West Flemish Pass
Exploration Drilling Program

Chapter 15 to 17 – Accidental Events, Effects of the Environment on the Project, and Summary and Conclusions

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15.0 ACCIDENTAL EVENTS

Chevron evaluates the risk of potential accidents that may occur throughout the life of a project including offshore drilling activities. Mitigating measures are applied to reduce the safety and environmental risks of operations. One of Chevron's key guiding principles is to undertake a project safely or not at all. Chevron will not take any unnecessary risks or short cuts to save time if it compromises safety.

In general, accidental events may include malfunctions, upset conditions or other unplanned events. Accidental events may occur in any operation as risks often cannot be reduced to a zero probability of occurrence. The Project will be designed to prevent accidents from occurring and to avoid or reduce any environmental effects. This chapter discusses potential Project-related accidental event scenarios, prevention and response measures, and potential environmental effects resulting from such events.

15.1 Potential Accidental Events Scenarios

15.1.1 Potential Accidental Scenarios

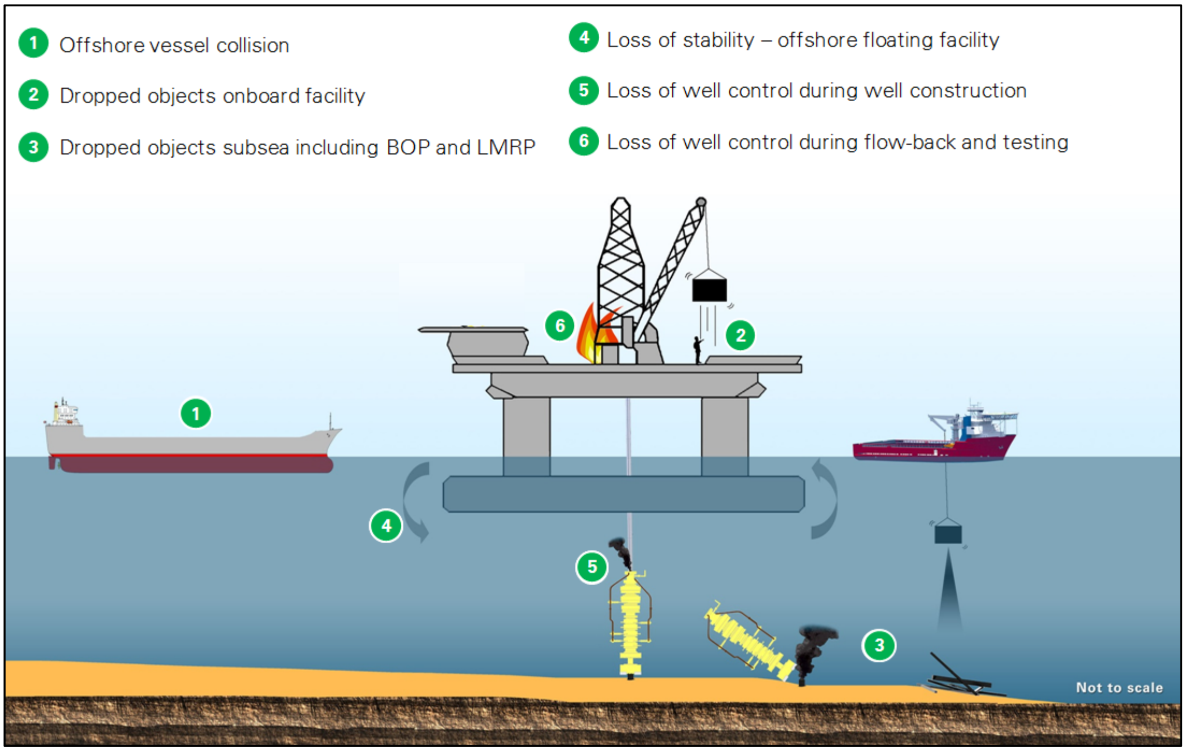
Accidental risk events with potential environmental consequences that could occur during Project operations include vessel collision, dropped objects, loss of MODU stability or structural integrity, and loss of well control (Figure 15-1). The accidental events are further described in the following sections.

15.1.1.1 Vessel Collision

Chevron anticipates the use of three supply vessels, one of which will remain on standby near the MODU the others will be used to deliver supplies and equipment from shore (see Figure 2-8 for potential transit routes), waste back to shore, and transport personnel if weather makes transport by helicopter unsafe.

Vessel collisions are classified as collisions between two vessels and may include:

- Supply vessels
- Supply vessel and non-Project vessel (either domestic or international)
- Vessel and MODU



Source: BP 2018
Note: BOP = blowout preventer; LMRP = lower marine riser package

Figure 15-1 Exploration Drilling Potential Accident Scenarios

The C-NLOPB has publicly disclosed preliminary information for approximately 120 incidents that were reported by oil and gas operators in the offshore area of Newfoundland and Labrador during the period of December 2010 to July 2019; of these, only four have involved PSVs (C-NLOPB 2019). One was related to a fire on the PSV during transit (approximately 100 km from St. John's) (C-NLOPB 2013a) and the other three incidents occurred while "in-field" at a drilling or production installation. One of these incidents included contact between a supply vessel and drilling installation, although there were no reported injuries or pollution (C-NLOPB 2011). The other two in-field incidents involved a non-occupational medevac (C-NLOPB 2013b) and the loss of an empty container overboard as it was being offloaded from a PSV (C-NLOPB 2016).

A review of marine transportation occurrence (accident and incidents) datasets from January 1995 to September 2018 revealed 21 records of vessel collisions in the Newfoundland and Labrador region. Three additional incidents were recorded as "near collision" or "allision" (striking a stationary object). Most of these incidents involved fishing vessels and/or Canadian Coast Guard vessels (Transportation Safety Board of Canada 2018).

Collision events are considered highly unlikely as there are strict guidelines and operating limits for operating vessels to and from the well site. Vessels will not attempt to pull alongside of the MODU for loading and offloading unless sea states are acceptable for the period required to complete the operation. Vessels are equipped with radar and GPS technologies that can easily identify other vessels (including fishing vessels) in surrounding waters around the well site and while transiting to and from the port of St. John’s. Entering and exiting the port of St. John’s will require the mandatory assistance of a pilot captain on the bridge of the vessel who is brought onboard from the St. John’s port authority. The MODU has a 500m radius safety exclusion zone where no unauthorized vessels are permitted to enter.

15.1.1.2 Dropped Objects

Along with the potential of falling objects on the MODU or supply vessel, is it possible but unlikely that objects may be dropped over the side and settle on the sea floor. This may occur as equipment and materials are lifted to and from the MODU or objects resulting from damage from a severe storm event. There have been two incidents in offshore Newfoundland in the past where the BOP running tool has been dropped. All BOP running equipment will require inspection and certification prior to use. To ensure that the wellhead is not compromised, the BOP will be run subsea in a safe handling distance and skid to well centre just before landing out and latching over the wellhead.

Between 2010 and July 18, 2019, there were 14 incidents reported by the C-NLOPB that involved dropped objects. All but one of these incidents involved objects dropping to the deck of the MODU, the exception being an empty container sinking to the seafloor (C-NLOPB 2017).

15.1.1.3 Loss of MODU Stability or Structural Integrity

MODU stability is essential to control the variability in motion of the drilling unit. Most drilling operations on MODUs are sensitive to sea states and where motion do not allow for a safe operation, the MODU is placed on standby waiting on the weather conditions to improve. The stability of the MODU is managed by the control room where rig motion is monitored and may be controlled. The control room operator (24-hour coverage) is certified and trained to operate the software and controls for the rig’s thrusters in order to keep the rig on station. This includes the ballast control system where the rig can be ballasted up to a higher draught while riding out a storm or while in transit to the well site. It is possible but highly unlikely that the MODU’s stability may be compromised due to the mismanagement of the ballast control system. An alarm system is set for rig motion limits and for rig position through GPS satellite to indicate if a drive off event may be occurring. The control room operator can then acknowledge the alarm and act, if necessary. Rig motion indicators are also located on the driller’s console where readings can be taken into consideration during rig floor activities.

The structural integrity of the drilling MODU is essential for a safe operation. The integrity may be compromised from a vessel collision that could either puncture or dent the columns or ballast tanks. It could originate from a supply vessel or a dropped object. The structural integrity is linked to the certificate of fitness and a license to operate. In rare cases, structural integrity has been affected by extreme weather events. If it is suspected that the MODU’s structural integrity has been compromised, an inspection and recertification process may be required prior to the MODU returning to normal operations.

15.1.1.4 Loss of Well Control

Well control and blowout prevention is of the utmost importance to Chevron and is essential for all drilling and completions operations. Well control is incorporated into the well design at the planning phase of a well based on maximum anticipated well pressures expected to be encountered. Casing shoe integrity is pressure tested prior to drilling ahead in order to determine if an influx (“kick”) can be safely shut in, hold pressure and then be circulated out of the well. Well control is lost if the kick cannot be contained in the well during well control operations or if the well cannot be returned to a static condition or be “killed”.

There are several reasons for loss of well control in an offshore well. Possible reasons for a loss of well control is a weak formation near the casing shoe that may not hold well pressures during a well kill operation. This is unlikely as formation integrity will be known prior to drilling ahead as noted previously. In addition, kick tolerance calculations are performed in advance of drilling at depth to ensure a kick can be safety circulated out of the well. If in the rare case, a kick is lost to a weak formation, it will lead to an underground blowout where in this situation, no loss of containment will occur at surface or the seabed unless broaching to the seabed occurs. The well will need to be plugged and abandoned as drilling cannot continue.

In a subsea well, conductor and surface hole are drilled riserless with water-based drilling mud and returns are directed to the seabed. The remote observation vehicle (ROV) is positioned near the wellhead monitoring returns visually and through sonar as the well is being drilled. Shallow seismic surveys are performed prior to spud to determine if there are shallow gas occurrences in the area. The spud location of the well may be adjusted to avoid potential areas of shallow gas. If shallow gas occurs, the ROV will notice gas bubbles coming from the wellhead. The well is then killed with pumping a higher density kill mud built and stored in the mud pits for well control purposes. The hole section is stopped short of planned depth and casing is then run and cemented to isolate the zone.

Loss of well control may also occur because of a BOP failure during a well control operation. This is highly unlikely as the BOP has multiple components or redundancies that can be used to shut in the well. The BOP is function tested and pressure tested periodically to ensure that it is capable of shutting in the well.

15.1.2 Potential Spill Scenarios

Offshore exploration and production facilities have spilled a total of 2,759 bbl of oil in 478 incidents over the last 22 years of Newfoundland and Labrador. One single event–the spill of 1,572 bbl of crude oil from the Husky Energy White Rose field (*SeaRose FPSO*) in November 2018 made up nearly 57% of the total volume of spillage. Another spill event involving 1,037.8 bbl from Petro-Canada’s Terra Nova FPSO occurred in November 2004. Together, these two events were responsible for 95% of the volume of oil spillage over 22 years (this does not include spills of SBM) Approximately 86% of the total volume of oil spillage occurred during development and production activities. A total of 33 incidents totaling 33 bbl occurred during exploration activities. Approximately 72% of these spills involved <1 bbl. Offshore exploration activities over the time period 1997 through 2018 also resulted in 11 synthetic-based fluid (SBM) spills for a total of 776 bbl. Development and production activities resulted in the spillage of 1,314 bbl of SBM in 44 incidents. Spill probabilities are discussed in Section 15.3.

15.1.2.1 Operational Spills

While drilling with SBM in a closed loop circulating system, all fluid volumes are closely monitored and accounted for. If there is a sudden drop in the active volume of SBM, the rig crew must determine if drilling mud is being lost downhole to the formation or if the unaccounted volume is being unknowingly moved to another pit or advertently being discharged to the sea. Multiple pit sensors are placed permanently over each mud pit and volume levels are tracked in real time and recorded by the mud logging crew and the drillers. Volumes are also physically measured from the top of each pit periodically by mud engineers to ensure that sensors are working correctly. Alarms are set on pit levels and updated depending on the working level of fluid in each pit. Whenever there is a planned fluid movement, addition or loss to the active system, the mudloggers and drillers are informed to ensure the operation is carried out as intended. Any unexplained losses or gains in pit levels are followed up immediately to ensure that an accidental transfer does not occur. Therefore, fluid volumes are monitored and tracked.

There are three possibilities for an SBM spill in a normal drilling operation. The first being the loss of mud through drilling returns where the shaker system is not managed correctly and the mud has opportunity to be discharged through the overboard line with the cuttings. This is highly unlikely as the shaker system is continuously monitored by solids control personnel and the number of shakers and shaker screens are changed out depending on flow rates and cuttings sizes.

The second is the failure of the slip joint packer on the riser. The slip joint is a telescopic section of the riser that extends and collapses as the MODU moves up and down with rig heave. The slip joint packer is pressurized with rig air pressure to prevent any leakage of SBM to the sea. The rig air supply is very reliable and is available even if there is a power outage. If the slip joint packer fails and becomes de-energized, drilling mud will have the opportunity to be discharged to the sea. This will be noticed immediately both from pit level alarms and cameras mounted in the moon pool. Drilling operations will be shut down if this event should occur. There is a backup slip joint packer that can be energized if the primary packer has failed.

The third is the accidental opening of an overboard line connected to a pit full of fluid or mud. This is unlikely as crews are trained in the opening and closing of valves leading overboard and the function of any overboard valves are completed under the permit to work system. The operation will be risk assessed and approval from the OIM or toolpusher will be required to carry out these operations.

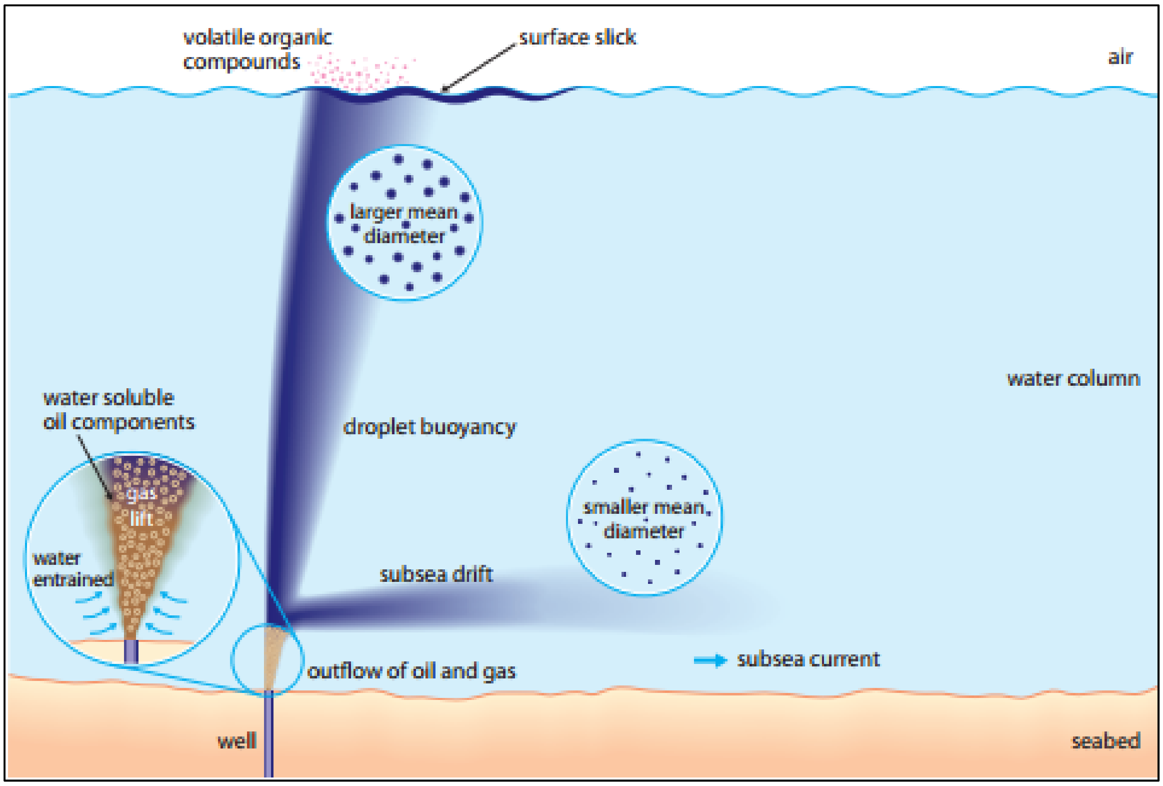
The C-NLOPB records all reported spills. Spills >1 L are divided by operational phase into SBMs and other hydrocarbons. SBM spills occurred less frequently than spills of other hydrocarbons. The volumes of SBM spills were higher for exploration spills than for development / production spills. Hydrocarbon spills averaged 6.9 bbl per well per year and 3 bbl per well per year for SBM spills. C -NLOPB data for spills of ≤1 L are not available in an individual per-incident format, nor are data on smaller spills classified regarding oil type.

15.1.2.2 Well Blowout Incident

If in the rare event a well blowout does occur, hydrocarbons may be released to the sea from the wellhead during a BOP failure. In this scenario, the BOP is either damaged or cannot be closed and a hydrocarbon plume is released from the wellhead. In this situation, the lighter hydrocarbons become segregated from the heavier fraction and quickly migrate to the surface to form a slick. Light gases are then evaporated. Heavier hydrocarbons become suspended and carried away by sea currents while others drop out of the water column onto the sea floor. In this case, the MODU will more than likely be moved off location so that the area can be accurately assessed, and preparations made for deployment of a capping stack under one response scenario.

Another scenario that could result in a spill to the sea involves a well kill operation where hydrocarbons are being circulated out from the well in a controlled procedure through the MODU's well control equipment. In this case depending on the size of the kick, the hydrocarbons are collected and held in surface tanks until after the well has been killed and then transported to a land-based waste disposal site. During the process of killing the well or transferring hydrocarbons for disposal, spillage to the sea may occur. Tier 1 spill response equipment would be deployed and the incident elevated to Tier 2 if necessary.

A schematic of a subsea well blowout incident is provided in Figure 15-2 (International Petroleum Industry Environmental Conservation Association [IPIECA]-IOGP 2015).



Source: IPIECA-IOGP 2015

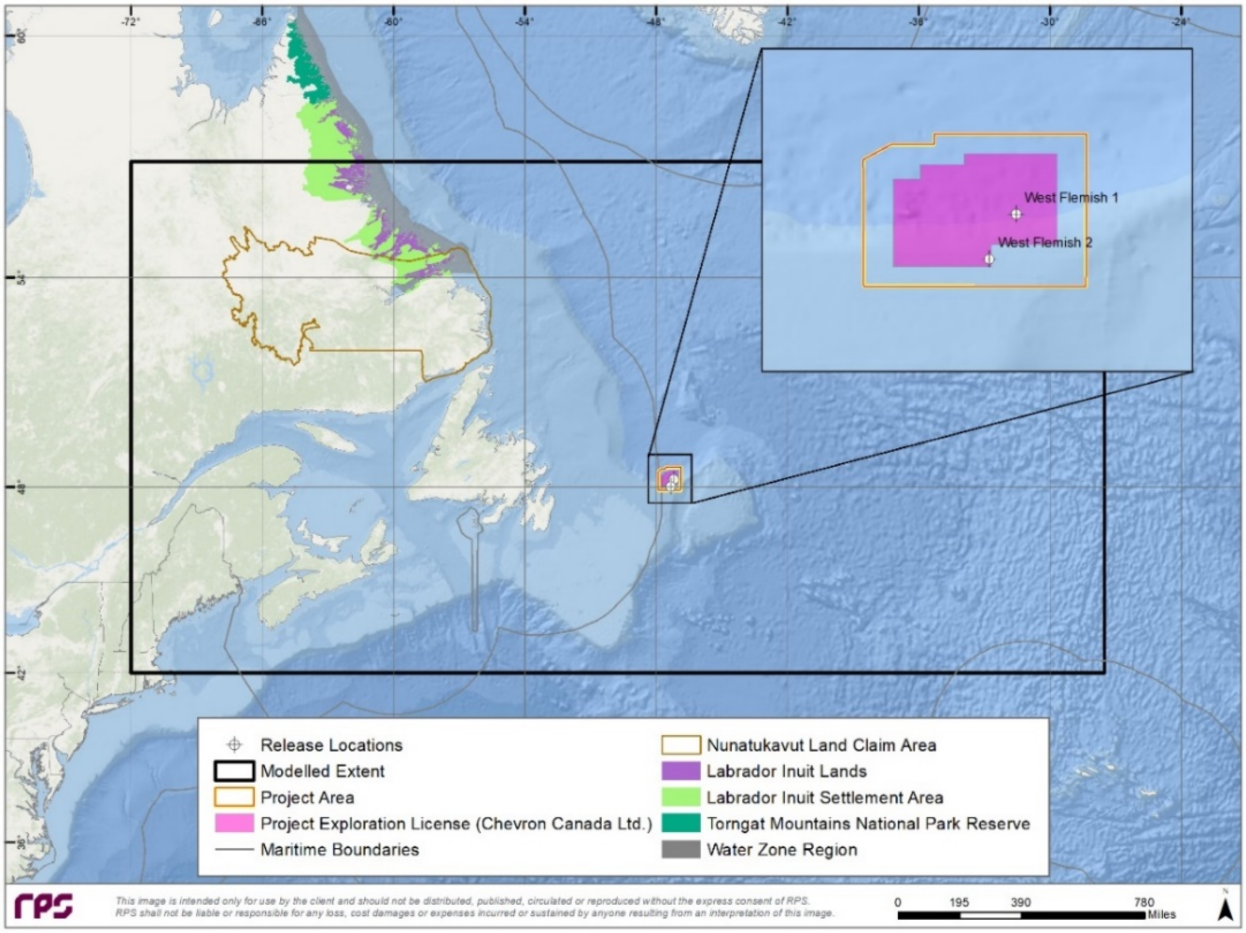
Figure 15-2 Schematic of a Blowout

15.2 Fate and Behaviour of Potential Spills

RPS conducted trajectory and fate modelling for unmitigated subsurface blowouts of crude oil and batch spills of marine diesel to support an evaluation of environmental effects of accidental events (refer to Appendix F). RPS's nearfield OILMAP Deep blowout model and the far-field Spill Impact Model Application Package (SIMAP) trajectory, fate, and effects models were used to conduct three-dimensional oil spill trajectory and fate modelling and analyses.

15.2.1 Overall Modelling Approach

Two release locations were used for spill modelling at representative sites within EL 1138 (Figure 15-3), representing a shallow water (500 m) and deep-water (1,500 m) well site. A batch spill at the deep-water well site was also modelled. Accidental event scenarios for the effects assessment are listed in Table 15.1.



The black bounding box represents the modelled extent, while the smaller orange box represents the Project Area.

Figure 15-3 Hypothetical Release Locations for the Subsurface Blowouts (West Flemish 1 and West Flemish 2)

Table 15.1 Hypothetical Model Scenarios for Effects Assessment

Scenario ID	Lat	Long	Water Depth (m)	Spill Rate	Release Duration (days)	Total Volume Released (m³)
Subsurface Blowout (West Flemish Pass Proposed Light Oil)						
WF1-123	48°13'20" N	47°11'00" W	1,500	22,640 m³/d	123	2,784,720 m³
WF1-30	48°13'20" N	47°11'00" W	1,500	22,640 m³/d	30	679,200 m³
WF2-135	48°01'00" N	47°18'23" W	500	20,190 m³/d	135	2,725,650 m³
WF2-27	48°01'00" N	47°18'23" W	500	20,190 m³/d	27	545,130 m³
Surface Batch Spill (Marine Diesel)						
BS-WF1	48°13'20" N	47°11'00" W	1,500	1,000 L	Instantaneous	6.3

This modelling study employed a combined stochastic and deterministic approach to determine the potential trajectory and fate of hypothetical hydrocarbon releases from two sites east of Newfoundland. Stochastic modelling provides a probabilistic view of the likelihood that a given region might be exposed to released hydrocarbons over specified thresholds as well as time it takes to reach these thresholds. Because stochastic analyses include >100 simulated releases with different start dates throughout a year and over multiple years, they provide a range of possible trajectories based upon variable environmental conditions. Deterministic analyses provide views of the time-history of individual releases including the spatially- and temporally-varying movement and behavior of released oil from specified individual releases (i.e., representative credible “worst cases”). Deterministic scenarios provide an understanding of the predicted spatial and temporal variability in thicknesses, concentrations, and mass within each environmental compartment. Together, these methods provide a more complete view of the likelihood, timing, and degree or magnitude of potential exposure.

Predicted surface oil thickness, dispersed oil in the water column, and shoreline oil mass exceeding specified thresholds for the full year (i.e., annual) are provided along with seasonal breakdowns associated with variable ice-cover conditions (i.e., summer/ice-free and winter/ice-covered). Individual deterministic trajectories that characterize single release scenarios are also presented associated with representative credible “worst-case” scenarios (i.e. 95th percentile “worst-case” for surface oil, subsurface contamination, and shoreline oiling). Stochastic analysis of hypothetical blowouts were modelled using the physical-chemical properties of West Flemish Pass Light Oil (WFPLO) and seven years of variable environmental data, which are discussed further in Section 15.3. The hypothetical spill sites are located within the West Flemish Pass Project Area (Figure 15-3). A total of 171 individual oil spill trajectories were modelled as unmitigated subsurface releases with randomized start dates/times within each two-week time period making up the seven-years modelled here (Table 15.1). The releases included 82 winter and 89 summer scenarios. The duration of each simulation within the stochastic scenario was 160 days.

In addition, a single representative deterministic release (1,000 L) was analyzed to evaluate a potential discharge of marine diesel on the surface associated with a batch spill that could occur from vessels, unloading hoses, or a tank.

15.2.2 Stochastic Approach

A stochastic approach was employed to determine the footprint and probability of areas that are at increased risk of oil exposure based upon the variability of meteorological and hydrodynamic conditions that might prevail during and after a release. A stochastic scenario is a statistical analysis of results generated from many (>100) different individual trajectories of the same release scenario, with each trajectory starting at a randomized time from a relatively long-term window. For this project, individual trajectory start dates were selected randomly every 14 days throughout the window of environmental data coverage (2006-2012) to ensure that the data was adequately sampled. This stochastic approach allowed for the same type of release to be analyzed under varying environmental conditions (e.g., summer vs. winter or one year to the next). The results provide the probable behavior of the potential releases based upon this environmental variability.

To reproduce the natural variability of winds and currents, the model requires both spatially- and temporally-varying datasets. Historical observations and models of multiple-year wind and current records were used to perform the simulations within the coinciding time period. These datasets allow for reproduction of the natural variability of the wind and current speeds and directions. Optimally, the minimum time window for stochastic analysis is at least five years, so that various weather patterns from year to year are represented. Seven years of environmental data were used for this modelling study, including 2006-2012.

Stochastic analyses provide two types of information: 1) the areas associated with the probability of oil exposure at some time during or after a release, and 2) the shortest time required for oil above a specified threshold to reach any point within the modelled areas. Because modelled trajectories were started on different dates and times, they experienced different environmental conditions, and thus traveled in different directions. To compute the stochastic results in this study, 171 individual trajectories were overlaid upon one another. The number of times that each given location throughout the modelled domain (i.e., grid cell) was intersected by a trajectory that exceeded the specified threshold was then quantified and used to calculate the probability of oil exposure for each specific location. The predicted footprint is the cumulative oil-exposed area for all of the 171 individual releases combined. The color-coding represents a statistical analysis of all the individual trajectories to predict the probability of oil at each point in space, based upon the environmental variability. The footprint of any single release of oil, be it modelled or real, would likely be much smaller than the cumulative footprint of all the simulations used in the stochastic analysis. Similarly, the footprint of oil from any individual release at a single time step (snapshot in time) would be even smaller than the cumulative swept area depicted here.

The number of individual trajectories and the timeframe of a given stochastic analysis play roles in the spatial extent of the resulting stochastic footprints. More individual simulations may incorporate greater environmental variability, which may result in larger footprints. As the number of trajectories modelled increases, the confidence and resolution of reported probabilities also increase. However, there is a “law of diminishing returns” and thousands of scenarios are not necessary to capture the environmental variability within the system. Annual stochastic model simulations resulted in the largest footprint, encompassing all environmental variability throughout the years. Seasonal footprints may be smaller, encompassing only the environmental variability expected within the smaller time period (e.g., prevailing winds, seasonal patterns, etc.). It is important to note that a single trajectory encounters only a small portion of an overall stochastic probability footprint (i.e., an individual trajectory may be less than 10% of an annual stochastic footprint). Maps of probability and minimum time to oil exceeding identified thresholds are provided in Section 15.2.6.

In a stochastic analysis, multiple model simulations (over one hundred releases) are overlaid upon one another to create a cumulative footprint of the potential trajectories. When combined with one another, the many individual deterministic footprints can be used to generate an area of probability that describes the potential areas that may be exposed to oil from the entire suite of modelled conditions. To determine the probability or likelihood of potential exposure, specific thresholds for surface oil thickness, oil on shorelines and sediments, and in-water concentrations were required (Table 15.2). Above these thresholds, with the socioeconomic threshold being the most conservative, previous studies identified that there is the potential for negative effects to occur.

Figures and further analyses in this study rely on the more conservative lower socio-economic thresholds of concern calculated from stochastic results. Should a higher, less conservative stochastic threshold be used (e.g., ecological threshold), the predicted probability footprint would be much smaller.

Floating surface oil is expressed as mass per unit area, averaged over a defined (grid cell) area. If the oil is evenly distributed in that area, it would be equivalent to a mean thickness, where 1 micron (µm) corresponds to a layer of oil that has a mass concentration of approximately 1 g/m^2. Surface oil thickness is typically associated with visual appearance by aerial observation for responders (NRC, 1985; Bonn Agreement, 2009, 2011; NOAA 2016a). As an example, barely visible sheens may be observed above 0.04 µm and silver sheens correspond with surface oil thickness of approximately 0.3 µm. Crude and heavy fuel oils greater than 1 mm thick typically appear as black oil, while light fuels and diesels that are greater than 1 mm thick may appear brown or reddish. Because of the differences between oils and their degree of weathering, as well as the weather conditions and sea state at the time of observations, floating oil will not always have the same appearance. As oil weathers, it may be observed in the form of scattered floating tar balls and tar mats where currents converge. Typically, oil slicks in the environment would be observed as patchy and discontinuous with a range of visual appearances including silver sheen, rainbow sheen, and metallic areas simultaneously, as a combination of thicknesses may be present. Thus, a model result presented as average oil mass per unit area or “thickness” is actually a region with patches of oil of varying thickness, which when distributed evenly in the area of interest, would average a certain thickness.

Table 15.2 Thresholds Used to Define Areas and Volumes Exposed Above Levels of Concern

Threshold Type	Cutoff Threshold*	Rationale / Comments (Socio-economic, Response, Ecological)	Visual Appearance	References
Oil Floating on Water Surface	0.04 g/m² (0.04 µm on average over grid cell)	Socio-economic: A conservative threshold used in several risk assessments to determine effects on socio-economic resources (e.g., fishing may be prohibited when sheens are visible on the sea surface). Socio-economic resources and uses that would be affected by floating oil include commercial, recreational and subsistence fishing; aquaculture; recreational boating, port concerns such as shipping, recreation, transportation, and military uses; energy production (e.g., power plant intakes, wind farms, offshore oil and gas); water supply intakes; and aesthetics.	Fresh oil at this minimum threshold corresponds to a slick being barely visible or scattered sheen (colorless or silvery/grey), scattered tarballs, or widely scattered patches of thicker oil.	French McCay et al., 2011; French McCay et al., 2012; French McCay, 2016; Lewis, 2007, Bonn Agreement 2009, 2011
	10 g/m² (10 µm on average over grid cell)	Ecological: Mortality of birds on water has been observed at and above this threshold. Sublethal effects on marine mammals, sea turtles, and floating Sargassum communities are of concern.	Fresh oil at this threshold corresponds to a slick being a dark brown or metallic sheen.	French et al., 1996; French McCay, 2009 (based on review of Engelhardt, 1983, Clark, 1984, Geraci and St. Aubin 1988, and Jenssen 1994 on oil effects on aquatic birds and marine mammals); French McCay et al., 2011; French McCay et al., 2012; French McCay, 2016
In Water Concentration	1.0 ppb (µg/L) of dissolved PAHs; corresponds to ~100 ppb (µg/L) of whole oil (THC) in the water column (soluble PAHs are approximately 1% of the total mass of fresh oil)	Water column effects for both ecological and socio-economic (e.g., seafood) resources may occur at concentrations exceeding 1 ppb dissolved PAH or 100 ppb whole oil; this threshold is typically used as a screening threshold for potential effects on sensitive organisms.	N/A	Trudel et al. 1989; French-McCay 2004; French McCay 2002; French McCay et al. 2012

Table 15.2 Thresholds Used to Define Areas and Volumes Exposed Above Levels of Concern

Threshold Type	Cutoff Threshold*	Rationale / Comments (Socio-economic, Response, Ecological)	Visual Appearance	References
Shoreline Oil	1.0 g/m² (1 µm on average over grid cell)	Socio-economic/Response: A conservative threshold used in several risk assessments. This is a threshold for potential effects on socio-economic resource uses, as this amount of oil may trigger the need for shoreline cleanup on amenity beaches and affect shoreline recreation and tourism. Socio-economic resources and uses that would be affected by shoreline oil include recreational beach and shore use, wildlife viewing, nearshore recreational boating, tribal lands and subsistence uses, public parks and protected areas, tourism, coastal dependent businesses, and aesthetics.	May appear as a coat, patches or scattered tar balls, stain	French-McCay et al., 2011; French McCay et al., 2012; French McCay, 2016
	100 g/m² (100 µm on average over grid cell)	Ecological: This is a screening threshold for potential ecological effects on shoreline flora and fauna, based upon a synthesis of the literature showing that shoreline life has been affected by this degree of oiling. Sublethal effects on epifaunal intertidal invertebrates on hard substrates and on sediments have been observed where oiling exceeds this threshold. Assumed lethal effects threshold for birds on the shoreline.	May appear as black opaque oil.	French et al., 1996; French McCay, 2009; French McCay et al., 2011; French McCay et al., 2012; French McCay, 2016

15.2.3 Deterministic Approach

Individual trajectories of interest were identified and selected from the stochastic ensemble of results for the deterministic analysis. The deterministic trajectory and fate simulations provided an estimate of the oil's transport and fate through the environment as well as its physical and chemical behavior for a specific set of environmental conditions. While the stochastic analysis provides insight into the probable behavior of oil spills given historic wind and current data for the Project Area, the deterministic analysis provides individual trajectory, oil weathering information, expected concentrations of oil contamination, mass balance, and other information related to a single release at a given location and time.

Representative deterministic scenarios (i.e., single trajectory) were identified from each set of stochastic subsurface blowout results. Individual scenarios were selected based upon the size of the surface oil footprint, the concentration of dissolved hydrocarbons in the water column, and the mass of oil on shorelines, based upon a set of highly conservative socioeconomic thresholds:

- Surface oil average thickness >0.04 µm
- Subsurface (within the water column) dissolved hydrocarbon concentrations >1.0 µg/L
- Shore oil average concentration >1.0 g/m²

A deterministic analysis of a single batch spill release of marine diesel was also modelled at the West Flemish Pass 1 with a release volume of 1,000 L. The modelled batch spill volume evaluated a potential discharge on the surface associated with marine diesel spills that could occur from a vessel, unloading hose, or tank. Scenarios were assumed to occur during the calmest wind-speed period during the summer/ice-free conditions, as they would result in the largest amount of oil on the surface. The simulation includes its own spatially and temporally variable trajectory, mass balance, surface oil thickness, in-water concentration of dissolved hydrocarbons, etc. reported individually.

15.2.4 Modelled Scenarios

Two hypothetical release locations were used for subsurface blowout modelling, representative of both deep (1,500 m) and shallow (500 m) locations in the West Flemish Pass Project Area (Tables 15.3 and 15.4). A surface batch spill was also modelled from the deeper West Flemish 1 location. Subsurface blowouts near the seafloor were modelled separately in a stochastic analysis that included 171 individual model simulations per location per scenario. This analysis investigated the influence of environmental variability throughout the year over multiple years, on the trajectory and fate of released oil (Table 15.4). The estimated volume of hydrocarbons released in the subsurface hypothetical blowout scenarios represent the best technical estimate of the release rates from the wells. In essence, these blowout rates represent credible "worst-case" release volumes given realistic inputs and hypothetical releases.

Table 15.3 Hypothetical Subsurface Release Location, Parameters, and Stochastic Scenario Information

Scenario Parameter	Release Locations of Hypothetical Subsurface Blowout Scenarios			
Block	EL 1138			
Release Location	West Flemish 1		West Flemish 2	
Latitude	48°13'20" N		48°01'00" N	
Longitude	47°11'00" W		47°18'23" W	
Water Depth of Release	1,500 m		500 m	
Released Product	West Flemish Pass Light Oil (WFPLO)			
Gas to Oil Ratio	1,500 scf/bbl			
Pipe Diameter	21.6 cm (8.5 in.)			
Oil Discharge Temperature	127°C			
Release Duration	30 d	123 d	27 d	135 d
Release Rate	22,640 m^3/d		20,190 m^3/d	
Total Released Volume	679,200 m^3	2,784,720 m^3	545,130 m^3	2,725,650 m^3
Model Duration	160 d			
Number of Simulations within Stochastic Analysis*	171 annual (82 winter & 89 summer) for each scenario			
*A total of 684 individual subsurface releases were modelled within the stochastic analyses.				

Table 15.4 Selected Representative Deterministic Scenarios

Scenario Parameter	Release Parameters for Representative 95th Percentile Deterministic Scenarios											
	30 d Subsurface Release			123 d Subsurface			27 d Subsurface Release			135 d Subsurface		
Representative Scenario	Surface Oil Exposure Area	Water Column Oil Volume	Shoreline Contact Length	Surface Oil Exposure Area	Water Column Oil Volume	Shoreline Contact Length	Surface Oil Exposure Area	Water Column Oil Volume	Shoreline Contact Length	Surface Oil Exposure Area	Water Column Oil Volume	Shoreline Contact Length
Block Release Site	EL 1138 West Flemish 1						EL 1138 West Flemish 2					
Release Type	Subsurface Blowout											
Water Depth of Release	1,500 m						500 m					
Released Product	WFPLO											
Release Duration	30 d			123 d			27 d			135 d		
Release Rate	22,640 m^3/d						20,190 m^3/day					
Total Released Volume	679,200 m^3			2,784,720 m^3			545,130 m^3			2,725,650 m^3		
Model Duration	160 d											
Modelled Start Date and Season	Jan. 17, 2010 Winter	Sep. 8, 2011 Winter	Dec. 25, 2009 Winter	Aug. 16, 2010 Winter	Jun. 1, 2008 Summer	Jan. 7, 2010 Winter	Mar. 3, 2010 Summer	Jun. 21, 2012 Summer	Sep. 13, 2010 Winter	Feb. 8, 2010 Winter	Jan. 17, 2010 Winter	Jul. 26, 2010 Summer

15.2.5 Model Input Data

Two hydrocarbon products (WFPLO and Marine Diesel) were modelled for this hypothetical release study. The physical and chemical data used to characterize WFPLO was provided by Chevron. WFPLO is a light crude oil that has a low viscosity and a high volatile content (Tables 15.5 and 15.6). Chevron noted that WFPLO is predicted to have a high (94%) maximum water content compared to most oils and specifically other light crudes with similar properties. The high maximum water content of this oil would result in the increased potential to form emulsions, which would rapidly increase the viscosity of the oil. Increased viscosity would be expected to limit entrainment, decrease the rate and extent of spreading, slow weathering processes, and ultimately affect the trajectory and fate of the oil. The characteristics of this oil will provide highly conservative approximations of anticipated surface oil concentrations following a release, as the oil would be more persistent than other light crude oils.

Table 15.5 Physical Properties for the Oil Products Used in the Modelling

Physical Property	WFPLO	Marine Diesel
Density (g/cm^3)	0.825 @16°C	0.83100 @25°C
Viscosity (cP)	4.0 @ 25^{o}C	2.76 @15°
API Gravity	40.0	38.8
Pour Point (°C)	-2.0	-50
Interface Tension (dyne/cm)	30.2	27.5
Emulsion Maximum Water Content (%)	94%	0

Table 15.6 Fraction of the Whole Oil Comprised of Different Distillation Cuts for the Modelled Oil Product

Distillation Cut[A]	Boiling Point (°C)	Description	WFPLO	Marine Diesel
AR1	<180	highly volatile and soluble monoaromatic hydrocarbons (BTEX[B] and MAHs C_6-C_9)	3.93	1.93
AR2	180 - 264	semi-volatile and soluble 2-ring aromatics (MAHs and PAHs C_{10}-C_{12})	1.02	1.14
AR3	265 - 380	low volatility and solubility 3-ring aromatics (PAHs C_{13}-C_{18})	0.18	1.56
AL1	<180	highly volatile aliphatics (C4-C_8)	17.07	14.46
AL2	180 - 280	semi-volatile aliphatics (C_9-C_{16})	37.28	47.86
AL3	280 - 380	low volatility aliphatics (C_{17}-C_{23})	3.22	30.32
THC1	< 180	total hydrocarbon fraction 1 (sum of AR1 and AL1)	21.00	16.40

Table 15.6 Fraction of the Whole Oil Comprised of Different Distillation Cuts for the Modelled Oil Product

Distillation Cut^A	Boiling Point (°C)	Description	WFPLO	Marine Diesel
THC2	180 - 280	total hydrocarbon fraction 2 (sum of AR2 and AL2)	38.30	49.01
THC3	280 - 380	total hydrocarbon fraction 3 (sum of AR3 and AL3)	3.40	31.89
Residuals	> 380	aromatics ≥ 4 rings and aliphatics > C_{20} that are neither volatile nor soluble	37.30	2.70

Note that the THC is the sum of the aromatic (AR) and aliphatic (AL) groups. Numbers of carbons (C#) in the included compounds are listed.

A = Note that the terms “aromatic” and “aliphatic” are used in a modelling context. “Aromatic” refers to all soluble and volatile hydrocarbons and may include actual aliphatic compounds (by chemical definition) that are soluble. In the modelling context, “aliphatic” refers to insoluble and volatile hydrocarbons. Note that Σ(AR) + Σ(AL) + residuals = Σ(THC) + residual = total hydrocarbon composition

B = BTEX (benzene, toluene, ethylbenzene, xylene), MAHs (monocylic aromatic hydrocarbons), and PAHs (polycyclic aromatic hydrocarbons) are the more soluble, bioavailable, and potentially toxic components in oil.

Marine diesel was modelled for the surface batch spill at the West Flemish 1 site. The marine diesel modelled is a standard diesel (light fuel oil with very little residual fraction) that has a low viscosity and high content of volatile hydrocarbons. Thus, marine diesel is expected to weather (i.e. evaporate) rapidly and be nearly completely on the water surface (Table 15.6). The physical and chemical data used to characterize these oils was provided by Chevron Canada, with additional information taken from Environment Canada’s oil database (ECCC 2001).

Numerous data sources and dozens of analyses are used to classify the different chemical and physical characteristics of the oil. As an example, this would include but not be limited to physical testing, distillation studies, weathering studies, measurements of chemicals (e.g. GCMS, PAH, alkanes, saturates, aromatics, resins, asphaltenes), emulsification studies, degradation studies, etc. All available data is used to classify each oil. When advanced analyses are not available, surrogate oils with more information are used to fill in data gaps and professional judgement and previous experience are used to further refine the oil characterization model inputs.

The “pseudo-component” approach is used to simplify the tracking of thousands of chemicals comprising oil for modelling (Payne et al. 1984, 1987; French et al. 1996; Jones 1997; Lehr et al. 2000). Chemicals in the oil mixture are grouped by physical-chemical properties, and the resulting component category behaves as if it were a single chemical with characteristics typical of the chemical group. In this component breakdown, aromatic (AR) groups are treated as both soluble (i.e., dissolve into the water column) and volatile (i.e., evaporate to the atmosphere), while the aliphatic (AL) groups are only volatile. The total hydrocarbon concentration (THC) within the boiling range of volatile components is the sum of all AR and AL components. The remainder of the oil is considered to be residual oil, which does not dissolve or volatilize but will degrade over time.

Environmental inputs (geographic and habitat data, ice cover, wind data, currents, water temperature and salinity) are provided in Appendix F.

15.2.6 Subsurface Model Blowout Results

In total, 171 unmitigated subsurface blowout release events were evaluated as part of this study. Oil and gas were introduced to the water column through a 21.6 cm (8.5 in) orifice near the seafloor at a rate of 22,640 and 20,190 m^3/d for West Flemish Pass 1 and West Flemish Pass 2, respectively, to simulate an uncontrolled release from the wellhead (i.e., a blowout). The modelled release depth ranged from 500 m (Site 2) to 1,500 m (Site 1) at the sediment / water interface at the two identified release locations. West Flemish Pass crude oil was modelled without the application of mitigation or response measures to exit each wellhead.

Graphical depictions of surface oil thickness, in-water concentrations, and shoreline and sediment contamination have been provided for stochastic and deterministic analyses. For each stochastic scenario, results images include both probability and minimum time for specific threshold exceedances. For deterministic scenarios, results include cumulative footprints of surface oil thickness, in-water concentrations, and shoreline and sediment contamination.

The results from both the unmitigated subsurface blowouts and topside releases presented below illustrate the spatial extent of the water surface and shoreline oil contamination. Stochastic results include:

- The probability footprints for surface oil in excess of 0.04 μm
- The corresponding minimum time for surface oil to exceed a threshold of 0.04 μm
- The probability footprints of shoreline oil in excess of 1 g/m^2
- The corresponding minimum time for surface oil to exceed a threshold of 1 g/m^2

The probabilities of oiling were based on a statistical analysis of the ensemble of individual trajectories modelled for each release scenario. Stochastic figures do not imply that the entire contoured area would be covered with oil in the event of a release, nor do they provide any specific information on the quantity of oil in a given area. Rather, these figures denote the probability of oil exceeding socioeconomic effects thresholds over all stochastic runs (171 individual releases for the annual scenario), at all modelled time steps (over 160 days), and for each point within the modelled domain. Note that only probabilities of ≥1% were included in the map output.

15.2.6.1 Stochastic Results

Stochastic analyses characterize results from many tens to hundreds of individual modelled releases. This study included 171 individual subsurface releases modelled for 160 days for each stochastic scenario. Modelled start times were distributed over a period of seven years of environmental data at two release sites (West Flemish 1 and West Flemish 2) to capture the natural variability in the environment. In total, four stochastic analyses were completed, totaling 684 individual trajectories. Each stochastic analysis was defined by release site and release duration (long or short). The release durations were consistent at each site with short/long subsurface blowouts lasting 30/123 days at West Flemish 1 and 27/135 days at West Flemish 2. These scenarios represent the time required to mobilize and implement a capping stack to contain the release (short) or mobilize and a drilling platform and drill a relief well (long). Water depth determines how long it takes the capping stack to be placed or the relief well to be drilled, hence the difference in flow durations between the two sites.

Because ice cover can affect the trajectory and fate of oil, individual model simulations within each stochastic scenario were broken into two groups based upon the specific modelled time period and associated presence or absence of ice cover. Statistics for all 171 releases within a stochastic scenario are referred to as “annual,” as they include all releases in any month over the course of the entire seven-year period. Sea-ice coverage in the region is present in specific regions from November through April, while May through October is mostly ice-free. Modelled releases with the majority of their simulated days (>80 of the 160-day modelled duration) experiencing mostly ice-free periods are referred to as “summer” simulations (89 modelled releases), while those releases with a majority of days experiencing periods with sea-ice coverage are referred to as “winter” simulations (82 modelled releases). Sea-ice coverage very rarely extended far enough offshore to reach within kilometers of the release locations, and when it did, <10% ice coverage was predicted. However, sea ice was present along most of the coastline in winter months, with February typically having the largest expanses of 90-100% sea-ice coverage.

The figures presented within this section illustrate the predicted spatial extent of surface floating oil, water column contamination, and shoreline contact above the conservative socio-economic thresholds (Table 15.2). They include both the probabilities and associated minimum times to threshold exceedance for the four hypothetical release scenarios (Tables 15.7 and 15.8). The probability maps define the area of potential exposure and the associated probability with which sea surface oil, water column contamination, or shoreline oil are expected to exceed the specified socio-economic thresholds at any point in time throughout each of the 171 simulations with 160-day modelled duration. The colored contours in the stochastic maps specify the probability boundaries for areas that may experience oil at or above the specified thresholds for each release scenario. Darker color contours denote areas that are more likely to exceed the specified threshold, but do not denote higher concentrations (e.g., the figure indicates that a threshold has been exceeded, but not by what amount). Lighter color contours depict regions that are less likely to exceed the specified threshold. Note that the lightest mint-green line represents areas where oil may exceed the specified threshold in only 1% of modelled simulations. In other words, the likelihood that any oil exceeding the identified threshold would leave the area bounded by the mint-green line is <1% out of 171 individual simulations. The area between the 1% contour and the next (10%) has between a 1 to 10% probability of exceeding the threshold, based upon the environmental variability and given that the modelled release scenario has occurred.

Table 15.7 Summary of Threshold Exceedance Information Predicted at West Flemish 1 and West Flemish 2 for Surface, Water Column, and Shoreline Oil Exposure within the Modelled Domain by Season (annual, winter, summer)

Hypothetical Stochastic Scenario Parameters				Areas Exceeding Threshold (km²)		
Component and Threshold	**Spill Location**	**Scenario**	**Probability Contour or Bin***	**Annual Results**	**Winter (ice cover)**	**Summer (ice-free)**
Surface Oil >0.04 µm, on average	West Flemish 1	30-day release	1%	3,447,000	3,477,000	3,270,000
			10%	2,676,000	2,892,000	2,521,000
			90%	655,300	580,600	772,100
		123-day release	1%	3,574,000	3,613,000	3,343,000
			10%	2,958,000	3,091,000	2,809,000
			90%	1,214,000	1,189,000	1,358,000
	West Flemish 2	27-day release	1%	3,474,000	3,518,000	3,276,000
			10%	2,610,000	2,778,000	2,510,000
			90%	696,800	579,600	819,000
		135-day release	1%	3,579,000	3,625,000	3,382,000
			10%	2,935,000	3,036,000	2,745,000
			90%	1,423,000	1,408,000	1,492,000
Water Column Dissolved Hydrocarbons >1 µg/L at some depth within the water column	West Flemish 1	30-day release	1%	2,811,000	3,040,000	2,709,000
			10%	1,877,000	1,955,000	1,830,000
			90%	174,800	203,900	155,200
		123-day release	1%	2,855,000	3,094,000	2,798,000
			10%	2,093,000	2,178,000	2,024,000
			90%	617,100	582,700	724,300
	West Flemish 2	27-day release	1%	2,743,000	3,006,000	2,715,000
			10%	1,922,000	1,971,000	1,868,000
			90%	219,300	254,600	192,600
		135-day release	1%	2,846,000	3,060,000	2,809,000
			10%	2,116,000	2,180,000	2,049,000
			90%	800,300	752,100	851,000

Table 15.7 Summary of Threshold Exceedance Information Predicted at West Flemish 1 and West Flemish 2 for Surface, Water Column, and Shoreline Oil Exposure within the Modelled Domain by Season (annual, winter, summer)

Hypothetical Stochastic Scenario Parameters				Areas Exceeding Threshold (km^2)		
Component and Threshold	**Spill Location**	**Scenario**	**Probability Contour or Bin***	**Annual Results**	**Winter (ice cover)**	**Summer (ice-free)**
Lengths Exceeding Threshold (km)						
Shoreline Oil >1 g/m^2, on average	West Flemish 1	30-day release	1 - 5%	2,481	2,048	147
			5 - 15%	58	942	-
			15 - 30%	-	-	-
			All Probabilities	2,539	2,990	147
		123-day release	1 - 5%	2,189	1,343	523
			5 - 15%	1,303	1,879	81
			15 - 30%	6	624	-
			All Probabilities	3,498	3,846	604
	West Flemish 2	27-day release	1 - 5%	1,747	1,779	325
			5 - 15%	36	365	15
			15 - 30%	-	-	-
			All Probabilities	1,783	2,144	330
		135-day release	1 - 5%	1,971	1,345	598
			5 - 15%	848	1,454	222
			15 - 30%	28	337	-
			All Probabilities	2,847	3,136	820

Notes:

Predicted areas (km^2) exceeding surface and water column thresholds are provided for the >1%, 10%, or 90% likelihood of exposure to oil contours. The predicted length (km) of shoreline susceptible to exposure by oil is provided at 1-5%, 5-15%, and 15-30% contoured intervals.

*Bins are based on stochastic probabilities; for example, 655,300 km^2 of the ocean surface is predicted to exceed the 0.04 µm surface oil threshold in 90% of the 171 modelled simulations from the hypothetical 27-day release at West Flemish 1 over the entire 160-day modelled duration.

Table 15.8 Shoreline Contamination Probabilities and Minimum Time for Oil Exposure Exceeding 1 g/m² for All Shorelines

Spill Location	Hypothetical Scenario	Scenario Timeframe	Average Probability of Shoreline Oil Contamination (%)	Maximum Probability of Shoreline Oil Contamination (%)	Minimum Time to Shore (days)	Maximum Time to Shore (days)
West Flemish 1	30-day release	Annual	2.6	7.0	26.4	140.5
		Winter	4.4	15.0	11.4	153.3
		Summer	1.9	4.0	11.4	128.5
	123-day release	Annual	5.1	18.0	11.2	155.4
		Winter	8.7	28.0	11.2	161.2
		Summer	2.4	12.0	26.1	159.6
West Flemish 2	27-day release	Annual	2.2	6.0	11.2	135.3
		Winter	3.4	12.0	11.2	155.8
		Summer	1.8	7.0	32.1	142.7
	135-day release	Annual	4.9	19.0	10.9	155.7
		Winter	7.5	28.0	10.9	159.9
		Summer	3.7	15.0	27.5	159.7

The probabilities of oil exposure were calculated from a statistical analysis of the ensemble of individual trajectories modelled for each release scenario. The fundamental assumption for this modelling was that an unmitigated release occurred. Therefore, probability contours should be interpreted as “In the unlikely event of a release, the probability that any one specific area may experience contamination above the specified threshold is X%.” Stochastic figures do not imply that the entire contoured area would be covered with oil in the event of a single release, nor do they provide any information on the quantity of oil in a given area. Additionally, these figures do not provide the likelihood of a blowout occurring in any given year. Rather, these stochastic figures denote the probability that contamination may exceed identified socio-economic thresholds at any modelled time step (over 160 days), for each point within the modelled domain, assuming a release were to occur at some point in time.

