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4 EFFECTS ASSESSMENT METHODS

The methods used to assess potential environmental effects of the Hebron Project (the Project) are described in this Chapter.

4.1 Types of Environmental Effects

The types of effects considered in this Comprehensive Study Report (CSR) are:

- The environmental effects of the Project on the environment
- The effects of the environment on the Project
- Environmental effects are defined in Section 2(1) of the *Canadian Environmental Assessment Act* (CEAA) as:

  a) any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, its critical habitat or the residences of individuals of that species, as those terms are defined in subsection 2(1) of the Species at Risk Act,

  b) any effect of any change referred to in paragraph (a) on

  (i) health and socio-economic conditions,
  (ii) physical and cultural heritage,
  (iii) the current use of lands and resources for traditional purposes by aboriginal persons, or
  (iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, or

  c) any change to the project that may be caused by the environment, whether any such change or effect occurs within or outside Canada

The potential environmental effects of each Project phase have been evaluated for each of the selected Valued Ecosystem Components (VECs). The environmental effects analyses also include both direct and indirect effects. Cumulative environmental effects have been evaluated in accordance with CEAA and its guidance documentation (Hegmann *et al*. 1999). As required by the *Development Plan Guidelines* (C-NLOPB 2006) and CEAA, residual environmental effects, or those environmental effects remaining after the application of mitigation measures, are presented.

The analyses of the effects of the environment, particularly the physical environment, on the Project include the effects of oceanographic and climatic conditions, among other environmental factors, and the subsequent implications for Project design.

Socio-economic effects resulting from environmental effects are described herein.

4.2 Scope of the Environmental Assessment

The scope of the Hebron Project includes surveys (geophysical, geotechnical, geohazard and environmental), construction, installation, commissioning, development drilling, production, operations and maintenance and decommissioning of an offshore oil / gas production system and associated facilities.

4.2.1 Factors to be Considered

This CSR includes a consideration of the following factors, as prescribed by Section 16 of CEAA:

- Purpose of and need for the Project
- Alternatives to the Project
- Alternative means of carrying out the Project which are technically and economically feasible and the environmental effects of any such alternative means
- The environmental effects of the Project, including those due to malfunctions or accidents that may occur in connection with the Project and any cumulative environmental effects that are likely to result from the Project in combination with other projects or activities that have been or will be carried out, and the significance of these effects (the term "environmental effects" is defined in Section 2 of CEAA, and Section 137 of the *Species at Risk Act* (SARA))
- Measures, including contingency and compensation measures as appropriate, that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the Project
- The significance of adverse environmental effects following the employment of mitigative measures
- The need for, and the requirements of, any follow-up program in respect of the Project (refer to the Canadian Environmental Assessment Agency's (CEA Agency) "Operational Policy Statement" regarding Follow-up Programs (CEA Agency 2007a))
- The capacity of renewable resources that are likely to be significantly affected by the Project to meet the needs of the present and those of the future
- Report on consultations undertaken by ExxonMobil Canada Properties (EMCP) with interested parties who may be affected by the Project and comments that are received from interested parties and the general public respecting any of the matters described above

4.2.2 Scope of the Factors to be Considered

This CSR addresses the CEAA factors listed above, as well as the matters listed in the appropriate sections of the *Development Plan Guidelines* (C-NLOPB 2006), the Scoping Document (C-NLOPB 2009), and issues and concerns identified and documented by EMCP through public consultation, including consultation with regulators and key stakeholders.

With regard to the current use of land and resources by aboriginal persons, as per the definition of environmental effect, these factors were not considered in the environmental assessment. The Hebron study area and Project area have not historically been identified as those with Aboriginal use or title. There are no land claims before the Government of Canada or the Government of Newfoundland and Labrador for these areas. Based on this assessment, current use of land and resources by aboriginal persons was not considered in the CSR.

4.3 Environmental Assessment Methods

This section describes the methodological approach used in the environmental assessment and scoping for the Hebron Project. The methodological framework is based on Barnes *et al*. (2000) and guidance documents produced by the CEA Agency (1994a,b, 2007b). The following discussion provides an overview of the approach as it was applied to the Hebron Project.

4.3.1 Step 1 – Scoping Issues and Selecting Valued Ecosystem Components

To focus or "scope" an environmental assessment, it is standard practice to identify a concise list of those components of the environment that are "valued" (socially, economically, culturally and/or scientifically), and of interest when considering the potential environmental effects of a project. In this process, information from public, regulatory and stakeholder consultation is summarized and synthesized into a list of overall issues and concerns. The Scoping Document (C-NLOPB 2009) for the environmental assessment of the Hebron Project provides the scope of Project, the scope of the assessment and the factors to be considered in the assessment. It reflects the comprehensive public and regulatory consultation process and provides guidance for the scope of the environmental assessment.

The Hebron Project study team conducted public and stakeholder consultation in preparation of the CSR and Development Plan. A summary of the consultation process is provided in Chapter 5. Where those issues are related to the scope of the Project under environmental assessment, they have been addressed in this CSR. For the convenience of readers and reviewers, the location where each issue is addressed in the CSR is provided in Chapter 5.

Each VEC has been selected based on the issues that have been raised throughout the consultation process and as reflected in the Scoping Document and based on the professional experience of the study team. The selected VECs comprehensively reflect the issues, while providing a focus for the environmental assessment so that effects can be meaningfully evaluated. The VECs included in the assessment are as follows:

Air Quality

Air Quality has been selected as a VEC for the following reasons:

- Air quality has an intrinsic or natural value, in that it is needed to sustain life and maintain the health and well-being of humans, wildlife, vegetation and other biota
- If not properly managed, release of air contaminants to the atmosphere from the Project may be harmful to human health and other biological resources in the vicinity of the Project
- Greenhouse gas (GHG) emissions can accumulate in the atmosphere and are believed to be a major factor in climate change

Fish and Fish Habitat

Fish and Fish Habitat has been selected as a VEC for the following reasons:

- Provisions of the *Fisheries Act* pertaining to the harmful alteration, disruption or destruction of fish habitat require that environmental effects to fish and fish habitat be fully evaluated
- The potential for interaction with the Project
- Marine fish and fish habitat are ecologically, recreationally and commercially important

The Fish and Fish Habitat VEC includes marine fish, shellfish, benthos, plankton, water and sediment that are not considered at risk species by SARA or the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). These components are intrinsically related to one another and together they allow a holistic approach to the assessment of potential effects in the marine environment.

