The information presented should be consistent between sections.	The wolffish is indeed a species that has a low potential for occurrence and the two sections have been made consistent.
385	40	DFO	5.2, Table 5.1, p. 122-123	Northern and Spotted Wolffish - "Non-migratory spawning occurs" – based on current information it is unknown if Northern and Spotted wolffish do or do not have spawning migrations. Northern wolfish also occurs in waters shallower than 500m.	Information pertaining to northern and spotted wolffish spawning migrations and depth range has been updated in the EA.
387	41	DFO	5.2, Table 5.1, p. 122-123	Atlantic Wolffish – This species occurs in waters greater than 350m.	Information regarding the depth distribution of the Atlantic wolffish has been updated

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77	42	DFO	5.2, Table 5.1, p. 122-123	White Shark (added to SARA Schedule 1 on July 6, 2011) should be included in the table.	Table 5.1 has been updated to include White Shark.
79	43	DFO	5.2, Table 5.2, p. 124	Requires explanation of how potential for occurrence is defined and calculated and what metric is used.	The criteria for occurrence is based on professional judgment taking into account available catch records, survey maps, habitat type and species behaviour.
386	44	DFO	5.2, Table 5.2, p. 124	Laurentian South Cod : There are problems with this characterization. Should state that there is a high potential for occurrence. Distribution maps exclude September survey information and winter distribution patterns. The statement, "Eggs and larvae may be present in the upper water column May to April" is inaccurate. There are two populations in this designatable unit; the population of concern here is the southern Gulf of St. Lawrence population. This population is distributed throughout the southern Gulf in summer and overwinters along the side of the Laurentian Channel, with dense aggregations typically occurring in the Laurentian Channel north of St. Paul Island. Cod use two migration routes between these overwintering grounds and summer grounds in the southern Gulf, the Cape Breton Trough and the southern slope of the Laurentian Channel (north of the Magdalen Islands). Essentially the entire population moves through this area in proximity to EL1105 each spring and fall.	Additional information regarding the Laurentian South cod population has been updated in the EA .
388	45	DFO	5.2, Table 5.2, p. 124	Striped bass: The statement the "Gulf population is considered extirpated" is incorrect and should state that the St. Lawrence estuary population is considered extirpated; the Gulf population is designated threatened as previously stated in same text block. This should be clear and as it reads now it is confusing.	Information regarding Striped bass populations has been noted and changes have been made to the EA.
80	46	DFO	5.2, Table 5.2, p. 124	The population of Killer Whale being referred to is the Northwest Atlantic/Eastern Arctic population. White Shark should be removed from the table. This species was added to SARA Schedule 1 on July 6, 2011.	Comment noted, changes have been made to the SARA table.
81	47	DFO	5.2, Table 5.2, p. 124	Deepwater Redfish - species name is *Sebastes mentella* (not *mentalla*). Spawning does not occur in fall. Mating between males and females occurs in fall but female extrude larvae (=spawn) from April-July.	Comment noted and details regarding the deepwater redfish have been changed in the EA.
82	48	DFO	5.2, Table 5.2, p. 124	Acadian Redfish (Atlantic) – spawning does not occur in fall. Mating between males and females occurs in fall but female extrude larvae (=spawn) from May-August.	Comment noted and details regarding the Acadian redfish have been changed in the EA.
83	49	DFO	5.2, Table 5.2, p. 124	Winter Skate (Southern Gulf of St. Lawrence population) – the description is inaccurate. This population occurs just within the Gulf (are distinct from populations on the Scotian Shelf and Georges Bank). Winter Skate lay egg cases and emerge as juveniles. The seasonality of "spawning" is not well known.	The description of winter skate has been updated.
84	50	DFO	5.2, Table 5.2, p. 124	American plaice (Maritime population) – the description is inaccurate. This population overwinters in deep water in the Laurentian Channel.	The description of American plaice (Maritime population) has been updated.
85	51	DFO	5.2, Table 5.2, p. 124	Table 5.2 should consider Swain et al. (1998); and Chouinard and Hurlbut (2011) as sources of information.	Comment noted. This data on species distributions in the Gulf (Chouinard and Hurlburt (2011) is only for the month of January during the years from 1994-1997. Although the publication is new the data is not.
86	52	DFO	5.2.1	In this and other sections on fish species (e.g. 5.2 Species at Risk) the EA reproduces a number of juvenile fish distributions from RV surveys. The data on which many of these figures is dated (at least 6 years old) and only a single year of RV data compiled into figures is common. Updated and additional years are required to indicate the distribution of juveniles for these species as RV surveys referenced are likely stratified-random surveys and any one year may not yield any sets within the Old Harry site. It would also be useful for figures to have the location of the exploration licenses covering the Old Harry area superimposed on distribution maps for reference. CSAS Docs are available for porbeagle, mako, basking sharks, spiny dogfish and blue sharks (all can be downloaded from the Publications page of the Shark website) and should be consulted and cited as such within the assessment.	The species distribution maps have been updated with current data where deemed appropriate for many species. Life history information pertaining to porbeagle, mako, basking sharks, spiny dogfish, and blue sharks has been updated using the latest information from CSAS documents.
87	53	DFO	5.2.1.1	References for depth distribution of northern wolffish are not provided – which also contradicts Table 5.1 content. However, for the Newfoundland and Labrador region, the densest concentrations of northern wolffish tend to be found at 400-900 m (Kulka et al. 2004, Simpson et al. 2011). Fecundity/number of eggs and parental care of northern wolffish are not known in Canadian waters, yet the EA states that northern wolffish can lay up to 27,000 eggs and guard their eggs. References are required for this information.	Comment noted and references for depth distributions and fecundity have been added to the EA.
389	54	DFO	5.2.1.1, p. 127, 2nd paragraph 5.2.1.1, p. 131, 2nd line at top of page	There is a reference given as SARA (2010). Does this mean the Species at Risk Public Registry? In the reference section, the Public Registry shows up as Species at Risk Public Registry 2010 and SARA Public Registry 2010. There should be consistency in the use of references within the document and within the reference section itself. It would be preferable to reference the COSEWIC status report or Recovery Strategy documents, rather than the website itself.	SARA (2010) means the Species at Risk Public Registry. Where applicable the COSWEIC status reports have been referenced.
88	57	DFO	5.2, Figure 5.2	Potential for occurrence of northern wolffish is listed as low in Table 5.2, yet based on this figure its distribution in the Gulf is centered on the EL1105 area	Figure 5.2 does not depict that the distribution of the Northern wolffish is centered on the EL1105 area. If one were to overlay the EL1105 area, the maximum relative occurrence of the Northern wolffish would be 0. The wolffish prefers substrate types that are not found within EL1105 and thus the project area is not a suitable habitat for the species in question.

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89	58	DFO	5.2.1.1, p 128	Depth discussion of Spotted wolffish contradicts Table 5.1 content	The depth discussion in Table 5.1 and Section 5.2.1.1 has been made consistent.
90	59	DFO	5.2, Figure 5.2 to 5.11	The information presented here is dated. More recent data exist from the study area. The data from 2003-2011 should be presented to illustrate current distributions - not the distribution from a decade ago.	Although the data is more than 10 years old, the published source from which it was obtained was published in 2010 and it is still considered relevant and appropriate.
390	60	DFO	5.2.1.1	Figures 5.6, 5.7 and 5.8 clearly show that highest densities of both juvenile and adult Atlantic wolffish are observed within 50-100 km of EL1105 (off western Newfoundland); but Table 5.1 indicates a low potential of occurrence in relation to EL1105	Adult and Juvenile Atlantic wolffish can be found from 50-100 km from EL1105. Within EL1105 and within the immediate vicinity of EL1105 the likelihood of encountering an Atlantic wolffish is quite low. The species prefers a habitat consisting of rocks, boulders, and sand where they can find shelter and protection. The area in which EL1105 is located has a muddy and soft bottom substrate which does not coincide with the preferred habitat of the Atlantic wolffish. The preferred depth of the species is 150-350 m. The EL1105 license is located at a depth which is greater than this (400-500 m). As a result the project area is situated in a habitat which is not preferred by the Atlantic wolffish, while the area where the majority of the species is located is favorable habitat. It is unlikely that the species would leave favorable habitat to inhabit less favorable conditions situated in EL1105.
91	61	DFO	5.2.1.2	The seasonal distributions and migrations need to be described for Atlantic Cod. This should use distribution information from summer surveys in both the southern and northern Gulf (i.e., September survey of the southern Gulf and August survey of the northern Gulf; Summer sentinel trawl surveys in both areas). Migration routes and timing and overwintering distributions should also be described.	Seasonal movements and migrations of each of the Atlantic Cod populations has now been described and incorporated into the EA.
92	62	DFO	5.2.1.2	An increasing proportion of the southern Gulf stock occurs on summer grounds in the region between the Magdalen Islands and northwestern Cape Breton, including waters along the southern slope of the Laurentian Channel. The entire stock migrates through the Cape Breton Trough or along the southern slope of the Laurentian Channel (past EL1105) each spring and fall. The entire stock overwinters in dense aggregations along the south side of the Laurentian Channel, in particular north of St. Paul Island.	Information on the Laurentian South Cod migration movements has been updated.
93	63	DFO	5.2.1.2	The EA refers to the four populations identified by COSEWIC in this section. However, there are only two residents (Laurentian North and South). Incursions of two other Atlantic populations are possible, but this should be distinguished.	Comment noted and resident cod populations have been identified
94	64	DFO	5.2.1.2	The legend of Figure 5.10 shows "*Atlantic Cod Distribution in the Gulf of St. Lawrence from 1990 to 2002* ," however, only the result of the August survey in the northern Gulf is presented. The results of the September survey in the southern Gulf should be added with the result representing the two cod stocks in the Gulf. This mistake occurs in several maps of other species.	The most up to date maps from the St. Lawrence Global Observatory have been added to the EA.
95	65	DFO	5.2.1.2	The spawning area for cod in the northern Gulf (3Pn, 4RS) that was identified some time ago off St. George's Bay (west coast of Newfoundland) is not mentioned in the EA. This area is closed to all fishing from April to mid-June and occurs approximately thirty miles east of the drilling area. This information is significant as fertilized eggs of cod are at surface and are therefore very vulnerable to any oil spill.	The Laurentian North Population of Atlantic Cod's spawning area has now been incorporated into the EA.
96	66	DFO	5.2.1.2	Some key sources of information include: Swain et al. (1998); Chouinard & Hurlbut (2011); Comeau et al. (2002); Benoît et al. (2003); Darbyson & Benoît (2003); and recent CSAS Science Advisory Reports and Research Documents coming from stock assessments.	Up to date Canadian Science Advisory Reports and research documents coming from stock assessments have been reviewed and incorporated into the EA where deemed appropriate.
97	67	DFO	5.2.1.2, p. 132, par. 4	First sentence is incomplete "Atlantic cod eggs and larvae are planktonic during and are primarily zooplankton feeders…" Needs editing.	The sentence regarding cod eggs and larvae has been completed.
98	68	DFO	5.2.1.3	Only general information is presented in this section; not information focused on winter skate in the Gulf. Information is available from Swain et al. (1998); Chouinard & Hurlbut (2011); Comeau et al. (2002); Benoît et al. (2003); Darbyson & Benoît (2003); and recent CSAS Science Advisory Reports and Research Documents coming from stock assessments, as well as CSAS Res Docs 2006/003; 2006/004; Swain et al. 2009 (and the associated supplementary material).	Up to date Canadian Science Advisory Reports and research documents coming from stock assessments have been reviewed and incorporated into the EA where deemed appropriate.
99	69	DFO	5.2.1.3	It should be noted that winter skate in Gulf are primarily distributed in the southern Gulf, where they are distinct from winter skate elsewhere.	The differences of winter skate in the gulf compared to other populations has been noted.
100	70	DFO	5.1.2, p. 135	The legend does not correspond with the figure; lower panel shows distribution in 2005-2009. RV catch rates are not shown for the Newfoundland and Labrador continental shelves and not for the study area and no units (kg/tow?, number of fish/tow?) are shown in this and other figures (Section 5.2).	The figure title has been updated to reflect the 2005-2009 trawl data. There are no units (kg/tow or number/fish/tow) or references to catch located in the DFO 2010 paper on Roundnose Grenadier. As a result, we cannot assume what it is or put a unit in the legend. The figure is still relevant as it shows relative catch data.

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101	71	DFO	5.2.1.5	The EA notes the Porbeagle shark as having a low potential for occurrence in the study area. However, relative to its overall population size, the likelihood of occurrence is moderate or high, although not in large numbers. As such, Table 2 needs to be amended to reflect this. A distribution map should also be presented.	For this EA, the potential for occurrence was based on the likelihood of encountering an individual from a species, not on the likelihood of occurrence related to species population. As a result, the likelihood of encountering a Porbeagle in relation to EL1105 is low.
102	72	DFO	5.2.1.5	Porbeagle shark mating occurs off southern Newfoundland and at the entrance to the Gulf, between late *August* and November. Pregnant females are present in this area from late *August* through to December and are seldom seen from January through to June (Jensen et al 2002).	Information pertaining to porbeagle shark reproduction has been updated from Campana et al. 2003.
103	73	DFO	5.2.1.6, p. 136	It mentions that White Shark is designated as endangered by COSEWIC. This should be updated to say that it is listed under Schedule 1 of SARA as endangered.	The recent updated Species at Risk status of the White Shark has been updated in the EA.
104	74	DFO	5.2.1.6, p. 136	Criteria for low occurrence need to be stated clearly. A distribution map should also be presented.	The criteria for occurrence is based on professional judgment taking into account available catch records, survey maps, habitat type and fish behaviour. The species has been recorded in Atlantic Canadian waters 32 times in the last 132 years. This would be deemed as having a low probability of occurrence in relation to EL1105.
105	75	DFO	5.2.1.7,	The EA states *"…The deepwater redfish has declined by 98 percent since 1984 and the Acadian redfish has declined by 99 percent…."* References to "declines" should be clarified that declines are in mature abundance as per the COSEWIC criteria.	Declines in redfish abundance have been clarified.
106	76	DFO	5.2.1.7,	The three recent scientific advices on redfish require mentioning in the EA: Stock Discrimination (CSAS SAR 2008/026), Stock Assessment of Units 1 and 2 (CSAS SAR 2010/037) and Recovery Potential Assessment (CSAS SAR 2011 /044).	Recent scientific advances on redfish have been revisited and incorporated into the EA where deemed appropriate.
107	77	DFO	5.2.1.7,	Figure 5.13 The information is dated. More recent data exist from the study area. The data from 2003-2011 should be presented to illustrate current distributions.	Information pertaining to the Magdalen Shallows water temperature has been added to the EA.
108	78	DFO	5.2.1.7, page 147	Incomprehensible translation – French version Ces espèces sont d'apparence similaire et sont associées de leur gestion.	Translation edits will be addressed as relevant during translation of the revised EA Report.
109	79	DFO	5.2.1.8	Criteria for low occurrence need to be stated clearly. A distribution map should also be presented.	The criteria for occurrence is based on a professional judgment taking into account available catch records, survey maps, habitat type and fish behaviour.
110	80	DFO	5.2.1.9	Information on seasonal distributions is lacking (see sources listed under cod for *information*). Winter distribution for plaice that spend the summer on the Magdalen Shallows and move into deep water in the Laurentian Channel is particularly relevant, and is not mentioned within the EA.	The seasonal distribution of American plaice has been added to the EA.
111	81	DFO	5.2.1.10,	The paragraph on Striped bass should be re-edited to reduce confusion. It starts by speaking about extirpated estuary population, and then it states the harvest restrictions put in place in 2000 seem to have assisted in recovery. Confusion exists between Estuary and Gulf populations. Please consult the recovery strategy on the SARA public registry. COSEWIC's (2004) assessment for striped bass is not a good reference nor is it used properly.	The Striped Bass section has been reworded to reduce confusion and update its relevance with the Project area.
112	82	DFO	5.2.1.10,	If indicating spawning in the St. Lawrence estuary, reference should also be made to spawning in the Miramichi. The introduction of these two populations should set up the rest of the text as they pertain to EL1105. Further, mention of St. Lawrence striped bass requires St. Lawrence striped bass be introduced in Table 5.1.	Reference to spawning of the Southern Gulf population has been incorporated into the EA.
113	83	DFO	5.2.1.10,	There is some evidence that there may be more than one striped bass population in the Bay of Fundy. It is relevant that Miramichi bass are genetically isolated from populations further south. However, Fundy striped bass are not relevant to the assessment and therefore it is not necessary to give any information on their biology.	Information pertaining to Bay of Fundy Striped Bass will be limited to introductory information as they are not found within the Gulf.
114	84	DFO	5.2.1.10,	Spawning of Striped Bass does not occur primarily in freshwater. This occurs near the fresh-salt boundary at the head of estuaries.	The spawning of Striped Bass can occur in freshwater or brackish water depending on the location of the population.
115	85	DFO	5.2.1.10,	The Bay of Fundy (Shubenacadie River) does not occur in the southern Gulf.	Refer to response provided for DFO-83.
116	86	DFO	5.2.1.10,	"school to fish" requires clarification. This may refer to predatory schooling behavior, in which case should also be qualified by "CAN cover tens…..	Information pertaining to Striped Bass predatory schooling behaviour has been updated.
117	87a	DFO	5.2.1.10,	Contrary to the EA, striped bass DO currently exist and spawn in the St. Lawrence Estuary. While extirpated there in the 1960s, they were re-introduced in 2002 and have potentially established a successful spawning population (DFO 2010).	Information pertaining to the St. Lawrence Estuary population of Striped Bass has been updated.
391	87b	DFO	5.2.1.10,	Striped bass are highly mobile and range very widely around the edge of the southern Gulf. However, they stay close to land, and hence are very unlikely to be in the area of proposed drilling. Therefore the most obvious omission in the text is the link between the striped bass populations and their 'low potential of occurrence' at EL1105.	Comment noted, low occurrence of Striped Bass and the fact that they area a coastal/estuarine species has been taken into account in the revised EA Report.

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118	88	DFO	5.2.1.10,	At a minimum, coastal behaviour at all life stages should be identified, but could be strengthened within the EA easily for the sGSL population by either COSEWIC's (2004) evaluation of Extent of Occurrence and/or its proposed refinement in Douglas and Chaput (2011).	Behaviour at various life stages has been incorporated into the EA Report.
119	89	DFO	5.2.1.16	Use Salmo (genus) instead of salmo.	Text updated to *Salmo* .
120	90	DFO	5.2.1.16	Much of the material in the 1st paragraph, 1st three sentences is incorrect or only partly correct. Most Atlantic salmon are anadromous, but not all. Many salmon spend two years in fresh water, but many do not. Many salmon migrate to the Labrador Sea, but some also migrate to Greenland. Pertinent literature on Atlantic salmon should be consulted and accurately summarize key points of their life history. In insular NL most Atlantic salmon remain in fresh water for 2 to 5 years. Atlantic salmon over winter in the waters off the Grand Banks, Labrador and west Greenland.	Information pertaining to Atlantic salmon has been updated.
121	91	DFO	5.2.1.16	Atlantic Salmon migration timing and routes need to be reviewed and summarized. Reddin (2006) summarizes the broad pattern of migration routes followed by post-smolts out of the Gulf and returning adults into the Gulf. However, routes are generally not known at a detailed level, which leaves some uncertainty as to how often salmon pass through or near EL1105. Recent unpublished studies using acoustic pingers indicate that post-smolts from a variety of Gulf rivers pass through the Strait of Belle Isle during a short period in early July (http://www.asf.ca/projects.php?id=4)	Updated information pertaining to Atlantic salmon migration patterns has been included in the EA.
122	92	DFO	5.2.1.16	Although the relative importance of the Strait of Belle Isle and Cabot Strait as salmon migration routes is not clearly understood, it seems likely that use of the Belle Isle route would be highest in salmon from the northern Gulf, including those from Anticosti Island.	Refer to response provided for DFO-91
123	93	DFO	5.2.1.16	*"All of these populations are considered to have a low potential for occurrence within EL1105, with any presence being transient in nature"* should be replaced with *"All of these populations are considered to have a moderate potential for occurrence within EL1105 during their post-smolt and returning adult migrations."* "Transient" should not be used to describe these migrations.	The text referring to Atlantic salmon occurrence has been updated
124	94	DFO	5.2.1.17, p. 140	This section requires additional information and revision. Most significantly, the assessment does not include bluefin tuna as a potential species at risk based on COSEWIC's recent determination that the Western Atlantic population is endangered. Accordingly, this species should also be included in Table 6.1., and much more consideration of the possible impacts on this high-profile stock is required in the EA. The western population of Atlantic bluefin tuna relies heavily upon the Gulf of St. Lawrence for critical foraging opportunities; and the largest and oldest individuals, typically comprising breeding adults, are found in the southern Gulf of St. Lawrence.	The Atlantic bluefin tuna is currently not listed under SARA and therefore is not listed in Table 5.1. It is considered endangered by COSEWIC and is listed as such in Table 5.2. Potential or candidate SAR species are not listed in Table 5.1, only officially designated species are listed. Information pertaining to Bluefin tuna life history and biology has been updated to reflect the most recent literature.
125	95	DFO	5.2.1.17, p. 140	It is incorrect (p141) that both the western and eastern populations can occur in the southern Gulf of St. Lawrence. More recent studies have shown convincingly that the fish occupying the southern Gulf of St. Lawrence are almost exclusively western origin fish (Schloesser et al. 2010).	Information pertaining to bluefin tuna stocks in the Gulf has been updated.
126	96	DFO	5.2.1.17, p. 140	Since the new and evolving recreational fishery for bluefin tuna in the southern Gulf has huge potential for economic development, the EA should include this information and completely examine this in the context of recreational fisheries.	Detailed descriptions of recreational and/or commercial fisheries are not discussed in Section 5.2. Please refer to Section 5.8 for commercial and recreational fishery information.
127	97	DFO	5.2.1.17, p. 140	Please refer to the 2011 COSEWIC report and DFO Recovery potential assessment (http://www.dfo-mpo.gc.ca/csas-sccs/Publications/Pro-Cr/2011/2011_049-fra.html).	Information from the 2011 COSEWIC status report and the DFO recovery potential assessment has been referenced where applicable.
128	98	DFO	5.2.3	The EA cites the TNASS 2007 inventory (Lawson and Gosselin, 2009) as the sole source of data to determine the probability of meeting of various species in the study area and the Gulf of St. Lawrence. However, there are other significant sources of information which should be included; Kingsley and Reeves (1998) and Lesage et al. (2007).	Information on blue whales cited in Kingsley and Reeves (1998) and Lesage et al. (2007) is in line with what has been presented in section 5.2.3. Lesage et al. (2007) depicts three combined studies showing no blue whales near or within EL1105.
129	99	DFO	5.2.3	Additionally, the level of information provided on the various marine mammal species is very uneven and inconsistent. The following information should be provided for each species: structure of the stock, seasonal movements, reasons for their presence in the Gulf of St. Lawrence, abundance, probability of meeting in the Gulf and the sector of EL1105, and threats to their recovery identified by COSEWIC or SARA.	A thorough review has been undertaken and text updated as appropriate to improve consistency of the information provided.
130	100	DFO	5.2.3.1	The presentation of current knowledge on distribution of blue whales does not consider the bias in observation effort / sampling of blue whales. Most past effort has been concentrated in the Northwest of the Gulf.	Text has been updated to reflect the bias of observation effort/sampling of blue whales which has been concentrated in the Northwest of the Gulf.

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131	101	DFO	5.2.3.1	A pattern of seasonal migration following a North-South axis is not only unrecognized, but is in fact challenged by recent data. Below is a more accurate description of the state of knowledge on seasonal migration by V. Lesage et al., extracted from a research document in prep: *The agreement that blue whales follow a general north-south movement to warmer and less productive waters is not fully supported by current data (CETAP 1982; Charif and Clark 2009, Mitchell 1991, Reeves et al., 2004, Sears 2002, Sergeant 1977). Recent monitoring studies of whale vocal activity over long periods suggest that blue whales and fin whales are still present in winter (December to Jan or February) in the Davis Strait (Simon et al., 2010: fin), off the Grand Banks (Clark 1995: blue whale), as well as west of the British Isles in the north-east Atlantic (Charif and Clark 2009), but some migrate farther south (Nieukirk et al., 2004: fin and blue whales). The ratio of winter and spring catches of blue whales by whaling station south of Newfoundland from December to May (Dickinson and Sanger 1990), mortality in the ice in March-April in southwestern Newfoundland (Stenson et al., 2003), and anecdotal observations in the lower estuary of the St. Lawrence and Gaspé (Sears and Calambokidis 2002, Archives of www.baleinesendirect.com) confirm that at least part of the population of blue whales remains at our latitude throughout the year.*	Text has been updated to acknowledge uncertainty surrounding migration patterns and to confirm at least part of the population of blue whales remains at our latitude throughout the year.
132	102	DFO	5.2.3.1	It is incorrect to report this population has 250 mature individuals since its size is actually unknown. Sears and Calambokidis (2002) was the source report for designation of the blue whale as endangered by COSEWIC. In this review of the available scientific information, there is no mention of such a figure (250 mature individuals). In fact, a maximum of 250 mature individuals is the COSEWIC assessment threshold for designating a population as endangered.	Text revised to indicate that likely no more than 250 mature blue whales are present in the Northwest Atlantic population (Beauchamp et al. 2009).
	103	DFO	5.2.3.2, page 162	Incomprehensible translation - French Version. Le programme de retablissement de la baleine noir de l'Atlantique Nord de 2009 mentionne que bien que les connaissances soient limitees quant a l'abondance a long terme ne peuvent etre determinees. Cependant l'objectif visant a atteindre une augmentation continue de l'abondance de la population a ete identifie.	Translation edits will be addressed as relevant during translation of the revised EA Report.
133	104	DFO	5.2.3.3	Loggerheads are opportunistic feeders. Therefore, while squid and zooplankton are known prey items, it may be misleading to reference only thoseprey (i.e., maybe preface with "including"). Finfish should also be included as prey as this can contribute to	Text revised to include recent data on beluga whales.
134	105	DFO	5.2.3.5, p. 154	Fin whale – A draft management plan is under review and will be available for public comment in 2012 as part of SARA recovery process.	Text has been updated to acknowledge the preparation of a draft management plan for the fin whale.
135	106	DFO	5.2.3.5, p. 154	The abundance data cited for this species is incorrect. The estimated abundance is 462 individuals (270−791) for the Gulf of St. Lawrence and Scotian Shelf combined (Lawson and Gosselin, 2009, Table 10) or 1,352 individuals (above 821−2226) for the portion of eastern Canada identified during the TNASS (Table 11). The estimate of abundance was 380 individuals (SD = 300) in 1995−1996 (Kingsley and Reeves 1998).	Text has been updated to include the estimated abundance of 380 individuals (Kingsley and Reeves 1998)
136	107	DFO	5.2.3.7, p. 154	The population of Killer Whale being referred to is Northwest Atlantic/Eastern Arctic.	Text has been updated to clarify the specific population of killer whale.
137	108	DFO	5.2	General comment for Section 5.2 – certain subsections refer to the COSEWIC designation and/or SARA status for the species, while other sections do not. It would be good to be consistent among sections.	Text in Section 5.2 has been updated to improve consistency regarding mention of COSEWIC/SARA designations.
138	109	DFO	5.2.4	In general, the EA relies heavily on citing dated literature documents (e.g. COSEWIC report and Recovery Team documents) rather than the available primary scientific literature for sea turtles. The EA contains only slight reference to studies that have specifically focused on leatherback movements in and around the proposed development site and the most recent information available on the biology and distribution of sea turtles in Canadian waters is not integrated into the assessment. Direct consultation of the primary literature is recommended. Notably, the exploration licenses overlap directly with important foraging habitat for leatherbacks – including an area currently being considered critical habitat for the species. Moreover, the exploration site lies directly in line with the route many leatherbacks take in and out of the Gulf of St. Lawrence.	Primary literature has been consulted and Section 5.2.4 has been updated as applicable.
139	110	DFO	5.2.4.1	The COSEWIC document referenced for this section is outdated and precedes most directed research on leatherbacks in Canada. Information of the distribution of leatherbacks in Canadian waters has been published in several articles (e.g., James et al. 2005; James et al. 2006; James et al. 2007).	Section 5.2.4.1 has been updated with primary literature references on the distribution and behavior of, and threats to, leatherbacks in Canadian waters.
140	111	DFO	5.2.4.1	References should include James et al. (2005; for source of mortality in Canadian waters) as well as to recovery documents as posted on the SARA public registry.	Section 5.2.4.1 has been updated with primary literature references on the distribution and behavior of, and threats to, leatherbacks in Canadian waters.
141	112	DFO	5.2.4.1	Specific mention of leatherback sightings in the Bay of Fundy can be misleading – while the species has been recorded there, it is conspicuously rare in this area.	Section 5.2.4.1 has been updated with primary literature references on the distribution of leatherbacks in Canadian waters including the Bay of Fundy.
	113	DFO	5.2.4.1	It is now known that leatherbacks forage in the vicinity of EL1105 – amend "may occur" to "occurs".	Text has been updated to confirm occurrence of leatherbacks foraging in the Study Area.