The stochastic maps depicting water column contamination by dissolved hydrocarbon concentrations do not specify the depth at which the threshold exceedance occurs. The maps depict the vertical maximum at any time during or after the release. Thus, images do not imply that the entire water column (i.e., from surface to bottom) will experience a concentration above the threshold, but rather a threshold may be exceeded at a specific depth (typically within a few metres from the surface) in the mapped location.

The minimum time footprints correspond with the associated probability of oil exposure maps. Each figure illustrates the shortest amount of time required (from the initial release) for each point within the footprint to exceed the defined threshold. The time reported is the minimum value for each point considering the entire ensemble of trajectories. Together, probability and minimum time figures can be interpreted to read: “There is X% probability that oil is predicted to exceed the identified threshold at a specific location, and this exceedance could occur in as little as Y days.”

The Exclusive Economic Zones (EEZ) in the North Atlantic, as well as the international border, are depicted on each map to provide context for the spatial extent and potentially affected territorial waters from any potential release (VLIZ 2014).

All figures depict data where the probability of a region exceeding the threshold is >1%. When comparing annual to seasonal results, the predicted percent exceedance depends on the total number of releases investigated in each subset of releases. Therefore, while only one scenario might be required to exceed the 1% threshold for visualization in seasonal results (82 or 89 modelled simulations), two scenarios would be required to exceed the same threshold in the annual analysis due to a greater number (171 modelled simulations) of modelled releases in the annual set of simulations being analyzed. Figures depicting stochastic results are provided for surface oil thickness >0.04 µm, dissolved hydrocarbon contamination >1 µg/L, and shoreline contact >1g/m² for annual scenarios for the two release sites (Figures 15-4 to 15-15). Results for the summer and winter scenarios are provided in Appendix F.

15.2.6.1.1 West Flemish Pass 1 – Hypothetical 30-Day Release

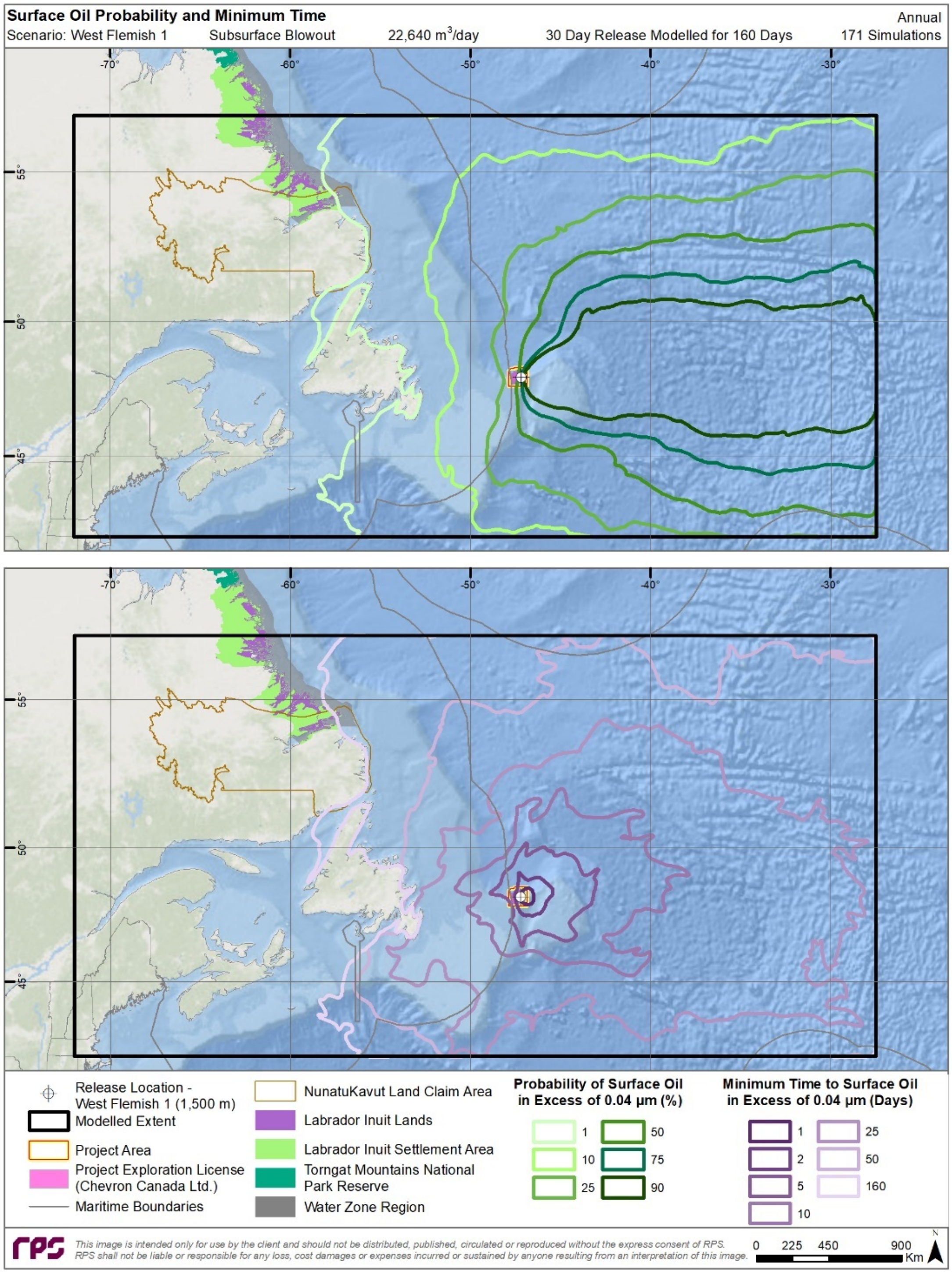


Figure 15-4 Annual probability of surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 30-day subsurface blowout at West Flemish 1

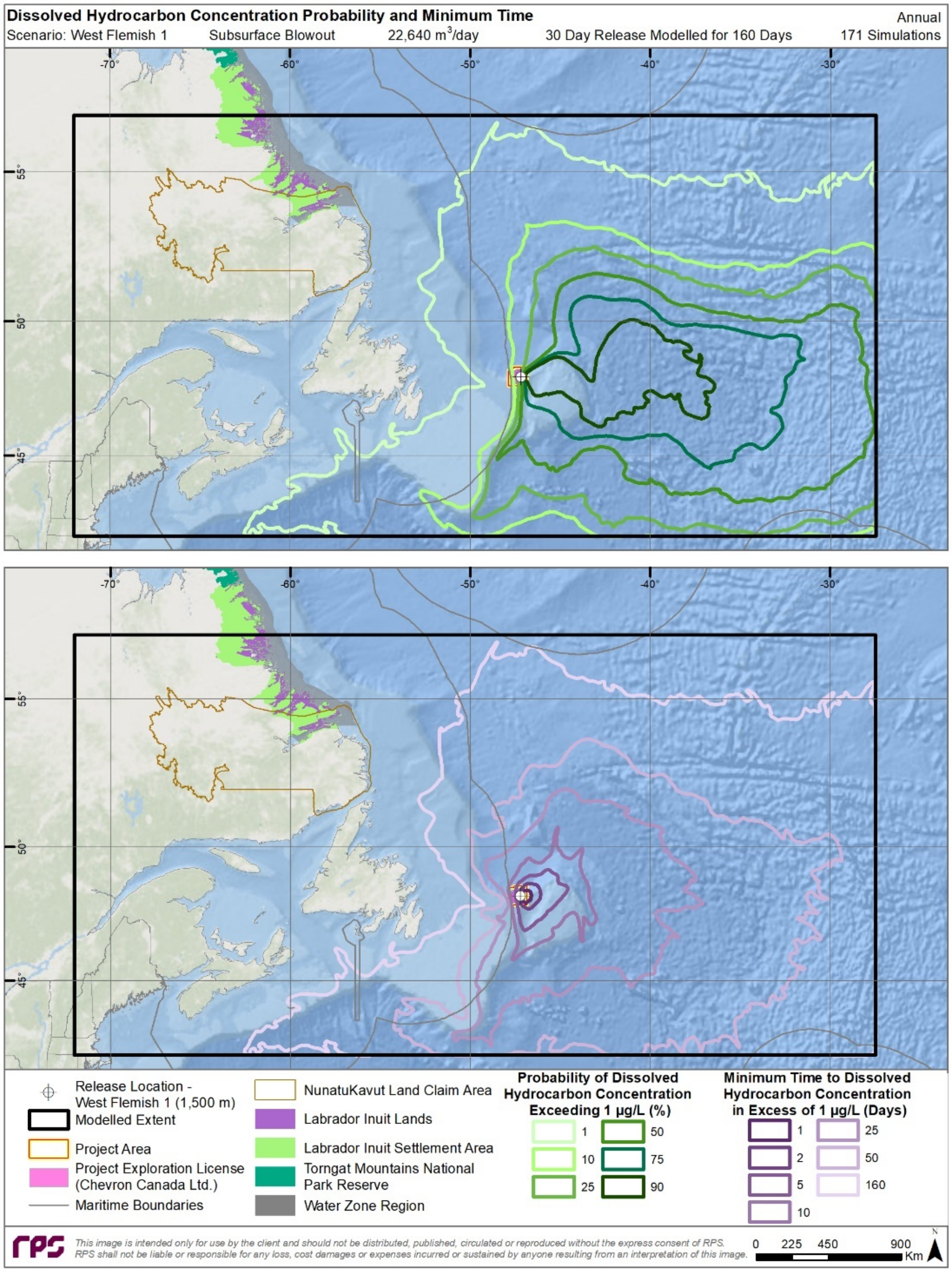


Figure 15-5 Annual probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 30-day subsurface blowout at West Flemish 1

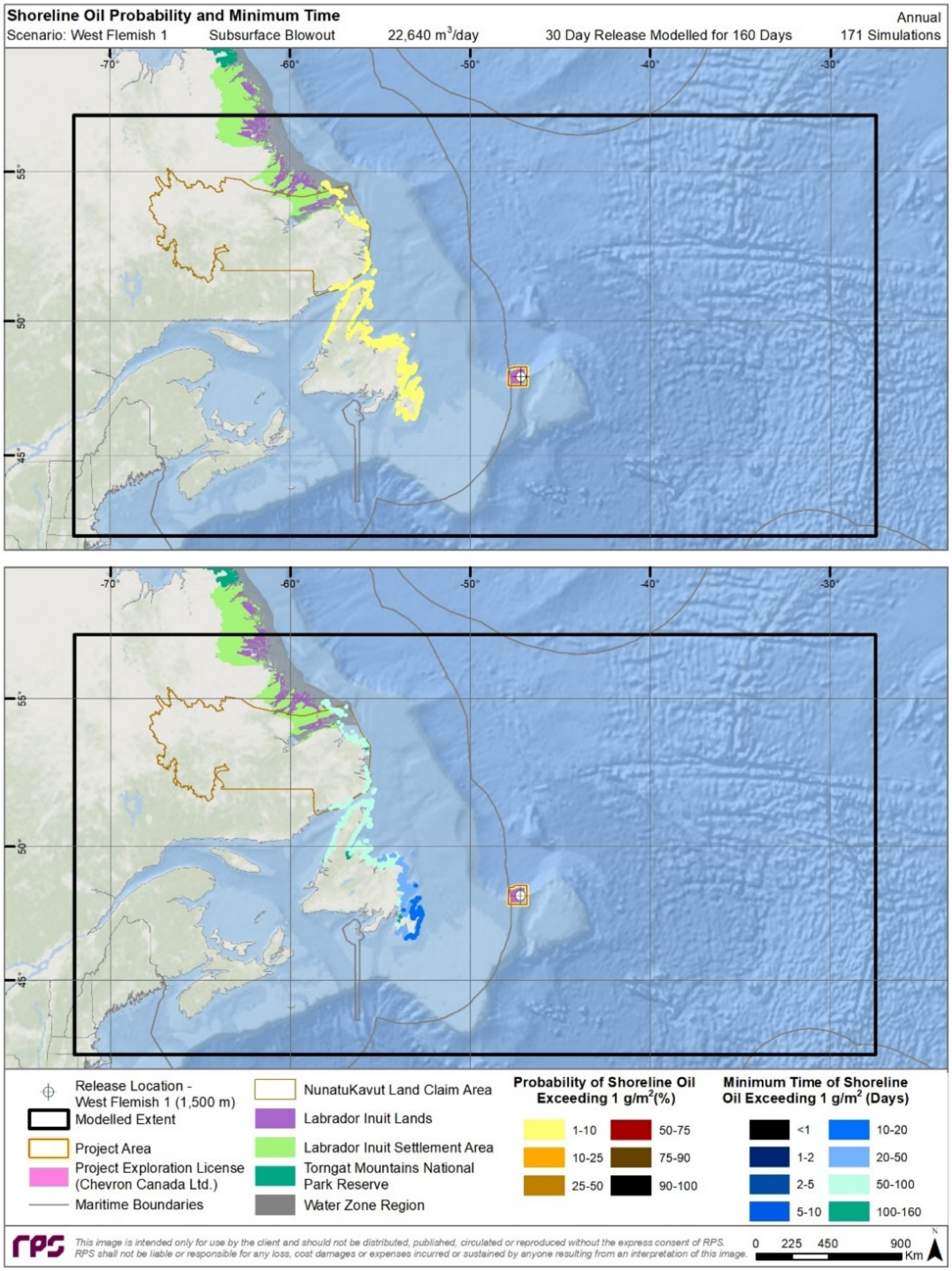


Figure 15-6 Annual probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 30-day subsurface blowout at West Flemish 1

15.2.6.1.2 West Flemish Pass 1 – Hypothetical 123-Day Release

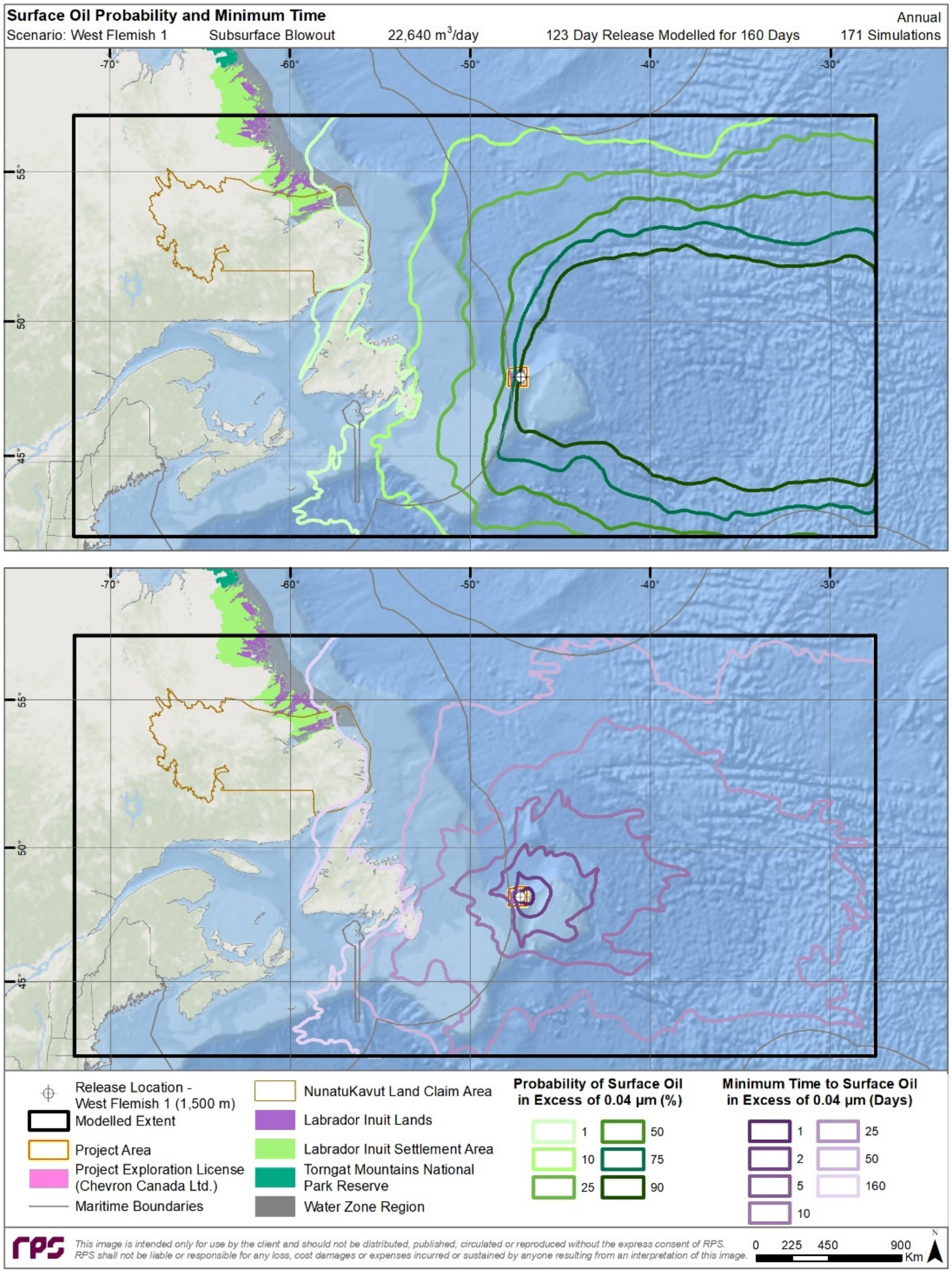


Figure 15-7 Annual probability of surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 123-day subsurface blowout at West Flemish 1

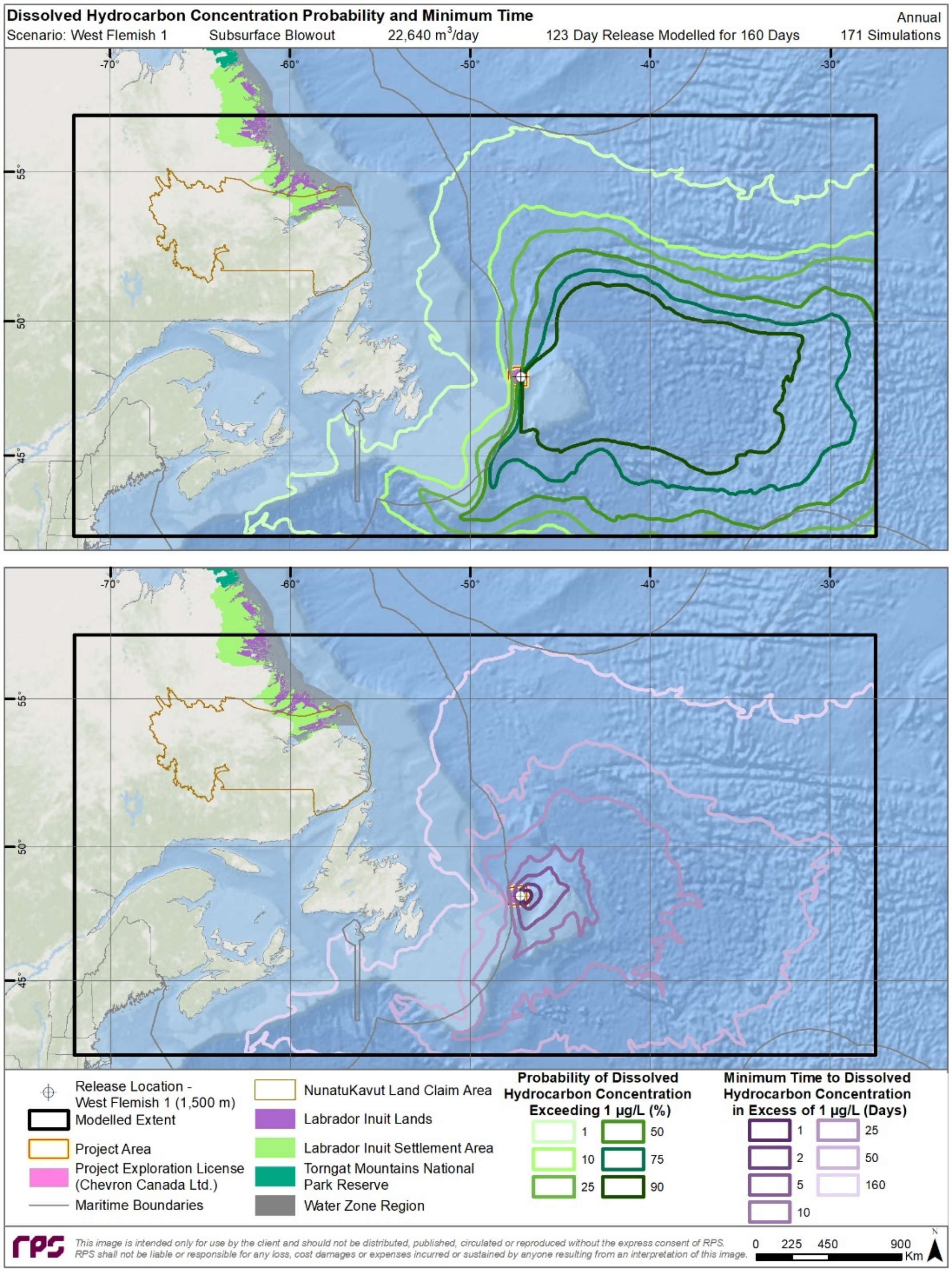


Figure 15-8 Annual probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 123-day subsurface blowout at West Flemish 1

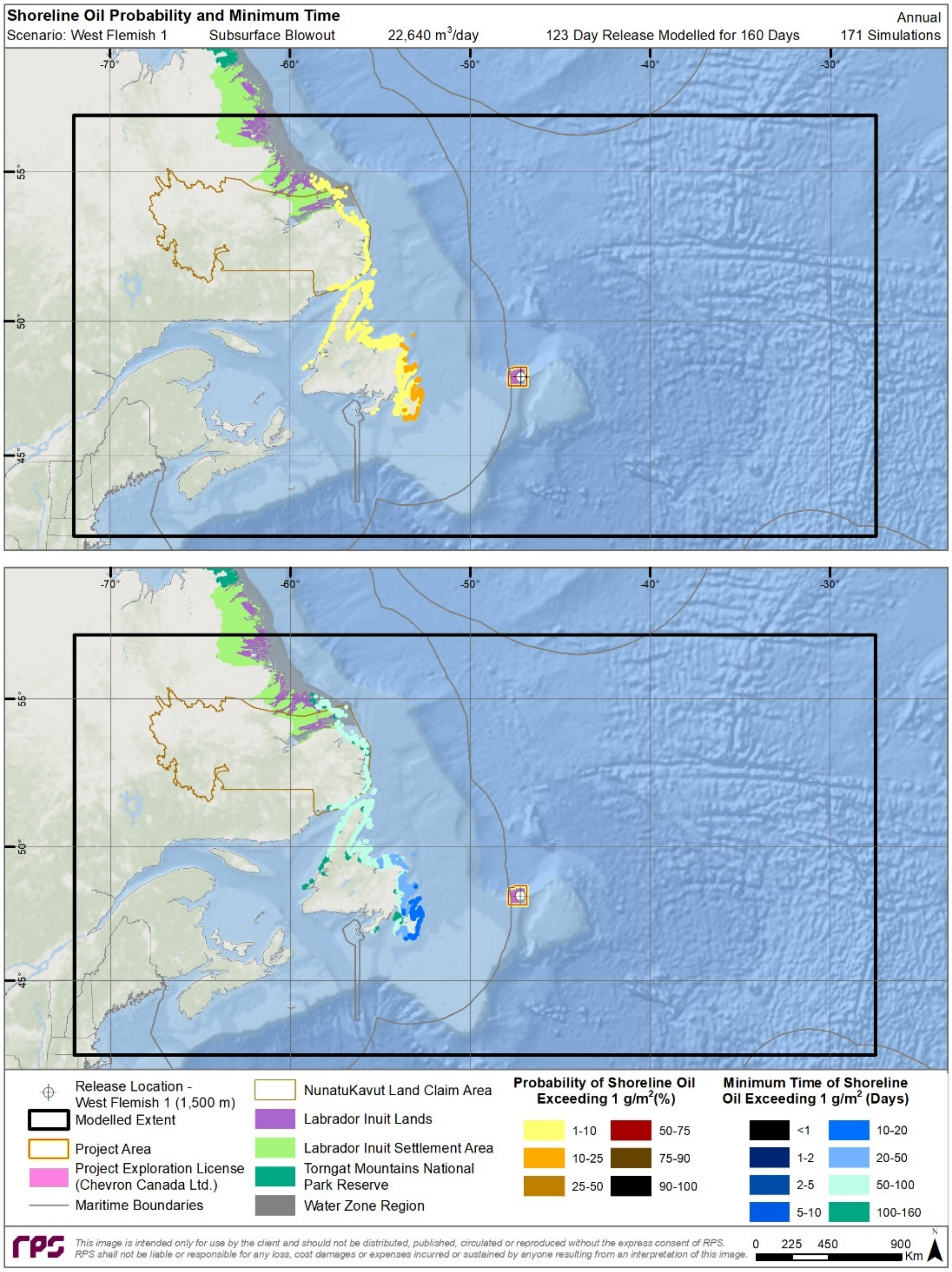


Figure 15-9 Annual probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 123-day subsurface blowout at West Flemish 1

15.2.6.1.3 West Flemish Pass 2 – Hypothetical 27-Day Release

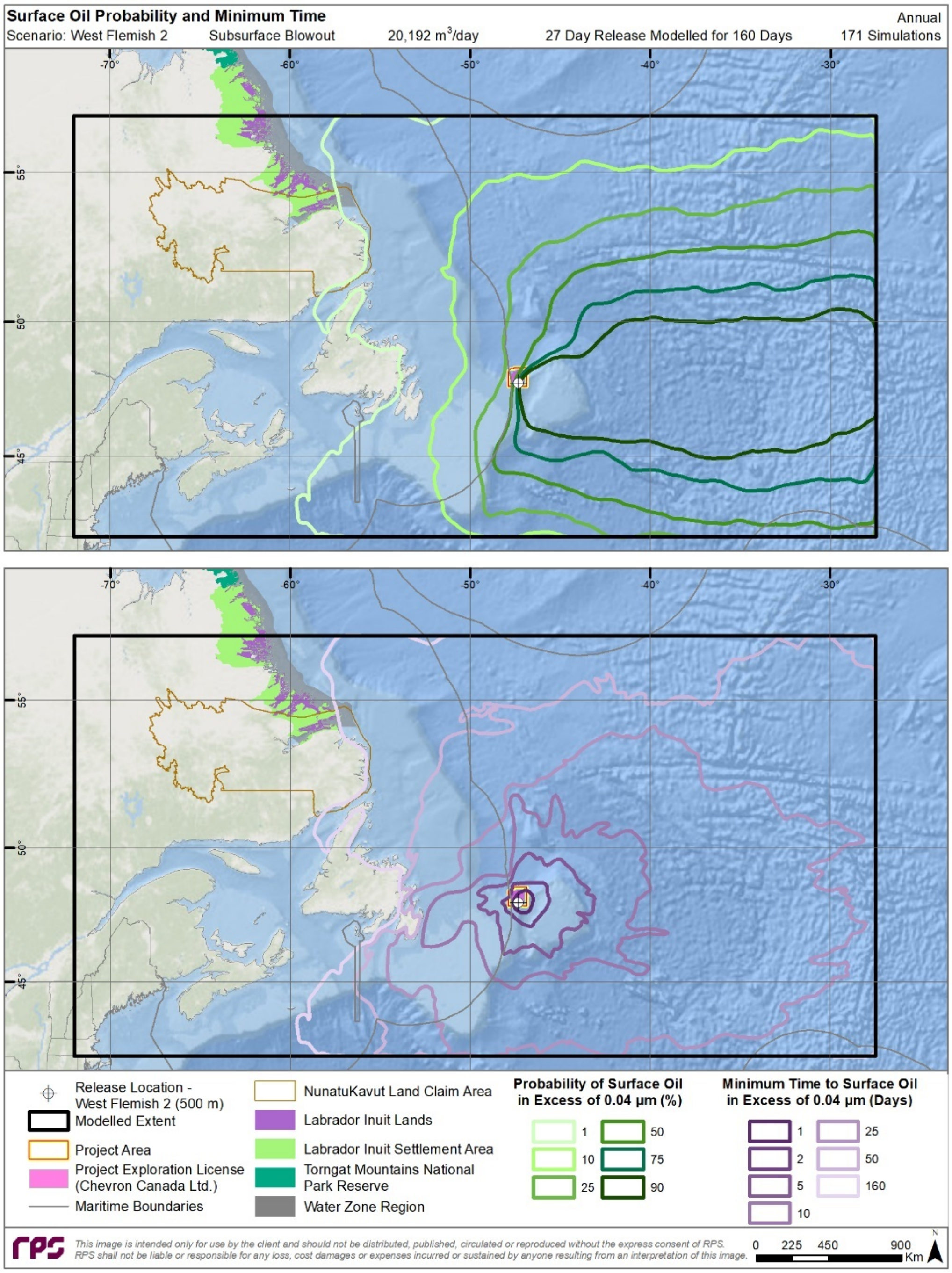


Figure 15-10 Annual probability of surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 27-day subsurface blowout at West Flemish 2

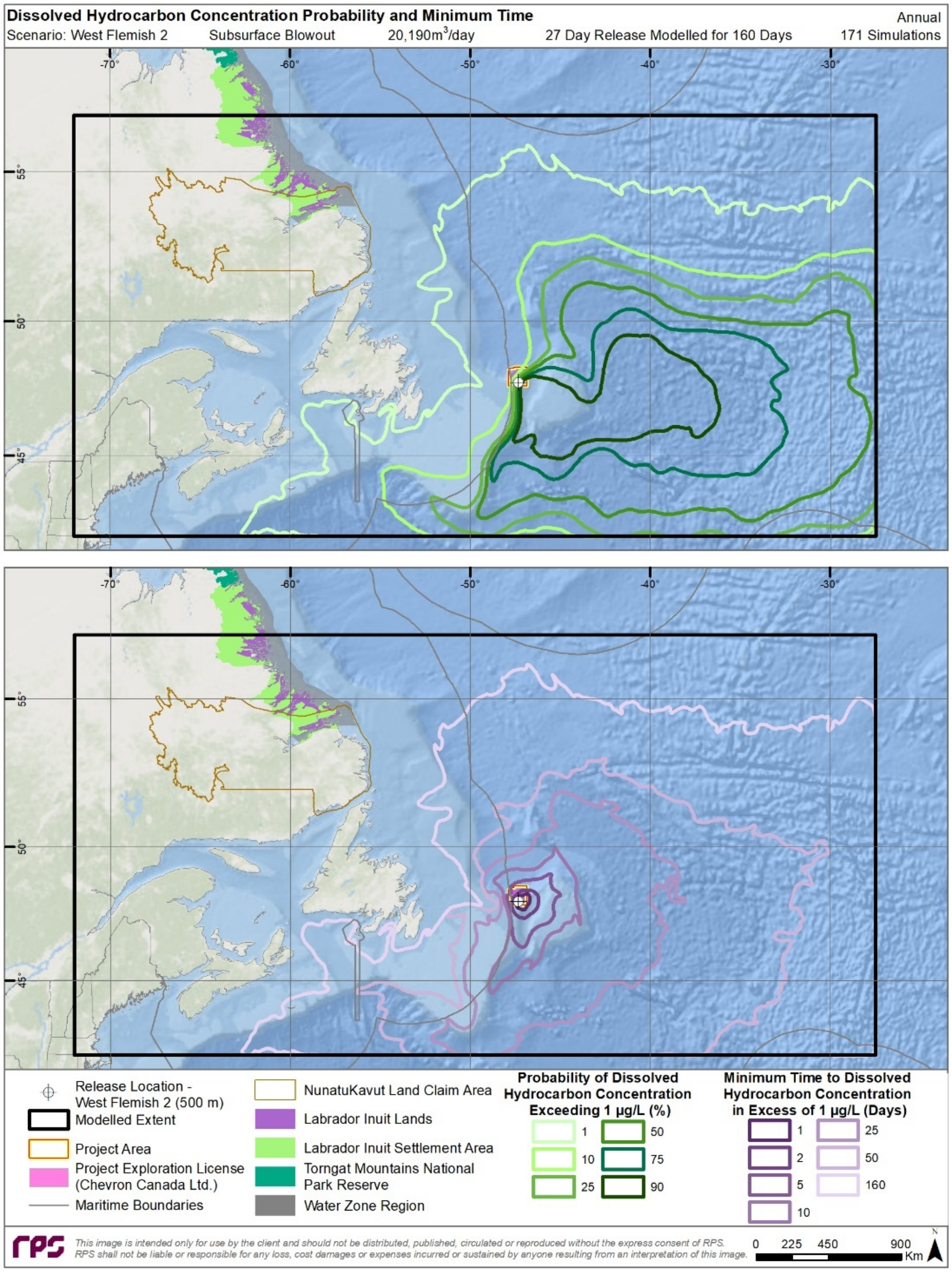


Figure 15-11 Annual probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 27-day subsurface blowout at West Flemish 2

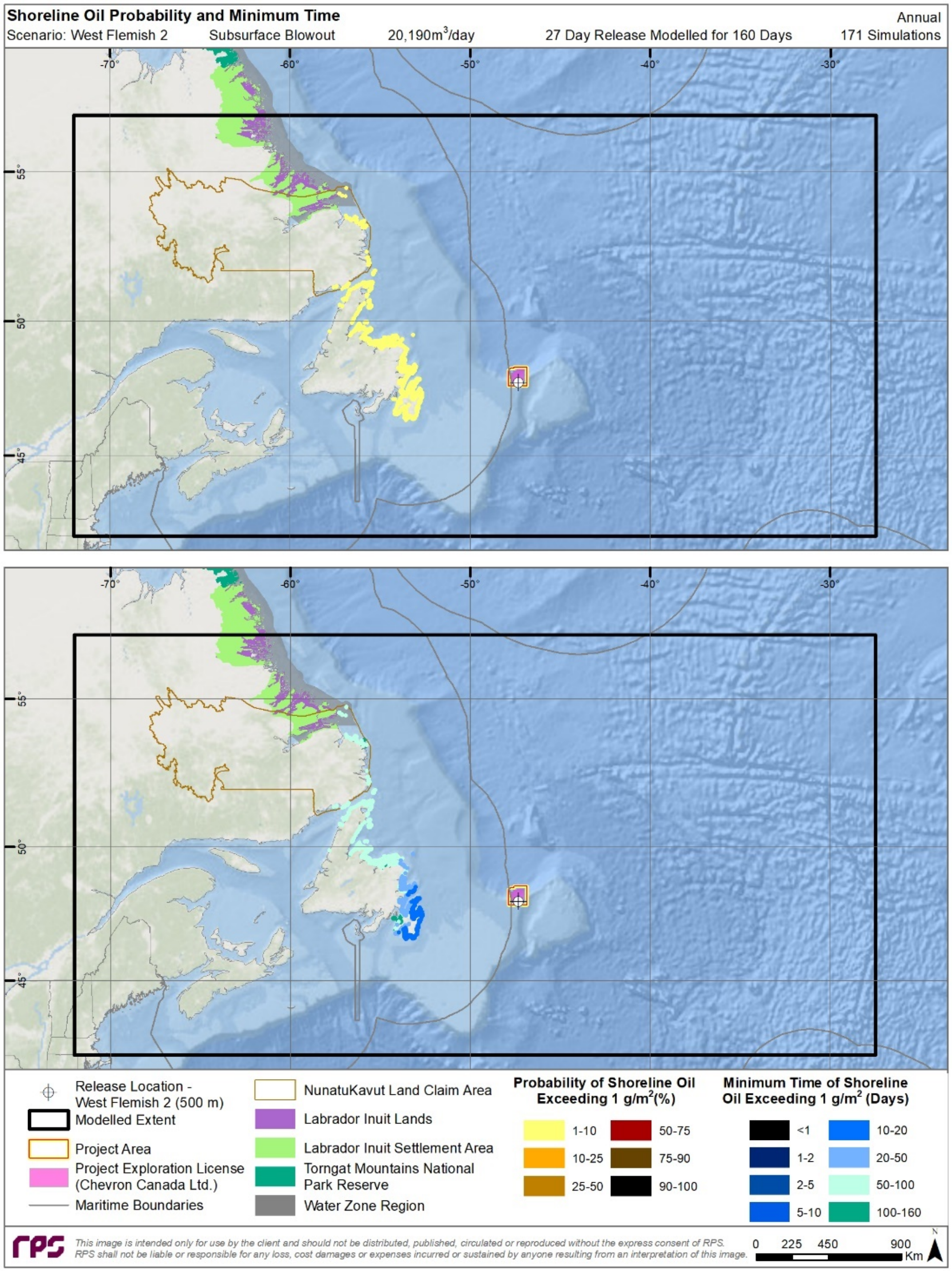


Figure 15-12 Annual probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 27-day subsurface blowout at West Flemish 2

15.2.6.1.4 West Flemish Pass 2 – Hypothetical 135-Day Release

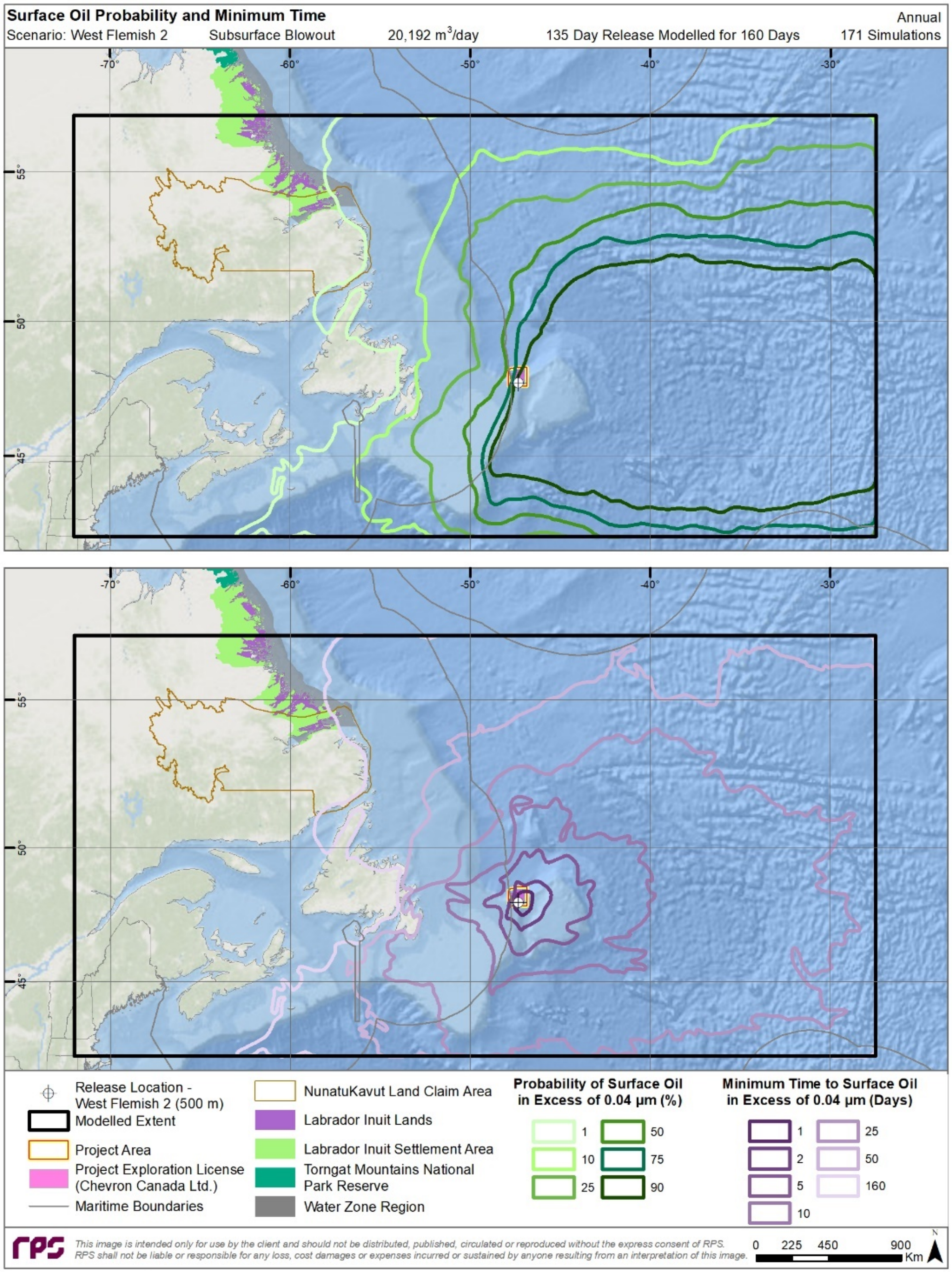


Figure 15-13 Annual probability of surface oil thickness >0.04 µm (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 135-day subsurface blowout at West Flemish 2

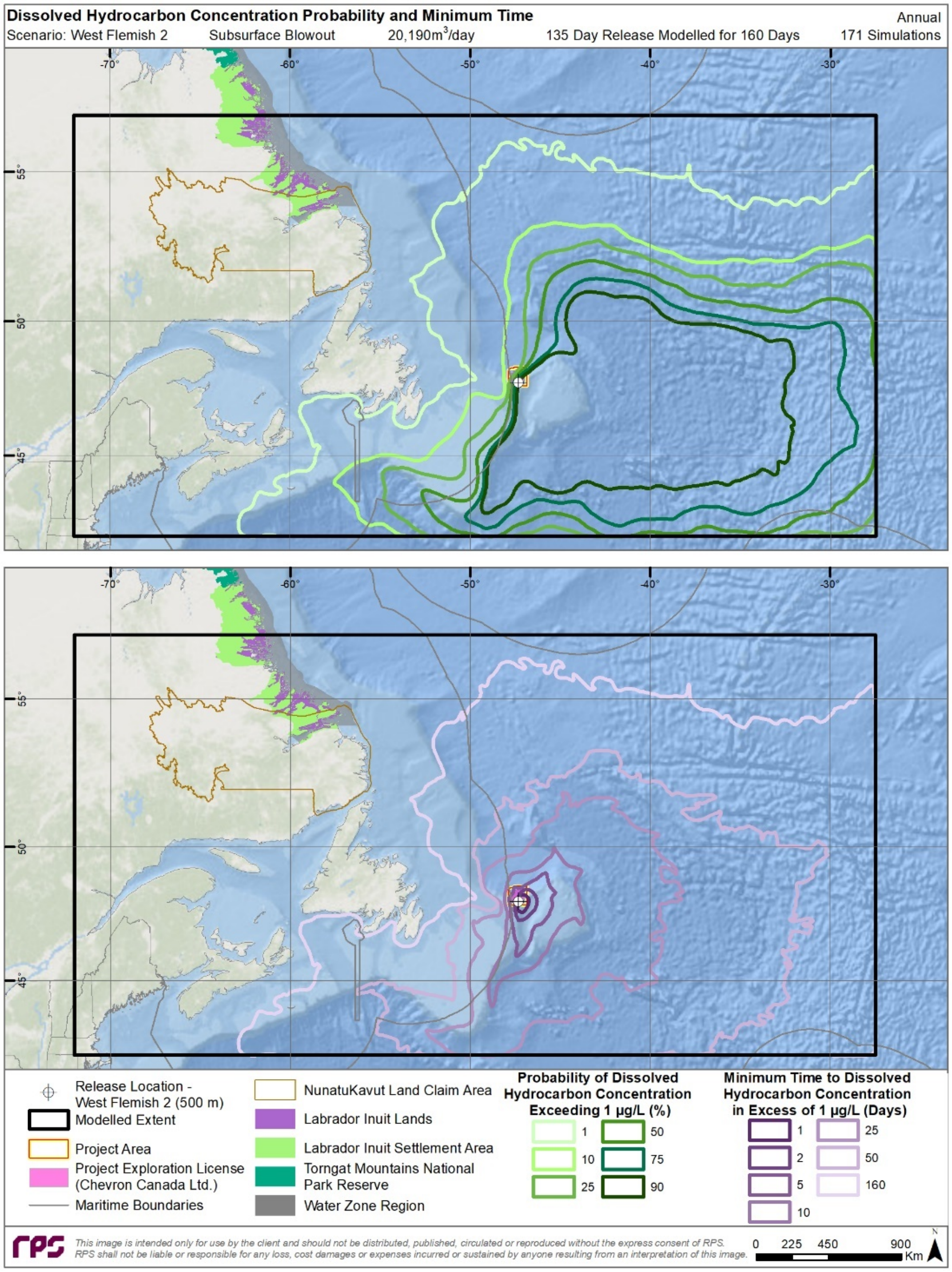


Figure 15-14 Annual probability of dissolved hydrocarbon concentrations >1 µg/L at some depth in the water column (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 135-day subsurface blowout at West Flemish 2

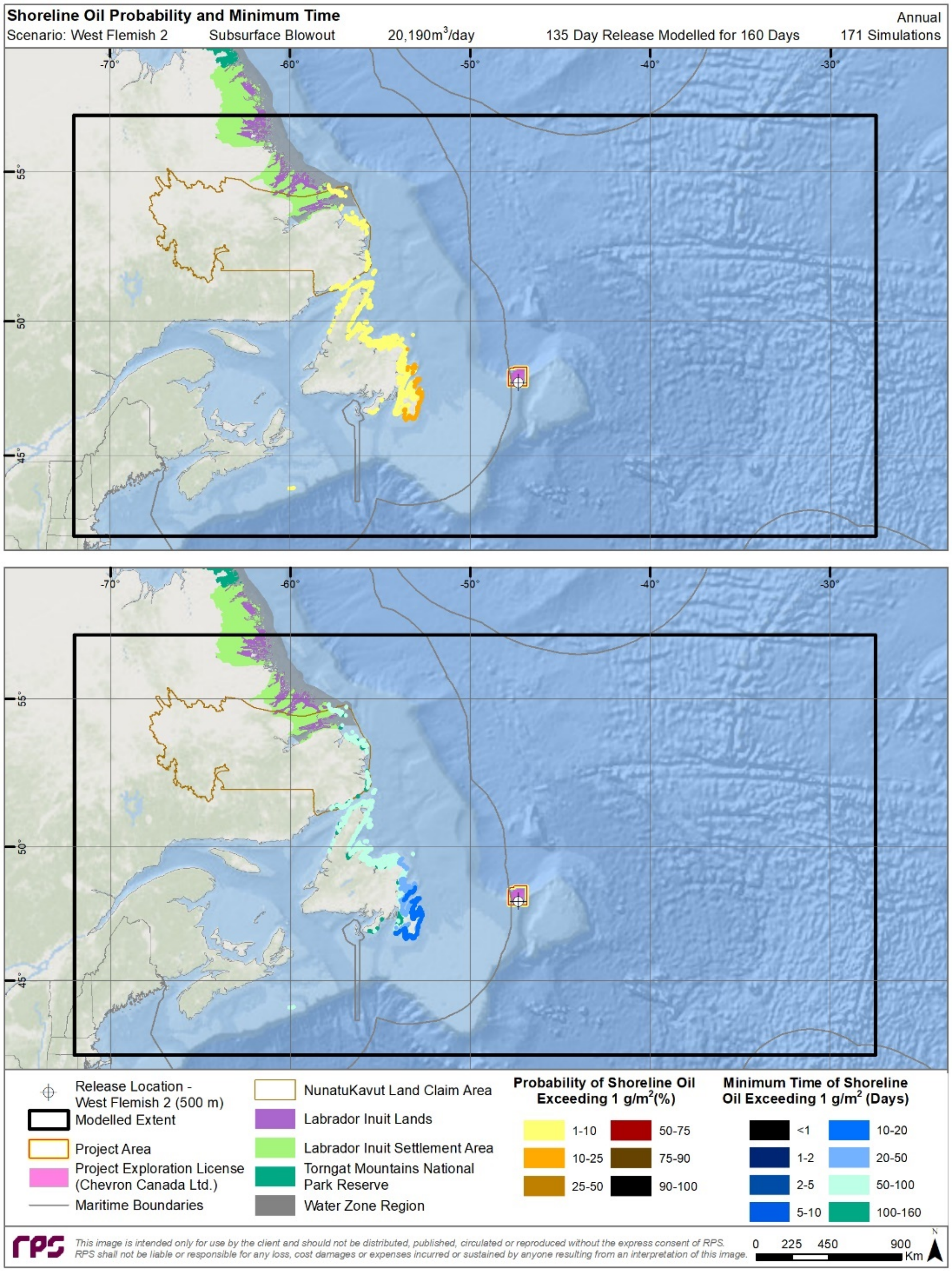


Figure 15-15 Annual probability of shoreline contact >1 g/m² (top) and minimum time to threshold exceedance (bottom) predictions resulting from a 135-day subsurface blowout at West Flemish 2

15.2.6.1.5 Summary of Stochastic Results

For both release sites, summaries of the stochastic analyses of potential surface oil and water column exposure by dissolved hydrocarbons depict areas to the east of the release sites as having the highest potential likelihood (>90%) to exceed conservative socio-economic thresholds. The >90% likelihood area typically extended over 1,500 km to the east to the edge of the model domain for the surface oil, but typically fell short of the boundary for the water column contamination with the 50% line making contact with the easternmost extent. This is the result of the WFPLO being persistent, resulting in emulsified oil on the surface. The soluble and volatile fraction making up the water column contamination was more likely to evaporate and degrade over the amount of time required for oil to be transported to the easternmost boundary. Predicted water column probability footprints were smaller than surface oil footprints, with the probability of threshold exceedance predicted to decrease more rapidly for water column results as distance from the release site increased (Table 15.7). In nearly all stochastic scenarios, lower probabilities of threshold exceedance are predicted for surface and/or water column oil contamination to the north and south, while generally <25% of releases have the potential to exceed socio-economic thresholds >100 km to the west of the Project Area.

Due to the primarily eastward transport of oil from wind and currents, and the distance of the Project Area to the shoreline of Newfoundland, the average probability of Canadian shoreline exposure above the threshold for the four stochastic scenarios was approximately 8.7% (Table 15.8). As the Labrador current flowed southward along the continental shelf, it was predicted to transport subsurface oil to the south, parallel to the coast. However, this trend is generally absent in the surface oil projections as wind forcing was more likely to transport oil to the east. Oil that was predicted to make its way to the shoreline of Canada would be patchy and discontinuous due to the considerable amount of weathering and natural dispersion that would take place over the weeks or months that were required for oil to reach shore. The minimum time to shorelines for threshold exceedance was 10.9-32 days along the Avalon peninsula and southeastern Newfoundland and 50-100 days along the shores of the northern shores of Newfoundland, eastern Gulf of St. Lawrence, and southwestern Labrador. While oil was predicted to enter the EEZ for the United States in one of the 684 simulations over four stochastic scenarios that were modelled for 160 days, no oil was predicted to strand on U.S. shorelines in any of the simulations.

Although minimal, there was some level of seasonal variability in spill behavior. Regardless of release site and duration, the average stochastic probability of shoreline oiling was consistently about two times higher for winter releases (3.4-8.7%) than for summer releases (1.8-3.7%) (Table 15.8). Similarly, the minimum time to shoreline threshold exceedance was about 2-3 times longer in the summer (26-32 days) than the winter (10.9-11.4 days) (Table 15.8).

Due to the similarities in release location, rate, and duration of the scenarios modelled at West Flemish 1 and West Flemish 2, the stochastic analysis results were not very different between sites. Both sites had comparable footprints predicted for 90% probability surface oil threshold exceedances.

As stated previously, stochastic figures do not imply that the entire contoured area would be covered with oil in the event of a single release, nor do they provide any information on the quantity of oil in each area. Furthermore, the largest-area threshold exceedance footprints from the annual results are not the expected exposure from any single release of oil, but rather areas where there is >1% probability that exposure above the highly conservative socio-economic threshold could occur, based on the combination of either 171 (annual), 89 (summer), or 82 (winter) individual releases analyzed together.

15.2.6.2 Deterministic Results

Individual trajectories of interest were selected from the stochastic ensemble of results for the deterministic analysis. The deterministic trajectory and fate simulations provided an estimate of the transport of oil through the environment as well as its physical and chemical behavior for the specific set of modelled environmental conditions. Representative 95th percentile credible “worst-case” trajectories for surface oil exposure, water column contamination, and contact with shoreline were identified from the stochastic scenarios for each site modelled (West Flemish 1 or 2) and release duration (i.e., 30 vs 123 days or 27 vs. 135 days). These highly conservative individual cases were selected based upon the size of the surface oil footprint, volume of oil in the water column, and the length of shoreline contacted with oil. This resulted in twelve individual trajectories associated with subsurface blowouts of WFPLO. One additional batch spill of marine diesel (1,000 L) was modelled at the West Flemish 1 location.

The following sections contain figures corresponding to each identified representative case and tables summarizing the areas exceeding specified thresholds. During modelling, components of oil were tracked as floating surface oil, entrained droplets of whole oil, dissolved hydrocarbon constituents, stranded oil on shorelines and sediments, evaporated, degraded, and left the model domain. The figures provided depict the cumulative footprint of all oil predicted to be within a region over the entire modelled duration. Therefore, the depicted footprints are much larger than the amount of oil that would be present in a region at any given time following the release of oil. This concept is illustrated in Figure 5-16 which portrays predicted surface oil thickness at five specific time steps or “snapshots” in time (days 2, 10, 50, 100, and 160) for the 95th percentile surface oil thickness case for the hypothetical 123-day release at West Flemish 1. Note the patchy and discontinuous nature of the predicted footprint as the released oil dispersed and thinned over time. Figure 15-16 portrays the cumulative footprint for the exact same simulation. The area covered is much larger, depicting the maximum surface oil thickness that was predicted to occur at each location over the entire modelled time period. The remaining figures in this report will depict cumulative footprints as opposed to “snapshots” at given time steps to provide conservative estimates of potentially affected areas.