Marine Birds

Marine Birds have been selected as a VEC for the following reasons:

- They are abundant in the Nearshore and Offshore Study Areas
- They are sensitive to oiling
- They are protected under the *Migratory Birds Convention Act*, 1994 (migratory birds)
- As high-level predators, marine birds can play an ecologically important role in indicating the health of the marine ecosystem

The Marine Birds VEC includes species of birds that typically use the nearshore / coastal marine and offshore environments that are not considered at risk species by SARA or COSEWIC. The groups considered under the Marine Birds VEC are waterfowl (geese and ducks), cormorants, fulmars and other shearwaters, storm-petrels, gannets, phalaropes and other shorebirds, larids (jaegers, skuas, gulls, and terns) and alcids (*e.g.*, dovekie, murres, and puffins).

Marine Mammals and Sea Turtles

Marine Mammals and Sea Turtles have been selected as a VEC for the following reasons:

- Populations of marine mammals and some sea turtle species migrate to the Offshore Study Area primarily to forage for food
- The potential for interaction with Project activities
- As high-level predators, marine mammals and sea turtles play an ecologically important role by serving as indicators of changes in the marine ecosystem

The Marine Mammal and Sea Turtle VEC includes cetaceans (whales, dolphins, and porpoises), pinnipeds (seals), and sea turtles that are not considered at risk species by SARA or COSEWIC.

Species at Risk

Species at Risk (SAR) has been selected as a VEC for the following reasons:

- SAR and their habitat are legally protected under federal legislation (SARA) and/or have been assessed by COSEWIC
- Due to their nature, SAR can be more vulnerable to human-induced changes in their habitat or population levels and therefore require special consideration with respect to mitigation strategies
- Several federally-listed and/or COSEWIC-assessed marine SAR could potentially occur in the Study Areas

Commercial Fisheries

Commercial fisheries have been selected as a VEC due to its cultural and economic importance, and the potential for interactions with the Project.

Sensitive or Special Areas

Sensitive or Special Areas has been selected as a VEC primarily due to stakeholder and regulatory concerns about the vulnerability of sensitive or special areas to potential Project-related effects, including potential exposure to contaminants from operational discharges and accidental spills from the Project.

Sensitive or Special 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 of special conservation status. As per the Scoping Document (C-NLOPB 2009), Sensitive or Special Areas include:

- Important or essential habitat to support marine resources
- Areas identified through the Placentia Bay-Grand Banks Large Ocean Management Area Integrated Management Plan Initiative

In the nearshore, these Sensitive or Special Areas include capelin beaches (*e.g.*, Bellevue Beach) and eelgrass. Offshore Sensitive or Special Areas

include the Northwest Atlantic Fisheries Organization (NAFO) proposed Southeast Shoal Vulnerable Marine Ecosystem (VME) and various canyon areas and seamount and knoll VMEs. In addition, ecologically and biologically significant areas identified by Fisheries and Oceans Canada (DFO) occur within the Hebron Offshore Study Area (*i.e*., Northeast Shelf and Slope; Virgin Rocks (immediately adjacent to the Hebron Offshore Study Area); Lily Canyon-Carson Canyon and Southeast Shoal and Tail of the Banks). These areas are described in Chapter 12. The Bonavista Cod Box is located outside of the Hebron Offshore Study Area and is therefore not considered.

4.3.2 Step 2 – Establishing Boundaries

An important aspect of an environmental assessment is determining boundaries, as they help focus the scope of the assessment and allow for a meaningful analysis of potential environmental effects associated with the Project. The setting of boundaries also aids in determining the most effective use of available study resources.

4.3.2.1 Spatial Boundaries

The spatial boundaries as described below have been defined based on predicted Project-environment interactions, modelling results and a consideration of VEC-specific boundaries, as per the CEA Agency Operational Statement (2003b). In accordance with the Scoping Document, the following spatial boundaries have been used in this CSR:

Nearshore

- Project Area: The marine area within Bull Arm in which all Project activities and works are to occur. It is defined by the marine areas of the Bull Arm property boundary (see Figure 4-1 and Figure 1-1 in Chapter 1)
- Affected Area: The area which could potentially be affected by Project works or activities within or beyond the Project Area. The Affected Area boundary varies with the component being considered (*e.g*., air emissions Affected Area and the fish and fish habitat Affected Area), the nature of the VEC and the sensitivity of different species within the VEC. The Affected Areas for several Project activities have been determined by modelling (see the following Supporting Documents: Noise (JASCO 2010) Drill Cuttings Deposition and Produced Water Dispersion (AMEC 2010) and Spill Modelling (ASA 2011a, 2011b))
- Study Area: The Nearshore Study Area (see Figure 4-1) has been defined by modelling Project-environment interactions, such as accidental events, and considers all Project-environment interactions. This is the area within which significance will be determined for nearshore activities and it represents a compilation of the various nearshore Affected Areas for all Project works and activities and VECs