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142	114	DFO	5.2.4.1	A long lifespan does NOT contribute to species decline as stated in the EA.	COSEWIC (2001) cites long lifespan as one of the factors leading to the leatherback's vulnerability. The sentence has been revised to cite "a number of factors contributing to their vulnerability…".
143	115	DFO	5.2.4.2	More recent references exist and are available for loggerhead population size – see recent NMFS Loggerhead Turtle Expert Working Group stock assessment.	Text has been updated to incorporate population estimates for loggerhead turtles in the North Atlantic waters.
144	116	DFO	5.2.4.2	Most loggerhead nesting in the North Atlantic does *not* occur at "near-equatorial nesting areas", and instead occurs in the states of Florida, Georgia, and, to a lesser extent, the Carolinas.	Text has been updated to reflect up to date information on nesting locations.
145	117	DFO	5.2.4.2	The size distribution (and therefore life history stage) of loggerheads in Canadian waters has not been reported, although sampling in adjacent areas suggests those that forage in Canada are mainly juveniles.	Text has been updated to describe known population distribution in Atlantic Canada waters.
147	118	DFO	5.2.4.2	Loggerheads are opportunistic feeders. Therefore, while squid and zooplankton are known prey items, it may be misleading to reference only thoseprey (i.e., maybe preface with "including"). Finfish should also be included as prey as this can contribute to vulnerability of loggerheads hooking in pelagic longline fisheries.	Text has been updated to reflect the variety of prey that loggerheads consume.
148	119	DFO	5.3	It is not accurate that "...fish habitat is divided into two areas, the shelf areas and the deep channels. The shallow waters along the shelf areas are characterized by warm, high productivity waters in the summer..." In fact, the bottom over much of the Magdalen Shallows is within the Cold Intermediate Layer (CIL), so that bottom waters are colder than those in the deeper waters of the channels.	Information pertaining to the Magdalen Shallows water temperature has been added to the EA.
149	120	DFO	5.3	DFO 2007a is cited but is not listed in the References.	The DFO 2007a is listed in the references.
150	121	DFO	5.3 p. 156; par.2.	The western Newfoundland SEA (LGL 2005b) and the amended SEA (LGL 2007) cited in this paragraph only cover the NAFO sub-division 4R portion of the Gulf. Given that this project has implications for the entire Gulf of St. Lawrence, this EA should reference SEA documentation for other parts of the Gulf as well. For example, the SEAs for the Baie des Chaleurs, Anticosti and Magdalen basins (see http://www.ees.gouv.qc.ca/english/documents/chapter/sea2_information.pdf).	The scope of the Old Harry Prospect Exploration Drilling Program EA is to assess a specific Project in a specific study area which has been defined as the likely extent of potential Project-environment interactions from the Old Harry Project which is covered adequately by the western Newfoundland SEA (LGL 2005b) and the amended SEA (LGL 2007).
151	122	DFO	5.3.1	Rocky shores do not characterize the whole Gulf of St. Lawrence. Both PEI and New Brunswick shorelines are characterized by highly erodible shorelines including barrier beaches, salt marshes and other geographical features.	The shoreline information of PEI and New Brunswick has been updated, although there is no predicted Project interation with these shorelines.
152	123	DFO	5.3.1.1	Tables 5.3 and 5.4 are based upon a book by G.R. South entitled 'Benthic Marine Algae'. However, the taxonomy of seaweeds has changed since that publication in 1983[1]. There are also many more species of algae found in western Newfoundland than are listed in the associated tables. A more appropriate and up to date listing can be found in 'NEAS Keys to Benthic Marine Algae of the Northeastern Coast of North America from Long Island Sound to the Strait of Belle Isle' (Sears 2002). [1] For example, Saccharina is now the genus name for a number of species of kelps formerly associated with the genus Laminaria.	This level of detail is not necessary for the EA Report, therefore these tables have been removed from the text and a reference to the Sears 2002 report has been added.
153	124	DFO	5.3.1.1	Table 5.3 and 5.4 – some of these species are not algae (maritime lichens, *cyanophyta?, Balanus, Mytilus, Zostera marina, Spartina sp., Plantago sp.).* Add *Laminaria digitata.*	Refer to response provided for DFO-123.
154	125	DFO	5.3.1.1	Table 5.4 – *Ascophyllum* , *Fucus* , *Ahnfeltia* and *Chaetomorpha* are not typically found associated with sand or mud. The listing infers that they may be common on this substrate.	Refer to response provided for DFO-123.
155	126	DFO	5.3.1.1	Note: *Agarum cribropsum* (in the french version) should be *Agarum cribrosum* (correct in the English version), but is now called *Agarum clathratum. Lamninaria longicruris* is now called *Saccharina longicruris* Pophyra should be Porphyra	Refer to response provided for DFO-123.
156	127	DFO	5.3.1.2;	It should be noted in the text that, Eelgrass (*Zostera marina*) in eastern Canada has characteristics which meet the criteria of an Ecologically Significant Species. This means that if the species were to be perturbed severely, the ecological consequences would be substantially greater than an equal perturbation of most other species associated with this community (see DFO 2009d).	Section 5.3.1.2 has been updated to include reviewer's text.
157	128	DFO	5.3.1.2;	This section states that "eel grass is also protected by law under the *Fisheries Act."* While eel grass is characterized as an important type of fish habitat it is important to note that all fish habitat is protected under the *Fisheries Act.*	Comment noted.
158	129	DFO	5.3.1.2;	The eelgrass beds described in this section are large and dominate soft bottoms in the shallow subtidal – they are considered extremely important habitat for the region.	Comment noted.
159	130	DFO	5.3.1.2;	Add sea urchin to the list at the end of the first paragraph (p.157).	Text updated to include sea urchin.
160	131	DFO	5.3.1.3	The high and low salt marsh communities described are also extensive and important habitat for the region. Should an oil spill reach coastlines salt marshes are likely to be impacted.	Oil spill modeling has been conducted to describe and depict worst case scenarios. None of these scenarios are predicted to affect salt marsh communities. The closest salt marshes are located on the Magdalen Islands and the western tip of Newfoundland which are located well outside of the impact zone. Refer to Figures 2.12-2.24 for spill modeling.
161	132	DFO	5.3.2; Page 160; Para 2	It should be noted in the text that, Cabot Strait is an important migratory corridor for marine mammals moving in and out of the Gulf of St. Lawrence (see http://www.dfo-mpo.gc.ca/CSAS/Csas/DocREC/2001/RES2001_115e.pdf).	Hammill et al. (2001) has been cited to acknowledge the importance of the Cabot Strait for migration of marine mammals.

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162	133	DFO	5.3.2; Page 160; Para 2	It should also be noted that, the Esquiman Channel is the main migration corridor for entire populations of ground fish, including cod and redfish (see DFO 2007b).	Comment on fish migration has been noted and incorporated in the EA.
163	134	DFO	5.3.3	In general, the main source of information for the corals and sponges section of the EA is Cogswell et al (2009), which focuses on the Maritimes region. Additional important data that is available on coral and sponge distributions has not been included in the report – this includes 2010 and 2011 data from the Gulf (mostly for sea pens) and some of the more recent NL records. As a result, the conclusions that EL1105 location is likely not suitable habitat for corals and sponges (p.155) may not be the case. Kenchington et al. (2010) show significant abundances of sea pens in the Gulf and Laurentian channel that could be considered near EL1105. Sponges also require further consideration and relevance somewhere in this general section of this report.	The main source of information has been updated with information and mapping from Kenchington et al. 2010. Significant locations of corals do occur within the Gulf; however they occur outside of EL1105 on the western Laurentian Channel slope. Information and updated mapping relating to the most recent literature on Sponges has been added to the EA.
164	135	DFO	5.3.3	The following is offered as an opening paragraph for this section: Deep-water corals are sessile or sedentary, largely colonial animals that can occur individually at low density or in significant concentrations, depending on the taxa considered and ecological conditions. They are generally slow growing, and may represent decades or centuries of growth. They are considered suspension feeders, but not a lot of attention has been given to food and feeding in the scientific literature. Numerous species of deep-water coral are present in the Gulf of St. Lawrence, with significant areas of coral concentrations occurring in the Gulf and Laurentian Channel (Cogswell et al. 2009; Kenchington et al. 2010). At least six species of sea pen occur (*Pennatula borealis* , *Pennatula borealis* , *Anthoptilum grandiflorum* , *Crassophyllum* spp., *Funiculina* quadrangularis, *Halipterus finmarchica*), including significant concentrations located adjacent to EL1105, on the western flank of the Laurentian Channel (Cogswell et al. 2009; Kenchington et al. 2010). Soft corals, especially *Gersemia rubiformis* , but also including *Duva Florida* and *Anthomastus grandiflorus* , are also common, especially in the western Gulf. However, they are not considered as vulnerable to disturbance as other types of corals, including sea pens (Fuller et al. 2008; Kenchington et al. 2010). At least two species of large gorgonian corals occur, *Primnoa resedaeformis* and *Paramuricea* spp., as well as the solitary stony cup coral, *Flabellum alabastrum* , but these do not appear to be nearly as common or abundant in the Gulf as either of the other types of coral.	The information presented by the reviewer has been incorporated into the EA where appropriate.
165	136	DFO	5.3.3	Orders Stolonifera and Heliporacea are not present in Canadian waters – as such this reference is irrelevant.	Orders Stolonifera and Heliporacea were not referenced as being present in Canadian waters. The two orders were being referenced as part of the Octocorallia subclass for background information. As such reference to the two orders is deemed appropriate to the subject matter.
166	137	DFO	5.3.3	The EA comments on sea pens hundreds of km away off Baffin Island, but ignores other significant records in the Gulf.	The EA has been updated to reflect sea pens in the Gulf.
167	138	DFO	5.3.3	It is incorrect that *Pennatula phosphora* is not observed near the Project - Pennatula phosphorea has been observed “near” the project in great numbers (Kenchington et al. 2010). The EA also needs to define “near”.	Areas of significant sea pen concentrations have been updated in the EA.
168	139	DFO	5.3.3	The October 2010 geohazard survey does not identify the presence of any deep-water corals or sponges – however, sea pens are corals.	Sea pens belong to the Class Anthozoa and to the Octocorallia Subclass and as such share some similar morphological, feeding and reproductive characteristics to true stony and soft corals and therefore are grouped with corals, but are not corals per se and do diverge with respect to some morphological features and growth forms. For example, sea pens have a peduncle at its base to anchor themselves in sandy or muddy substrate, with the exposed portion that may rise up to 2 m in some species and which is atypical of corals. However, it is recognized that sea pens can be present alongside deep water corals and share the same vulnerability as corals towards anthropogenic impacts. Therefore sea pens and corals are grouped into the same vulnerable marine ecosystem of an environmentally sensitive deep-water coral community.
169	140	DFO	5.3.3	It is incorrect that there are no data on presence / absence of corals and sponges within the Laurentian Channel outside the Gulf – data are figured in Cogswell et al. (2009).	Comment noted and correction has been made regarding no data on corals outside the Gulf.
170	141	DFO	5.3.3	The statement that “water depth may not be a limiting factor in their distribution” is misleading since factors determining distribution include depth, and most others are typically correlated with depth, therefore responding quite clearly to depth, even though it is not just depth itself.	The sentence is depicting that water depth is not the limiting factor when talking about coral distribution. Since these corals do not require light, depth does not limit their distribution. Substrate type, current speed, and prey availability limit the distribution of cold-water corals.

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171	142	DFO	5.3.3	Many forms and species of deep water coral are not generally found on hard substrate as inferred in the EA.	Research into recent literature tells us that generally cold water corals are found on hard substrate as this serves as an important structure for larval settlement (Campbell and Simms 2009). Nonetheless, corals benefit from areas of relatively high current to deliver food items and the area in EL1105 has relatively slow current speeds. This fact is supported by the lack of dense aggregations of corals or sponges in the Project area. Refer to Figures 5.21-5.24 of the EA Report.
172	143	DFO	5.3.3	The report by LGL (2007) indicates that "*In general, the low abundance of corals in the Laurentian Channel (other than the Stone Fence at the southern end of the Laurentian Channel) probably reflects the low cover of cobble and boulder in the area (Mortensen 2006).*" This is out of context (refers to large gorgonians only or is or outdated) See Kenchington et al. (2010).	Kenchington et al. 2010 has been referred to in the revised EA Report.
173	144	DFO	5.3.3	Deep-water corals may benefit from rather than require higher water current speeds. It's also not clear exactly what they feed on, though plankton is probably an important source for some if not many species, at least at shallow to relatively moderate depths. Occurrence along continental slopes and shelves may also be more to do with the availability of food or increased substrate variability at the appropriate depths rather than currents.	Comment noted, refer to response provided for DFO-142.
174	145	DFO	5.3.3	The commentary around favorable habitat for deep-water corals and sea pens in reference to EL1105 is confusing.	Coral habitat and abundance has been clarified in the EA.
175	146	DFO	5.3.3	Coral and sponge data from NL and the eastern Canadian Arctic is overemphasized, while ignoring or minimizing other relevant information actually from within the Gulf of St. Lawrence and Laurentian Channel. The most recent, peer reviewed, published information is not referenced (e.g. Kenchington et al. 2010). This information is the definitive culmination and summary of all quantitative data concerning coral and sponge from the eastern Arctic to the U.S. border, and should not be ignored. Data is presented within that clearly demonstrates significant concentrations of both coral and sponge in the Gulf, and must at least be presented and considered as being near the proposed development.	Refer to response provided for DFO-134.
176	147	DFO	5.3.3	There is apparent ambiguity with classifying sea pens as being corals. Sea pens are considered corals, phylogenetically, biologically/ecologically and by policy makers, including DFO. Sea pens are octocorals, belonging to the subclass Octocorallia, along with gorgonian corals and soft corals. Ambiguously framing sea pens in any way confuses the assessment.	Refer to response provided for DFO-139.
177	148	DFO	5.3.3	The term "near" is used often, and proximity is used as potential factor implying mitigation of any impacts. Therefore a clearer definition of "near" should be provided. It is potentially misleading to simply state that corals and sponge are not concentrated "near" the development. Actual distance would be more useful in this context.	The proximity of corals and sponges to EL1105 has been outlined in the EA.
178	149	DFO	5.3.3	Kenchington et al. (2010) report that the highest abundances (trawl catch data) of seapens in eastern Canada occur in the Gulf region. The area is certainly suitable habitat for seapens which are found on unconsolidated sediments (p.154). The EA should review Kenchington et al. (2010) and current information on the classification and conservation considerations for sea pens below, including the geo-referenced map summarizing data on the concentrations of sea pens and sponge near the proposed Old Harry development (see attached).	Refer to response provided for DFO-134.
179	150	DFO	5.3.3	Figures 5.22 and 5.23 – (coral and sponge records) show high coverage on the Scotian shelf and Gulf regions with almost no occurrences in the Newfoundland region. This is attributable to NL data not being included in the assessment.	Refer to response provided for DFO-134.
180	151	DFO	5.3.3	The EA states (p.155), *"These factors suggest that the area for which the Project is planned is not a favourable habitat for deep-water corals and likely for sponges as well, since they too depend on plankton for food."* The term 'plankton' as used here is too general. We know that corals and sponges represent a diverse range of trophic groups including carnivores (feeding on zooplankton) and suspension feeders (feeding on suspended organic particulate matter). Their food sources include organisms and detritus resident near the seabed surface and organic matter sinking from surface layers which is why they can survive at deep depths below the photic zone.	The term plankton covers both phytoplankton and zooplankton. Detritus and other organic matter has been added as a food source.
181	152	DFO	5.3.3	Inconsistency exists in the spelling of *Anthoptilum grandiflorum* . This is the correct spelling.	Text updated and consistencies in spelling *Anthoptilum grandiflorum* corrected.
182	153	DFO	5.3.3	It would be useful to the EA to recognize that various NAFO working groups concluded that for corals the following taxa formed the conservation units (from Kenchington et al. 2010): Sea pen fields (Pennatulaceans); Small gorgonians (*Acanella arbuscula* was the only species in the NAFO Regulatory Area within this group); Large gorgonians (Sea fans: genera: *Primnoa* , *Paragorgia* , *Keratoisis* , *Paramuricea* ; *Radicipes,* etc.); Cerianthid anemone fields; Antipatharians (black corals), and Reef-building corals (e.g., *Lophelia pertusa*).	Comment noted, From Kenchington et al. 2010, the location of significant concentrations of sea pens in the Gulf of Saint Laurence is located within the Study Area and to the South-West of EL 1105.
183	154	DFO	5.3.3	Table 5.9 – the record of *Littorina littorea* from a grab sample (GS-02) from a depth of > 400 m is remarkable given that this is primarily an intertidal species extending into the shallow subtidal (< 20 m). This may have been an empty shell that had been transported to deep water.	Comment noted and incorporated into the EA

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184	155	DFO	5.3.4	The statement (p.165), "The transect line across Cabot Strait (identified as TDC in the AZMP program) is of most relevance because it spans across the Laurentian Channel between Newfoundland and Cape Breton Island and is situated approximately 70 km southeast of EL1105. General water flow through EL1105 and water properties would likely resemble those at Cabot Strait.", requires second consideration. The continental shelf waters entering the Cabot Strait do not point directly to the EL1105 site. In terms of plankton communities, AZMP transect within the Gulf (especially the center transects - at the eastern tip of Anticosti Island) would be more appropriate in this case.	Based on the water current data, the plankton along the Cabot strait transect of the AZMP is more likely to intercept the Old Harry platform than the plankton from the transect of Anticosti Island to Magdalen Islands shelf in the Southern Gulf of St. Lawrence. This is because the currents entering the Gulf of St. Lawrence, which is across the majority of the Cabot Strait, occurs along most of the Laurentian Channel and Newfoundland coast, and exit along a narrower area of the western Cabot Strait (and away from Old Harry) on the Cape Breton side and along the shelf (see also attached image). Section 4.2.2 shows most of the seasonal currents are flowing northward. So it would not be unreasonable to include plankton data from only the Cabot Strait transect of the AZMP and more likely to be affected by the Project.
	156	DFO	5.3.4.2	Incorrect translation - French Version. En retour, plusieurs organismes <u>sous des tropiques eleves</u>, tels des poissons et des mammiferes marins incluent le zooplancton dans leur diete. Incorrect translation of "higher trophic levels".	Translation edits will be addressed as relevant during translation of the revised EA Report.
185	157	DFO	5.4.1	The magnitude of the photographic coverage of the sea floor seems low and mainly located in western margin of the area for which the license is applied (Figure 5.26). The determination of animal biodiversity of soft bottoms, particularly the macro-and mega-benthic fauna, must be based on the use of a variety of sampling tools (grab, drag, epi-and supra-benthic sled, beam trawl). One cannot determine the nature of macro and mega-benthic communities simply based on a number of photos and some samples or grab sampler (three, according to Table 5.9).	Comment noted and incorporated into the EA.
186	158	DFO	5.4.1	Legend of Figure 5.27 should refer to Figure 5.26 for the position of the stations, NOT to Figure 5.23. In the legend of Figure 5.26 and elsewhere in the text, it refers to the "ocean floor".	The typo on Figure 4.27 has been updated to reference Figure 4.26.
187	159	DFO	5.4.1	Table 5.9 – this table does not reflect the extent of benthic biodiversity in the targeted region (see previous comment). At a minimum, the EA report should include an inventory of many benthic species listed in the bilingual document written by Brunel et al. (1998). The study area is included in LCI, historically less well sampled for benthos that LCH, but both areas could have a rather similar fauna.	The Brunel et al. 1998 reference contains every recorded invertebrate species in the Gulf of St. Lawrence which is approximately 2,214 records. The samples collected from the site give a representation of the benthic fauna and not the complete community structure. Information on regional benthic communities can be found in Brunel et al. 1998 or the CNLOPB Western Newfoundland SEA.
188	160	DFO	5.4.1	Table 5.9 – *Limacina helicina* is a pteropod (mollusc) epipelagic, not a benthic species. *Littorina littorea* is a coastal species that likes the intertidal and subtidal: although one may occasionally find it in bathyal environment, it is very rare and certainly not representative of the bathyal fauna. Finally, Brunel et al. (1998) and the virtual catalog WoRMS do not report the presence of *Spio limicola* in the Gulf of St. Lawrence. This species is found further south along the coast of North America.	Comment noted and incorporated into the EA
189	161	DFO	5.4.2	The structure of the introduction may suggest that the species of shellfish listed in the following sentence (e.g. lobster, rock crab ...) are found in the area of EL1105.	Comment noted and incorporated into the EA
190	162	DFO	5.4.2	The document refers to "giant snow crab". This is not a species.	Text has been updated to omit "giant".
191	163	DFO	5.4.2	The list of other commercially important species in coastal areas around EL1105 does not include the Iceland scallop (*Chlamys islandicus*), sea cucumber (*Cucumaria frondosa*) and sea urchins (*Strongylocentrotus droebachiensis*) which also support established or emerging fisheries in the area.	While licenses for fishing Iceland scallop have been granted in NAFO Division 4R since 1969 the location of the fishery is not within the study area. The identified fishing areas in Division 4R occur in the Strait of Belle Isle north of the project area (DFO 2001, GNL 2002, NAFO 2009, CSAS 2009). The Project Area encompasses coastal sea urchin habitats in NAFO division 4Rd. There were no reported landings of sea urchins within that division from 2004 to 2010 (EA). Sea urchin landings were reported within division 4Vn though the Project is not anticipated to interact with the coastal habitats within that area. Exploratory harvest of sea cucumbers have been initiated along the southern coast of Newfoundland, the Strait of Belle Isle and the southern coast of Labrador (DFO 2007) as well as a commercial fishery on St. Pierre Bank (DFO 2009) neither of these regions are located within the Project Area and as such will not be affected by the Project.
192	164	DFO	5.4.2	Northern Stone Crab (*Lithodes maja*) is not mentioned in this assessment. It is not a commercially important species but is present near Old Harry.	Comment noted. As described within the EA methods, life histories of non-commercially viable species were omitted.
193	165	DFO	5.4.2	The Atlantic razor is not *Siliqua costata* but *Ensis directus* , caught in eastern Canada.	Text updated to include the proper species name.

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194	166	DFO	5.4.2.1	The first paragraph contains inaccuracies and should be re-written. The following is proposed: American lobsters are distributed in localized reefs in nearshore areas around the four Atlantic Provinces and eastern Quebec. The spring fishing season removes individuals from the population prior to moulting and spawning. Adult female moulting and mating occurs during one summer, whereas the second summer is dedicated to laying the eggs. With proper conditions, some young females could moult, spawn and lay eggs in the same summer (DFO 2003).	Comment noted and incorporated into the EA.
195	167	DFO	5.4.2.1	"Courtship" is not a term that should be applied to Lobsters and crab – *mating* is the appropriate term.	Comment noted and incorporated into the EA.
	168	DFO	5.4.2.1	The last sentence of the 2nd paragraph of p192 is incorrect - may be bad translation (French Version)	Translation edits will be addressed as relevant during translation of the revised EA Report.
196	169	DFO	5.4.2.1	The statement that one in ten fertilized eggs will grow to become adults is likely incorrect. Also stages I II and III are not at the surface and are next to impossible to find.	Comment noted and incorporated into the EA.
197	170	DFO	5.4.2.1	The diet of juvenile lobsters is significantly different from that of adult lobsters (see Sainte-Marie and Chabot 2002)	Comment noted and incorporated into the EA.
198	171	DFO	5.4.2.1	Referring to "the coastal zone between the outer Port au Port Bay and Island Shag", these localities are in Newfoundland and Îles-de-la-Madeleine respectively. It is the Laurentian Channel, which separates them, where there are no lobsters, and it is not a 'spawning' area.	Shag Islands are a small group of islands in the southern part of Coppett Harbour off the south coast of Newfoundland.The text has been updated to clarify the reference to Shag Island as one of the Shag Islands off the coast of Newfoundland and not off of the Magdalen Islands.
200	172	DFO	5.4.2.2	Some descriptions of snow crab are not correct. In the southern Gulf of St. Lawrence, snow crab does not move to shallower water to mate. They do not migrate to shallower waters for speeding up embryonic development. Mating does occur for pubescent females after the terminal molt but multiparous females (terminally molted) do not molt before mating. Females can use stored sperm to fertilize oocytes but it is not a general event. When mating partners are present they mate again. The statement *"Males continue to molt into adulthood and only a portion will recruit into the fishery"* has to be rewritten as it is ambiguous. Adult is the terminally molted crabs and a portion of terminally molted crab larger than the minimum size limit will recruit to the fishery when they harden their carapace in a following year. The description of snow crab life cycle/biology has to be re-written.	Comment noted and incorporated into the EA.
201	173	DFO	5.4.2.2	Snow crab distribution is also available from September multispecies survey as well as snow crab annual survey from Gulf Region. A snow crab fishing area (CFA) map in the southern Gulf of St. Lawrence, Eastern Nova Scotia and southwestern NL can be displayed here as it was done for lobster, particularly CFA 12F, 19, 4Vn, and 12A-C which are very close to Old Harry.	Comment noted though the mapping described was not available at the time of publication.
202	174	DFO	5.4.2.2	Regarding stock structure, Atlantic snow crab have recently been identified as a single stock complex ranging from Labrador to Gulf of Maine and encompassing the Gulf of St. Lawrence (see recent paper by Puebla et al.). This information should be amended in the text.	Comment noted and incorporated into the EA.
203	175	DFO	5.4.2.2	In reference to presence of green crab *in "the waters off Newfoundland…"* does this mean that green crab is in the area EL1105? Green crab (*Carcinus maenas*) is also present around Cape Breton Island and Prince Edward Island. Reference search should be done to include the recent distribution records of this species in the southern Gulf and northern Cape Breton.	Comment noted and incorporated into the EA though discussion on green crab populations in Cape Breton and PEI were not included as the areas are outside the geographic scope of the EA.
204	176	DFO	5.4.2.2	Spermatophores are stored in the *spermathecae*.	Comment noted and incorporated into the EA.
205	177	DFO	5.4.2.2	Smaller crabs are *not* found *"within the interstitial spaces of harder substrates."* The first benthic stages are furtive and live hidden among woody debris, biogenic structures or buried in the fine silt.	Comment noted and partially incorporated into the EA, woody debris is likely not present on the seafloor within EL 1105.
206	178	DFO	5.4.2.3	The following is text is proposed to describe Rock Crab: Rock crabs are decapods crustaceans that congregate in waters typically less than 20 m deep and occupy different substrates from sandy bottom to rocky habitats. There is a sexual dimorphism in the size of rock crab, with males growing to bigger sizes (140 mm) than females (100 mm). Sexual maturity is generally attained at carapace widths of 57 and 75 mm for females and males respectively. Molting peak period for males usually happen in the late winter months to allow carapace hardening before mating with soft-shell females in late summer-early fall. Fertilized eggs are extruded soon after mating and are stored under the female's abdomen for up to 10 months. Larval hatching occurs in the late spring / summer months, with the free-swimming larvae aggregating near the surface. The larvae go through six stages which can take up to three months in total before settling to the seafloor as a benthic crab. Rock crab larvae are omnivorous planktivores.	Comment noted and incorporated into the EA.
207	179	DFO	5.4.2.3	Rock crabs play an important ecological role in northern subtidal communities, mainly because of their wide abundance. Their diet includes bivalves, snails, green sea urchins, sea stars, amphipods, sand shrimp, and polychaetes. Rock crab is an important prey item for lobster of all sizes. Adult male rock crabs will reach commercial size (102 mm) at about six years of age.	Comment noted and incorporated into the EA.