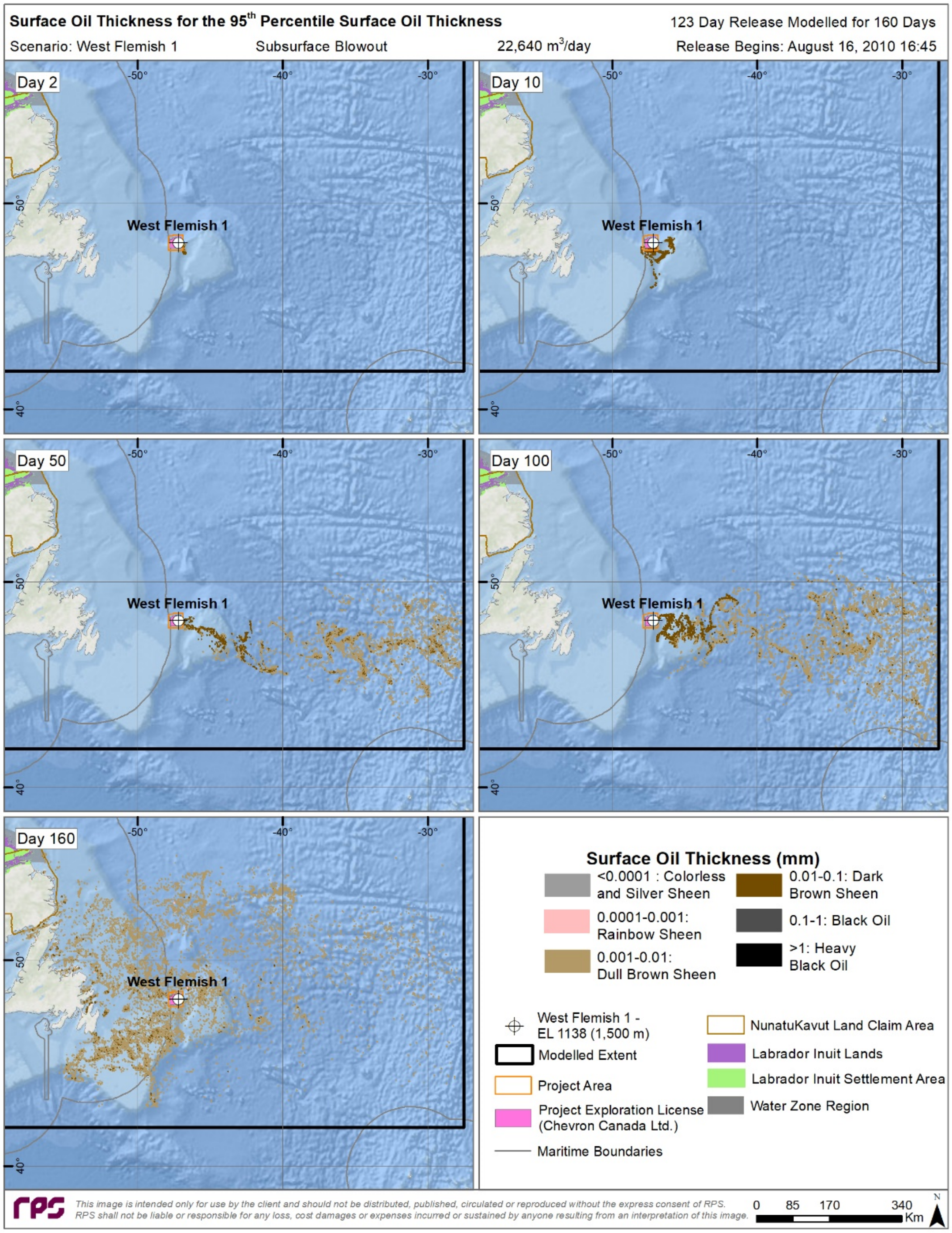


Figure 15-16 **Predicted surface oil thickness for the 95th percentile surface oil exposure case for the hypothetical 123-day release at West Flemish 1 at days 2, 10, 50, 100, and 160 to illustrate the variation in size of the surface oil footprint over the course of the model duration**

The types of figures that were used to summarize modelling results are provided, along with brief descriptions of the information that they portray. Note that the thicknesses and concentrations for the modelled blowouts were calculated on a grid with a resolution (i.e., grid cell size) of 1,800 m by 2,500 m, which is equivalent to 0.02 degrees by 0.02 degrees. For concentration grids, vertical binning included 50 m increments over the entire water column.

1. Mass Balance Plots: Illustrate the predicted weathering and fate of oil for a specific run over the entire model duration as a fraction of the oil released up to that point. Components of the oil tracked over time include the amount of oil on the sea surface, the total entrained hydrocarbons in the water column, the amount of oil in contact with the shore or sediments, the amount of oil evaporated into the atmosphere, and the amount of oil degraded (accounts for both photo-oxidation and biodegradation).
2. Surface Oil Thickness Maps: Depict the predicted footprint of maximum floating surface oil and the associated oil thicknesses (mm) over all modelled time steps for an individual release simulation. The minimum thickness of surface oil >0.04 μm is displayed (cumulative over all modelled time steps). Note that floating oil mass is calculated as an average over grid cells, thus in reality, the oil would be patchy and discontinuous and could be thinner or thicker within particular areas of a single grid cell.
3. Water Column Dissolved Hydrocarbon Concentration (DHC) Maps: Depict the predicted footprint of the vertical maximum water column concentration of dissolved hydrocarbons over all modelled time steps for an individual release simulation. Dissolved hydrocarbons are the constituents of the oil with the greatest potential to affect water column biota. Only concentrations above 1 μg/L for the representative cases are displayed.
4. Water Column THC Maps: Depict the predicted footprint of the vertical maximum water column concentration of total hydrocarbons over all modelled time steps for an individual release simulation. Only concentrations above 1 μg/L for the representative cases are displayed.
5. Shoreline and Sediment THC Maps: Depict the predicted total mass of oil (per unit area as g/m²) deposited onto the shoreline and on sediments.

15.2.6.2.1 Representative Cases: Surface, Water Column, and Shoreline Oil

For the representative credible “worst-case” deterministic scenarios at West Flemish 1 and West Flemish 2, subsurface oil was predicted to rise through the water column where it surfaced and predominantly was transported to the east and south. In several simulations, oil was predicted to strand on the Newfoundland shoreline, as well as to a lesser extent the southern shores of Labrador and even Sable Island, over the unmitigated releases modelled for 160 days. In each scenario, nearly half of the oil was predicted to evaporate, while a third was predicted to degrade by natural processes (Table 15.9). Of the remaining roughly 15-20% of the released oil, 1-15% was predicted to remain on the surface, <2% remain in the water column, <0.1% to 0.4% stranded on shorelines, and <0.1% settled onto sediments over 160 days (Table 15.10). Because the simulations were so long, between 3.6 to 21.2% of the oil (predominantly surface oil as heavily weathered emulsifications and tar balls) was predicted to leave the model domain to the east. Note that all scenarios assume a completely unmitigated release, which is an unlikely situation because various emergency response tactics would typically be employed immediately in the event of a spill.

Table 15.9 Representative Deterministic Cases and Associated Areas, Lengths, and Volumes Exceeding Specified Thresholds for 95th Percentile Surface, Water Column, and Shoreline Contact Trajectories at the Hypothetical West Flemish 1 and 2 Sites and Batch Spill

Hypothetical 95th Percentile Scenario	Site	Released Volume	Approximate Surface Area exceeding thickness thresholds (km²)		Approximate Shore Length exceeding mass per unit area thresholds (km)		Approximate Subsurface Volume exceeding THC threshold (km³)
			Socio-economic (0.04 µm)	Ecologic (10 µm)	Socio-economic (1 g/m²)	Ecologic (100 g/m²)	Socio-economic* (1 µg/L)
Subsurface Blowout Releases							
Surface oil exposure case- 30 d	West Flemish 1	679,200 m³ (22,640 m³/d)	2,800,000	888,200	935	425	66,720
Water column case- 30 d			1,221,000	673,200	-	-	77,410
Shoreline contact case- 30 d			2,910,000	1,039,000	425	314	65,880
Surface oil exposure case- 123 d		2,784,720 m³ (22,640 m³/d)	2,759,000	1,917,000	3779	3694	125,500
Water column case- 123 d			1,701,000	1,137,000	-	-	89,310
Shoreline contact case- 123 d			2,991,000	1,741,000	1061	790	84,940
Surface oil exposure case- 23 d	West Flemish 2	545,130 m³ (20,190 m³/d)	2,412,000	710,900	-	-	67,010
Water column case- 23 d			1,499,000	676,700	-	-	77,530
Shoreline contact case- 23 d			2,332,000	712,400	100	98	98,410
Surface oil exposure case- 135 d		2,725,650 m³ (20,190 m³/d)	2,843,000	1,756,000	21	4	95,790
Water column case- 135 d			2,602,000	1,437,000	350	145	77,020
Shoreline contact case- 135 d			2,730,000	1,804,000	993	946	111,000
Batch Spill							
Surface Batch Spill of 1,000 L	West Flemish 1	1,000 L	8	-	-	-	-

*There is only one category threshold (socio-economic) for THC – calculated by multiplying the area times the depth of the grid cell.

Table 15.10 Summary of the Mass Balance Information for All Representative Hypothetical Scenarios

Hypothetical 95th Percentile Scenario	Site	Percent of Total Released Oil (%)						
		Surface	Evaporated	Water Column	Sediment	Ashore	Degraded	Outside Grid
Subsurface Blowout Releases								
Surface oil exposure case- 30 d	West Flemish 1	4.2	47.2	0.2	<0.1	0.2	38.3	9.9
Water column case- 30 d		0.0	46.8	0.6	<0.1	0.0	31.4	21.2
Shoreline contact case- 30 d		7.8	47.5	0.4	<0.1	0.1	40.7	3.6
Surface oil exposure case- 123 d		11.0	46.9	1.6	<0.1	0.4	32.3	7.7
Water column case- 123 d		5.0	46.9	1.7	<0.1	0.0	30.7	15.7
Shoreline contact case- 123 d		13.4	47.1	0.6	<0.1	0.1	34.3	4.6
Surface oil exposure case- 23 d	West Flemish 2	0.2	48.7	0.8	<0.1	0.0	32.2	18.1
Water column case- 23 d		1.0	48.1	0.1	<0.1	0.0	34.9	15.9
Shoreline contact case- 23 d		2.2	49.3	1.1	<0.1	<0.1	33.8	13.7
Surface oil exposure case- 135 d		10.4	48.2	1.1	<0.1	0.0	31.0	9.3
Water column case- 135 d		12.4	48.2	0.9	<0.1	<0.1	31.2	7.3
Shoreline contact case- 135 d		10.5	48.9	2.0	<0.1	0.1	28.8	9.7
Batch Spill								
Surface Batch Spill of 1,000 L	West Flemish	0.1	63.9	10.9	<0.1	0.0	25.1	0.0
All values represent a percentage (%) of the total amount of released oil at the end of the representative (95th percentile) deterministic or batch spill scenarios.								

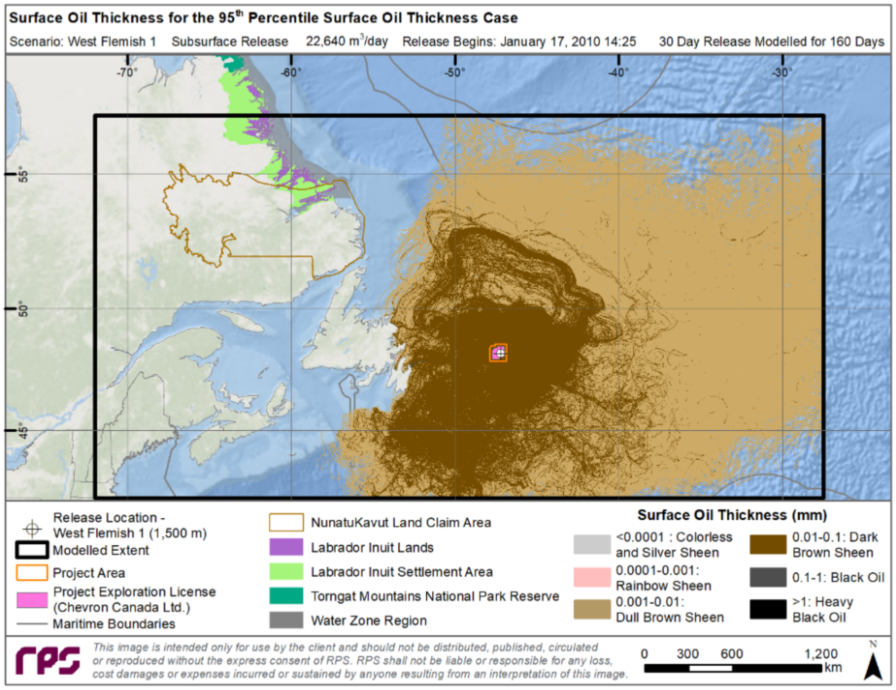
The predicted cumulative surface oil footprints of most of the identified representative cases were centered to the east of the release sites, due to surface oil transport mainly towards the east, with natural dispersion to the north and south. Cumulative maximum surface oil in all cases was predicted to have an average thickness within the range of 0.001-0.1 mm (1-100 µm), which would appear as discontinuous, patchy brown sheens to dark brown sheens, with thinner features predicted further from the release site. In some cases, patchy black oil (0.1-1 mm) was predicted to occur near the release site as it was transported, primarily to the east, up to a few hundred kilometres away. The predicted areas of surface oil exposure for the short (27- and 30-day) and long (123- and 135-day) 95th percentile cases were similar between sites, with short releases have the potential to affect a total of 1,221,000 to 2,910,000 km² above the socio-economic threshold over 160 days and long releases having the potential to affect a total of 1,701,000 to 2,991,000 km² over 160 days (Table 15.9).

The maximum subsurface water volumes exposed to THC concentrations for the 95th percentile water column cases were predicted to range between 77,020 km^3 and 89,310 km^3 (Table 15.9). Areas of relatively high THC concentration (500-5,000 µg/L) occurred in the Flemish Pass and Flemish Cap region in most scenarios. Regions of >500 µg/L dissolved hydrocarbons were predicted to be transported primarily northeast and southwest of the release site in the 95th percentile cases at West Flemish 1 and primarily southwest at West Flemish 2. These differences in dissolved hydrocarbon transport were due to the rising oil droplets from the release and the site locations relative to the strong subsurface currents (e.g. Labrador current) moving within the Flemish Pass and along the shelf break. Entrained oil concentrations in surface waters were predicted to vary considerably from day to day as expected from variable wind and wave conditions that control entrainment, mixing, and resurfacing rates (Table 15.10).

For the shoreline oil exposure cases, shoreline oil contamination was predicted to range from approximately 100-1,060 km for socioeconomic effects and 98-946 km for ecological effects (Table 15.9). In general, most oiling in these scenarios was predicted along the eastern and southern shores of Newfoundland, although stochastic results did result in the potential for shoreline oiling from southern Newfoundland up through Labrador. The oil that was predicted to strand along shorelines was generally in the 100 to >500 g/m^2 range, but would be patchy, discontinuous, and generally highly weathered by the time it reached shore. Offshore sediment contamination was much less prevalent and occurred at very low levels (<0.01 g/m^2) at locations near the release sites and to the south along the continental shelf break (Table 15.10). The extents of shoreline exposures were predicted to be less for West Flemish 2, especially for the short-duration release.

The contrasting results demonstrate the importance of stochastic probability footprints outlining the range of spill outcomes from environmental variability rather than differences in site characteristics. In general, stochastic results provided an understanding of the locations that were susceptible to potential effects, while representative deterministic results provide more context with the anticipated magnitude of effects for 95th percentile “worst-case” scenarios.

Deterministic modelling results and mass balance plots for blowouts at West Flemish 1 and West Flemish 2 are provided in Figures 15-17 to 15-28. Detailed discussion on results of the surface, water column, and shoreline oil deterministic scenarios are provided in Sections 4.2.1 to 4.2.3, respectively, in Appendix F.



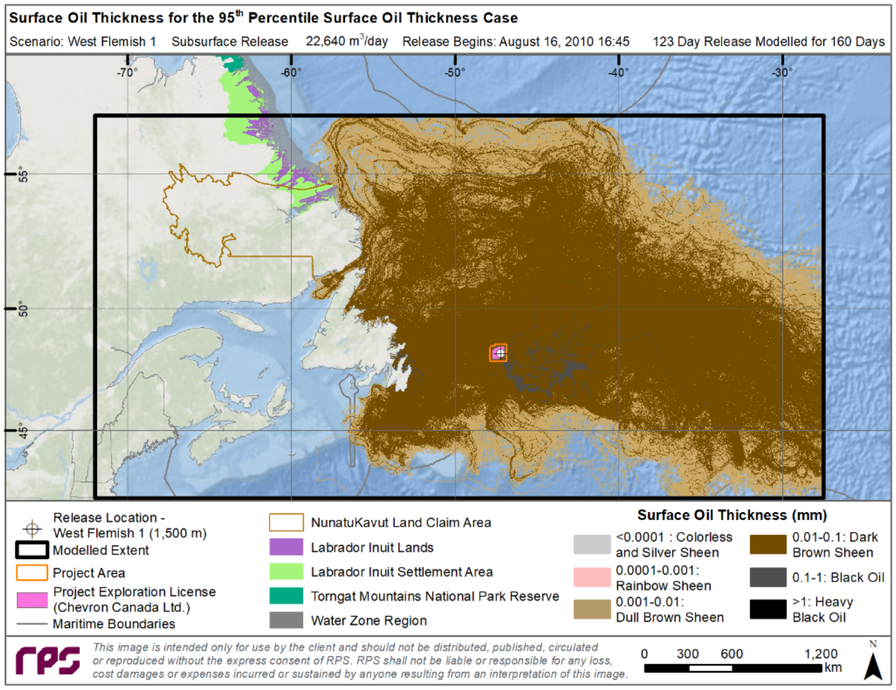


Figure 15-17 Surface oil thickness for the 95th percentile average surface oil thickness cases resulting from hypothetical 30- (top) and 123-day (bottom) blowouts at West Flemish 1

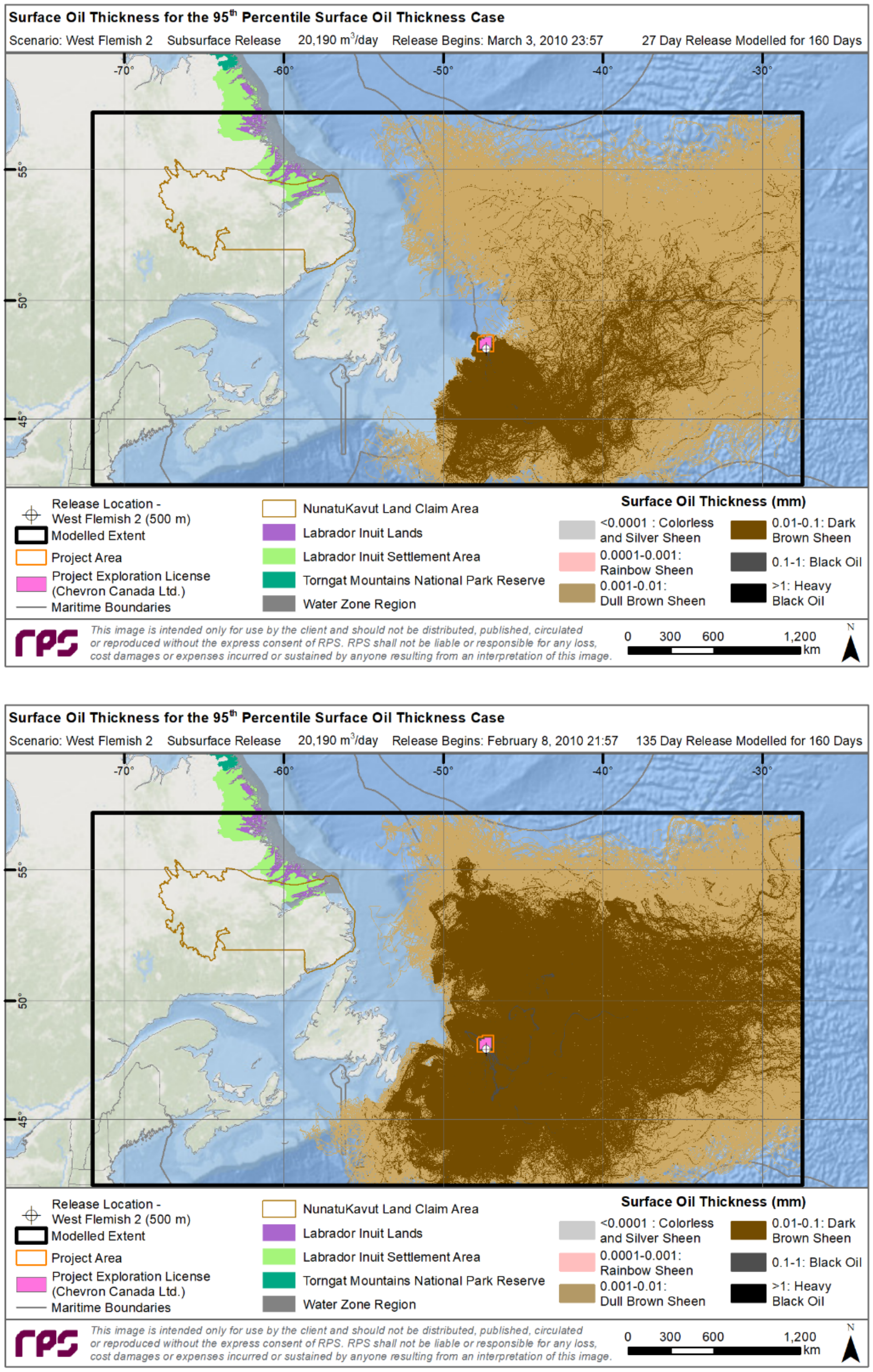


Figure 15-18 **Surface oil thickness for the 95th percentile average surface oil thickness cases resulting from hypothetical 27- (top) and 135-day (bottom) blowouts at the West Flemish 2**

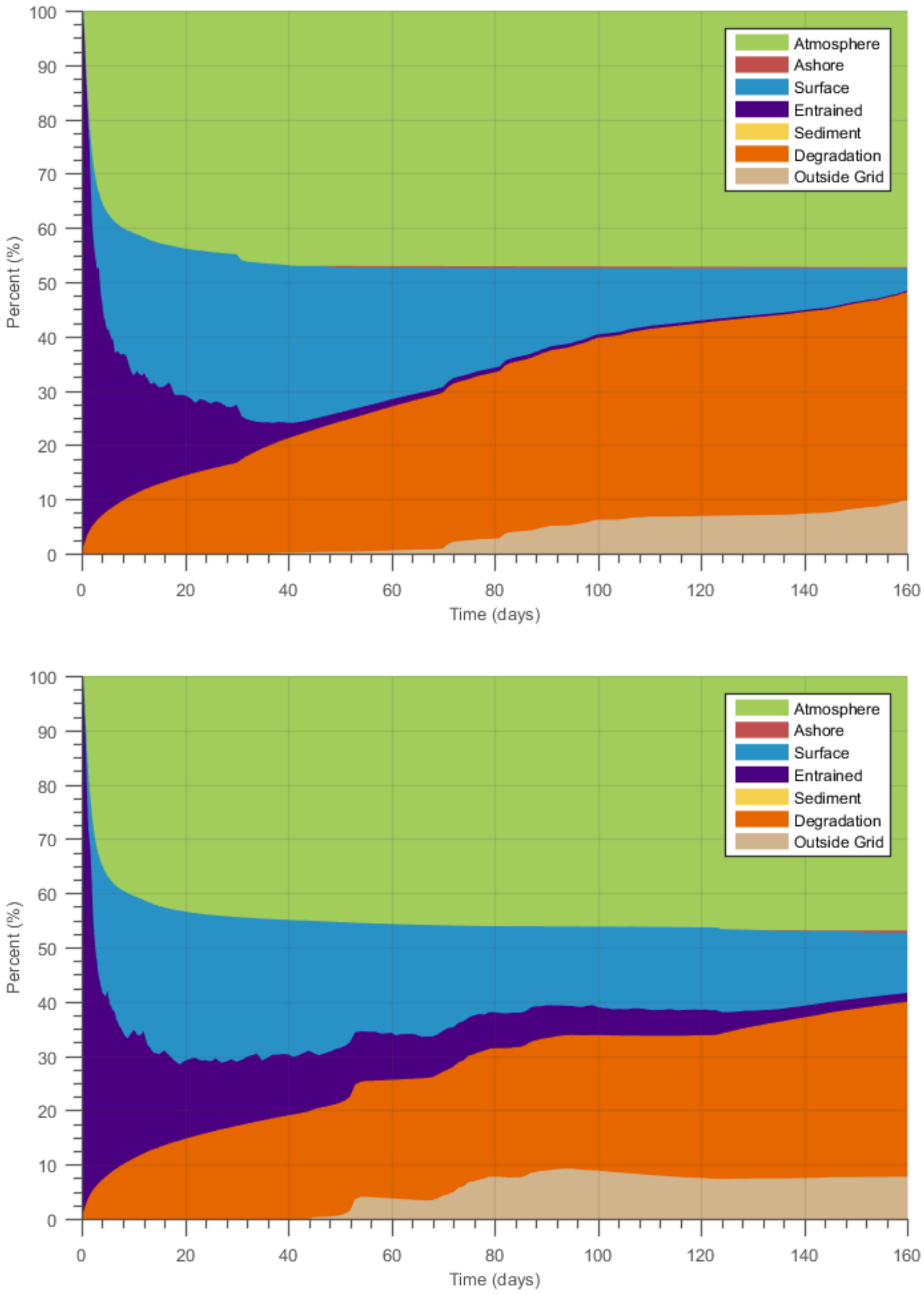
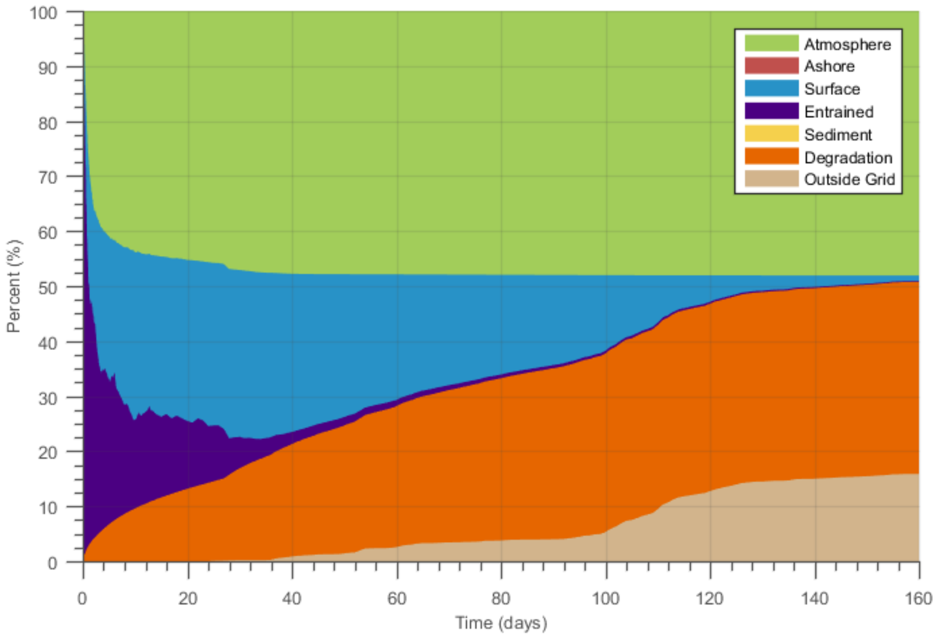


Figure 15-19 **Mass balance plots of the 95th percentile surface oil thickness cases resulting from hypothetical 30- (top) and 123-day (bottom) blowouts at West Flemish 1**



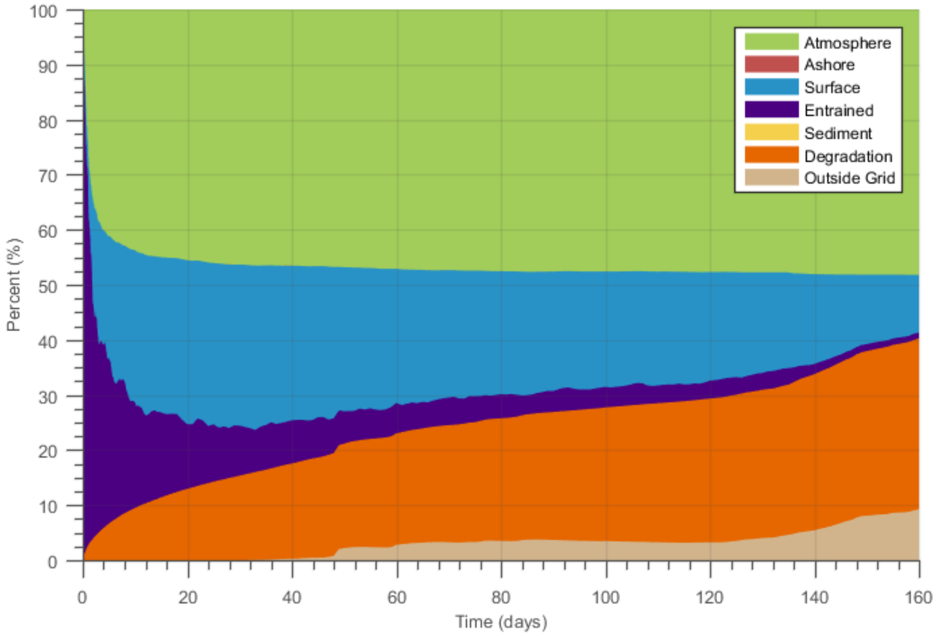


Figure 15-20 **Mass balance plots of the 95th percentile surface oil thickness cases resulting from hypothetical 27- (top) and 135-day (bottom) blowouts at West Flemish 2**

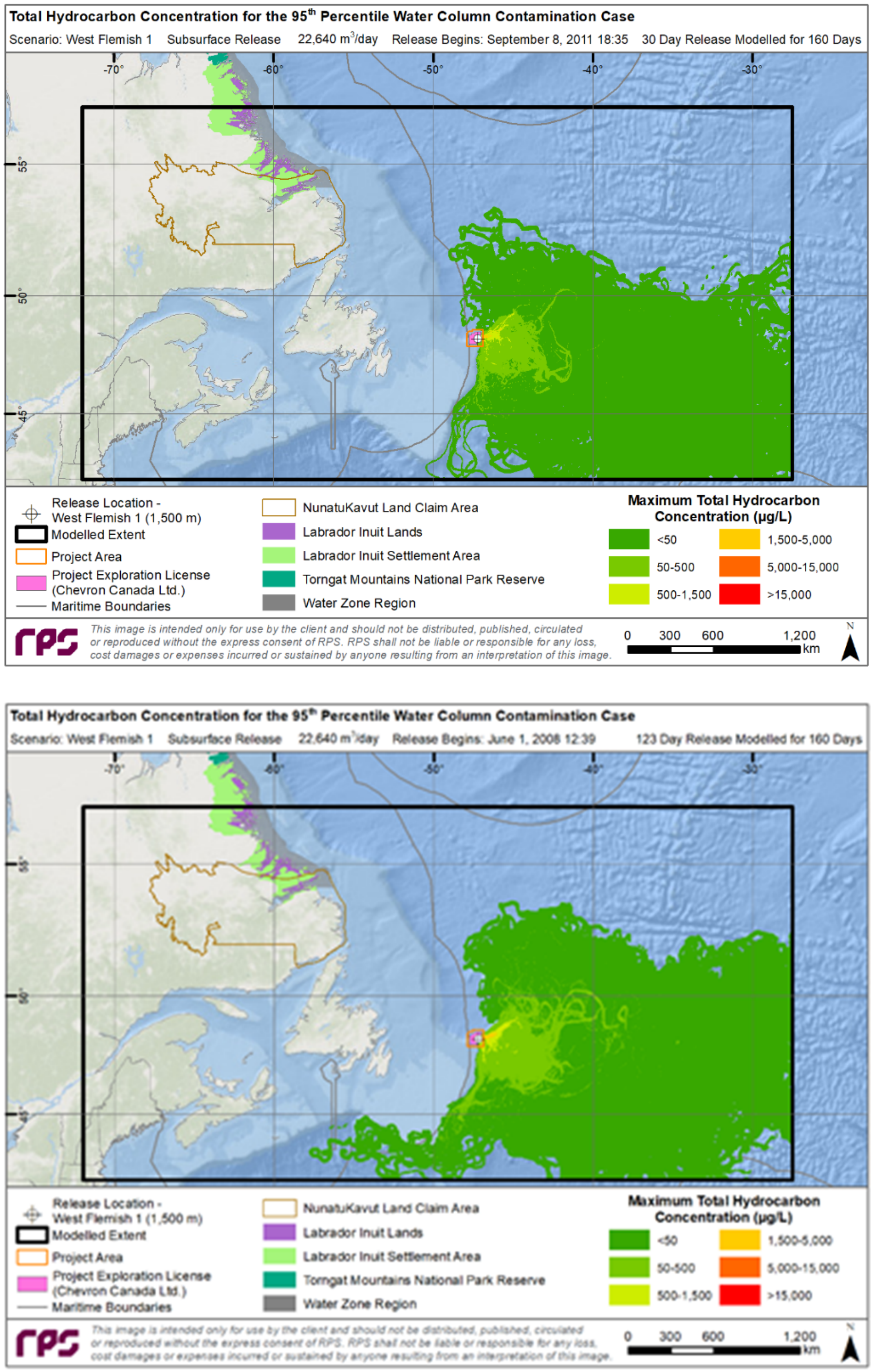


Figure 15-21 Maximum THC at any depth in the water column for the 95th percentile water column cases resulting from hypothetical 30- (top) and 123-day (bottom) blowouts at West Flemish 1

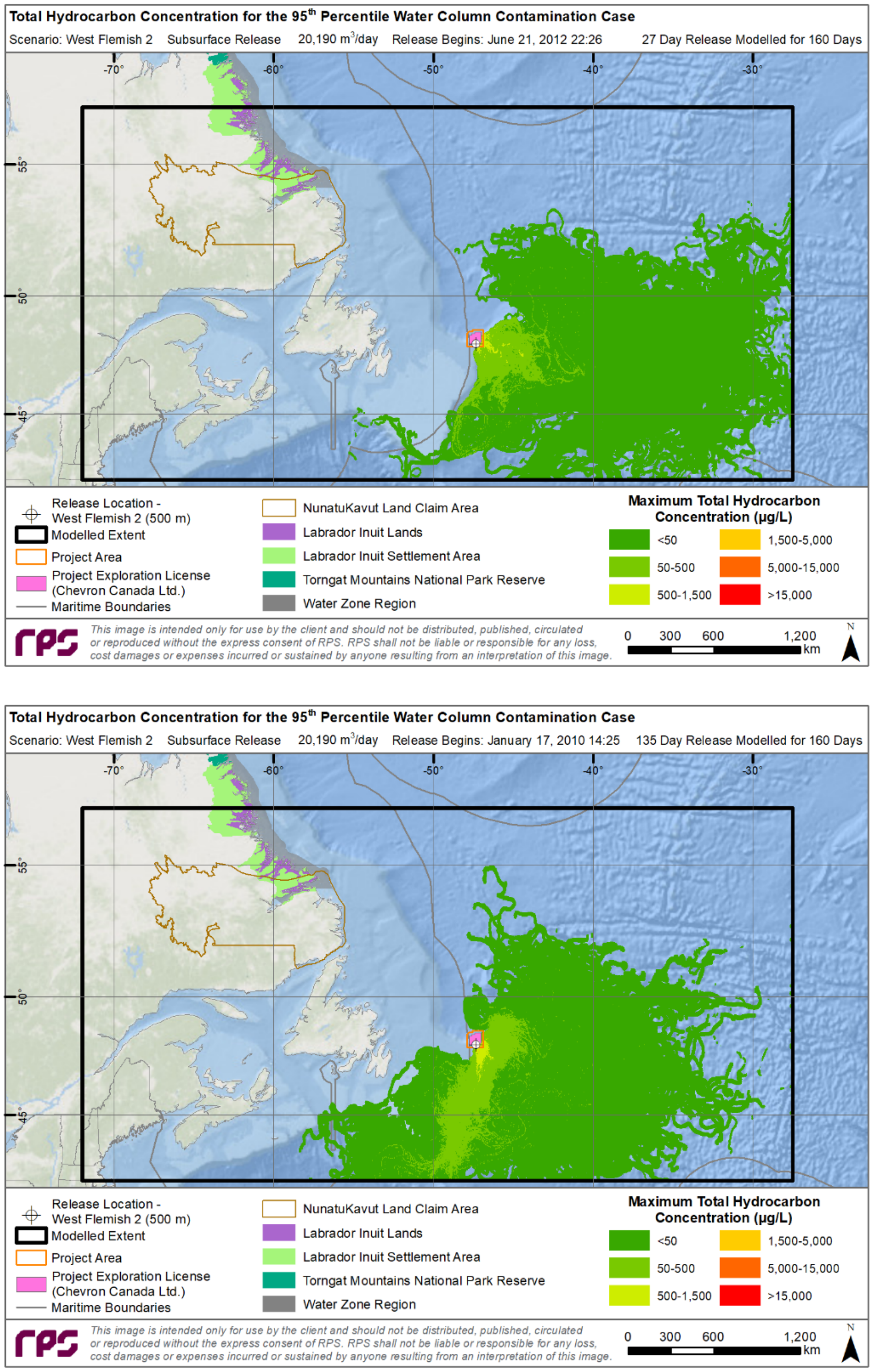


Figure 15-22 Maximum THC at any depth in the water column for the 95th percentile water column cases resulting from hypothetical 27- (top) and 135-day (bottom) blowouts at West Flemish 2

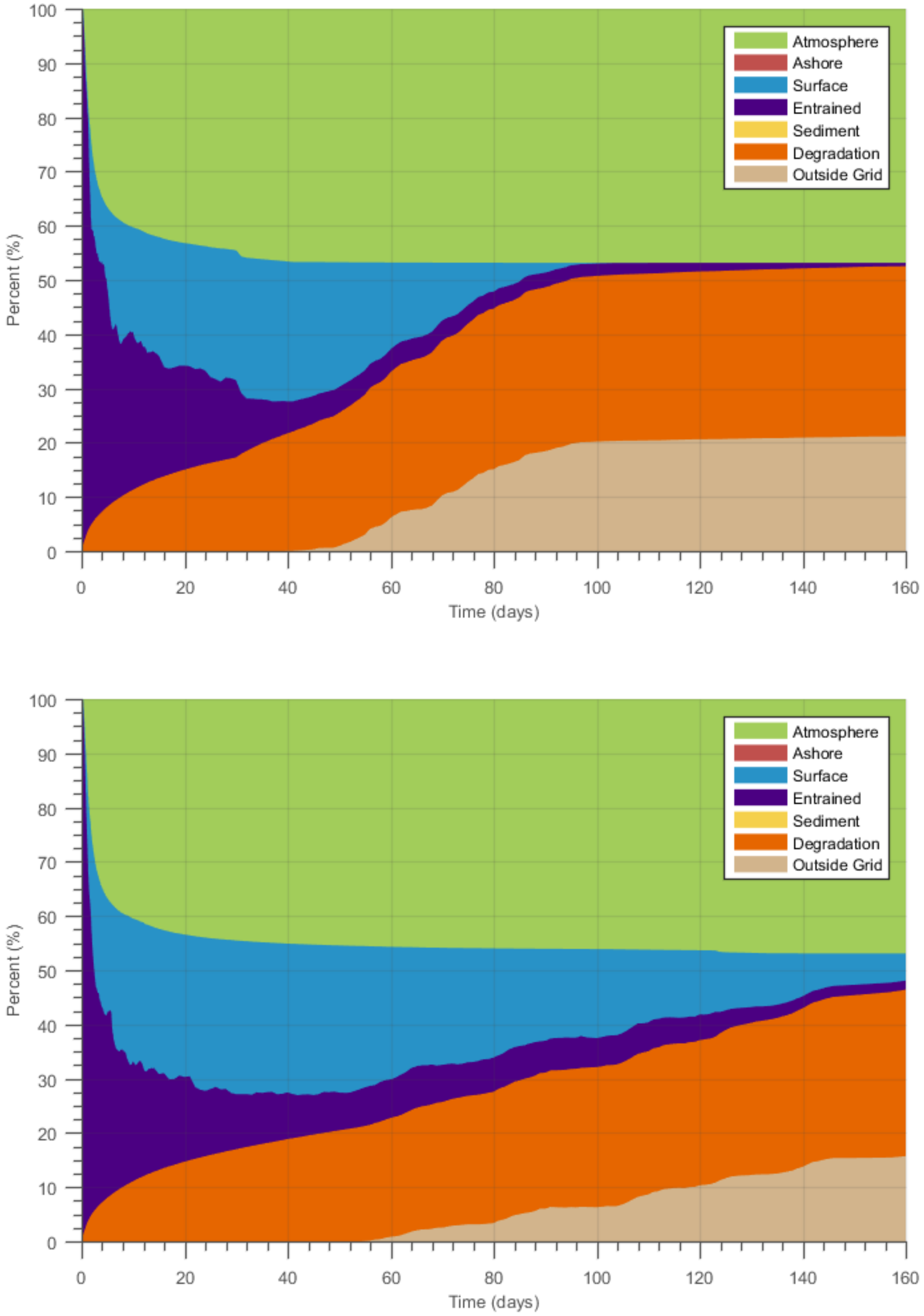
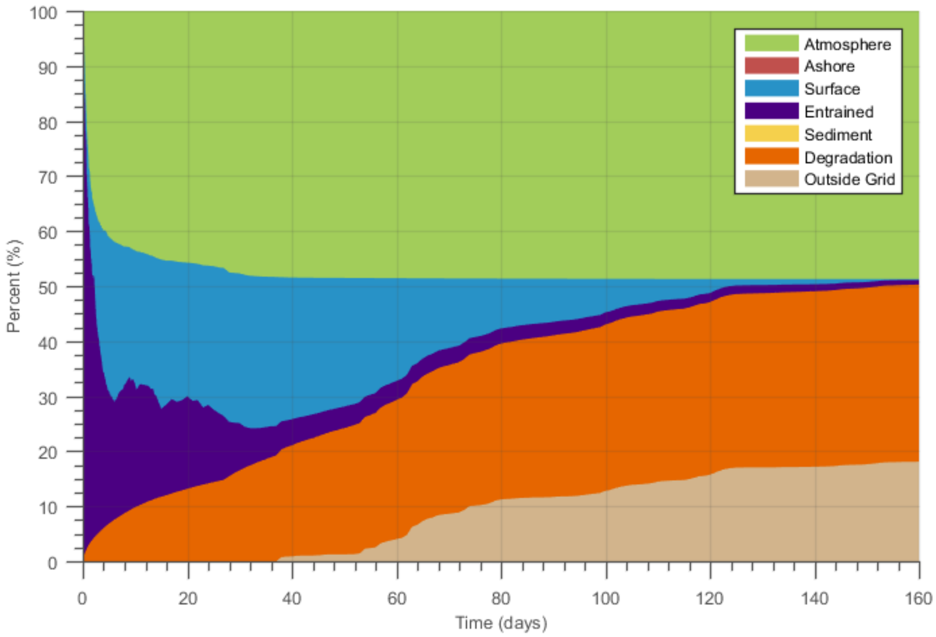


Figure 15-23 **Mass balance plots of the 95th percentile water column cases resulting from hypothetical 30- (top) and 123-day (bottom) blowouts at West Flemish 1**



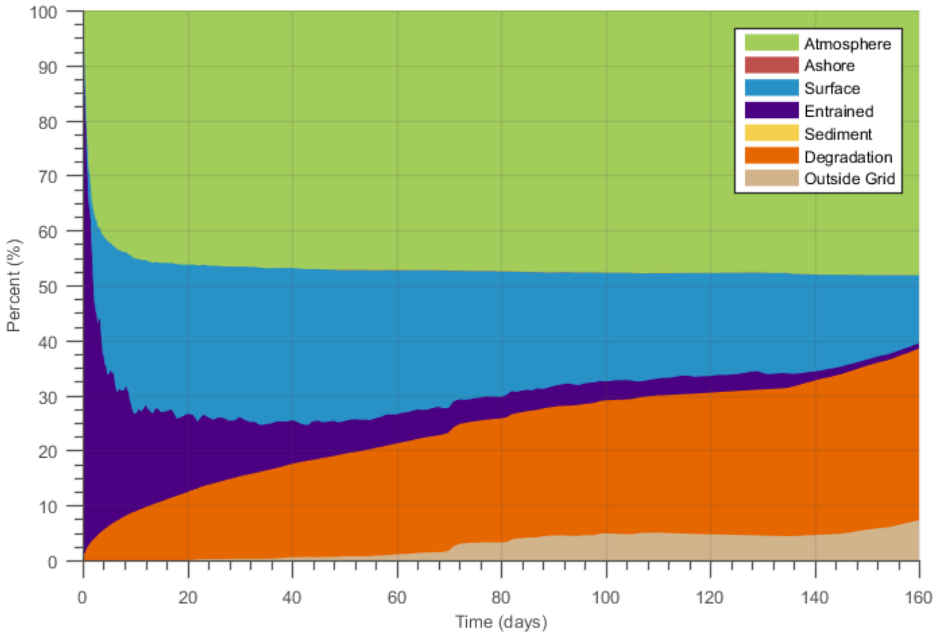
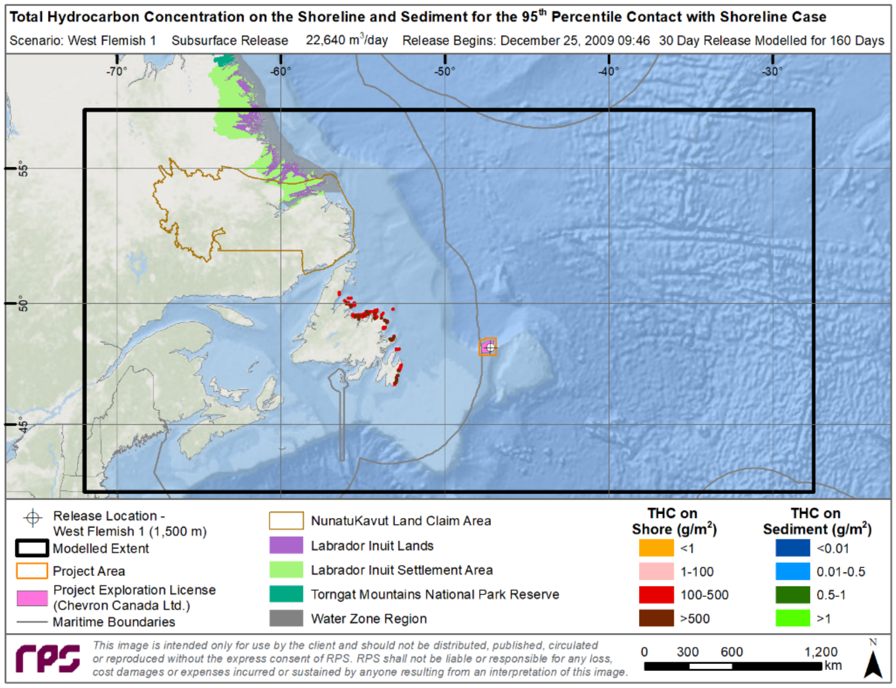


Figure 15-24 Mass balance plots of the 95th percentile water column cases resulting from hypothetical 27- (top) and 135-day (bottom) blowouts at West Flemish 2



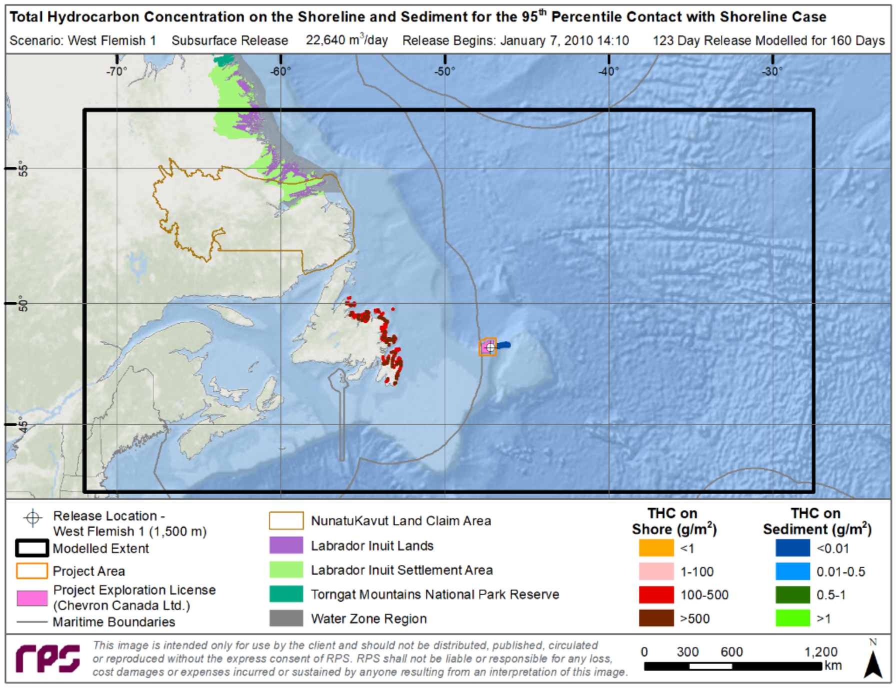
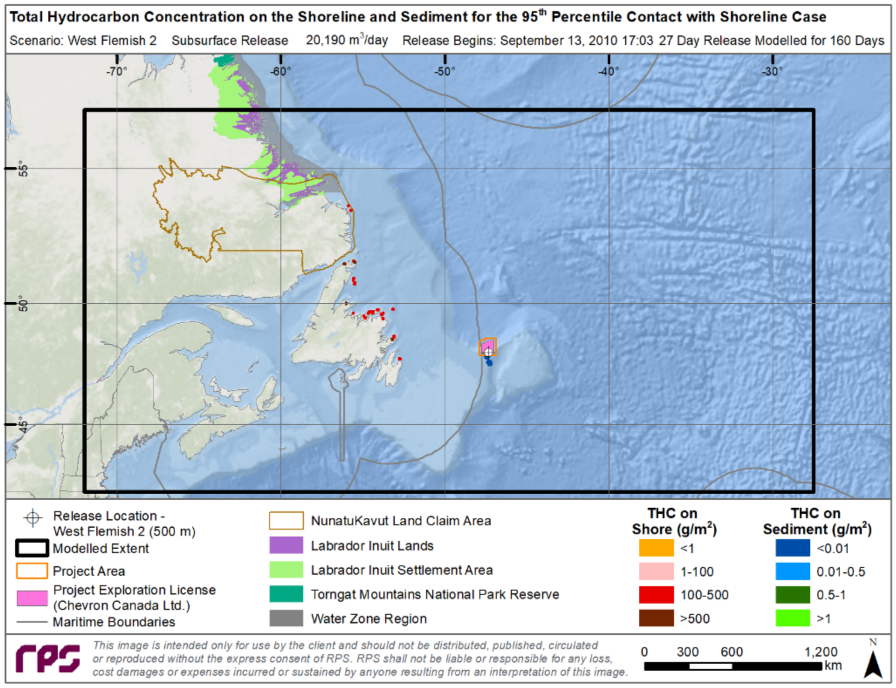


Figure 15-25 THC on the shore and sediment for the 95th percentile shoreline cases resulting from hypothetical 30- (top) and 123-day (bottom) blowouts at West Flemish 1



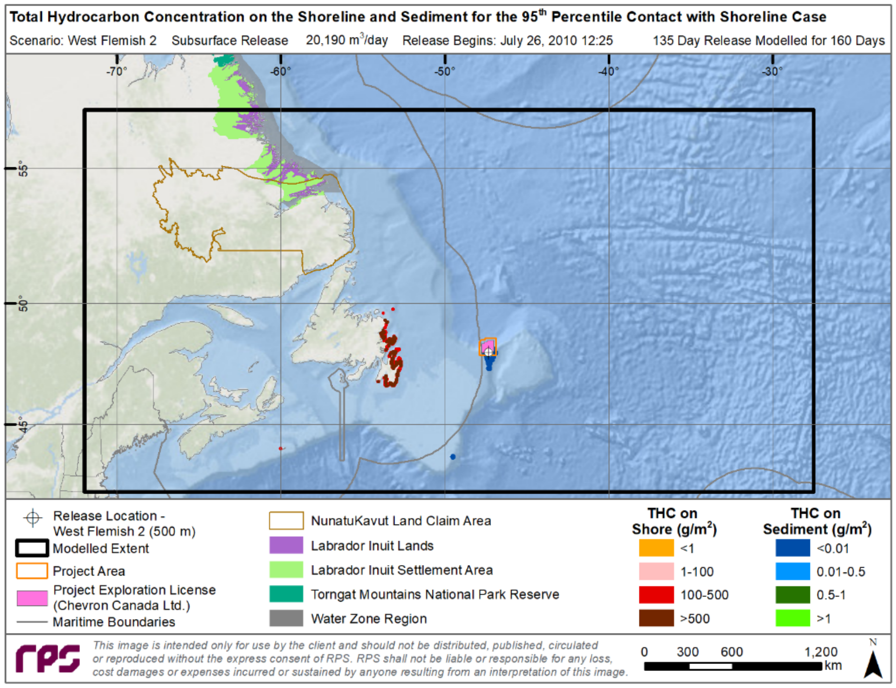


Figure 15-26 THC on the shore and sediment for the 95th percentile shoreline cases resulting from hypothetical 27-day (top) and 135-day (bottom) blowouts at West Flemish 2

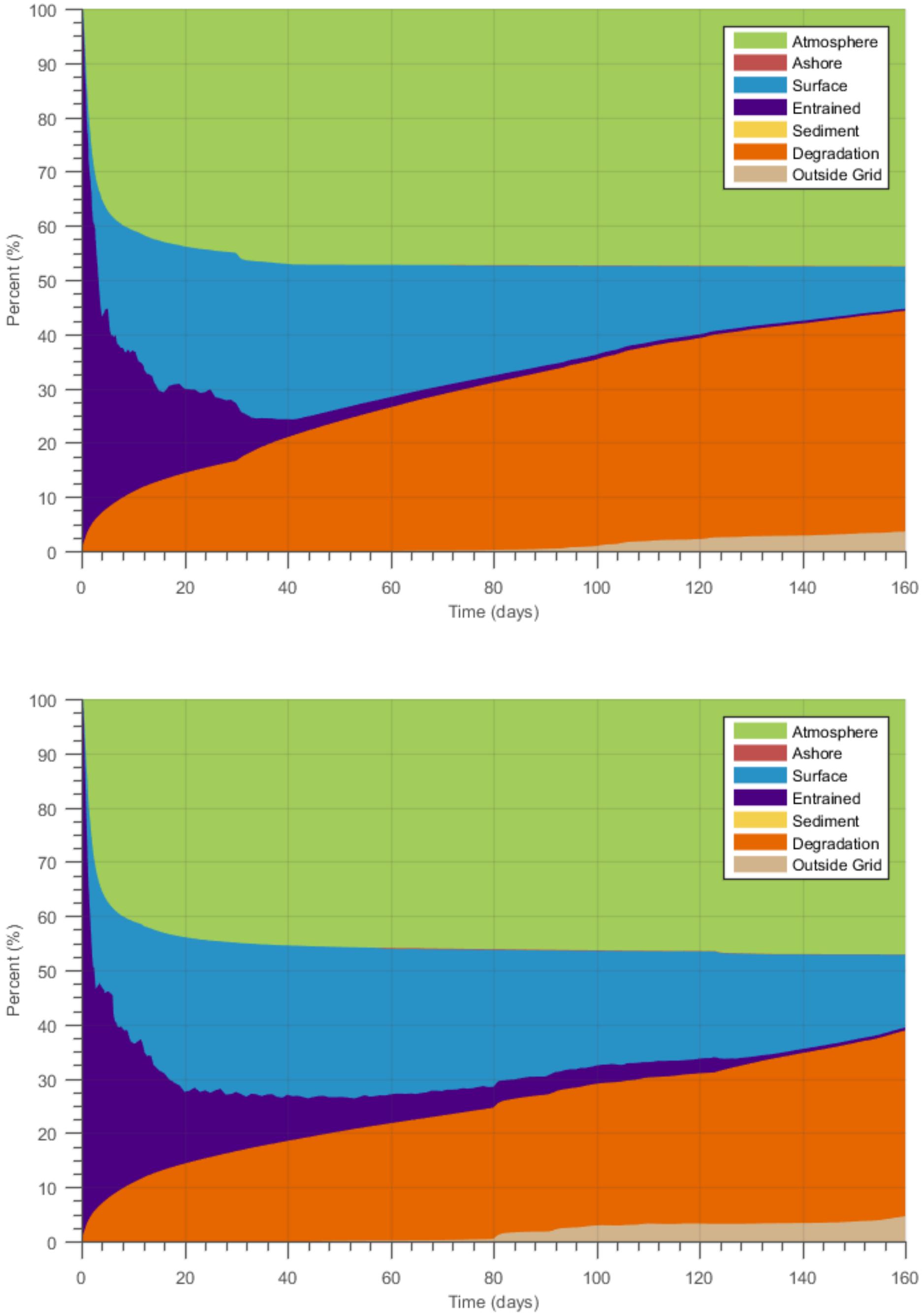
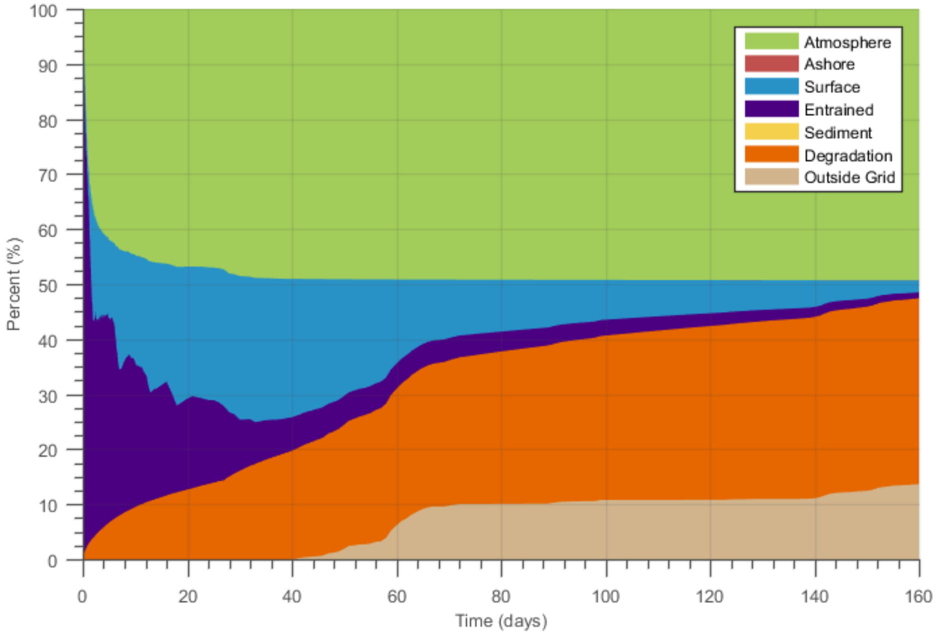


Figure 15-27 Mass balance plots of the 95th percentile shoreline cases resulting from hypothetical 30- (top) and 123-day (bottom) blowouts at West Flemish 1



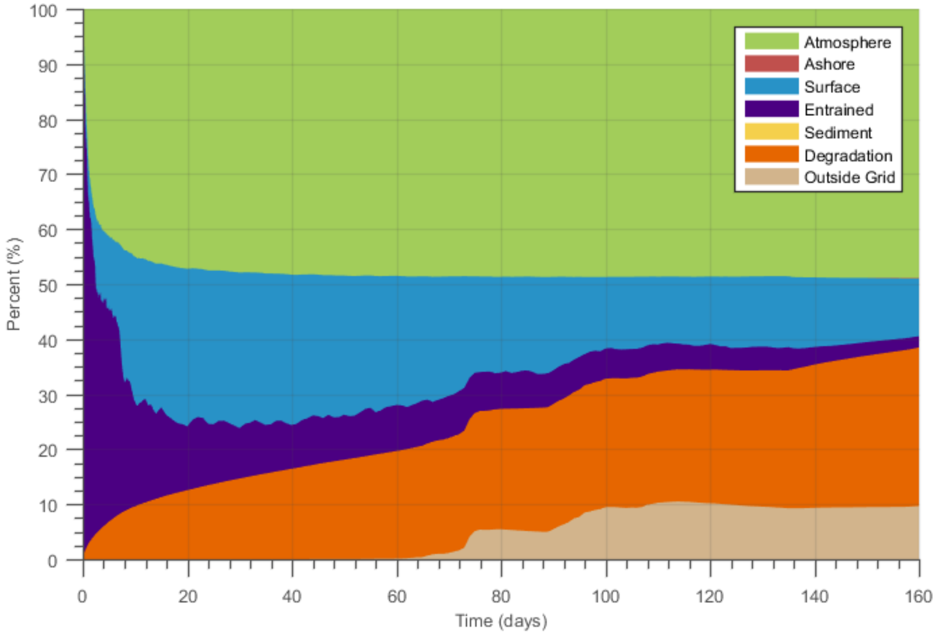


Figure 15-28 **Mass balance plots of the 95th percentile shoreline cases resulting from hypothetical 27- (top) and 135-day (bottom) blowouts at West Flemish 2**

15.2.6.2.2 Batch Spill

A smaller scale near-instantaneous batch spill of marine diesel was modelled as an accidental release. One 1,000 L release was modelled at West Flemish 1 and was simulated for 30 days. The marine diesel used in this scenario was a standard diesel that had a low viscosity and a high aromatic content that was expected to evaporate quickly during the summertime releases. The marine diesel release was predicted to result in a patchy distribution of colorless or silver sheen of oil <0.0001 mm (0.1 µm), where the total area of that was exposed to oil >0.04 µm over 30 days was 8 km² (Figure 15-29). Due to the small release volume, low entrainment, and size of the concentration gridding (150 m by 150 m), predicted concentrations of dissolved or total hydrocarbons in the water column did not register above the threshold (Figure 15-30). Oil was not predicted to reach any shorelines from the modelled batch spill (Figure 15-31). The mass balance plot is provided in Figure 15-32. Detailed discussion on results of the batch spill are provided in Section 4.2.4 in Appendix F.