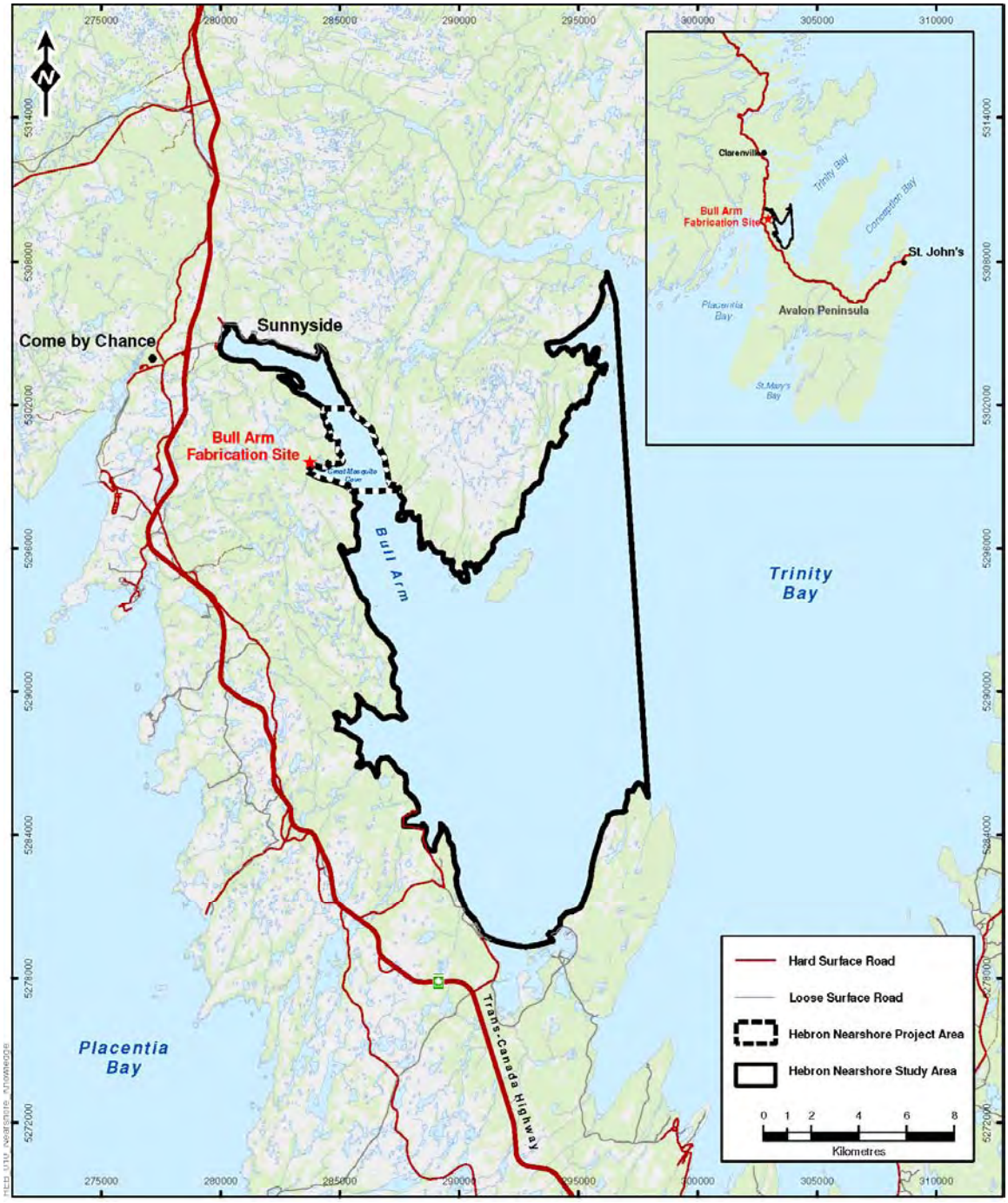

Figure 4-1 Nearshore Study and Project Areas

Offshore

- Project Area: The marine area within which all offshore Project works and activities are to occur (as defined in Chapter 2). The Offshore Project Area (see Figure 4-2 and Figure 1-2 in Chapter 1) is defined by the four Significant Discovery Licenses (SDLs) (Hebron SDL 1006, Hebron SDL 1007, Ben Nevis SDL 1009 and West Ben Nevis SDL 1010) and area required by the turning radius of seismic vessels

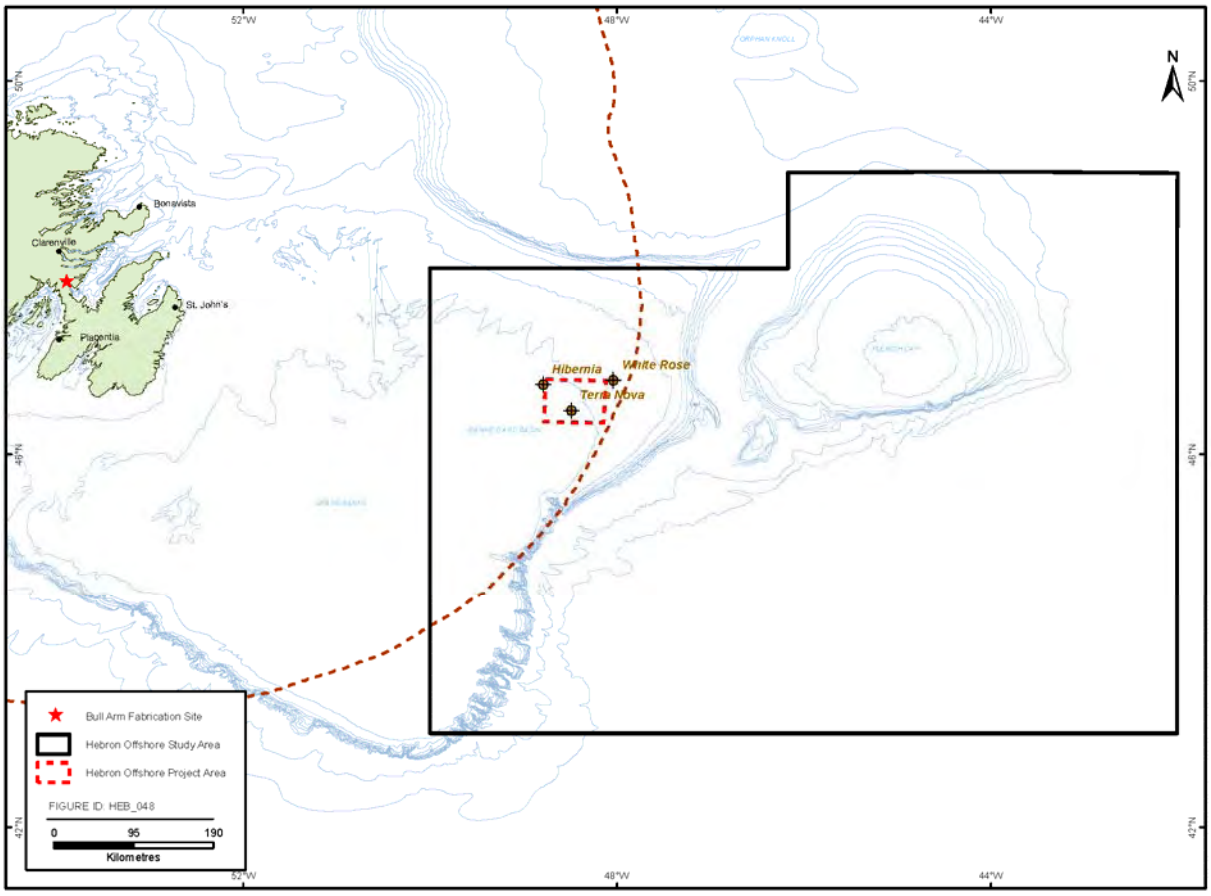

Figure 4-2 Offshore Study and Project Area

- Affected Area: The area which could potentially be affected by Project works or activities within or beyond the Project Area. The Affected Area boundary varies with the component being considered (*e.g.*, drill cutting discharges Affected Area and air emissions Affected Area), the nature of the VEC and the sensitivity of different species within the VEC. The Affected Areas for several Project activities have been determined by modelling (AMEC 2010; ASA 2011a, 2011b; JASCO 2010; Stantec 2010b)
- Study Area: The Offshore Study Area (see Figure 4-2) has been defined by modelling Project-environment interactions, such as accidental events and emissions and discharges, and considers all Project-environment interactions. This is the area within which significance will be determined for offshore activities and it represents a compilation of the various offshore Affected Areas for all Project works and activities and VECs

4.3.2.2 Temporal Boundaries

The temporal boundaries of the environmental assessment reflect the construction period, the operating life of the Project, through to decommissioning and abandonment. The scheduling of physical works and activities associated with the Project have been considered in relation to the sensitive life cycle phases of the VECs. Chapter 2 provides a description of the activities that will occur during the Project phases.