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208	180	DFO	5.4.2.5	Several statements regarding whelk are incomplete or incorrect. Females lay capsules that contain numerous eggs – it is the capsules which are attached to hard substrates, and juveniles emerge from these capsules, not "young larvae".	Comment noted and incorporated into the EA.
209	181	DFO	5.4.2.6	It is stated that shrimp are usually hermaphroditic. However, this species is always hermaphroditic.	Comment noted and incorporated into the EA.
210	182	DFO	5.4.3	The EA needs to be clear in which species are/are not being presented with species-specific distribution and life history information and why. For example, Thorny skate are presented within the assessment and not Smooth skate. Accordingly, the entire section following table 5.10 should be amended for clarification.	Comment noted and a better explanation of the reasoning behind the inclusion of specific species in the discussion has been provided.
212	183	DFO	5.4.3	Atlantic hagfish (also Table 5.10), Thorny skate, Smooth skate, and Black Dogfish are not pelagic species as stated in the text – they are groundfish species.	Comment noted and incorporated into the EA.
213	184	DFO	5.4.3	Contrary to that stated in the EA, there are currently moratoria on directed fishing for cod in the Laurentian South DU.	Comment noted and incorporated into the EA.
214	185	DFO	5.4.3.1	Overall, the information presented on pelagic fish is incomplete. The most recent DFO CSAS Research documents and Science Advisory Reports pertaining to pelagic fish should be consulted for this assessment. Notably, a section on capelin should be added here.	CSAS research documents and Science Advisory Reports have been reviewed and incorporated as relevant. A section has been added for capelin.
215	186	DFO	5.4.3.1	Table 5.10 – for herring, add “spring spawning”; for mackerel, it is not present all year round, but from May to November, and there are also eggs and larvae, not only adults; for capelin, there is also immature. Also, the text mentions spring spawning which is not presented in Table 5.10.	Comment noted and incorporated into the EA.
216	187	DFO	5.4.3.1	Table 5.11 – add April to July for herring; and add capelin to the table.	Comment noted and incorporated into the EA.
217	188	DFO	5.4.3.1	Figure 5.32 – data from the southern Gulf survey (the southern Gulf is presented for some species) should be added.	There were four criteria that were pursued for obtaining figures outlining fish distribution for inclusion in the EA. These criteria are listed below in order of priority. • The figures must have distributional data to include EL 1105 or the Project Area. • Primary source data collected by DFO, EC, academia, or consultants, for example, must be used to create the figures. • The data should have been collected recently (i.e., within the previous 10 years) and allow for the identification of current distributional patterns to include EL 1105 or the Project Area. • The data should encompass as much of the temporal and spatial boundaries as possible (i.e., large, broad datasets collected over longer durations were preferred). Using these criteria, Figure 5.32 was retained. While it is agreed that this figure does not include the southern Gulf of Saint Lawrence, this area of the Gulf is outside EL1105 and the Project Area boundaries.
218	189	DFO	5.4.3.1	Figure 5.33 – the distribution presented for Atlantic mackerel in the Estuary and northern Gulf is incorrect. For pelagic fish such as herring, mackerel, capelin, using data from bottom trawl catches does not provide the distribution of these species as shown here. Other techniques are required to establish such a distribution.	Distribution data on pelagic species is limited. While it is agreed that DFO trawl data is not an efficient means of determining abundance or distribution. The 12 years of trawl data do indicate that Atlantic Mackerel are located throughout the Gulf and within the Project Area.
219	190	DFO	5.4.3.1	Figure 5.33 – this should be replaced by maps of eggs and catches from commercial fishing (purse seine) (the fishing positions of herring and capelin catches should also be included).	Maps of fish catches and records of weights are provided in Section 5.8.1 Commercial Fisheries.
	191	DFO	5.4.3.1 p. 201	Incorrect - French version. Pendant cette periode les larves survivent sur la vesicule ombillicale […] incorrect translation of "yolk sac"	Translation edits will be addressed as relevant during translation of the revised EA Report.

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220	192	DFO	5.4.3.2	Figure 5.40 – information is dated. More recent data exists for the study area. The data from 2003-2011 should be presented to illustrate current distributions as opposed to the distribution from a decade ago. Criteria for low occurrence need to be stated clearly.	There were four criteria that were pursued for obtaining figures outlining fish distribution for inclusion in the EA. These criteria are listed below in order of priority. • The figures must have distributional data to include EL 1105 or the Project Area. • Primary source data collected by DFO, EC, academia, or consultants, for example, must be used to create the figures. • The data should have been collected recently (i.e., within the previous 10 years) and allow for the identification of current distributional patterns to include EL 1105 or the Project Area. • The data should encompass as much of the temporal and spatial boundaries as possible (i.e., large, broad datasets collected over longer durations were preferred). Using these criteria, Figure 5.40 was retained. While it is agreed that more recent data may presently exist. At the time of the report no distributional data was identified which better matched the aforementioned criteria.
221	193	DFO	5.4.3.2	Figures 5.42, 5.43, 5.48 – only present one year of data. This should be expanded to illustrate current distribution.	The figures illustrating the 2005 distribution of fish species were meant to be used in conjunction with the figures illustrating the 2009 and 2010 catch data from the summer trawl surveys to provide a recent description of fish species presence within the Project Area.
222	194	DFO	5.4.3.2	It is stated (p.156) *"Yellowtail flounder is a demersal flatfish found in the waters from Chesapeake Bay to Labrador..."* However, Yellowtail flounder are at the northern extension of their range on the northern Grand Bank in 3L off eastern Newfoundland.	Comment noted and incorporated into the EA.
223	195	DFO	5.4.3.2	Atlantic Halibut – information on distribution is restricted to data from the 2009 and 2010 August surveys of the northern Gulf. There is much additional information available on summer distribution from the sources listed below, including areas not covered or poorly covered by the August survey (information from the 2010 survey appears incomplete, or survey coverage was incomplete). Information on distribution in other seasons should also be presented. Swain et al. (1998); Chouinard & Hurlbut (2011); Comeau et al. (2002); Benoît et al. (2003); Darbyson & Benoît (2003); and recent CSAS Science Advisory Reports and Research Documents coming from stock assessments.	Comment noted and a new figure showing Atlantic Halibut January Distribution in the Estuary and Northern Gulf of St. Lawrence was added. There were four criteria that were used for obtaining figures outlining fish distribution for inclusion in the EA. These criteria are listed below: • The figures must have distributional data to include EL 1105 or the Project Area. • Primary source data collected by DFO, EC, academia, or consultants, for example, must be used to create the figures. • The data should have been collected recently (i.e., within the previous 10 years) and allow for the identification of current distributional patterns to include EL 1105 or the Project Area. • The data should encompass as much of the temporal and spatial boundaries as possible (i.e., large, broad datasets collected over longer durations were preferred). While it is agreed the data collection coverage in 2010 was poor within the lease site, the 2009 data illustrates that Atlantic Halibut are present within EL1105. Further both the 2009 and 2010 data sets illustrate that Atlantic Halibut are present within the project area predominantly located within the offshore habitats.
224	196	DFO	5.4.3.2	Haddock – information on distribution is limited to an old ECNASAP map. A considerable amount of more current information is available from the sources above.	Figure 5.32 was changed to include a more recent figure from Environment Canada. No suitable substitution could be identified from the sources provided in the comment. These sources of data from 1986-1992 (Darbyson and Benoit 2003), 1994-1997 (Chouinard and Hurlbut 2011) and sources of data collected prior to 2002 (Swain et al. (1998); Comeau et al. (2002) and Benoit et al. (2003)) were relegated to sources of background information as the information contained was not as complete or recent as the Environment Canada figure.

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225	197	DFO	5.4.3.2	Turbot and longfin hake – information on distribution is restricted to data from the 2009 and 2010 August surveys of the northern Gulf. This is a particular error since survey coverage was incomplete in 2010 and with the area of greatest interest for this report (the area around EL1105) not sampled.	While it is agreed the data collection coverage in 2010 was poor within the lease site, the 2009 data illustrates that turbot and longfin hake are present within EL1105. Further, both the 2009 and 2010 data sets illustrate that both fish species are present within the Project Area predominantly located within the offshore habitats.
226	198	DFO	5.4.3.2	Greenland Halibut –important information, while only recently published, should be included in this assessment. Ouellet et al (2012) present evidence that the project area corresponds to the main site of the spawning population of Greenland halibut in the Gulf of St. Lawrence. The species lays bathypelagic eggs (which grow in deep water) and eggs and larvae will be therefore abundant in the work area at the time of breeding (February-May). Greenland halibut is a major fish species for fisheries in the Gulf of St. Lawrence.	Comment noted and information which became available after the EA document was submitted has been incorporated into the EA.
227	199	DFO	5.4.3.2	Monkfish – the text refers to monkfish outside of the Gulf in NAFO areas 3LNOPs. It is likely incorrect that "the Gulf provides habitat for an abundant population [of monkfish] within the warmer shelf waters."	Comment noted and incorporated into the EA.
228	200	DFO	5.4.3.2	Pollock – the text refers to Pollock outside of the Gulf.	The data contained within the life history section on Pollock includes data on stocks from NAFO Area 4V, which includes the Cabot Strait. There is a paucity of Pollock data within the Gulf of Saint Lawrence as the majority of data available on Pollock stocks is due to the localized fisheries on the Scotian Slope and Grand Banks.
229	201	DFO	5.4.3.2	White Hake – this section is inadequate. Information from southern Gulf surveys, noting that hake are distributed in either shallow inshore waters or in deep water along the Laurentian Channel in summer, migrating to overwintering grounds in deep waters of the Laurentian Channel should be included in the assessment. Please see: Swain et al. (1998); Chouinard & Hurlbut (2011); Comeau et al. (2002); Benoît et al. (2003); Darbyson & Benoît (2003); and recent CSAS Science Advisory Reports and Research Documents coming from stock assessments.	This pre-spawning aggregation is included in the EA "Witch flounder aggregate in deep channel waters like those found in the Laurentian Channel, just southwest of St. Georges Bay, from January to February prior to spawning".
230	202	DFO	5.4.3.2	Witch Flounder – this section is inadequate. Much of the text is only general in descriptions of species range outside of the Gulf. It should be emphasized that in winter pre-spawning adults appear to be aggregated in the area of EL1105 (Bowering and Brodie 1984).	Upon analysis of the catch data it was determined that witch flounder is not a key commercial fishery within the Project Area and the section has therefore been removed.
231	203	DFO	5.4.3.2	The pre-spawning aggregation of witch flounder located within or near EL1105 should be considered as a sensitive/significant area. The overwintering aggregations of southern Gulf cod, and their migration route along the Laurentian Channel, represent other sensitive/significant areas near EL1105.	Refer to response provided for DFO-203.
232	204	DFO	5.4.3.2	Thorny Skate – this section is inadequate. Much of the text is only general in descriptions of species range outside of the Gulf (e.g., the Grand Banks). See the above sources for information on the seasonal distribution of thorny skate within the Gulf. See Swain and Benoît (2006) for a description of recent changes in summer distribution, with an increasing concentration in deep water along the south side of the Laurentian Channel. Note: Thorny Skate (p.158) has under gone declines and is being considered by COSEWIC as a species at Risk.	Thorny skate is not a key commercial fishery within the Project Area and the section has therefore been removed.
233	205	DFO	5.6	Table 5.16 – The conclusion that the potential occurrence of blue whale in relation to the Project is uncommon is incorrect. This probability of occurrence is unknown, and may be higher in the spring and autumn when the blue whales migrate via the Cabot Strait, or in autumn through the area. Moreover, according to table 5.17 and DFO data presented therein, blue whale is a species that would be at least as common as the fin whale. The text should therefore be reviewed, as well as information at the beginning of p. 216	Text in Table 5.16 has updated to "seasonally common".
235	206	DFO	5.6	The frequency of occurrence of belugas is probably very occasional. However, considering the high numbers recently reported along the West coast of Newfoundland (J. Lawson, DFO, Newfoundland, unpublished data), the characterization of rare does not do justice to their possible exposure to activities related to the project. The text of p. 219 should therefore also be edited.	Text in Table 5.16 and the applicable paragraph has been updated to "uncommon".
236	207	DFO	5.6	Is Ocean Biogeographic Information System(OBIS) appropriate to establish such an inventory? What proportion of existing data does OBIS include? Does it include inventories mentioned earlier in the section on endangered species?	OBIS is a database based on observation data collected from various data providers worldwide. Although it is not likely a complete database, it provides complementary data for assessing what species of marine mammals and sea turtles have been observed in a given area of interest, such as the Study Area for the Project. Further, it is believed that this database has beneficial use over much larger regional databases that generally provide range of species distribution and used for the section on endangered species. It should be noted that in Table 5.17, DFO recorded data are provided in addition to OBIS data, which together is intended to provide an overall indication of the presence of marine mammals and sea turtles in the vicinity of the Project.

Total Comment #	Agency/ Company Comment #	Government Department / Company	Section of EIS	Comment /Information Request	Response
237	208	DFO	5.6.1	Evaluation of abundance and potential presence of species in the study area should be carried out taking into account not only the study of Lawson and Gosselin (2009), but also that of Kingsley and Reeves (1998). Lawson and Gosselin (2009) estimates of abundance (with standard deviation) differ substantially from those obtained by Kingsley and Reeves (1998) very likely due to a delay in entry of animals into the Gulf. This hypothesis is substantiated by observations made on the Scotian Shelf and in U.S. waters during the survey period (see discussion of the paper). Estimates of distribution and abundance of Kingsley and Reeves (1998) are therefore also relevant and cover the area of the EL 1105.	Text has been updated to include abundance and potential presence using Kingsley and Reeves 1998.
238	209	DFO	5.6.3	It is incorrect to state that the four species of seals are hunted commercially in the Atlantic. Harbour seals, hunted to very low levels in the 1960s and 70s, are no longer included on personal sealing licenses. There is no commercial hunt for them anywhere in Canada.	Text has been updated to exclude harbour seal from the commercial hunting reference.
239	210	DFO	5.6.3	Harp seal diet data requires updating. Capelin and not Arctic cod now appears its main source of food.	Text has been modified to acknowledge new information on harp seal diet.
240	211	DFO	5.6.3	It should be noted that the area of the EL 1105 is part of the highly preferred hooded seal habitat, particularly males, when present in the Gulf of St. Lawrence (Lesage et al. 2007, Fig. 22; Bajzak et al. 2009)	It has been noted that the area of EL1105 is part of the highly preferred hooded seal habitat.
241	212	DFO	5.6.3, page 241	Incorrect translation – French version On observe le phoque commun et le phoque gris au même endroit, cependant la répartition est telle que le phoque commun est régulièrement vu dans le Golfe tandis que la population du phoque gris est concentrée au sud (LGL 2005b). In the English version, the sentence formulated below does not present the same information: Both the harbour and grey seals are likely to be common in the western Newfoundland offshore regions, with the distribution of the harbour seal being continuous in the Gulf and that of the grey seal to be more concentrated in the south (LGL 2005b).	Translation edits will be addressed as relevant during translation of the revised EA Report.
242	213	DFO	5.6.4	The leatherback is found in the vicinity of EL1105. Therefore “potentially” should be removed within the text.	Text has been updated in Section 5.2.4 to reflect known presence of leatherbacks in the Study Area. Text in Section 5.6.4 has been updated to include discussion of green sea turtle and the sentence in question modified to include Kemp’s ridley and green turtle. Therefore, the reference to “potential” occurrence remains valid since the presence of Kemp’s ridley and green turtle is less likely.
243	214	DFO	5.6.4	There are actually four (not three) species of sea turtles that may be found in the area – need to add green turtle (*Chelonia mydas*) to list.	Green turtle (Chelonia mydas) added to the list.
244	215	DFO	5.6.4	Include primary publication reference for Kemp’s Ridleys preferring shallow water, and remove “apparently” and repetition of shallow water preference.	Text revised to remove redundancies and a primary reference for shallow water preference provided (Ogren 1989).
245	216	DFO	5.7; Page 224; Fig. 5.57	It should be stated in the text that, while the boundary lines depicted on the map represent areas, EBSAs (and species) that are considered, above others, to contribute significantly to the Gulf of St. Lawrence ecosystem, these lines should not be taken as the absolute limits of that particular biological activity or ecological significance which may vary both spatially and temporally over the course of the year. *"The fact that a significant ecosystem component is not included or partially included in an EBSA cannot be considered as an ecologically significant absence. Sensitive populations as well as certain exceptional areas were not – or not entirely/always – included in the EBSA" DFO (2007b).*	Text has been updated as indicated to acknowledge that EBSA boundaries do not signify absolute boundaries in terms of sensitivities or ecological importance.
246	217	DFO	5.7; Page 224; Fig. 5.57	Figure should also include the pre-spawning aggregation of witch flounder in EL1105. Although mentioned somewhat in the text of the EA, the overwintering aggregation of cod north of St. Paul Island and the migration paths of southern Gulf cod (and other demersal fish) should also be emphasized, as should the fact that most large demersal fishes in the southern Gulf overwinter in the Laurentian Channel.	This is discussed within the SAR section on Atlantic cod.
247	218	DFO	Title of Table 5.11, page 216	Incorrect translation – French version Résumé des périodes de frai et d’éclosion des principales espèces faisant l’objet d’une pêche commerciale avec le potentiel de survenance dans la zone visée par le PP 1105 Incorrect translation of "occurrence"	Translation edits will be addressed as relevant during translation of the revised EA Report.
248	219	DFO	5.7.1, p. 225	The title should be Ecologically and Biologically SIGNIFICANT Areas if this is what is meant. Otherwise, EBSAs should not be used as an acronym as it is more commonly associated with SIGNIFICANT areas within the context of ecosystem based management.	Text has been edited to “Significant”.
249	220	DFO	5.7.1, p. 225	Considering the extremely complex and dynamic nature of the Estuary and Gulf of St. Lawrence (EGSL), EBSAs and their boundaries are meant to be presented only as a reference. It should also be recognized that EBSAs require re-evaluation over time (DFO 2011). Analyses leading to the identification of the ten potential EBSAs were based on the best scientific data available at the time – in this, several data sets were not included due to either of lack of geo-referencing or suitable electronic versions as well as large areas of the Gulf being poorly sampled. Therefore it should be noted that EBSAs for the ESGL do not cover all the areas or species that contribute in a significant way to the dynamic of the system. For example, only a small proportion (approximately 0.02%) of the benthic invertebrate species known to be present in the EGSL were considered in the EBSA process (Chabot et al., 2007).	Comment noted. Text updated to include information that EBSAs will be re-evaluated over time.

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250	221	DFO	5.7.1, p. 225	The EA correctly identifies that EL1105 is within several identified important areas – including a wintering area for many demersal fish species; and an area important for marine mammals. However, EL1105 is within an area where the number of overlapping Important Areas (IAs) across thematic layers and dimensions was high (see Figure 17 in Savenkoff et al., 2007). The EA also does not mention the area of interest for the marine protected area surrounding the Les-de-la Madeleine (project under study by Parks Canada).	The AOI surrounding the Magdalen Islands was announced in December 2011. The revised EA now mentions this new AOI. The EA focused on the EBSAs identified in DFO 2007 which are delineated areas of significance. EL 1105 does not fall within any EBSAs.
251	222	DFO	5.7.1, p. 225	The EA should also specify that there is a co-occurrence of several marine mammals in the area in winter for feeding – including deep-divers and blue whale (listed as endangered under the Species at Risk Act in 2005; northwest Atlantic population).	Marine mammals use of the area around EL 1105 (including the endangered Blue Whale) is discussed in Sections 5.2.3 and 5.6.
252	223	DFO	5.7.1, p. 225	The EA should include that this region is one of the rare significant areas for soft corals and the only area where certain deep water shrimp species are found (Pasiphaea tarda, Sergestes arcticus, Atlantopandalus propinqvus, Acanthephyra pelagica) (Chabot et al., 2007).	Section 5.71 is Ecological and Biologically Significant Areas (EBSAs). Soft corals are discussed specific to the Project area in Section 5.3.3.
253	224	DFO	5.7.2 (& in Section 6.2 page 226)	There should be more consideration given to sensitive coastal areas throughout the Gulf. For example, with the exception of seabird nesting sites in section 5.7.3, there is no consideration of sensitive coastal areas of southwestern Newfoundland. Significant coastal and marine Areas, based on traditional knowledge, have been mapped for the Bay St. George/Port au Port area [see http://www.longrange.ca/pages/coastal.html]. Other documentation exists for Bay of Islands and the Northern Peninsula.	The only potential interaction with routine Project related effects would be from supply vessel traffic to and from the Project site. Vessels will follow existing shipping routes and will adhere to Annex 1 of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) and pollution prevention regulations of the Canada Shipping Act. Any interaction with the coastal environment is limited in nature and as a result, sensitive coastal areas have not been assessed in the EA.
254	225	DFO	5.8 French Version	To avoid any confusion, we recommend adhering to the official terminology used by Fisheries and Oceans Canada for the names of the following fish species: "Flétan de l'Atlantique" (Atlantic halibut) rather than "Flétan" (halibut) "Flétan du Groenland" (Greenland halibut) rather than "Flétan noir" (black turbot or black halibut) "Chaboisseau" (sculpin) rather than "Chabots" (sculpin) Crabe araignée or "crabe hyas" (toad crab) rather than "crabe lyre" (toad crab or lyre crab)	Translation edits will be addressed as relevant during translation of the revised EA Report.
255	226	DFO	5.8, Page 230	Fisheries catch data appear to have been collected independently from the 4 Gulf Regions: Newfoundland and Labrador, Maritimes, Gulf and Quebec. DFO National Headquarters (Ottawa) maintains a compiled database of fishing activity from each region and this may be a more complete source of data. Furthermore, regional data systems capture information on landings only for the respective region. Fish may be caught in a NAFO unit area and landed in another unit area. Please contact Rowena Orok DFO HQ (613) 881-6114 to inquire about the appropriateness of "ZIFF" data for this project.	It is presumed that information collected from the four Gulf Regions would be the same information that Ottawa would collect from the four regions. It is believed that the data collected is complete and accurate. However, updated data (2011) was obtained for the revised EA Report from DFO National Headquarters.
256	227	DFO	5.8, Page 230	Inshore fleets are not required to report geocoded landings by latitude and longitude. However, they are required to indicate unit area of their catch. As the fisheries catch information is presented by NAFO unit area it would be prudent to capture all commercial fishing activity, including inshore sectors.	All available catch data from DFO has been requested and has been included in the Assessment. Routine operations will not have any effect on inshore areas. The only effect on nearshore areas will be a slight increase in vessel traffic. All worst case scenario oil spills will remain confined to EL1105.
257	228	DFO	5.8.1, Page 230	St. Pierre does have fishing rights in 3Ps. Please revise accordingly.	The text has been updated to include Saint Pierre and Miquelon.
258	229	DFO	5.8.1, Page 231	It would appear that the species listed reflect both directed and by-catch. It would be useful have a separate list for directed and by-catch species.	Directed and by-catch fisheries have been have been separated in the revised EA Report.
259	230	DFO	Figure 5.58, Page 232	The boundaries for 4Rd and 4Ss are not correct and should be revised. (i.e. 4Rc and 4Sx have been omitted)	The boundaries for 4Ss and 4Rd have been inadvertently extended to include those for 4Sx and 4Rc, respectively. The boundaries have been revised on Figure 5.58, and where required on other figures, to only include 4Ss and 4Rd and which are of relevance to the Study Area for NAFO areas 4S and 4R, respectively.
260	231	DFO	Table 5.19 to 5.23	Source should be included in the tables.	The data for the tables were provided by DFO Regions Statistical officers and the source has been updated as personal communications.
261	232	DFO	5.8.1, Page 235 & 237	The commercial fisheries data for 4Rd & 3Pn are not consistent with NL Region's Catch and Effort data. For example the Landings (kg) and Landed Value ($) for 4Rd lobster outlined in the EA document are the same value for each year in the series. *See attached NL data (February 2012).*	The commercial fisheries data for 4Rd and 3Pn has been updated to reflect accurate information.
262	233	DFO	Figure 5.59 to 5.62	Source should be included in the tables.	The data for the figures were provided by DFO Regions Statistical officers. In the text the information has been updated as personal communcations.

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263	234	DFO	5.8.2.1, Page 270	This section is titled Aboriginal Fisheries Newfoundland but it includes content for the entire Gulf region. Suggest that this section be titled "Aboriginal Fisheries." Note that as of 26 Sept 2011, the FNI achieved Landless Band Status and changed their legal name. They are now the Qalipu Mi'kmaq First Nation Band (www.qalipu.ca). They are the sole owner of that firm. The QMFNB have a number of licenses with DFO. In total, 8 of their communal commercial licenses are held in the name of the QMFNB and 1 is held in the name of Mi'kmaq Commercial Fisheries. They hold 7 licenses in 4R. Please contact DFO for more up-to-date information.	The title of the Aboriginal Fisheries Newfoundland has been changed. FNI has been changed to QMFNB.
264	235	DFO	5.8.1.3	Historical fisheries should include a section on redfish.	A section on redfish has been added to the Historical Fisheries Section.
265	236	DFO	5.8.2.2, Page 272	The text references Salmon fishing on the West Coast only (SFA 13 and 14A). As commercial fisheries data are for portions of the south coast and west coast (4Rd and 3Pn) we suggest that to be consistent, information on SFA 12 should also be included.	Information pertaining to Salmon Fishing Area 12 has been updated.
266	237	DFO	5.8.2.2 French version of EA Report	The title should be "Utilization militaire" rather than "Les militaires emploient."	Translation edits will be addressed as relevant during translation of the revised EA Report.
267	238	DFO	5.8.2.2 French version of EA Report	"Pinfold (2009) a étudié l'estimation de la participation" should read "Pinfold (2009) a estimé la participation."	Translation edits will be addressed as relevant during translation of the revised EA Report.
268	239	DFO	5.8.2.7, p. 278	The Port of Belledune is a major commercial port in Northern New Brunswick operating within a highly industrialized area. The proponent should be aware that the traffic separation scheme is voluntary. Vessels may therefore be directed toward the drilling area if required by the route recommended in winter (open water area in the middle of the ice).	Comment noted. Corridor intends to drill when there is no ice in the Gulf.
269	240	DFO	5.8.2.7, p. 278	The VHF coverage available in the Magdalen Islands does not cover this sector. The Newfoundland and Labrador region probably has better coverage starting at Port-aux-Basques and at the Table Mountain site. In this case, tests should be required or provisions be made at the very least for an HF installation (2182).	Comment noted. Based on the nature and duration of the project, testing and provisions of an HF installation is not required.
270	241	DFO	5.8.2.7, p. 278	This sector is well covered by the Cape Ray DGPS. However, since the AIS signal coming from vessels is not always received by the Magdalen Islands site, we would suggest that the drilling site have its own AIS site or receiving beacon connected to the shipping traffic management system (Innav).	Corridor will take this recommendation into consideration.
271	242	DFO	5.8.2.7, p. 278	The document seems to downplay the impact of shipping traffic in the Old Harry region by indicating that between four and eight vessels, mainly container vessels, pass through this sector daily. Given an average of six vessels per day, that nevertheless equals 2,190 vessels annually, concentrated during the summer and fall. This part would have deserved better documentation.	Comment noted. Based on the duration and nature of the project, we feel the section adequately assesses potential effects on shipping traffic.
272	243	DFO	6.2; Page 282	The Marine Ecosystem VEC should have a broader focus than just corals and plankton. These two ecosystem components may represent VECs but do not constitute an assessment of the environmental effects at the marine ecosystem level. The marine ecosystem, in this case, is the entire Gulf of St. Lawrence and could be represented in the EA by the 10 Ecologically and Biologically Significant Areas (EBSAs) identified in DFO 2007b plus any other species or areas considered important at the ecosystem level. EBSAs were identified by DFO as a tool for assessing and managing ecosystem level effects of human activities. Therefore, it is suggested they be used as a way to assess ecosystem level environmental effects in this EA.	The Marine Ecosystem VEC encompasses plankton (water) and benthic communities (corals) as these two factors are the basis for marine life in the ocean. Without plankton abundance, the majority of life in the ocean would cease. As a result, we have assessed how Project activities will affect the health of both plankton and the benthic communities in the Study Area. Outside of this VEC, Species at Risk, Marine Fish, Shellfish, and Habitat, Marine Birds, Marine Mammals and Sea Turtles, Sensitive Areas, and Commercial Fisheries and Other Uses have been assessed. It can be concluded that after assessing these key indicators the entire marine ecosystem and all of its major components have been assessed and taken into account in a Project context. The marine ecosystem in the case of this Project is the Study area. A broader scale Strategic Environmental Assessment (SEA) is currently ongoing to encompass Western Newfoundland. This Assessment will likely take into account the 10 Ecologically and Biologically Significant Areas (EBSAs) identified in DFO2007b plus any other areas considered important at the ecosystem level.
273	244	DFO	6.2; Page 282	Coastal systems should be treated as a separate VEC in this EA because the project is situated in a unique ecological area that is almost entirely surrounded by land.	The only potential interaction with routine Project related effects would be from supply vessel traffic to and from the Project site. Vessels will follow existing shipping routes and will adhere to Annex 1 of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) and pollution prevention regulations of the *Canada Shipping Act* . Any interaction with the coastal environment is limited in nature and as a result, Coastal Systems will not be added as a stand-alone VEC.