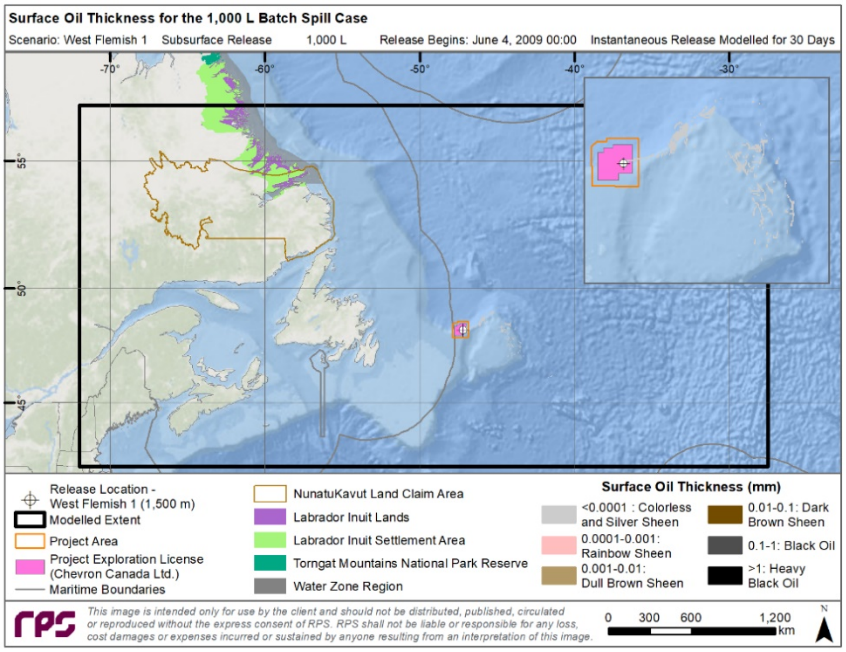


Figure 15-29 Surface oil thickness for the hypothetical marine diesel batch spill of 1,000 L at West Flemish 1

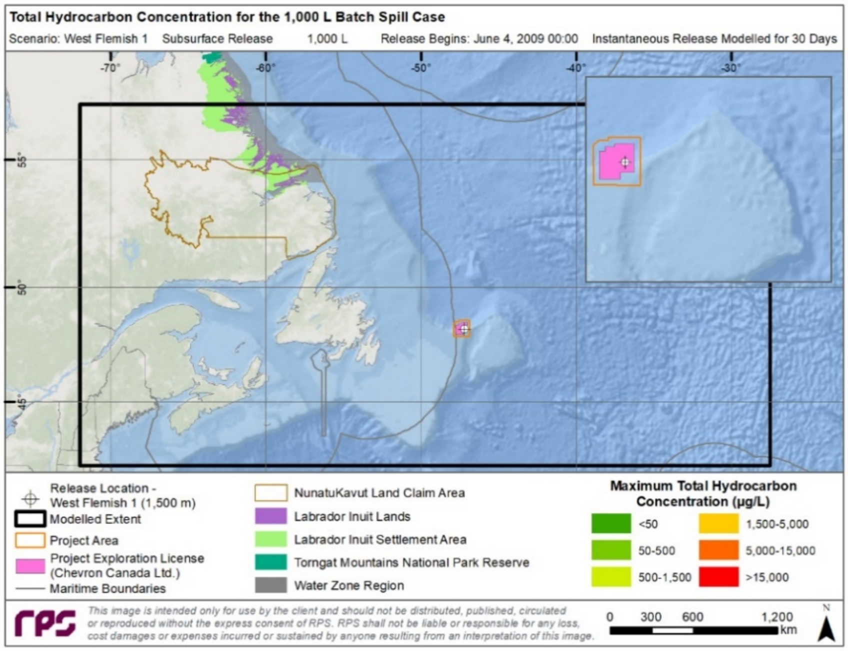


Figure 15-30 Maximum THC at any depth in the water column for the hypothetical marine diesel batch spill of 1,000 L at West Flemish 1

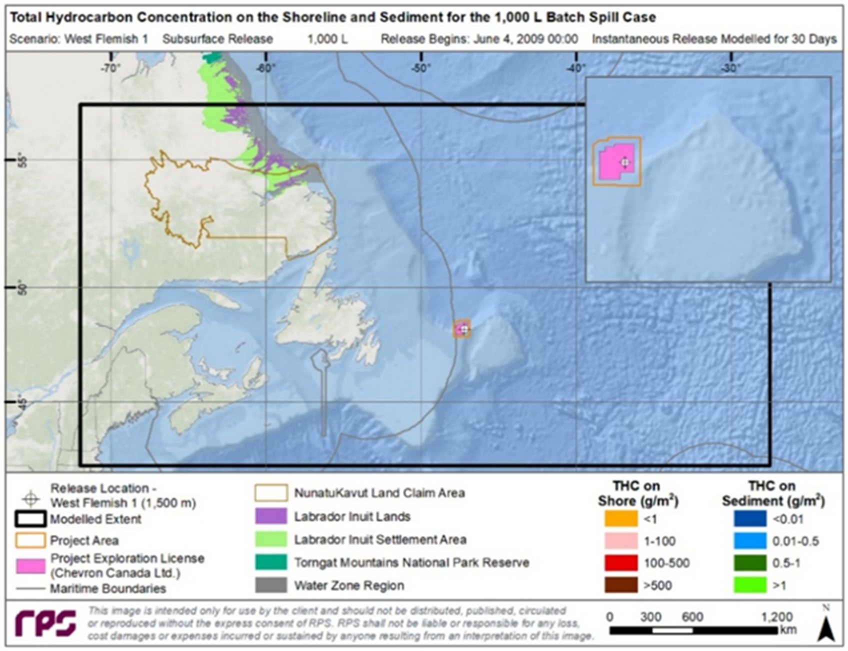


Figure 15-31 THC on the shore and sediment for the hypothetical marine diesel batch spill of 1,000 L at West Flemish 1

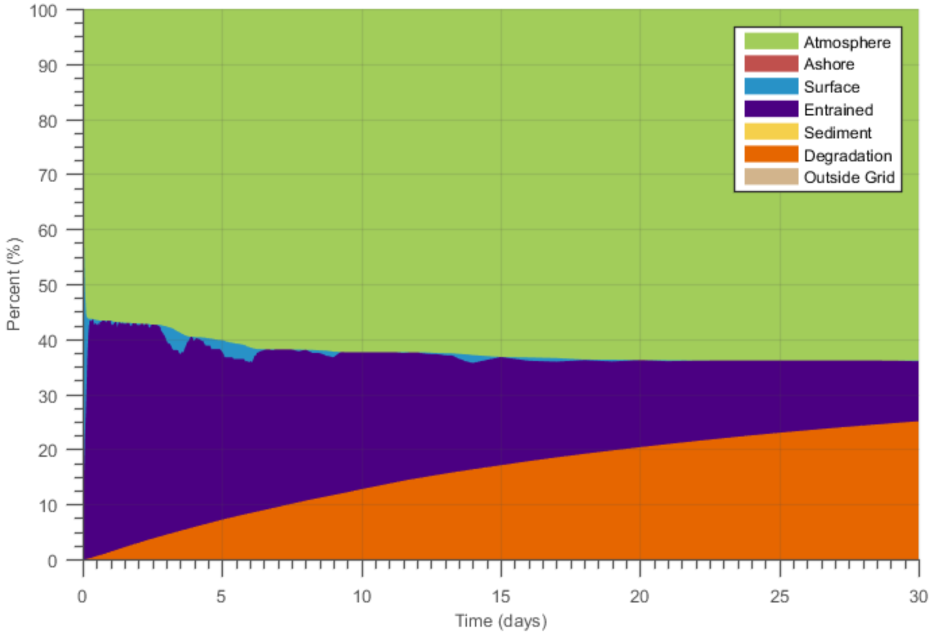


Figure 15-32 Mass balance plot of the hypothetical marine diesel batch spill of 1,000 L at West Flemish 1

15.2.7 Model Uncertainty and Validation

The SIMAP model has been developed over several decades to include past and recent information from laboratory-based experiments and real-world releases to simulate the trajectory and fate of discharged oil. However, there are limits to the complexity of processes that can be modelled, as well as gaps in knowledge regarding the affected environment. Assumptions based on available scientific information and professional judgment were made in the development of the model, which represent a best assessment of the processes and potential exposures that could result from oil releases.

The major sources of uncertainty in the oil fate model are:

- Oil contains thousands of chemicals with differing physical and chemical properties that determine their fate in the environment. The model must, out of necessity, treat the oil as a mixture of a limited number of components, grouping chemicals by physical and chemical properties.
- The fate model contains a series of algorithms that are simplifications of complex physical-chemical processes. These processes are understood to varying degrees.
- The model treats each release as an isolated, singular event and does not account for any potential cumulative exposure from other sources.
- Several physical parameters, including but not limited to, hydrodynamics, water depth, total suspended solids concentration, and wind speed were not sampled extensively throughout the entire modelled domain. However, the data that did exist was sufficient for this type of modelling. When data was lacking, professional judgment and previous experience was used to refine the model inputs.

SIMAP has been validated against many real-world releases including the Deepwater Horizon (DWH) oil spill, where it was used in the US Government's Natural Resource Damage Assessment. In this specific example, a small portion of the released oil may have sunk as a result of the interaction of released oil with sediments, drilling muds, and other material used in response efforts such as procedures used to seal a leaking well. These are currently areas of active research. While there are additional fate processes that may result in slight differences in the ultimate fate of oil, these processes are known to have relatively lower effects on the total volume of oil in each environmental compartment (on the order of single percentages different, depending on the release and receiving environment) as compared to the fate processes such as entrainment, which are already being modelled. The science and algorithms that may be used to model these processes have not been developed in the scientific community to the point of a consensus or use in modelling. Ongoing research topics currently underway include the formation of marine oil snow (MOS), photo-degradation, droplet size distributions, and other research areas. These and other multi-year research projects are considered for incorporation in modelling nearly constantly. Due to these topics being in the research phase, without scientific consensus, they have not been included in this analysis.

In the unlikely event of an actual release of oil, the trajectory and fate will be strongly determined by the specific environmental conditions, the precise location, and a myriad of details related to the event and specific timeframe of the release. Modelled results are a function of the scenarios simulated and the accuracy of the input data used. The goal of this study was not to forecast every detail that could potentially occur, but to describe a range of possible consequences and exposures of oil releases under various representative release scenarios.

15.3 Spill Risk and Probabilities

The following section considers the probability of both continuous longer-term, larger scale blowouts, as well as smaller scale, shorter-term spill scenarios (batch spills) from offloading and production riser losses in association with the Project.

There are three important aspects to determining "spill risk" associated with offshore oil exploration:

- Determining the likelihood or probability that a well blowout or other well release will occur
- Determining the potential oil spillage volumes that might occur and the probabilities that the spill will be a large-scale spill
- Determining the potential impacts of hypothetical spills (see Section 15.5)

The results of the analyses show that the probability of a well blowout or other release is very low (i.e., blowouts and other spills from offshore production wells are quite rare). The analyses also show that if a blowout or other spill were to occur, the chances are great that it would be a small volume of spillage rather than a very large event with high consequences. This section reviews the available data and findings based on historical research on offshore spills to determine the probabilities for spills and the potential spill volumes that might be involved. In general, this section complements the modelling and assessment of potential spill scenarios (as presented in the previous section) by providing a perspective on the probability of occurrence of the various scenarios as well as the probability distributions of spill volumes (Table 15.11).

Table 15.11 Modelled Hypothetical Chevron West Flemish Pass Spill Scenarios

Scenario ID	Spill Event	Oil Type	Location	Spill Rate	Release Duration	Total Volume
WF1-123	Subsurface blowout	WFPPLO	West Flemish 1	22,640 m³/day 142,400 bbl/day	123 days	2,784,720 m³
						17,515,200 bbl
WF1-30	Subsurface blowout	WFPPLO	West Flemish 1	22,640 m³/day 142,400 bbl/day	30 days	679,200 m³
						4,272,000 bbl
WF2-135	Subsurface blowout	WFPPLO	West Flemish 2	20,190 m³/day 127,000 bbl/day	135 days	2,725,650 m³
						17,145,000 bbl
WF2-27	Subsurface blowout	WFPPLO	West Flemish 2	20,190 m³/day 127,000 bbl/day	27 days	545,130 m³
						3,429,000 bbl
BS-WF1	Batch spill	Marine diesel	West Flemish 1	1 m³ (1,000 liters)	Instantaneous	1 m³
						6.3 bbl

The hypothetical 30-day and 27-day release durations are based on the maximum time for a successful capping and containment operation. The hypothetical 123-day and 135-day release durations are based on the maximum time for the successful drilling of a relief well.

15.3.1 Historical Spill Data - Canada-NL Offshore Area

15.3.1.1 Sources of Oil Inputs in Newfoundland and Labrador Offshore

During the 1990s, total inputs of oil from anthropogenic sources in coastal areas of Eastern Canada have averaged 9,000 barrels (bbl) annually, and in offshore areas, 2,700 bbl annually, for a total of 11,700 bbl. Spill volumes off Eastern Canada have decreased significantly in the last decade to about 600 bbl. Occasional tanker spills have provided the greatest threat to the region in the past.

In addition to anthropogenic inputs from spills, urban runoff, and vessel and facility operations, natural seepage may also contribute to overall hydrocarbon inputs in the region. Several natural seeps have been identified in the region, though there are no quantifications of annual inputs from this source.

15.3.1.2 Canada-Newfoundland and Labrador Offshore Spill Data

The Canada-Newfoundland & Labrador Offshore Petroleum Board (C-NLOPB) spill data for 1997–2018 were analyzed. The data were divided by operational phase into synthetic-based drilling fluids (SBMs) and other hydrocarbons. Annual spillage varied widely (Table 15.12). There were 532 spills, of which 44 (8.3%) occurred during exploration and 488 (91.7%) occurred during development and production. During exploration, 809 bbl spilled, and development and production, 5,827 bbl spilled.

Table 15.12 Newfoundland and Labrador Offshore Exploration and Production Oil Spills (1997-2018)

Year	Exploration						Development & Production						Total					
	Spill Number			Bbl			Spill Number			Bbl			Spill Number			Bbl		
	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All
1997	1	0	1	0.3	0.0	0.3	10	0	10	10.6	0.0	10.6	11	0	11	10.9	0.0	10.9
1998	4	0	4	20.1	0.0	20.1	22	2	24	3.7	12.6	16.3	26	2	28	23.8	12.6	36.4
1999	11	0	11	10.7	0.0	10.7	28	8	36	7.3	46.4	53.7	39	8	47	18.0	46.4	64.4
2000	1	0	1	1.0	0.0	1.0	4	5	9	0.4	29.6	30.0	5	5	10	1.4	29.6	31.0
2001	0	0	0	0.0	0.0	0.0	15	2	17	0.8	35.2	36.0	15	2	17	0.8	35.2	36.0
2002	0	0	0	0.0	0.0	0.0	24	2	26	0.2	77.1	77.3	24	2	26	0.2	77.1	77.3
2003	1	1	2	0.6	27.7	28.3	19	4	23	1.8	167.5	169.3	20	5	25	2.4	195.2	197.6
2004	0	0	0	0.0	0.0	0.0	50	5	55	1,043.5	680.0	1,723.5	50	5	55	1,043.5	680.0	1,723.5
2005	0	0	0	0.0	0.0	0.0	40	1	41	1.2	25.4	26.6	40	1	41	1.2	25.4	26.6
2006	3	1	4	0.1	3.8	3.9	31	3	34	3.9	19.1	23.0	34	4	38	4.0	22.9	26.9
2007	0	1	1	0.0	465.5	465.5	37	1	38	0.6	6.9	7.5	37	2	39	0.6	472.4	473.0
2008	0	0	0	0.0	0.0	0.0	35	1	36	30.3	0.6	30.9	35	1	36	30.3	0.6	30.9
2009	4	0	4	0.1	0.0	0.1	37	0	37	1.8	0.0	1.8	41	0	41	1.9	0.0	1.9
2010	3	0	3	0.0	0.0	0.0	16	0	16	1.2	0.0	1.2	19	0	19	1.2	0.0	1.2
2011	2	5	7	0.3	180.8	181.1	36	2	38	3.5	28.9	32.4	38	7	45	3.8	209.7	213.5
2012	0	0	0	0.0	0.0	0.0	7	0	7	0.1	0.0	0.1	7	0	7	0.1	0.0	0.1
2013	0	0	0	0.0	0.0	0.0	11	2	13	39.3	1.4	40.7	11	2	13	39.3	1.4	40.7
2014	0	1	1	0.0	5.4	5.4	11	3	14	1.4	6.9	8.3	11	4	15	1.4	12.3	13.7
2015	1	1	2	0.0	92.9	92.9	1	1	2	0.0	0.9	0.9	2	2	4	0.0	93.8	93.8
2016	1	0	1	0.0	0.0	0.0	3	0	3	0.0	0.0	0.0	4	0	4	0.0	0.0	0.0
2017	1	1	2	0.0	0.0	0.0	5	0	5	0.0	0.0	0.0	6	1	7	0.0	0.0	0.0
2018	0	0	0	0.0	0.0	0.0	4	2	6	1,574.6	176.1	1,750.7	4	2	6	1,574.6	176.1	1,750.7

Table 15.12 Newfoundland and Labrador Offshore Exploration and Production Oil Spills (1997-2018)

Year	Exploration						Development & Production						Total					
	Spill Number			Bbl			Spill Number			Bbl			Spill Number			Bbl		
	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All	HC	SBM	All
Total	33.0	11.0	44.0	33.2	776.1	809.3	446.0	44.0	490.0	2,726.2	1,314.6	4,040.8	479.0	55.0	534.0	2,759.4	2,090.7	4,850.1
Avg	1.5	0.5	2.0	1.5	35.3	36.8	20.3	2.0	22.3	123.9	59.8	183.7	21.8	2.5	24.3	125.4	95.0	220.5
C-NLOPB data current through December 2018																		

Exploration spills occurred, on average, 0.42 times per well per year, with an average volume of 7.2 bbl spilled per well. Development well spills were more frequent with 1.9 spills per well with an average volume 10 bbl per well. Synthetic-based drilling fluids (SBMs) occurred less frequently than spills of other hydrocarbons. The volumes of SBM spills were higher for exploration spills than for development/production spills. Hydrocarbon spills averaged 6.9 bbl per well per year and 3 bbl per well per year for SBM spills.

A more detailed breakdown of spills of more than one litre was available in the C-NLOPB data. The percentage of spills by oil type for spills of 1 litre or larger are shown in Table 15.13. These data show that for some years there are no spills of a particular type of oil, and in other years there may be one or more. The volumes of spillage are dominated by individual incidents. This is very apparent for the synthetic fluid spillage, in particular. There was a total of 11 incidents involving more than 1 litre over the course of 18 years. There was a single incident in 2007 in which 465.45 bbl spilled, and another incident in 2015 in which 92.93 bbl spilled. In 2011, there were five incidents totaling 180.78. When the volume of spillage is averaged over 21.5 years, the average is 37.6 bbl per year. This does not mean that 37.6 spills each year consistently. Similarly, crude oil spillage was dominated by two incidents involving 1,043 bbl and 1,572 bbl, respectively. As is typical for spills, most spills are relatively small with only infrequent larger spills. The spill volumes by size category for exploration based on the C-NLOPB data are provided in Table 15.14.

Table 15.13 Oil Types in Spills in Offshore Newfoundland and Labrador (spills >1L)

Oil Type [1]	Exploration				Development & Production			
	Incidents		Volume		Incidents		Volume	
	#	% Total	Bbl	% Total	#	% Total	Bbl	% Total
Crude Oil / Condensate	5	13.2%	5.8	0.7%	63	28.4%	2,698.29	66.8%
Diesel and Jet Fuel	10	26.3%	26.45	3.3%	19	8.6%	4.09	0.1%
Hydraulic / Lubricating	8	21.1%	0.44	0.1%	73	32.9%	17.84	0.4%
Other Types (Oil)	4	10.5%	0.49	0.1%	24	10.8%	2.96	0.1%
Synthetic Oils / Fluids	11	28.9%	776.03	95.9%	43	19.4%	1,314.46	32.6%
Total	38	100.0%	809.21	100.0%	222	100.0%	4,037.64	100.0%

Notes:

[1] “Other Hydrocarbon” category incorporates crude, diesel/jet fuels, hydraulic/lube oils, and “other types.” In C-NLOPB data presentations, the term “other hydrocarbons” is used instead of what is termed “other types” in this report. A distinction is made herein to avoid confusion.

Table 15.14 Spill Volumes for Exploration in Newfoundland and Labrador

Volume Category (bbl)	% Total Spills >1 Litre					% Total All Spills (w/<1 Litre)
	Crude Oil / Condensate	Diesel/Jet Fuel	Hydraulic / Lube Oil	Synthetic Oils / Fluids	Other Types (Oil)	
0.00001-0.00009	-	-	-	-	-	2.3%
0.0001-0.0009	-	-	-	-	-	4.5%
0.001-0.009	-	-	-	-	-	6.8%
0.01-0.09	40.0%	10.0%	87.5%	27.3%	50.0%	34.1%
0.1-0.9	0.0%	30.0%	12.5%	0.0%	50.0%	13.6%
1-9	60.0%	50.0%	0.0%	27.3%	0.0%	25.0%
10-99	0.0%	10.0%	0.0%	27.3%	0.0%	9.1%
100-999	0.0%	0.0%	0.0%	18.2%	0.0%	4.5%
1,000-9,999	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

15.3.1.2.1 Largest Offshore Spills in Newfoundland

Two spill incidents–a spill of 1,572 bbl of crude oil from Husky Energy’s White Rose field (SeaRose FPSO) in November 2018, and a spill of 1,037.8 bbl of crude oil from Petro-Canada’s Terra Nova field (Terra Nova FPSO) in November 2004–constitute 95% of the total volume of oil spillage over 22 years. (This does not include spills of synthetic based mud or SBM spills.) Neither of these spills were well blowouts.

The 2018 Husky incident was attributed to a failed connection, specifically a “weak connector” in a subsea flowline. Husky reported that the SeaRose FPSO was “attempting to restart the operation during a fierce storm that was, at the time, the most intense in the world. Husky was the only producer that attempted to restart production during the storm.”

As of 2 July 2019, C-NLOPB has approved Husky’s plan to reinstall a replacement flowline connector. On 2 July 2019, C-NLOPB received Husky’s Interim Investigation Report, which is currently under review.

The second largest incident, the spill from Petro-Canada’s Terra Nova FPSO in 2004 was attributed to a produced water separation process. According to news reports, Petro-Canada stated that it was not human error but rather two equipment failures that caused the spill–“an oil and water separator did not work properly, and a chemical injection system this is supposed to aid the separation process malfunctioned.” No C-NLOPB reports on the investigation into the cause were found.

15.3.2 Probabilities of Spills from the Project

15.3.2.1 Probability of Batch Spills

Other spills may potentially occur from offshore operations, including batch spills from vessel or bunkering (fueling) operations as shown in Table 15.15. These spills would be expected to be substantially smaller than a blowout due to the more limited quantities of oil on a vessel. The expected frequencies depend on the number of exploration wells drilled.

Table 15.15 Expected Frequency of Batch Spills for West Flemish Pass

Number of Wells	Expected Frequency of Batch Spills over 180-Day Exploration Time Frame for Each Well	Chance of Batch Spills over 180-Day Exploration Time Frame for Each Well [A]
1	0.21	1-in-4.8
2	0.41	1-in-2.4
3	0.62	1-in-1.6
4	0.83	1-in-1.2
5	1.0	1-in-1.0
6	1.2	1-in-0.8
7	1.4	1-in-0.7
8	1.7	1-in-0.6

Notes:

A Expected frequencies over 1 or chances of 1 in a number smaller than one indicate that it is expected that there would be at least one batch spill (likely of a small volume) in the exploration time period.

Note that these expected frequencies are for spills of any volume over the course of the exploration period. Most of the spills would be expected to be relatively small. The spill frequencies were combined with the probability volume distribution to determine the probability of batch spills of different volumes, including the modeled scenario (BS-WS1, 6.3 bbl), as shown in Table 15.16 (the same data are shown as chances in Table 15.17).

Table 15.16 Probabilities of Non-crude Batch Spillage by Spill Size and Well Number

Number of Wells	Expected Frequency of Spills over Project Time Frame				
	Small <1 bbl <159 l	Small/Moderate 1–10 bbl 159–1,590 l	Moderate/Large 100–1,000 bbl 15.9–159 m³)	Large 1,000–10,000 bbl 159–1,590 m³	Scenario BS-WF1 (6.3 bbl)
1	0.21	0.11	0.0021	0.00021	0.032
2	0.42	0.21	0.0042	0.00042	0.063
3	0.62	0.32	0.0063	0.00063	0.095
4	0.83	0.42	0.0084	0.00084	0.13
5	1.0	0.53	0.011	0.0011	0.16
6	1.2	0.63	0.013	0.0013	0.19
7	1.5	0.74	0.015	0.0015	0.22
8	1.7	0.84	0.017	0.0017	0.25

Table 15.17 Chances of Non-crude Batch Spills by Spill Size and Well Number

Number of Wells	Small <1 bbl <159 l	Small/Moderate 1–10 bbl 159–1,590 l	Moderate/Large 100–1,000 bbl 15.9–159 m^3	Large 1,000–10,000 bbl 159–1,590 m^3	Scenario BS-WF1 (6.3 bbl)
1	1-in-5	1-in-9	1-in-476	1-in-4,762	1-in-31
2	1-in-2	1-in-5	1-in-238	1-in-2,381	1-in-16
3	1-in-2	1-in-3	1-in-159	1-in-1,587	1-in-11
4	1-in-1.2	1-in-2	1-in-119	1-in-1,190	1-in-8
5	1-in-1.0	1-in-2	1-in-91	1-in-909	1-in-6
6	1-in-0.8	1-in-2	1-in-77	1-in-769	1-in-5
7	1-in-0.7	1-in-1.4	1-in-67	1-in-667	1-in-5
8	1-in-0.6	1-in-1.2	1-in-59	1-in-588	1-in-4

The expected frequencies of batch spills over the course of the WFP Project will depend on the number of exploratory wells drilled. Note that when there is an expected frequency of greater than one, as is the case with five or more wells in the small (>1 bbl) category, it means that it is expected that there would be one or more spills of this volume over the course of the Project. However, there is no guarantee that they will occur.

15.3.2.2 Probability of Blowouts and Well Releases from the Project

Analyses of international and national historical spill data, well blowouts (with spillage) and other well-related spills from offshore drilling activities verify that large blowouts can be considered extremely rare events. The estimated probability that a specific individual exploratory well from the proposed project would have a blowout varies by location, with the difference being attributable to water depth. The calculated probability results for a subsurface release are summarized in Table 15.18 (and represented as chances in Table 15.19). The calculated probability results for a well release are summarized in Table 15.20 (and represented as chances in Table 15.21). The mean frequencies represent the expected number of blowouts over the course of the exploration period based on the site and the number of wells. For example, with eight wells at site WF1, the mean expected frequency is 0.00068. This means that there is a 1-in-1,471 chance that with eight wells there may be a blowout (of any size) over the exploration period. With fewer wells, the likelihood of a blowout decreases. With only one well at the WF1 site, there is a 1-in-11,765 chance that there would be a blowout over the exploration period.

Table 15.18 Mean Frequencies of Subsurface Releases for the Project during Exploration

Site	Subsurface Blowouts by Well Number							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
WF1	0.000085	0.00017	0.00026	0.00034	0.00043	0.00051	0.0006	0.00068
WF2	0.00032	0.00063	0.00095	0.0013	0.0016	0.0019	0.0022	0.0025

Table 15.19 Chances of Subsurface Releases for the Project during Exploration

Site	Subsurface Blowouts by Well Number							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
WF1	1-in-11,765	1-in-5,882	1-in-3,846	1-in-2,941	1-in-2,326	1-in-1,961	1-in-1,667	1-in-1,471
WF2	1-in-3,125	1-in-1,587	1-in-1,053	1-in-769	1-in-625	1-in-526	1-in-455	1-in-400

Table 15.20 Mean Frequencies Well Releases for the Project during Exploration

Site	Other Well Releases by Well Number							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
WF1	0.000055	0.00011	0.00016	0.00022	0.00027	0.00033	0.00038	0.00044
WF2	0.00026	0.00052	0.00078	0.001	0.0013	0.0016	0.0018	0.0021

Table 15.21 Chances of Well Releases for the Project During Exploration

Site	Other Well Releases by Well Number							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
WF1	1-in-18,182	1-in-9,091	1-in-6,250	1-in-4,545	1-in-3,704	1-in-3,030	1-in-2,632	1-in-2,273
WF2	1-in-3,846	1-in-1,923	1-in-1,282	1-in-1,000	1-in-769	1-in-625	1-in-556	1-in-476

These probabilities do not indicate release volume or imply a worst-case discharge, only that there could be a release of any size. The probabilities / chances of blowouts for West Flemish 1 by volume category and well number are provided in Tables 15.22 and 15.23, respectively. The probabilities / chances of blowouts West Flemish 2 by volume category and well number are provided in Tables 15.24 and 15.25, respectively. Probabilities / chances of West Flemish 1 well releases are shown in Table 15.26 and Table 15.27, respectively. Probabilities / chances of West Flemish 2 well releases are shown in Table 15.28 and Table 15.29, respectively.

Probabilities of well blowouts and releases are based on historical data. It is highly likely that future blowouts will be less frequent and involve smaller volumes due to technological advances. One research team conducted a fault-tree analysis of blowouts including newer intervention technologies developed after the Macondo MC252 incident (Caia et al. 2018). They concluded that the interventions would reduce flow duration and reduce the total blowout volume, by 30% to 60%. Their analysis predicted much smaller volumes of release.

Table 15.22 Probability of Blowouts by Volume Category by Well Number – West Flemish Pass 1

Spill Volume	Blowout Probability over Exploration and 20-Year Abandonment Period							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
Any Volume	1.9 x 10^{-4}	3.8 x 10^{-4}	5.7 x 10^{-4}	7.6 x 10^{-4}	9.5 x 10^{-4}	1.1 x 10^{-3}	1.3 x 10^{-3}	1.5 x 10^{-3}
1,000 bbl (159 m^3)	1.7 x 10^{-4}	3.4 x 10^{-4}	5.1 x 10^{-4}	6.8 x 10^{-4}	8.5 x 10^{-4}	1.0 x 10^{-3}	1.2 x 10^{-3}	1.4 x 10^{-3}
10,000 bbl (1,590 m^3)	1.5 x 10^{-4}	3.0 x 10^{-4}	4.5 x 10^{-4}	6.0 x 10^{-4}	7.5 x 10^{-4}	9.0 x 10^{-4}	1.1 x 10^{-3}	1.2 x 10^{-3}
100,000 bbl (15,900 m^3)	1.3 x 10^{-4}	2.6 x 10^{-4}	3.9 x 10^{-4}	5.2 x 10^{-4}	6.5 x 10^{-4}	7.8 x 10^{-4}	9.1 x 10^{-4}	1.0 x 10^{-3}
Scenario WF2-27 3,429,000 bbl (545,130 m^3)	1.9 x 10^{-7}	3.8 x 10^{-7}	5.7 x 10^{-7}	7.6 x 10^{-7}	9.5 x 10^{-7}	1.1 x 10^{-6}	1.3 x 10^{-6}	1.5 x 10^{-6}
Scenario WF2-135 17,145,000 bbl (2,725,650 m^3)	1.9 x 10^{-9}	3.8 x 10^{-9}	5.7 x 10^{-9}	7.6 x 10^{-9}	9.5 x 10^{-9}	1.1 x 10^{-8}	1.3 x 10^{-8}	1.5 x 10^{-8}

Table 15.23 Chances of Blowouts by Volume Category by Well Number – West Flemish Pass 1

Volume Category	Blowout Probability over Exploration and 20-Year Abandonment Period							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
Any Volume	1-in-5,300	1-in-2,600	1-in-1,800	1-in-1,300	1-in-1,100	1-in-910	1-in-770	1-in-670
1,000 bbl (159 m^3)	1-in-5,900	1-in-2,900	1-in-2,000	1-in-1,500	1-in-1,200	1-in-1,000	1-in-830	1-in-710
10,000 bbl (1,590 m^3)	1-in-6,700	1-in-3,30	1-in-2,200	1-in-1,700	1-in-1,300	1-in-1,100	1-in-910	1-in-830
100,000 bbl (15,900 m^3)	1-in-7,700	1-in-3,800	1-in-2,600	1-in-1,900	1-in-1,500	1-in-1,300	1-in-1,100	1-in-1,000
Scenario WF1-30 4,272,000 bbl (679,200 m^3)	1-in-5.3 million	1-in-2.6 million	1-in-1.75 million	1-in-1.3 million	1-in-1 million	1-in-910,000	1-in-770,000	1-in-670,000
Scenario WF2-123 17,525,200 bbl (2,784,720 m^3)	1-in-526 million	1-in-263 million	1-in-175 million	1-in-132 million	1-in-105 million	1-in-91 million	1-in-77 million	1-in-67 million

Table 15.24 Probability of Blowouts by Volume Category by Well Number – West Flemish Pass 2

Spill Volume	Blowout Probability over Exploration and 20-Year Abandonment Period							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
Any Volume	4.2×10^{-4}	8.4×10^{-4}	1.3×10^{-3}	1.7×10^{-3}	2.1×10^{-3}	2.5×10^{-3}	2.9×10^{-3}	3.4×10^{-3}
1,000 bbl (159 m^3)	3.8×10^{-4}	7.6×10^{-4}	1.1×10^{-3}	1.5×10^{-3}	1.9×10^{-3}	2.3×10^{-3}	2.7×10^{-3}	3.0×10^{-3}
10,000 bbl (1,590 m^3)	3.4×10^{-4}	6.8×10^{-4}	1.0×10^{-3}	1.4×10^{-3}	1.7×10^{-3}	2.0×10^{-3}	2.4×10^{-3}	2.7×10^{-3}
100,000 bbl (15,900 m^3)	2.5×10^{-4}	5.0×10^{-4}	7.5×10^{-4}	1.0×10^{-3}	1.3×10^{-3}	1.5×10^{-3}	1.8×10^{-3}	2.0×10^{-3}
Scenario WF2-27 3,429,000 bbl (545,130 m^3)	4.2×10^{-7}	8.4×10^{-7}	1.3×10^{-6}	1.7×10^{-6}	2.1×10^{-6}	2.5×10^{-6}	2.9×10^{-6}	3.4×10^{-6}
Scenario WF2-135 17,145,000 bbl (2,725,650 m^3)	4.2×10^{-9}	8.4×10^{-9}	1.3×10^{-8}	1.7×10^{-8}	2.1×10^{-8}	2.5×10^{-8}	2.9×10^{-8}	3.4×10^{-8}

Table 15.25 Chances of Blowouts by Volume Category by Well Number – West Flemish Pass 2

Volume Category	Blowout Probability over Exploration and 20-Year Abandonment Period							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
Any Volume	1-in-2,400	1-in-1,200	1-in-770	1-in-590	1-in-480	1-in-400	1-in-350	1-in-290
1,000 bbl (159 m^3)	1-in-2,600	1-in-1,316	1-in-910	1-in-670	1-in-526	1-in-440	1-in-370	1-in-330
10,000 bbl (1,590 m^3)	1-in-2,900	1-in-1,471	1-in-1,000	1-in-710	1-in-588	1-in-500	1-in-420	1-in-370
100,000 bbl (15,900 m^3)	1-in-4,000	1-in-2,000	1-in-1,333	1-in-1,000	1-in-769	1-in-670	1-in-560	1-in-500
Scenario WF2-27 3,429,000 bbl (545,130 m^3)	1-in-2.4 million	1-in-1.2 million	1-in-7.7 million	1-in-5.9 million	1-in-4.8 million	1-in-400,000	1-in-340,000	1-in-290,000
Scenario WF2-135 17,145,000 bbl (2,725,650 m^3)	1-in-240 million	1-in-120 million	1-in-770 million	1-in-590 million	1-in-480 million	1-in-40 million	1-in-34 million	1-in-29 million

Table 15.26 Probability of Releases by Volume Category by Well Number – West Flemish Pass 1

Spill Volume	Number of Wells							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
1 bbl (0.159 m^3)	5.5 x 10^{-5}	1.1 x 10^{-4}	1.7 x 10^{-4}	2.2 x 10^{-4}	2.8 x 10^{-4}	3.3 x 10^{-4}	3.9 x 10^{-4}	4.4 x 10^{-4}
10 bbl (1.59 m^3)	3.9 x 10^{-5}	7.7 x 10^{-5}	1.2 x 10^{-4}	1.5 x 10^{-4}	1.9 x 10^{-4}	2.3 x 10^{-4}	2.7 x 10^{-4}	3.1 x 10^{-4}
100 bbl (15.9 m^3)	1.1 x 10^{-5}	2.2 x 10^{-5}	3.3 x 10^{-5}	4.4 x 10^{-5}	5.5 x 10^{-5}	6.6 x 10^{-5}	7.7 x 10^{-5}	8.8 x 10^{-5}
1,000 bbl (159 m^3)	5.5 x 10^{-10}	1.1 x 10^{-9}	1.7 x 10^{-9}	2.2 x 10^{-9}	2.8 x 10^{-9}	3.3 x 10^{-9}	3.9 x 10^{-9}	4.4 x 10^{-9}

Table 15.27 Chances of Releases by Volume Category by Well Number – West Flemish Pass 1

Spill Volume	Number of Wells							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
1 bbl (0.159 m^3)	1-in-18,000	1-in-9,000	1-in-5,900	1-in-4,500	1-in-3,600	1-in-3,000	1-in-2,600	1-in-2,300
10 bbl (1.59 m^3)	1-in-26,000	1-in-13,000	1-in-8,300	1-in-6,700	1-in-5,300	1-in-4,300	1-in-3,700	1-in-3,200
100 bbl (15.9 m^3)	1-in-91,000	1-in-45,000	1-in-30,000	1-in-23,000	1-in-18,000	1-in-15,000	1-in-13,000	1-in-11,000
1,000 bbl (159 m^3)	1-in-1.8 billion	1-in-910 million	1-in-590 million	1-in-460 million	1-in-360 million	1-in-300 million	1-in-260 million	1-in-230 million

Table 15.28 Probability of Releases by Volume Category by Well Number – West Flemish Pass 2

Spill Volume	Number of Wells							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
1 bbl (0.159 m^3)	2.6 x 10^{-4}	5.2 x 10^{-4}	7.8 x 10^{-4}	1.0 x 10^{-3}	1.3 x 10^{-3}	1.6 x 10^{-3}	1.8 x 10^{-3}	2.1 x 10^{-3}
10 bbl (1.59 m^3)	1.8 x 10^{-4}	3.6 x 10^{-4}	5.5 x 10^{-4}	7.3 x 10^{-4}	9.1 x 10^{-4}	1.1 x 10^{-3}	1.3 x 10^{-3}	1.5 x 10^{-3}
100 bbl (15.9 m^3)	5.2 x 10^{-5}	1.0 x 10^{-4}	1.6 x 10^{-4}	2.1 x 10^{-4}	2.6 x 10^{-4}	3.1 x 10^{-4}	3.6 x 10^{-4}	4.2 x 10^{-4}
1,000 bbl (159 m^3)	2.6 x 10^{-9}	5.2 x 10^{-9}	7.8 x 10^{-9}	1.0 x 10^{-8}	1.3 x 10^{-8}	1.6 x 10^{-8}	1.8 x 10^{-8}	2.1 x 10^{-8}

Table 15.29 Chances of Releases by Volume Category by Well Number – West Flemish Pass 2

Spill Volume	Number of Wells							
	1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
1 bbl (0.159 m³)	1-in-3,800	1-in-1,900	1-in-1,300	1-in-1,000	1-in-770	1-in-630	1-in-560	1-in-480
10 bbl (1.59 m³)	1-in-5,600	1-in-2,800	1-in-1,800	1-in-1,400	1-in-1,100	1-in-910	1-in-770	1-in-670
100 bbl (15.9 m³)	1-in-19,000	1-in-10,000	1-in-6,300	1-in-4,800	1-in-3,800	1-in-3,200	1-in-2,800	1-in-2,400
1,000 bbl (159 m³)	1-in-380 million	1-in-190 million	1-in-130 million	1-in-100 million	1-in-77 million	1-in-63 million	1-in-56 million	1-in-48 million

15.3.3 Summary

The estimated probabilities (and return periods) of modelled scenarios are shown in Table 15.30. Overall, the probabilities of spillage are very low and if spillage does occur, the spill volumes are likely to be relatively small. The same data are presented as chances in Table 15.31.

Table 15.30 Probabilities of West Flemish Pass Hypothetical Scenario Spillage

Modeled Scenario	Volume	Expected Frequency over WFP Project							
		1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
WF1-30 Blowout	679,200 m³ 4,272,000 bbl	1.9×10^{-7}	3.8×10^{-7}	5.7×10^{-7}	7.6×10^{-7}	9.5×10^{-7}	1.1×10^{-6}	1.3×10^{-6}	1.5×10^{-6}
WF1-123 Blowout	2,784,720 m³ 17,515,200 bbl	1.9×10^{-9}	3.8×10^{-9}	5.7×10^{-9}	7.6×10^{-9}	9.5×10^{-9}	1.1×10^{-8}	1.3×10^{-8}	1.5×10^{-8}
WF2-27 Blowout	545,130 m³ 3,429,000 bbl	4.2×10^{-7}	8.4×10^{-7}	1.3×10^{-6}	1.7×10^{-6}	2.1×10^{-6}	2.5×10^{-6}	2.9×10^{-6}	3.4×10^{-6}
WF2-135 Blowout	2,725,650 m³ 17,145,000 bbl	4.2×10^{-9}	8.4×10^{-9}	1.3×10^{-8}	1.7×10^{-8}	2.1×10^{-8}	2.5×10^{-8}	2.9×10^{-8}	3.4×10^{-8}
BS-WF1 Batch	1 m³ 6.3 bbl	3.2×10^{-2}	6.4×10^{-2}	9.6×10^{-2}	1.3×10^{-1}	1.6×10^{-1}	1.9×10^{-1}	2.2×10^{-1}	2.6×10^{-1}

Table 15.31 Chances of West Flemish Pass Hypothetical Scenario Spillage

Modeled Scenario	Volume	Expected Frequency over WFP Project							
		1 Well	2 Wells	3 Wells	4 Wells	5 Wells	6 Wells	7 Wells	8 Wells
WF1-30 Blowout	679,200 m^3 4,272,000 bbl	1-in-5.3 million	1-in-2.6 million	1-in-1.75 million	1-in-1.3 million	1-in-1 million	1-in-910,000	1-in-770,000	1-in-670,000
WF1-123 Blowout	2,784,720 m^3 17,515,200 bbl	1-in-526 million	1-in-263 million	1-in-175 million	1-in-132 million	1-in-105 million	1-in-91 million	1-in-77 million	1-in-67 million
WF2-27 Blowout	545,130 m^3 3,429,000 bbl	1-in-2.4 million	1-in-1.2 million	1-in-7.7 million	1-in-5.9 million	1-in-4.8 million	1-in-400,000	1-in-340,000	1-in-290,000
WF2-135 Blowout	2,725,650 m^3 17,145,000 bbl	1-in-240 million	1-in-120 million	1-in-770 million	1-in-590 million	1-in-480 million	1-in-40 million	1-in-34 million	1-in-29 million
BS-WF1 Batch	m^3 6.3 bbl	1-in-31	1-in-16	1-in-10	1-in-8	1-in-6	1-in-5	1-in-5	1-in-4

There are three types of oil releases that could potentially occur directly from wells and their associated infrastructure–subsurface blowouts, well releases, and corrosion-caused leaks after abandonment. Batch spills of fuel oils and other oils used in operations, as well as SBM may also occur from supply vessels and drilling rigs. The likelihood of incidents occurring depends on the number of wells and the duration of the exploration period. With more wells there are greater chances of having a spill. There are some differences in chances of a blowout between the West Flemish 1 and West Flemish 2 sites based on water depth.

For West Flemish 1, there is a 1-in-12,000 chance that there will be a blowout during exploration if there is one well. With eight wells, the chance increases to 1-in-1,500. For West Flemish 2, there is a 1-in-3,100 chance of a well blowout for each well during the exploration period. With eight wells, the chances are 1-in-400.

It is important to remember that when a blowout occurs, it is more likely to involve a relatively small volume than a very large volume. The vast majority (84%) of blowouts bridge over naturally within a few hours to days even in the absence of any intervention or before an intervention can be implemented. The chances of a blowout involving 1,000 bbl or more are 1-in-5,900 for West Flemish 1, and 1-in-2,600 for West Flemish 2 per well. Larger blowout volumes are less likely. The chances of a blowout of 100,000 bbl are 1-in-7,700 and 1-in-4,000, respectively.

The chances for the four hypothetical blowout scenarios modeled are as shown in Table 15.32. These scenarios were identified as potential “worst-case” discharges and assume that intervention measures could not be properly implemented until 27 to 30 days (capping) or 123 to 135 days (relief well).

Table 15.32 Chances of West Flemish Pass Modelled Hypothetical Blowout Scenarios

Hypothetical Scenario	Total Volume	Chances with 1 Well	Chances with 8 Wells
WF2-27	3,429,000 bbl	1-in-2.4 million	1-in-290,000
WF1-30	4,272,000 bbl	1-in-5.3 million	1-in-670,000
WF2-135	17,145,000 bbl	1-in-240 million	1-in-29 million
WF2-123	17,515,000 bbl	1-in-526 million	1-in-67 million

For well releases, the chances are 1-in-18,000 per well for West Flemish 1 and 1-in-3,800 per well for West Flemish 2. With eight wells, the chances increase to 1-in 2,300 and 1-in 480, respectively. Well releases also tend to be small with a maximum that is much smaller than a potential worst-case blowout.

There is a 1-in-5 chance of a batch spill for each well. This means that with five or more wells, it can be expected that there will be at least one batch spill, although this is not “guaranteed.” There is no difference between the sites. Batch spills also are generally relatively small as there is a limited amount of oil that is contained in the fuel tanks or other storage capacity.

For corrosion-caused leakage, applying the most conservative assumptions (i.e., tending to overestimate the likelihood), there may be 1-in-32 chance of leakage in each well over the course of 20 years post-abandonment and no interventions. With eight wells, the chance is 1-in-4. This assumes that the conditions are conducive to corrosion. These leaks, if they occur, tend to be very small.

The analyses on probabilities of blowouts, well releases, and batch spills are based on historical data. There are continuing developments in blowout prevention and mitigation, as well as improved safety practices in offshore operations, that will continue to reduce the likelihood and severity of these incidents in the future.

15.4 Contingency Planning and Spill Response

Under the Atlantic Accord, oil spill response at an offshore facility falls under the jurisdiction of the C-NLOPB pursuant to section 161 of the Act. The C-NLOPB has a specific regulatory mandate to ensure the operator is taking all reasonable measures to prevent further spillage and to mitigate the effect and impacts of the spill. Where reasonable measures are not being taken, the Chief Conservation Officer (CCO) can direct the operator to take those measures or can take over management of the response effort directly.

C-NLOPB is the designated lead agency in offshore spill incidents at the drilling site under memoranda of understanding with a variety of federal and provincial ministries which may act in supporting roles. These agencies may include:

- DFO
- Canadian Coast Guard (CCG)
- ECCC
- Transport Canada
- Provincial government departments

The C-NLOPB is also named as the lead agency in offshore spill incidents under the CCG National Emergency Response Plan. The C-NLOPB expects that Chevron will have a credible response capability including:

- Designated response personnel
- A training program for Chevron personnel and Chevron contractors
- Spill tracking and clean-up equipment at the offshore site

In addition to specific requirements under formal guidelines, the C-NLOPB has expressed a series of 'expectations' or policies that pertain to drilling operations. Specifically, the offshore Operator shall have:

- An on-site oil spill response capability
- Access to third party oil spill personnel and equipment
- Mutual aid agreements with other Grand Banks operators

The project-specific Oil Spill Response Plan (OSRP) will cover the management, countermeasures, strategies and training that will be used in the response to potential spills originating inside the safety zone at Chevron's exploratory West Flemish Pass drill site.