Nearshore

Early works activities (*e.g.*, re-establishment of bund wall, drydock construction, blasting / dredging) are scheduled to commence in the second quarter of 2011. The construction of the Gravity Base Structure (GBS) is scheduled to commence in the second quarter of 2012. GBS construction, Topsides fabrication and assembly, and commissioning activities will continue at Bull Arm until approximately the end of 2016.

Offshore

Construction activities may commence as early as 2013 to avail of potential synergies with other operations offshore. Site preparation / start-up, and drilling activities are scheduled to commence in 2016/17, but may commence as early as 2015. Production operations will continue through the approximate 30+ years of operational life for the Hebron field. Decommissioning and abandonment will take place at the end of production activities. Project activities, including field survey programs, may occur at any time of the year.

The potential timing of Project activities in the Offshore Project Area includes:

a) Offshore Surveys (geotechnical, geophysical, geohazard and environmental) from 2011 through the life of the Project
b) Offshore construction activities from 2013
c) Site preparation as early as 2015
d) Drilling and production beginning in 2016 or 2017 (or earlier) and continue through the life of the Project, estimated at 30 or more years. All production and drilling activities (either from the Hebron Platform or mobile offshore drilling unit (MODU)) and ancillary activities will occur year-round as required
e) Potential expansion opportunities - subsea tiebacks (excavated drill centres, subsea installation, MODU drilling, flow-line installation) may occur at any time of the year throughout Project life

The temporal scope is summarized in Table 4-1.

Table 4-1 Temporal Scope of Study Areas

Study Area	Temporal Scope
Nearshore	• Construction: 2011 to 2016, activities will occur year-round
Offshore	• Surveys (geophysical, geotechnical, geological, environmental): 2011 throughout life of Project, year-round • Construction activities: 2013 to end of Project, year-round • Site preparation / start-up / drilling as early as 2015 • Production year-round through to 2046 or longer • Potential expansion opportunities - as required, year-round through to end of Project • Decommissioning/abandonment: after approximately 2046

4.3.2.3 Administrative Boundaries

Administrative boundaries are the boundaries associated with resource management or socio-cultural boundaries (*e.g.*, NAFO Division and Unit

Areas designating fishing areas along Newfoundland and Labrador's coast and offshore area). Administrative boundaries are described for each VEC, as required.

4.3.3 Step 3 – Definition of Significance

Under CEAA, determining the significance of environmental effects is central to decision-making. Significance definitions are developed for each VEC to provide the threshold for the significance of residual adverse environmental effects. These definitions have been established using information obtained through issues scoping, available information on the status and characteristics of each VEC and the experience of study team members. Significance thresholds indicate at which point the VEC would experience environmental effects of sufficient geographic extent, magnitude, duration, frequency and/or reversibility to whereby its status or integrity is altered beyond an acceptable level even after application of the mitigation measures (each of these is described in more detail in Step 6 - Section 4.3.6).

Significance definitions for each of the VECs are provided below.

Air Quality: A significant adverse residual environmental effect is one that degrades the quality of the air such that the maximum Project-related ground-level concentration of the criteria air contaminants being assessed frequently exceeds stipulated air quality guidelines in the Nearshore or Offshore Study Area. Frequently is defined as once per week for 1-hour standards and once per month for 24-hour standards.

Fish and Fish Habitat: A significant adverse residual environmental effect is one that affects fish and/or fish habitat resulting in a decline in abundance or change in distribution of a population(s) over more than one generation within the Nearshore and/or Offshore Study Areas. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent.

For potential environmental effects on marine fish habitat, a significant adverse residual effect would be one that results in a harmful alteration, disruption or destruction of fish habitat that is so large and/or the fish and fish habitat is of such importance that it cannot be adequately compensated.

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

Marine Birds: A significant adverse residual environmental effect is one that affects marine birds by causing a decline in abundance or change in distribution of a population(s) over more than one generation within the Nearshore and/or Offshore Study Areas. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent.

Marine Mammals and Sea Turtles: A significant adverse residual environmental effect is one that affects marine mammals or sea turtles by causing a decline in abundance or change in distribution of a population(s)

over more than one generation within the Nearshore and/or Offshore Study Area. Natural recruitment may not re-establish the population(s) to its original level within several generations or avoidance of the area becomes permanent.

Species at Risk: A significant, adverse residual environmental effect is one that, after application of feasible mitigation and consideration of reasonable Project alternatives:

- Will jeopardize the achievement of self-sustaining population objectives or recovery goals
- Is not consistent with applicable allowable harm assessments
- Will result in permanent loss of SAR critical habitat as defined in a recovery plan or an action strategy
- An incidental harm permit would not likely be issued

Sensitive or Special Areas: A significant adverse residual environmental effect is one that alters the valued habitat of the identified Sensitive or Special 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.

A population as considered above in the definitions of significance for each VEC are those individuals occurring within the Study Areas.

4.3.4 Step 4 – Description of Existing Environment

A key step in an environmental assessment is the characterization of the environmental conditions within which a project will occur. In this CSR, the existing environmental conditions for each VEC are presented, focussing on the Nearshore and Offshore Study Areas. Key data sources include results from sediment quality and fish surveys conducted by Chevron in 2002 and 2003, Environmental Effects Monitoring (EEM) programs conducted on the Grand Banks, primary literature, Newfoundland and Labrador offshore oil and gas environmental assessment reports and Environment Canada and DFO databases.

4.3.5 Step 5 – Identifying Project-VEC Interactions and Environmental Effects

To conduct an environmental assessment, it is necessary to understand how a project may affect the defined VECs by both direct and indirect means. The manner in which a project may affect the VECs is a function of the linkage, or pathway, from one to the other. The environmental effects of a project are a function of its activities, while the pathways are a function of several things, including project activities, ecological systems, and contaminant properties. Environmental effects and pathways have been identified and considered using the following criteria:

- Input from experts, stakeholders, and regulators

- Experience from previous environmental assessments, in particular environmental assessments for offshore oil development projects
- Primary scientific literature
- Results from EEM programs on the Grand Banks
- Analyses of modelling studies of discharges and accidental events

This step involved identifying VEC-specific environmental effects resulting from interactions with the Project, and a description of issues and concerns regarding key interactions. A Project activity-environmental effects interaction matrix is used for each VEC, as shown in Table 4-2. The "Effect" as presented in the table is specific to each VEC; an example of an "Effect" is "Change to Habitat Quantity".