Total Comment #	Agency/ Company Comment #	Government Department / Company	Section of EIS	Comment /Information Request	Response
274	245	DFO	7	Literature on the potential environmental impacts of exploratory drilling is covered quite well and conclusions are in line with many reviews and individual studies dealing with the effects of drilling fluids and cuttings (e.g. MMS2000; CAPP 2001; NEB et al 2002; Buchanan et al 2003; Hurley and Ellis 2004; Neff 2005; Mathieu et al. 2005). Discharges associated with the drilling of a single exploratory well would normally be expected to disturb/impact habitat within a few to tens of meters from a drilling site.	Comment noted.
275	246	DFO	7.1.1	The EA notes that, *"Such a study has not been done for leatherback turtles; however, this species is recognized as being the fastest reptile 35.2 km/hr (19 knots) when frightened (McFarlan 1992) and might be expected to be better able to avoid a strike."* This is an inappropriate and misleading suggestion, as it is not necessarily the potential top speed of a marine vertebrate which influences its susceptibility to ship strikes. More relevant variables include whether or not the animal is in foraging "mode" versus transiting, as foraging animals are particularly vulnerable. EL1105 is located in key leatherback foraging habitat. It would be prudent to remove this argument from the assessment.	Section 7.1.1 has been updated to highlight the difference between foraging and transiting animals.
276	247	DFO	7.1.2	Barium is the main metal in OBM and WBM. Questions have been raised about the potential for chronic toxicological effects in fish. A recent publication reported no health effects as assessed by a variety of indices, in fish chronically exposed to barite for several months (Payne et al 2011).	Comment noted. Section 7.1.2 discuses barium as a dominant component in drill muds and considers health effects associated with barite.
277	248	DFO	7.1.4; Page 318	The approximate number of supply vessels that might be used during exploratory drilling operations should be given.	There will be 2 to 3 support vessels for this project - 1 standby vessel and 1 to 2 supply vessels.
278	249	DFO	7.1.4; Page 318	Ship strikes and noise and are among the most frequently identified stressors of marine mammals in the Gulf of St. Lawrence.	Comment noted. This is acknowledged in the cumulative effects assessment of marine mammals (Section 9.5).
279	250	DFO	7.1.5	For the impact of noise generated by the work, no modeling of the affected area by the different sources of noise, continuous and impulse, is done to provide realistic estimates of noise levels at different frequencies and to map them on vertical and horizontal plane.	The scoping document doesn't require quantification/modeling of noise. Based on the duration and the location of the project, the qualitative assessment further confirms that a quantitative approach is not required. However, Section 7.1.5 has been substantially revised.
280	251	DFO	7.1.5	· The exploration well is in relatively deep water (~470m). Sound in deep water will propagate to ranges of kilometers to tens of kilometers with less attenuation than characteristic of shallower more typical areas of the Grand Banks or Scotian Shelf – this would be especially so for sound propagating along the axis of the Laurentian Channel.	Comment noted. Section 7.1.5 has been substantially revised.
281	252	DFO	7.1.5	Considerable seasonable variation might also be expected in the amplitude of long-range propagated sound. In summer near-surface originating sound, as from air guns, will tend to be generally refracted downward by the prevailing sound speed stratification leading to substantial interaction with the bottom and rapid attenuation with range. In winter and spring the conditions in the deep water of the Laurentian Channel may be upward refractive (at least this is the case on the Scotian Shelf) and near-surface sound can be trapped in sound channels in the upper water column leading to substantially reduced sound attenuation at long range. While these effects are probably negligible close to a surface sound source at short range where acute effects on organisms might be expected, they could be of some consequence at long ranges where low levels of sound might, for example, exert behavioral effects on marine mammals such as influencing their movement. This would be especially relevant to the time of year the activities are taking place.	The influence of seasonal variation on the propagation of sound and extent of biological effects is acknowledged.
282	253	DFO	7.1.5.1	There appears to be some confusion in the EA in referring to VSP and "well site" surveys. For example, within the text, *"A typical well site survey (VSP survey) could..." - However, the "well site survey"* discussed in the quoted reference (Davis et al. 1998) is a conventional 2-D seismic survey conducted using a smaller, higher frequency air gun array to gather detailed geological/geotechnical info on shallow sediment structures around the well in order to plan well initiation and placement of any necessary equipment on bottom. The VSP survey generally looks at deeper geological structures and requires placing the receiving array down the well bore – and appears to be the type of survey proposed for Old Harry given the quoted source level of 242 dB re 1μPa @ 1m is typical for a true VSP survey. This information requires clarification.	Reference to the well site survey has been removed from the section. The Project at Old Harry will be using a VSP survey.
283	254	DFO	7.1.5.1	The intent of the sentence *"The energy levels emitted from the VSP will be considerably less in source (760 in^3)."* is unclear. Lower source energy normally implies a lower total volume airgun array. The key point should be that VSP sources have a sound pressure level intermediate between sources intended for shallow, local geotechnical type surveys and sources typically used for deep 2 or 3-D exploration seismic surveys.	Section 7.1.5.1 has been extensively revised and these reviewer comments have been taken into consideration during this rewrite.
284	255	DFO	7.1.5.1	It has been identified that either a semi-submersible or a drill ship platform may eventually be chosen for the Old Harry exploratory well. As per Table 7.5, semi-submersibles are generally significantly quieter than drill ships. Noise levels emitted by a drill ship are roughly comparable to those emitted by other vessels of similar size; however, a drill ship represents a stationary, long duration noise source (20 – 50 days as per project scheduling) as opposed to a temporary noise source of a passing vessel.	Section 7.1.5.1 has been extensively revised and these reviewer comments have been taken into consideration during this rewrite.

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285	256	DFO	7.1.5.1	The statement *"...low frequency noise from a drilling platform might be detectable no more than 2 km away near a shelf break.."* may be best case scenario given that Table 7.5 identifies noise from a moored drill ship will attenuate to 115 to 120 dB (well above quiet ambient noise levels) at distances of 1 to 10 km. This 2 km detection range for drilling is also mentioned (p. 350) in the context of the avoidance of drill platforms by baleen whales.	Section 7.1.5.1 has been extensively revised and Table 7.5 has been updated.
286	257	DFO	7.1.5.1	Accurate estimates are required. Also, essential measures are not included here: i.e., the levels of ambient noise, noise from the source at the frequencies considered and the estimated losses by propagation. Moreover, to what depths of the water column do we refer?	Section 7.1.5.1 has been extensively revised and these reviewer comments have been taken into consideration during this rewrite.
287	258	DFO	7.1.5.1	Table 7.5 – the "Noise Level (dB re 1μPa)" column contains some error in presentation. Two, and possibly three, quite different acoustic measures are presented in this column without distinction. As such they are misleading for use in making determinations. For example, based on how they are labeled, it is natural to believe these numbers refer to broadband acoustic pressure level measurements at a point in space. However, a numeric level of 60 for "calm seas" appears much too low for a broadband pressure measurement – although is reasonably consistent with a typical power spectral level reported over a 1 Hz bandwidth in the frequency range 10 – 1000 Hz under calm conditions (and the correct units being dB re 1 μPa/$Hz^{1/2}$. The quantity for "Moderate (not 'Modern' sic) Waves/surf" (100 – 700 Hz) seems to be properly labeled as broadband and 102 dB re 1μPa is not unreasonable. The quantity for "Pile-driving" appears to revert to the originally labeled point measurement of broadband noise (given the observation distance of "1 km"). The original literature should be checked to determine how "Fin whale" (probably source level), island drill rigs, or helicopter levels were measured or defined also. This becomes more important if these numbers are used elsewhere in the report to arrive at conclusions about the Old Harry drilling environmental impacts. For example, the EA notes bad weather ambient noise levels are stated in the range 90 to 100 dB re 1μPa – actually less than the moderate wave and surf levels of Table 7.5	Section 7.1.5.1 has been extensively revised and these reviewer comments have been taken into consideration during this rewrite.
288	259	DFO	7.1.5.1	It should be understood and noted that broadband levels are quite dependent on how "broadband" is defined. The "jack-up", "semi-submersible", "moored drill ships", and various specialized vessel noise levels would appear to be acoustic source levels where the broadband acoustic noise levels expected from these devices if measured at a (mathematical only) reference distance of 1 m, the correct acoustic units in this case being dB re 1 μPa @ 1m.	Section 7.1.5.1 has been extrensively revised and these reviewer comments have been taken into consideration during this rewrite.
289	260	DFO	7.1.5.1	Table 7.5 – the EA presents the frequency at which the intensity of the sound is observed. However, none of the sources presented is limited to a single frequency; the energy spreads on a band of frequencies, which may be more or less wide according to the sources. A presentation of the SPL with frequencies for each of the sources would have been much more informative to evaluate the impacts of each.	Section 7.1.5.1 has been extensively revised and these reviewer comments have been taken into consideration during this rewrite.
290	261	DFO	7.1.5.1	Table 7.5 – this should specify whether the levels @ 1 m are for discrete sources or other distances (e.g., fin whales, drilling platform)	Section 7.1.5.1 has been extensively revised and these reviewer comments have been taken into consideration during this rewrite.
291	262	DFO	7.1.5.1	Table 7.5 – the statement *"Overall broadband sound level did not exceed ambient beyond about 1 km…received levels at 100 m would be approximately 114 dB re 1 μPA."* is inconsistent. How can the overall broadband sound level at 1 km be less than ambient levels beyond 1 km, while it is still as high as 114 dB re 1 μPa at 110 km? This reference is probably not applicable here. In the St. Lawrence, the median broadband in the waterway is approximately 112 dB re 1 μPa (Simard et al. 2010).	Section 7.1.5.1 has been extensively revised and these reviewer comments have been taken into consideration during this rewrite.
306	263	DFO	7.1.5.2	The exploration well will be drilled in the Laurentian Channel, a major shipping channel, which is already subject to frequent high level ship noise. Therefore, near the well, on a long term average, the incremental noise level increase from support vessel activity as a fraction of the pre-existing ambient background should be less than if similar operations were conducted in other areas further removed from shipping lanes.	Section 7.1.5.2 has been updated to acknowledge pre-existing ambient noise levels from shipping.
307	264	DFO	7.1.5.2	Figure 7.5 – there is error in the Y axis and legend. The indication of the Y axis is perplexing. From the English version (OB = octave band), one can deduce that these noise levels in third octave. The English legend indicates 1 m, the French 10 km.	Translation edits will be addressed as relevant during translation of the revised EA Report.
308	265	DFO	7.1.5.3	The statement, *"The seismic signals are typically in the range of 10 to 200 Hz (Turnpenny and Nedwell 1994)"* is incorrect. Studies since that time showed that the sounds of airguns are on a broader band (e.g. see Potter et al. 2007).	Section 7.1.5.3 has been updated to correct the acoustic range of seismic signals
309	266	DFO	7.1.5.3	The EA uses conclusions of Turpenny et al. (1994). These are questioned in the expert review of Popper and Hastings (2009) who note: Turpenny et al. (1994) examined the behaviour of three species of fish in a pool in response to different sounds, but results are not useable due to lack of calibration of the sound field at different frequencies and depths and many other problems with experimental design. In enclosed chambers that have an interface with air, such as tanks and pools used by Turpenny et al., the sound field is known to be very complex and will change significantly with frequency and depth (Parvulescu, 1967; Blackstock, 2000; Akamatsu et al., 2002). As a consequence, responses of the animals in the Turpenny et al. (1994) study cannot be correlated with any aspect of the acoustic signal, and the findings are highly questionable.	Conclusions from Turpenny et al. (1994) have been removed from the EA Report
310	267	DFO	7.1.5.3	"250 to 255 dB re 1 μPa" is incomplete in units – lacking "a ... @1m".	Text has been updated to include the unit "@ 1m".

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311	268	DFO	7.1.5.3	The statement, *"The limited studies available suggest that anthropogenic sounds, even from very high intensity sources, might have no effect in some cases …"* is incorrect and incomplete. This statement does not match current knowledge. See more references from Hastings, Fay and Popper on the effects of noise on fish.	The statement in question was intended to comment on the varying responses of fish to anthropogenic sounds from various studies and has been edited to provide clarity.
312	269	DFO	7.1.5.3	The statement, *"There are numerous anecdotal observations of fish under noisy bridges or near noisy vessels indicating that adverse effects are not necessarily overt and obvious, but anecdotal observations are unable to indicate whether fish experience any negative consequences related to the noise (Slabbekoorn et al. 2010)."* is an opposite interpretation of the Slabbekoorn et al. 2010 conclusion, and other information that follows (p.325) that show with references to support it the different ways in which anthropogenic noise can significantly affect fish, including: *"(1) Noise-dependent fish distributions…(2) Reproductive consequences of noisy conditions…(3) Masking effects on communicative sounds…impact the ability of fish to communicate acoustically or use the acoustic 'soundscape' … (4) Masking effects on predator–prey relationships…ability of fish to find prey (get food) or detect the presence of predators…"*	The opposing comment from Slabbekoorn et al. 2010 has been removed from the EA Report.
313	270	DFO	7.1.5.3	The statements, "*Available data suggest that they are capable of detecting vibrations but they do not appear to be capable of detecting pressure fluctuations." and "Crustaceans appear to be most sensitive to sounds of low frequencies (i.e., <10,000 Hz)."* require explanation. How does one distinguish the vibrations of pressure fluctuations? These are contradictory. Also, low frequencies are referred to in reference to frequencies up to 10 000 Hz, which is well beyond the usual range of low frequencies.	In water, only those animals can perceive the pressure component of sound which are equipped with pressure to displacement converters. Many species of fish pick up pressure waves with their swim bladder. The pulsation of the swim bladder in the sound pressure field causes a displacement and stimulation of the otocysts, and thus the perception of a sound wave. Most aquatic crustaceans lack any air filled chambers and therefore cannot perceive pressure variation in a sound field. Instead they perceive sound through vibration of mechanorecptors including setae (hair-like) cells on the surface of the body (Wiese 2002). Text in 7.1.5.3 has been clarified.
314	271	DFO	7.1.5.3	The statement, "*The rate of injury experienced by macroinvertebrates due to the passage of a seismic survey should be less than indicated for planktonic organisms and fish. Lobsters are similar to crab in that they are thought to be resilient to seismic activity because decapods lack the gas-filled voids that would make them sensitive to changes in pressure."* is speculative and must be supported by references or removed. The differences in density and sound velocity of various tissues of crabs and lobsters (hepatopancreas, gonad, muscle, eggs, etc.) do not support this speculation that they are insensitive to pressure changes.	A reference for this has been provided (Pearson et al. 1994, Payne et al. 2007). Similar studies (Payne et al. 2007) have supported this reference in that crustaceans are less sensitive to pressure changes than fish.
292	272	DFO	7.1.5.3	The developer assumes that *the discontinuous, short duration nature of these pulses is expected to result in limited masking of baleen whale calls.* This is true for short distances. However, periods of silence are reduced as one moves away from the source by the reflection of sound, which increases the potential for masking. Several studies have shown that the propagation effects by multipath have the effect of producing multiple replicas of the pulses, thus increasing the risk of masking over long distances. (e.g. Madsen et al. 2006)	The text has been changed to reflect the masking of sounds over long distances.
293	273	DFO	7.1.5.3	Figure 7.7 and 7.8 – a source is required for these figures.	Sources have been added for Figures 7.7 and 7.8.
294	274	DFO	7.1.5.3	The statement (p.333), *"Whistles have a fundamental frequency below 20 to 30 kHz plus higher harmonics…plus higher harmonics."* is inaccurate here; a reference is required and the list of species which have been shown *"…whistling harmonics above 30 kHz "*	For a species list of mammals with whistling frequencies above 30 KHz please refer to Figure 7.8
295	275	DFO	7.1.5.3	The statement (p.333), *"Baleen whales communicate using low frequency sounds (generally between 25 Hz…"* is incorrect. This lower limit of 25 Hz excludes the most frequent vocalizations of blue whales and fin whales.	The lower limit of baleen whale communication has been reduced to 10 Hz to reflect those vocalizations produced by blue and fin whales.
296	276	DFO	7.1.5.3	The EA notes that "Several species of baleen whales have been observed to continue calling in the presence of seismic pulses, including bowhead whales (Richardson et al. 1986), blue whales and fin whales (McDonald et al. 1995)." Continuation of vocal activity during seismic surveys does not imply a lack of masking as proponents claim (see previous sentence of the EA). Animals that vocalize likely cannot be heard by their conspecifics due to noise generated by the project activities. Masking of vocalizations during a period where the voice activity is used for functions such as the search for partners for reproduction may have non-negligible effects on individuals and these life history patterns. This can be particularly significant during the fall for large whales, when an increase in social activity has been documented in species such as the blue whale (Doniol-Valcroze et al. 2011).	Text has been added to acknowledge that continuation of vocalization during seismic sounds does not necessarily mean masking does not occur.
299	277	DFO	7.1.5.3	The effects of seismic surveys on echolocation are discussed for the odontocetes within the project. However, the more likely issue will arise due to the masking of vocalizations for communication, which are broadcast in some odontocetes such as beluga, at much lower frequencies (between 0. 5−16 kHz) than discussed in the EA (Sjare et al. 1986; Lesage et al. 1999), and where the beluga's signal components could be obscured by the higher frequencies of seismic pulses.	The topic of masking has been discussed in the EA. The peak pressure from seismic sounds is in the 5-300 Hz range, with some energy in the 500 – 1000 Hz range. The frequencies of beluga vocalizations (0.5 – 16 KHz) falls outside of the main energy emitted during VSPs.

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342	278	DFO	7.1.5.3	The statements (p.335 and 337), *"...masking effects are expected to be negligible for toothed whales."* and *"The sounds produced by seismic air guns are in the frequency range of low hearing sensitivity for toothed whales."* are incorrect. Madsen et al. 2006 shows that the sounds received by the animals reach frequencies of several kHz, audible by odontocetes.	Madsen et al. 2006 reports that the sounds received by odontocetes can reach frequencies of up to 150 KHz. It is also noted that odontocetes produced echolocation and communication in the frequencies from 1 – 150 KHz. Due to the fact that the majority of the energy emitted from seismic sources is in the range of 5 – 300 Hz, with some energy in the range of 500 – 1000 Hz (Low frequency), it is unlikely that odontocetes will be highly affected (both by masking or injury due to hearing) by VSP sound sources.
343	279	DFO	7.1.5.3	The EA notes, *"The impact of both natural and man-made noise is less severe when it is intermittent rather than continuous (NRC 2003)* ." However, this conclusion is not obviously stated within this reference – therefore it must be qualified within the EA. This assertion is probably true in the context where the intermittent nature of noise is likely better communication during periods of silence between the pulses. However, to conclude that intermittent noise essentially has less impact on marine mammals is probably not a generality, since a strong impulse noise can have major impacts on an animal rather than a lesser intensity continuous noise.	In the context of our assessment intermittent noise caused by VSP would be much less severe than a constant output of the same pressure level.
344	280	DFO	7.1.5.3	Richardson et al. 1995 are cited for *"…limited documented situations…"* This should be updated as it dates back 15 years, and several studies have been conducted since, for many species.	Richardson et al. 1995 are indeed cited for "…limited documented situations…" This is taken out of context as the entire citation is Richardson et al. 1995; Gordon et al. 2004; Nowacek et al. 2007; and Southall et al. 2007. One can see that the statement made by Richardson et al. 1995 is supported by several recent scientific advances from peer reviewed academic journals.
345	281	DFO	7.1.5.3	The statement (p.338) *"In addition, baleen whales have often been seen well within distances where seismic sounds would be audible and yet show no obvious reaction to those sounds (LGL 2005b)…"* is incomplete and requires updated references (e.g. Nieukirk, et al. 2012; Castellote, et al. in press; Yavenko et al. 2007).	This text has been removed and new text added acknowledging various avoidance radii depending on species, locations, whale activities, and oceanographic conditions affecting sound propagation.
346	282	DFO	7.1.5.3	The EA notes, *"The sound emission associated with the VSP and drilling noise would result in avoidance or temporary displacement, negating any potential positive effect. The Project Area does not represent any known critical habitat for any of the species that may pass through the area... The residual adverse environmental effects are therefore assessed as not significant."* The EA uses the project area as the area of influence. However, in the case of seismic surveys, the area of influence is likely much larger than this. The proponent assumes that avoidance of the area insonified (by drilling activity, dynamic repositioning jets of the platform, or seismic surveys) for a period up to 2 months (50 days) in the case of the drilling, has no impact on the use of the area as migration or feeding area. It is actually likely that, at certain times of the year as in the fall and in the spring, this area is a migration route for blue whales in particular. The use of this area for feeding by turtles or large whales is presumed low, whereas in fact, recent data indicate it is used as a foraging area by leatherback turtles.	It is acknowledged that the area of influence extends beyond EL 1105 and that leatherback turtles have been recorded in the Study Area, although it is still maintained that temporary avoidance of this area by the Leatherback would not result in significant adverse effects as the species has been shown to forage over a much larger area in the Gulf and Scotian Shelf.
347	283	DFO	7.1.5.3	The following statements in the EA are misleading: "Avoidance of the Project Area by sea turtles as a result of sound is also not expected to cause any adverse biological effects given that the area is not known to congregate jellyfish, a primary prey item. Jellyfish are transitory, with distributions changing within and between years, so there is no more reason to expect jellyfish within the Project Area than any other area of the Gulf." Also, "The Project Area offers no unique habitat or feeding areas for sea turtles." The area corresponding to EL1105 is part of a broader high-use foraging area for leatherback turtles, as demonstrated through satellite telemetry (see James et al., 2005). As leatherback presence in this area is well documented, spanning multiple years of data collection, etc., there is good evidence that jellyfish are concentrated in this areas and that there is a predictable concentration of leatherback prey in the Project Area. At this time, it cannot be concluded that the area of EL1105 does not provide unique habitat or feeding areas for leatherbacks.	Refer to response to DFO-282.
348	284	DFO	7.1.5.3	Ketten and Bartol (2005) and other more recent references included in the topic of sea turtle hearing would be useful inclusions in this assessment.	Ketten and Bartol 2005 has been added to the EA Report to provide a reference on the hearing range of sea turtles.
328	285	DFO	Section 7.1.5.3, page 359	Incorrect translation – French version […] bien que certaines espèces, en particulier les phoques à oreilles, n'aient pas un aussi vaste champ d'audibilité. Incorrect translation of "otaries"	Translation edits will be addressed as relevant during translation of the revised EA Report.
349	286	DFO	7.2, p. 342, 1st paragraph	The statement about Section 32 of SARA is not correct – it is not linked to critical habitat protection. Rather, critical habitat destruction is prohibited under Section 58. Section 32 relates to protection of individuals of listed extirpated, endangered or threatened species.	The statement regarding Section 32 of the *Species at Risk Act* has been updated to remove discussion on habitat as this is covered under Section 58 of the Act.

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350	287	DFO	7.2.2	The statement (p.343), *"As many Project-related activities are limited to the Project Area, they would only interact with species likely to occur in EL1105."* is unproven. No simulated noise fields have been performed and it is likely they will extend beyond EL1105. Impacts can also spread beyond the area, for example by pushing organisms outside, modifying, interrupting their migrations, as it is repeated several times that the animals avoid the area because of the noise that will be generated.	The statement has been modified to convey that the zone of influence of most Project-related effects (VSP and drilling) are limited to and within close proximity to EL1105. The effects of VSP and drilling are not expected to impact nearshore species located several kilometres away from the source of disturbance (See Section 7.1.5).
351	288	DFO	7.2.4	Table 7.8 – Suggests that mortality resulting in collision with vessel is reversible? Please be advised that it is unlawful to kill harm, harass, capture or take an individual of a species that is listed as Endangered or Threatened under SARA unless permitted. This measure assists in protecting species, as the loss of an individual could be significant for a certain species (e.g. blue whale).	The results of mortality from a vessel collision have been changed to irreversible due to the fact that the loss of an individual from certain species could lead to negative population level effects .
352	289	DFO	7.2.2.5	The potential impacts of drilling noise and duration should also be discussed in this section.	The potential impacts of drilling noise and duration on fish, marine mammals, sea turtles and birds are addressed in Section 7.2.2.5 and Section 7.1.5.
353	290	DFO	7.3; Page 352	Corals and plankton are identified even though "deepwater corals and sponges are not considered likely in the area"(see last line on pg 352). Kelp was also identified but eel grass was not although there are significant eelgrass beds in the adjacent coastal areas (see attached) and its importance was noted in section 5.3. Eel grass has been identified by DFO as an Ecologically Significant Species and their sensitivity to oil pollution is well documented, therefore eel grass should be included in the Marine Ecosystem assessment.	The only potential routine effects to eel grass would be from supply vessel traffic to and from the Project site. Vessels will follow existing shipping routes and will adhere to the Annex 1 of the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) and Pollution Prevention Regulations of the *Canada Shipping Act* . Therefore, any routine interactions between supply vessels and eel grass would be limited in nature and have not been assessed in the Marine Ecosystem Assessment. Corals and Sponges have been identified because there is the slight possibility that they may be found in the area, although highly unlikely. Eel grass would not be found in the potentially affected area offshore.
354	291	DFO	7.1.1 and 7.3.2.1	The total impact of light is not considered in the EA. The effect of light that has not been considered is that on the circadian cycle of diel vertical migrations of pelagic organisms, rising to the surface to feed during the night, and take refuge deep to escape predation by visual predators (e.g., fish, birds). The presence of light around the platform at night will change local dynamics.	The effect of light has been addressed in Section 7.3.2.1 and 7.4.2.1. The effect on pelagic organisms has been added to the assessment and the effect of light on these organisms would be similar to plankton and fish which was previously assessed and concluded that the effects would be localized and temporary, reversing once the drilling period has ceased (20-50 day period).
355	292	DFO	7.4.2.1	Regarding the statement (p.330), *"Several benthic sessile species have a very long generation time (e.g. Corals)."* Sea urchins and brittle stars are not sessile.	The text has been edited to acknowledge effects on sessile and slow-moving organisms.
356	293	DFO	7.4.2.1	There is a lack of references to support recovery in 3-5 years. This is recognizably much longer for corals and sponges.	Additional references have been added to support the statement that the benthic environment will recover within 3-5 years.
337	294	DFO	Section 7.4.2.2, page 389	Incorrect translation – French version Les organismes sédentaires qui ont des capacités motrices nulles ou très limitées, comme le pouce-pied et la moule […]. Incorrect translation of "barnacle" L'endofaune, comme la plupart des polychètes, amphipodes et palourdes, emprunte des espèces […]. Incorrect translation of "burrowing organisms"	Translation edits will be addressed as relevant during translation of the revised EA Report.
338	295	DFO	Section 7.4.2.2, page 390	Incomprehensible translation- French version Plusieurs études de terrain et en laboratoire ont été menées sur les effets possibles de la sédimentation et de la boue dans les coraux de forage.	Translation edits will be addressed as relevant during translation of the revised EA Report.
357	296	DFO	7.4.2.5	References or examples are required for *"Most available literature indicates…"*, as well as all other statements of fact contained in this section regarding effects on fish and shellfish.	The preceding paragraph in Section 7.4.2.5 refers the reader to Section 7.1.5.3 where additional information and references can be found on the biological effects of sound on fish and shellfish.

Total Comment #	Agency/ Company Comment #	Government Department / Company	Section of EIS	Comment /Information Request	Response
358	297	DFO	7.6.3	While this section lists the mitigation to be implemented, details of these mitigations should be detailed. (i.e. details on implementation marine mammal observer, mitigations included in the Statement of Canadian Practice on Mitigation of Seismic Noise in the Marine Environment)	Mitigations measures have been listed; however reference has been made to key documents that are readily available to the public, where it was deemed appropriate as to reduce the length of the document. The Statement of Canadian Practice on Mitigations of Seismic Noise in the Marine Environment and other references documents can be easily obtained from their respected Federal Agencies and have been left out to discourage redundancy. Any additional mitigation requirements beyond those discussed in the EA are expected to be developed in coordination with applicable agencies and outlined in work authorizations and the EPP document.
359	298	DFO	7.8.2.1, p. 381	The authority to enforce the exclusion zones must be specified.	The Offshore Installation Manager (OIM) has the authority, granted by the *Canada-Nova Scotia Offshore Petroleum Resources Accord Implementation Act* , to enforce the exclusion zones. In accordance with the Offshore Petroleum Drilling and Production Regulations, all reasonable measures will be taken to warn persons who are in charge of vessels and aircraft of the safety/exclusion zone boundaries, of the facilities within the safety zone and of any related potential hazards.
360	299	DFO	8.7.1.1	First bullet, second paragraph – the text states that pelagic and benthic fish have low exposure risk because they are highly mobile and able to avoid oiled areas. Larval and early juvenile fish are less mobile than older fish and so may be at greater risk. American eels at the glass eel stage migrate through the EL1105 area. Glass eels may not be able to avoid oiled areas because they cannot swim as rapidly as older eels.	Comment noted. The ability of larval and juvenile fish species to avoid oil slicked areas has been changed.
361	300	DFO	8.7.1.1	There is no mention in this section about the potential impact of spilled oil drifting towards adjacent areas where marine fish species at risk are found in high densities. For example, residual surface and deep water currents in the project and adjacent areas tend to move from east to west around the southwest and west coasts of Newfoundland (Figs. 4.6-4.7, 4.9-4.11) where high concentrations of juvenile and/or adult fish occur (e.g. Figs. 5.5 through 5.10).	The potential effect of spilled oil drifting towards adjacent areas where marine species at risk are found in high densities is minor if not non-existent. The worst case scenario for an oil spill (Refer to Figures 2.12-2.24) will not affect areas of high densities of marine species at risk either adult or juveniles.
362	301	DFO	8.7.1.1	The EA states (p.402) *"…Perhaps the species of greatest concern would be redfish as the Project Area overlaps a potential redfish mating area. Redfish typically mate in the fall; however, eggs are hatched within the female and are not extruded until the following April to July (Section 5.2.1.7). An oil spill would not affect redfish larvae, as the potential larvae extrusion area is outside (to the north, in the Cabot Strait) of the Study Area (Figure 5.56)."* However, this paragraph suggests the project area overlaps a potential redfish mating area, then goes on to suggest a potential larval extrusion area is outside the Study area. Is this speculation or is there a publication to reference for these claims? It is also possible that the project area is also a potential larval extrusion area.	A reference has been added to support the redfish larval extrusio
364	302	DFO	8.7.1.3	Sea turtles should be specifically referenced in the title as there is discussion of them in the corresponding text.	The title of Section 8.7.1.3 has been updated to include Sea Turtles at risk.
365	303	DFO	Section 8.7.2; Page 405	Eelgrass is addressed, but the likelihood of direct oiling is minimized due to the distance of the project from shore, although it is well known that direct oiling of coastlines is a frequent result of a large oil spill, with surface slicks moving considerable distances. In addition calm, sheltered shorelines, marshes and river estuaries where eelgrass beds thrive are among the most sensitive areas to oil, providing quiet zones where oils can accumulate and bind to suspended particles, forming dense tar mats. Oil pollution can cause acute mortality of eelgrass beds, and other sea grass and seaweed beds by physically coating the plants, blocking sunlight and preventing photosynthesis. In addition, structural habitat provided by eelgrass can be compromised by the accumulation of toxic components of oil. Clean-up operations can also damage eelgrass beds.	The sensitivity of eelgrass is acknowledged, although Corridor Resources maintains that oiling of coastlines from a spill is not likely based on predictive modeling.