This OSRP will provide a comprehensive review of:

- Chevron's philosophy and policies concerning oil spill response
- The organization of Chevron's response efforts and the evolution of those efforts with the increasing scale of the spill response
- Arrangements for assistance from contractors, other operators and corporate resources
- Environmental issues resulting from an offshore oil spill
- Chevron's policies concerning safety, oil spill waste management, and training

Detailed information within the following areas will be included in the plan:

- Actions - Personnel checklists and the forms to be used both in the field and by the onshore Emergency Response Team (ERT) during oil spill response including communications protocols
- Resources - Details of the personnel, equipment and vessel resources available to Chevron for use in an oil spill response
- Oil Spill Fate - Anticipated fate and characteristics of spilled crude
- Procedures - Stand-alone detailed procedures which describe specific actions that may be undertaken during oil spill response. Some of these procedures will be used directly as training materials
- Glossary - A dictionary of oil spill terms and acronyms
- Contacts - Contact information for:
  - Chevron emergency personnel
  - Key Chevron contractors
  - Oil spill consultants and contractors
  - Government agencies
  - Other offshore Operators' emergency personnel
  - Grand Banks offshore platforms and vessels

Chevron vessels will be equipped with sorbent materials for the response to small fuel, hydraulic, or testing spills. Eastern Canada Response Corporation (ECRC) has been contracted as Chevron's prime spill response contractor thereby providing a pool of equipment and consistency with all Grand Banks Operators. Chevron is a signatory to the current Grand Banks Operators Mutual Emergency Assistance Agreement.

As Operator, Chevron will always assume a responsible role for oil spills which occur within the 500 m safety zone, regardless of the cause of the spill. In cases where the oil is discharged by a vessel and drifts into the zone, it is unlikely that Chevron would be considered the legally responsible party. In the interest of rapid response and protection of the environment adjacent to the affected offshore drill ship, Chevron will, in all likelihood, initiate operational response activities at the time of the spill. In implementing a response to an oil spill in the safety zone, Chevron does not necessarily accept responsibility for the spill itself.

Chevron's East Coast Oil Spill Response Program has been structured to support any of Chevron's operations offshore Newfoundland. The Program is comprehensive and consists of two components – Operational Response and Response Management. The operational component meets or exceeds standards established by the *Canada Shipping Act.* The response management component is linked to Chevron's East Coast Emergency Response Program and the ECRC Spill Management System, which is certified under the *Canada Shipping Act*.

Chevron has established an operational capability to respond to offshore oil spills. Equipment has been staged to allow prompt response to small spills with resources at site and an efficient response to larger spills using equipment stored at ECRC's facility in Mount Pearl. Oil spill response resources include:

- Surveillance and monitoring
- Oil and oiled wildlife sampling
- Wildlife monitoring and handling
- Physical dispersion
- Containment and recovery (Sorbent boom or other systems stored onshore)

The management of Chevron's response to an offshore oil spill will follow the process established for the response to other emergencies. The response management process will be described in Chevron's West Flemish Pass Emergency Response Plan and will be an integrated and coordinated approach to a spill incident that includes:

- Immediate reaction to the incident controlled by the Person in Charge (i.e., Incident Commander) in the Emergency Command Centre or bridge of the offshore facility
- Prompt and direct support for the offshore emergency response by Chevron's onshore Local Emergency Operations Centre (LEOC)
- Activation of ECRC in all spill events requiring mobilization of Chevron's LEOC, either as advisors to the Chevron ERT or through the mobilization of the ECRC Spill Management Team
- Activation of Oil Spill Response Limited (OSRL)

For response planning purposes, the severity of the response to potential oil spills will be divided into three levels or tiers. This scheme is based on the level of the response and not just on the volume of oil released.

This classification allows for an appropriate initial response to each level of spill and provides for the escalation of the response should the potential impact of the spill increase. Each tier will require a successively higher level of operational effort and response management. The parameters to be considered in selecting the appropriate level of response include:

- Size and nature of the oil spill
- Environmental and operational conditions at the time of the spill
- Vessel and equipment availability
- Numbers and qualifications of personnel available at site
- On-site waste oil storage
- Corporate exposure to risk and liability as a result of the oil spill

The three levels are defined as follows:

- A **Tier 1** spill can be managed using resources available at site. For Project operations this includes spill kits on all charter vessels
- A **Tier 2** spill response requires local shore-based management support and resources in addition to those already at site. Resources include aircraft, vessels, and equipment based or stored in the St. John's area
- A **Tier 3** oil spill has the potential to affect Chevron and shareholder company business operations and may require considerable corporate and contract resources drawn from local, regional, and international sources. Resources include vessels chartered outside of Newfoundland and Labrador; equipment cascaded in from identified sources in Canada; and aircraft, equipment, and personnel obtained from international oil spill response organizations

In the unlikely event of a spill, Chevron will employ a structured, systematic, and proportional management process in the response to any uncontrolled release of hydrocarbons at any offshore site. Priorities in managing the response will be:

- Protection of personnel
- Protection of the environment
- Protection of assets

Any oil spill response will be managed at two levels regardless of the magnitude of the incident or the number of participants:

- **Incident Management** - the management of field activities to contain, recover, and clean up the spill based on an escalating scale of required response. This level is often referred to the "down and in" perspective
- **Issues Management** - the management of the community, business and communications aspects of the response at a corporate level. This level is often referred to the "up and out" perspective

In any spill response, Chevron's response priority will be to safely mitigate the effects of the spill in a way that results in the highest Net Environmental Benefit. The measures implemented will be reasonable and will be taken after consultation with Regulators. Reasonableness will be based on safety, impact to the environment, practicality, and cost-effectiveness. Response strategies, including cost, are determined by

ECRC through the ICS planning process. Chevron may consult with and seek input from C-NLOPB with supporting federal and provincial government agencies.

The OSRP will specify tactical response methods, procedures, and strategies for safely responding to different spill scenarios such as:

- Offshore containment and recovery
- Surveillance and tracking
- Cold weather response
- Dispersant application (surface and subsea injection)
- In-situ burning
- Shoreline protection
- Shoreline clean-up
- Oiled wildlife response

Chevron's OSRP provides a process for deciding initial countermeasures to be used in developing a strategy. Critical to the process is constant situation analysis to determine the nature of the problem posed by the spill and the effectiveness of response actions. Guidelines to be followed when developing a strategy include:

- Safety is foremost
- The Offshore Installation Manager should make an informed decision in consultation with the Master of the standby vessel and local observers
- Background information or technical advice can always be provided by ECRC
- When high sea state prohibits a response, natural dispersion of oil is enhanced
- Prop washing or high pressure water spray is the best solution for thin oil sheen. Prop washing does not work well for crude oil
- Sorbent boom should be considered in the initial stages because of the speed of deployment and the high probability of capturing the slick before spreading
- Every planned task should include frequent situation analysis
- Aerial surveillance is very useful. Use aircraft (contracted helicopters, Transport Canada flights) working in the area at the time of the spill. If the volume of oil spilled is unknown, arrangements should be made for dedicated aerial reconnaissance
- Waste disposal will be a problem in every spill response and could create bottlenecks in operations. Wherever possible, oily waste products should only be handled once to prevent secondary contamination
- Personnel handling oily waste should ensure that clothing and personal protective equipment are protected by a disposable or easily-cleaned outer suit

Strategy development will consider a range of offshore spill response options. The decision when to use each of these is based on an evaluation of the current and forecast operating conditions, the anticipated characteristics of the oil, the effectiveness of the option, and effects on the environment. Table 15.33 provides guidelines for possible actions at each level of response.

Table 15.33 Possible Actions at Each Response Level

		Spill Description	Offshore Response		Onshore Response
Tier 1	*Type:*	Batch Instantaneous	Platform:	Control spill source Notify Drilling Superintendent Notify CCG Marine Communications Traffic Service (MCTS)	Ensure CCG-MCTS has been notified Notify Incident Commander Notify C-NLOPB
	Volume:	Small (<50 bbl)			
	Source:	Identified Stopped	On Water:	Mechanical dispersion Sorbent side sweep Monitor slick/sheen Waste management	
	Continued Risk:	Negligible			
	Examples:	Process, equipment, offloading, flaring or fuel transfer leaks			
Tier 2	*Type:*	Batch	Platform:	Tier 1 actions plus Mobilize additional oil response equipment from shore Activate onshore Emergency Response Team (ERT) Transfer command/control of response to Deputy Incident Commander in LEOC	Tier 1 actions plus ERT mobilizes onshore LEOC. ERT mobilizes ECRC to direct all field operations. Mobilize additional resources Incident Commander interaction with ERT & stakeholders
	Volume:	Medium (50-1000 bbl)			
	Source:	Identified Controlled			
	Continued Risk:	Diminishing			
	Examples:	Larger leaks from process or pipeline or offloading system	On Water:	Large on-water response effort with equipment and vessels mobilized from shore, as required Monitor slick	
Tier 3	*Type:*	Batch or continuous	Platform:	Tier 2 actions plus Provide operational support, as required	Tier 2 actions plus Mobilize Corporate Oil Spill Response Team
	Volume:	Large (>1000 bbl)			
	Source:	May be unidentified May be uncontrolled			
	Continued Risk:	Persistent Increasing	On Water:	Large on-water response with equipment and vessels mobilized from shore Monitor slick	

Response also includes wildlife monitoring. In an offshore spill incident, CWS will be particularly concerned about oiled seabirds and DFO will monitor any fish or invertebrate populations and oiled mammals. Seabirds that live on or close to the sea surface have been identified as the biological resource most vulnerable to an offshore oil spill. The following operations will be undertaken in the event of an offshore spill:

- Downwind aerial and vessel surveillance in advance of the drifting slick to identify seabirds and mammals at risk
- Employment of bird hazing techniques to deter seabirds from the affected area, using vessels, aircraft, and noise making devices. The intention is to scare birds away from oil on water (all deterrent techniques must be approved and permitted by CWS)
- Recovery, evaluation, and appropriate treatment for affected seabirds (collect carcass, euthanize, or recover for rehabilitation) and delivery of birds to a central location for shipment to shore

15.5 Environmental Effects Assessment

The environmental assessment for accidental events considers the following accidental spill scenarios:

- Subsea blowout
    1. Continuous 30-day (capping stack scenario) and 123-day (relief well scenario) subsea well blowout at West Flemish Pass 1 wellsite (1,500 m water depth)
    2. Continuous 27-day (capping stack scenario) and 135-day (relief well scenario) subsea well blowout at West Flemish Pass 2 wellsite (500 m water depth)
- Batch spill
    1. Instantaneous 30-day spill of 1,000 L of marine diesel from the MODU
    2. spill from a PSV in transit to or from the MODU
- SBM spill
    1. SBM spill from the MODU and the marine riser

As detailed in Section 15.2 (see also Appendix F), stochastic and deterministic modelling was conducted for subsea blowout and marine diesel spill scenarios at the MODU (refer to Table 15.1). This modelling was based on an unmitigated spill (i.e., no oil spill response was undertaken) and that flow rates were based on the worst credible case at each of the two potential locations. Modelling was conducted on two primary cases – unmitigated spill until installation of a capping stack (30 days for West Flemish 1 and 27 days for West Flemish 2) and unmitigated spill until completion of a relief well (123 days for West Flemish 1 and 135 days for West Flemish 2) (although it could take considerable less time to drill a relief well). For the purpose of this environmental assessment the focus is primarily on the hypothetical 120-day well blowout scenario, as it would result in a relatively higher spatial extent, magnitude, and duration of associated potential environmental effects.

Project-specific modelling was not conducted for an SBM whole mud spill of a marine diesel spill from an in-transit supply vessel. CNOOC modelled a whole mud SBM spill at EL 1144, at a water depth (1,137 m) comparable to Chevron's EL (1,500 m). Modelling was conducted for CNOOC's Flemish Pass Exploration Drilling Project (2018-2028) (Nexen Energy 2018) based on a supply vessel collision between the CNOOC ELs and the St. John's shore base. CNOOC modelled a hypothetical release of 750,000 L (6,391 bbl) over

30 days a (CNOOC 2017). CNOOC's project area is in the Flemish Pass, as is Chevron's, providing a qualitative assessment of environmental effects from both scenarios associated with the Chevron Project.

The same methods applied to the assessment of effects of routine activities were applied to the accidental events effects assessment (i.e., identification of pathways, mitigation, and characterization of residual environmental effects). While VC-specific mitigation has been identified where appropriate, the emergency response and spill management as outlined in Section 15.4 would be the primary mitigation. Residual effects are characterized in residual effect summary tables and their significance is determined using the same VC-specific thresholds applied to the assessment of routine Project activities (refer to Chapters 8 to 13).

The following sections assesses the environmental effects from an accidental event on the VCs. Given the similarities in Project description, proximity of activities in Orphan Basin and Flemish Pass, and currency of data, the EIS incorporates information from previous EA documents (e.g., ExxonMobil 2017; Nexen 2017; Statoil 2017; BP 2018, Husky 2018) for similar exploration drilling projects in Atlantic Canada, including comments received during Indigenous and stakeholder review processes, with updates incorporated as applicable.

15.5.1 Marine Fish and Fish Habitat

The West Flemish Pass and surrounding area provides habitat for a variety of groundfish, pelagic fish, and invertebrate species. At least 65 species of fish have been identified within the RAA, with the most frequently reported: deepwater redfish, lanternfishes (not identified to species), roughhead grenadier, blue hake, common grenadier, longnose eel, Greenland halibut, and Atlantic cod (DFO 2018).

One fish SAR and seven fish SOCC were identified in the DFO trawl surveys, indicating that they are present in the Project Area and/or RAA at various times of the year (see Section 6.1.8). Of these species, the northern wolffish is the only species formally protected under Schedule 1 of SARA. There is proposed critical habitat for both the northern wolffish and the spotted wolffish within the transit route, LAA, and a small portion of the Project Area.

Deep-sea corals, sea pens, and sponges are often of environmental interest due to the habitat-forming capacity of these benthic invertebrates, their importance in supporting early life stages of fish and invertebrates, and their relative sensitivity to anthropogenic stressors. Existing and available information for corals, sea pens, and sponges in this region indicates that portions of the Project Area and RAA overlap with several areas of known occurrence for these species.

Section 6.4 describes special areas of importance to marine fish that are found within the RAA. Additional details regarding existing conditions for marine fish and fish habitat are provided in Section 6.1.

An accidental release of oil or SBM could extend outside of the Project Area to affect SAR, SOCC, and secure species in the larger RAA. The potential effects of the accidental release of oil or SBM in the marine environment on marine fish and fish habitat are largely dependent on a variety of biotic (species, life history, behaviour, resistance) and abiotic (oceanographic conditions, exposure duration, oil type, oil treatment methods) factors.

15.5.1.1 Project Pathways for Effects

Accidental spill scenarios can result in a change in risk of mortality or physical injury and/or a change in habitat quality and use for marine fish and fish habitat. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in space and in time. The assessment is conservative (i.e., geographic and temporal overlap are assumed to occur, and modelling results assume worst-case credible discharge rates and no implementation of mitigation measures).

15.5.1.1.1 Potential Effects of an Oil Spill on Marine Fish and Fish Habitat

Potential effects pathways for a change in risk of mortality or physical injury and/or change in habitat quality and use for marine fish and fish habitat due to an oil spill include: reduction of water and/or sediment quality; reduced primary productivity due to a reduction in air-water gas exchange and light penetration; and lethal and sublethal effects from acute or chronic exposure to water-soluble fractions of hydrocarbons.

The risk of exposure of fish and invertebrates to an oil spill depends on the type of oil and volume released, but also on the habitat these species occupy, their behaviour, the time of year, their life history, and the general health of the population at the time of the spill. Fish kills are typically brief and localized following a discrete spill event due to the rapid loss of the acutely lethal low-molecular weight components of oil as a result of dilution and weathering (Lee et al. 2015), the ability of motile species to detect and avoid impacted areas, and the ability of phytoplankton, zooplankton, and adult fish to metabolize hydrocarbons (Wolfe et al. 1996; Graham et al. 2010).

In general, adult pelagic and benthic fish occurring in relatively deep waters have lower exposure risk because they are highly mobile and able to avoid oiled areas (Irwin 1997; Law et al. 1997). Larval and juvenile pelagic and benthic fish species are at a greater risk of exposure as they are often less motile than adults (Yender et al. 2002) and have shown higher sensitivity to lower concentrations of hydrocarbons, since they may not have yet developed detoxification systems allowing them to metabolize hydrocarbons (Rice 1985; Carls et al. 1999; Incardona et al. 2013; Lee et al. 2015). While individuals in these life stages could be affected, effects on larval stages does not necessarily result in effects on adult populations (Gallaway et al. 2017; Carroll et al. 2018).

Acute toxicity (short-term exposures) would be more representative of exposure during a discrete spill event. The ecological risks for this type of exposure would be reduced as the more toxic components of the spill, lower molecular weight compounds (LMW), evaporate and dilute rapidly (Lee et al. 2015). However, there are documented sublethal effects such as reduced feeding (Lari et al. 2015) and larval deformities (Mager et al. 2014). Potentially lethal effects (associated with LMW) include a variety of responses related to lipid membrane receptors in effects collectively termed narcosis (Peterson et al. 2003). Continued exposure can result in symptoms that range from depression in respiratory-cardiovascular activity, tissue hypoxia, and ultimately respiratory paralysis (death) if exposure continues. These effects are short term as the LMW volatize from the oil on the order of days (Lee et al. 2015). Cold-water invertebrate taxa (bivalves, gastropods, crustaceans) have been shown to have comparable reactions in terms of specific PAH sensitivities when compared to temperate species (Olsen et al. 2011). These short-term effects can be recoverable if exposure does not continue.

Chronic, long-term exposure would have a range of potential effects from genetic and molecular responses of cells to effects on reproduction, growth, disease, and survival (Lee et al. 2015; Busky et al. 2016). The uptake pathways vary but can include respiratory uptake, direct contact, diet, or maternal transfer to eggs. Studies on finfish have shown that the dissolved oil components can travel across respiratory membranes in gills (Lee et al. 2015). More recent studies have identified that the PAH phenanthrene disrupts cardiac function and is associated with heart malformations in developing fish and it becomes proportionally more toxic as the spilled oil weathers (Brette et al. 2017). Long-term exposure may also affect fish health and condition through susceptibility to higher parasite loads (Khan 1990). Uptake of PAHs in a bivalve indicated that it primarily accumulated in the gonads resulting in reproductive delays (Frouin et al. 2007). Like invertebrates, deep-sea fish species typically have lower metabolisms, are slower growing, have longer life spans, and would likely be more susceptible to disturbances such as oil spills (Cordes et al. 2016). As previously discussed, the early life stages are likely more sensitive to hydrocarbon exposures than adults (Lee et al. 2015; Sørensen et al. 2017).

After the DWH oil spill, early life stages of coastal fishes using seagrass habitat in the northern Gulf of Mexico were investigated. The studies concluded that immediate, catastrophic losses of 2010 cohorts were largely avoided, and that no shifts in species composition occurred following the spill. However, it was pointed out that this did not preclude potential long-term effects experienced by fish from chronic exposure and delayed indirect effects (Fodrie and Heck 2011). In another study, commercial fish and shellfish (crab, shrimp, oyster) species were collected after the DWH oil spill from closed fishing grounds along the Mississippi coast. Higher levels of PAHs were detected in all four taxa (fish, crab, shrimp, oyster) during the early sampling. When compared with later months, and after one year, PAH levels in the collected samples were similar to those reported in commonly consumed processed foods and below regulated levels (Xia et al. 2012).

Plankton are a key component of primary and secondary production in ocean environments, and potential effects on these organisms may have implications for higher trophic levels. The response of plankton and other microbial communities to oil spills is diverse and largely dependent on exposure level. In general, plankton and other microorganisms do not have an avoidance response to contaminants, as oceanographic conditions largely control their horizontal movements. However, certain coastal and estuarine zooplankton have been shown to be able to detect and avoid small patches (1 to 7 cm) of hydrocarbon contaminated water (Seuront 2010), resulting in distribution changes. Reduction of air-water gas exchange and light penetration following a spill generally results in reduced productivity and growth and ultimately a change in community composition (Teal and Howarth 1984; Abbriano et al. 2011; Gilde and Pinckney 2012).

Post-spill studies on phytoplankton conducted using crude oil obtained from the DWH oil spill and a mixture of Texas crude samples found that total phytoplankton biomass declined with increasing concentration of oil, and that the phytoplankton community was modified. Diatoms, cyanobacteria, euglenophytes, and chlorophytes were found to be relatively resistant to contamination, while cryptophytes were found to be vulnerable (Gilde and Pinckney 2012).

Zooplankton have also been shown to be sensitive to hydrocarbons, with increased mortality, decreased feeding and decreased reproduction (Suchanek 1993; Seuront 2011). Zooplankton with the ability to sense and avoid spills (e.g., copepods) can reduce contact and mortality risk (Seuront 2010). At sublethal levels, hydrocarbons accumulated in zooplankton after a spill can be depurated within days of moving to clean water (Trudel et al. 1985). Recovery of zooplankton communities are likely to occur soon after a spill due to their short generation time, high fecundity, and the ability of some zooplankton to actively avoid spill sites (Seuront 2011). When there is a spill of crude oil or hydrocarbons, the bacteria capable of degrading the substance proliferate and multiply quickly (ASM 2011). The local community of microbes in an area is adapted to the background concentrations of hydrocarbons. When a spill occurs, there is a lag time during which the microbes replicate and increase their populations in response to the influx of a new energy source. During an oil spill, the volume of oil released into the environment initially out paces the ability of bacteria to degrade the substance until the community catches up in numbers in response to the increased availability of a hydrocarbon source. In coordination with other physical processes including evaporation, dissolution, dispersion, and photooxidation, bacteria will eventually remediate the spill by consuming the hydrocarbon compounds that are biodegradable (ASM 2011). Studies have shown that bacterial respiration, through biodegradation of hydrocarbons, has the potential to cause oxygen depletion, eventually leading to hypoxia in areas near oil spills (Adcroft et al. 2010).

In general, life histories of corals, sponges, and sea pens (planktonic larvae, slow growing, long life spans, and slow recovery) and feeding mechanisms (suspension feeding) make them susceptible to accidental events (Fisher et al. 2014; Prouty et al. 2016; Cordes et al. 2016). Sessile adults and planktonic larvae of these species also have no known avoidance mechanisms to oil spill events. The effects of hydrocarbons on corals are typically assessed *in situ* using visual indicators of stress (White et al. 2012). Visual indicators of coral stress related to the DWH spill included partial tissue loss, excessive mucus production, retracted polyps, partial coverage by brown flocculant sourced to the spill, and death (Busky et al. 2016; Prouty et al. 2016; Ragnarsson et al. 2017). Follow-up studies on the DWH spill has shown a patchy distribution of effects which were highly site-specific and included incidence of hydroid colonization, a sign of deterioration on affected coral branches (Hsing et al. 2013). For example, one site 13 km to the southwest of the Macondo wellhead (lease block MC294) showed that over half of the corals were partially covered by a brown flocculant material, but follow-up surveys 16 months later indicated that recovery was occurring (Fisher et al. 2014).

Sponges have been shown to have relatively high bioaccumulation capabilities for PAH compounds (Batista et al. 2013, Gentric et al. 2016). However, sponges exposed to hydrocarbons may exhibit highly variable accumulations as they may alter their filtering behaviours in response to contaminants (Kutti et al. 2015). In short exposure experiments, altered feeding behaviours allowed sponges to cope with exposure to oil and dispersant contaminated sediments (Vad and Duran 2017). The PAH benzo(a)pyrene, a type of carcinogen, has been observed to be strongly bioaccumulated in sponges (Gentric et al. 2016) with potential damage to their DNA (Zahn et al. 1983). Presence of hydrocarbons may also have effects on larval distribution with experimental studies showing decreased larval settlement in the presence of hydrocarbons (500 and 100 ng/L PAH) and copper (Cebrian and Uriz 2007).

15.5.1.1.2 Potential Effects of an SBM Spill of Marine Fish and Fish Habitat

In the event of an accidental batch spill of SBM, the pathways for effects would be similar to those assessed for routine drilling discharges (refer to Chapter 8). Potential effects pathways for a change in risk of mortality or physical injury and/or change in habitat quality and use for marine fish and fish habitat due to an accidental SBM release include: smothering of sessile or slow-moving individuals and food sources for fish and shellfish; sedimentation; and potential for contamination.

SBMs were developed to replace oil-based muds (OBMs) that were historically used in drilling activities. The toxic components of the OBMs have been essentially removed in synthetic based fluids, resulting in drilling fluids that have lower acute toxicity (Tsvetnetko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016). Potential base fluids for SBMs may include esters, poly alpha olefins, internal olefins, linear alpha olefins, and others. Acute toxicity of SBMs is relatively low based on laboratory experiments and field evaluations of SBM-associated drill-cutting piles (Still et al. 2000; Tsvetnetko et al. 2000; Hamoutene et al. 2004; Paine et al. 2014; Tait et al. 2016).

SBM is a heavy, dense fluid which sinks rapidly in the water column when released (refer to Section 2.8.2 for information on SBM constituents). SBM constituents will be selected according to the OCSG so that low-toxicity chemicals are used wherever practicable. Therefore, environmental effects are mostly restricted to smothering of sessile or slow-moving individuals and sedimentation. Elevated TSS levels can have detrimental effects on fish, including physiological stress, reduced growth, and adverse effects on survival, with the severity of these effects dependent on various factors including life-history stage and risk of exposure (e.g., ability of fish to avoid undesirable conditions). It is expected that increases in TSS levels from an SBM spill would be transient. An accidental spill of SBM would also have the potential to result in a small, thin surface sheen (more likely if the SBM spill occurred at the surface) with effects similar to those discussed above for hydrocarbon spills, but more limited in nature.

15.5.1.2 Mitigation of Project-Related Environmental Effects

Chevron will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. Refer to Section 2.5 for specific information on well control and blowout prevention, and Section 15.4 for a description of Chevron’s contingency planning and emergency response measures.

As noted in Section 15.4, the Project will include contingency plans for responding to specific emergency events, including potential spill or well control events. The contingency plans, such as an Oil Spill Response Plan (OSRP), will be submitted to the C-NLOPB prior to the start of any drilling activity as part of the Operations Authorization process. The OSRP will specify tactical response methods, procedures, and strategies for safely responding to different spill scenarios such as:

- offshore containment and recovery;
- surveillance and tracking;
- dispersant application (surface and subsea injection);
- in-situ burning;
- shoreline protection;
- shoreline clean-up; and
- oiled wildlife response.

Refer to Section 15.4 for details regarding incident management and spill response.

Chevron will undertake a Spill Impact Mitigation Assessment (SIMA) / Net Environmental Benefit Analysis (NEBA) as part of the Operations Authorization process with the C-NLOPB. The SIMA is a structured process that will qualitatively evaluate the risks and trade-offs of all feasible and effective response options, when compared to no action. The SIMA process will inform the selection of an overall spill response strategy for the Project. If identified as a preferred response option, use of chemical dispersants would not occur without first obtaining regulatory approval.

In the unlikely event of a spill, specific monitoring (e.g., environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

15.5.1.3 Characterization of Residual Project-Related Environmental Effects

15.5.1.3.1 Subsea Blowout

A hypothetical subsea blowout scenario has the greatest potential for causing environmental effects. The actual effects of a blowout incident would largely depend on the duration and volume of the spill, as well as the environmental conditions at the time of the spill. A blowout is defined as "a loss of well control or uncontrolled flow of formation or other fluids, including flow to an exposed formation (an underground blowout) or at the surface of the seabed (a surface blowout), flow through a diverter, or uncontrolled flow resulting from a failure of surface equipment or procedures." (US Bureau of Safety and Environmental Enforcement n.d.).

Modelling was undertaken for hypothetical blowout scenarios at two representative well locations (representing a shallow water [500 m] and deep-water [1,500 m] well site) (Appendix F). Subsea oil releases were modelled unmitigated over a 160-day period for both wells, based on worst-case credible discharges. These assumptions result in very conservative (i.e., highest potential) effects assessments. Separate stochastic simulations were carried out to represent summer (May to October) and winter (November to April) seasonal weather conditions.

For both release sites, the model suggested that areas to the east have the highest potential likelihood to exceed socio-economic thresholds (i.e., surface oil average thickness >0.04 µm, subsurface dissolved hydrocarbon concentrations >1.0 µg/L, and shore oil average concentration >1.0 g/m^2) with respect to potential surface oil and water column exposure by dissolved hydrocarbons. Socio-economic thresholds were selected as they represent the most conservative available threshold numbers (see Table 15.2 for a full discussion of available thresholds). For the purposes of the spill modelling, a >1.0 µg/L in-water total hydrocarbon concentration (THC) of oil that is dispersed, dissolved, and entrained in the water column was selected as the threshold for acute exposure of aquatic species. The highest potential likelihood areas for exceeding the threshold typically extended over 1,500 km to the east to the edge of the model domain for the surface oil but less for the water column contamination (Appendix F).

Four hypothetical blowout scenarios (two at each release site) were modelled for 160-day periods to simulate short (30 and 27 day) and long (123 and 135 day) continuous durations for the blowout. Stochastic modelling results indicate that the geographic extent of a residual change in habitat quality and use for marine fish could spread beyond the RAA (Appendix F). Seasonality of effects was observed in the model results. The average stochastic probability of shoreline oiling was consistently about two times higher for winter release scenarios than for summer release scenarios (Table 15.8). Also, the lower probability (1% to 10%) footprints for surface oil contamination were greater in the winter when compared to summer footprints, while the 90% footprints were larger in the summer (Table 15.7). These ‘footprints’ are not the expected exposure from any single release of oil, but rather areas where there is >1% probability that exposure above the highly conservative socio-economic threshold could occur, based on the combination of either 171 (annual), 89 (summer), or 82 (winter) individual releases analyzed together. During the summer, the minimum time to shoreline threshold exceedance was approximately 2 to 3 times more (i.e., took longer to reach the shore) than for the winter (Table 15.7). For an overview of threshold exceedances and corresponding areas, see Table 15.7. Figures 15-2 and 15-3, 15-5 and 15-6, 15-8 and 15-9, and 15-11 and 15-12 highlight areas with likely threshold exceedances.

All four hypothetical blowout scenarios have high potential for oil to enter the water column due to high wind speeds, which can cause surface oil to dissolve into the water column. Similar water column concentrations of total hydrocarbon concentration and dissolved hydrocarbon concentration were predicted between both sites. The exception was that at West Flemish 2, transport of dissolved hydrocarbons was predicted to move through the Flemish Pass (Figures 4-50 and 4-55, Appendix F).

Due to the direction of transport of oil from wind and currents (primarily east), and the distance of the Project Area to the shoreline of Newfoundland, the average probability of Canadian shoreline exposure above the threshold for the four stochastic scenarios was approximately 8.7% (Table 15.8).

Although the areas of potential effects delineated by the modelling results are relatively large, substantial portions of these areas would have low probabilities of occurrence even if the release is allowed to continue unmitigated.

The implementation of mitigation measures would further reduce the already relatively low probabilities of oil extending beyond the RAA or reaching nearshore areas. In the unlikely event of an actual subsea blowout, mitigation (including emergency response measures such as containment [e.g., capping stack] and recovery operations) would be implemented well before 160 days elapse, thereby likely reducing the magnitude, duration, and geographic extent of the spill and associated residual environmental effects.

As noted in Section 15.4, in the event of a well blowout, Chevron would attempt direct intervention measures where appropriate and in consultation with regulators (e.g., capping stack, dispersants). The timing of these intervention measures would reduce the magnitude, duration, and geographic extent of the spill. These activities were not factored into modelling in order to demonstrate the worst-case scenarios of an unmitigated blowout in the West Flemish Pass.

The exposure of oil to fish, either naturally or chemically dispersed, following a spill has the potential to affect the development, structure, and function of the cardiac system in fish embryos leading to impaired swimming stamina (Lee et al. 2015). Fish are typically at risk from acute oil exposure in a 24- to 48-hour period following an oil spill, during which time loss weathering and dilution of the oil results in loss of the acutely toxic, water-soluble I aromatic components (Lee et al. 2015). As a result of this, mortality to fish (primarily early life stages such as eggs and larvae) are typically brief and localized. Dispersants have the potential to expose smaller organisms in the water column to both acute (short-term) exposure to toxic concentrations of these lower molecular weight compounds and sub-lethal effects from the persistent bioavailable components.

Studies have indicated that dispersed oil is more toxic to fish than surface oil slicks, from the increase in availability and subsequent exposure to hydrocarbons (Tjeerdema et al. 2013, Adams et al. 2014). There have been many laboratory experiments, field studies and actual spill response activities examining the toxicity of dispersants and their effectiveness (including toxicity of dispersed oil) and the results were used in many countries (including Canada) for the regulatory approval of application of dispersants. The extent of exposure (concentration, duration, chemistry) of an organism to dispersants and dispersed oil determines its toxic response. Similar exposure conditions may elicit different degrees of response in species and/or specific life stages; therefore, thresholds for environmental effects are derived from species sensitivity distributions (BP 2014).

Corexit 9500A was the primary dispersant used during the DWH incident spill response effort and is approved for used by both the US Environmental Protection Agency (USEPA) and Environment Canada (USEPA 1994, 2017; Environment Canada 2016) due to its low toxicity to marine organisms a. Corexit 9500A is composed of surfactant components similar to components found in common household product, with low toxicity to aquatic species when free in solution (Nordtug et al. 2011; Word et al. 2014; Lee et al. 2015).

There is limited chronic toxicity data for oil and associated polycyclic aromatic hydrocarbons (Lee et al. 2015); as a result, chronic toxicity thresholds are often derived from acute toxicity test data. Echols et al. (2016) used mysid shrimp and inland silversides to study the chronic toxicity of fresh and weathered oil. The results indicated that while fresh oil had some effect on the survival and growth of mysid shrimp and inland silversides, and weathered oil also had some effect on silverside survival and growth, weathered oil had no effect on the survival and growth of mysid shrimp.

During the DWH spill, the decay and sinking of the surficial plume contributed to a large marine snow formation event, which may have also been affected by the presence of dispersants. Deep-sea communities were vulnerable to both the large plume of oil and the sinking marine snow (Girard and Fisher 2018). The marine snow formation event had the potential to affect groundfish, as well as benthic habitat, from precipitation and deposition of hydrocarbon compounds onto the sea bottom.

Benthic macrofauna communities also remained impaired in relation to the marine snow events resulting from the DWH spill. Macrofauna richness and diversity were still substantially lower within 10 km of the site. While the benthic macrofauna communities indicated signs of recovery, lower taxonomic richness indicated that by 2017, these communities had not fully recovered from the hydrocarbon contamination (Reuscher et al. 2017).

Observations of coral recovery from the DWH spill from 2011 to 2017 illustrated that overall recovery was slow. The recovery of coral is a complex process that can be influenced by a combination of several factors including size, age, morphology, predation, environment, and competition and the degree to which the colonies were impacted. Observations indicated a long-term, non-acute effect from the spill; however, moderately to heavily impacted corals would likely require several more years to recover (if they do recover) (Girard and Fisher 2018).

In-situ burning releases 85 to 95% of the spill volume into the atmosphere as gases, water vapour and soot; the remaining burn residue is similar to that of the original oil (Ferek et al. 1997). These residues are generally comprised of less volatile hydrocarbons, are denser and more viscous and denser than the unburned oil, and may either float or sink. For example, the 1% to 2% of oil remaining after burning from the *Exxon Valdez* spill continued to float on the surface (Allen 1990), which the remaining burn residues from the 1991 Haven tanker incident near Genoa, Italy, sank. Temperature can also influence whether the oil floats or sinks. Test burns using Alaska North Slope crude showed that some of the burn residues sank as it cooled (Buist 1995); prompt collection of burn residues can prevent the burn residues from sinking in at least some cases.

A test burn within a towed boom in Newfoundland waters indicated that surface water temperatures do not seem to increase on surface waters, as towing the boom continually replenishes the ambient temperature seawater below the oil layer (Fingas et al. 1994). Laboratory studies and In-situ field studies in Newfoundland also focused on water column toxicity and found that while toxicity did increase in samples collected below the burning oil, it was comparable to the toxicity resulting from the unburned oil slick (Daykin et al.1994). This was borne out by the low hydrocarbon levels in the water samples.

An important component of the water column is the “surface microlayer,” which is considered to be the upper millimetre or less of the water surface. This layer provides habitat for many sensitive life stages (eggs, larvae and other reproductive stages of both plans and animals) The eggs or larval stages of cod, sole, flounder, hake, anchovy, crab, and lobster develop in this layer and these life stages would not survive in-situ burning at the surface. However, in-situ burning is a rare event that is typically conducted within a small confined area, and the surface microlayer is rapidly renewed from adjacent areas, resulting in negligible long-term biomass loss (Shigenaka and Barnea 1993).

As a result of a subsea blowout lethal and sublethal effects could occur if the spill encompasses areas where fish eggs, larvae, or juveniles are located, including those in spawning and nursery areas. Most fish species in the RAA spawn in a variety of large areas, over long time-scales; a spill is not predicted to encompass all these areas or time-scales to such a degree that natural recruitment of juvenile organisms may not re-establish the population(s) to their original level within one generation. It is also not likely that an entire year class would be lost due to the toxic effects of oil from a large blowout on early life stages of fish species. In the event of a large blowout incident, the area affected is unlikely to encompass all the spawning locations for any one species. The few species that spawn in a limited geographic area have potential to spawn over many months or the entire year. Therefore, with mitigation (e.g., containment and/or recovery), their spawning window will not be completely affected by a blowout incident.

It is anticipated that most adult finfish would be able to avoid exposure via temporary migration. Effects on slow-moving or sessile species would be similar to those on phytoplankton, zooplankton, and larval and juvenile fish species.

With spill prevention plans and response procedures in place, potential effects of a subsea blowout on marine fish and fish habitat are predicted to be:

- Adverse
- Moderate to high in magnitude

- Occur in the RAA
- Short-to-medium term in duration
- Occur as a single event
- Reversible

15.5.1.3.2 Marine Diesel Spill

Project-specific deterministic modelling for the batch release of diesel was undertaken at the deep site (West Flemish Pass 1) for a spill volume of 1,000 L. This batch spill was modelled to represent a potential spill during bunkering operations. Modelling was conducted for the calmest wind speed during the summer, as well as account for ice-free conditions. This scenario was modelled for a duration of 30 days (Appendix F).

Deterministic modelling results indicate that surface oil was predicted to travel east, clockwise around the perimeter of the Flemish Cap for approximately 1,500 km. Figure 15-27 indicates that the spill thicknesses were representative of colorless or silver sheens (<0.0001 mm). Figures 4-70 and 4-71 (Appendix F) suggest that the predicted concentrations of both dissolved and total hydrocarbons in the water were not present in concentrations above the recordable thresholds (Table 15.2). This was due to the small volume of the release, low amount of entrainment, and size of the concentration gridding. The modelled batch spill was not predicted to reach shorelines or result in oil settling on the benthic substrate (Figure 15-29). The total area that was exposed to oil concentrations greater than 0.04 µm over the 30 days that were modelled was 8 km^2. Predictions at the end of the 30-day simulation were that 64% would evaporate, 35% would degrade, 11% would remain entrained in the water column, and 0.1% would remain floating on the surface (Appendix F).

Based on the Project-specific spill modelling results provided in Appendix F and discussed above, diesel spills are not likely to result in biological effects on fish over a large area. With respect to a change in habitat quality and use, it is expected that most diesel from a spill would evaporate and disperse quickly (refer to Appendix F). Depending on the location and extent of the spill, nearshore spawning and nursery areas could potentially be affected. Diesel is known to have immediate toxic effects on many intertidal (e.g., molluscs, amphipods) and benthic organisms (Stirling 1977; Simpson et al. 1995; Cripps and Shears 1997), with sessile and early life stages (eggs, larvae) the most at risk as they are unable to actively avoid the diesel and/or are during sensitive life-stage development periods. Benthic invertebrates, including commercial species, have experienced sublethal effects resulting from low-level exposure to hydrocarbons, with crustaceans being the most sensitive taxa (Sanders et al. 1980; Jewett et al. 1999). However, given the small-scale and short-term nature of the spill, effects on nearshore areas are expected to be limited to a scenario in which marine diesel is spilled close to the shore. Oil spill containment and recovery operations will further reduce residual effects on fish and fish habitat associated with total dissolved hydrocarbons.

With respect to a change in risk of mortality or physical injury, although there is a risk of mortality of phytoplankton and zooplankton (food sources), and sublethal and lethal effects to larval and juvenile fish species present in the mixed surface layer of the water column, these residual effects will likely be restricted to a localized area. The potential for these effects would also be temporary and reversible. Adult fish species in surface waters will largely be unaffected due to avoidance mechanisms; demersal (bottom dwelling) species are unlikely to be exposed to harmful concentrations of dissolved total hydrocarbons, unless the spilled was unmitigated and resulted in infiltration of the sea floor. Residual effects following a nearshore diesel spill could include localized mortality and sublethal effects to fish eggs, larvae, and juveniles.

With spill prevention plans and response procedures in place, potential effects of a marine diesel spill on marine fish and fish habitat are predicted to be:

- Adverse
- Moderate in magnitude
- Occur within the RAA
- Short-to-medium term in duration
- Occur as a single event
- Reversible

15.5.1.3.3 SBM Spill from the MODU and the Marine Riser

Based on the SBM modelling conducted in EL 1144 for Nexen Energy's Flemish Pass Exploration Drilling Project (Amec 2017), an accidental surface release of SBM would reach the seafloor within a maximum of one kilometre from the drilling site. The maximum spill distance from the drilling site would range from 264 m (in the summer) to 982 m (in the fall), and the maximum spatial extent (footprint) of SBM deposition on the seafloor would range from 7,200 m^2 to 9,000 m^2. The maximum modelled deposition thickness was 7.1 cm, and the average modelled deposition thicknesses ranged from 1.7 cm to 2.2 cm. The average modelled deposition thicknesses as well as the maximum deposition thickness are above the proposed threshold of 6.5 mm (see Section 8.3). The SBM originating from a potential BOP disconnect scenario could contact the seafloor within approximately 40 to 60 m of the drilling site, resulting in smaller initial footprint, but potentially larger initial SBM layer thicknesses of approximately 23 to 28 cm (AMEC 2017).

In consideration of these modelling results, it is conservatively estimated for the Project that a change in risk of mortality or physical injury in the case of an unintended bulk release of SBM would likely be restricted to smothering effects on immotile individuals and benthic prey species within up to approximately 1 km from the spill site.

With respect to a change in habitat quality and use following an SBM spill, it is conservatively predicted that there would likely be a temporary and reversible degradation in habitat quality within up to approximately 1 km from the spill site. As discussed in Section 8.3, the acute toxicity of SBM is considered relatively low and would not result in adverse effects from contamination of marine biota or habitats.

Benthic recovery following discharges of drill muds and cuttings in relatively shallow waters has been documented as occurring within as few as approximately one to four years (Neff et al. 2000; Hurley and Ellis 2004; Renaud et al. 2008; Corrêa et al. 2009; Santos et al. 2009; Bakke et al. 2011; Lee et al. 2011). Although little is known about the timeline for recolonization by benthic communities in deep-water environments, benthic recovery is generally expected to take longer at greater depths and in colder waters due to lower rates of metabolism and growth (Gates and Jones 2012). For slow-growing and long-lived species of large benthic organisms, such as sponges, corals, and crinoids, Clark et al. (2016) estimate that it may take centuries for benthic communities to recover following large-scale removal of attached epifauna from hard substrates in deep-water environments (e.g., with bottom-contact fishing gear). However, benthic recovery following an accidental spill of SBM is anticipated to take much less time since a spill would not entail the removal of large swathes of attached epifauna. Neff et al. (2000) also note that complete recovery of deep-water benthic animals requires many years because they reproduce and grow slowly, but that this recovery is likely to be initiated shortly after completion of cuttings discharges and is expected to be well advanced within three to five years once the synthetic material has degraded to low concentrations. This is anticipated to also be the case following the deposition of spilled SBM.

With spill prevention plans and response procedures in place, potential effects of a SBM spill on marine fish and fish habitat are predicted to be:

- Adverse
- Low in magnitude
- Occur within the LAA
- Short-to-long term in duration
- Occur as a single event
- Reversible

15.5.1.3.4 Summary

Table 15.34 provides a summary of predicted residual environmental effects of accidental events on marine fish and fish habitat.

Table 15.34 Summary of Residual Project-Related Environmental Effects on Marine Fish and Fish Habitat – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological and Socio-economic Context**
Change in Risk of Mortality or Physical Injury/Change in Habitat Quality and Use							
Well Blowout Incident	A	M-H	RAA*	ST-MT	S	R	D
Marine Diesel Spill	A	M	RAA	ST-MT	S	R	D
SBM Spill	A	L	LAA	ST-LT	S	R	D

KEY: See Table 8.2 for detailed definitions N/A: Not Applicable Direction: P: Positive A: Adverse Magnitude: N: Negligible L: Low M: Moderate H: High	Geographic Extent: PA: Project Area LAA: Local Assessment Area RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*" Duration: ST: Short-term MT: Medium-term LT: Long-term	Frequency: S: Single event IR: Irregular event R: Regular event C: Continuous Reversibility: R: Reversible I: Irreversible Ecological / Socio-Economic Context: D: Disturbed U: Undisturbed

15.5.1.4 Determination of Significance

Based on information presented above and a consideration of the significance criteria identified in Section 8.1.5, the predicted residual adverse environmental effects from any of the accidental event scenarios on marine fish and fish habitat is predicted to be not significant. This determination considers the conservatism of the spill modelling and assumptions, the use of mitigation measures to prevent and reduce effects from a spill, and the nature of the adverse effects as described in the literature summarized above. This conclusion is made with a high level of confidence for the SBM spill scenario based on the low magnitude and geographic extent of likely effects. A medium level of confidence is assigned to the hypothetical marine diesel spill and well blowout scenarios given the potential magnitude of the spill. However, as noted above, the majority of fish species spawn in a variety of large areas, over long time-scales, and a spill is not predicted to encompass all of these areas or time scales within the RAA to such a degree that natural recruitment of juvenile organisms may not re-establish the population(s) to their original level within one generation. None of the spill scenarios are expected to result in permanent alteration or irreversible loss of critical habitat as defined in a recovery plan or an action strategy.

15.5.2 Marine and Migratory Birds

As detailed in Section 6.2.2 a variety of marine and migratory bird species occur in large numbers within the marine and coastal environments off eastern NL at various times of the year, including seabirds and other avifauna that inhabit the region for breeding, summering, staging, wintering, migration, or other activities according to their individual life histories and habitat requirements, and could be present in the RAA at the time of an accidental event.

Seabirds, waterfowl, loons, grebes, and shorebirds (plovers, sandpipers) are the most vulnerable to perturbation as they spend much of their life in the marine environment. Some land bird species may also be affected, especially those associated with coastal habitats and those that undertake nocturnal migration over offshore waters. The time of year that a marine and migratory bird species are present depends on the species, with some abundant year-round (such as large gull species and black-legged kittiwake, some alcid species, and northern fulmar) while others are more likely to be present in the winter (dovekie, thick-billed murre, ivory gull, coastal waterfowl) or the nesting and migration seasons (Leach’s storm-petrel). Several important habitats for birds have also been identified at locations along the coastline of NL. Although not in the Project Area itself but within the RAA, there are several IBAs, MBSs, SERs, nesting sites around coastal NL, and EBSAs in the Northwest Atlantic designated in part due to their importance to seabirds (see Figure 6-30).

There are 15 marine and migratory bird species at risk or of conservation concern that are likely to occur within the marine areas RSA and or coastal regions of RAA (Section 6.2.4). Species designated as having low conservation status (i.e., Least Concern) are not included in this assessment of effects on SAR. As discussed in Chapters 6 and 9, there is a low potential for these SAR (listed in Table 9.4 in Section 9.3.3) to interact with the routine Project-related activities due to their low densities in the Project Area, LAA and overall RAA, and because there are no critical habitats or nesting sites of SAR or SOCC in the RAA. However, as with secure bird species, at risk marine and migratory birds are at risk from oil spills.

15.5.2.1 Project Pathways for Effects

Accidental spill scenarios have potential to result in a change in risk of mortality or physical injury and/or a change in habitat quality and use for marine and migratory birds. The extent of the potential effects will depend on how the spill trajectory and the VC overlap in space and time. The assessment is conservative (i.e., geographic and temporal overlap are assumed to occur, and modelling results assume no implementation of mitigation measures).

15.5.2.1.1 Potential Effects of an Oil Spill on Marine and Migratory Birds

An accidental release of hydrocarbons can result in the physical exposure of birds to oil in the affected area. Such discharges, and even routine operational discharges from vessels and platforms may lead to sheens of crude oil and other substances on the water's surface, to which avifauna (especially pelagic seabirds) may be exposed (Wiese and Robertson 2004; O'Hara and Morandin 2010; Morandin and O'Hara 2016). There would be an increased risk of mortality for individual birds that encountered the sheen (particularly for diving birds and those that spend large amounts of time on the water), as well as potential sublethal toxicity effects (metabolic rate and chick growth) to species such as Leach's storm-petrel. Chicks and eggs are more susceptible to negative effects of exposure to oil (even at very low levels). The possible physical effects of oil exposure on birds include changes in thermoregulatory capability (hypothermia) and buoyancy (drowning) due to feather matting (Clark 1984; Montevecchi et al. 1999), as well as physiological effects of oil ingestion from excessive preening (Hartung 1995).

Even small amounts of oil from sheens have been shown to affect the structure and function of seabird feathers (O'Hara and Morandin 2010; Matcott et al. 2019), which has the potential to result in water penetrating plumage and displacing the layer of insulating air, resulting in loss of buoyancy and hypothermia. This can cause a heightened metabolic rate (increased energy expenditure) and potential starvation due to increased energy needs to compensate for heat loss resulting from oiling and loss of insulation (Peakall et al. 1980, 1982; MMS 2001). Greater heat loss accompanied by an increase in food consumption has been documented in a species of marine bird, (Cunningham et al. 2017; Mathewson et al. 2018). A decrease in body temperature from plumage oiling has been documented in another marine bird species (Maggini et al. 2017c). External oiling (applied experimentally to homing pigeons released to fly 50, 80, or 100 miles) also alters birds' flight paths, increases flight duration, and increases flight distance, and reduces the ability to regain body weight between flights (Perez et al. 2017a, 2017b, 2017c).

Plumage oiling can also lead to behavioural changes such as increased time spent preening at the expense of foraging and breeding, and potentially death (Morandin and O'Hara 2016). Birds whose plumage is lightly oiled may not suffer hypothermia or drowning, but the effects on their flight feathers may cause inefficient flight, requiring increased energy demand during flight. Evidence for this comes from experimentally applying a light oiling to the plumage of a marine bird, which reduces takeoff speed by 30% and increases flight energy cost by 20-45% (Maggini et al. 2017a, 2017b, 2017c).

The potential for toxic effects from ingesting small amounts of oil are becoming better understood due to recent research and may have greater effects on bird populations than acute mortality (Bursian et al. 2017b). While acute toxic effects from exposure to sheens are considered unlikely (Morandin and O'Hara 2016), some studies have shown effects from exposure to low levels of oil on adult birds (Miller et al. 1980;

Trivelpiece et al. 1984; Butler et al. 1986, 1988; Alonso-Alvarez et al. 2007). Ingested oil can cause lethal and sublethal effects (McEwan and Whitehead 1980), including damage to the liver (Khan and Ryan 1991), pneumonia (Hartung and Hunt 1966), brain damage (Lawler et al. 1978), and immunotoxic effects (Barron 2011). Oxidative injury to cytoplasmic hemoglobin (anemia) causing fatigue and reduction in energy available for metabolic energy due to oil ingested through diet and through preening has been documented in six species of marine birds, and in a seventh species results consistent with hemolytic anemia were found (Bursian et al. 2017a; Dean et al. 2017; Harr et al. 2017c; Horak et al. 2017; Maggini et al. 2017c; Pritsos et al. 2017; Fallon et al. 2018). These effects have the potential to reduce survival and lifetime reproductive success. Species-specific differences were found in this effect, potentially due to physiology, foraging strategies, habitat preferences, and behaviour (Fallon et al. 2018). This hemolytic anemia can have its greatest effects during migration, when metabolic oxygen requirements are very high (Bursian et al. 2017b). Increases in liver and kidney weights have been found in two species (Harr et al. 2017b; Horak et al. 2017). Lesions in kidney, liver, heart, and thyroid gland were found in one species (Harr et al. 2017a). Damage to the thyroid gland can cause endocrine disruption, which affects metabolism, weight gain, thermoregulation, reproduction, and development (e.g., common murres oiled by the M/V Tricolour spill; (Troisi et al. 2016). Impaired heart function has also been noted in one species of marine bird (Harr et al. 2017a). Birds that feed on organisms from affected areas are also at heightened risk of contamination from their food sources (Engelhardt 1982). Residual oil can result in chronic exposure long after a spill. For example, biomarkers in harlequin ducks showed that individuals of this species continued to be exposed to oil at least 22 years after the *Exxon Valdez* spill in Prince William Sound, Alaska (Esler et al. 2017). Other studies have, however, found little or no effects from exposure to low doses of oil on adult seabirds (Ainley et al. 1981; Stubblefield et al. 1995; Alonso-Alvarez et al. 2007; Camphuysen 2011).

Morandin and O’Hara (2016) reviewed several short- and long-term studies of marine oil spills and reinforced that these effects can result in increased mortality rates, physiological impairment, reduced reproductive success and, in severe cases, possible long-term population declines. Bird species at greatest risk are those that spend a considerable time resting or foraging on the water surface, i.e., alcids, waterfowl, loons, and grebes (Wiese and Robertson 2004; Boertmann and Mosbech 2011). However, in the breeding season following the DWH blowout, brown pelicans, great egrets and tri-colored herons in oiled colonies showed no significant difference in the number and size of chicks compared with unoiled colonies (Burger 2018). Piping plovers (SARA and NL ESA endangered) wintering on coastlines oiled by the DWH blowout did not have different demographic rates than those on unoiled coastlines (Gibson et al. 2017). The long lifespan of marine bird species, delayed sexual maturation, and small clutch size (one egg in most species) also suggests that these species are vulnerable to long-term population effects from oil exposure (Esler et al. 2002; Wiese and Robertson 2004). While the primary potential for exposure and thus for direct effects on seabirds occurs within the spatial extent of the spill itself, the ecological effects of oiled areas may also be transferred away from the affected site due to the migratory nature of some marine-associated avifauna (Henkel et al. 2012).