Table 4-2 Example Potential Project-Valued Ecosystem Component Interactions Matrix

Potential Project Activities, Physical Works, Discharges and Emissions	Potential Effects			
	Effect 1	Effect 2	Effect 3	Effect 4
Construction				
Nearshore Project Activities				
Presence of Safety Zones (Great Mosquito Cove Zone followed by a deepwater site Zone)				
Bund Wall Construction (*e.g.*, sheet / pile driving, infilling)				
Inwater Blasting				
Dewater Drydock / Prep Drydock Area				
Concrete Production (floating batch plant)				
Vessel Traffic (*e.g.*, supply, tug support, tow, diving support, barge, passenger ferry to/from deepwater site)				
Lighting				
Air Emissions				
Re-establish Moorings at Bull Arm deepwater site				
Dredging of Bund Wall and Possibly Sections of Tow-out Route to deepwater site (may require at-sea disposal)				
Removal of Bund Wall and Disposal (dredging / ocean disposal)				
Tow-out of GBS to Bull Arm deepwater site				
GBS Ballasting and De-ballasting (seawater only)				
Complete GBS Construction and Mate Topsides at Bull Arm deepwater site				
Hook-up and Commissioning of Topsides				
Surveys (*e.g.*, geophysical, geological, geotechnical, environmental, Remotely Operated Vehicle (ROV), diving)				
Platform Tow-out from deepwater site				
Offshore Construction / Installation				
Presence of Safety Zone				
Offshore Loading System (OLS) Installation and Testing				

Potential Project Activities, Physical Works, Discharges and Emissions	Potential Effects			
	Effect 1	Effect 2	Effect 3	Effect 4
Concrete Mattress Pads / Rock Dumping over OLS Offloading Lines				
Installation of Temporary Moorings				
Platform Tow-out/Offshore Installation				
Underbase Grouting				
Possible Offshore Solid Ballasting				
Placement of Rock Scour Protection on Seafloor around Final Platform Location				
Hookup and Commissioning of Platform				
Operation of Helicopters				
Operation of Vessels (supply, support, standby and tow vessels / barges / diving / ROVs)				
Air Emissions				
Lighting				
Potential Expansion Opportunities				
Presence of Safety Zone				
Excavated Drill Centre Dredging and Spoils Disposal				
Installation of Pipeline(s) / Flowline(s) and Testing from Excavated Drill Centre(s) to Platform, plus Concrete Mattresses, Rock Cover, or Other Flowline Insulation				
Hook-up and Commissioning of Drill Centres				
Surveys (*e.g.*, geophysical, geological, geotechnical, environmental, ROV, diving)				
Offshore Operations and Maintenance				
Presence of Safety Zone				
Presence of Structures				
Lighting				
Maintenance Activities (*e.g.*, diving, ROV)				
Air Emissions				
Flaring				
Wastewater (*e.g.*, produced water, cooling water, storage displacement water, deck drainage)				
Chemical Use/Management/Storage (*e.g.*, corrosion inhibitors, well treatment fluids)				
WBM Cuttings				
Operation of Helicopters				
Operation of Vessels (supply, support, standby and tow vessels / shuttle tankers / barges / ROVs)				
Surveys (*e.g.*, geophysical, 2D / 3D / 4D seismic, Vertical Seismic Profile (VSP), geohazard, geological, geotechnical, environmental, ROV, diving)				
Potential Expansion Opportunities				
Presence of Safety Zone				
Drilling Operations from MODU at Future Excavated Drill				

Potential Project Activities, Physical Works, Discharges and Emissions	Potential Effects			
	Effect 1	Effect 2	Effect 3	Effect 4
Centres				
Presence of Structures				
WBM and SBM Cuttings				
Chemical Use and Management (Blowout Preventer fluids, well treatment fluids, corrision inhibitors)				
Geophysical / Seismic Surveys				
Offshore Decommissioning / Abandonment				
Presence of Safety Zone				
Removal of the Hebron Platform and OLS Loading Points				
Lighting				
Plugging and Abandoning Wells				
Abandoning the OLS Pipeline				
Operation of Helicopters				
Operation of Vessels (supply, support, standby and tow vessels / ROVs)				
Surveys (*e.g.*, geophysical, geological, geotechnical, environmental, ROV, diving)				
Accidents, Malfunctions and Unplanned Events				
Bund Wall Rupture				
Nearshore Spill (at Bull Arm Site)				
Failure or Spill from OLS				
Subsea Blowout				
Crude Oil Surface Spill				
Other Spills (fuel, chemicals, drilling muds or waste materials / debris from the drilling unit, GBS, Hebron Platform)				
Marine Vessel Incident (*i.e.*, fuel spills)				
Collisions (involving Hebron Platform, vessel, and/or iceberg)				
Cumulative Environmental Effects				
Hibernia Oil Development and Hibernia Southern Extension (HSE) (drilling and production)				
Terra Nova Development (production)				
White Rose Oilfield Development and Expansions (drilling and production)				
Offshore Exploration Drilling Activity				
Offshore Exploration Seismic Activity				
Marine Transportation (nearshore and offshore)				
Commercial Fisheries (nearshore and offshore)				

Notes:

- The “Hook-up and Commissioning of Topsides” activity may result in discharges to the environment
- The “Geophysical / Seismic Surveys” may include the use of 2D, 3D, and/or 4D as required, geohazard / wellsite surveys, as well as VSP
- “OLS Offloading Lines” includes flow lines

For the purposes of the environmental assessment, the construction phase for the Project includes two sub-phases: nearshore construction (*i.e*., all activities at Bull Arm including removal of the bund wall); and offshore construction (*i.e*., Platform tow-out, installation, hook-up and commissioning). The operations and maintenance phase includes all activities occurring at the Platform. Decommissioning and abandonment will include decommissioning of the Hebron Platform at the offshore site. All activities associated with this Project will be conducted within the Project Areas. As required by CEAA and the Scoping Document (C-NLOPB 2009), the potential environmental effects of accidental events and cumulative environmental effects are also assessed. Potential accidental events, and other projects and activities that could result in potential environmental effects that act cumulatively with the Project are also identified in Table 4-2. Additional information on the assessment of cumulative environmental effects is provided in Section 4.3.7.