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366	304	DFO	8.7.5	There is evidence following the recent well blow-out in the Gulf of Mexico (Deepwater Horizon) that hydrocarbon spills can be debilitating and lethal for sea turtles. Suggest including technical reports from NOAA, other sources here, as the impact is not negligible and should be recognized within the assessment.	The reviewer's comment is noted in that the environmental effects on sea turtles from oil exposure is not negligible and which is noted in Section 8.7.1.3. Unlike the circumstances of the Deepwater Horizon blow-out and the existing conditions in the Gulf of Mexico where sea turtles are likely more prevalent over the course of a year, the occurrence of sea turtles in the Project Area or Study Area is limited to feeding during the warmer months of the year in the Gulf of St. Lawrence. Therefore the probability of a high risk of exposure from a blow-out combined with the presence of sea turtles at the same time would be much lower than that in the Gulf of Mexico.
367	305	DFO	8.7.7, Page 410	The text does not reference seafood market price impacts associated with an oil spill – spills have led to food safety concerns and loss of reputation – these in turn have had negative market impacts.	Section 8.7.7 has been updated to include reference to food safety concerns and loss of reputation.
368	306	DFO	9.5	The statement (p.416), *"Richardson et al. (1995) predicted a radius response to noise during development and production activities for baleen and ondontocetes to be less than 100 m."* is erroneous and requires correction. This general source, which contains several hundred pages should not be cited. The authors did not predict a "radious response." The effects of changing the behavior of animals can spread over very large distances (e.g. Risch et al. (2012).	This statement has been removed.
369	307	DFO	9.5	Regarding the statement (p.416), *"Limited data suggest that vessels speeds below 26 km/hr (14 knots) may be beneficial in reducing marine mammal vessel collisions (Laist et al. 2001)."* See also: Vanderlaan et al. (2008); and Vanderlaan and Taggart (2007).	Text updated to include the Vanderlann et al 2008 reference which states that vessel traffic should be limited to 10 knots.
370	308	DFO	Section 9.6; Page 417	Should consider eelgrass under sensitive areas: Low oxygen levels, typical of sheltered sea grass habitat, limit the biodegradation of oil and result in extremely slow degradation, with oil persisting for as much as ten years or more, depending on the amount and type of oil spilled. Recovery begins rapidly in rocky shorelines, but oil can persist for 6 to 12 years or more in protected soft sediments. When significant eelgrass areas are lost, they can be extremely difficult (or impossible) to re-establish, even with interventions such as transplants or seeding.	Under the worst case scenario for an oil spill/blow-out, oil would not reach any areas where eelgrass would be located. As a result, there is no potential effects on eelgrass and it has not been included under the Sensitive Areas Section.
371	309	DFO	Supporting Document - Modeling in Support of Corridor Resources Old Harry Exploratory Drilling Environmental Assessment	In general, the scenarios in this document were not clearly described. The subsurface transport of dispersed oil (majority of the total oil) was not sufficiently modeled. The model only considered the re-entrained oil from surface in a 30m layer and did not consider the dispersion into water column during the rise of oil while oil was released from 470m. Overall, the results were not clearly presented. Notably, the document did not take the expertise gained from the oil spill in the Gulf of Mexico into consideration for the Gulf of St. Lawrence which shares a good deal of similarities. We do not have the specific oil category that is to be extracted in the Gulf of St. Lawrence. However, the indications show that we expect it to be on the lighter side of the crude, close to the category of the one in the Gulf of Mexico. In short, the nature of the crude and the physical setting of both areas, a semi-enclosed sea, make it appropriate to use the expertise gained in the Gulf of Mexico to project the potential risks in the Gulf of St. Lawrence. As such, it is recommended to project the potential risks in the Gulf of St. Lawrence using the results of the oil spill in the Gulf of Mexico.	See Section 2.1.2 in the SL Ross report (SL Ross 2011a, updated 2012) for a description of the behaviour of the oil and gas from a shallow water subsea blowout. In general, significant entrainment of oil in the water column is unlikely during its rise to the surface in the gas bubble driven plume. The behaviour of a shallow water blowout (minimal hydrate formation) will be different from a deep water event (extensive hydrate formation) such as the Deep Water Horizon event in the Gulf of Mexico. The formation of gas hydrates depletes the hydrocarbon plume of the high energy natural gas and the driving buoyancy of the plume is essentially lost. In the case of a shallow water blowout, the gas is preserved in the plume and the high energy bouyancy effect is maintained. The overall impact is that the hydrocarbon plume travels very rapidly to the sea surface with little or no oil dispersed into the water column during its rise to the surface. The expected oil to be encountered at Old Harry is a very light 45-56 degree API oil/condensate (see response for DFO-06), in contrast to the much heavier oil encountered at Macondo (~35 degree API oil). The Old Harry site is located in 470 m water depth, which is much shallower that the 1520 m of water depth at the Macondo site. A subsea blowout at the Old Harry site is expected to behave like a shallow water event with minimal hydrate formation whereas hydrate formation at Macondo was likely extensive.

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372	310	DFO	2. OIL SPILL SCENARIOS AND MODELING INPUTS	Regarding the trajectories of the oil spill, the trajectories presented in the document are unrealistic and do not serve the purpose. They should be redone with realistic winds and surface currents. The model used to generate the surface current fields (Tang et al. 2008) is a good one. However, the oil-spill trajectories are calculated using seasonal mean surface water velocities (2.3.3. Water Currents on page 16). This choice of currents is completely unrealistic. There are no tides, no wind induced currents, and no influence of the surface outflow from fresh water runoff. The latter part is surprising given that the seasonal mean surface currents were used. Since in a typical oil spill, all of these components are present, the trajectories should be calculated with the hourly outputs of the model driven with realistic winds from Meteorological Service of Canada outputs. Within this section, a blow out from the surface is illustrated. However, a blowout from the bottom is not illustrated. The Gulf of Mexico spill did not behave as a text book spill as the blow out was from the bottom; it was not at the surface. Some of the oil did not reach the surface, and a good portion of it stayed near the bottom. There is a need to determine where that oil would go using the hourly bottom currents of the ocean model. The document should therefore track the oil spills using near bottom currents.	The surface water current data utilized provides the seasonal average trends in water movement in the region. When this is combined with the 52 years of MSC50 wind data used in the trajectory assessments the variation in trajectories possible from the drilling location are well represented for the purposes of environmental impact assessment, especially for a spill of non-persistent light oil/condensate. Tidal variations would also not significantly alter the probable footprint of the oil spills. With respect to the wind data used, the MSC50 hind cast wind set used in the modeling is a long term data set with good spatial resolution over the entire Atlantic region. The data was developed by the Climate Research Division of Environment Canada and the Federal Program of Energy Research and Development. In the research paper describing the data set, the authors state that "The wind and wave data are considered to be of sufficiently high quality to be used in the analysis of long return period statistics, and other engineering applications". As such, we contend that this data set is the best available for offshore spill trajectory and behavior modeling. The use of land-based weather data from a single weather station, suggested by the reviewer, does not necessarily accurately portray the winds offshore. Sub-surface water currents were not considered in the subsea oil release because the strong, buoyant gas-bubble plume that would result from a shallow subsea release (see response to DFO-309) would overwhelm such currents and result in minimal deflection of the developed plume (see page 8 and 9 of full spill modeling report for additional description of the models used). For example, a sea bottom current of 3 kts (~0.15 m/s) is significantly weaker than the vertical velocities that can be
373	311	DFO	2.1.2 Subsea Blowouts 5	The name of the model for this study is given here, but a description of the formulation, capability, and limitation of the model is not provided. It is unclear if the processes described in section 2.1.2 have been fully or partially included in SLROSM. Justifications need to be provided on why this model (SLROSM) was used instead of other models (published and probably more advanced models, such as Deep Blow by SINTEF, OILMAPDEEP by ASA, or CDOG by Clarkson University). It is important to demonstrate that the selected model is technically sound for the proposed modeling work. Figure 3 – the illustration of vertical profile is inaccurate. With the presence of currents, the plume will be deflected rather than straight upwards.	SLROSM utilizes the algorithms developed by Fannelop and Sjoen for shallow subsea blowouts as identified in the report on page 10. These are the same algorithms used by SINTEF in their shallow water discharge model and this approach has been validated against the IXTOC blowout event, a more representative blowout for this spill scenario than the Deep Water Horizon event. Supplementary modelling completed by ASA (submitted to C-NLOPB on September 21, 2012) to compare the oil mass balance for surface, evaporated and entrained oil for two different oil specifications (Cohasset crude and diesel) shows that oils with similar properties have similar on-water persistence predictions when using SLROSM and OILMAP. With respect to Figure 3, because of the strong gas bubble plume, the oil would rise to the surface very quickly, and there would be minimal deflection of the plume by subsea cross-currents. Any potential minimal deflection would not result in a significant change in the surface oil footprint (a few hundreds of metres at most).
374	312	DFO	*2.3.2 Discharge Volumes and Flow Rates 15*	Blowout scenarios were not clearly described in this section or in Table 3. Only the flow rate was provided but did not state the blowout period (10 days, or 3 months, etc.). Such information is key to the extent of oil covered area.	Descriptions of surface and subsea blowout behaviour are provided in Sections 2.1.2 and 2.1.3 in the SL Ross Report (SL Ross 2011a, updated 2012). These descriptions in the SL Ross report have been expanded upon since the DFO review. The blowout periods modelled are for one month (30 days).

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375	313	DFO	*2.3.3 Water Currents*	It was stated that surface water current was used in the modeling. The surface only case is fine for the surface spill scenarios, but it is insufficient in modeling subsurface blowout. Although the 470m depth was classified as shallow in terms of hydrate formation it is deep enough that the subsurface current can play an important role to deflect and affect the plume behaviors. The deep/subsurface currents are particularly important for the study of dispersed oil transport process in the water column. The deep current is important considering the drill site is in a channel.	The extensive experience of SL Ross with oil spill modelling over 25 years indicates that the strong gas bubble plume will bring oil to the surface quickly and there would be minimal deflection of the plume by subsea cross-currents (a few hundreds of metres at most). Any minor deflection of the gas bubble plume by cross-currents will result in only minor changes in the surface foot print of oil. Because of the strong gas bubble plume, the oil would rise to the surface very quickly and there would be little loss of oil to the surrounding waters.
376	314	DFO	*3. MODELING RESULTS*	The duration of the trajectories presented in the document is unrealistic. The choice to stop the trajectories at a given level of ppm concentration is not documented. It is implied that all oil spills will be dispersed and absorbed in the environment at that level. In fact, a greater spill would make the oil go further and eventually reach a coastline. The document did not consider this issue which is a serious flaw. It is recommended to use the results from the ocean model under the proper conditions and ensure that the duration is long enough to show the coastline potentially at risk.	The reviewers indicated that the choice to stop the trajectories at a given level of concentration in the water column was not documented. The extent of the sub-surface dispersed oil plumes was stopped at 0.1 ppm (the concentration considered no longer harmful to marine life) as indicated on page 24 along with references for justification. For the batch diesel spills of fixed volume (1000 and 10,000 litres), the dispersed oil in the upper 30 m of the water column was tracked until the oil concentration dropped to 0.1 ppm. For the subsea and surface blowouts, the models were run for one month (30 days) and the dispersed oil in the upper 30 m of the water column was tracked until the oil concentration dropped to 0.1 ppm. The light Cohasset crude oil/condensate will evaporate or disperse to a concentration of 0.1 ppm before impacting any coastline no matter how long the models are run.
377	315	DFO	3.1 Batch Diesel Spill Fate Modeling	The modeling was conducted in average wind conditions, what about under worst case scenarios without wind? This scenario is missing. It is stated that “The subsurface oil also diffuses laterally as it is moved away from the spill site by the prevailing surface water currents”. Again, this is very confusing that subsurface oil is dispersed by surface current. It is stated that “It has been assumed that the oil will mix in the upper 30 m of water as this is the minimum surface water mixing depth reported in the literature for the region (Drinkwater & Gilbert 2004)”. Why assume the mixing depth while there are models available to simulate the 3D (including vertical) transport behaviors? This simplification (30m mixing) may cause overestimate of concentration in some areas and underestimations in other areas.	Statistical wind data was used for Environmental Assessment purposes. Average weather conditions were modelled to provide the most likely behavior of these small diesel spills to meet the requirements of the EA. As the dispersed oil cloud moves with the prevailing currents, it also diffuses and dilutes as it moves with the water body. The 30 m mixing depth provides a reasonable estimate of in-water oil concentration for Environmental Assessment purposes.

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378	316	DFO	3.2 Subsea Blowout Fate and Behaviour Modeling	Without knowing the blowout period, it is difficult to interpret the results. It was stated that between 16 and 29% will evaporate and the remainder will disperse, but the associated time step was not given as the mass balance will continue to change with continuous blowout (maybe month long). Therefore the results in Table 7 only represent the condition at a given time point but the evolution with time is missing. Furthermore, very little has been presented here about the fate of dispersed oil (84 to 71% of total oil, majority), including the vertical distribution. A contour plot of horizontal and vertical area should be provided, as should the depths where 0.1 ppm concentrations are found. Also, without the use of deep currents, the distances in Table 7 are questionable as the deflection of plumes was not considered. The bathymetry around the site is not provided, which may also affect the behaviors of dispersed oil, but there is no discussion on this subject. One important factor that affects the fate of dispersed oil is the droplet size distribution. What distribution was used and how was it calculated?	The blowout period modelled was one month, or 30 days, and oil was 'released' at 6 hour time steps. Note that releasing the volume of 6 hours of oil flow at one instant will take longer to evaporate and disperse than a continuous flow of oil for 6 hours. The dispersed oil plume will diffuse and dilute as it moves away from the spill site and the zones of influence in Table 7 represent the maximum likely extent of significant surface and sub-surface oiling with a continuous release of oil under average environmental conditions. Therefore, the model does provide for the evolution of a potential spill with time. The dispersed oil was tracked in the upper 30 m of the water column until the concentration dropped to 0.1 ppm. Table 7 shows the maximum likely distance from source for the dispersed oil. Other sections in the SL Ross report describe how the oil footprints may vary considering historical wind data. Deep currents will not affect the dispersed oil in the upper 30 m of the water column. Further, the gas bubble plume will move the oil to the surface very rapidly (as with any other shallow water subsea event) with minimal deflection of the plume and little loss of oil to the water column (see response provided for DFO-309 and DFO-313). The oil was moved to the surface by a gas bubble plume not by oil drop buoyancy so the oil drop size distribution is not required (see response for DFO-309).
379	317	DFO	*3.3 Surface Blowout Fate and Behaviour Modeling*	The document refers to “throughout the blowout period”. How long is the period? This is not provided anywhere. Section (4) provides this information for surface oil trajectory, but it was stated there that “This does not represent a scenario that would actually occur in a continuous blowout situation but rather provides a reasonable worst-case assessment of spill behaviour”, it is unclear if this “every 6-hour batch for a month” release case used in section 4 was also used in section 3.	The blowout period modelled was one month, or 30 days. Additional text has been provided in Section 4.0 to add clarity to that section.
380	318	DFO	*4.2 Typical Monthly Surface Oil Slick Trajectories*	The document states, *“Each one of these six-hour quantities of oil has been tracked until the surface oil is completely evaporated and dispersed from the surface.”* However, have the emulsification process been modeled? Although this may not be important in summer conditions, it cannot be neglected in winter conditions as a fraction of emulsion may stay on surface much long and transport far beyond the modeled 3-4 km radii (Fig 5).	The light oil/condensate being modelled does not form a water-in-oil emulsion, based on the data in the Environment Canada oil database and previously conducted tests on the Cohassett-Panuke oil. Condensates in general are not susceptible to water-in oil-emulsion formation.
381	319	DFO	*5.1 Introduction*	The title is “dispersed oil plume trajectories”, however, this section only covers the re-entrained oil from above surface release as mentioned in page 33 “In these simulations, the quantity of oil that would be released from six hours of a continuous above sea blowout has been introduced on the surface at the exploration site as a batch spill every six hours over month-long periods” The behaviour of near bottom release and mass in the water column will be entirely different and are not covered here.	As described in the response to DFO-311, all oil released at the seabed for a shallow water, subsea blowout will travel quickly to the surface with the strong gas/water/oil plume (that is driven by the rising gas bubbles) to the surface (i.e. it is likely that no oil would trapped near the bottom or in the water column). All of the oil would rise to the surface and either evaporate or disperse. The dispersed plume trajectories were tracked until the concentration dropped to 0.1 ppm.
382	320	DFO	*5.2 Typical Monthly Dispersed Oil Plume Trajectories*	The document states, *“The initial movement of the dispersed oil plume is assumed to be due to a combination of winds and surface water currents. The prevailing surface water currents alone are assumed to drive the dispersed oil plume once the surface slick is depleted.”* As discussed before, once the oil is entrained into water column, surface current should not be used, as the high amplitude of surface current may cause over flushing/dilution and underestimate oil concentration.	Oil concentration estimates based on a completely mixed, upper ocean mixing region provide adequate estimates of in-water oil concentration for Environmental Assessment purposes. Any additional resolution, either temporally or spatially, would be of limited use given the spatial and temporal knowlege of the resources that the dispersed oil could impact.
383	321	DFO	5.2, Table 5.1	White shark should be included on this list. Scientific Name:*Carcharodon carcharias* Taxonomy Group:Fishes Range:Atlantic Ocean Last COSEWIC Assessment: April 2006 Last COSEWIC Designation:Endangered SARA Status: Schedule 1, Endangered	Text updated to include White Shark.
384	322	DFO		Regarding the statement (p.94), “Tidal mixing is also a permanent and dominant modifier of the intermediate and deeper waters near the head of Jacques Cartier Strait and in the Strait of Belle Isle (Lu et al. 2001; Saucier et al. 2003).”, Lu et al (2001) showed that where bathymetry was sufficiently shallow that tidal mixing should be strong enough to mix the layer (typically around 50 m depth), and therefore should not by cited in relation to modifying deep water masses.	Comment noted and corrected.

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392	1	DND	General	The mitigation section of the EA report should note that should any suspected unexploded ordinates be encountered during the course of the proponent's operations, it should not be disturbed/manipulated. The proponent should mark the location and immediately inform the Coast Guard. Additional information is available in the 2011 Annual Edition – Notices to Mariners, Section F, No. 37.	DND specific mitigation regarding unexploded ordnances has been added to Section 11.0.
393	2	DND	5.8.2.6 Military Use, line 1, pg 277	the first part of this sentence is inaccurate. DND may use the general area.	Text has been updated to indicate that DND may use the general area.
394	3	DND	5.8.2.6 Military Use, Figure 5.92, pg 277	the context in which this figure is referred to in the text is not accurate, i.e. the figure does not indicate "military use", it indicates unexploded ordinates.	Text has been updated to clarify the context of Figure 5.9.2.
395	4	DND 5.8.2.6 Military Use, Figure 5.92, pg 277	5.8.2.6 Military Use, Figure 5.92, pg 277	DND's Formation Safety and Environment does not have a record of providing this figure for this project, therefore; its proper source should be referenced.	The figure was provided to Stantec by Fugro Geophysics Inc. who received it from Defence Construction Canada (DCC). The text has been updated to reflect this.
396	1	EC	2.11.13 Air Emissions	There are unlikely to be an air issues resulting from normal operations of the exploratory drilling for this proposal. On page 24, the proponent commits to reporting in accordance with the OWTG and the National Pollution Release Inventory. This commitment is redundant as there are no reporting requirements for exploratory drilling under these initiatives. On page 25, the proponent makes reference to Environment Canada's authority to regulate emissions from marine diesel engines of less than 37 kW. It is unclear if this authority relates to the proposed project.	Section 2.11.12 has been updated to remove extraneous and erroneous information on reporting requirements.
397	2	EC	4.1.11 Ice	Page 103, 1st paragraph, sentence 6: *"All sea ice in EL 1105 is first-year ice, ranging in its un-deformed thickness from 30 to 120 cm (SLGO 2011; Figure 4.20).* Comment: Not all sea ice in EL1105 is greater than 30cm (first-year ice), especially at the start of the winter season. Also, your reference to Figure 4.20 is in error … Figure 4.20 in the EA report is a tide map. Rephrase this sentence. Say something like "All sea ice in EL 1105 is seasonal ice, with undeformed thicknesses normally not reaching the thin first-year ice category (30-70cm) until March. Predominant ice thicknesses greater than 70cm are generally not observed until mid-April, towards the very end of the ice season in the Gulf." Also – cite the 1981-2010 CIS Atlas for the information. See your own description at the bottom of p.108, where this is correctly described.	The paragraph was updated to reflect the updated Figure 4.24 (now Figure 4.29) with information from the 1981-2010 CIS Atlas and referenced accordingly.
398	3	EC	4.1.11 Ice	Insert a new figure to replace the erroneous reference to Figure 4.20. Use a figure from the CIS online atlas, for example: http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=AE4A459A-1&wsdoc=C3DAE7C6-0C7E-11E0-9694-185EF62D62D6	The Figure 4.20 reference now refers to Figure 4.24 (now Figure 4.29) as intended which has been updated in accordance with EC-367.
399	4	EC	4.1.11 Ice	Page 103, 1st paragraph, sentence 7: *"Daily graphs such as depicted in Figure 4.24 are available as a seasonal service from http://slgo.ca/en/ocean/data/ice-concentration.html, starting in December / January through May / June."* *Comment: The charts (not graphs, unless you meant to say graphics) published on the SLGO website are forecasts produced by a computer model. This computer model uses CIS analysis data for input. Real CIS analysis charts, NOT model forecast graphics, should be used here, where describing climatological sea ice conditions in the Gulf of St. Lawrence* *• Replace Figure 4.24. Use either the corresponding Ice Stage chart for 31 Jan 2011, found on the CIS web site archive:* *http://ice-glaces.ec.gc.ca/www_archive/AOI_12/Charts/sc_a12_20110131_WIS57SD.gif* *or the one for 07 Feb 2011:* *http://ice-glaces.ec.gc.ca/www_archive/AOI_12/Charts/sc_a12_20110207_WIS57SD.gif* *• In these charts, note that ice stage relates to ice thickness according to last (bottom) table on the following webpage: http://www.ec.gc.ca/glaces-ice/default.asp?lang=En&n=4FF82CBD-1&wsdoc=19CDA64E-10E4-4BFF-B188-D69A612A0322* *• Also - Replace the reference to SLGO with the appropriate reference to the CIS web page.*	Figure 4.24 (now Figure 4.29) has been changed to the Ice Stage chart for 31 Jan 2011 from the CIS Online Atlas. References have been updated to reflect this.
400	5	EC	4.1.11 Ice	Comment: The paragraphs on these pages were copied nearly verbatim from the CIS 1971-2000 sea ice climatic Atlas. Passages and phrases copied word-for-word should be in quotation marks, followed by the appropriate reference. No quotation marks are used and no references are given for the copied sentences until the end of each paragraph, making it appear that the information was paraphrased from this source or that only the last sentence is from this source. The above is plagiarism and needs to be corrected. Simply changing a word in the copied sentence (e.g. replacing significant with substantive so that the sentence has not been copied verbatim in its entirety) is not sufficient.	Paragraphs have been paraphrased where necessary and referenced correctly.

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401	6	EC	4.1.11 Ice	Also, note that there are two editions of the Atlas. The first is for 1971-2000 and was published in 2002. The second is for 1981-2010 and was published online in 2011. The reference given on pages 104-106 is Environment Canada 2011, but the reference at the end of the report (p. 447) says this is for the 1971-2010 Atlas. Please change the reference on p.447 to say "Sea Ice Climatic Atlas for the East Coast 1981-2010". Also correct the web link if necessary.	The references on p.447 were updated to correct citation of "Sea Ice Climatic Atlas for the East Coast 1981-2010". The web link was also updated.
402	7	EC	4.1.11 Ice	Also, p.104, 2nd paragraph, sentence *3 "Typical rates of motion over the Madeleine of 3 to 5 nm per day."* makes no sense as it is written. This sentence was mis-copied and needs to be corrected (and correctly referenced, with quotation marks).	Sentence was identified, paraphrased, and referenced correctly.
403	8	EC	4.1.11 Ice	Page 107, Figure 4.27: This figure is captioned *"Maximum pack ice extent in March"* but shows the chart for the end of March when sea ice retreat has already begun. Maximum ice extents occur in the first half of March, not at the end of March. Comment: Either replace the ice chart shown with one from either the 12th or 19th of March, or change the caption to read "Maximum pack ice extent at the end of March".	March 26 Frequency of Presence of Sea Ice chart was replaced with the March 12th chart as requested.
404	9	EC	4.1.11 Ice	Page 108, Figure 4.28: The caption for this figure says it is the *"Maximum pack ice extent in April",* yet the chart shown is that of February 19 (identical to that in Figure 4.26). Comment: Replace this chart with one that is actually from April.	The incorrect chart was replaced with the Frequency of Presence of Sea Ice chart from April 16th.
405	10	EC	4.1.11 Ice	P.108, 1st paragraph, sentence 1 reads: "The Project Area is located in an area that ranges from 51 to 84 percent 30-Year frequency for the presence of sea ice (green and purple color bands) depending upon the month." Comment: Because the chart used in Figure 4.28 was wrong, this sentence is wrong. The 30-year frequency of presence of sea ice in the project area ranges from 51 to 84% during the peak of the season (late February and early March), then drops to 16-50% in early April and to less than 15% by the end of April. This sentence needs to be corrected as indicated.	The paragraph was changed to reflect the corrected Maximum Pack Ice Extent chart.
406	11	EC	4.1.11 Ice	P.108, 1st paragraph, sentences 2-5 + P.109, Figures 4.29 and 4.30 (4.31) reads: "Ice formation for the 2010/2011 year (Environment Canada 2011) is presented in Figure 4.29. Based on the average and median data for percentage ice coverage, the 2010/2011 season would be considered a "below average" ice coverage year. The maximum ice coverage year was March 1, 1993 (Figure 4.30) and the minimum ice coverage year was March 1, 2010 (Figure 4.31). EL 1105 is located in the area that has an average ice freeze up date of January 29 (Figure 4.31)." Comment: Figure 4.29 is missing as described in the text. The actual Figures 4.29 and 4.30 on p.109 actually correspond to Figures 4.30 and 4.31 as described in the text. "Figure 4.31" is referred to in relation to 2 different charts in the text: 1) what is actually Figure 4.30 on p.109, and 2) the dates of freeze-up chart, labeled Figure 4.31 on p.110. • Insert a new Figure 4.29 (the chart for the ice formation for the year 2010/2011). • Correct the figure numbers for Figures 4.29, 4.30 and 4.31, so that 4.29 becomes 4.30, and 4.30 becomes 4.31, and 4.31 becomes 4.32 … to match what is described in the text. • Correct the Figure numbers (captions and in the text) by adding 1 to their numbers, for the rest of the figures in all of Section 4.	A new Figure 4.29 (now 4.34) was added to the text and all figure numbers were corrected to reflect this in the captions as well as the text.
407	12	EC	4.1.11 Ice	P.108, 1st paragraph, sentence 5 reads*: "EL 1105 is located in the area that has an average ice freeze up date of January 29 (Figure 4.31)."* *Comment: From the Freeze-up chart, the average freeze-up date is February 12, not January 29.* *Correct the date given in sentence 5 from January 29 to February 12.*	The sentence was updated to include the correct February 12th date.
499	13	EC	4.1.11 Ice	P.110, 1st, 2nd and 3rd paragraphs: Comment: See plagiarism notes for P.104-106. Use quotation marks and correctly reference sections copied verbatim or nearly verbatim from the CIS Atlases.	Paragraphs have been paraphrased where necessary and referenced correctly.