The possible effects of oil exposure on birds vary between species, as well as with different types of oil (Gorsline et al. 1981), weather conditions, times of year, variation in distribution and abundance of prey, migratory patterns, and other activities (Wiese et al. 2001; Montevecchi et al. 2012), making the effects on population difficult to predict. Mortality rates and potential changes in bird populations due to accidental releases of oil are poorly known, but this is often cited as the main risk to marine birds from the offshore oil and gas industry (Fraser et al. 2008; Ellis et al. 2013). As noted above, seabirds have a life history strategy that depends on low annual adult mortality to compensate for very low annual reproductive rates. Consequently, a significant increase in mortality of adults of reproductive age results in a significant decrease in the number of juveniles recruited into a population, resulting in long-term effects on population size (Esler et al. 2002; Wiese and Robertson 2004). In years of poor food availability, nesting birds may abandon reproductive attempts, resulting in massive die-offs of chicks but preserving fitness of adult birds to reproduce in subsequent years. Although the volume of oil spilled and number of seabirds oiled is weakly correlated (Burger 1993), it is clear that the timing, location of a given spill (and not just its size) has an important influence on avifauna mortality and injury rates resulting from that spill due to the influence of variation in seabird abundance at a given location and of the effect of weather at the time on the dissipation of the slick (Wiese et al. 2001). As a result, the effects of a spill on seabird populations cannot be predicted with a high degree of confidence.

15.5.2.1.2 Potential Effects of Dispersants on Marine and Migratory Birds

The use of dispersants, which is intended to enhance the natural microbial degradation, may be beneficial for marine and migratory birds within a spill area by reducing the exposure to floating oil on the sea surface. As a result, application of chemical dispersants reduces the risk of adverse effects on marine and migratory birds at the water's surface, and potentially results in a far greater rate of biodegradation of oil to a matter of weeks rather than of years (Baelum et al. 2012). Such a relatively rapid rate of degradation greatly reduces the chance of accidentally released oil reaching shorelines, where it could potentially cause great harm to shorebirds and adversely affect seabird nesting colonies (Prince 2015). However, a recent review of studies of the effects of dispersants on biodegradation showed the majority of studies found that dispersants inhibit microbial degradation of oil (Fingas 2017). The effect of dispersants and surfactants on biodegradation was most dependent on the characteristics of the dispersant itself, perhaps due to toxicity of specific components to microbial degraders (Fingas 2017). In addition, the use of dispersants results in increased oil in the water column, potentially resulting in exposure of food sources (fish and water column invertebrates) to oil, and exposure of diving birds near the dispersed oil (Fingas 2017). A study of the effect of dispersant use on feather structure, waterproofing, and buoyancy of common murres showed no significant difference between the effects of oil alone and the effects of a mixture of dispersant and oil (Whitmer et al. 2018). In both cases the effect was dose-dependent and resolved over two days. A high concentration of dispersant alone caused an immediate, life-threatening loss of waterproofing and buoyancy, which resolved within two days. The measured toxicity of dispersants themselves to birds varies among studies. Prince (2015) found very low toxicity. Fiorello et al. (2016) found that common murre, a species that forages underwater, exposed to Corexit EC9500a, crude oil, develops conjunctivitis and is at higher risk of corneal ulcers. Preliminary studies of dispersant use during the DWH blowout show that dispersants enhance oil's toxicity to early life stages of coastal waterbirds (Beyer et al. 2016). The dispersed oil has similar effects to that of oil, as presented earlier, but the size of the slick and exposure concentrations would be lower than untreated oil. Hence, dispersant mitigates the potential adverse effects of oil on birds compared to untreated oil.

Hydrocarbon spills can also result in a change in habitat quality and use for marine and migratory birds. Day et al. (1997) examined the effects of the *Exxon Valdez* oil spill on marine bird habitat use, determining that while initial effects were severe, most of the habitat use for most bird species recovered within 2.5

years of the spill. While initial effects to bird habitat were severe, this rate of recovery was attributed to high-latitude seabird populations, which appear to be fairly resilient to environmental perturbations, as well as Prince William Sound being a high wave energy and a largely rocky substrate environment where oil does not persist as long as other settings (Day et al. 1997). In shorebird staging areas in coastal Louisiana oiled by crude oil from the DWH blowout, sanderlings had lower fueling rates (for energy stores) than in unaffected areas in the first spring migration following the blowout, but red knots showed no difference (Bianchini and Morrissey 2018). Both sanderlings and red knots depart oiled staging areas to resume northward migration later than the study average.

15.5.2.1.3 Potential Effects of an SBM Spill on Marine and Migratory Birds

SBM is considered to be of low toxicity (IOGP 2016) and environmental effects are mostly restricted to physical smothering effects on the sea floor. A release of SBM would result in elevated levels of TSS in the water column and possibly a small thin sheen on the surface, with effects potentially similar to those discussed above for hydrocarbon spills, but more limited in magnitude given the comparative volume and physical property of the SBM. O’Hara and Morandin (2010) investigated the effects of thin oil sheens associated with both crude oil and synthetic-based drilling fluids on the feathers of pelagic seabirds (common murre and dovekie) and found that feather weight and microstructure changed substantially for both species after exposure to thin sheens of both hydrocarbons, concluding a plausible link even between operational discharges of hydrocarbons and increased seabird mortality.

15.5.2.2 Mitigation of Project-Related Environmental Effects

Chevron will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. Refer to Section 2.5 for specific information on well control and blowout prevention and Section 15.4 for a description of Chevron’s contingency planning and emergency response measures.

As noted in Section 15.4, the Project will include contingency plans for responding to specific emergency events, including potential spill or well control events. The contingency plans, such as an Oil Spill Response Plan (OSRP), will be submitted to the C-NLOPB prior to the start of any drilling activity as part of the Operations Authorization process. The OSRP will specify tactical response methods, procedures, and strategies for safely responding to different spill scenarios such as:

- Offshore containment and recovery
- Surveillance and tracking
- Dispersant application (surface and subsea injection)
- In-situ burning (including hazing in advance of ignition)
- Shoreline protection
- Shoreline clean-up
- Oiled wildlife response

Refer to Section 15.4 for details regarding incident management and spill response.

Chevron will undertake a Spill Impact Mitigation Assessment (SIMA) / Net Environmental Benefit Analysis (NEBA) as part of the Operations Authorization process with the C-NLOPB. The SIMA is a structured process that will qualitatively evaluate the risks and trade-offs of all feasible and effective response options, when compared to no action. The SIMA process will inform the selection of an overall spill response strategy for the Project. If identified as a preferred response option, use of chemical dispersants would not occur without first obtaining regulatory approval.

In the unlikely event of a spill, specific monitoring (e.g., environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

15.5.2.3 Characterization of Residual Project-Related Environmental Effects

15.5.2.3.1 Subsea Blowout

The potential effects of a subsea well blowout will depend on the nature of the spill and its trajectory and how the spill trajectory overlaps in space and time with marine and migratory birds. Although unlikely to occur, such a blowout has potential to change both the risk of mortality or physical injury and the habitat quality and use for marine and migratory birds. Two oil exposure thresholds were used to assess the effects on marine and migratory birds. These thresholds are based on the habitats of seabirds (open water) and shorebirds (shorelines). There is potential for direct effects from oil from a blowout on the nesting habitat of a subset of marine-associated species, but there is greater potential for direct effects on habitat at sea (i.e., those used for foraging, loafing, and roosting). For seabirds at-sea, the greatest potential risk of mortality or injury is from exposure to oil on the sea surface. The threshold thickness of surface oil causing lethal effects to seabirds is greater than 10 μm thick (>10 g/m²) (French et al. 1996; French-McCay and Rowe 2004; French-McCay 2009). For shorebirds (and other wildlife) on or along the shore, and for nesting seabirds resting on the water near their coastal nesting colonies, an oil exposure index consisting of the length of shoreline oiled by the more conservative threshold for the potential effects on socio-economic VCs of >100 g/m² (100 μm thick) was used (French-McCay 2009).

As discussed in 15.5.2.1, change in risk of mortality or physical injury to marine birds from exposure to hydrocarbons is manifested as hypothermia and drowning leading to death, and sub-lethal effects of lower reproductive rates or premature death. Sub-lethal effects may persist for a number of years, depending upon generation times of affected species and the persistence of any spilled hydrocarbons. Most marine birds are relatively long-lived. Survival rate for oiled birds were traditionally considered to be very low even with rescue and cleaning attempts (French-McCay 2009). In recent years, however, the percent of African penguins successfully released after de-oiling has often been over 90% (Wolfaardt et al. 2009). Survival rate of cleaned little blue penguins following their release back into the wild did not differ from control birds (Sievwright et al. 2019a). Post-release breeding success in this species differed from control birds only in reduced hatching success in the first season in rehabilitated pairs of penguins (Sievwright et al. 2019b). However, oiled birds are generally assumed to have a very low survival rate (approximately 0 – five%). The probability of lethal effects to birds is therefore primarily dependent on the probability of exposure, which is influenced by behavior (i.e., the percentage of the time an animal spends on the water or shoreline as well as any oil avoidance behavior) (French-McCay 2009). French-McCay (2009) calculated vulnerability scores (i.e., the combined probabilities of a) encountering oil and b) mortality once oiled) which are, in effect, the mortality rate of a bird in the area of an oil slick. These scores were calculated for various wildlife groups which were then applied to species: surface-diving seabirds and waterfowl) (99 % combined probability of oil encounter and mortality once oiled); nearshore aerial (plunge) divers (35 % combined probability); and aerial seabirds (5 % combined probability). In Newfoundland waters during summer large numbers of sooty shearwaters moult their flight feathers and, as a result, spend a great deal of time on the sea surface (Hedd et al. 2012). Great shearwaters are also moulting their flight feathers at this time of year and probably also spend a larger proportion of their time on the surface. Sub-adult northern fulmars also moult their flight feathers in offshore Newfoundland waters during summer (Huettmann and Diamond 2000). The vulnerability score of moulting shearwaters and fulmars, therefore, may be more like that of surface-diving seabirds than that of aerial seabirds. Table 15.35 indicates the combined probabilities of oiling and mortality once oiled for various generic behaviour categories.

As part of this assessment, the ecological risk to marine birds was assessed by using these metrics in combination with the threshold concentrations for marine birds for the oil floating on the surface (10 µm thickness, 10 g/m²,) and the socio-economic threshold for shoreline oil (1 g/m²).

Table 15.35 Combined Probability of Encounter with Oil and Mortality Once Oiled for Generic Behaviour Categories

Bird Group	Probability[1]	Habitats[2]
Surface-divers[3]	99%	Coastal and pelagic waters
Aerial divers (plunge-divers), shorebirds[4]	35%	Intertidal, coastal and pelagic waters
Aerial seabirds[5]	5%	Coastal and pelagic waters

Source: Modified from French-McCay (2009)

Note:

[1] A thickness of 10 µm is assumed as threshold thickness for oiling mortality of wildlife (If present in the habitats listed and area swept by oil exceeding threshold thickness).

[2] Intertidal includes all between-tide or terrestrial areas flooded by tides or by storm surges.

[3] Cormorants, waterfowl, loons, grebes, both murre species, dovekie, puffin, razorbill, black guillemot, both phalarope species, moulting shearwaters and fulmars.

[4] Northern gannet, arctic and common terns, plovers, sandpipers, bald eagle, osprey.

[5] Leach's storm-petrel, non-moulting shearwaters and fulmars, gadfly petrels, gulls, jaegers and skuas.

Hydrocarbon spills are not likely to cause a permanent change in habitat quality and use for marine and migratory birds. Prey availability may be reduced, or birds may avoid affected habitat. However, spill cleanup and natural weathering processes are likely to result in the eventual recovery of such habitat. Recovery of marine bird abundance and use of oiled shorelines sites in Prince William Sound, Alaska, following the 1989 *Exxon Valdez* oil spill, back to estimated (naturally variable) baseline levels, was reported for all surveyed species within 12 years (Wiens et al. 2004). The recovery of sessile, mobile, and infaunal invertebrate species on oiled rocky and open coast soft-sediment shorelines, which provide an important food source for marine birds, is expected to occur within five to ten years following oiling (Moore 2006). The recovery time of sand beaches is variable, depending on conditions and initial disturbance during spill response, but is estimated at a maximum of three years (French-McCay 2009).

The risk of marine birds interacting with oil would take place in the various habitats used by those birds in their annual cycle (see Section 6.2.2). Interactions could occur in foraging habitat whether inshore, where nesting birds feed on pelagic fish that have come inshore to spawn, or the continental shelf slope used by nesting, summering, staging, or wintering birds. Inshore waters are also used by nesting birds that rest and preen in large numbers close to nesting colonies. Although stochastic modelling shows the average probability of oil from a blowout coming into contact with the Avalon Peninsula is 8.7% (Table 15.8), and the representative 95th percentile shoreline exposure case (deterministic, worst case) predicted 0.1% or less of the total volume of oil released would contact shore (Table 15.10), contact during the breeding season has the potential to affect species' populations because of the large concentrations of birds nesting in colonies. However, the greatest risk of adverse seabird interactions with an oil spill generally occurs in the winter months when water and air temperatures are colder and consequently thermoregulation is most difficult, increasing the likelihood of mortality for affected birds (Morandin and O'Hara 2016). The species at greatest risk of interactions with an oil spill vary with the species' abundance in the area, which depends on the season, weather, and on prey distribution, which at short time scales is dependent on weather and currents.

Adult common murre, Atlantic puffin, razorbill, and black guillemot are vulnerable to interactions with oil in inshore waters during the nesting season while foraging and while resting near their nesting colonies (Section 6.2.2). Fledglings of these species are also vulnerable following colony abandonment, as chicks are flightless for a period of one to two months while they are accompanied by their male parent to foraging areas on the continental shelf slope. Although the core wintering range of the common murre is south of the Project Area, this species winters in relatively large numbers in the continental shelf slope waters. Dovekie and thick-billed murre are vulnerable in those shelf slope waters because of the globally significant numbers of birds overwintering there. In recognition of these globally significant bird concentrations portions of these waters are designated as Northeast Shelf and Slope EBSA (Table 6.13) and Seabird Foraging Zone in the Southern Labrador Sea CBD EBSA (Figure 6-30).

Among the species of gulls, black-legged kittiwake concentrates inshore while foraging and attending nesting colonies. Following colony abandonment kittiwakes are most vulnerable in shelf slope and deeper waters where the globally significant concentrations overwinter. Great black-backed gull is at risk in in the fall in both inshore and offshore waters. This and other species of gulls are at risk on inshore foraging grounds and near the colonies during the nesting season. Iceland's nesting population of great skua is vulnerable to interactions with oil in the waters off Atlantic Canada because these waters are the core wintering area for this population.

Northern gannet is most vulnerable to interactions with oil during the nesting season in coastal areas, where they feed on spawning fish and attend nesting colonies, and during the fall when fledglings depart the colony (Garthe et al. 2007).

Leach's storm-petrel is at greatest risk during the nesting season in the shelf slope and deep waters of the RAA, when adults nesting in globally significant numbers at Baccalieu Island and at Great Island commute to foraging areas in the deep waters off the Grand Banks including the Project Area (Hedd et al. 2018). Breeding adults may be exposed to hydrocarbons while foraging within the affected area and transfer oil from their breast plumage to eggs or nestlings. This species is also at risk of exposure during the fall when fledglings depart the colonies for those feeding grounds. Great shearwater and large numbers of sooty shearwater are vulnerable to oiling during the summer months in coastal and offshore waters because most of the world's great shearwaters and large numbers of sooty shearwaters summer in the Northwest Atlantic.

Fulmars are most vulnerable in winter due to the relatively large numbers wintering in the shelf slope and deeper waters of the RAA.

A hypothetical subsea blowout scenario has the greatest potential for causing environmental effects to marine and migratory birds. The actual effects of a blowout incident would largely depend on the duration and volume of the spill, as well as the environmental conditions at the time of the spill. Modelling was undertaken for hypothetical blowout scenarios at two representative well locations (representing a shallow water [500 m] and deep-water [1,500 m] well site) (see Section 15.2; Appendix F). Subsea oil releases were modelled unmitigated over a 160-day period for both wells, based on worst-case credible discharges. These assumptions result in very conservative (i.e., highest potential) effects assessments. Separate stochastic simulations were carried out to represent summer (May to October) and winter (November to April) seasonal weather conditions.

For both release sites, the model suggested that areas to the east have the highest potential likelihood to exceed ecological thresholds (i.e., surface oil average thickness >10 µm, and shore oil average concentration >100 g/m²) or socio-economic threshold (subsurface dissolved hydrocarbon concentrations >1.0 µg/L) with respect to potential surface oil and water column exposure by dissolved hydrocarbons. The highest potential likelihood areas for exceeding the threshold typically extended over 1,500 km to the east to the edge of the model domain for the surface oil (see Section 15.2; Appendix F).

Four hypothetical blowout scenarios (two at each release site) were modelled for 160-day periods to simulate short (30 and 27 day) and long (123 and 135 day) continuous durations for the blowout. Stochastic modelling results indicate that the geographic extent of a residual change in habitat quality and use for marine birds could spread beyond the RAA (see Section 15.2; Appendix F). Seasonality of effects was observed in the model results. The average stochastic probability of shoreline oiling was consistently about two times higher for winter release scenarios than for summer release scenarios (Table 15.8). Also, the lower probability (1% to 10%) footprints for surface oil contamination were greater in the winter when compared to summer footprints, while the 90% footprints were larger in the summer (Table 15.7). These ‘footprints’ are not the expected exposure from any single release of oil, but rather areas where there is >1% probability that exposure above the highly conservative socio-economic threshold could occur, based on the combination of either 171 (annual), 89 (summer), or 82 (winter) individual releases analyzed together. During the summer, the minimum time to shoreline threshold exceedance was approximately 2 to 3 times more (i.e., took longer to reach the shore) than for the winter (Table 15.7). For an overview of threshold exceedances and corresponding areas, see Table 15.7. Figures 15-2 and 15-3, 15-5 and 15-6, 15-8 and 15-9, and 15-11 and 15-12 highlight areas with likely threshold exceedances.

All four hypothetical blowout scenarios have high potential for oil to enter the water column due to high wind speeds, which can cause surface oil to dissolve into the water column.

Due to the direction of transport of oil from wind and currents (primarily east), and the distance of the Project Area to the shoreline of Newfoundland, the average probability of Canadian shoreline exposure above the threshold for the four hypothetical stochastic scenarios was approximately 8.7% (West Flemish 1, winter, 123-day release; Table 15.8).

Although the areas of potential effects delineated by the modelling results are relatively large, substantial portions of these areas would have low probabilities of occurrence even if the release is allowed to continue unmitigated.

As noted in Section 15.4, in the event of a well blowout, Chevron would attempt direct intervention measures where appropriate and in consultation with regulators (e.g., capping stack, dispersants). The timing of these intervention measures would reduce the magnitude, duration, and geographic extent of the spill. These activities were not factored into modelling in order to demonstrate the worst-case scenarios of an unmitigated blowout.

The modelling results suggest that the areas most likely to be affected by an unmitigated, subsurface, well blowout are Flemish Pass, Flemish Cap and the areas to the north, south and east. As a result, a blowout during summer would have the potential to interact primarily with the relatively high concentration of great shearwaters, Leach's storm-petrels foraging for their nestlings, and smaller concentrations of northern fulmars and sooty shearwaters. Of these species, the shearwaters and fulmars would be most vulnerable to interaction with oil due to their moulting of flight feathers and the resulting greater amount of time on the sea surface. A blowout during winter would have the potential to interact with large concentrations of thick-billed murres, dovekies, kittiwakes, and fulmars, and smaller concentrations common murres. Of these species, the murres and dovekies would be most vulnerable due to the large proportion of time that alcids spend on the sea surface. A blowout during spring or fall has the potential to interact with all of the above species, with murres and dovekies as the most vulnerable species. However, higher average wind speeds and sea states during winter and fall would decrease the length of time that contiguous areas of oil would persist on the surface.

The magnitude and extent of potential effects would be reduced with the application of spill response measures, therefore the risk of adverse effects on secure and at-risk to marine and migratory birds would be reduced. Rapid response to prevent immediate oiling of marine birds may include hazing the birds or in-situ burning. The effect of hazing on birds may include the expending of the birds' energy resources, but the effects would be small in comparison to those of fouling of feathers with oil. In-situ burning would be avoided by birds (Fingas 2011). Burn residues have similar or larger fouling and damaging effects than fresh oil on feather microstructure (Fritt-Rasmussen et al. 2016). However, the total volume of oil would be reduced and, in some cases, burn residue may be submerged or sunken, further removing hydrocarbons from potentially fouling feathers (Fritt-Rasmussen et al. 2016).

In the even less likely event of shoreline oiling, particularly at or near the seabird colonies of the Avalon Peninsula and for coastal SERs on the Avalon, such as Baccalieu Island and Witless Bay Islands, there is potential for marine and migratory birds present and nesting in these areas to interact with surface oil. It is probable that only a small proportion of local populations would be affected. As stated above, by the time oil made contact with the shoreline, it would be patchy, discontinuous and weathered. As with surface oil, the potential effects would be reduced with mitigation measures, therefore the risk of adverse effects on shoreline and coastal marine and migratory birds would be reduced.

As discussed above, there is a low potential for SAR (see in Section 9.3.3) to interact with accidental hydrocarbon releases.

With spill prevention plans and response procedures in place, the residual effects of a subsurface blowout on marine and migratory birds are predicted to be:

- Adverse
- Potentially high in magnitude
- Occur within the RAA
- Short- to medium-term in duration
- Occur as a single event
- Reversible

15.5.2.3.2 Marine Diesel Spill

A batch diesel spill or vessel spill has the potential to result in a change in risk of mortality or physical injury and change in habitat quality and use for marine and migratory birds. A threshold concentration for lethal effects to seabirds is the open water area covered by an oil plume greater than 10 µm thick (>10 g/m²). For shorebirds (and other wildlife) on or along the shore, an exposure index is length of shoreline oiled by a slick >100 g/m² in thickness.

Project-specific deterministic modelling for the batch release of diesel was undertaken at the deep site (West Flemish Pass 1) for a spill volume of 1,000 L. This batch spill was modelled to represent a potential spill during bunkering operations. Modelling was conducted for the calmest wind speed during the summer, as well as account for ice-free conditions. This scenario was modelled for a duration of 30 days (see Section 15.2; Appendix F).

Deterministic modelling results indicate that surface oil was predicted to travel east, clockwise around the perimeter of the Flemish Cap for approximately 1,500 km. Figure 15-27 indicates that the spill thicknesses were representative of colorless or silver sheens (<0.0001 mm). Figures 4-70 and 4-71 (see Section 15.2; Appendix F) suggest that the predicted concentrations of both dissolved and total hydrocarbons in the water were not present in concentrations above the recordable thresholds (Table 15.2). This was due to the small volume of the release, low amount of entrainment, and size of the concentration gridding. The modelled batch spill was not predicted to reach shorelines or result in oil settling on the benthic substrate (Figure 15-29). The total area that was exposed to oil concentrations greater than 0.04 µm over the 30 days that were modelled was 8 km². There was no surface area predicted to be exposed to thicknesses above the ecological threshold and no shoreline predicted to be exposed to concentrations greater than the ecological threshold (Table 15.9). Predictions at the end of the 30-day simulation were that 64% would evaporate, 35% would degrade, 11% would remain entrained in the water column, and 0.1% would remain floating on the surface (see Section 15.2; Appendix F).

Based on the modelling results, a batch spill could result in a temporary and reversible degradation in habitat quality. Depending on the location and extent of the spill, it could directly and indirectly reduce the amount of habitat available to marine and migratory birds at sea. In the event of a vessel spill in the nearshore area, there is the potential for shoreline to be affected by a diesel spill. When diesel spills interact with the shoreline, it tends to penetrate porous sediments quickly and washes off quickly by waves and tidal flushing (NOAA 2016b). These effects would be short-term in duration until the slick disperses and the diesel content in the area reaches background levels. A batch spill of diesel is therefore not expected to create permanent or irreversible changes to habitat quality and use.

A batch spill of hydrocarbons has the potential to cause a change in risk of mortality or physical injury for marine and migratory birds through direct contact. However, since the sheen's predicted thickness is below the ecological threshold it is predicted that birds coming into contact with the sheen would not suffer mortality or sublethal effects. The number of birds affected would also be limited due to the short time and small area where the diesel would be on the water's surface.

With spill prevention response procedures in place, potential effects of a batch spill on marine and migratory birds are predicted to be:

- Adverse
- Low in magnitude
- Within the LAA
- short-term in duration
- Occur as a single event
- Reversible

15.5.2.3.3 SBM Spill from the MODU and the Marine Riser

An SBM spill has the potential to result in a surface sheen which in turn could cause a change in risk of mortality or physical injury or change in habitat quality and use for seabirds present in the immediate vicinity of the MODU (Morandin and O'Hara 2016). A sheen would be limited in size, temporary, and moderate wind and wave conditions would quickly beak it up. Given the low surface oil thickness required to result in a sheen (0.04 μm), it is expected that effects would be minor and unlikely to result in seabird mortality.

Potential effects of a drill mud spill on marine and migratory birds are predicted to be:

- Adverse
- Low in magnitude
- Within the LAA
- Short-term in duration,
- Occur as a single event
- Reversible

15.5.2.3.4 Summary

Table 15.36 provides a summary of predicted residual environmental effects of accidental events on Marine and Migratory Birds.

Table 15.36 Summary of Residual Project-Related Environmental Effects on Marine and Migratory Birds – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Risk of Mortality or Physical Injury/Change in Habitat Quality and Use							
Well Blowout Incident	A	H	RAA*	ST-MT	S	R	D
Marine Diesel Spill	A	L	LAA	ST	S	R	D
SBM Spill	A	L	LAA	ST	S	R	D

KEY: See Table 9.2 for detailed definitions N/A: Not Applicable Direction: P: Positive A: Adverse Magnitude: N: Negligible L: Low M: Moderate H: High	Geographic Extent: PA: Project Area LAA: Local Assessment Area RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*" Duration: ST: Short-term MT: Medium-term LT: Long-term	Frequency: S: Single event IR: Irregular event R: Regular event C: Continuous Reversibility: R: Reversible I: Irreversible Ecological / Socio-Economic Context: D: Disturbed U: Undisturbed

15.5.2.4 Determination of Significance

Based on the characterization of residual effects described above, a precautionary conclusion is drawn that the residual adverse environmental effect of a blowout incident, large batch spill, or vessel spill is predicted to be significant for marine and migratory birds, but not likely to occur. Infrequent small spills, as well as a SBM release, would be not significant.

Although hydrocarbon spills could result in some mortality at the individual level, these residual adverse environmental effects are predicted to be reversible at the population level. However, these environmental effects could be significant if the consequences carried over more than one generation according to the significance threshold used in this environmental assessment or self-sustaining population objectives or recovery goals for listed species are jeopardized. Again, this is considered unlikely given the low probability of a large spill event to occur and the response that would be in place to reduce the consequences of such an event.

A medium level of confidence is assigned to the significance determination for all accident scenarios, with the exception of a blowout incident (which is made with high confidence), as the significance is based on a worst-case credible scenario, with the actual significance influenced by a number of factors such as volume spilled, duration, location, season, presence of birds, and effectiveness of mitigation.

15.5.3 Marine Mammals and Sea Turtles

Thirty-two marine mammal species could potentially occur in the Project Area and RAA, including 26 cetaceans (whales, dolphins, and porpoises) and six phocids (true seals). The occurrence of seven of the cetacean species is considered outside their normal ranges. Four sea turtle species could also occur within or near the Project Area. Of these marine mammal and sea turtle species, there are five marine mammal SAR (North Atlantic right whale, blue whale [Atlantic population], northern bottlenose whale [Scotian Shelf population], fin whale, and Sowerby's beaked whale), two sea turtle SAR (leatherback and loggerhead sea turtles), and two marine mammal SOCC (killer whale and harbour porpoise) (see Tables 6.14 and 6.15). Most of these SAR are expected to be rare or uncommon in the Project Area, although fin and northern bottlenose whales could occur there regularly. Nonetheless, an accidental release of oil could extend outside of the Project Area and affect SAR, SOCC, and other species in the larger RAA.

Many marine mammal and sea turtle species that could occur in the RAA have the potential to be present year-round but are most likely to occur from late spring or summer through fall; this is also the period when most migratory marine mammals and sea turtles frequent the area. Exceptions are harp and hooded seals, which may occur year-round but mostly from winter to spring; ringed seals, which are seasonally present from winter to spring; and leatherback sea turtles, which are seasonally present from April to December.

The species of marine mammals most likely to be found in coastal areas within the RAA include the North Atlantic right whale, fin whale, humpback whale, minke whale, blue whale, Atlantic white-sided dolphin, common bottlenose dolphin, killer whale, harbour porpoise, grey seal, ringed seal, and bearded seal.

Sections 6.3.8 and 6.4 describe several areas of importance to marine mammals and sea turtles that are found within the RAA, including nearshore and offshore areas. Additional details regarding existing conditions for marine mammal and sea turtle species are provided in Section 6.3.

15.5.3.1 Project Pathways for Effects

Accidental spills have potential to result in a change in risk of mortality or physical injury and/or a change in habitat quality and use for marine mammals and sea turtles. The extent of potential effects will depend on how the spill trajectory and the VC overlap in both time and space (Frasier et al. 2020). Although the effects of dispersants on marine mammals and sea turtles is not well known (Frasier et al. 2020), they can be toxic or change the characteristics of the oil spill thereby exposing certain biota to oil longer (Dupuis and Ucan-Marin 2015; Beyer et al. 2016). However, according to Prince (2015), the positive effects of its use on a spill likely outweigh the environmental consequences; nonetheless, the use of dispersants is controversial (Beyer et al. 2016). Although spill modelling for this assessment does not include the use of dispersants, it is conservative in its analysis of potential effects of oil spills on marine mammals and sea turtles, and assumes that geographic and temporal overlap occur; in addition, the modelling results assume no implementation of mitigation measures.

15.5.3.1.1 Potential Effects of an Oil Spill on Marine Mammals and Sea Turtles

Marine Mammals

The effects of oil on marine mammals depend on the extent of exposure to toxic components of oil. Exposure may occur due to external coatings of oil (e.g., interaction with surface slicks when animals surface for air, clogging of baleen plates), inhalation of aerosols of particulate oil and hydrocarbons, and ingestion of contaminated prey (Helm et al. 2015; Lee et al. 2015; NRDA 2016). Animals that move through an area covered by floating oil (e.g., emulsions, slicks, or other floating forms such as tar balls) are assumed to be oiled based on the probability of encounter; those individuals that are oiled above a threshold dose are assumed to die (French-McCay 2009). A combined probability of oil encounter and mortality once oiled for marine mammals present in the area swept by oil exceeding a threshold thickness of 10 μm (for spills larger than 230 m in diameter) was 0.1% for cetaceans and 75% for fur-bearing marine mammals such as seals (French-McCay 2009).

Studies to date have shown variable result regarding the ability of marine mammals to detect and/or avoid oil-contaminated waters (Engelhardt 1983; St. Aubin et al. 1985; Smultea and Würsig 1995; Ackleh et al. 2012; Wilkin et al. 2017). Several cetacean and seal species were reported to behave normally in the presence of oil (St. Aubin 1990; Harvey and Dahlheim 1994; Matkin et al. 1994). During the 1989 *Exxon Valdez* spill in Prince William Sound, killer whales were seen swimming through surface oil within 24 hours of the spill (Matkin et al. 2008). It is possible that cetaceans swim through oil because of strong behavioural motivation, such as the need to feed. Following the *Exxon Valdez* spill, harbour seals were seen swimming through and surfacing in floating oil while foraging and moving to and from haul-out sites (Lowry et al. 1994).

However, other studies have documented that cetaceans avoid surface slicks. Aerial surveys conducted between 1979 and 1982 in Atlantic Canada monitored the presence of cetaceans near small oil slicks, reporting that some individuals were seen swimming near surface oil but rarely within surface slicks (Sorensen et al. 1984). During the 1989 *Exxon Valdez* spill, humpback whales may have shown temporary avoidance of the oiled area (von Ziegesar et al. 1994). Some data indicates that dolphins attempt to minimize contact with surface oil by decreasing their respiration rate and increasing the dive duration (Smultea and Würsig 1995). In some cases, marine mammals may avoid the area beyond the detected slick. Based on a comparison of sperm whale acoustic activity from pre-spill (2007) and post-spill (2010) conditions associated with the DWH oil spill, Ackleh et al. (2012) reported that sperm whales may have relocated out of areas that had high concentrations of oil and pollutants, possibly because of food shortages, and increased boat traffic, which likely had increased levels of anthropogenic noise.

According to Geraci and St. Aubin (1980, 1982), whales exposed to an oil spill are unlikely to ingest enough oil to cause serious internal damage. Marine mammal species feed in restricted areas or within restricted ranges may be at greater risk of ingesting oil (Würsig 1990; Helm et al. 2015). However, when returning to clean water, contaminated animals can depurate this internal oil (Engelhardt 1978, 1982). Hydrocarbons consumed via contaminated prey can be metabolized and excreted, but some is stored in blubber and other fat deposits (Lee et al. 2015). Absorbed oil can cause toxic effects such as liver, kidney, and brain lesions (Geraci and Smith 1976; Geraci 1990; Spraker et al. 1994). Examination of deceased common bottlenose dolphins that had been exposed to oil during and after the Deep Water Horizon spill indicated that elevated petroleum compounds in coastal waters had caused adrenal and lung disease and contributed to increased numbers of dolphin mortalities (Venn-Watson et al. 2015). Lung disease, as well as adrenal toxicity, were evident during examination of live dolphins in 2011 that inhabited an area of the Gulf of Mexico that received heavy oiling from the spill (Schwacke et al. 2014). A health assessment of dolphins from the same area conducted four years after the spill showed some improvement in dolphin health, although impaired stress response and lung disease were still evident (Smith et al. 2017).

Crude oil could coat the baleen plates of mysticetes and reduce filtration efficiency, but these effects are considered reversible (Geraci 1990). Geraci (1990) noted that adverse effects on cetaceans, such as sickness, stranding, or mortality tended to be associated with crude or bunker C oil. Nonetheless, most marine mammals can tolerate some oiling without toxic or hypothermic effects. Direct contact with oil can cause fouling in fur-bearing marine mammals such as seals, reducing their ability to thermoregulate (Kooyman et al. 1977) and potentially causing effects similar to those associated with thermoregulatory failure in birds (Lee et al. 2015) (refer to Section 15.5.2). Whales and seals use blubber to maintain core body temperature, which is not affected by a covering of oil (Helm et al. 2015). However, hypothermia is possible if marine mammals that rely on fur for insulation (e.g., polar bears, fur seals, otters) are oiled (Helm et al. 2015). Contact with oil decreases the insulative value of hair, but for healthy seals, this is unlikely a major problem as they rely primarily on blubber for insulation; thus, the risk of hypothermia may be offset by thick layers of blubber (Lee et al. 2015). However, young seal pups, if oiled, are susceptible to hypothermia, as it takes several months to build up a blubber layer sufficient to maintain body heat. Oil fouling could affect seal locomotion, by causing flippers to stick to the body with heavy oiling. Seals became cleaner over time if they are not repeatedly exposed to oil. Various types of skin lesions likely caused by crude oil have also occurred in harbour seals. Examination of dead, oiled seals suggested lesions may have been related to inhalation of toxic fumes and mortality could have resulted from behavioural disorientation, lethargy, and stress response (Ott et al. 2001). Stimmelmayr et al. (2018) reported that oiled arctic seals showed hepatic, pulmonary, and cardiac lesions likely associated with increased levels of polycyclic aromatic hydrocarbon (PAH) in their tissues.

Monitoring studies of marine mammals following oil spills have shown evidence implicating oil exposure with the mortality. Sea otters, harbour seals, Stellar sea lions, killer whales, and humpback whales were most affected by the *Exxon Valdez* oil spill (Lee et al. 2015). Monitoring over a 16-year period after the spill showed a measurable decrease and lack of recovery in the population of a resident fish-eating killer whale pod using the area affected by the spill (Dahlheim and Matkin 1994; Matkin et al. 2008). Fraker (2013) challenged Matkin's conclusion that the killer whale deaths could be attributed to the *Exxon Valdez* spill, as there does not appear to be a clear and plausible connection given other factors, such as bullet wounds that might have contributed to the documented mortalities. Nonetheless, neither the resident pod nor the transient population of killer whales in Prince William Sound has recovered, even though it has been 28 years since the spill (Esler et al. 2018). Although Esler et al. (2018) noted that chronic direct effects after this many years is unlikely, they suggest that demographic factors such as a small population size and life history characteristics are constraining the recovery.

Five harbour porpoises were also found dead in Prince William Sound following the *Exxon Valdez* spill. Although three autopsied individuals showed elevated levels of hydrocarbons in live and blubber tissues, the levels of assimilated oil were not high enough to conclude with certainty that the animals succumbed from exposure to crude oil (Dalheim and Matkin 1994). The deaths could have resulted from a combination of factors, including acute toxicity of crude oil, starvation due to chronic respiratory damage, reduced prey abundance, increased energy expenditure from epidermal fouling, and increased susceptibility to parasitism or disease (Albers and Loughlin 2003; Lee et al. 2015).

Following the DWH oil spill in the Gulf of Mexico, over 150 dolphins and whales were found dead of which nine were visibly oiled; 90% of mortalities consisted of bottlenose dolphins (NOAA 2018). The low estimated carcass recovery rates of cetaceans (as low as 2%) after the DWH oil spill (Williams et al. 2011) limits the statistical validity of proposed cause-effect relationships. The low carcass recovery after a spill is one reason why it is challenging to link oil exposure to acute and chronic effects in marine mammals (Lee et al. 2015). Nonetheless, some studies of dolphin populations inhabiting areas of the Gulf of Mexico that were affected by the oil spill have indicated that elevated petroleum compounds contributed to increased numbers of dolphin mortalities (Schwacke et al. 2015; Venn-Watson et al. 2015). Pregnancy success rates were of dolphins inhabiting the exposed area were also depressed (Lane et al. 2015). Poor reproductive success may have been caused by increased concentrations of genotoxic metals in these animals (Wise et al. 2018). Although chronic effects are uncertain, long-term acoustic monitoring in the Gulf of Mexico suggests local declines in marine mammal presence (e.g., sperm whale, beaked whales, *Kogia* spp.), possibly due to reduced reproductive success as a result of oil exposure (Frasier et al. 2020).

Sea Turtles

The effects of oil on sea turtles depend on the extent of exposure to toxic components of oil. Exposure pathways for effects on sea turtles are similar to those of marine mammals: external coatings of oil (e.g., interaction with surface slicks when animals surface for air); inhalation of aerosols of particulate oil and hydrocarbons; and ingestion of contaminated prey (Shigenaka et al. 2003; Lee et al. 2015; NRDA 2016). Sea turtles are likely unable to detect oil during a spill (e.g., Vargo et al. 1986; Gramentz 1988; Milton et al. 2003). Loggerhead and Kemp’s ridley turtles continued to forage in oil-exposed areas even after the DWH oil spill (Vander-Zanden et al. 2016; Reich et al. 2017).

French-McCay (2009) suggested a combined probability of oil encounter and mortality once oiled of 5% for juvenile and adult sea turtles and 50% for hatchling sea turtles. This is based on a moderate to high short-term survival rate if oiling occurs as indicated by the literature (Vargo et al. 1986), but also takes into consideration that there are few data on the long-term effects of oil on reptiles. Hatchlings are especially vulnerable as they spend most of their time at the surface of the water, and their size and anatomy (e.g., weaker mobility) increases their susceptibility to passing through oil and suffocating as a result of exposure. Hatchlings may not be able to swim as well once oiled, thereby increasing their predation risk. French-McCay (2009) acknowledged that the probability for oiling and dying of hatchlings ranges from 10 to 100%, but used 50% as a best estimate. Compared to hatchlings, juveniles and adult sea turtles spend less time at the surface of the water, which likely reduces their exposure to smaller oil slicks. The data on hatchlings is provided for context, as there is an absence of sea turtle hatchlings in Atlantic Canada waters. Sea turtles are especially susceptible to prolonged exposure to petroleum vapours as a consequence of their diving behaviour, which requires rapidly inhaling large volumes of air before diving and continually resurfacing (Milton et al. 2003).

Even if sea turtles avoid direct contact with oil slicks, they can be directly affected through ingestion of oil or contaminated prey. As turtles consume anything that is the same size as their preferred prey (e.g., jellyfish), ingestion of tar balls is an issue for turtles of all ages (e.g., Witherington 2002, 2012). Ingested oil can be retained within a turtle's digestive tract for several days thereby increasing the likelihood of absorption of toxic compounds and the risk of gut impaction (Milton et al. 2003). Sea turtle exposure to oil has also been shown to cause histologic lesions, as well as damage to nasal and eyelid tissue, a reduction in lung diffusion capacity, and a decrease in oxygen consumption or digestion efficiency (Lutz et al. 1989; Bossart et al. 1995; Lutcavage et al. 1995; Camacho et al. 2013). Hall et al. (1983) observed seven live and three dead sea turtles following the Ixtoc 1 oil well blowout incident in 1979. Two of the carcasses had oil in the gut but no lesions; there was no evidence of aspirated oil in the lungs. However, hydrocarbon residues were found in liver, kidney, and muscle tissues of the three dead turtles; prolonged exposure to oil may have disrupted foraging behaviour and weakened the turtles.

Following the DWH oil spill, there was an increase in sea turtle strandings rates in the Gulf of Mexico (Beyer et al. 2016). Although on average, 240 sea turtles strand in the northern Gulf of Mexico each year, 1700 standings were reported between May 2010 and November 2012 (Beyer et al. 2016). More than one thousand turtles were collected, including at least 450 living but oiled turtles (McDonald et al. 2017; Stacy et al. 2017; NOAA 2018) that were cleaned and released back into the wild (NOAA 2018), and 600 dead turtles of which 18 were visibly oiled (NOAA 2018). Most (95%) of the live released turtles were loggerheads, and most (75%) of the dead turtles were Kemp's ridley turtles (NOAA 2018). It is likely that 100% of heavily oiled turtles died from the effects of oiling, and 30% of oceanic turtles that were not heavily oil succumbed to the effects from oil ingestion (Mitchelmore et al. 2017). In total, it was estimated that up to 7600 adults and large juveniles and as many as 160,000 small juveniles were killed by the spill (NRDA 2016).

The most acute adverse effect on turtles from the DWH Oil Spill was coating by oil and becoming entrained in the oil slick; turtles stuck in the oil had decreased mobility, and suffered from exhaustion, dehydration, and overheating leading to death (NRDA 2016; Stacy et al. 2017). Stacy et al. (2017) reported that turtles exposed to the spill showed metabolic and osmoregulatory derangements, while Ylitalo et al. (2017) showed that oiled sea turtles had increased levels of PAH in their tissues. Reich et al. (2017) reported that 51.5% of Kemp's ridley turtles that were sampled in the Gulf of Mexico after the DWH oil spill showed isotopic evidence of oil exposure in their scutes. However, the long-term health effects of oil exposure on turtles in the Gulf of Mexico are unknown (Vaner Zanden et al. 2016). A total of 2360 non-oiled sea turtles stranded in Alabama, Louisiana, and Mississippi from 2010 through 2014 (Stacy 2015). Necropsies found that most of these turtles succumbed as bycatch in the fishery, not because of exposure to oil; however, general decline in nutritional condition was also apparent for stranded turtles since the oil spill (Stacy 2015).

Here it is assumed that any sea turtles occurring within the zone of influence of an accidental event have the potential to be exposed to oil and experience related health effects, as described above. As the sea turtles occurring in the RAA would be juveniles and adults, the potential for mortality from oil exposure would be lower than for hatchlings. Sea turtles would also experience a short-term reduction in habitat quality, during which they have the potential to ingest oil or oiled prey.

Effects of Dispersants on Marine Mammals and Sea Turtles

In general, dispersed oil is predicted to reduce potential adverse environmental effects on marine mammals and sea turtles. Marine mammals are susceptible to floating oil due to the fact they need to surface at regular intervals to breathe. The use of dispersants may be beneficial for marine mammals within a spill area by reducing the exposure to floating oil on the sea surface. The dispersion of oil, however, may expose swimming or feeding marine mammals to the consumption of contaminated plankton, skin/fur contamination, and potentially the clogging of baleen (Lee et al. 2015). Hydrocarbons consumed by marine mammals through contaminated prey can be metabolized and excreted. Some hydrocarbons, however, may be stored in blubber and other fat deposits which may be released into circulation during periods of physiological stress (low prey availability, migration, lactation) and may be bioavailable and toxic to a fetus or newborns (Lee et al. 2015).

15.5.3.1.2 Potential Effects of an SBM Spill on Marine Mammals and Sea Turtles

SBM is a heavy, dense fluid which sinks rapidly in the water column when released. SBM constituent selection is controlled by the OCSG so that low toxicity chemicals are used wherever practicable. Therefore, SBMs are of low toxicity, and environmental effects are mostly restricted to physical smothering effects on the sea floor (C-NLOPB 2011). Any interaction between an SBM whole mud spill and marine mammals and sea turtles would be limited given the scale of effects in the water column and low toxicity of the material, resulting in a temporary reduction in habitat quality. Any risk of physical injury would be limited to individuals in the immediate vicinity (within 1 km; AMEC 2017) of the spill. A subsea release of SBM at the wellsite would have no expected effects on sea turtles given the water depth.

15.5.3.2 Mitigation of Project-Related Environmental Effects

Chevron will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. Refer to Section 2.5 for specific information on well control and blowout prevention, and Section 15.4 for a description of Chevron’s contingency planning and emergency response measures.

As noted in Section 15.4, the Project will include contingency plans for responding to specific emergency events, including potential spill or well control events. The contingency plans, such as an Oil Spill Response Plan (OSRP), will be submitted to the C-NLOPB prior to the start of any drilling activity as part of the Operations Authorization process. The OSRP will specify tactical response methods, procedures, and strategies for safely responding to different spill scenarios such as:

- offshore containment and recovery;
- surveillance and tracking;
- dispersant application (surface and subsea injection);
- in-situ burning;
- shoreline protection;
- shoreline clean-up; and
- oiled wildlife response.

Refer to Section 15.4 for details regarding incident management and spill response.

Chevron will undertake a Spill Impact Mitigation Assessment (SIMA) / Net Environmental Benefit Analysis (NEBA) as part of the Operations Authorization process with the C-NLOPB. The SIMA is a structured process that will qualitatively evaluate the risks and trade-offs of all feasible and effective response options, when compared to no action. The SIMA process will inform the selection of an overall spill response strategy for the Project. If identified as a preferred response option, use of chemical dispersants would not occur without first obtaining regulatory approval.

In the unlikely event of a spill, specific monitoring (e.g., environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

15.5.3.3 Characterization of Residual Project-Related Environmental Effects

The residual effects of accidental events involving the release of oil from a subsea blowout, release of diesel fuel, and SBM spill are assessed in the following sections.

15.5.3.3.1 Subsea Blowout

A well blowout may result in a change in risk of mortality or physical injury and a change in habitat quality and use for marine mammals and sea turtles. The likelihood, magnitude, geographic extent and duration of potential effects of a subsea blowout will depend in large part on the occurrence and distribution of marine mammals and sea turtles at the time of the blowout, as well as the duration and spatial extent (i.e., natural attenuation) of oil release (i.e., potential severity of effects will be dependent on the potential for exposure). Given that marine mammals and sea turtles are known or expected to occur throughout most, if not all of the RAA, the magnitude of effects may be higher for subsea releases of larger scale and extended duration, as was observed during the DWH spill in the Gulf of Mexico (e.g., Takeshita et al. 2017). Marine mammals and sea turtles may be exposed to oil via a combination of pathways (inhalation, ingestion, aspiration, and adsorption). Marine mammals and sea turtles that are closer to the site of the blowout are most likely to be exposed to a more constant flow and higher concentrations of recently released oil, as compared to species that are more prevalent in the nearshore.

A threshold concentration for sub-lethal effects to marine mammals and sea turtles was identified as a 10 µm thick layer of on-water oil (French et al. 1996; French-McCay and Rowe 2004; French McCay 2009). For the purposes of this assessment, a surface oil thickness of 10 µm is the threshold at which it is assumed that a change in risk of mortality or physical injury may occur for marine mammals and sea turtles. However, a more conservative threshold of 0.04 µm (visible sheen) was used in the modelling in recognition of potential socio-economic effects on fisheries (refer to Table 15.2). A surface oil thickness of 0.04 µm is also conservatively used in this assessment as the threshold for a change in habitat quality and use for marine mammals and sea turtles. For wildlife on or along the shore (e.g., seals and otters), an exposure index is length of shoreline oiled by 100 µm thick (>100 g/m^2). This emulsion thickness would be characterized as “light oiling”.

Modelling was undertaken for hypothetical blowout scenarios at two representative well locations (a shallow water [500 m] and deep-water [1,500 m] well site) (see Section 15.2). Subsea oil releases were modelled over a 160-day period for both wells, based on worst-case credible discharges and for unmitigated releases.

Separate stochastic simulations were conducted to represent summer (May to October) and winter (November to April) seasonal weather conditions.

For both release sites, the stochastic models predicted that oil would be transported primarily to the east and as such, areas to the east have the highest potential likelihood to exceed socio-economic (and ecological) thresholds with respect to potential surface oil and water column exposure by dissolved hydrocarbons. Due to the direction of transport of oil from wind and currents (primarily east), and the distance of the Project Area to the shoreline of Newfoundland, the average probability of shoreline exposure above the threshold was approximately 8.7% (Table 15.8).

For the representative credible “worst-case” deterministic scenarios nearly half of the oil was predicted to evaporate, while a third was predicted to degrade by natural processes (Table 15.9). Of the remaining roughly 15-20% of the released oil, 1-15% was predicted to remain on the surface, <2% remain in the water column, <0.1% to 0.4% stranded on shorelines, and <0.1% settled onto sediments over 160 days (Table 15.10). The deterministic modelling results indicate that areas most likely to be affected by an unmitigated, subsea, well blowout are Flemish Pass, Flemish Cap, and the areas to the east (including areas beyond the modelling domain). As a result, a blowout would have a greater potential to interact with marine mammals that inhabit these deeper waters including species like sperm whales, beaked whales, and delphinids. Fin whales also occur regularly in the Flemish Pass area. Harp and hooded seals are considered common in the Project Area and adjacent deep water basins. Sea turtles are expected to be rare in Flemish Pass, Flemish Cap, and the areas to the east. It is possible that marine mammals and sea turtles that do occur in offshore areas where predicted concentrations of hydrocarbons occurs above the ecological threshold levels from an unmitigated subsurface blowout could experience adverse changes in habitat quality and use, health, and in extreme cases increases in injury and mortality levels. As reviewed above, while some marine mammals seem to avoid oil spills, other marine mammals have been observed swimming through, and feeding in, large slicks (see Helm et al. 2015; Wilkin et al. 2017). Sea turtles may be more susceptible to the effects of exposure to hydrocarbons than marine mammals because they do not respond with avoidance behaviour, exhibit indiscriminate feeding, and take large pre-dive inhalations (see Milton et al. 2010; Vander Zanden et al. 2016). The magnitude and extent of potential effects would be reduced with the application of spill response measures; therefore, the risk of adverse effects on secure and at-risk marine mammals and sea turtles would be reduced. If in-situ burning of oil is used as a mitigation measure, there is limited potential for this measure to affect marine mammals (and sea turtles). Chevron will take steps to deter marine mammals from the area as part of its Oil Spill Response Plan before in-situ burning commences (see Section 15.4).

For the shoreline oil exposure cases, shoreline oil contamination was predicted to range from approximately 98-946 km at levels exceeding the ecological threshold (Table 15.9). In general, most oiling in these scenarios was predicted along the eastern and northern shores of Newfoundland with some shoreline oiling predicted in Placentia Bay and possibly Labrador. The oil that was predicted to strand along shorelines was generally in the 100 to >500 g/m² range. Shoreline oil would be highly weathered, patchy and discontinuous particularly at longer ranges from the release site. There is potential for harbour and grey seals that are known to haul-out in small numbers and use coastal areas, particularly on the Avalon and Burin peninsulas, to interact with oiled shoreline. As with surface oil, the potential effects would be reduced with mitigation measures, therefore the risk of adverse effects on shoreline and coastal marine mammals would be reduced. Small numbers of seals which may interact with hydrocarbons (albeit highly weathered oil that is patchy and discontinuous), could conceivably experience a change in mortality or injury or a change in health; however, it is probable that only a small proportion of local populations would be affected. The magnitude and extent of potential effects would be reduced with the application of spill response measures; therefore, the risk of adverse effects to coastal marine mammals would be reduced.

As described in Section 6.3.7, there are nine marine mammal and two sea turtle Species at Risk that are known or expected to occur in the in the LAA and/or RAA. In the extremely unlikely event of a subsea blowout to the marine environment, these species have the potential to be adversely affected, if the spill occurs when the Species at Risk is in the area. The likelihood, however, of a subsea blowout occurring is extremely low. In an actual event, emergency response measures would likely reduce the magnitude, duration and geographic extent of the spill, and therefore reduce the potential impacts on marine mammals and sea turtles.

With spill prevention plans and response procedures in place, potential effects of a subsea blowout on marine mammals and sea turtles are predicted to be:

- Adverse
- Medium in magnitude
- Medium to long-term in duration
- Within the RAA
- Occur as a single event
- Reversible

15.5.3.3.2 Marine Diesel Spill

Depending on the location and extent of the batch diesel spill, it could directly and indirectly reduce the amount and quality of habitat available to marine mammals and sea turtles. If the vessel spill of diesel occurred in the nearshore area, there is the potential for shoreline to be affected. When diesel spills interact with the shoreline, it tends to penetrate porous sediments quickly and washes off quickly by waves and tidal flushing (NOAA 2016a). These effects would be short-term in duration until the slick disperses and the diesel content in the area reaches background levels. A batch spill of diesel is therefore not expected to create permanent or irreversible changes to habitat quality and use. Likewise, there is limited potential for a batch spill of diesel to change the risk in mortality or physical injury for marine mammals and sea turtles.

Project-specific deterministic modelling for the batch release of diesel (1,000 L) during bunkering operations was undertaken at the deep site (West Flemish Pass 1). Modelling results predicted that the marine diesel release would result in a patchy and discontinuous colourless or silver sheen (<0.1 μm thick) that would travel east. The total area that was exposed to oil concentrations greater than 0.04 μm over the 30 days that were modelled was 8 km^2; the area exposed to concentrations greater than the ecological threshold (>10 μm) would be much smaller. At the end of the 30-day simulation, the model predicted that 64% of the marine diesel would evaporate, 35% would degrade, 11% would remain entrained in the water column, and 0.1% would remain floating on the surface (Appendix F). The modelled batch spill was not predicted to reach shorelines.