4.3.6 Step 6 – Environmental Effects Analysis and Mitigation

The next step in the environmental assessment process involves evaluating potential residual adverse environmental effects by Project phase. The evaluation of environmental effects, including cumulative environmental effects, included:

- The potential interaction between Project activities, for each Project phase, 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
- Evaluation criteria for characterizing the nature and extent of the environmental effects

Environmental effects assessment matrices have been used to summarize the analysis of environmental effects, including cumulative environmental effects, by Project phase and include accidents, malfunctions and unplanned events (Table 4-3). This allows for a comprehensive analysis of all Project-VEC interactions. Supporting discussion in the accompanying text highlights particularly important relationships, data or assessment analyses results. Where appropriate (*e.g.*, Air Quality), the effects of various Project activities have been assessed under one comprehensive Project activity (*e.g.*, air emissions from vessels are assessed under Vessel Operations).

The concept of classifying environmental effects simply means determining whether they are adverse or positive. The following includes some of the key factors that must be considered in determining adverse environmental effects, as per the CEA Agency's guidance (1994b):

- Negative environmental effects on the health of biota
- Loss of rare or endangered species
- Reduced biological diversity
- Loss or avoidance of critical / productive habitat
- Habitat fragmentation or interruption of movement corridors and migration routes
- Transformation of natural landscapes

- Chemical discharge
- Adverse effects on human health
- Loss or detrimental change in current use of lands and resources for traditional purposes
- Foreclosure of future resource use or production
- Negative environmental effects on human health or well-being

Table 4-3 Example Environmental Effects Assessment Matrix (Construction)

Project Activity	Potential Positive (P) or Adverse (A) Environmental Effect	Mitigation	Evaluation Criteria for Assessing Residual Adverse Environmental Effects				
			Magnitude	Geographic Extent	Duration/ Frequency	Reversibility	Ecological / Socio-economic Context
Activity 1							
Activity 2							
Activity 3							
Activity 4							
Activity 5							
Activity 6							

KEY

Magnitude:
1 = Low: <10 percent of the population or habitat in the Study Area will be affected.
2 = Medium: 11 to 25 percent of the population or habitat in the Study Area will be affected.
3 = High: >25 percent of the population or habitat in the Study Area will be affected.

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

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

Frequency:
1 = <10 events/year
2 = 11 to 50 events/year
3 = 51 to 100 events/year
4 = 101 to 200 events/year
5 = >200 events/year
6 = continuous

Reversibility:
R = Reversible
I = Irreversible

Ecological / Socio-economic Context:
1 = Area is relatively pristine or not adversely affected by human activity.
2 = Evidence of adverse effects.

Note: Sample key is typical for biological VECs and is provided for illustrative purposes only. The key will vary from VEC to VEC as appropriate

Mitigation includes environmental design, environmental protection strategies, environmental management systems, compensation and measures specific to the avoidance, reduction or control of potential adverse environmental effects on a particular VEC. As required by CEAA, these measures must be technically and economically feasible. In the case of positive environmental effects, enhancement opportunities need to be considered. Depending on the anticipated environmental effects, mitigation and enhancement strategies

have been optimized to reduce adverse environmental effects and enhance those that are positive. Therefore, the significance of an environmental effect is determined by taking the mitigative measures into consideration to determine the residual environmental effects.

The criteria used to characterize potential environmental effects for VECs are described below and are consistent with those outlined in CEAA guidance documents (the CEA Agency 1994a,b), in accordance with the Scoping Document. These criteria established the framework for the assessment of environmental effects.

- **Nature:** the ultimate long term trend of the environmental effect (*e.g*., positive, neutral or adverse)
- **Magnitude:** the amount or degree of change in a measurable parameter or variable relative to existing conditions
- **Geographic Extent:** the area over which the effect will occur
- **Frequency:** the number of times during the Project or a specific Project phase that an effect might occur (*e.g*., one time or multiple times)
- **Duration:** the period of time over which the effect will occur
- **Reversibility:** the likelihood that a VEC will recover from an environmental effect, including consideration of active management techniques (*e.g*., habitat reclamation works). This may be due to the removal of a Project component / activity or due to the ability of a VEC to recover or habituate. As well, reversibility is considered on a population level for biological VECs. Therefore, although an environmental effect like mortality is irreversible at the individual level, the environmental effect on the population may be reversible
- **Ecological or Social Context:** the general characteristics of the area in which the Project is located, as indicated by existing levels of human activity and associated disturbance

These criteria are defined and presented within the environmental effects analyses in Table 4-3.

- **Level and Degree of Certainty of Knowledge:** level of confidence in the knowledge that supports the prediction. The Level and Degree of Certainty of Knowledge is evaluated for the determination of significance, and is summarized in the Residual Environmental Effects table for each VEC (see Section 4.3.8 as an example)

4.3.7 Step 7 – Cumulative Environmental Effects

Past, present and likely future projects and activities that will be carried out and that could interact in combination with the Hebron Project are identified in Table 4-4. These projects have been characterized for consideration in the analysis of the contribution of the Hebron Project to cumulative environmental effects. Within-Project cumulative environmental effects have been assessed as part of the Project-specific environmental effects analysis. The extent that other past, present and future projects have been considered is determined based on the guidance documentation developed by the CEA Agency (Hegmann *et al*. 1999). The current activities (*e.g.*, marine transportation and

commercial fisheries) and those future projects or activities that are reasonably likely to proceed (*i.e.*, proceeding through regulatory approvals process) have been considered. The projects and activities described in Table 4-4 have been identified as having the potential to act in combination with the Hebron Project to cause cumulative environmental effects to one or more of the defined VECs.

Table 4-4 Past, Present and Likely Future Projects and Activities Considered in the Environmental Assessment