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500	14	EC	4.1.11 Ice	P.110, 3rd paragraph, sentence 1: Comment: The CIS Atlas makes clear the jump between this paragraph and the one before it by adding a section title "Ice Features in the Area". In this environmental assessment, the lack of section header leads to a confusing disjoint between the two paragraphs. Modify the first sentence of this paragraph to make clear that ice dispersal is no longer being discussed and that the topic has changed to Ice Features. Suggestion: -- During the peak of the ice season, "ice in the central part of the Gulf produces an ice cover of large floes of thick ice, combined with new ice formation, from Gaspé Passage to Cape Breton Island" (Environment Canada, 2011). -- Again, as indicated, use correct quotations and referencing of text copied word-for-word from the CIS Atlas to avoid plagiarism.	The lead in sentence was modified to better identify the change of subject. Paragraphs have been paraphrased where necessary and referenced correctly.
501	15	EC	4.1.11 Ice	P.111, 1st paragraph: Comment: See plagiarism notes for P.104-106, P.110. Use quotation marks and correctly reference sections copied verbatim or nearly verbatim from the CIS Atlases.	Paragraphs have been paraphrased where necessary and referenced correctly.
502	16	EC	4.1.11 Ice	p.111, 2nd paragraph: Comment: Most of the text in this paragraph was copied from a paragraph which exists in the older 1971-2000 CIS Atlas (published 2002) but which was removed from the more recent 1981-2010 CIS Atlas (published 2011). Thus, in addition to plagiarizing much of the text, you have also used the wrong reference. Use quotation marks and correctly reference sections copied verbatim or nearly verbatim from the CIS Atlases. Correct the reference to Environment Canada (2002) and add a second reference to the list on page 447 to include this second, earlier version of the Alas.	Paragraphs have been paraphrased where necessary and referenced correctly.
514	17	EC	4.1.12 Icebergs	The report's short paragraph on iceberg describes typical iceberg motions from the Strait of Belle Isle and along the Québec shore in the Gulf of St-Lawrence; their graphics does not portray this motion. Although this iceberg preferred trajectory is correct, the study makes no attempt to describe iceberg climatology. The following statements are derived from the CIS archive of iceberg reconnaissance from 1987 to today. 1- Icebergs have been spotted in the Strait of Belle Isle during every month of the year during the past 25 years. 2- Deeper intrusion of icebergs in the Gulf of St-Lawrence and along the west coast of Newfoundland can only occur after the pack ice becomes increasingly mobile during the spring months; this typically occurs in April, May and June. 3- No icebergs have ever been spotted south of 48°30' N in the Gulf of St-Lawrence. 4- Icebergs sighted south of Newfoundland were never seen west of 59° W. 5- The primary water current flow in the Laurentian Channel would prevent icebergs from approaching this area from the east. 6- For any iceberg to approach the drill site from the west would mean the iceberg would first have to drift west of Anticosti Island and out through the Onguedo Passage (south of Anticosti Island). 7- Few icebergs have been spotted west of Anticosti Island (back in April of 1987). 8- No icebergs have ever been sighted south of Anticosti Island.	Section 4.1.12 was updated to include more iceberg climatology as it pertains to the Project Area.
515	18	EC	12.1 Potential Effects of the Physical Environment on the Project	Page 422, section 12.1, 3rd paragraph, sentence 3 reads: "The effects of ice on the Project will be minimal because most of the Project Area is often free of sea ice and subject to relatively few icebergs most of the year." Comment: The effects of ice on the project will be minimal because the drilling, as indicated in the second bullet after the first paragraph on this page, will be conducted during ice-free periods and because the area is free of sea ice for most of the year. This could be made clearer.	The paragraph was updated to improve its clarity as requested.
516	19	EC	Physical Environment (4.0)	There seem to be errors in the numbering of sections in Chapter 4.0 Physical Environment. Section 4.1 titled Geology includes several subsections that do not belong there, on physical oceanography, currents, tides, waves, and storm tracks.	The text has been formatted so that Physical Oceanography is its own major heading.
534	20	EC	Waves (4.1.9)	This section relies entirely on the statistical summary of waves at one point within the Project area, based on the MSC50 Wind and Wave Hindcast Dataset. Measurements from scientific buoys in other parts of the Gulf of Lawrence may be useful (link below). The definition of peak wave period and significant wave height should be provided.	Definitions for peak wave period and significant wave height were added to the text. However, with respect to using scientific buoys in other parts of the Gulf, the scope of the Old Harry Prospect Exploration Drilling Program EA is to assess a specific Project in a specific study area which has been defined as the likely extent of potential Project-environment interactions from the Old Harry Project. It is suggested that this regional information request is more appropriate to be addressed in a regional study such as the updated Western Newfoundland Strategic Environmental Assessment, scheduled for completion in summer 2013, which has a much broader scope.

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535	21	EC	Waves (4.1.9)	The column and row headings for Tables 4.2 – 4.5, showing the percent occurrence of peak wave period against significant wave height (SWH), are reversed. This error is repeated in the text which states that the majority of significant wave heights are 7 to 9 m, when those values apply to wave periods. Similarly the values for the typical peak period correspond to wave heights. Imagine a 7 m wave every 2 seconds, as the text would suggest.	The table headings and text associated with Tables 4.2 - 4.5 were updated to reflect the correct values for the percent occurrence of peak wave period against significant wave height.
297	22	EC	Waves (4.1.9)	The percentages are given to the 2nd decimal place, insufficient to indicate the occurrence of the most extreme values. Table 4.1 shows that significant wave heights of 7.0 m or more occur in each of the 4 seasons but this is not evident the tables for MAM or JJA. Table 4.1 shows that significant wave heights of 9.0 m or more occur in the fall and winter seasons, but this is not evident in the table for the fall (OND).	Tables have been changed to show that percentages are less than 0.01 percent and not 0. Since the data for these tables was generated through Hindcast modeling, the percentages were kept to two decimal places as it is more reflective of the source data's precision.
298	23	EC	Waves (4.1.9)	The last paragraph of this section seems misplaced.	The misplaced paragraph in Section 4.1.9 was removed from the text. The paragraph duplicated one found in Section 2.12.2.
300	24	EC	Storm Tracks in the Gulf of St. Lawrence (4.1.10)	This section contains 3 figures that inadequately describe the intended subject. Figures 4.21 and 4.22 barely cover the Gulf of St Lawrence and thus cannot show Figure 4.23 is very hard to read. It is missing the panel for the winter season (DJF); the summer panel (JJA) is repeated twice. major storm tracks for both extra-tropical and tropical cyclones that approach from the south or southwest and track northeastwards over the Gulf of St Lawrence and the Atlantic Provinces. Tropical cyclones/transitioning tropical cyclones need to be considered (ref. below)	Figures 4.21 and 4.22 were replaced with 4 figures more relevant to storm tracks in the Gulf of St. Lawrence. Figure 4.23 was separated into four figures for readability with the winter panel being corrected to show the proper season.
301	25	EC	Climate (4.2.1)	The caption for Table 4.6 should indicate that the monthly precipitation values are means. The monthly extremes were not included, even though that is part of the standard description of station climate normals from EC.	Table 4.6 updated to show that precipitation values are means and the monthly extremes were added.
302	26	EC	Climate (4.2.1)	occurrence of freezing precipitation and freezing spray should be explicitly described in Ch 4; their effects are discussed in the Effects of the Environment on the Project, 12.1 12.1.	Freezing spray and freezing rain have now been added to the Climate section (4.2.1).
303	27	EC	Climate (4.2.1)	Since the project includes helicopter operations, climatology relevant for aviation should be included for the project area from the drilling platform to any shore-based facilities. That includes information on hazards such as low level turbulence and icing, and information on the frequency of low cloud ceilings (as well as visibility).	Information on hazards such as low-level turbulence, icing, and the frequency of low cloud ceilings has been added to the EA.
304	28	EC	Wind Climate (4.2.2)	The wind climate was described solely from the MSC50 dataset for a single point in the Project area. This is insufficient to give a full picture of the conditions over the entire Project and Study Area. The analysis should include hourly mean and gust wind speeds from land/island stations in the surrounding area. Local effects and elevation differences need to be considered.	The MSC50 Data point gives a central data point with regards to unimpeded wind conditions. As such this point was chosen to give an overall picture of the wind characteristics in the Project and Study Area.
305	29	EC	Wind Climate (4.2.2)	Tables 4.6 to 4.10, percent occurrence of winds by speed and direction, give values only to the 2nd decimal, insufficient to show the occurrence of the most extreme winds.	Tables 4.6 – 4.10 give values to the 2nd decimal, which does show the occurrence of the most extreme wind speeds during those seasons where one would expect to see them (winter and spring). In the summer and fall months these extreme wind conditions are much less likely as is shown in the MSC50 Data Set.
315	30	EC	Wind Climate (4.2.2)	There should be some discussion/description of local effects including mountain or lee waves, known locally as Wreckhouse Winds (in NL) and Les Suetes Winds (in NS) that can be hurricane force (measured by the Wreckhouse and Grand Etang autostations).	For a description of Wreckhouse winds refer to section 4.2.1. Les Suetes Winds occur in Nova Scotia, which is outside the Project and Study Area.
316	31	EC	Visibility and Fog (4.2.3)	This section gives information for Port-aux-basques that may under-represent the frequency of low visibiliies over the Project area or along the west coast of Newfoundland. Other station data should be used as well, including Les Iles de la Madeleine. Statistical summaries and marine weather observations archived in the ICOADS (International Comprehensive Ocean Atmosphere Dataset) based on ship reports, would provide information on visibility over the water.	Environment Canada's Les Iles de la Madeleine Weather station does not keep records on visibility. Port Aux Basques is the closest weather station to record this data, and as such it was used to characterize the visibility in the Project and Study Area.
317	32	EC	Visibility and Fog (4.2.3)	The text incorrectly states that visibility in an earlier report was assessed using the AES40 dataset. The AES40 includes only wind and wave information.	The text has been clarified to indicate that visibility information was taken from near AES40 and not directly from the dataset.
318	33	EC	Visibility and Fog (4.2.3)	The caption for Table 4.11 does not adequately describe the values reported.	The caption for Table 4.11 has been revised to better reflect its contents.
319	34	EC	Climate Change (4.3)	This section includes discussion only of sea-level change. This section should describe changes in ice frequency that have occurred over the last few decades, and the effect of reductions in ice cover (longer fetch allowing higher waves to build, and more frequent occurrence of adverse weather)	Observations over the last few decades show an increase in ice cover in the Gulf, and has not supported predictions that the area will be ice free year round. "Observations of the past decades do not support this prediction, with sea ice getting more severe in the Gulf" (Dufour and Ouelette 2007). As a result, it would not be justified to say that the Gulf has seen reductions in ice cover, allowing for increased fetch for wave propagation.

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320	35	EC	Marine Transportation	There is very little consideration of the effects of the project on marine traffic, or vice versa, even though the drilling location overlaps with the main shipping lane from the Cabot Strait through the Gulf of St. Lawrence to Montreal. The material is hard to find, being included Ch 5, Biological Environment, or in sub-sub-sections titled Commercial Fisheries and Other Users, or neglected altogether.	Comment noted. Based on the duration and nature of the drilling program, we feel that the effects to marine traffic have been adequately addressed. The Project will be short term and outside of ice conditions.
321	36	EC	Potential Effects of the Physical Environment on the Project (12.1)	delays in aviation operations due to adverse flying weather could be significant but was not mentioned	Section 12.1 has been updated to include delays in aviation due to adverse flying conditions.
322	37	EC	Additional Source of Information	NOAA Historical Hurricane Tracks, at NOAA Coastal Services Center http://www.csc.noaa.gov/digitalcoast/tools/hurricanes/index.html · Hart, R.E. and Evans, J.L., 2001. A Climatology of the Extratropical Transition of Atlantic Tropical Cyclones, Journal of Climate, 14, pp. 546-564. · Meteorological Service of Canada (Atlantic). 2005. A Climatology of Hurricanes for Canada – Improving our Awareness of the Threat, available on CD-ROM from Environment Canada. · Scientific Buoy Data, St Lawrence Global Observatory (SLGO); Maurice Lamontagne Institute: http://ogsl.ca/app-sgdo/en/accueil.html and http://slgo.ca/en/buoys/data.html · Nav Canada Local Area Weather Manuals: http://www.navcanada.ca/NavCanada.asp?Content=contentdefinitionfiles%5Cpublications%5Clak%5Cdefault.xml	Corridor Resources will take these sources of data under consideration.
324	38	EC	Migratory Birds	An issue throughout the EA report is the standard formatting of the species names and guild names of migratory birds. The standard formatting is that common bird names should be capitalized except after a hyphen (*i.e.* Harlequin Duck, White-winged Crossbill), except where the last two words are hyphenated (*i.e.* Wilson's Storm-Petrel). Additionally, groups or guilds of birds should not be capitalized where a specific species is not mentioned (*i.e.* alcids, phalaropes, waterfowl, cormorants, *etc.*). Quotes from the environmental assessment have been corrected in this review to fit the standard formatting rule.	The EA Report has been reviewed and formatting updated to capitalize common bird names as appropriate.
326	39	EC	5.2 Species at Risk	Tables 5.1 and 5.2 do not take into account the Yellow Rail (*Species at Risk Act* (SARA)-listed species of special concern) and the Red Knot (*rufa* subspecies; proposed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)). Yellow Rails can be found at the upper levels (drier margins) of estuarine and salt marshes. In winter, the rails are known to use coastal wetlands. Currently, among the most important areas for migrating Red Knots in eastern Canada is along the North Shore of the Gulf of St. Lawrence in Quebec, and some also stage among the Magdalen Islands. Avian species listed under the "*Espece menacee ou vulnerable du Quebec act"* should be included in this list to reflect birds present on the Magdalen Islands.	Table 5.1 has been updated to include consideration of Yellow Rail and Red Knot although both are considered unlikely to be encountered in EL 1105. In order to focus the assessment, only federally assessed species are included (SARA, COSEWIC) in Tables 5.1 and 5.2; although where applicable, provincial designations are discussed in species' descriptions.
329	40	EC	5.2 Species at Risk	A section should be added here concerning shorebirds and their habitats used during migration. Aubry and Cotter (2007) provide valuable information on shorebirds and areas used as stopover sites (feeding and resting) during migration. Stopover sites can be crucial for shorebirds because of their migration behaviour, which often consists of long stops to substantially increase energy reserves before taking off for long, uninterrupted flights. These feeding grounds are vulnerable to oil spills and impacts should be assessed. See also Fradette (1992) and Mousseau *et al*. (1976) for more information on the subject.	Section 5.2 addresses federally designated Species at Risk, including shorebirds (e.g., Red Knot, Piping Plover), and specific migratory information is discussed for these species where relevant in Table 5.1 and Section 5.2.2. Additional information on shorebirds is provided in Section 5.5, including information on the importance of stop-over sites during migration.
331	41	EC	5.2.2 Bird Species at Risk	Red Knot should be discussed in this section.	Subsections have been added in Section 5.2.2 to discuss Red Knot (5.2.2.4) and Yellow Rail (5.2.2.6).
333	42	EC	Table 5.2 Species at Risk	Migratory birds such as Red Knot may occur throughout the Gulf coastal areas (beaches and intertidal flats) during migration, and should be added to this table.	Red Knot has been added to Table 5.1.
335	43	EC	5.2.2.3 Piping Plover	"A census in Newfoundland in 2006 identified 48 nesting adult Piping Plovers, an increase from 39 birds in 2001." 2011 was also a census year for Piping Plover (PIPL). As an update, 51 Piping Plovers (21 pairs, 9 singles) were recorded on 16 beaches in Newfoundland during 2011	Section 5.2.2.2 has been updated to reflect Environment Canada's updates from the 2011 International Piping Plover Census.
339	44	EC	5.2.2.3 Piping Plover	"Piping Plovers have not been found on the northeast coast since 1987." A single Piping Plover was recorded on the northeast coast during the 2011 International Piping Plover Census.	Section 5.2.2.2 has been updated to reflect Environment Canada's updates from the 2011 International Piping Plover Census.
340	45	EC	5.2.2.3 Piping Plover	"In 2009, a pair of nesting Piping Plovers was identified in Gros Morne National Park for the first time since 1975 (Newfoundland and Labrador Department of Environment and Conservation 2010)." Additionally, a pair of Piping Plovers has nested in Gros Morne National Park in 2010 and 2011.	Section 5.2.2.2 has been updated to reflect Environment Canada's updates from the 2011 International Piping Plover Census.

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341	46	EC	5.2.2.3 Piping Plover	"Piping Plover habitat is protected under SARA, which provides a residence description of the melodus (and circumcinctus) subspecies (SARA 2010)." Piping Plover, as well as other migratory birds, their eggs, nests, and young are protected under the Migratory Birds Convention Act (MBCA). Migratory birds protected by the MBCA generally include all seabirds except cormorants and pelicans, all waterfowl, all shorebirds, and most landbirds (birds with principally terrestrial life cycles). Most of these birds are specifically named in the Environment Canada publication, Birds Protected in Canada under the Migratory Birds Convention Act, Canadian Wildlife Service Occasional Paper No. 1. Under Section 6 of the Migratory Birds Regulations (MBR), it is forbidden to disturb, destroy or take a nest or egg of a migratory bird; or to be in possession of a live migratory bird, or its carcass, skin, nest or egg, except under authority of a permit. It is important to note that under the current MBR, no permits can be issued for the incidental take of migratory bird caused by development projects or other economic activities. Furthermore, Section 5.1 of the MBCA describes prohibitions related to deposit of substances harmful to migratory birds: "5.1 (1) No person or vessel shall deposit a substance that is harmful to migratory birds, or permit such a substance to be deposited, in waters or an area frequented by migratory birds or in a place from which the substance may enter such waters or such an area. (2) No person or vessel shall deposit a substance or permit a substance to be deposited in any place if the substance, in combination with one or more substances, results in a substance — in waters or an area frequented by migratory birds or in a place from which it may enter such waters or such an area — that is harmful to migratory birds." Piping Plover critical habitat is identified in the draft Recovery Strategy for Piping Plover, which is open for public consultation until April 2012 (currently accessible at http://www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=923). Under SARA, the general prohibitions and critical habitat protection prohibitions only apply on federal land, in the exclusive economic zone of Canada, or on the continental shelf of Canada unless otherwise stipulated by an Order. However, the expectation is that provinces will ensure that effective protection is put in place for critical habitat on non-federal lands. Applicable prohibitions under SARA include: "32 (1) No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species"; and "33. No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species, or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada." "This species is not expected to occur in offshore areas of the Gulf, such as within the Study Area…" It should be noted that the migration patterns, migration routes, migration height, and other aspects of migration are unknown for this species. The Piping Plover also nests on the Magdalen Islands, where approximately 40 pairs are present each year. It is important to note that critical habitat for this species has been identified in the draft Recovery Strategy.	Section 5.2 has been revised to include reference to the Migratory Birds Regulations. Additionally, Section 5.2.2.2 has been updated to acknowledge the identification of critical habitat for Piping Plover, as identified by the Recovery Strategy for this species (Environment Canada 2012).
345	47	EC	5.2.2.4 Roseate Tern	Please remove "peripheral" from "small peripheral colonies of Roseate Terns nesting on Sable Island and the Magdalen Islands".	The term "peripheral" has been removed.
401	48	EC	5.2.2.4 Roseate Tern	Critical habitat has been identified for Roseate Terns on Sable Island and the Magdalen Islands. (see http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=913). It is important to note, however that Roseate Terns are often difficult to identify, as they can breed in the same locations as other tern species. Hence, numbers could be underestimated.	Text has been updated to acknowledge designation of critical habitat on Sable Island and the Magdalen Islands.
402	49	EC	5.2.2.5 Horned Grebe	The factors limiting Horned Grebe populations in Canada are not known, but several possible causes for the decline have been identified, including oil spills on their wintering grounds.	Text has been added to recognize potential limiting factors such as loss of wetlands and spills on wintering grounds.
403	50	EC	5.2.2.6 Harlequin Duck	Harlequin Duck can be found offshore of the Magdalen Islands (near île Brion and Rocher-aux-Oiseaux) during migration periods.	Text has been added to include presence offshore Magdalen Islands during migration periods.

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404	51	EC	5.2.2.7 Barrow's Goldeneye	More recent information suggests slightly more Barrow's Goldeneye wintering in the Gulf of St. Lawrence and Estuary than identified in the environmental assessment. Mid-winter surveys conducted in waters of Quebec, Prince Edward Island, Nova Scotia and New Brunswick in February / March 2009 tallied 6,800 wintering Barrow's Goldeneye, most of which (approximately 6,250) were in Quebec, with the remainder in the Gulf of St. Lawrence zone of the Maritime Provinces (surveys were not conducted in Newfoundland and Labrador, or along the Atlantic coast of Nova Scotia). Please contact EC-CWS for more information concerning this unpublished data.	Recent survey information regarding Barrow's Goldeneye wintering population in the Gulf of St. Lawrence, as provided by Environment Canada, has been incorporated into Section 5.2.2.8.
405	52	EC	5.5 Marine Birds (Waterfowl Paragraph)	Geese should be discussed in the "waterfowl" paragraph.	Discussion on geese, particularly Canada Goose, has been added to "waterfowl" paragraph of Section 5.5.
406	53	EC	5.5 Marine Birds (Waterfowl Paragraph)	"Eiders typically nest on coastal islands and raise their broods in coastal waters" Eiders tend to nest on islands where fresh water is available. During incubation, eider females leave the nest site to drink fresh water. Ducklings may benefit significantly from access to fresh water prior to departure from colonies.	Text has been added to include reference to required availability of fresh water on coastal islands for eider nesting.
407	54	EC	5.5 Marine Birds (Waterfowl Paragraph)	*"Outside of the breeding season, sea ducks are found only on coastal waters."* *Sea ducks can also be found over reefs and banks at depths where benthic prey are accessible. They are additionally known to migrate across large ocean expanses and over land.*	Text has been added to acknowledge potential foraging of sea ducks over reefs and banks as well as migration over large ocean expanses or land.
408	55	EC	5.5 Marine Birds (Waterfowl Paragraph)	It should be noted that Bufflehead, Common Goldeneye and Red-breasted Merganser are sea ducks, not bay ducks.	Text has been updated to include these species as sea ducks, not bay ducks.
409	56	EC	5.5 Marine Birds (Shorebird Paragraph)	Purple Sandpiper needs to be mentioned in this section. Purple Sandpiper regularly overwinter in the Gulf of St. Lawrence, and mainly use rocky coastal habitats. It thus differs somewhat from other shorebirds mentioned. See the "*Québec Shorebird Conservation Plan*" for more details (available at www.ec.gc.ca/Publications/default.asp?lang=En&xml=03F99E30-EFBE-42C3-ABA9-90F2A0CC57EB).	Text on Purple Sandpiper's preference for rocky coastlines during migration and overwintering has been incorporated into Section 5.5.
410	57	EC	5.5 Marine Birds (Shorebird Paragraph)	"Outside of the breeding season, most shorebirds forage along coastal beaches, mud flats or salt marshes," The words "exposed and estuarine" should be added as adjectives to "mud flats or salt marshes". The statement should be more precise and should indicate that shorebirds concentrate in coastal areas (mud/sandflats, barachois, saltmarshes, etc.) in western Newfoundland during fall migration (July to October) and on rocky ledges, shorelines and islands in winter (e.g. Purple Sandpiper).	"Exposed" has been added to the work "mudflats". Although many estuarine habitats do provide important foraging habitat during the non-breeding season, "estuarine" has not been added as a habitat qualifier in the statement because non-estuarine salt marsh systems are also used. Additional text has been added to discuss use of coastal environments as stopover sites during migration, and for overwintering by Purple Sandpipers.
411	58	EC	5.5 Marine Birds (Shorebird Paragraph)	*"Some of the more abundant shorebird species found in the Gulf include Semipalmated Sandpiper, Semipalmated Plover, Greater Yellowlegs and Blackbellied Plover."* *It should be noted that in addition to consideration of overall abundance, the proportion of a species' continental population is important.*	Text has been added to acknowledge that the proportion of species's continental population supported by the Gulf is important.
412	59	EC	5.5 Marine Birds (Shorebird Paragraph)	The shorebird list should be completed: Shorebirds that occur off western Newfoundland include Semipalmated Plover (in list), Piping Plover (in list), Killdeer (to be added), Black-bellied Plover (in list), American Golden-plover (to be added), Ruddy Turnstone (to be added), Whimbrel (to be added), Spotted Sandpiper (to be added), Willet (in list), Greater Yellowlegs (in list), Lesser Yellowlegs (to be added), Red Knot (to be added), Pectoral Sandpiper (to be added), White-rumped Sandpiper (to be added), Least Sandpiper (to be added), Dunlin (to be added), Short-billed Dowitcher (to be added), Semipalmated Sandpiper (in list), Sanderling (to be added), Stilt Sandpiper (to be added), American Oystercatcher (to be added), Purple Sandpiper (to be added).	The listed shorebird species have been added to Table 5.12 with the exception of Stilt Sandpiper and American Oystercatcher which are only known as vagrants to the area and are unlikely to occur in the immediate vicinity of Exploration License 1105, or off Western Newfoundland.
413	60	EC	5.5 Marine Birds (Seabird Paragraph)	"Pelagic seabirds feed at sea over deep waters". This should be replaced with "Pelagic seabirds typically feed at sea over deep waters".	Text has been updated to include "typically".
414	61	EC	5.5 Marine Birds (Seabird Paragraph)	Greater Shearwater should be replaced with "Great Shearwater" throughout the document.	Greater Shearwater" has been changed to "Great Shearwater".
415	62	EC	5.5 Marine Birds (Seabird Paragraph)	Wilson's Storm-Petrel should be added to the list of common pelagic seabird species found in the Gulf.	Wilson's Storm Petrel is listed in Table 5.12 and has been added to the text of Section 5.5.
416	63	EC	5.5 Marine Birds (Meritic and Pelagic Seabirds Paragraph)	An inclusive interpretation of the term 'seabird' is fine, but is not reflected in the tally of "18 different species" breeding in the Gulf of St. Lawrence. A list of these species would be useful to include. It should be noted that the Gulf is also important to pelagic seabirds that do not breed in the Gulf. These should be listed as well and treated here.	Text has modified to clarify that the Gulf is important to both breeding and non-breeding seabirds.
417	64	EC	5.5 Marine Birds (Meritic and Pelagic Seabirds Paragraph)	"To this end, seabirds can be classified into two groups based on their vulnerability to oil pollution." Species vulnerability more likely represents a continuum from 'least vulnerable' to 'most vulnerable'. Also, here only direct effects are presented. Knowledge of indirect effects (such as effects of oil pollution via food-chain) should be provided as well.	Text has been modified to reflect a continuum of vulnerability from "most vulnerable" to "least vulnerable". Additionally, text has been added to acknowledge the indirect effects of oil spills to seabirds.