With spill prevention response procedures in place, potential effects of a batch spill of marine diesel on marine mammals and sea turtles are predicted to be:

- Adverse
- Low in magnitude
- Short-term in duration
- within the LAA
- Occur as a single event
- Reversible

15.5.3.3.3 SBM Spill from the MODU and the Marine Riser

There is potential for an SBM spill to result in a surface sheen which in turn could potentially cause a change in habitat quality and use and possibly a change in the risk of mortality or physical injury for marine mammals and sea turtles present in the immediate area. If the wind and wave conditions were such that a sheen formed, it would be temporary and limited in size (see SBM modelling conducted in EL 1144 for Nexen Energy’s Flemish Pass Exploration Drilling Project (Amec 2017)), such that only individuals in the immediate area of the spill would likely be affected. Furthermore, given the low surface oil thickness required to result in a sheen (0.04 µm), it is expected that effects would be minor and unlikely to result in marine mammal or sea turtle mortality or injury. Likewise, any reductions in habitat quality and use would be temporary, reversible and localized.

Potential effects of a SBM spill on marine mammals and sea turtles are therefore predicted to be:

- Adverse
- Low in magnitude
- Within the LAA
- Short-term in duration
- Occur as a single event
- Reversible

15.5.3.3.4 Summary

Table 15.37 provides a summary of predicted residual environmental effects of accidental events on marine mammals and sea turtles.

Table 15.37 Summary of Residual Project-Related Environmental Effects on Marine Mammals and Sea Turtles – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological and Socio-economic Context**
Change in Risk of Mortality or Physical Injury/Change in Habitat Quality and Use							
Well Blowout Incident	A	M	RAA*	MT-LT	S	R	D
Marine Diesel Spill	A	L	LAA	ST	S	R	D
SBM Spill	A	L	LAA	ST	S	R	D

KEY:
See Table 10.2 for detailed definitions

N/A: Not Applicable
Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*"

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological / Socio-Economic Context:
D: Disturbed
U: Undisturbed

15.5.3.4 Determination of Significance

Based on consideration of the information presented above, the residual adverse environmental effects from the accidental event scenarios on marine mammals and sea turtles are predicted to be not significant. This determination is made in consideration of the precautionary approach of the spill modelling (results show an unmitigated release), the use of mitigation measures to prevent and reduce effects from a spill, and the nature of the adverse effects as described in the literature summarized above. This conclusion is made with a high level of confidence for the diesel and SBM spill scenarios based on the low magnitude and geographic extent of likely effects. A medium level of confidence is assigned to the hypothetical well blowout scenarios given the larger geographic extent of affected area, the potential for marine mammal species at risk to occur in the affected area, and data gaps in the scientific literature.

15.5.4 Special Areas

Special areas within the RAA have been designated as protected or identified as being special due to their biological, ecological, or cultural importance. Special areas are governed by provincial, federal, or international regulatory bodies or special interest groups to protect important ecological or cultural features. Special areas may be vulnerable to an accidental event, as degradation of their conditions may affect habitat quality and associated biological life cycles or cultural aspects. See Section 6.4 for descriptions of special areas within the RAA.

The potential effects of accidental events on the biological VCs are discussed above in Sections 15.5.1 to 15.5.3 for marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles, respectively, and are summarized in this section, where relevant. The principal potential environmental effect on special areas used in the assessment of effects of routine activities (Chapter 11) was a change in habitat quality, which is also relevant to the assessment of accidental events. The extent of the potential effects on special areas and their defining features is dependent on spill trajectory and spatial and temporal overlap. In the unlikely event of an accidental release of hydrocarbons, potential effects on special areas include degradation of the integrity of a special area such that it no longer fulfills the biological, ecological, or cultural function for which it was designated. As such, the special areas VC is directly linked to the aforementioned VCs considered in this assessment.

15.5.4.1 Project Pathways for Effects

Accidental spill scenarios have the potential to alter habitat quality within special areas. The extent of the potential effects will depend on the spatial and temporal overlap between the VC and spill trajectory. The following assessment is conservative (i.e., geographic and temporal overlap are assumed to occur, and modelling results assume no implementation of mitigation measures) and based on worst-case scenarios.

Special areas provide important/sensitive habitat that may be more vulnerable to accidental effects than other areas within the RAA. Adverse effects on special areas could alter the ecological integrity of a special area such that it is no longer capable of providing the important function for which it was designated (e.g., protection of sensitive or commercially important species). Therefore, the assessment of accidental events on special areas is directly linked to that of the marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles VCs, particularly for accidental events where the physical effects on the biological resources found in these areas represent the potential effects of greatest concern. These potential effects are discussed in Sections 15.5.1 to 15.5.3 for marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles, respectively, and are not repeated here.

15.5.4.1.1 Potential Effects of a Subsea Blowout on Special Areas

If left unmitigated, a subsea blowout in the West Flemish Pass Project Area could result in the release of a high volume of oil that may extend to and affect resources within adjacent areas in the RAA, and is the accidental event of greatest environmental concern. Although highly unlikely, a subsea blowout may result in a change in habitat quality of special areas within the RAA. The magnitude, geographic extent and duration of potential effects of a blowout will depend on the nature of the spill, its trajectory, and spatial and temporal overlap with special areas.

As described in Section 15.2, deterministic and stochastic oil spill modelling was conducted for the Project, using two hypothetical release locations representing deep (1,500 m; West Flemish Pass [WF] 1) and shallow (500 m; WF2) wellsite locations within the Project Area. As noted in Section 15.2.6, the resultant figures associated with the deterministic modelling of a credible worst case spill scenario illustrates the probable cumulative extent of spilled oil exceeding socio-economic effect thresholds for the modelled duration, but do not imply that an entire contoured area would be covered with oil or indicate specific oil quantity for a given area or time. The stochastic model scenarios depict the probability of and minimum time for spilled oil from a subsea blowout to reach specific threshold exceedances (see Figures 15-4 to

15-15). The deterministic scenarios model cumulative footprints of surface oil thickness, in-water concentrations, and shoreline and sediment contamination (see Figures 15-16 to 15-18, 15-21 to 15-22, and 15-25 to 15-26 in Section 5.2).

Table 15.38 indicates the predicted overlap of special areas in the RAA with the 95th percentile deterministic results for conservative socio-economic thresholds for surface oil thickness (0.04 µm), subsurface total hydrocarbons (1 µg/L), and shoreline contact (1 g/m^2) along with the primary reason for designation of the special area (e.g., marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles). Results are presented for the modelled WF1 (30-day release [capping stack scenario] and 123-day release [relief well scenario]) and WF2 (27-day [capping stack] and 135-day [relief well]) wellsite unmitigated hypothetical oil spill scenarios.

Although some special areas that were designated due to sensitive, ecologically important benthic features (e.g., NAFO VME Sponge, Coral, and Seapen Closures) overlap with probable worst-case scenario subsea spill surface oil, total hydrocarbon, or shoreline exposure contours, deterministic modelling for all representative scenarios predicted that <0.1% of oil would settle onto sediments (see Table 15.10). Therefore, sediment concentration is excluded from Table 15.38.

Most of the predicted cumulative surface oil footprints were centered eastwards from the modelled WF1 and WF2 release sites, with the cumulative maximum surface oil having an appearance ranging from discontinuous, patchy brown to dark brown sheens, and average thickness of 0.001-0.1 mm, thinning with distance from the release site. Some models predicted patchy black oil (0.1-1 mm thickness) to occur near the release site and get transported up to several hundred kilometres away, primarily to the east. Modelling results for both the WF1 and WF2 well sites predicted surface oiling in exceedance of the conservative socio-economic threshold (0.04 µm) on waters that overlap with special areas.

The credible worst case deterministic modelling scenarios for hypothetical 30-day and 123-day releases at WF1 indicate that special areas primarily designated for the presence of fish and fish habitat in which surface oil could exceed the socio-economic threshold include MPAs, NMCAs, proposed critical habitat for northern and spotted wolffishes, Marine Refuges, SBAs, Canadian and UNCBD EBSAs, Canadian Fisheries Closure Areas – Snow Crab Conservation Exclusion Zones, Provincial Parks, VME Sponge Coral, and Seapen Closures, VME Seamount Closures, VME Canyons, and the NAFO Shrimp Closure Area (Table 15.38). Surface oil was also predicted to potentially exceed the socio-economic threshold for special areas for the WF2 release site, including NMCAs, proposed critical habitat for northern and spotted wolffishes, Marine Refuges, SBAs, Canadian and UNCBD EBSAs, Snow Crab Conservation Exclusion Zones, VME Sponge, Coral, and Seapen Closures, VME Seamount Closures, VME Canyons, and the NAFO Shrimp Closure Area for the hypothetical 27-day release scenario, and NMCAs, proposed critical habitat for northern and spotted wolffishes, Marine Refuges, SBAs, Canadian and UNCBD EBSAs, Snow Crab Conservation Exclusion Zones, Provincial Parks, VME Sponge, Coral, and Seapen Closures, VME Seamount Closures, VME Canyons, and the NAFO Shrimp Closure Ares for the 135-day scenario (Table 15.38).

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Marine Protected Area (MPAs)													
Eastport – Round Island	Marine fish and fish habitat	X	X								X		X
Eastport – Duck Islands		X	X								X		X
Gilbert Bay			X										
National Marine Conservation Area (NMCA)													
Northwestern Conception Bay – Representative Marine Area (RMA)	Marine fish and fish habitat Marine and migratory birds Marine mammals and sea turtles	X	X							X	X		X
South Grand Bank Area – RMA		X	X	X	X	X	X	X	X				
South Coast of Burin Peninsula - RMA													
Virgin Rocks - RMA		X	X	X	X				X				
Labrador Coast (B) – Candidate NMCA			X									X	
Unknown 17 – Region Without Studies		X	X							X	X	X	X
Proposed Critical Habitat													
Northern Wolffish	Marine fish and fish habitat Marine mammals and sea turtles	X	X	X	X	X	X						
Spotted Wolffish		X	X	X	X	X	X						
Leatherback Sea Turtle			X										

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Marine Refuge													
Northeast Newfoundland Slope Closure	Marine fish and fish habitat	X	X	X	X	X							
Gooseberry Island Lobster Closure		X	X							X	X		X
Glovers Harbour Lobster Closure			X							X	X	X	
Mouse Island Lobster Closure			X							X	X	X	
Farmer’s Island Lobster Closure			X							X	X	X	
Gander Bay Lobster Closure		X	X							X	X	X	
Funk Island Deep Closure		X	X		X								
Hawke Channel Closure			X		X								
Hopedale Saddle Closure			X										
Migratory Bird Sanctuary (MBS)													
Terra Nova	Marine and migratory birds	X	X								X		X
Shepherd Island			X									X	
Île aux Canes			X									X	
Significant Benthic Areas (SBA)													
Sea Pens	Marine fish and fish habitat	X	X	X	X	X	X						
Sponges		X	X	X	X								
Large Gorgonian Corals		X	X	X	X			X	X				
Small Gorgonian Corals		X	X	X	X			X	X				

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Ecologically or Biologically Significant Area (EBSA)													
Haddock Channel Sponges	Marine fish and fish habitat	X	X										
Gilbert Bay	Marine fish and fish habitat Marine and migratory birds		X										
Grey Islands			X									X	
Northeast Slope	Marine fish and fish habitat Marine mammals and sea turtles	X	X	X	X	X	X		X				
Lilly Canyon-Carson Canyon		X	X	X	X	X	X	X	X				
Laurentian Channel		X	X		X				X				
Eastern Avalon	Marine and migratory birds Marine mammals and sea turtles	X	X		X				X	X	X		X
Southwest Slope		X	X	X	X		X	X	X				
Placentia Bay			X										
Bonavista Bay	Marine fish and fish habitat Marine and migratory birds Marine mammals and sea turtles	X	X							X	X		X
Smith Sound		X	X								X		X
Baccalieu Island		X	X							X	X	X	X
St. Mary's Bay			X								X		X
Virgin Rocks		X	X	X	X				X				
Southeast Shoal		X	X	X	X		X	X	X				
Fogo Shelf		X	X							X	X	X	X
Hamilton Inlet			X									X	
Labrador Marginal Trough			X		X								
Labrador Slope			X		X								

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Notre Dame Channel	Marine fish and fish habitat Marine and migratory birds Marine mammals and sea turtles	X	X		X								
Orphan Spur		X	X	X	X								
Canadian Fisheries Closure Ares – Snow Crab Conservation Exclusion Zone													
Bonavista Bay (A) – Crab Fishing Area (CFA) 5A	Marine fish and fish habitat	X	X							X	X	X	X
Bonavista Bay (B) – CFA 5A		X	X							X	X	X	X
Trinity Bay (A) – CFA 6A		X	X							X	X		X
Trinity Bay (B) – CFA 6A		X	**X**							X	X		X
Conception Bay – CFA 6B		X	X							X	X	X	X
8BX– CFA 8BX		X	X	X	X		X	X	X				
St. Mary's Bay (A) – CFA 9A		X	X								X		X
Nearshore – Near Shore CFA		X	X		X				X				
National Historic Site													
Cape Spear	Cultural history	X	X		X					X	X		X
Signal Hill		X	X		X					X	X		X
Ryan Premises		X	X							X	X	X	X
Caste Hill													
Battle Harbour (National Historic District)			X										
National Park													
Terra Nova	Coastal natural history	X	X								X		X

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Provincial Ecological Reserve													
Baccalieu Island	Marine and migratory birds	X	X							X	X	X	X
Cape St. Mary's			X										X
Funk Island		X	X							X	X	X	X
Hare Bay Islands			X										
Lawn Bay													
Witless Bay		X	X		X					X	X		X
Mistaken Point		X	X		X					X	X		X
Provincial Park													
Main River Waterway	Marine fish and fish habitat Marine and migratory birds Marine mammals and sea turtles		X										
Gooseberry Cove			X										
Dungeon		X	X							X	X	X	X
Dead Man's Bay		X	X							X	X	X	X
Chance Cove		X	X		X					X	X		X
Dildo Run		X	X							X	X	X	
La Manche		X	X		X					X	X		X
Marine Drive		X	X								X	X	X
Windmill Bight		X	X							X	X		X
Jack's Pond													
Bellevue Beach		X	X								X		X

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Provincial Historic Site													
Heart's Content Cable Station	Cultural history	X	X							X	X		X
Cape Bonavista Lighthouse		X	X							X	X	X	X
Municipal Stewardship Agreement Conservation Area – Wetland Management Unit													
Indian Bay	Marine and migratory birds	X	X							X	X		X
Torbay Bight Shoreline		X	X		X					X	X		X
Indian Brook Estuary			X							X	X		
Traverse Brook		X	X								X		X
Middle Brook Estuary/Marsh Point		X	X								X		X
Gambo Bog		X	X								X		X
Gambo Brook Estuary		X	X								X		X
Come By Chance Estuary													
Carmanville Pond		X	X							X	X	X	
Middle Arm		X	X							X	X	X	
Shearstown Estuary		X	X								X		X
Coastal MU													
Old Day's Pond		X	X							X	X	X	X
Main River Gully and Western Pond		X	X								X		X
Blast Hole Ponds and Ocean Pond		X	X								X		X
Broad Cove River Gully		X	X								X		X

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Beachy Cove Brook Gully	Marine and migratory birds	X	X								X		X
Business Pond		X	X							X	X		X
Newtown (Queen's Meade)		X	X							X	X		X
Bottom Brook Estuary		X	X							X	X	X	
Northwest Pond Watershed		X	X							X	X	X	
Black's Brook and Southwest Feeder Ponds		X	X							X	X		X
Coastal Mus (Otter Gulch, Gruchy Point, Strawberry Point)		X	X		X						X	X	X
Pigeon Island		X	X								X	X	X
Vulnerable Marine Ecosystem (VME) – Sponge, Coral, and Seapen Closures													
Tail of the Bank (1)	Marine fish and fish habitat	X	X	X	X	X	X	X	X				
Flemish Pass/Eastern Canyon (2)		X	X	X	X	X	X	X	X				
Beothuk Knoll (3)		X	X	X	X	X	X	X	X				
Eastern Flemish Cap (4)		X	X	X	X	X	X	X	X				
Northeast Flemish Cap (5)		X	X	X	X	X	X	X	X				
Sackville Spur (6)		X	X	X	X	X	X	X	X				
Northern Flemish Cap (7)		X	X	X	X	X	X	X	X				
Northern Flemish Cap (8)		X	X	X	X	X	X	X	X				
Northern Flemish Cap (9)		X	X	X	X	X	X	X	X				
Northwest Flemish Cap (10)		X	X	X	X	X	X	X	X				
Northwest Flemish Cap (11)		X	X	X	X	X	X	X	X				

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Northwest Flemish Cap (12)	Marine fish and fish habitat	X	X	X	X	X	X	X	X				
Beothuk Knoll (13)		X	X	X	X	X	X	X	X				
Division 3O Coral Closure		X	X	X	X		X	X	X				
VME – Seamount Closure													
Fogo Seamounts 1	Marine fish and fish habitat	X	X	X	X		X	X	X				
Newfoundland Seamounts		X	X	X	X	X	X	X	X				
Orphan Knoll		X	X	X	X	X	X	X	X				
VME - Canyon													
Denys	Marine fish and fish habitat Marine mammals and sea turtles	X	X	X	X	X	X	X	X				
Cameron		X	X	X	X	X	X	X	X				
Jackman		X	X	X	X	X	X	X	X				
Guy		X	X	X	X	X	X	X	X				
Hoyles		X	X	X	X	X	X	X	X				
Kettle		X	X	X	X	X	X	X	X				
Clifford Smith		X	X	X	X	X	X	X	X				
Lilly		X	X	X	X	X	X	X	X				
Carson		X	X	X	X	X	X	X	X				
Unnamed 1		X	X	X	X	X	X	X	X				
Unnamed 2		X	X	X	X	X	X	X	X				
Unnamed 3		X	X	X	X	X	X	X	X				

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Unnamed 4	Marine fish and fish habitat Marine mammals and sea turtles	X	X	X	X	X	X	X	X				
Desbarres		X	X	X	X		X	X	X				
Treworgie		X	X	X	X		X	X	X				
Jukes		X	X	X	X		X	X	X				
Whitbourne		X	X	X	X		X	X	X				
Shrimp Closure Area													
Division 3M (and 3L)	Marine fish and fish habitat	X	X	X	X	X	X	X	X				
United Nations (UN) Convention on Biological Diversity (CBD) EBSA													
Orphan Knoll	Marine fish and fish habitat	X	X	X	X	X	X	X	X				
Slopes of the Flemish Cap and Grand Bank		X	X	X	X	X	X	X	X				
Seabird Foraging Zone in the Southern Labrador Sea	Marine and migratory birds	X	X	X	X	X	X	X	X				
Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank	Marine fish and fish habitat Marine and migratory birds Marine mammals and sea turtles	X	X	X	X	X	X	X	X				
UNESCO World Heritage Site													
Mistaken Point (Ecological Reserve)	Natural history	X	X		X					X	X		X
Important Bird Area (IBA)													
Cape St. Mary's (NF001)	Marine and migratory birds		X										X
Witless Bay Islands (NF002)		X	X		X					X	X		X
Baccalieu Island (NF003)		X	X							X	X		X

Table 15.38 Potential (95th Percentile) Unmitigated Subsea Well Blowout Interactions with Special Areas in the RAA (Credible Worst Case)

Special Area	Predominant Reason for Designation	Surface Oil				Water Column Total Hydrocarbon				Shoreline Oil Contact			
		Spill Release Duration (days)											
		WF1		WF2		WF1		WF2		WF1		WF2	
		30	123	27	135	30	123	27	135	30	123	27	135
Funk Island (NF004)	Marine and migratory birds	X	X							X	X	X	X
Fischot Islands (NF008)			X										
Northern Groais Island (NF009)			X									X	
Bell Island South Coast (NF010)			X									X	
Wadham Islands and adjacent Marine Area (NF013)		X	X							X	X	X	
The Cape Pine and St. Shotts Barren (NF015)			X										X
Terra Nova National Park (NF017)		X	X								X		X
Grates Point (NF019)		X	X							X	X		X
Cape St. Francis (NF021)		X	X								X	X	X
Mistaken Point (NF024)		X	X		X					X	X		X
Cape Freels Coastline and Cabot Island (NF025)		X	X							X	X		X
Placentia Bay (NF028)			X										
Corbin Island (NF030)			X										
Middle Lawn Island (NF031)													
St. Peter's Bay (LB023)			X										

Note: WF = West Flemish Pass wellsite; 'X' indicates that oil above socio-economic threshold (surface oil = 0.04 µm; total hydrocarbon (1 µg/L); shoreline contact = 1 g/m^2) intersects with the special area at some point during the modelled period. This analysis corresponds with the deterministic scenarios model for cumulative footprints of surface oil thickness, in-water concentrations, and shoreline contamination (see Figures 15-16 to 15-18, 15-21 to 15-22, and 15-25 to 15-26 in Section 5.2).

Surface oil from a subsea blowout from the 30-day and 123-day credible worst case deterministic release scenarios at WF1 was predicted to exceed the socio-economic threshold in special areas identified for the presence of marine and migratory birds, including NMCAs, Migratory Bird Sanctuaries, Canadian and UNCBD EBSAs, Provincial Ecological Reserves and Parks, Municipal Stewardship Agreement Conservation Areas, and IBAs (Table 15.38). Surface oil was predicted to exceed the socio-economic threshold at NMCAs, and Canadian and UNCBD EBSAs during the hypothetical 27-day release scenario from WF2, and at NMCAs, Canadian and UNCBD EBSAs, Provincial Ecological Reserves and Parks, Municipal Stewardship Agreement Conservation Areas, and IBAs during the hypothetical 135-day release from WF2 (Table 15.38).

Modelling hypothetical scenarios for 30-day and 123-day releases at WF1 also predicted that surface oil in exceedance of the socio-economic threshold could reach special areas designated for the presence of marine mammals and sea turtles (Table 15.38), including NMCAs, proposed critical habitat for leatherback sea turtles (hypothetical 123-day release only), Canadian and UNCBD EBSAs, Provincial Parks, and VME Canyons. Surface oil from a subsea blowout from the WF2 wellsite was predicted to exceed the socio-economic threshold at NMCAs, Canadian and UNCBD EBSAs, and VME Canyons for the hypothetical 27-day release scenario, and at NMCAs, Canadian and UNCBD EBSAs, Provincial Parks, and VME Canyons for the hypothetical 135-day scenario (Table 15.38).

The 95th percentile scenarios for total hydrocarbon concentrations in the water column predicted that areas reaching or exceeding the socio-economic threshold (1 µg/L) could primarily occur east and south of the WF1 and WF2 wellsites, with areas of relatively high concentration occurring in the Flemish Pass and Cap regions. Special areas within which total hydrocarbons could exceed the socio-economic threshold for the 30- and 123-day WF1 and 27- and 135-day WF2 release scenarios could include NMCAs, proposed critical habitat for northern and spotted wolffishes, Marine Refuges, SBAs, Canadian and UNCBD EBSAs, Snow Crab Conservation Exclusion Zones, VME Sponge, Coral, and Seapen Closures, VME Seamount Closures, VME Canyons, and the NAFO Shrimp Closure Area (Table 15.38).

Deterministic modelling predicted that ≤0.2% and ≤0.4% of released oil from the WF1 wellsite would reach the shore during the 30- and 123-day scenarios, respectively, and ≤0.1% during both the 23- and 135-day hypothetical release scenarios from the WF2 wellsite (see Table 15.38). Shoreline contact would probably occur along the eastern and southeastern shores of Newfoundland, with some modelling (i.e., hypothetical 27-day release scenario from WF2) also indicating the potential for oil to reach the shoreline from southeastern Newfoundland to southeastern Labrador. Oil predicted to make shoreline contact generally ranged from 100-500 g/m^2, and would be patchy, discontinuous, and highly weathered.

Special areas designated for the presence of sensitive or important fish and fish habitat could be affected by oil from the WF1 and WF2 release scenarios that reached the shorelines of NL at or in excess of the ecological threshold (100 g/m^2). For all WF1 and WF2 modelled scenarios, these special areas include MPAs (123-day at WF1 and 135-day at WF2), NMCAs, Lobster Closure Marine Refuges, Canadian EBSAs, Snow Crab Conservation Exclusion Zones, and Provincial Parks (Table 15.38). The modelling for all release scenarios from WF1 and WF2 indicated that oil at or in exceedance of the socio-economic threshold that reached the coast of NL could overlap special areas which have been identified for the presence of marine and migratory birds. These special areas include NMCAs, Migratory Bird Sanctuaries, Canadian EBSAs, Provincial Ecological Reserves and Parks, Municipal Stewardship Agreement Conservation Areas, and IBAs (Table 15.38). Shoreline oil at or in excess of the socio-economic threshold could also overlap with special areas designated for the presence of marine mammals or sea turtles for the WF1 and WF2 release scenarios, including NMCAs, Canadian EBSAs, and Provincial Parks (Table 15.38).

The modelled worst case release scenarios from the WF1 and WF2 wellsites indicated that coastal marine components of special areas that are important for cultural and natural history may be affected by oil at or in excess of the socio-economic threshold, with potential effects dependent on the sensitivity and type of marine fish and fish habitat, marine and migratory birds, or marine mammals and sea turtles present (see Sections 6.4 and 15.5.1-15.5.3). These special areas include National Historic Sites, a National Park (hypothetical 123-day release at WF1 and hypothetical 135-day release at WF2), Provincial Historic Sites, and the Mistaken Point United Nations Educational Scientific and Cultural Organization (UNESCO) World Heritage Site (Table 15.38).

15.5.4.1.2 Potential Effects of a Marine Diesel Spill on Special Areas

An instantaneous, 1,000-L release marine diesel batch spill was modelled at WF1, that predicted a patchy distribution of colourless or silver sheens of surface oil (0.1 µm), with a total area exposed to oil >0.04 µm (the socio-economic threshold) of 8 km^2 over the 30-day modelling period (see Figures 15-29 to 15-31). These sheens are predicted to be transported east of the wellsite, along the northern and eastern slopes of the Flemish Cap, and it is expected that most diesel from such a spill would evaporate and quickly disperse. Predicted concentrations of dissolved or total hydrocarbons in the water column did not register at the socio-economic threshold (1 µg/L) and no oil was predicted to reach the shoreline or settle on benthic substrate (see Tables 15-9 and 15-10). There is potential for interaction with oil from a marine diesel batch spill with special areas near the Flemish Cap, including a UNCBD EBSA (Slopes of the Flemish Cap and Bank), NAFO VME Sponge, Coral, and Seapen Closures, and the NAFO Shrimp Closure Area, all of which are important for marine fish and fish habitat (Table 15.38). The effects of exposure of fish and fish habitat to a marine diesel spill are described in Section 15.5.1.3.2.

15.5.4.1.3 Potential Effects of a SBM Spill from the MODU and Marine Riser on Special Areas

The potential effects of a SBM spill from the MODU and Marine Riser are described for marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles in Sections 15.5.1.1.2, 15.5.2.1.3, and 15.5.3.1.2, respectively. A SBM spill could result in smothering of benthos, sedimentation, or bioaccumulation/contamination that could affect the risk of mortality or injury for marine fish or alter marine fish habitat quality; and/or a surface sheen that could change the risk for mortality or injury for marine and migratory birds and possibly marine mammals and sea turtles. Modelling results for Nexen Energy's Flemish Pass Exploration Drilling Project (Amec 2017) suggest that most SBM spills at the surface would reach the seabed within 1 km and the deposit footprint could have an area up to 9,000 m^2 from a deep wellsite, with initial deposits having mean and maximum thicknesses of 1.7 cm and 7.1 cm, respectively. Modelling also suggests that most deposition would occur within approximately 430 m and up to 9,900 m^2 from a shallow wellsite, with mean and maximum deposit thicknesses of 2.7 cm and 7.1 cm, respectively (AMEC 2017). If a surface sheen formed as a result of a SBM spill, it would be limited in size and duration, possibly affecting marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles in the immediate area. Portions of the Northeast Slope Canadian EBSA, Northeast Newfoundland Slope Closure Marine Refuge, proposed critical habitat for northern and spotted wolffishes, and Slopes of the Flemish Cap and Grand Bank UNCBD EBSA nearest to or overlapping the Project Area may be exposed to released drilling muds from a SBM spill.

15.5.4.2 Mitigation of Project-Related Environmental Effects

Chevron will implement several preventative/response procedures to manage incident risk and mitigate potential outcomes of accidental events as they relate to special areas. Refer to Section 2.5 for specific information on well control and blowout prevention, and Section 15.4 for a description of Chevron's contingency planning and emergency response measures.

The Project will include specific contingency plans for emergency event response (see Section 15.3.1), which will be submitted to the C-NLOPB prior to the commencement of drilling activity. Tactical mitigation measures for Project-related environmental effects will be specified by the OSRP and are provided for marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles in Sections 15.5.1.2, 15.5.2.2, 15.5.3.2, respectively. These same measures are applicable to the special areas VC and include:

- Offshore containment and recovery
- Surveillance and tracking
- Dispersant application (surface and subsea injection)
- In-situ burning
- Shoreline protection
- Shoreline clean-up
- Oiled wildlife response

As part of the Operations Authorization process with the C-NLOPB, Chevron will develop a SIMA/NEBA. In the event of a spill, Chevron will develop specific monitoring (e.g., environmental effects monitoring) and follow-up programs as applicable in consultation with relevant regulatory agencies.

15.5.4.3 Characterization of Residual Project-Related Environmental Effects

The residual effects of accidental events stemming from the release of oil from a subsea blowout, a marine diesel spill, and a SBM spill are assessed for marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles in Sections 15.5.1-15.5.3, which, due to the nature of designation reasons for special areas, are generally directly linked to the special areas residual effects assessment. The residual effects for these events for special areas are assessed in the following sections.

15.5.4.3.1 Subsea Blowout

An assessment of effects on fish and fish habitat from a subsea blowout was completed in Section 15.5.1, which concluded that residual effects on fish and fish habitat would not be significant. Surface oiling would affect marine and migratory birds with possible significant effects from a blowout incident, large batch spill, or vessel spill. (see Section 15.5.2). A subsea blowout could affect the biological and ecological integrity of the Seabird Foraging Zone in the Southern Labrador Sea CBD EBSA if surface oil affects a large portion of this Special Area. In the unlikely event of oil from a blowout travelling northwards (most modelled spill scenarios predict the oil to travel eastwards), there is potential for high numbers of wintering marine birds, a large proportion of which are especially susceptible to oiling (dovekies and murres), experiencing mortality. The implementation of mitigation measures would reduce the overall interaction with and extent/magnitude of effects from surface oiling for marine and migratory birds including those in the Seabird Foraging Zone in the Southern Labrador Sea CBD EBSA. Effects on marine mammals and sea turtles from a subsea blowout were assessed in Section 15.5.3. It was predicted that that residual adverse environmental effects from the accidental event scenarios on marine mammals and sea turtles would not be significant.

The effects of exposure of fish and fish habitat to oil reaching the coast of NL are described in Section 15.5.1. The effects of the albeit minimal risk of interaction between shoreline oil from a subsea blowout and marine fish and fish habitat along the coast of NL would be reduced with the implementation of mitigation measures. As described in Section 15.5.2, the unlikely event of oil on the coastline and overlapping sensitive areas could alter the risk of mortality, physical injury, or habitat quality and use for marine or migratory birds. The scope and extent of the already low probability of interaction between shoreline oil and marine and migratory birds would be further reduced with the implementation of mitigation measures. The effects of shoreline oil on marine mammals and sea turtles were assessed in Section 15.5.3 and predicted to be adverse, but unlikely to occur and reversible. The modelled likelihood of oil reaching the shoreline is low and it would have a patchy distribution, and the unlikely but potential effects on special areas important for cultural or natural history would be further reduced with the use of mitigation measures.

In summary, with the implementation of mitigation measures, spill prevention plans, and response procedures, potential effects of a subsurface blowout on special areas are predicted to be:

- Adverse
- Moderate to potentially high in magnitude
- Short- to long-term in duration
- Within the RAA
- Occur as a single event
- Reversible

15.5.4.3.2 Marine Diesel Spill

Special areas that may interact with a marine diesel spill were designated due to the presence of important or sensitive marine fish and fish habitat. The effects of interaction between oil from a marine diesel spill and marine fish and fish habitat are described in Section 15.5.1 and would be reduced within affected special areas upon implementation of mitigation measures.

With the implementation of mitigation measures and appropriate prevention and response procedures, the potential effects of a marine diesel spill on special areas are predicted to be:

- Adverse
- Low to moderate in magnitude
- Short- to medium-term in duration

- Within the LAA to RAA
- Occur as a single event
- Reversible

15.5.4.3.3 SBM Spill from the MODU and Marine Riser

The special areas that may overlap with a SBM spill were designated due to the presence of important or sensitive marine fish and fish habitat. The effects of a SBM spill on marine fish and fish habitat was assessed in Section 15.5.1, and it was predicted that residual effects would be not significant.

With the use of appropriate mitigation measures, spill prevention plans and response procedures, potential effects of a SBM spill on special areas are predicted to be:

- Adverse
- Low in magnitude
- Short-term to long-term in duration
- Within the LAA
- Occur as a single event
- Reversible

15.5.4.3.4 Summary

Table 15.39 provides a summary of predicted residual environmental effects of accidental events on special areas.

Table 15.39 Summary of Residual Project-Related Environmental Effects on Special Areas – Accidental Events

Residual Effect	**Residual Environmental Effects Characterization**						
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological and Socio-economic Context**
Change in Habitat Quality and Use							
Well Blowout Incident	A	M-H	RAA*	ST-LT	S	R	D
Marine Diesel Spill	A	L-M	LAA-RAA	ST-MT	S	R	D
SBM Spill	A	L	LAA	ST-LT	S	R	D

KEY:
N/A: Not Applicable

Direction:
P: Positive
A: Adverse

Magnitude:
N: Negligible
L: Low
M: Moderate
H: High

Geographic Extent:
PA: Project Area
LAA: Local Assessment Area
RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*"

Duration:
ST: Short-term
MT: Medium-term
LT: Long-term

Frequency:
S: Single event
IR: Irregular event
R: Regular event
C: Continuous

Reversibility:
R: Reversible
I: Irreversible

Ecological / Socio-Economic Context:
D: Disturbed
U: Undisturbed

15.5.4.4 Determination of Significance

Overall, it is predicted that the residual adverse environmental effects associated with most accidental event scenarios on special areas will not be significant. However, should surface oil affect a large portion of the Seabird Foraging Zone in the Southern Labrador Sea CBD EBSA it could significantly affect the biological and ecological integrity of this special area. This overall determination of significance of accidental events on special areas is made in consideration of the precautionary approach of the spill modelling (results show a worst case, unmitigated release), the use of mitigation measures to prevent and reduce effects from a spill, and the nature of the adverse effects as described in the literature summarized in Sections 15.5.1-15.5.3. The conclusion is made with a medium level of confidence for the hypothetical subsea well blowout scenarios, due to the large geographic extent of the affected area, uncertainties associated with actual oil volume spilled, duration, location, time of year, response and recovery capability of relevant species or habitats within special areas, and data gaps in the literature. This conclusion is made with a high level of confidence for the marine diesel and SBM spill scenarios, given the low magnitude and geographic extent of probable effects.

15.5.5 Indigenous Communities and Activities

Several Indigenous groups reside in Newfoundland and Labrador, the Maritime Provinces, and Quebec, which, under certain circumstances, could potentially be affected by the Project as a result of an accidental spill. Many of these groups have asserted and/or established Aboriginal and/or Treaty rights including the right to hunt, fish or gather resources which could potentially be affected in the event of an accidental spill. Several Indigenous groups hold commercial communal and/or FSC licences to harvest species in the RAA or to harvest species which may migrate through the RAA.

15.5.5.1 Project Pathways for Effects

Accidental spills can potentially affect fisheries resources (e.g., direct and indirect effects on fished species) and/or fishing activity (e.g., displacement from fishing areas, gear loss or damage) in such a way that it may affect commercial communal or FSC fishing and/or use of lands and resource for traditional purposes, either of which could potentially affect the physical or social health and well being of affected Indigenous communities. The extent of potential effects will depend on how the spill trajectory and Indigenous activities and species of interest intersect in space and time. This assessment conservatively assumes that geographic and temporal overlap do occur, and modelling results assume no implementation of spill countermeasures.

15.5.5.1.1 Potential Effects of an Oil Spill on Indigenous Communities and Activities

Although commercial communal and FSC fisheries have not been confirmed to occur in the vicinity of the Project Area, an oil spill could potentially extend to other parts of the RAA or even beyond RAA boundaries to reach harvesting areas, or affect species of interest that could be migrating through or using the spill-affected area. In the event of a spill, an effect on fished species or implementation of fishery closure could affect health and/or socio-economic conditions of Indigenous communities through reduced fisheries revenue, change in cultural practices and heritage, and/or direct (e.g., direct contact) or indirect exposure (e.g., ingestion of contaminated food) to contaminants. Current use of lands and resources for traditional purposes could also be adversely affected as a result of a change in quantity, quality or availability of traditional lands and resources.

The uptake of oil by exposed fish may pose a potential threat to human consumers and affect the marketability of catches. Physical contamination of fishing gear can also occur and in some cases, result in transfer of oil to the catch (International Tanker Owners Pollution Federation Limited [ITOPF] 2011a). Fishery closures are intended to reduce risk of contamination of gear and protect consumers from consumption of potentially contaminated resources. However, the restriction of access to commercial communal or FSC fisheries can also result in adverse socio-economic effects on Indigenous communities.

Refer to Sections 15.5.1, 15.5.2, and 15.5.3 for an assessment of biophysical effects from an accidental spill on marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles, respectively. Biophysical effects on marine fish, marine and migratory birds, and marine mammals that are harvested for commercial and/or traditional purposes can potentially affect the physical health of persons harvesting or consuming contaminated resources. Biophysical effects on harvested species are not repeated here, with the exception of key migratory species that have been identified as having commercial and/or cultural value to Indigenous communities.

As discussed in Section 7.4.8 and Chapter 13, there are two communal commercial species (swordfish and bluefin tuna) and two species harvested for FSC purposes (Atlantic salmon and American eel) that have been identified by Indigenous groups as being particularly important to Indigenous communities from a socio-economic and/or cultural perspective. Potential effects of a hydrocarbon spill are discussed for each of these species below.

Swordfish

Adults of migratory fishes such as swordfish can probably avoid crude oil spills, but larvae are likely more vulnerable (De Sylva et al. 2000). Spawning and nursery habitats are distant from the RAA (e.g., Gulf of Mexico, eastern continental shelf of the United States) (Arocha 2007), so larvae and juveniles would not come into contact with hydrocarbons from the Project in the unlikely event of an accidental spill. The species' seasonal distribution in Canadian waters, combined with their non-schooling behaviour, further reduces any potential population effects from a potential Project-related spill (Arocha 2017). Given these factors, it is unlikely that swordfish would be present within a spill affected area in large concentrations during an accidental event and the highly mobile nature of the species would likely allow individuals to avoid affected areas. It is highly unlikely therefore that swordfish would experience adverse effects from an accidental spill to the extent that it would affect the viability of the population and/or the viability of the fishery.

Bluefin Tuna

Bluefin tuna are a highly migratory species. Adult bluefin are capable of moving at a scale of approximately 100 km per week, thus it is likely they could move to avoid direct exposure to oil for prolonged periods (Hazen et al. 2016). The occurrence and abundance of bluefin tuna in any one location varies from one year to the next and there are no known spawning or rearing habitats for larval and juvenile stages in Canadian waters (COSEWIC 2011). Given their overall ranges and migration patterns, it is unlikely that bluefin tuna would be present within a spill affected area in large concentrations during an accidental event and the highly mobile nature of the species would likely allow individuals to avoid affected areas. It is highly unlikely therefore that bluefin tuna would experience adverse effects from an accidental spill to the extent that it would affect the viability of the population and/or the viability of the tuna fishery.

Atlantic Salmon

Atlantic salmon breed and spend the early-part of their life cycle in freshwater systems; adult salmon may have a transient presence in the RAA during migration. Given that salmon egg and larval stages are restricted to freshwater, the potential effects to salmon are limited to potential changes in food availability and direct effects on highly mobile marine life history stages.

There are few studies that have been conducted on the avoidance behaviour of returning adult salmon to hydrocarbons in water under natural conditions. Weber et al. (1981) conducted a behavioural study on adult Pacific salmon (*Oncorhynchus* sp.) where hydrocarbons were added to one of two fishways as salmon were migrating upriver (hydrocarbon concentrations ranging from 300 to 6,100 ug/L). They found that migrating salmon substantially avoided (i.e., when 50 percent of fish that were expected to ascend a fishway avoided it) hydrocarbons in the water at concentrations of 3,200 µg/L. Given the potential transitory presence of Atlantic salmon through the RAA, and potential ability to avoid contaminated waters, it is unlikely that Atlantic salmon would experience population level effects from an accidental spill.

American Eel

American eel could be present in the RAA as a migratory / transient species, particularly between March and November. American eel have been shown to be less sensitive than other fish to oil. When exposed to oil, American eel, like other fish, have been shown to induce oil degrading enzymes with a 5 mg/kg dose. It is speculated that this lower sensitivity is because eels spend a portion of their life in estuaries with an increased chance of exposure to contaminants (Schlezinger and Stegeman 2000). The potential for occurrence of American eel in a spill affected area within the RAA is low; however, if they are exposed to hydrocarbons as a result of an accidental spill from the Project, it is highly unlikely that American eel would experience effects that could result in a decrease of availability of resources for Indigenous fisheries.

15.5.5.1.2 Potential Effects of an SBM Spill on Indigenous Communities and Activities

SBM is a dense low toxicity fluid which, if released accidentally as a bulk spill, would sink rapidly through the water column (Neff et al. 2000; CNSOPB 2005, 2018). Although a surface sheen could potentially occur from the spill, the majority of the SBM would sink to the seafloor, impacting marine benthos within a localized area around the wellsite. Potential interactions with marine resources harvested for commercial communal or FSC purposes, including but not limited to those species identified above, would therefore not be expected to occur.

15.5.5.2 Mitigation of Project-Related Environmental Effects

Chevron will implement multiple preventative and response measures to reduce risk of incidents occurring and mitigate potential consequences (refer to Section 15.4). Chevron will undertake a Spill Impact Mitigation Assessment (SIMA) / Net Environmental Benefit Analysis (NEBA) as part of the Operations Authorization process with the C-NLOPB. The SIMA is a structured process that will qualitatively evaluate the risks and trade-offs of all feasible and effective response options, when compared to no action. The SIMA process will inform the selection of an overall spill response strategy for the Project. If identified as a preferred response option, use of chemical dispersants would not occur without first obtaining regulatory approval.

Mitigation to reduce effects from an accidental spill on Indigenous communities and activities include the following:

- Implementation of an Indigenous Fisheries Communication Plan, which would include procedures for informing Indigenous communities of an accidental event and planned response. Emphasis will be on timely communication, allowing fishers to haul out gear from affected areas, reducing potential of fouling of fishing gear.
- Compensation for damage to gear in accordance with the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017).

In the unlikely event of a spill, specific monitoring and follow-up programs may be required and will be developed in consultation with regulatory agencies, Indigenous communities, and fisheries stakeholders as applicable.

15.5.5.3 Characterization of Residual Project-Related Environmental Effects

15.5.5.3.1 Subsea Blowout

In the event of a subsea blowout, there is potential for adverse changes in socio-economic conditions for Indigenous communities as well as a potential adverse change in current land and resource use for traditional purposes. Surface oiling could have a short-term effect on commercial communal fisheries due to the exclusion of fishing in areas where oil exceeds a thickness of 0.04 μm (a visible sheen). Affected areas would be closed to fishing to prevent human contact with spilled oil and consumption of potentially contaminated food sources. Effects may also occur due to reduced consumer confidence and marketability of seafood following a spill (ITOPF 2011a).

Tainting of seafood (when a fish absorbs oil-derived substances into its tissues, causing petroleum tastes and odours) can occur at exposures to low hydrocarbon concentrations (ITOPF 2011a). And although tainting is reversible through depuration, concerns and altered consumption patterns may linger after seafood has been determined safe for consumption, leading to potential continued economic losses (Yender et al. 2002; ITOPF 2011a) that can have adverse health and socio-economic effects for affected Indigenous communities.

It is also important to recognize that consumers of seafood for subsistence use (e.g., members in Indigenous communities) may have higher seafood consumption rates than the general population and rely more heavily on local seafood resources for sources of protein (Yender et al. 2002). Therefore, potential effects on health and socio-economic conditions from an oil spill may be higher in magnitude than for the general population of seafood consumers.

The Project is not located within an area of high harvesting activity by Indigenous fishers, and oil spill trajectory modelling has shown that in the unlikely event of a blowout incident, prevailing winds and currents are most likely to force released oil to the east, away from Canadian shorelines. Stochastic modelling predicted that less than 25% of modelled unmitigated (e.g., no spill response) blowout release scenarios have the potential to exceed surface or water column thresholds greater than 100 km to the west of the Project Area. Depending on the season, stochastic modelling predicted the average probability of shoreline oiling ranging from 1.9% (summer) to 8.7% (winter). Depending on the time of year and environmental conditions, areas susceptible to shoreline oiling included the entire east coast and much of the west coast of Newfoundland, the Avalon Peninsula, the southern shores of Labrador reaching into the Gulf of St. Lawrence, and Sable Island. Oil that reached shore was expected to be patchy, discontinuous, and weathered, as it would have taken a minimum of 10 days (and frequently much longer) to reach shore.

Oil intersection with areas traditionally fished for commercial communal and/or FSC fisheries is therefore unlikely; however, there is a possible interaction with species of interest to Indigenous communities as a species may potentially move through a spill affected area prior to being harvested in a non-affected area. This may include fish species as well as marine mammals (e.g., seals) and marine and migratory bird species (e.g., murres). The magnitude of effects on marine species depends on the timing of a spill and extent to which the spill trajectory may intersect with areas inhabited by marine species. Dispersed oil is unlikely to reach nearshore and coastal areas where birds may congregate (e.g. near breeding colonies) but fish, bird, and marine mammal species may migrate through affected areas offshore. Effects on marine fish are evaluated in Section 15.5.1, effects on marine and migratory birds are evaluated in Section 15.5.2, and effects on marine mammals are evaluated in Section 15.5.3.

Adverse effects on species targeted for commercial communal and/or FSC fishing or harvesting are expected to be moderate in magnitude given the highly migratory nature of species of interest and low likelihood of nearshore interaction. However, any measurable effect on commercial communal or FSC fishing / harvesting could have socio-economic implications for Indigenous communities as a result of economic loss and/or reduction of food security, thereby potentially affecting quality of life within communities. Therefore, residual effects associated with a subsea blowout on change in socio-economic conditions and change in current land and resource use for traditional purposes are predicted to be moderate to high in magnitude. Residual effects are also anticipated to be medium to long term in duration given the potential for prolonged marketability effects associated with tainting.

In the event of a subsea blowout, dispersants may be used to lessen risk of adverse environmental effects due to the reduction in floating oil on the sea surface. Indirect effects from the use of dispersants can also affect Indigenous communities and activities. As discussed in Section 15.5.1, dispersants may bioaccumulate in fish species, this may affect their quality, thereby having an effect on commercial communal and FSC fisheries. Following the DWH spill, the US Food and Drug Administration conducted laboratory tests on the effects of a commonly used dispersant on eastern oyster, blue crab, and found that the dispersant was depurated from the organisms' tissues with 24 to 72 hours (Tjeerdema et al. 2013). Although studies indicate that dispersants have relatively low toxicity to fish species, the use of dispersants may increase public concern over seafood safety and tainting, thereby potentially prolonging effects on commercial communal fisheries (HDR Inc. 2015). Through the SIMA, biophysical and socio-economic risks of dispersant use will be evaluated, including the analyzing the trade-off between the toxic effects of the dispersed oil in the water column compared to the advantages of removing floating oil from the surface and preventing shoreline impacts.

In summary, with the implementation of mitigation measures, spill prevention plans, and response procedures, potential effects of a subsurface blowout on Indigenous communities and activities are predicted to be:

- Adverse
- Moderate to high in magnitude
- Within the RAA
- Medium to long-term in duration
- Occur as a single event
- Reversible

15.5.5.3.2 Marine Diesel Spill

A marine diesel spill is not likely to result in effects to fish, birds, or mammals over a large area. A diesel spill is expected to evaporate quickly, particularly if a spill occurs in the summer season. A surface batch spill of 1,000 L of diesel at the MODU is predicted to result in a total area of 8 km² exposed to oil >0.04 µm (assumed threshold for fisheries closure) over 30 days. Associated socio-economic effects due to a marine diesel spill is therefore likely to be negligible to low in magnitude, as effects to the resource and/or activity is predicted to be short-to medium-term and localized. No spilled diesel would make contact with any shoreline or result in oil settling on sediments.

Although unlikely to occur, if a marine diesel spill were to occur from a supply vessel in the nearshore, during transit to or from the MODU, depending on the spill location, there is potential for nearshore or shoreline interaction. The majority of spilled diesel would evaporate and disperse fairly quickly though so the time (short-to medium-term) and spatial extent of diesel oil exposure time would be limited, with marine and migratory birds most at risk (refer to Section 15.5.2).

In summary, with the implementation of mitigation measures, potential effects of a marine diesel spill on Indigenous communities and activities are predicted to be:

- Adverse
- Negligible to low in magnitude
- Occur within the RAA
- Short-to-medium term in duration
- Occur as a single event
- Reversible

15.5.5.3.3 SBM Spill from the MODU and the Marine Riser

In the event of an SBM spill from the MODU and marine riser, the SBM would rapidly sink to the seafloor within approximately 1 km from the MODU, resulting in a temporary degradation of benthic habitat and potential smothering of benthic fauna. Effects on commercial communal fisheries are expected to be negligible to low in magnitude given the localized extent of benthic interaction and short-term in duration. Although unlikely to occur, there is potential for an SBM spill to result in a surface sheen, which could potentially result in mortality or physical injury of marine birds in the immediate area of the spill. However, as noted in Section 15.5.2, this is not predicted to result in population effects such that Indigenous harvesting of marine birds would be affected. No adverse effects are predicted on seals as a result of an SBM spill.

In summary, with the implementation of mitigation measures, potential effects of a SBM spill on Indigenous communities and activities are predicted to be:

- Adverse
- Negligible to low in magnitude
- Occur within the RAA
- Short term in duration
- Occur as a single event
- Reversible

15.5.5.3.4 Summary

Table 15.40 summarizes predicted residual environmental effects on Indigenous communities and activities from various accidental event scenarios.

Table 15.40 Summary of Residual Project-Related Environmental Effects on Indigenous Communities and Activities– Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	**Magnitude**	**Geographic Extent**	**Duration**	**Frequency**	**Reversibility**	**Ecological and Socio-economic Context**
Change in Health and Socio-economic Conditions							
Subsea Well Blowout	A	M-H	RAA	MT-LT	S	R	D
Marine Diesel Spill	A	N-L	RAA	ST-MT	S	R	D
SBM Spill from MODU and Marine Riser	A	N-L	RAA	ST	S	R	D
Change in Current Use of Lands and Resources for Traditional Use							
Subsea Well Blowout	A	M-H	RAA	MT-LT	S	R	D
Marine Diesel Spill	A	N-M	RAA	ST-MT	S	R	D
SBM Spill from MODU and Marine Riser	A	N	RAA	ST	S	R	D

KEY: See Table 12.2 for detailed definitions N/A: Not Applicable Direction: P: Positive A: Adverse Magnitude: N: Negligible L: Low M: Moderate H: High	Geographic Extent: PA: Project Area LAA: Local Assessment Area RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*" Duration: ST: Short-term MT: Medium-term LT: Long-term	Frequency: S: Single event IR: Irregular event R: Regular event C: Continuous Reversibility: R: Reversible I: Irreversible Ecological / Socio-Economic Context: D: Disturbed U: Undisturbed

15.5.5.4 Determination of Significance

The significance of a spill-related event depends on the magnitude, timing and location of a spill.

A subsea blowout could affect Indigenous communities and activities on a larger spatial and temporal scale compared with other accidental scenarios, with potential effects on health and socio-economic conditions and/or current use of lands and resources for traditional purposes lasting longer than the physical effects of the spill itself. Prolonged effects could occur due to reduced marketability of fish and concerns regarding consumption of potentially tainted resources.

Although human health risk will be mitigated through fisheries closure and ongoing monitoring (e.g., toxicity testing) as applicable, socio-economic and health conditions could be adversely affected such that there is a detectable and sustained decrease in the quality of life of a community should Indigenous communities lose access to traditional use areas, sustain economic losses as a result of fisheries closures, and/or experience a reduced supply of resources for resulting in food insecurity for community members. A subsea blowout could therefore potentially result in a significant adverse effect for Indigenous communities and activities. However, the likelihood of a significant adverse environmental effect occurring is low given the low probability of a blowout to occur (refer to Section 15.3.2.2) and the response measures that will be implemented to mitigate potential effects.

A diesel spill offshore is unlikely to measurably affect Indigenous fishing or harvesting activities and therefore would not have a significant effect on health and socio-economic conditions or current use of lands and resources for traditional purposes. This prediction is made with a medium level of confidence given the limited spatial and temporal exposure of spilled diesel (based on oil fate and behaviour modelling) to Indigenous fisheries resources, but recognizing potential concerns by Indigenous communities and perception of adverse effects on quality of life and concerns about tainting of resources.

In recognition of the variances of magnitude depending on the time of year, volume, and location of a supply vessel, a diesel spill from a supply vessel in the nearshore is conservatively predicted to have a significant adverse environmental effect on Indigenous communities and activities as it could potentially adversely affect health and socio-economic conditions and/or current use of lands and resources for traditional purposes due to closures or potential contamination of resources. However, the likelihood of a significant adverse environmental effect occurring is low given the low probability of a moderate / large diesel spill (refer to Section 15.3.2.1) and the response measures that will be implemented to mitigate potential effects. Furthermore, most of the diesel spills would be expected to be relatively small.

Given the low toxicity of SBM and the limited spatial footprint and temporary period of predicted effects on the marine benthos, an SBM spill is predicted to be not significant on Indigenous communities and activities. This prediction is made with a high level of confidence.