Project Name	Project/Activity Description
Projects	
Hibernia Development and the HSE Project	The Hibernia oil field is located approximately 35 km northwest of the Hebron Project location. The Hibernia platform, including a GBS with storage capacity for 1.3 million barrels of oil, has been in production since November 1997. An approximately 6 km^2 Safety Zone has been established in accordance with the *Drilling and Production Guidelines* and is around the Hibernia platform and the OLS, which is approximately 2 km east of the Platform. Activities associated with this field include drilling and production activities, three multi-function support and stand-by vessels, and three purpose-built shuttle tankers that transport the crude to the International-Matex Tank Terminal Transshipment Terminal at Whiffen Head or direct to market The HSE Project is located approximately 6 km from Hibernia and may include up to six drill centres that will be connected back to the existing Hibernia GBS. Each drill centre may include the drilling of up to 11 wells. The total approximate size of the Safety Zone to be established for HSE is 53 km^2, plus zones for each future flowline. Geotechnical surveys are scheduled to occur in 2010 and excavated drill centre excavation and subsea construction is scheduled from 2011 to 2012. Production is scheduled to commence in late 2012, with an anticipated Project life of 24 years
Terra Nova Development	The Terra Nova oil field is located approximately 9 km south of the Hebron Project location. Terra Nova has been in production since January 2002. The Terra Nova operation uses a floating production, storage and offloading (FPSO) facility that can store up to 960,000 barrels of oil. The Terra Nova Development includes four drill centres. Terra Nova completed the latest phase of its initial development drilling program in August 2007. A total of 34 distinct wellbores and sidetracks have been drilled to date Drilling operations resumed in 2009 for approximately six months. There have been 14 development wells drilled in the Graben area, 11 development wells in the East Flank area and one extended reach producer and an extended reach water injection well in the Far East Central area. The Terra Nova Field Safety Zone extends 9.26 km (5 nautical miles) from the FPSO and is recognized by International Maritime Organization and Transport Canada. Two shuttle tankers and two to four support vessels are associated with the Terra Nova Development
White Rose Oilfield Development and Expansions	The White Rose Development is located approximately 46 km northeast from the Hebron field. The project involves an FPSO vessel, with three drill centres (Northern, Central and Southern), and subsea flowlines tied-back to the FPSO. A total of 21 wells support the core White Rose Development. The White Rose Safety Zone (including proposed new drill centres) is approximately 95 km^2. The Safety Zone has been established in accordance with the *Drilling and Production Regulations* Husky is proposing to develop up to five additional drill centres, within the White Rose field and the southern North Amethyst field. The associated Safety Zone will be approximately 17 km^2. Excavated drill centre construction, including installation of sub-sea equipment, for the North Amethyst drill centre was completed in 2008. Development drilling began the fourth quarter of 2008 and first oil target is second quarter 2010. Activities associated with the White Rose and North Amethyst fields include drilling by MODU and production subsea equipment installation with tieback to the *SeaRose FPSO*. As of December 2009, three shuttle tankers and four to six supply vessels provide support services in the ice-free season. An additional five supply vessels may be in service during the ice season

<table>
<tr><th>Project Name</th><th>Project/Activity Description</th></tr>
<tr><td colspan="2">Activities</td></tr>
<tr><td>Offshore Oil Exploration Activities, including multi-year drilling and seismic programs</td><td>As of February 2010, there have been a total of 308 exploration, delineation and development / production wells drilled on the Grand Banks, including 104 exploration wells, 45 delineation wells and 159 development / production wells (C-NLOPB 2010a). As of April 2010, there were 46 SDLs and 24 Exploration Licenses (ELs) and eight production licenses active on the Grand Banks (C-NLOPB 2010b). According the C-NLOPB website, there are three proposed marine seismic programs and two proposed exploratory drilling programs on the Grand Banks. There is one seismic program proposed / ongoing in the Jeanne d'Arc Basis, one seismic program proposed/ongoing in the Laurentian Subbasin, and one seismic/drilling program proposed for the Sydney Basin. Off the coast of Labrador there are three seismic program proposed
The programs in the following table are proposed:
<table>
<tr><th>Proponent</th><th>Exploration Activity (e.g. drilling, seismic surveys)</th><th>Location</th><th>Timing</th><th>Comments</th></tr>
<tr><td>Statoil Canada</td><td>Maximum of 27 wells</td><td>Jeanne d'Arc basin
Flemish Pass</td><td>2008 to 2016</td><td>Single and/or dual side-track exploration and appraisal / delineation wells</td></tr>
<tr><td>Statoil Canada</td><td>2D, 3D, and potential 4D seismic program</td><td>Jeanne d'Arc Basin (in and near EL 1100 and 1101 and within the Terra Nova Field)</td><td>2008 to 2016</td><td></td></tr>
<tr><td>Suncor Energy</td><td>Maximum of 18 wells</td><td>Jeanne d'Arc Basin</td><td>2009 to 2017</td><td>Single and/or dual side-track exploration wells</td></tr>
<tr><td>Suncor Energy</td><td>Seismic Surveys</td><td>Jeanne d'Arc Basin</td><td>2007 to 2010</td><td></td></tr>
<tr><td>Husky Energy</td><td>Drilling</td><td>Jeanne d'Arc Basin</td><td>2008 to 2017</td><td>18 oil and gas targets; combination of vertical and deviated (twin) wells</td></tr>
<tr><td>ConocoPhilips</td><td>Seismic Survey</td><td>Laurentian Subbasin</td><td>2010 to 2013</td><td>2 exploration blocks 1085 / 1082</td></tr>
<tr><td>ExxonMobil</td><td>Geohazard Survey</td><td>SDL 1006, 1007, 1009, 1010</td><td>2010</td><td></td></tr>
</table></td></tr>
<tr><td>Marine Transportation and Vessel Traffic</td><td>Various marine transportation activities take place along the Atlantic coast, including tankers, cargo ships, supply vessels, cruise ships and other vessels both commercial and recreational. Marine transportation in Trinity Bay is predominantly comprised of fishing vessels</td></tr>
<tr><td>Commercial Fisheries</td><td>There is a considerable amount of commercial fishing activity on the Grand Banks and Flemish Cap. The Hebron Field does not overlap with any major fishing areas. There is a high concentration of fishing activity approximately 50 km to the southeast (within NAFO Unit Area 3L) (snow crab and scallop) and 50 km to the northeast (within NAFO Unit Area 3L) (snow crab). Snow crab fishing is also common along the proposed traffic routes between Hebron and the Avalon Peninsula. Commercial fishing is an activity in Bull Arm (and Trinity Bay). Commercial fisheries include herring, mackerel, capelin, cod, lobster and squid. A more detailed description of commercial fisheries is outlined in Chapter 8 of this CSR</td></tr>
</table>

Results of the marine environmental effects monitoring (EEM) program conducted at Bull Arm from August 1991 to November 1997 indicated that the construction activities associated with the Hibernia GBS did not affect the marine environment beyond acceptable levels (*i.e.*, none of the null hypotheses developed for the marine EEM program were rejected) (Christian and Buchanan 1998).

Cumulative environmental effects have been assessed in an integrated manner for each VEC. In analyzing cumulative environmental effects within this integrated methodological framework, a number of key elements were essential for evaluating the contribution of Project-related environmental effects. The environmental effects analysis for the CSR included a consideration of the following questions, where they are applicable.