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418	65	EC	5.5 Marine Birds (Meritic and Pelagic Seabirds Paragraph)	*"Highly vulnerable species also have low reproductive rates such that…"* *These seabirds thus rely on correspondingly high rates of adult survival. These traits are among the general characteristics of seabirds and apply to less vulnerable species as well.*	Comment noted; text has been modified to accommodate.
419	66	EC	5.5 Marine Birds (Meritic and Pelagic Seabirds Paragraph)	*"Some species such as cormorants and sea ducks are highly susceptible to oiling but have relatively high reproductive rates and are able to recover from mortality events more rapidly."* *Some sea ducks, such as eiders, also have lower annual reproductive rates and correspondingly higher adult survival rates.*	Comment noted. Section 5.5 acknowledges that a lower reproductive rate increases species' vulnerability.
420	67	EC	5.5 Marine Birds (Meritic and Pelagic Seabirds Paragraph)	"Pelagic seabirds considered to be highly vulnerable to oil pollution include…" The phalaropes should be included in this list.	Phalaropes have been added to the list of vulnerable birds.
421	68	EC	5.5 Marine Birds (Meritic and Pelagic Seabirds Paragraph)	"Seabirds such as storm-petrels, terns and gulls that spend relatively little time on the water are not considered to be vulnerable." "not considered to be vulnerable" should be changed to "are considered to be less vulnerable"	Edit has been made as requested.
422	69	EC	5.5 Marine Birds (Meritic and Pelagic Seabirds Paragraph)	Table 5.12 Marine Birds that Could Occur in the Vicinity of Exploration License 1105 and off Western Newfoundland Purple Sandpiper and Red Knot should be added to the list of shorebirds. Loons and grebes are mentioned above, but not in this list. The area for which this list applies should be better defined.	Purple Sandpiper, Red Knot, and Common Loon have been added to the list of shorebirds. Based on available species distribution maps, grebes are unlikely to be present in the vicinity of Exploration License 1105 or off Western Newfoundland. Table 5.12 has been modified to reference Figure 6.1 for information on the spatial area to which the list applies.
423	70	EC	5.5.1.1 Seabirds	*The figures (5.49 to 5.56) require refinement. Data for the 'Gulf' (versus 'Vicinity of EL1105') include a broad combination of sites, including sites near colonies and other physical features that contribute to concentrating marine bird densities at sea. This would tend to bias figures in a way that overestimates abundance measures for 'Gulf', underemphasizing the relative value of 'Vicinity of 1105'. Use of averages is also problematic given the distribution of count data. Maps would serve far better to contrast the relative importance of 'Vicinity of EL 1105' within the Gulf and beyond, across species. This suite of figures uses only Programme intégré pour le recherche des oiseaux pélagiques (PIROP) data, but should include significant amounts of newer Environment Canada's Eastern Canadian Seabirds at Sea (ECSAS) data for the Gulf.* *Fifield et al. 2009, cited as the source of estimates of avian density of the area, includes only Gulf of St. Lawrence data from the Cabot Strait, north to Belle-Isle Strait. As such, densities presented in table 5.13 are derived from observations in the eastern Gulf only and may not well represent the rest of the Gulf. Additional data for much of the Gulf, within ECSAS, are now available through EC-CWS. It should also be noted that the database can be queried across spatial scales.*	ECSAS and PIROP data have been obtained for the Gulf region from CWS and integrated into maps. Separate figures have been prepared for common species as well as for guilds / taxonomic groups to convey the relative distribution and abundance of seabirds. Maps have also been produced to convey information on the seasonal and temporal variability of ECSAS and PIROP data collection.
424	71	EC	5.5.1.1 Seabirds	Figure 5.49 Monthly Seabird Abundance of Black-legged Kittiwake in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105 Vicinity should be defined, so as to know what distance from EL 1105 data were included. Y-axis - Count data are not normally distributed. Also, many seabird species have a patchy distribution. These factors make the use of averages problematic. Use of maxima is more informative. X-axis - Breeding season months should be shown. Birds may be absent from areas where ship-based surveys occur, but be present at colonies and their seaward extensions (foraging range from colonies) during the breeding season.	ECSAS and PIROP data have been obtained for the Gulf region from CWS and integrated into maps to convey information on the relative distribution and abundance of seabirds. Maps have also been produced to convey information on the seasonal and temporal variability of ECSAS and PIROP data collection.

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425	72	EC	5.5.1.1 Seabirds	Black-legged Kittiwake breed in the Gulf of St. Lawrence; the breeding season should be considered across species. For example, how might breeding behaviour affect patterns of distribution and abundance at sea? How might congregation of individuals at breeding colonies affect their relative vulnerability?	Information on the breeding season for species in the Gulf is integrated throughout the document. For example, text associated with Figure 5.12 discusses how the abundance of Black-legged Kittiwakes observed at sea (as obtained from ship-based surveys) varies with regards proximity to major colonies. Furthermore, additional baseline information on the congregation of individuals at breeding colonies is provided in Section 5.5.1.1 (Seabird Colinies), with a discussion on the exposure of these sites to Project activities being provided in Section 7.
426	73	EC	5.5.1.1 Seabirds	It should be noted that this table shows abundance as detected during offshore ship-based surveys only, as opposed to additional consideration of colony counts for breeding species.	The preamble to Figures 5.1 to 5.16 states the ECSAS and PIROP data plotted on the maps has been obtained from ship-based surveys. Additional information on colony counts is provided in Section 5.5.1.3 (Seabird Colonies) for the coastal portions of the Gulf that are in closest proximity to EL 1105 (i.e., Magdalen Islands, western Newfoundland, southern Newfoundland, Cape Breton Island, and the southern Portion of Anticosti Island.
427	74	EC	5.5.1.1 Seabirds	Figure 5.50 Monthly Seabird Abundance of Large Auks in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105 Large auks breed in the Gulf of St. Lawrence.	Section 5.5.1.1 and 5.5.1.3 acknowledge the presence of breeding auks in the Gulf.
428	75	EC	5.5.1.1 Seabirds	Figure 5.51 Monthly Seabird Abundance of Northern Fulmars in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105 Northern Fulmar do not breed in the Gulf of St. Lawrence in significant numbers.	Text has been added to acknowledge Northern Fulmar do not breed in the Gulf of St. Lawrence in significant numbers.
429	76	EC	5.5.1.1 Seabirds	Figure 5.5.2 Monthly Seabird Abundance of Greater Shearwater in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105 Great Shearwater are not known to breed in the Northern Hemisphere.	Section 5.5.1.1 states that Great Shearwater breed in the South Atlantic Ocean.
430	77	EC	5.5.1.1 Seabirds	*Figure 5.53 Monthly Seabird Abundance of Dovekie in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105* *Dovekie do not breed in Canada in significant numbers.*	Text has been added to acknowledge Dovekies do not breed in Canada in significant numbers.
431	78	EC	5.5.1.1 Seabirds	Figure 5.54 Monthly Seabird Abundance of Storm-Petrels in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105 Leach's Storm-Petrel do breed in the Gulf of St. Lawrence, but Wilson's Storm-Petrel do not breed in the Northern Hemisphere. Both species are confounded in this figure.	Text has been added to differentiate between Leach's Storm-Petrel which breeds in the Gulf of St. Lawrence and Wilson's Storm-Petrel which breeds in the southern hemisphere.
432	79	EC	5.5.1.1 Seabirds	Figure 5.55 Monthly Seabird Abundance of Northern Gannets in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105 It should be noted that 69% of entire North American population of Northern Gannet occurs in and/or is associated with three colony locations within Gulf of St. Lawrence. See http://bna.birds.cornell.edu/bna/species/693/articles/demography for further details.	Text has been added to reference the occurrence of approximately 69% of the total North American population in the Gulf of St. Lawrence.
433	80	EC	5.5.1.1 Seabirds	Figure 5.56 Monthly Abundance of Total Seabirds in the Gulf of St. Lawrence and in the Vicinity of Exploration License 1105 This figure suggests a total, but it should be specified that this applies only to linear densities quantified using offshore ship-based surveys, as opposed to consideration of birds at colonies or using migratory corridors potentially segregated from at-sea survey data.	Previous figures have been replaced with Figures 5.1 to 5.16 to convey information on the relative abundance and distribution of seabird, as observed during ship-based surveys (i.e., ECSAS and PIROP). Additional information on colony counts is provided in Section 5.5.1.3 (Seabird Colonies) for the coastal portions of the Gulf that are in closest proximity to EL 1105 (i.e., Magdalen Islands, western Newfoundland, southern Newfoundland, Cape Breton Island, and the southern Portion of Anticosti Island.
434	81	EC	5.5.1.1 Seabirds (page 206; Black-legged Kittiwakes)	"Black-legged Kittiwakes are the most abundant species" This should be changed to "Black-legged Kittiwake is the most abundant species"	Text has been adjusted.

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435	82	EC	5.5.1.1 Seabirds (page 206; Black-legged Kittiwakes)	"Black-legged Kittiwake abundance decreases" It should be stated if this is absolute or relative abundance.	The discussion on Black-legged Kittiwake abundance and distribution has been re-written to reflect the PIROP and ECSAS data recently obtained from the CWS.
436	83	EC	5.5.1.1 Seabirds (page 206; Auks)	"From March through May, the large auks are the most abundant seabird species in the Gulf. Large auk abundance peaks in April then decreases until September, when very few large auks are present." Numbers of auks for the Gulf of St. Lawrence may still be high in the fall, as birds may congregate at colonies.	Discussion on the abundance and distribution of large auks has been re-written to reflect the PIROP and ECSAS data recently obtained from the CWS.
437	84	EC	5.5.1.1 Seabirds (page 206; Northern Fulmar)	"In June, Northern Fulmar is the most abundant pelagic seabird in the Gulf." This may suggest that the area is of particular importance to this species, as Northern Fulmar is not known to nest in significant numbers anywhere in the Gulf of St. Lawrence or Newfoundland and Labrador. Large North American colonies are located in the Arctic.	Discussion on the abundance and distribution of Northern Fulmar has been re-written to reflect the PIROP and ECSAS data recently obtained from the CWS. Text has been edited to acknowledge that Northern Fulmar does not nest in significant numbers in the Gulf of St. Lawrence and that large colonies are located in the Arctic.
438	85	EC	5.5.1.1 Seabirds (page 206; Great Shearwater)	"Greater Shearwater are the most abundant pelagic…" This should be changed to "Great Shearwater is". Throughout this paragraph there is a confusing use of plural versus singular species names, and associated verb conjugations.	Discussion on the abundance and distribution of shearwaters has been re-written to reflect the PIROP and ECSAS data recently obtained from the CWS. Edits have been made to improve the use of verb conjugations.
439	86	EC	5.5.1.1 Seabirds (page 206; Dovekie)	It should be noted that the vast majority of Dovekie do not breed in Canada	Text has been added to acknowledge Dovekies do not breed in Canada in significant numbers.
440	87	EC	5.5.1.1 Seabirds (page 206; Leach's Storm-Petrel and Wilson's Storm-Petrel)	Given the concentration of Leach's Storm-Petrel at breeding colonies, some treatment of the relative abundance of Wilson's Storm-Petrel seems warranted.	The discussion on storm-petrel abundance and distribution has been re-written to reflect the PIROP and ECSAS data recently obtained from the CWS and includes a treatment of the relative abundance of these two species.
441	88	EC	5.5.1.1 Seabirds (page 206; Northern Gannet)	It should be noted that small numbers of Northern Gannet are detected during Christmas Bird Counts into December. The comment concerning densities is only accurate in the case of birds detected during offshore ship-based surveys. Total numbers for the Gulf essentially should be stable and increase as young of the year are added to the total population at sea, following departure from colonies. It is unclear whether or not the density numbers have been calculated from colony counts. Note also that small numbers of Northern Gannets are present into December, rather than until December.	Discussion on the abundance and and distribution of Northern Gannets in Section 5.5.1.1 has been re-written to reflect the PIROP and ECSAS data recently obtained from the CWS. Additional information on colony counts is provided in Section 5.5.1.3 (Seabird Colonies) for the coastal portions of the Gulf that are in closest proximity to EL 1105 (i.e., Magdalen Islands, western Newfoundland, southern Newfoundland, Cape Breton Island, and the southern Portion of Anticosti Island. Text has been modified to reflect the presence of small numbers of Northern Gannets in the Gulf into December, as evidenced by Christmas Bird Count surveys.
442	89	EC	5.5.1.1 Seabirds (page 206; Seasonal Abundance)	*The effort map from Fifield et al. 2009 (Figure 5) would be appropriate to show here. "Seasonal distributions" should be "seasonal distribution". The reference of summary of data by seabird group is presented as being in Table 5.12, but is actually in Table 5.13.*	ECSAS and PIROP data have been obtained for the Gulf region from CWS and integrated into maps. Separate figures have been prepared for common species as well as for guilds / taxonomic groups to convey the relative distribution and abundance of seabirds. Maps have also been produced to convey information on the seasonal and temporal variability of ECSAS and PIROP survey effort. Fifield et al. (2009) survey data for the Gulf is encompassed in the ECSAS database.
443	90	EC	5.5.1.1 Seabirds (page 207; Seasonal Abundance)	*"Seabird abundance in the Gulf was highest in the fall (September and October)"* *This statement should only concern the far eastern and north-eastern Gulf of St. Lawrence; densities for the remainder of the Gulf should not be inferred from these data. A clear caveat should be presented for this section.*	Data from Fifield et al. (2009) are no longer present in table format but maps have been produced to convey information on the seasonal and temporal variability of ECSAS survey effort (which contains those observations used in the Fifield ate al. (2009) report). Fifield et al. (2009) continues to be referenced for comparing seabird densities in the eastern portion of the Gulf and other parts of the Atlantic. The spatial extent of the data presented by Fifield et al. (2009) is clearly outline in Section 5.5.

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444	91	EC	5.5.1.1 Seabirds (page 207; Seasonal Abundance)	"This is likely attributable to the presence of large numbers of newly fledged young from local seabird colony sites, as well as an influx of wintering Greater Shearwater from the South Atlantic." This is possible, but there may be other plausible explanations, such as higher productivity, prey availability, migration, and others.	The statement has been modified to acknowledge other potential contributions to higher seabird abundance in the Gulf of St. Lawrence in the fall.
445	92	EC	5.5.1.1 Seabirds (page 207; Seasonal Abundance)	"Comparatively, some of the lowest seabird abundances were observed in the fall in both the Scotian Shelf-Gulf of Maine and the Newfoundland and Labrador Shelf." Given the ranges presented, it is difficult to make this statement with certainty. Acknowledgement of the variance should be included here.	The sentence has been modified to read as a general statement on comparative abundance based on the seasonal weighted median presented in Fifield et al. (2009).
446	93	EC	5.5.1.1 Seabirds (page 207; Seasonal Abundance)	"The data indicate that this is largely attributable to the fact that large numbers of Northern Gannet are not present in these areas during the fall and higher concentrations of Greater Shearwater are present in the Gulf during the fall than in either the Scotian Shelf or the Grand Banks." The relative distribution and abundance of the most abundant species would tend to drive the "all waterbirds" patterns discussed. A species-by-species treatment may be more appropriate.	Along with summarized data for all waterbirds, more specific data on the abundances of particular seabirds in the Gulf are provided in Figures 5.3 to 5.16. Separate figures have been prepared for common species as well as for guilds / taxonomic groups to convey the relative distribution and abundance of seabirds.
447	94	EC	5.5.1.1 Seabirds (page 207; Seasonal Abundance)	*Table 5.13 Seasonal Weighted Median (and range) of Densities (birds/km2) by Seabird Group in Each of the Three Ocean Regions in Atlantic Canada* *Phalaropes should be included in this table. It is also not clear where the weighted medians (and range) were obtained (i.e. Fifield et al. 2009?). Additionally, "Ocean Regions" should be referred to as Marine Biogeographic Units. See DFO 2009 for more information.*	Although no longer presented, Table 5.13 was derived from Fifield et al. 2009 (as noted below the table) and the presentation of data therein followed that source.
448	95	EC	5.5.1.1 Seabirds (page 208; Overall seabird abundance)	"Overall seabird abundance in the Gulf was lowest during the summer months (May through August)." It should be noted that this was measured offshore via ship-based surveys, without considering proportion of populations at colonies and their seaward extensions.	Text has been modified to acknowledge the limitations of the ship-based surveys to capture colonies and seaward extensions and that observations will naturally be lower in the summer due to nesting populations.
449	96	EC	5.5.1.1 Seabirds (page 208; Overall seabird abundance)	"Seabird abundance in both the Scotian Shelf-Gulf of Maine and the Newfoundland and Labrador Shelf were also relatively low in the summer months." This statement is contrary to data shown in Table 5.13 that shows measures (maxima) being greatest for 'All Waterbirds' during summer months, despite a large proportion of birds being constrained to colonies and their seaward extensions (foraging range of breeding adults). These varying statements need to be reconciled.	Text has been modified to clarify.
450	97	EC	5.5.1.1 Seabirds (page 208; ECSAS data for spring)	"The ECSAS data indicate that Northern Fulmar, Northern Gannet and murres (spp.) are the most abundant seabirds in the Gulf during the spring (March and April)." It should be noted that this data concerns the far eastern and north-eastern Gulf of St. Lawrence only.	Information on the relative seasonal distribution and abundance of seabirds has been updated based on recently obtained ECSAS and PIROP data. Although data from Fifield et al. (2009) continues to be referenced, it is no longer present in table format and the spatial extent of the data is clearly outlined in Section 5.5.
451	98	EC	5.5.1.1 Seabirds (page 208; ECSAS data for spring)	"However, Northern Gannet are not abundant in these regions, probably due to the fact that 70 percent of the Northern Gannet in Canadian waters nest in the Gulf." It should be noted that 69% of the total North American population of this species is associated with colonies located within the Gulf.	Text has been corrected to reference the Chardine (2000) estimate of 69% of the North American population of Northern Gannet associated with colonies in the Gulf.
452	99	EC	5.5.1.1 Seabirds (page 208; ECSAS data for summer)	"The ECSAS data indicate that murres (spp.), Northern Fulmar and Northern Gannet are the most abundant seabirds in the Gulf during the summer months" This should be further specified that these are the most abundant seabirds "observed at sea".	Text has been modified to clarify that ECSAS and PIROP data reflect ship-based "at sea" observations, and not colony counts.
453	100	EC	5.5.1.1 Seabirds (page 209; ECSAS data for fall)	There is no mention of winter distribution; potential effects of ice extent and occurrence of ice-associated species would be appropriate.	The discussion of relative seabird abundance and distribution during the winter months has been modied to reflect the ECSAS and PIROP data, which have been recently obtained from CWS.

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454	101	EC	5.5.1.1 Seabirds (page 209; ECSAS data for fall)	“It should be noted that large gulls are not one of the seabird guilds presented in the PIROP data.” Herring Gull, Great Black-backed Gull, Iceland Gull, and Glaucous Gull data for the Gulf of St. Lawrence all are available within PIROP.	Data on the relative abundance and distribution of gulls has been obtained from the ECSAS and PIROP databases and integrated into Figure 5.15, along with accompanying text.
455	102	EC	5.5.1.1 Seabirds (page 209; ECSAS data for fall)	*“The seasonal abundance patterns for the two data sets are similar but not identical.”* *It is not clear which data sets are being referred to.*	The previous statement had referred to the PIROP and ECSAS datasets. ECSAS data was derived from Fifield et al. (2009) but is no longer presented.
456	103	EC	5.5.1.1 Seabirds (page 209; ECSAS data for fall)	“It is not possible to determine with certainty whether the differences between the two data sets are attributable to changes in the relative abundance of seabird species or are attributable to differences in the way the data were collected or processed.” It is possible to query and merge PIROP and ECSAS datasets to generate data that can be mapped to illustrate relative distribution and abundance for the Gulf. Survey effort also can be mapped (spatially and temporally), and further considered. EC-CWS should be contacted for assistance with accessing the relevant data from these databases.	ECSAS and PIROP data have been obtained for the Gulf region from CWS and integrated into maps to convey information on the seasonal and temporal distribution and abundance of seabirds, as well as survey effort.
457	104	EC	5.5.1.2 Coastal Waterfowl	Maps should be presented to illustrate relative abundance and distribution. As contrasts were made with adjacent Marine Biogeographic Units for seabirds, the same could be done here to show the relative importance of sites within Atlantic Canada.	ECSAS and PIROP data have been obtained for the Gulf region from CWS and integrated into maps to convey information on the relative abundance and distribution of seabirds.
458	105	EC	5.5.1.2 Coastal Waterfowl	“Other areas with relatively high concentrations of eider breeding pairs include the eastern tip of the Gaspé Peninsula, the New Brunswick coast and the portion of the North Shore of Québec extending from the Mingan Archipelago to Sept-Îles.” It should be noted that there are large colonies of eider in the St. Lawrence estuary. Maps with locations of these colonies can be found in the Quebec Management Plan for the Common Eider Somateria mollissima dresseri (The Joint Working Group on the Management of the Common Eider 2004). Discussion of eider colonies should extend to these colonies as well. It should additionally be noted that there are large eider colonies in western Newfoundland; EC-CWS should be contacted for further information on the Newfoundland and Labrador eider colonies.	Text has been modified to refer to the presence of large eider colonies in the St. Lawrence Estuary. Section 5.5.1.2 acknowledges the presence of eider colonies along western Newfoundland, based on available information. EC-CWS has been contacted for further information on eider colonies in Newfoundland and Labrador but this information has not yet been received.
459	106	EC	5.5.1.2 Coastal Waterfowl	*“In general, during the winter months, large concentrations of coastal waterfowl can occur along the North Shore of Québec between Sept-Îles and the Mingan Archipelago, along the shores of Anticosti Island and along the eastern tip of the Gaspé Peninsula.”* *During the summer, very large numbers of eider can be found moulting along the southern shore of Anticosti Island and the North Shore of Québec (Rail and Savard 2003; EC-CWS Unpublished data). About 12,000 eiders have been observed wintering offshore of the Magdelan Islands (mostly close to île Brion and Rochers-aux-Oiseaux) (EC-CWS Unpublished data). Numerous scoters can also be found during the spring (migration) and summer (moulting period) on the North Shore of Québec between Sept-Îles and Natashquan (Rail and Savard 2003). Please contact EC-CWS for access to the aforementioned unpublished data concerning eiders.*	Information provided on eider and scoter distribution and abundance has been integrated into the discussion of seasonal patterns of coastal waterfowl. Access to unpublished data concerning eiders has been requested from EC-CWS but has not yet been made available.
460	107	EC	5.5.1.2 Coastal Waterfowl	It is stated that there are relatively high concentrations of eider breeding pairs found in New Brunswick. These high concentrations are likely referring to birds nesting on the Fundy coast of New Brunswick; it should be noted that there are relatively low concentrations of eider breeding pairs found on the Northumberland coast of New Brunswick, which is the coast that is affected by this project.	Data from Lock et al. (1994) indicate that relatively high amounts of breeding eiders are present in association with the Northumberland Coast of New Brunswick. For example, 1,014 breeding pairs of Common Eiders were estimated for the area between Miscou Island and Escuminac Point, and 1,949 pairs between Escuminac Point and Cape Tormentine. As such, the statement has been left intact.
461	108	EC	5.5.1.2 Coastal Waterfowl	*The environmental assessment identifies that “coastal waterfowl (all species)” use the Gulf, Estuary and the Bay du Chaleur during spring migration. Specific reference should be made to the importance of these areas to migrating Scoters (refer to the Sea Duck Joint Venture website for more information: http://seaduckjv.org/index.html)*	Text has been modified to make specific reference to the importance of the Gulf to migrating scoters.

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462	109	EC	5.5.2.1 Seabirds (Page 209)	Figures 5.49 to 5.56" Data derived from ECSAS, PIROP or both need to be presented as maps, then interpreted. Please contact EC-CWS for assistance.	ECSAS and PIROP data have been obtained for the Gulf region from CWS and integrated into maps. Separate figures have been prepared for common species as well as for guilds / taxonomic groups to convey the relative distribution and abundance of seabirds. Maps have also been produced to convey information on the seasonal and temporal variability of ECSAS and PIROP data collection.
463	110	EC	5.5.2.1 Seabirds (Page 209)	"Compiled in survey blocks" Maps are needed in this section in order to properly and intuitively interpret the data. The current presentation inadequately contrasts the value (to marine birds) of EL 1105 with other areas in the Gulf.	ECSAS and PIROP data have been obtained for the Gulf region from CWS and integrated into maps. Separate figures have been prepared for common species as well as for guilds / taxonomic groups to convey the relative distribution and abundance of seabirds. Maps have also been produced to convey information on the seasonal and temporal variability of ECSAS and PIROP data collection.
464	111	EC	5.5.2.1 Seabirds (Page 209)	"Black-legged Kittiwake and Northern Fulmar (Figures 5.49 and 5.51, respectively) are the most abundant species at this time of the year and the only pelagic seabirds recorded in the area." Dovekie is not mentioned in this section, but was mentioned in statements made previously in the document. Dovekie should be discussed here as well.	Text has been modified to reflect the ECSAS and PIROP data that have been obtained for the Gulf region from CWS, including the discussion on Dovekie.
465	112	EC	5.5.2.1 Seabirds (Page 210)	"Seabirds that breed in the Gulf would already have arrived and begun nesting." As such, abundance measures for the Gulf of St. Lawrence derived from at-sea distribution would be underestimated, given that large proportions of populations are concentrated at colonies (incubating birds) and their seaward extensions.	Text has been modified to clarify the caution that should be applied when interpreting the abundance of at-sea observations of colonial nesters during the breeding season.
466	113	EC	5.5.2.1 Seabirds (Page 210)	"Pelagic seabird abundance decreases substantially in July, as does the number of seabird species present (Figure 5.56)." Abundance decreases at sea, as measured during ship-based surveys.	Text has been modified throughout section 5.5.1.1 to clarify that PIROP and ECSAS data were obtained from ship-based surveys and are not necessarily indicative of a species abundance and distribution throughout the Gulf at all times of year.
467	114	EC	5.5.2.1 Seabirds (Page 210)	"Many seabirds are feeding nestlings in July and adults may tend to forage more frequently in areas adjacent to colony sites." Change to "Many seabirds are feeding nestlings in July and adults tend to forage more frequently in seaward extensions of colonies."	Edit has been made as suggested.
468	115	EC	5.5.2.1 Seabirds (Page 210)	"Storm-Petrels are also the most abundant pelagic seabird guild in August (Figure 5.54). Pelagic seabird abundance increases substantially in August; however, species richness remains low." It is difficult to quantify species richness when species are often (appropriately) lumped within guilds.	Comment noted. Text has been altered to not infer species richness based on guilds.
469	116	EC	5.5.2.1 Seabirds (Page 210)	"..influx of wintering Greater Shearwater and the cessation of nesting activity at seabird colonies," This should be changed to "influx of wintering Great Shearwater and the departure of adults and young from seabird colonies,"	Text has been modified to reflect the influence of the arrival of wintering species and the departure of adults and young from seabird colonies on the abundance of seabird observations made during ship-based surveys.
470	117	EC	5.5.2.1 Seabirds (Page 210)	"The Cabot Strait would provide a migration corridor for seabirds moving out of the Gulf and into the Atlantic Ocean, increasing the number of seabirds present." It should be stated as to how many potential migration corridors exist.	It is unclear as to what the reviewer is requesting with regards to "how many potential migration corridors exist", as these would be dependent on the numbers and identifies of species and / or guilds considered and the spatial scale of the inquiry. However, the text has been modified to acknowledge the potential for species which breed in more northern latitudes to be concentrated in the vicinity of the Strait of Belle Isle during their fall migration to the Gulf (i.e. in addition to the Cabot Strait being a likely migration pathway for pelagic seabirds moving to and from more southern localities).