- Are there Project-related environmental effects that act in combination with other effects to result in cumulative environmental effects
- Do identified Project-related environmental effects overlap with (*i.e*., act in combination with) those of other past and/or present projects? This can be established through characterizing the existing baseline conditions of the VEC, and then reflecting the overlapping cumulative environmental effects with those of past, present and/or future projects
- What is the contribution of the Project to the overlapping cumulative environmental effects of past and/or present projects
- Do the combined Project and cumulative environmental effects of past and/or present projects overlap with those of any likely future projects and/or activities that will be carried out

Historical trends for VECs (*i.e*., fish and shellfish, marine birds, marine mammals and sea turtles) are described to help characterize past and current population trends. Temporal and spatial boundaries are established for the cumulative environmental effects assessment for each of the VECs. In some cases, cumulative environmental effects assessment boundaries may vary from those defined for Project-specific environmental effects. The cumulative environmental effects assessment included explicit indication of other projects and activities that may contribute to cumulative environmental effects for that VEC, and mitigation measures that EMCP proposes to reduce the Project's contribution to cumulative environmental effects. The proposed mitigation measures are outlined in the appropriate VEC analysis sections.

4.3.8 Step 8 – Determination of Significance

Analyzing and predicting the significance of environmental effects, including cumulative environmental effects, encompasses the following:

- Determining the significance of residual adverse environmental effects, for each Project phase and for the Project overall
- For any predicted significant adverse environmental effect, determining the capacity of renewable resources (*e.g.*, fish species associated with the commercial fishery), that are likely to be significantly affected, to meet the needs of the present and those of the future and determining the probability of occurrence

- Establishing the level of confidence for predictions
- Estimating the probability of occurrence

At the completion of the environmental effects evaluation, the residual adverse environmental effects are assigned an overall rating of significance for each Project phase (*e.g.,* construction, operation and maintenance, decommissioning and abandonment, and accidents, and malfunctions and unplanned events). The significance rating for each Project phase is presented in a residual environmental effects summary table. An example of this is provided in Table 4-5.

Table 4-5 Example Residual Environmental Effects Summary Matrix

Phase	Residual Adverse Environmental Effect Rating[A]	Level of Confidence	Probability of Occurrence (Likelihood)
Construction / Installation[B]			
Operation and Maintenance			
Decommissioning and Abandonment[C]			
Accidents, Malfunctions and Unplanned Events			
Cumulative Environmental Effects			

KEY

Residual Environmental Effects Rating:
S = Significant Adverse Environmental Effect
NS = Not Significant Adverse Environmental Effect
P = Positive 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 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 Includes all Bull Arm activities, engineering, construction, removal of the bund wall, tow-out and installation of the Hebron Platform
C Includes decommissioning and abandonment of the GBS and offshore site

An overall rating of "significant" or "not significant" has been assigned for adverse environmental effects within each Project phase on a VEC-by-VEC basis. The rating of significance was determined by applying the definition of significance to the aggregate of Project-related environmental effects. The significance criteria were considered and applied for each VEC. Significance definitions are provided for residual environmental effects (*i.e*., the environmental effect remaining after the application of mitigation or effects management measures) and are VEC-specific. Significant residual environmental effects are those that are considered to be of sufficient magnitude, duration, frequency, geographic extent, and/or reversibility to cause a change in the VEC, whereby its status or integrity is altered beyond an acceptable level even after application of the mitigation measures. The thresholds developed for this assessment are based on guidance from the CEA Agency, applicable regulatory standards and requirements, previous environmental assessments, and the professional experience of the Hebron

Project study team. The text accompanying each section provides a summary of the cumulative environmental effects analysis, with a significance determination for adverse cumulative environmental effects.

4.3.9 Step 9 – Evaluating the Need for Follow-up

A follow-up program, as defined in CEAA, is a program that verifies the accuracy of the environmental assessment of a project, and/or determines the effectiveness of any measures taken to mitigate the adverse environmental effects of the project.

A follow-up program will be developed for the Hebron Project. The elements of the program will be developed through consideration of each VEC; where appropriate or warranted, follow-up measures will be recommended. In accordance with the requirements of a follow-up program, actions will be proposed for those cases where the accuracy of the environmental effects analysis for a VEC should be verified, and/or where the effectiveness of mitigation measures should be determined. The results of Steps 1 through 5 will help focus the Project on important interactions in the development of follow-up programs.

In addition to follow-up programs pursuant to requirements of CEAA, EMCP will also evaluate the need for monitoring pursuant to other statutes, and principles of EMCP environmental management.

4.4 Determining the Effects of the Environment on the Project

The effects of the environment on the Project have also been taken into consideration. Details of the Project description were reviewed for interactions with the natural environment, including wind, waves and ice. Project plans and activities have been designed to reflect the limitations imposed by the natural environment. An example of a table summarizing the environmental effects of the environment on the Project is presented in Table 4-6.

Table 4-6 Environmental Effects of the Environment on the Project

Marine Environmental Event	Mitigation
Nearshore Events	
Wind / Waves – ROV operations	
Wind / Waves – barge, tug or support vessel operations	
Wind / Waves – access to GBS at deepwater site	
Waves – bund wall failure	
Waves / Currents – mooring failure	
Storm surges / high water levels - flooding and damage to drydock / bund wall	
Sea Temperature - contributor to vessel and structure icing potential	
Sea Temperature - exposure to personnel	

Table 4-6 Environmental Effects of the Environment on the Project (continued)

Marine Environmental Event	Mitigation
Offshore Events	
Tsunamis – OLS / Tanker disruption (high currents)	
Wind / Waves – tug or support vessel operations (*e.g.*, ice, spill response, Search and Rescue)	
Waves / Low water level – affecting Hebron Platform installation on seabed	
Currents – OLS / Tanker disruption	
Sea Temperature - contributor to vessel and structure icing potential	
Sea Temperature - exposure to personnel	
Seaonally-occurring Sea Ice and Icebergs	
Climate Change – Sea level rise	
Climate Change – Waves	
Climate Change - Sea Surface Temperature	
Climate Change - Sea Ice and Icebergs	

A significant effect of the environment on the Project is one that:

- Harms Project personnel or the public
- Results in a substantial delay in construction (*e.g.*, more than one season) or shutdown of operations
- Damages infrastructure and compromises public safety
- Damages infrastructure to the extent that repair is not economically or technically feasible

While effects of the environment on the Project can in turn result in effects on the environment (*e.g.*, an oil spill could result from weather or ice conditions), this is fully addressed in the environmental assessment for each of the VECs. For instance, in the case of an accidental event, the worst case scenario event, regardless of the cause, has been assessed for each VEC. The effects of the environment on the Project are assessed in Chapter 13.