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471	118	EC	5.5.2.1 Seabirds (Page 210)	"In addition, the level of effort in the PIROP sampling program also decreases at this time, resulting in fewer seabirds being detected." Further discussion of effort and related impacts on interpretation of data and maps would be appropriate in this section.	Additional discussion on effort and related impacts to interpretation of data has been integrated into Section 5.5.
472	119	EC	5.5.3 Long Term Trends for Nesting Seabirds (page 213)	"In each of the census periods, three species accounted for over 75 percent of the total seabird population – Northern Gannet, Black-legged Kittiwake and Common Murre." It is not clear if this refers to the breeding population, migrating population, or other. This would not include species migrating through the Gulf or wintering within the Gulf.	Surveys conducted by CWS (Cotter and Rail 2007) were performed in June and early July and therefore are best considered an estimate of breeding bird populations. The discussion provided was under the heading "Long Term Trends for Nesting Seabirds" and several references to "breeding" are made in the preamble to the statement in question to clarify that it is the breeding population that is being referred to. Note, however that this section has been removed from the EA.
473	120	EC	5.5.3 Long Term Trends for Nesting Seabirds (page 213)	Figure 5.57 Sensitive Areas Located near Exploration License 1105 This map should also include locations of important seabird colonies (Rocher aux oiseaux, Pointe de l'est, Île Bonaventure, Refuge des îles Sainte-Marie, Refuge de la baie des Loups, etc.). This map should also include locations for colonies that host important proportions of Eastern Canadian populations of certain species (e.g., Northern Gannet, Horned Grebe). Additionally, Piping Plover critical habitat should be identified on this map.	The intention of Figure 5.57 is to provide an overview of sensitive areas relative to EL 1105, and not a species-specific account of important habitat throughout the Gulf. Important Bird Areas have been presented in Figure 5.57 and encompass many important seabird colonies (including that of Northern Gannet) as well as habitat for specific Species at Risk (including Piping Plover and Horned Grebe). Table 5.18 provides more detailed information on the bird species represented in the IBA's and is cross-referenced with Figure 5.57 to facilitate interpretation. Additional information on the distribution of specific Species at Risk is provided in Section 5.2.2. Section 5.5.1.3 provides more detailed information on the locations of seabird colonies in the vicinity f EL 1105 and the types and abundances of species they support.
474	121	EC	5.7.1 Ecological and Biologically Sensitive Areas	There is no mention of the proposed National Marine Conservation Area (NMCA) around the Magdalen Islands. NMCA are under Canada's National Parks Act. Please contact M. Nelson Boisvert (Parks Canada; nelson.boisvert@pc.gc.ca; 418-649-8213) to obtain more information on this proposed protected area (e.g. maps).	The proposed NMCA around the Magdalen Islands has been referenced. There is no predicted Project interaction with this NMCA.
475	122	EC	5.7.1 Ecological and Biologically Sensitive Areas	There are many provincial wildlife habitats (designated under the Conservation et mise en valeur de la faune act) on the Magdalen Islands, some of which are included in the different Important Bird Areas (IBA), National Wildlife Areas (NWA), or Migratory Bird Sanctuaries (MBS): • Aire de concentration d'oiseaux aquatiques de l'Île de l'Est. • Refuge faunique de la Pointe-de-l'Est. • Colonie d'oiseaux sur une île ou une presqu'île de l'étang de l'Est # 2,# 3. • Colonie d'oiseaux sur une île ou une presqu'île de l'Île Shag (Havre-aux-Maisons). • Colonie d'oiseaux sur une île ou une presqu'île de l'Île Rouge, Havre-Aux-Maisons. • Colonie d'oiseaux en falaise de l'Île aux Goélands, Étang-du-Nord. • Aire de concentration d'oiseaux aquatiques de la Plage de l'ouest #2 20-12-04. • Aire de concentration d'oiseaux aquatiques de la Plage de l'Ouest # 1 20-12-03. • Colonie d'oiseaux en falaise du Sud du Havre-Aux-Basques # 3-Colonie 2D. • Colonie d'oiseaux sur une île ou une presqu'île du Sud du Havre-Aux-Basques # 1,# 2. Please contact the Ministère des Ressources naturelles et de la Faune du Québec for more information (e.g. georeferenced maps) : services.clientele@mrnf.gouv.qc.ca	Text has been modified to acknowledge the presence of provincial wildlife habitats on the Magdalen Islands.
476	123	EC	5.7.3 Vulnerable Seabird Nesting Sites	"Lock et al. (1994) list 136 known colonies of vulnerable seabirds in the Gulf. Seabird colonies are patchily distributed around the Gulf." These could be presented as a list, though such a list would not address the 'continuum' of vulnerability across species. Lock et al. 1994 is in large part out of date; EC-CWS has more up-to-date information and should be contacted to provide as required.	A map and table has been added to Section 5.5.1.3 to show the locations of known seabird breeding sites in the portion of the Gulf surrounding EL 1105, and to provide more detailed information on the types and abundances of species which are supported at each of these locations. The information that is provided is based on the most recent survey data available.

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477	124	EC	5.7.3 Vulnerable Seabird Nesting Sites	"There are only six colonies along the western shore of Newfoundland." This statement requires a reference, as it is unclear if the source is Lock et al. 1994.	The statement was based on Lock et al. (1994) but has been revised to reflect more recent colony data obtained from the CWS (i.e., the Atlantic Canada Colonial Waterbird database)
478	125	EC	5.7.3 Vulnerable Seabird Nesting Sites	"Four of the six colonies are found at the mouth of the Humber River. The lack of seabird colonies on the west coast of Newfoundland is attributable to a general lack of suitable nesting sites and the relatively low productivity of the waters along this coast. Seabird species breeding in these colonies include Black-legged Kittiwake, Great Cormorant, Double-crested Cormorant and Black Guillemots, with Black-legged Kittiwake the most abundant species." The wording should be revised to emphasize that it is seabirds vulnerable to oil pollution which are being discussed; there are numerous additional seabird colonies along the southwest coast of Newfoundland and Labrador, namely those of Herring Gull, Great Black-backed Gull and Ring- billed Gull, which should also be mentioned.	Text has been revised to reflect more recent information within the Atlantic Canada Colonial Waterbird database (obtained from the CWS) which includes gull colonies.
479	126	EC	5.7.3 Vulnerable Seabird Nesting Sites	"The southern portion of the Gulf is not an important area for nesting vulnerable seabirds. Only 13 colonies of vulnerable seabirds are found along the portion of the Gulf that borders Nova Scotia. Fourteen colonies are present in Prince Edward Island and five colonies are present in New Brunswick. All of these colonies are occupied primarily by Double-crested Cormorants and Great Cormorants. The paucity of seabird colonies in the southeastern part of the Gulf is believed to be attributable to oceanographic conditions rather than a lack of suitable nesting habitat." This paragraph should be revised to properly reflect the high importance of this area for breeding seabirds, especially the Great Cormorant. The North American breeding and wintering range for this species is centered in the eastern part of the Gulf (e.g., Magdalen Islands, southwest Newfoundland, Prince Edward Island) with the largest concentrations occurring on Cape Breton Island (see "Birds of North America"), including the largest North American colony located in IBA NS001 (this IBA also hosts various breeding alcids, kittiwakes, and Leach's Storm-Petrel, and should be included in the list of IBAs below). If an oil spill occurred at the proposed study site, it would likely have a significant impact on the North American Great Cormorant population.	The paragraph has been revised to reflect the high importance of the Gulf for breeding Great Cormorants. Table 5.18 has been updated to include the Bird Islands IBA (although it is outside of the Gulf), and other IBAs located in the vicinity of the Gulf which support marine birds. Figure 5.57 has been updated to accommodate additional IBAs.
480	127	EC	5.7.3 Vulnerable Seabird Nesting Sites	The text should be changed to best to present both (1) number of colonies and (2) estimated breeding pairs for a region; i.e. stating "only 13 colonies" can be unintentionally misleading and can downplay the importance of an individual colony, as some colonies can host several thousand breeding pairs. Recent data exists which has been collected by EC-CWS (and summarized in reports), which show that seabird populations have increased in the Maritime portion of the Gulf, particularly in New Brunswick, which now also hosts Black-legged Kittiwake colonies. Cape Breton also hosts important Great Black-backed and Herring Gull populations. Please contact EC-CWS for this information.	A map and table has been added to Section 5.5.1.3 to show the locations of known seabird breeding sites in the portion of the Gulf surrounding EL 1105, and to provide more detailed information on the types and abundances of species which are supported at each of these locations. Additionally, text has been modified to include information on the number of seabirds in colonies along the western coast of Newfoundland (i.e., the portion of the Gulf which has potential to be affected by the Project).
481	128	EC	5.7.3 Vulnerable Seabird Nesting Sites	"Refuge des Isle Ste-Marie" This should be Refuge des îles Ste-Marie.	Text has been corrected.
482	129	EC	5.7.3 Vulnerable Seabird Nesting Sites	"…each of which supports more than 10,000 pairs of seabirds." Other sites (including groupings of neighbouring islands) that have hosted and potentially could host 10,000 pairs of seabirds include: Île du Corossol, Archipel Mingan, Refuge de la Baie des loups, and Refuge de la Baie de Brador. Other St. Lawrence estuary sites include: Île Blanche, Île Bicquette, Île aux Pommes, Battures aux Loups-Marins, Québec. Tabusintac, in New Brunswick, has hosted and potentially could host 10,000 pairs.	Text has been updated to acknowledge the locations of other areas known to support large congregations of seabirds along the Quebec coastline.
483	130	EC	5.7.3 Vulnerable Seabird Nesting Sites	"Each of these IBAs lies more than 75 km away from the Project." The size of the IBAs (Important Bird Areas) should be noted.	The size of each of the IBAs has been incorporated into Table 5.18.

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484	131	EC	5.7.3 Vulnerable Seabird Nesting Sites	"A number of Piping Plover habitat locations, though not designated as IBAs, were also identified on the coast of Newfoundland (Stephenville Crossing, Sandy Point, Flat Pay Peninsula, Searston, Little Codroy, East of Windsor Point, J.T. Cheeseman Provincial Park, Jerret Point-Windsor Point, Big Barrachois, Second) (LGL 2007)." There is a Piping Plover breeding beach on the Magdalen Islands that should be added to this paragraph. Additionally, the overall Gulf of St. Lawrence population of Piping Plover as a proportion of the Canadian population should be noted. These areas should be added to Figure 5.57.	Text has been modified to acknowledge the presence of critical habitat for Piping Plover on the Magdalen Islands. Although the intent of Figure 5.57 is to provide an overview of sensitive areas relative to EL 1105, and not a species-specific account of important habitat throughout the Gulf, many of the Important Bird Areas presented in Figure 5.57 are known to provide habitat for Piping Plover (see Table 5.18). Additional information on the eastern population of Piping Plover is provided in Section 5.2.2.3.
485	132	EC	5.7.3 Vulnerable Seabird Nesting Sites	"The nearest vulnerable seabird colony to EL 1105 is the large seabird colony on Rocher aux Oiseaux" Perhaps reword as 'colony of vulnerable seabirds'. It is unclear if the intended meaning is that the colony itself is vulnerable. If the colony itself is vulnerable, it should be explained why other Magdalen Island colonies would not also be vulnerable. The following text should be corrected accordingly.	Text has been modified to clarify that it is the colony of "vulnerable" species that is being referred to, rather than being the colony itself which is vulnerable.
486	133	EC	5.7.3 Vulnerable Seabird Nesting Sites	There are many other seabird colonies on Magdalen Islands. See Chapdelaine and Rail (2004), or contact EC-CWS for a list of Magdalen Island seabird colonies. Data can also be extracted from the Banque informatisée des oiseaux de mer du Québec (BIOMQ). See also Fradette (1992) and Mousseau et al. (1976) for more information on the subject.	A map and table has been added to Section 5.5.1.3 to show the locations of known seabird breeding sites in the portion of the Gulf surrounding EL 1105 (including the Magdalen Islands), and to provide more detailed information on the types and abundances of species which are supported at each of these locations. Data from the *Banque informatisée des oiseaux de mer du Québec* has been obtained from CWS and along with information provided in *Colonial and sea birds of the Magdalen Islands* (Rail 2009) has been used to summarize seabird colony information for Quebec. Information on the location and of seabird colonies along the coasts of the Atlantic provinces has been obtained from CWS's *Atlantic Canada Colonial Waterbird database* .
487	134	EC	5.7.3 Vulnerable Seabird Nesting Sites	Table 5.18 Important Bird Areas for Marine Birds An additional IBA site for Nova Scotia is NS055, located at the same latitude as NS057 but on the other side of the peninsula; this site is important for Great Cormorants.	Although outside the Gulf, NS055 has been added to Table 5.18.
488	135	EC	5.7.3 Vulnerable Seabird Nesting Sites	Table 7.1 Routine Project Activity Interactions with Valued Ecosystem Components Direct and indirect effects of light attraction on marine fauna (e.g., migratory birds, fish) should be added to this table.	Effects of light attraction on marine fauna are captured under the "Support vessels (supply boat and helicopter)" item of Table 7.1 and discussed in Section 7.1.4.
489	136	EC	5.8.2.5 Bird Hunting	Summaries of the Regulations for Migratory Game Bird Hunting season dates, bag and possession limits are set by the Federal government, and while proposals for hunting of migratory game birds may be published in the Newfoundland and Labrador Hunting Guide, these should be accessed via the Environment Canada website, as the information contained in the Guide may not be accurate (not available at the time of publications of the guide). The link to these regulations is as follows: http://www.ec.gc.ca/rcom-mbhr/default.asp?lang=En&n=8FAC341C-1	Text updated to include corrected information regarding Migratory Game Bird Hunting.
490	137	EC	5.8.2.5 Bird Hunting	It should be specified that "There is no open season for Harlequin Ducks in Atlantic Canada or in Quebec", as such seasons do exist elsewhere in Canada.	Text updated to specify that there is no open season for Harlequin Ducks in Atlantic Canada or Quebec.
491	138	EC	7.1.1 Presence of the Drill Platform	"Tasker et al. (1986) observed that bird density (birds/km2) was seven times greater within a 500-m radius of a platform than in the surrounding area." Higher densities around platforms can be the result of direct (light attraction) and indirect (reef effect or light attraction of prey) effects. Hence, such a finding is not surprising.	Comment Noted.
492	139	EC	7.1.1 Presence of the Drill Platform	"During exploration drilling, vessel traffic and the drill rig may affect seabirds by attracting them to lighting." Migrating landbirds are also sometimes attracted to lighting (e.g. Blackpoll Warbler).	Text updated to include migrating birds are attracted to drill rig lighting.
493	140	EC	7.1.1 Presence of the Drill Platform	"Seabirds primarily navigate by sight, and lights can be an eye-catching visual cue (Wiese et al. 2001)." Procellariiform seabirds also use olfactory cues to navigate (Nevitt and Bonadonna 2005). For example, dimethyl sulfide is known as an attractant.	Text has been updated to acknowledge potential attraction from olfactory cues.

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494	141	EC	7.1.1 Presence of the Drill Platform	"However, 52 Leach's storm petrels were recovered and released with no mortality observed during monitoring on board a Terra Nova vessel over a three-week period during the summer of 1998 (Husky Oil 2000)." Given certain environmental conditions (e.g., wind speed and direction), characteristics of Leach's Storm-Petrels (e.g., relatively low mass), and quantified occurrence of known predators of this species (e.g., Great Black-backed Gull) at and in the vicinity of platforms (EC-CWS unpublished data), it is likely that some unknown proportion of individuals entering into contact with the flare or otherwise negatively affected by the flare would not be recovered during monitoring. This expectation would apply more so to injured and dead birds that had fallen directly into the water. An analogous fate could be expected for migratory passerines similarly affected by flares, and/or lights (Dryson M. unpublished study). See Wiese et al. 2001 and De Groot 1996 for further information, and please contact EC-CWS for more information concerning the unpublished data and studies.	Text has been modified to acknowledge findings documented in Wiese et al. (2001) and to accommodate potential difficultly in documenting bird mortality as a result of interaction with flaring and / or lights.
495	142	EC	7.1.1 Presence of the Drill Platform	"Therefore, the effects of discharges of these fluids on marine birds (including Species at Rick) will be negligible." "Species at Rick" should be "Species at Risk."	Text has been corrected in Section 7.1.3.
496	143	EC	7.1.5.3 Biological Effects - Marine Birds (page 329)	"The lack of data regarding seabirds and seismic activity (as well as sounds associated with other offshore oil and gas activities) may be a reflection of the fact that there is little evidence that problems occur (Davis et al. 1998) or maybe as a result of the paucity of data." Dedicated studies are required to elucidate potential effects and generate relevant data.	Comment noted. Text has been modified to acknowledge the need for dedicated studies.
497	144	EC	7.2.2.1 Presence of the Drill Platform- Marine Bird Species at Risk (page 344)	"All other marine birds considered within this VEC would occur in nearshore / coastal waters of the Study Area and would therefore not interact with the presence of the drilling platform." An exception could possibly be during migratory movements over ocean expanses. Spatial patterns during migration remain poorly understood for avian Species at Risk (and most other avian species).	Text has been modified to acknowledge potential for interaction during migration.
498	145	EC	7.2.2.4 Supply Vessels – Marine Bird Species at Risk	"Helicopters servicing the Project will avoid major colonies and will fly at a minimum of 600 m above sea surface whenever possible, limiting potential for disturbance." Helicopters should also avoid nesting areas for Species at Risk.	Text has been modified to accommodate new mitigation regarding the avoidance of known Species at Risk nesting sites during helicopter activities. Note: New mitigation.
503	146	EC	7.5 Marine Birds	"The following families of marine birds occur within the Study Area and could potentially be affected: Procellariidae (fulmars and shearwaters), Hydrobaridae (storm-petrels), Sulidae (gannets), Phalaropodinae (phararopes), Laridae (gulls, terns, kittiwakes, jaegers, skuas) and Alcidae (dovekie, murres, razorbills, puffins)." Depending on project timing, migratory landbirds could also be affected.	Text has been modified to acknowledge the potential for certain migratory land birds to be affected, depending on the timing of Project activities.
504	147	EC	7.5 Marine Birds	"The zones of influence of other routine Project activities are generally limited to the Project Area." It should be noted that birds nesting at colonies on the Magdalen Islands could be expected to forage within the project area.	Text has been modified to acknowledge that seabird colonies located outside of the Project Area (e.g., in association with the Magdalen Islands) have potential to interact with Project activities if their members forage in the area or pass through during migration. Additionally, it is noted in Section 8.7.4 that birds nesting at colonies on the Magdalen Islands could forage within the Project Area and could be exposed to effects from routine Project activities.
505	148	EC	7.5 Marine Birds	"Due to a general lack of suitable nesting sites along the west coast of Newfoundland, there are only six colonies along the western shore of Newfoundland, four of which are found at the mouth of the Humber River." See comments in section 5.7.3 related to the importance of this area to breeding birds, and note that gull colonies have not been included in this tally.	Text has been revised to reflect more recent information within the Atlantic Canada Colonial Waterbird database (obtained from the CWS) which includes gull colonies.
506	149	EC	7.5.2.1 Effects Assessment – Presence of Platform	"Existing knowledge related to marine birds and lighting on the platform is provided in Section 7.1.1" Landbirds should be considered in this section.	Text has been modified in Sections 7.1.1 and 7.5.2 to acknowledge the potential for interaction with migrating land birds.

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507	150	EC	7.5.2.1 Effects Assessment – Presence of Platform	"Marine birds attracted to flares may result in mortalities, but while gas flaring produces light that may attract birds, heat and noise generated by the flare may also deter birds from the immediate area, minimizing potential effects." This point requires further investigation, and should be elaborated upon.	Text has been modified to clarify the paucity of information regarding the potential for heat and noise generated by flaring activities to deter birds.
508	151	EC	7.5.2.5 Drilling Noise / Vertical Seismic Profiles	"Exiting knowledge indicates that marine birds diving in close proximity to a loud underwater sound could be injured." "Exiting" should be "existing"	Text updated to correct the spelling mistake.
509	152	EC	7.5.3 Mitigation	"a pelagic marine bird monitoring program will be implemented according to the protocols developed by EC-CWS and Corridor will include a trained observer among their staff" This should be rephrased as "a pelagic marine bird monitoring program with EC-CWS (ECSAS) protocols will be implemented and Corridor will include trained observer(s) among their staff."	Text rephrased as suggested.
510	153	EC	7.5.3 Mitigation	"Corridor will have a Bird Handling Permit and will comply with the requirements for documenting and reporting any stranded birds (or bird mortalities) to the CWS during the 20 to 50 day drilling program." There should additionally be a requirement for training to differentiate Leach's Storm-Petrel from Wilson's Storm-Petrel, so that proper species' identification can be attained when handling storm-petrels.	Photographs will be used to differentiate between Wilson's Storm-Petrel and Leach's Storm-Petrel and will be provided to trained observers.
511	154	EC	8.7.1.2 Marine Bird Species at Risk	The Magdalen Islands Horned Grebe should be discussed here.	As outlined in Section 5.2.2.6, Horned Grebe is not expected to occur offshore in the vicinity of EL 1105 or elsewhere along the west coast of Newfoundland. Results of the oil spill modeling, as presented in Section 2.12 do not suggest that any spill would reach the Magdalen Islands. As such, Horned Grebe is not discussed in Section 8.7.1.2.
512	155	EC	8.7.1.2 Marine Bird Species at Risk	"and survival (Vangilder and Peterle 1980; Trivelpiece et al. 1984)" It should be noted that reduced survival is of adults as well as offspring.	Text has been modified to recognize reduced survival of adults as well as offspring.
513	156	EC	8.7.1.2 Marine Bird Species at Risk	"Although oil spills at sea have the potential to kill tens of thousands of seabirds (Clark 1984; Piatt et al. 1990), some studies suggest that even very large spills may not have long-term effects on seabird populations (Clark 1984; Wiens 1995)." The veracity of this statement depends on how 'populations' are defined, especially for Species at Risk.	Comment noted. Text has been modified to accommodate.
517	157	EC	8.7.1.2 Marine Bird Species at Risk	"Piping plover are known to breed in western Newfoundland." Piping Plover are also known to breed in the Magdalen Islands, and elsewhere in the Gulf of St. Lawrence.	Text has been modified to acknowledge breeding in the Magdalen Islands and elsewhere in the Gulf of St. Lawrence.
518	158	EC	8.7.1.2 Marine Bird Species at Risk	Harlequin Duck would be present (if at all) in very low densities along the west coast of Newfoundland. Cape St. Mary's would represent the largest wintering area in Newfoundland for the eastern population, but should not be affected by a localized spill of diesel fuel. See Souliere and Thomas 2009 for further details and maps concerning Harlequin Duck occurrences.	As discussed in Section 8.7.1.2, Harlequin Ducks would be present in very low densities off western Newfoundland. More detailed information on the distribution of Harlequin Ducks is provided in Section 5.2.2.8.
519	159	EC	8.7.1.2 Marine Bird Species at Risk	The largest proportion of eastern population Barrow's Goldeneye winters in a few localized areas some distance west of the proposed drill site along the Quebec North Shore, the St. Lawrence Estuary, Anticosti Island, and the Bay du Chaleur. During the breeding season these birds are nesting on interior lakes adjacent to the Quebec North Shore, and so would not be exposed to potential oil spills. An oil spill adjacent to these primary wintering areas could have very significant implications in terms of population sustainability. This potential occurrence has been flagged as a primary concern in the "Management Plan for the Barrow's Goldeneye (Bucephala islandica), Eastern Population, in Canada" (found at http://www.sararegistry.gc.ca/document/default_e.cfm?documentID=1566). There exists a chance an oil spill could occur from any supply or other vessel using the shipping lane, however the risk is relatively small assuming the oil spill modeling for this project (Section 2.12.3) is accurate.	Comments noted. Section 8.7.1.2 discusses the low risk that potential oil spills associated with the Project have on Barrow's Goldeneye.

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520	160	EC	8.7.2 Marine Ecosystems	"Based on modeling conducted by SL Ross (2011; see Section 2.12 for summary), there will be no interaction between a spill at the wellsite and coastal ecosystems (algal, eelgrass and saltmarsh communities) (Figure 2.20). A diesel spill from a vessel accident could potentially affect the coastline and this is discussed below." Several marine bird species are strongly associated with eelgrass habitat and saltmarsh habitat. The residual (long-term) presence of hydrocarbons from a spill could directly (through oiling) and or indirectly (through effects on prey or shelter) impact marine birds in aforementioned habitats outside the immediate time frame of the accident itself.	Comment noted.
521	161	EC	8.7.2 Marine Ecosystems	"As condensate product from a surface spill would form a thin slick on the ocean surface and only disperse into the top 30 m of the water column (Section 2.12.2.4), it is unlikely that there would be an interaction between a surface spill and deep-water corals and sponges." It should be noted that this is where the highest proportion of available prey for marine birds is concentrated.	Text has been added to acknowledge that highest proportion of available prey for marine birds is concentrated in the upper zone of the water column.
522	162	EC	8.7.4 Marine Birds	"Diving species such as Black Guillemot, murre (spp.), Atlantic Puffin, Dovekie, eider (spp.), Long-tailed Duck, scoters, Red-breasted Merganser (Mergus serrator), and loons (spp.) are considered to be the most susceptible to the immediate effects of surface slicks (Leighton et al. 1985; Chardine 1995; Wiese and Ryan 1999; Irons et al. 2000)." Grebes should be included in this list.	Grebes have been added to the list of birds considered to be the most susceptible to the immediate effects of surface slicks.
523	163	EC	8.7.4 Marine Birds	"There also appears to be a strong seasonal effect, as significantly higher proportions of alcids (along with other seabird groups) are oiled in winter versus summer (Wiese and Ryan 1999)." This is necessarily a function of the location, size and importance (percentage of a population) of bird congregations (colonies, seaward extensions, migration staging areas, wintering areas).	Text has been modified to acknowledge factors (i.e., location, size, and importance of congregations) influencing oiling rates.
524	164	EC	8.7.4 Marine Birds	"Other species such as Northern Fulmar, shearwaters (spp.), storm-petrels (spp.), gulls (spp.), and terns (spp.) are vulnerable to contact with oil because they feed over wide areas and make frequent contact with the water's surface. They are also vulnerable to the disturbance and habitat damage associated with oil spill cleanup (Lock et al. 1994)." Phalaropes should be added to this list.	Phalaropes have been added to the list of birds that are vulnerable to contact with oil.
525	165	EC	8.7.4 Marine Birds	"Shorebirds may be more affected by oil spills than has been suggested by carcass counts." Phalaropes and other coastal species should be added to this list.	Text has been modified to accommodate Phalaropes.
526	166	EC	8.7.4 Marine Birds	"The west coast of Newfoundland supports six vulnerable seabird colonies, with four of the six found at the mouth of the Humber River, the waterway leading to the Port of Corner Brook." The large and important marine bird colonies in the Magdalen Islands should be mentioned here. The known or expected foraging range of species nesting at these (and other) Gulf colonies should be added as well.	Text has been updated to provide information on the potential foraging range for species associated with the Magdalen Island colonies. However, as outlined in Section 2.12, results of the oil spill modeling do not suggest that any spilled material would reach the Magdalen Islands themselves.
527	167	EC	8.7.4 Marine Birds	"A survey of an extensive area around the well after the well was capped (11 days after the blow-out) observed a total of seven oiled marine birds (three Dovekies and four murres), with no obvious oiling of gulls, kittiwakes and fulmars (Martec Ltd. 1984, in Hurley and Ellis 2004)." It is also important to report that most oiled birds are never recovered, and that oiled carcasses can disappear very quickly in the marine environment, especially in light of this study having been conducted after the well was capped, rather than during the release of the oil. See Wiese 2002, Hlady and Burger 1993, Page et al. 1990, and Ford et al. 1987 for further details.	Text has been modified to provide context in the interpretation of findings by Martec Ltd. (1984).
528	168	EC	8.7.4 Marine Birds	"Some studies have suggested that oil pollution is unlikely to have major long-term effects on bird productivity or population dynamics (Clark 1984; Butler et al. 1988; Boersma et al. 1995; Erikson 1995; Stubblefield et al. 1995; White et al. 1995; Wiens 1995, 1996; Seiser et al. 2000)." Some studies (such as Harvey et al. 1981 and Leighton 1993) do show long-term effects of oil pollution on birds (e.g., birds having ingested oil no longer contribute to the reproductive output of a species); the different aspects of this issue concerning long-term effects of oil pollution on birds should be included and discussed.	Text has been modified to acknowledge the different aspects of the long-term effects of oil pollution on birds.

Total Comment #	Agency/ Company Comment #	Government Department / Company	Section of EIS	Comment /Information Request	Response
529	169	EC	8.7.4 Marine Birds	“The west coast of Newfoundland supports six vulnerable seabird colonies, with four of the six found at the mouth of the Humber River, the waterway leading to the Port of Corner Brook. The lack of seabird colonies is attributable to a general lack of suitable nesting sites and the relatively low productivity of the waters along this coast. There are also some relatively large tern colonies present along the west coast of Newfoundland.” See comments in section 5.7.3 regarding: 1) underestimation of the number of seabird colonies (i.e. gull colonies are not accounted for here), 2) underestimating the importance of this area to seabirds by not presenting the number of breeding pairs; there are thousands of pairs of kittiwakes, gulls, cormorants and terns breeding in the southwest part of insular Newfoundland, and 3) the importance of this area to Great Cormorant, who have a restricted breeding range in North America.	Text has been modified to acknowledge the presence of gull colonies along the western shore of Newfoundland and provide information on the number of breeding pairs supported by the colonies along the western shore of Newfoundland (including cormorants), and which have potential to be affected by the Project. Although based on spill modelling results, there is no prediction interaction with coastal ecosystems if a spill were to occur at the drill site.
530	170	EC	8.7.4 Marine Birds	“… it is unlikely that an accidental spill would affect a large number of birds or that the effects would be measurable at a population level.” An exception to this statement would be the Great Cormorant.	Information on the predicted extent of accidental spills (based on the modeling results presented in Section 2.12) and data on the abundance of Great Cormorant along the western shore of Newfoundland do not indicate that an accidental spill would have a measurable effect on the North American population of Great Cormorant. For example, data from Lock et al. (1994) indicate that the western coast of Newfoundland was known to support approximately 39 Great Cormorant breeding pairs, while the same reference identifies approximately 2,540 breeding pairs in the Gulf, with many more being found outside this region. More recnt data obtained from the CWS, (i.e. from the Atlantic Canada Colonial Waterbird database) indicate that cormorants (species unidentified) are present at five of the colonies, with four of these being estimated to contain less than a hundred pairs.
531	171	EC	11.0 Follow-up and Monitoring	“Routine checks will be done for stranded birds that may have been attracted to vessel lighting.” Documentation should include photographs, following a pre-determined protocol, established with EC-CWS.	Text revised to include the commitment that a pre-determined protocol will be established with EC-CWS.
532	172	EC	11.0 Follow-up and Monitoring	“Corridor will use a Marine Mammal Observer during the drilling program.” The aforementioned seabird observer(s) should be listed here as well.	Text updated to include the seabird observer.