15.5.6 Commercial Fisheries and Other Ocean Users

The Project Area is located within NAFO Division 3L, specifically Unit Areas 3Le and 3Lf, and straddles the Canadian EEZ and NAFO Regulatory Area and the NAFO Fishing Footprint. The RAA overlaps with all of Divisions 3KL and portions of 2HJ, 3MNO and Subdivisions 3Ps and 4Vs. Fishing effort by domestic fleets in the RAA is dependent on species, as follows:

- Groundfish (Figure 7-10, Section 7.2.2.2; Figures 7-49 to 7-53, Section 7.2.5.2): Groundfish species, including Atlantic halibut, Atlantic cod, Greenland halibut, redfish and American plaice are mainly fished along the Northeast Newfoundland shelf and slope and the Labrador shelf and slope.
- Pelagic (Figure 7-11, Section 7.2.2.2): Small pelagic species, such as capelin, are commercially fished in near-shore areas surrounding the Avalon Peninsula, with larger pelagic species, such as swordfish and tuna harvested mainly in NAFO Division 3O along the northwest slope of the Grand Banks.
- Shellfish (Figure 7-12, Section 7.2.2.2; Figures 7-40 and 7-43, Section 7.2.5.1): northern shrimp are harvested most intensely along the Fogo shelf within NAFO Division 3K. NAFO Division 3L is currently closed to all commercial fishing activity for shrimp. Snow crab are harvested throughout the RAA, with effort focused on the Grand Banks Divisions 3L, and some fishing occurring along the Tail of the Grand Banks in NAFO Division 3N and on the Fogo Shelf in NAFO Divisions 3K.
- Molluscs (Figure 7-13, Section 7.2.2.2): Mollusc species are mainly harvested in near-shore areas of NAFO Division 3Ps, with Fortune Bay and Placentia Bay. Commercial fishing activity for Arctic surf clams has recently started to occur on the Tail of the Grand Banks within NAFO Divisions 3N.

The Project Area is situated on the northeast Newfoundland shelf and slope, and overlaps with fishing grounds for Greenland halibut and snow crab, as indicated in Table 7.11 (Section 7.2.2.3). Greenland halibut are harvested year-round, with peak catches occurring from August to December, while snow crab is harvested from May-August (Figure 7-33, Section 7.2.2.3). The most common types of fishing gear that are used within the RAA by domestic fleets reflect the species being harvested (Table 7.10) , and include crab pots (fixed gear, see Figure 7-29), and shrimp trawls, gillnets and longline (mobile gear, see Figure 7-30).

Species harvested by international commercial fisheries outside the Canadian EEZ, within the NAFO Fishing Footprint, would include groundfish species managed by NAFO within Division 3L, and include redfish, Atlantic cod, American plaice, witch flounder, yellowtail flounder, Greenland halibut, and thorny skate. The region of Project Area along the Newfoundland slope, leading into the Sackville Spur, is expected have commercial fishing activity by NAFO fleets (excluding those from Canada), as it overlaps with the NAFO Fishing Footprint.

Atlantic cod, smelt, Atlantic salmon, and trout are all fished recreationally in near-shore and mid-shore areas off the coast of NL. Aquaculture operations on the east coast of Newfoundland, within the RAA, and in the Atlantic Ocean include blue mussels, Atlantic cod, trout, and oysters (see Figure 7-31).

In addition to commercial and recreational fishing activity and aquaculture, other human-related activities that take place within offshore Newfoundland and Labrador (including in areas that overlap with the Project Area and RAA) include marine research, marine transportation, other offshore oil and gas activity, military operations, and subsea infrastructure, as described in Section 7.3.

15.5.6.1 Project Pathways for Effects

An accidental event can interact directly and indirectly with commercial fisheries and other ocean users by causing a change in availability of resources. Direct interactions can include displacement from fishing grounds and damage to gear, vessels or instruments, while indirect interactions include those that may result in physical effects on commercially fished species, such as changes in fish health or quality and fish avoiding popular fishing grounds due to changes in water quality.

Indirect effects on commercially fished species and species targeted during research activities due to change in abundance, distribution and quality are discussed in the assessment of accidental events on Marine Fish and Fish Habitat (Section 15.5.1) and are not repeated in the following discussion.

15.5.6.1.1 Potential Effects of an Oil Spill on Commercial Fisheries and Other Ocean Users

An accidental subsea oil spill or marine diesel spill can result in a change in the availability of resources for commercial fisheries depending on the extent, duration, and timing of such an event, and overlap with popular fishing grounds or locations that commercial fishing, marine research or military activities could take place.

Under some accidental spill scenarios, oil could reach coastal locations. In these cases, there is the potential for interaction of oil with nearshore fisheries and aquaculture operations. Direct effects would be similar to offshore, and result in displacement of fleets until the area has been cleared; however, the time taken for the oil to reach the shore would provide plenty of time to adjust operations and reduce the impact of a spill on aquaculture and other ocean activities taking place near shore.

The uptake of oil and hydrocarbons present in the water column by exposed fish poses a potential threat to human consumers and affects the marketability of catches. Market perceptions of poor product quality (e.g., tainting) can persist even when results demonstrate safe exposure levels for consumption, thereby prolonging the economic effects for fishers. According to ITOPF (2011b), the presence of taint, which is recognized as when a food product has an unusual odour or flavour (e.g., petroleum taste or smell), can be influenced by the type of oil, species affected, extent and duration of exposure, hydrographical conditions, and water temperature. The hydrocarbon concentrations at which tainting can occur are very low (no reliable chemical threshold has been established) with the presence of taint determined by sensory testing. If seafood is taint-free, it is considered safe to eat since contaminant levels detected during sensory testing are so low (ITOPF 2011b).

Reduced demand for seafood that is perceived to be tainted can also lead to depressed market prices. As demonstrated in the Gulf of Mexico following the DWH oil spill, lack of consumer confidence in seafood quality and in the validity of government testing methods can have effects that persist beyond the period of actual effects. Even after federal and state testing showed Gulf seafood to be safe to eat, sales remained depressed due to lack of consumer confidence (National Commission on the BP DWH Oil Spill and Offshore Drilling 2011).

Physical contamination of boats, fishing gear, and aquaculture facilities can also occur, with flotation equipment (e.g., buoys, nets, fixed traps) and shoreline cultivation facilities at higher risk. In some cases, fouling of gear can result in oil being transferred to the catch or product (ITOPF 2011b).

Fishery closures may be imposed after a spill to prevent gear from being contaminated and to protect or reassure seafood consumers while the spill is being remediated. Fishery closures are usually implemented in area where: a visible sheen exists on the ocean surface, which occurs at a surface oil thickness of 0.04 µm or more; in areas (including a buffer) with detectable levels of subsurface oil; and, as a precautionary measure, in areas where surface oil is predicted to occur based on trajectory modelling (National Commission on the BP DWH Oil Spill and Offshore Drilling 2011).

The implementation of a fishery closure would prevent localized or area-specific harvesting of fish, and possibly alleviate concerns about marketing of tainted product, but it also represents a material concern for fishers. Closures typically remain in place until (National Commission on the BP DWH Oil Spill and Offshore Drilling 2011):

- An area is free of oil and oil sheen on the surface
- There is low risk of future exposure based on predicted trajectory modelling
- Seafood has passed sensory sampling (smell and taste) for oil exposure (taint) and chemical analysis for oil concentration (toxicity)

With respect to other ocean users, the quality of marine research could be affected through closure of survey areas, fouling research gear, or contaminating research results due to the presence of hydrocarbons on surface water or in the water column. Offshore training exercises such as military training activities could also be affected if areas are closed due to a spill and operation need to be moved or delayed.

15.5.6.1.2 Potential Effects of an SBM Spill on Commercial Fisheries and Other Ocean Users

SBM is a dense low toxicity fluid which, if released accidentally as a bulk spill, would sink rapidly through the water column (Neff et al. 2000; CNSOPB 2005, 2018). Although a surface sheen could potentially occur from the spill, the majority of the SBM would sink to the seafloor, impacting marine benthos within a localized area around the wellsite. Potential interactions with marine resources harvested for commercial purposes therefore is not be expected to occur.

15.5.6.2 Mitigation of Project-Related Environmental Effects

Chevron will implement multiple preventative and response measures to reduce risk of incidents occurring and mitigate potential consequences (refer to Section 15.4). Chevron will undertake a Spill Impact Mitigation Assessment (SIMA) / Net Environmental Benefit Analysis (NEBA) as part of the Operations Authorization process with the C-NLOPB. The SIMA is a structured process that will qualitatively evaluate the risks and trade-offs of all feasible and effective response options, when compared to no action. The SIMA process will inform the selection of an overall spill response strategy for the Project. If identified as a preferred response option, use of chemical dispersants would not occur without first obtaining regulatory approval.

Mitigation to reduce effects from an accidental spill on Indigenous communities and activities include the following:

- Implementation of a Fisheries Communication Plan, which would include procedures for informing Indigenous communities of an accidental event and planned response. Emphasis will be on timely communication, allowing fishers to haul out gear from affected areas, reducing potential of fouling of fishing gear. This engagement will be coordinated through One Ocean, Fish, Food and Allied Workers-Unifor, Ocean Choice International, Association of Seafood Producers, and Groundfish Enterprise Allocation Council.
- Compensation for damage to gear in accordance with the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activity (C-NLOPB and CNSOPB 2017).
- Chevron will maintain ongoing communications with the NAFO Secretariat, through DFO as the Canadian representative, regarding the occurrence of an accidental event, including timely communication on restricted access zones and applicable buffers.

In the unlikely event of a spill, specific monitoring and follow-up programs may be required and will be developed in consultation with regulatory agencies, Indigenous communities, and fisheries stakeholders as applicable.

15.5.6.3 Characterization of Residual Project-Related Environmental Effects

15.5.6.3.1 Subsea Blowout

A hypothetical subsea blowout scenario has potential to cause environmental effects that would cause a change in the availability of resources for commercial fishers and other ocean users. The actual effects of a hypothetical subsea blowout scenario would depend on the duration and volume of the spill, resulting in differing spatial extents of the resulting spill. If such an event we're to occur, the effects would be restricted to areas where the spill trajectory and the activities and resources of commercial fisheries and other ocean users overlap.

The threshold of <0.04 µm (visible sheen threshold) was used for spill trajectory modelling of surface oiling and represents the threshold at which socio-economic impacts. In recognition of the possibility of a fisheries closure occurring at this threshold (refer to Table 15.2), >0.04 µm is also the threshold for a change in availability of resources in this assessment.

The threshold for socio-economic impacts along nearshore environments on the shoreline is a mass per unit area threshold of 1 g/m². This threshold would result in impacts on nearshore aquaculture and commercial fishing for sessile spices like clams, scallop, whelk, and sea cucumber.

Under unmitigated circumstance, modelled subsurface crude oil spills for a short release (30 day and 27 day) resulted in an area between 1,221,000 to 2,910,000 km² exceeding the socio-economic threshold (<0.04 µm) at 160 days. An unmitigated long spill (123 days and 130 days) would result in an area of 1,701,000 to 2,991,000 km² being above the threshold of. However, at one day the approximate area of oil exceeding 0.04 µm is 3,000 km² and is mostly contained with in the Project Area, allowing plenty of time to let fishers in the area know that an accidental event has occurred and they are able to retrieve gear before fouling can take place.

In the event of a spill, surface oiling would have a short-term effect on commercial fishing activity due to the exclusion of fishing in areas where oil exceeds a thickness of <0.04 µm. Affected areas would be closed to commercial fishing to prevent contact of gear and personnel with spilled oil and also to limit the consumption of potentially contaminated food sources. Effects may also occur due to reduced consumer confidence and marketability of seafood following a spill (ITOPF 2011b).

Tainting of seafood (when a fish absorbs oil-derived substances into its tissues, causing petroleum tastes and odours) can occur at exposures to low hydrocarbon concentrations (ITOPF 2011b). And although tainting is reversible through depuration, concerns and altered consumption patterns may linger after seafood has been determined safe for consumption, leading to potential continued economic losses (Yender et al. 2002; ITOPF 2011b).

The Project is not located within an area of high harvesting activity, and oil spill trajectory modelling has shown that in the unlikely event of a blowout incident, prevailing winds and currents are most likely to force released oil to the east, away from Canadian shorelines. Stochastic modelling predicted that less than 25% of modelled unmitigated (e.g., no spill response) blowout release scenarios have the potential to exceed surface or water column thresholds greater than 100 km to the west of the Project Area. Depending on the season, stochastic modelling predicted the average probability of shoreline oiling ranging from 1.9% (summer) to 8.7% (winter). Depending on the time of year and environmental conditions, areas susceptible to shoreline oiling included the entire east coast and much of the west coast of Newfoundland, the Avalon Peninsula, the southern shores of Labrador reaching into the Gulf of St. Lawrence, and Sable Island. Oil that reached shore was expected to be patchy, discontinuous, and weathered, as it would have taken a minimum of 10 days (and frequently much longer) to reach shore.

Due to the magnitude and spatial extent of modelled results, the residual environmental effects due to an accidental subsurface crude oil spill are expected to be high in magnitude, long term in duration (given the prolonged potential for perceived tainting of seafood) and extending to the RAA and beyond.

In the event of a subsea blowout, dispersants may be used to lessen risk of adverse environmental effects due to the reduction in floating oil on the sea surface. Indirect effects from the use of dispersants can also affect commercial fisheries and other ocean users. The use of dispersants may increase the size of a closure area, if one is put in place, or may inadvertently displace oil to a location that is open, where active fishing is occurring. As discussed in Section 15.5.1, dispersants may also bioaccumulate in fish species, this may affect their quality, thereby having an effect on both commercial fisher and researchers. Following the DWH spill, the US Food and Drug Administration conducted laboratory tests on the effects of a commonly used dispersant on eastern oyster, blue crab, and found that the dispersant was depurated from the organisms’ tissues with 24 to 72 hours (Tjeerdema et al. 2013). Although studies indicate that dispersants have relatively low toxicity to fish species, the use of dispersants may increase public concern over seafood safety and tainting, thereby potentially prolonging effects on commercial fisheries (HDR Inc. 2015). Through the SIMA, biophysical and socio-economic risks of dispersant use will be evaluated, including the analyzing the trade-off between the toxic effects of the dispersed oil in the water column compared to the advantages of removing floating oil from the surface and preventing shoreline impacts.

In summary, with the implementation of mitigation measures, spill prevention plans, and response procedures, potential effects of a subsurface blowout on commercial fisheries and other ocean users are predicted to be:

- Adverse
- High in magnitude
- Within the RAA
- Long-term in duration
- Occur as a single event
- Reversible

15.5.6.3.2 Marine Diesel Spill

A batch spill of 1,000 L of diesel at the surface could result in a change in availability of resources for commercial fisheries and other ocean users if a closure was implemented due to the spill. Modelled results of an accidental discharge of marine diesel resulted in a total area of 8 km² where thicknesses were above the threshold of >0.04 µm (Figure 4-69, Appendix F). The impact of the closure would depend on its overlap with popular fishing grounds, with modelled results indicating that the area of impact would be located to the east of the Project area, dispersing clockwise along the Flemish Cap, outside the Canadian EEZ. This area is within the NAFO Fishing footprint, but outside known areas of domestic commercial fishing activity. In consideration of the mitigation measures and modelled extent of a surface diesel spill the effects of a 1,000 L diesel batch spill are expected to be low in magnitude, located within the RAA and last for a short period of time. Routine activities related to commercial fishers and other ocean users would return to normal once the area is considered safe and closures no longer in place.

In summary, with the implementation of mitigation measures, potential effects of a diesel spill on commercial fisheries and other ocean users are predicted to be:

- Adverse
- Low in magnitude
- Within the RAA
- Short-to-medium term in duration
- Occur as a single event
- Reversible

15.5.6.3.3 SBM Spill from the MODU and the Marine Riser

All drilling muds are screened through a chemical management system in consideration of the OCSG (NEB et al. 2009). Neff et al. (2000) found that there is little or no risk of drilling base chemicals to bioaccumulate to potentially harmful concentrations in tissues of benthic animals or to be transferred through marine food webs to fishery species. The predicted affected area due to an SBM spill would be within the LAA, the measurable effect on water quality would be temporary, and the product is considered to be of low toxicity. The need for a fisheries closure area is not likely to occur in the event of an SBM spill and damage to gear due to fouling would be unlikely given the relatively small spatial and temporal footprint of the spill event.

In summary, with the implementation of mitigation measures, potential effects of a SBM spill on commercial fisheries and other ocean users are predicted to be:

- Adverse
- Low in magnitude
- Within the RAA
- Short-to-medium term in duration
- Occur as a single event
- Reversible

15.5.6.3.4 Summary

A summary of predicted residual environmental effects of accidental event scenarios on commercial fisheries and other ocean users is presented in Table 15.41. Values provided are based on the conservative (unmitigated, worst case scenario) approach that was used for the spill modelling.

Table 15.41 Summary of Residual Project-Related Environmental Effects on Commercial Fisheries and Other Ocean Users – Accidental Events

Residual Effect	Residual Environmental Effects Characterization						
	Direction	Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Ecological and Socio-economic Context
Change in Availability of Resources							
Subsea Blowout	A	H	RAA*	LT	S	R	D
Marine Diesel Spill	A	L	RAA	ST-MT	S	R	D
SBM Spill from MODU and the Marine Riser	A	L	LAA	ST	S	R	D

KEY: N/A: Not Applicable Direction: P: Positive A: Adverse Magnitude: N: Negligible L: Low M: Moderate H: High	Geographic Extent: PA: Project Area LAA: Local Assessment Area RAA: Regional Assessment Area; in certain scenarios, effects may extend beyond the RAA as indicated by an "*" Duration: ST: Short-term MT: Medium-term LT: Long-term	Frequency: S: Single event IR: Irregular event R: Regular event C: Continuous Reversibility: R: Reversible I: Irreversible Ecological / Socio-Economic Context: D: Disturbed U: Undisturbed

15.5.6.4 Determination of Significance

The significance of spill-related adverse environmental effects resulting from an accidental oil spill is ultimately dependant the magnitude and spatial and temporal scale of the spill, and the implementation of mitigation measures to prevent and reduce effects from a spill. Although a subsurface crude oil spill and a

1,000 L diesel batch spill are likely to result in residual environmental effects, the occurrence of such an event is unlikely. In consideration of the result of spill modelling exercises and planned mitigation and financial compensation, the overall predicted residual environmental effects from an accidental event scenario on commercial fisheries and other ocean users is considered not significant.

15.6 References

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16.0 EFFECTS OF THE ENVIRONMENT ON THE PROJECT

16.1 Scope

This chapter considers how existing environmental conditions and natural hazards in and around the Project Area could adversely affect the Project. This consideration is required by Section 19(1)(h) of CEAA 2012, relating to a change to the designated Project that may be caused by the environment. Also discussed in this section are relevant engineering and environmental design criteria, industry standards, guidelines, regulatory conditions, and mitigation measures.

16.1.1 Key Environmental Considerations

Based on information provided in Chapter 5 (Existing Physical Environment) and considering the location of EL 1138, as well as information in other EIS documents completed for exploration projects in offshore NL, the Project may be subject effects from the following environmental conditions:

- Geohazards (seismic activity, tsunamis, and landslides)
- Weather (fog and visibility, lightning, and extreme weather conditions
- Currents
- Ice related (e.g., sea ice, icebergs, and superstructure icing)
- Climate Change

These environmental factors should be considered in the design and operation of exploration activities associated with the Project. Understanding the interaction between Project activities and environmental conditions will help to avoid or lessen the potential for accidental events to occur.

16.1.1.1 Significance Definition

A significant adverse residual effect of the environment on the Project is defined as one that results in:

- Damage to Project infrastructure that causes harm to Project personnel or the public
- Damage to Project infrastructure such that the well has to be temporarily abandoned to conduct repairs
- Damages to Project Infrastructure resulting in repairs that are not feasible to implement (either due to technical or economic limitations)
- Affects Project components and/or activities resulting in an adverse environmental effect on ecological or socio-economic components that meets or exceeds respective thresholds for significant adverse environmental effects (see Chapters 8 to 13)

16.2 Assessment of Effects of the Environment on the Project

16.2.1 Geohazards

16.2.1.1 Seismic Activity

The Project Area and RAA are in an area of low seismic hazard (refer to Figure 5-4 in Section 5.2 [NRCan 2018]). Between 1985 and 2019, 55 earthquakes have occurred in the RAA; 44 had magnitudes of 2 to 4, and 11 had magnitudes of 4 to 4.7. No earthquakes have occurred within the Project Area in the last 34 years and most of the earthquake epicenters (refer to Figure 5-5 in Section 5.2) are to the northwest and southwest of the Project Area.

Earthquakes with a magnitude of 6 or greater could cause structural damage to offshore oil and gas infrastructure (Statoil Canada Ltd. 2017). Historic records dating back to 1663 show that there has been one earthquake with a magnitude of 7 or greater that has occurred in the NL offshore area. This earthquake occurred along the Laurentian slopes, approximately 250 km offshore NL in 1929 and had a magnitude of 7.2. Based on these records, the probability of an earthquake affecting the NL offshore is 0.0028 per year or once in 354 years (Statoil Canada Ltd. 2017).

Chevron is currently planning to drill up to eight exploration and delineation / appraisal wells over a ten-year time period from 2016 to 2025, with an initial well to be drilled in 2021, and Project activities at each well could take approximately 180 days. Based on historical data, and predicted seismic hazard levels in the Project Area, the likelihood of a major seismic event (magnitude greater than 6) occurring during the temporal boundaries of the Project are low.

16.2.1.2 Landslides and Tsunamis

Seismic activity can indirectly cause other natural hazards to occur, including sediment and seafloor instability (i.e., landslides) and tsunamis. Each of these events also has potential to affect the Project to result in a significant adverse residual effect of the environment on the Project.

The gradient, magnitude of seismic acceleration, and sediment strength determine whether sediment failure will occur (Statoil Canada Ltd. 2017). Most sediments found on the Grand Banks are relatively stable and would require seismic accelerations associated with a large earthquake, with a magnitude of 5 or greater, to cause sediment failure (Nadim et al. 2005).

Large, complex landslides have been mapped along a 65 km length of northeast flank of the Flemish Pass that extends approximately 20 km downslope (Statoil Canada Ltd. 2017). Failed sediments have been observed out as far as 20 km onto the floor of the Flemish Pass, forming Mass Transport Deposits (slumps, slides and debris flows that were transported downslope by gravitational processes) that are typically 50 m thick These sediment failures in the Flemish Pass are thought to be the result of earthquake triggers and are believed to have occurred 27,000 and 20,500 years ago (Cameron et al. 2014).

In an assessment of geohazards in the Flemish Pass area, Piper and Campbell (2002) suggested that most large debris flow deposits in the area are the result of earthquake-triggered slumps on both flanks of the Flemish Pass. A major earthquake would likely be required to trigger future landslides, and it has been estimated that such an event would occur approximately once in 10,000 years in a worst-case scenario (Cameron et al. 2014).

Tsunamis can travel at speeds of approximately 750 km/hour in the open ocean (4,500 m deep), slowing down (approximately 350 km/hour in 1,000 m water depth) and gaining wave height as it travels into shallower water (NOAA 2009). In the open ocean, amplitudes are usually less than 2 m in height. The earthquake mentioned above that occurred in 1929 near the Laurentian Slope triggered an underwater landslide that generated a tsunami and impacted Newfoundland's Burin Peninsula causing loss of life (NRCan 2011).

A typical submarine earthquake generated tsunami in the Atlantic Ocean is expected generate a wave height of 1 m, a wave period of 200 s and a wavelength of 40 km (Ward 2010). As it travels from its epicenter in the Atlantic Ocean (approximately 4,000 m water depth), to the Grand Banks (36 to 185 m water depth), its wave height would increase from 1 m to 3.2 to 2.2 m, and its wavelength would decrease from 40 km to approximately 4 to 8 km, correspondingly (Husky Oil and Operations 2019).

There is a low probability of other geohazards (landslides and tsunamis) occurring within the Project Area during the temporal boundaries of the Project, as the likelihood of a seismic event occurring to trigger a landslide is low. However, the chance of a landslide occurring is greater at EL 1138 than around existing oil platforms in offshore NL as it is located on a sloped area of the Sackville Spur, along the Northeast Newfoundland Slope.

16.2.2 Weather

The Project Area experiences weather conditions typical of a marine environment, with the surrounding waters having a moderating effect on temperature. In general, marine climates experience cooler summers and milder winters than continental climates and have a much smaller annual temperature range. A marine climate tends to be humid, resulting in reduced visibility, low cloud heights, and considerable amounts of precipitation.

A detailed discussion on climatological conditions over the past 30 years for the Project Area is presented in Section 5.4, using data from the Meteorological Service of Canada 50 North Atlantic Wave Hindcast (MSC50) wind and wave climatology database at grid point 13741. This includes a detailed discussion on wind speed and direction, air and sea surface temperatures, precipitation, and fog and visibility. Weather events that have the potential to directly or indirectly affect the Project are discussed below and include fog, lightning, and extreme weather conditions.

16.2.2.1 Fog and Visibility

Annually, 37.9% of the observations in the Project Area have visibility less than 10 km. During winter months, the main obstruction is snow; however, mist and fog may also reduce visibility at times. As spring approaches, the amount of visibility reduction attributed to snow decreases. As the air temperature increases, so does the occurrence of advection fog. Advection fog forms when warm moist air moves over cooler waters. By April, the sea surface temperature south of Newfoundland is cooler than the surrounding air. As warm moist air from the south moves over the colder sea surface, the air cools and its ability to hold moisture decreases. The air will continue to cool until it becomes saturated and the moisture condenses to form fog. The presence of advection fog increases from April through July. The month of July has the highest percentage of obstruction of visibility, most of which is in the form of advection fog, although frontal fog can also contribute to the reduction in visibility. Starting from August, the temperature difference between the air and the sea begins to decrease and by September the air temperature begins to fall below the sea surface temperature. As the air temperature drops, the occurrence of fog decreases. Reduction in visibility during autumn and winter is relatively low and is mainly attributed to the passage of low-pressure systems. Fog is the main cause of the reduced visibility in autumn, and snow is the main cause of reduced visibility in winter. October has the lowest occurrence of reduced visibility since the air temperature has, on average, decreased below the sea surface temperature and it is not yet cold enough for snow.

Fog and/or weather conditions resulting in poor visibility can cause delays in transit of cargo and personnel to and from the MODU and increase the potential for supply vessel and/or helicopter collisions. With the implementation of the mitigation measures described in Section 16.3 fog and visibility is not expected to have a substantive adverse effect of the environment on the Project.

16.2.2.2 Lightning

Thunderstorms occur relatively infrequently over the Project Area (refer to Table 5.7 in Section 5.4.3) but may occur in any month of the year. Lightning strikes are stronger during the winter months. Lightning is most commonly produced in thunderstorms and is usually accompanied by thunder (Statoil Canada Ltd. 2017). Lightning can pose a safety risk to personnel and can potentially affect electronic systems on the MODU, supply vessel and helicopters. With the implementation of the mitigation measures described in Section 16.3 lightning is not expected to affect the Project.

16.2.2.3 Extreme Wind and Wave Events

For the Project Area, the annual 100-year extreme 1-hour wind speed is 32.81 m/s. The highest extreme monthly wind occurs during February with a 100-year extreme wind estimate of 31.75 m/s.

The annual and monthly extreme value estimates for significant wave height for return periods of 1-year, 10-year, 25-year, 50-year and 100-year are given in Table 5.17 in Section 5.6.3.2. The annual 100-year extreme significant wave height is 15.5 m. The highest extreme significant wave height occurs during the month of February, with an extreme height of 15.3 m.

Extreme wind and wave conditions could result in accidental spills, suspension or delay of Project activities, evacuation of the MODU, and in extreme cases, cause injury or fatality, as when 84 crew members were lost when the semi-submersible MODU *Ocean Ranger* sank 267 km east of St. John's during a fierce winter storm in February 1982. This tragedy resulted in important improvements for working on oil and gas projects in offshore waters in Canada; key being the establishment of the C-NLOPB and CNSOPB, as well as developing more rigorous safety training, equipment, and inspection requirements.

16.2.2.4 Currents

The Labrador Current is the dominant current in RAA, and is composed of the West Greenland Current, Baffin Island Current, and Irminger Current. The currents on the Newfoundland Slope are highly variable due to the influences of strong atmospheric forcing, large inflows of sea ice, and interactions with the Gulf Stream and North Atlantic Current (Han and Li 2004). This results in the Labrador Current having seasonal and interannual variations in velocity and transport. Typically, the upper waters of the Labrador Current are stronger in fall and winter and weaker in spring (Lazier and Wright 1993; Han and Tang 1999; Han and Li 2004). Lazier and Wright (1993) found seasonal variations in the upper 400 m level circulation and no substanial variations deeper than the 1,000 m level.

The Labrador Current flows southward until it reached the southern part of Orphan Basin, where it is diverted eastward by the bathymetry. Upon reaching the entrance to Flemish Pass, the current divides into two branches. One branch continues to flow eastward north of Flemish Cap and the other branch flows southward through Flemish Pass (see Figure 16.1).

Six moored current measurements were made in West Flemish Pass between April 11, 1976, and May 07, 2010. The mooring sites are in EL 1138. A summary of mean speed, velocity, and direction of current for differing depths at these mooring locations can be found in Table 5.14 in Section 5.6.2.

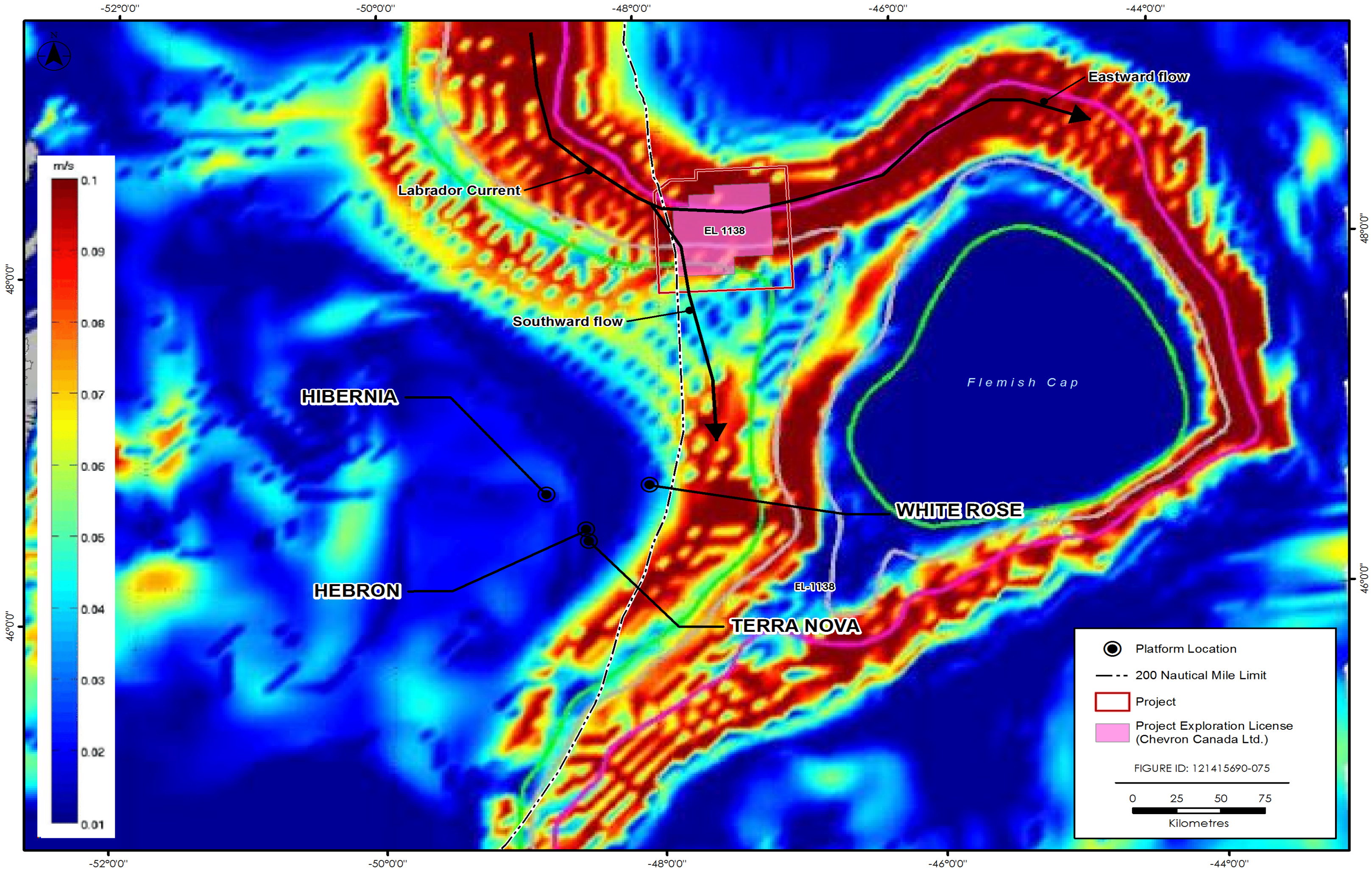
In 2014, Wang and Greenan (2014) modelled the mean bottom current speed for the Newfoundland Shelf and Flemish Cap region for NAFO. The model shows that the bottom currents are stronger along the edge of the newfoundland Shelf and the edge of the Flemish Cap, where the water depth gradients are the largest. The speed of the bottom currents can reach up to 10ms/ even at depth greater than 2,500 m (Wang and Greenan 2014).

Given the location of the Project, at the junction where the Labrador Current splits into two (Figure 16.1), there is the potential for currents to affect the Project. Currents may cause increased stress on MODU infrastructure (including the riser) and supply vessels which could result in the disruption of operations (Statoil Canada Ltd. 2017). In consideration of Project mitigation measures outlined in Section 16.3 impacts on the Project due to currents are expected to be low.

16.2.3 Ice-related

16.2.3.1 Sea Ice and Icebergs

A weekly analysis of the Canadian Ice Service's 30-year median of ice in North Atlantic reveals that ice is only present in Flemish Pass, and within the Project Area, from mid-January until late May. The likelihood of ice present in Flemish Pass is highest during the week beginning February 5. During this week, the median of ice concentration in some areas of Flemish Pass is 9-9+/10. The frequency of sea ice presence in the Project Area is 1% to 15% (refer to Figure 5-26 in Section 5.9).



Source: Wang and Greenan 2014

Figure 16-1 Track of Labrador Current and Modelled Bottom Current Velocity

Icebergs typically appear off the coast of Newfoundland by February or March and the majority of icebergs are present from April to June or July. By the end of summer, most icebergs along the coast of Newfoundland have drifted south of the Grand Banks or have melted (AMEC 2014). The risk of iceberg collisions varies year to year. There have been years when no icebergs have been recorded passing across the Project Area, while other years more than 1,000 icebergs are recorded (Bigg 2016).

Both sea ice and icebergs have the potential to occur in the Project Area, and may affect the Project in the following ways:

- Present navigational hazards for the supply vessel, delaying transportation of personnel and supplies to and from the MODU
- The MODU may be required to disconnect and move off the well site to avoid collision with an iceberg, leading to possible Project delays
- Increase the risk of an accidental event, injury to workers, and/or irreparable damage to the MODU

16.2.3.2 Marine Icing

Spray icing can accumulate on vessels and shore structures when air temperature is below the freezing temperature of water and there is potential for spray generation. In addition to air temperature, icing severity depends on water temperature, water salinity, wave conditions, and wind speed, which influence the amount of spray and the cooling rate of droplets.

Potential spray icing conditions start during the month of November, with a frequency of icing potential of just 0.6%. As temperatures cool throughout the winter, the frequency of icing potential increases to a maximum of 31.5% of the time in January. Extreme sea spray icing conditions are calculated to occur 1.6% and 1.5% of the time during February and March, respectively. Icing potential decreases rapidly after March in response to warming air and sea surface temperatures, and by May the frequency of icing conditions is only 0.1%.

Superstructure icing can result in a raised centre of gravity, slower supply vessel speed, maneuvering difficulty, and problems with cargo-handling equipment (DFO 2012). Delays to the Project may occur if operations are slowed down or suspended to remove ice accumulations caused by superstructure icing. If icing is not managed, damage to the MODU is possible.

16.2.4 Climate Change

Climate change is defined as a change in the state of climate in a given region, identified by changes in the mean or variability of its properties, and persists for an extended period. Climate change can be caused by natural events, including volcanic eruptions and solar cycles, or by anthropogenic (human) activities (International Panel on Climate Change [IPCC] 2014). To assess the environmental effects of climate on the Project, current climate, extreme weather, and potential climate change must be considered in the design of marine structures, so structural integrity can be maintained throughout the structure’s lifetime (Vanem 2017). Current climate conditions are established by compiling relevant historical data and establishing a climatological background for the Project Area (refer to Section 5.4). Predictions of future climate trends are derived from mathematical and statistical models. The most relevant climate-related changes to the Project include: 1) atmospheric climate change, including changes to temperature, precipitation, winds, and storms; and 2) oceanographic climate change, including changes to ocean water temperature, waves / currents, sea level, sea ice, and icebergs.

Engineering design of a MODU should consider anticipated changes in atmospheric and oceanographic conditions due to climate change, so structural integrity can be maintained throughout the structure's lifetime. If this does not occur, there is the possibility that interruptions to the Project will happen due to repairs required to the MODU resulting from changes in known climate related factors (i.e., air temperature, sea temperature, precipitation).

16.3 Mitigating Potential Effects of the Environment on the Project

Table 16.1 outlines mitigation measures for environmental conditions that may have an effect on the Project. These include general mitigation measures, as well as those specific to the five main environmental factors that have the potential to adversely affect the Project (e.g., geohazards, weather, currents, ice-related, and climate change). The primary means of mitigating adverse effects of the environment on the Project is through detailed engineering and use of environmental design criteria, compliance with industry codes of practice, and avoidance of environmental hazards where possible.

The following factors / measures, in addition to those described in Table 16.1, will reduce the potential of occurrence, and magnitude of effects of the environment on the Project:

- Short-term duration of potential offshore activities between 2016 and 2025 (approximately 180 days drilling per well for eight wells)
- Absence of fixed offshore infrastructure
- Harsh-weather design criteria for the MODU
- Requirements of C-NLOPB's Operations Authorization for drilling an exploration well
- Requirements of the *Newfoundland Offshore Certificate of Fitness Regulations* and the Offshore Physical Environment Guidelines (NEB et al. 2008)
- Continuous monitoring of meteorological and oceanographic conditions
- Operating limits and stop-work procedures if conditions are unsafe

In addition to design standards and compliance with regulatory guidelines as the primary means for reducing adverse effects of weather conditions on the Project, Chevron has a number of plans to respond to adverse conditions, should they threaten Project operations. These plans include the EPP and a Safety Plan. These plans include detailed mitigation measures for activities associated with exploration (see Section 2.10.3) and will include specific conditions of approval.

16.4 Residual Effects Summary

As described in the above sections, the components of the physical environment that may affect the Project are: geohazards (seismic activity, tsunamis, and landslides); weather conditions (fog and visibility, lightning, and extreme wind and wave evens); currents; ice conditions (sea ice, icebergs, and superstructure icing); and climate change. The engineering design, operation procedures, and mitigation measures described in the previous sections will reduce the potential adverse effects of these environmental components on the Project.

Based on the significance criteria described in Section 16.1.2, and the described mitigation measures, it is predicted that there will be no significant adverse residual effects of the environment on the Project.

Accidental events or malfunctions (potentially caused by an effect of the environment on the Project), and associated adverse effects on environmental components, are assessed in Chapter 15.

Table 16.1 Mitigation for Potential Effects of the Environment on the Project

Environmental Condition	Mitigation
General	Chevron will collect detailed site-specific information on climatic, meteorological, and oceanographic conditions as part of the planning and design of an offshore program and implement a physical environment monitoring program, including metocean monitoring, onsite weather observation, and ice management, as required by the Offshore Physical Environment Guidelines (NEB et al. 2008).
	Radio communications systems will be in place to contact other marine vessels
	MODU, supply vessels and shore bases will have systems in place for communication
	Compliance with Canadian regulations for engineering design, and adherence to international standards, where applicable
	Engineering design of a MODU will consider the type and magnitude of loads imposed by ice, snow, waves, tides, currents, wind, and operating ambient temperatures
	MODU selected will be a deep-water, all-weather MODU that is specifically designed to operate in extreme environments
	A Certificate of Fitness will be obtained for the MODU from an independent third-party Certifying Authority before the commencement of drilling operations in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations*
	MODU will have capability to disconnect the riser from the well in a short period of time, to reduce the risk of damage to the well, riser, and MODU
	Supply vessels used for the Project will be equipped for safe all-weather operations, including increased stability in rough seas. In addition, measures to reduce superstructure icing hazards on supply vessels will be implemented as necessary and may include (DFO 2012): • Reducing vessel speed in heavy seas • Placing gear below deck and covering deck machinery, if possible • Moving objects that may prevent water drainage from the deck • Making the ship as watertight as possible • Manual removal of ice if required under severe icing conditions
	Supply vessels will undergo Chevron's marine assurance process, and external inspections / audits by the C-NLOPB as part of the pre-authorization inspection process
	Adequate food and water supplies will be stored on the MODU to accommodate delays

Table 16.1 Mitigation for Potential Effects of the Environment on the Project

Environmental Condition	Mitigation
Geohazards	The MODU will have capability to disconnect the riser from the well in a short period of time, to reduce the risk of damage to the well, riser, and MODU
	Chevron will conduct a comprehensive regional geohazard baseline review as well as a detailed geohazards assessment for each well site
	An imagery-based seabed survey will be conducted at the well site(s) to confirm the absence of sensitive environmental features, such as habitat-forming corals or species at risk (as well as shipwrecks, debris on the seafloor, and unexploded ordnance). The survey will be carried out before drilling. If environmental or anthropogenic sensitivities are identified during the survey, Chevron will move the well site to avoid affecting them if it is feasible to do so. If it is not feasible, Chevron will consult with the C-NLOPB to determine an appropriate course of action. This survey will also provide baseline data for coral and sensitive benthic habitat that may be present and be used to inform discussions on potential follow-up and monitoring with respect to drill waste discharges.
Weather	If the set visibility requirements for helicopter flights are not met, flights will not occur. There are also specific navigational lighting requirements on the MODU's helipad and exterior
	While supply vessels can operate in most weather conditions, slower speeds may be required during periods of reduced visibility
	Obstruction lights, navigation lights, and foghorns will be maintained in working condition on the MODU and supply vessels
	Supply vessels captains, helicopter pilots, and the MODU's Offshore Installation Manager will have the authority to suspend or modify operations in the case of adverse weather that could compromise the safety of supply vessels, helicopter, or MODU operations
	If required due to extreme weather, the riser will be disconnected from the well, and the MODU will be moved to reduce the risk of damage or injury
	Supply vessels and the MODU will have lightning protection systems to ground lightning electrical charges and transfer the energy to the sea water where it can be dissipated
	Safe work practices will be implemented to reduce the risk of lightning to Project personnel, such as restricting access to external areas of the supply vessels and MODU
Currents	MODUs and supply vessels will incorporate water current loads into their design
	A Certificate of Fitness will be obtained for the MODU from an independent third-party Certifying Authority before the commencement of drilling operations in accordance with the *Newfoundland Offshore Certificate of Fitness Regulations*, considering the potential environmental loads imposed by naturally-occurring phenomena
Ice Related	Chevron will prepare and submit an Ice Management Plan as part of the application for Drilling Program Authorization as per the Offshore Physical Environment Guidelines (NEB et al. 2008). This Plan will include details on sea ice / iceberg monitoring and detection, and risk assessment, mitigation, and contingency procedures.
Climate Change	Engineering design of a MODU should consider anticipated changes in atmospheric and oceanographic conditions due to climate change, such that structural integrity can be maintained throughout the structure's lifetime.

16.5 References

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17.0 SUMMARY AND CONCLUSIONS

Chevron proposes to undertake exploration drilling activities within its existing offshore EL in the Flemish Pass, approximately 375 km northeast of St. John's, NL in water depths ranging from approximately 400 to 2,200 m. Drilling operations will be conducted within the EL boundaries, but exact well site locations are not yet known. The Project may involve drilling up to eight exploration and delineation / appraisal wells over the term of the EL (2016 to 2025), with an initial well proposed to be drilled in 2021 pending regulatory approval.

This chapter provides the following:

- Summary of potential Project-related effects on selected valued components (VCs) (Section 17.1)
- Summary of mitigation, monitoring, and follow-up proposed for the Project (Section 17.2)
- Summary of residual environmental effects, after mitigation has been applied, for the selected VCs (Section 17.3)
- Summary of predicted environmental changes and effects and their relationship to Federal jurisdiction and decisions (Section 17.4)
- Conclusion, including significance determinations for the selected VCs (Section 17.5)

17.1 Summary of Potential Effects

The methods used to assess the effects of routine Project activities and accidental events, as well as the potential cumulative effects of the Project, are outlined in Chapter 4 and have been developed in consideration of the requirements of CEAA 2012 and guidance issued by the Agency following guiding principles that stress the importance of environmental assessment as a planning and decision-making tool, with emphasis on the early identification of mitigation and follow-up programs and meaningful public participation and engagement with Indigenous groups.

The assessment methods used in the preparation of this EIS included an evaluation of the potential environmental effects for each VC that may arise during routine Project activities and potential accidental events. The assessment methods also included an evaluation of potential cumulative effects to consider whether there is potential for the residual environmental effects of the Project to interact cumulatively with the residual environmental effects of other past, present, or future (i.e., certain or reasonably foreseeable) physical activities in the vicinity of the Project.

Chevron undertook several Project-specific modelling studies to understand the fate and behaviour of discharges and emissions from the Project. This included drill cuttings dispersion modelling (Appendix C), underwater sound modelling (Appendix D), and spill trajectory modelling and probability analysis (Appendix F).

The scope of the Project evaluated as part of this EIS was selected to align with the EIS Guidelines. Routine and accidental events were assessed against several VCs, specifically:

- Marine Fish and Fish Habitat (including Species at Risk)
- Marine and Migratory Birds (including Species at Risk)
- Marine Mammals and Sea Turtles (including Species at Risk)
- Special Areas
- Indigenous Communities and Activities
- Commercial Fisheries and Other Ocean Users

Routine Project activities with the potential to affect the environment have been specifically identified and considered in this assessment, including the presence and operation of a MODU (including lights and flare, underwater sound, and safety zone); VSP surveys (underwater sound); discharges and emissions (e.g., drill muds and cuttings, liquid discharges, atmospheric emissions); well abandonment; and supply vessel (underwater sound), and helicopter operations. A summary of potential interactions between the VCs and Project activities included in the scope of the EIS, which formed the basis for the effects analysis, are presented in Table 17.1.

Non-routine events (i.e., accidental events or malfunctions) have also been identified and considered within the scope of the Project, including blowouts (uncontrolled release of hydrocarbons during drilling), and platform and vessel batch spills and releases (e.g., hydraulic fluid, drilling mud, diesel). Accidental releases, or “spills”, have the potential to occur in the offshore (e.g., during drilling) or nearshore (e.g., during supply vessel transit) environment. A summary of potential interactions between the VCs and non-routine events included in the scope of the EIS are presented in Table 17.1.

Effects of the environment on the Project considers how local environmental conditions and natural hazards (e.g., extreme weather) could adversely affect the Project and thus result in potential effects on the environment (e.g., accidental events). Potential adverse effects of the environment on a project are typically a function of project design and environmental conditions (e.g., geology, ice conditions) that could affect the project. The implementation of mitigation measures through engineering and environmental design criteria, industry standards, and environmental monitoring will reduce the potential adverse effects on, and risks to, the Project.

The implementation of mitigation measures to reduce or eliminate potential adverse effects are fully integrated into the effects assessment and summarized in Section 17.2 with an overview of the effects analysis presented in Section 17.3.

Table 17.1 Potential Project-VC Interactions and Effects

Planned Activity	Valued Component									
	Marine Fish and Fish Habitat (including Species at Risk)		Marine and Migratory Birds (including Species at Risk)		Marine Mammals and Sea Turtles (including Species at Risk)		Special Areas	Indigenous Communities and Activities		Commercial Fisheries and Other Ocean Users
	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Risk of Mortality or Physical Injury	Change in Habitat Quality and Use	Change in Habitat Quality	Change in Health and Socio-economic Conditions	Change in Current Use of Lands and Resources for Traditional Purposes	Change in Availability of Resources
Routine Activities										
Presence and operation of a MODU (including drilling, associated safety zone, lights, and sound)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
VSP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Discharges (e.g., drill muds / cuttings, liquid discharges)	✓	✓	✓	✓	–	✓	✓	✓	✓	✓
Well Testing and Flaring (including air emissions)	–	–	✓	✓	–	–	–	✓	✓	–
Well Abandonment	✓	✓	–	–	-	✓	✓	✓	–	✓
Supply and Servicing Operations (including helicopter transportation and Project supply vessel operations)	–	✓	✓	✓	✓	✓	✓	✓	✓	✓
Accidental Events										
Well Blowout Incident	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marine Diesel Spill	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Synthetic-based Muds (SBM) Spill	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Notes:
✓ = Potential interaction
– = No interaction

17.2 Summary of Mitigation, Monitoring and Follow-up

17.2.1 Summary of Mitigation Measures

The implementation of mitigation measures is proposed to reduce or eliminate potential adverse effects. Mitigation may include documented practices, measures proven effective in the past, best management practices, as well as measures developed specifically for the Project. In some cases (e.g. fishing gear loss, major spills), compensation measures may be warranted. Each VC assessment indicates how the mitigation measures will reduce or eliminate potential adverse effects on the VC. A summary of standard mitigation and Project-specific commitments to be implemented is provided in Table 17.2.

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
General		
1.	Contractors and subcontractors shall be required to demonstrate conformance with the requirements that have been established, including health, environment, and safety (HES) standards and performance requirements.	Section 2.10.3
2.	Chevron will obtain a Certificate of Fitness from an independent third-party Certifying Authority for the MODU prior to commencement of drilling operations in accordance with the Canada-Newfoundland and Labrador Offshore Petroleum Board's (C-NLOPB's) *Offshore Certificate of Fitness Regulations*.	Section 2.10.3 Section 16.4
3.	Chevron will collect detailed site-specific information on climatic, meteorological, and oceanographic conditions as part of the planning and design of an offshore program and implement a physical environment monitoring program, including metocean monitoring, onsite weather observation, and ice management, as required by the Offshore Physical Environment Guidelines (NEB et al. 2008).	Section 2.10.3 Section 16.4
4.	Chevron and contractors working on the Project will regularly monitor weather forecasts to forewarn supply vessels, helicopters, and the MODU of inclement weather or heavy fog before it poses a risk to their activities and operations. Extreme weather conditions that are outside the operating limits of supply vessels or helicopters will be avoided if possible. Captains / Pilots will have the authority and obligation to suspend or modify operations in case of adverse weather or poor visibility that compromises the safety of supply vessel, helicopter, or MODU operations.	Section 2.10.3
5.	Icing conditions and accumulation rates on supply vessels, helicopters, and the MODU will be monitored during fall and winter operations, particularly when gale-force winds may be combined with air temperatures below -2°C (DFO 2012).	Section 2.10.3
6.	Safe work practices will be implemented to reduce exposure of personnel to lightning risk (e.g., restriction of access to external areas on the MODU or supply vessel during thunder and lightning events).	Section 2.10.3
7.	Prior to drilling activity, Chevron will conduct a comprehensive regional geohazard baseline review, followed by detailed geohazard assessments for each proposed well site.	Section 2.10.3 Section 16.4
8.	Chevron will require the Drilling Contractor to provide details of the safety zone to the Marine Communication and Traffic Services for broadcasting and publishing in the Navigational Warning and Notices to Mariners systems. Details of the safety (exclusion) zone will also be communicated by Chevron during ongoing consultations with commercial and Indigenous fishers.	Section 2.10.3 Section 12.3 Section 13.3

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
9.	Chevron will develop and implement a compensation program for damages resulting from Project activities. This compensation program will be developed in consideration of C-NLOPB guidelines, including the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (C-NLOPB and Canada-Nova Scotia Offshore Petroleum Board [CNSOPB] 2017).	Section 2.10.3 Section 12.3 Section 13.3
10.	Chevron will continue to engage with Indigenous communities to share Project details and facilitate information sharing. This will be facilitated by the development and implementation of an Indigenous Fisheries Communication Plan.	Section 12.3
11.	Chevron will continue to engage commercial fishers to share Project details, as applicable and determine the need for a fisheries liaison officer during mobilization and demobilization of the MODU. This engagement will be coordinated through One Ocean, Fish, Food and Allied Workers-Unifor, Ocean Choice International, Association of Seafood Producers, and Groundfish Enterprise Allocation Council. A Fisheries Communication Plan will be used to facilitate coordinated communication with fishers.	Section 13.3
12.	Chevron will maintain ongoing communications with the Northwest Atlantic Fisheries Organization (NAFO) Secretariat, through Fisheries and Oceans Canada (DFO) as the Canadian representative, regarding planned Project activities, including timely communication of drilling locations, safety zone, and decommissioned well heads.	Section 13.3
13.	Chevron will contact DFO regarding timing and locations of planned DFO research surveys.	Section 13.3
14.	Chevron will contact the Department of National Defence regarding timing of planned offshore military exercises.	Section 13.3
15.	Supply vessels captains, helicopter pilots, and the MODU's Offshore Installation Manager will have the authority to suspend or modify operations in the case of adverse weather that could compromise the safety of supply vessels, helicopter, or MODU operations.	Section 16.4
16.	Safe work practices will be implemented to reduce the risk of lightning to Project personnel, such as restricting access to external areas of the supply vessels and MODU.	Section 16.4
17.	MODUs and supply vessels will incorporate water current loads into their design.	Section 16.4
18.	Chevron will prepare and submit an Ice Management Plan as part of the application for Drilling Program Authorization as per the Offshore Physical Environment Guidelines (NEB et al. 2008). This Plan will include details on sea ice / iceberg monitoring and detection, and risk assessment, mitigation, and contingency procedures.	Section 16.4
Presence and Operation of the MODU		
19.	To maintain navigational safety during the Project, obstruction lights, navigation lights, and foghorns will be kept in working condition on board the MODU and supply vessels. Radio communication systems will be in place and in working order for contacting other marine vessels as necessary.	Section 2.10.3 Section 13.3 Section 16.4
20.	The MODU will be equipped with local communication equipment to enable radio communication between the supply vessels and the MODU's bridge. Communication channels will also be put in place for internet access and to enable communication between the MODU and shore.	Section 2.10.3 Section 16.4

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
21.	In accordance with the *Newfoundland Offshore Petroleum Drilling and Production Regulations*, a safety (exclusion) zone (estimated to be a 500-m radius) will be established around the MODU, within which non-Project related vessels are prohibited.	Section 2.10.3
22.	An imagery-based seabed survey will be conducted at the proposed well site(s) to confirm the absence of sensitive environmental features, such as habitat-forming corals or species at risk (as well as shipwrecks, debris on the seafloor, and unexploded ordnance). The survey will be carried out prior to drilling. If environmental or anthropogenic sensitivities are identified during the survey, Chevron will move the well site to avoid affecting them if it is feasible to do so. If it is not feasible, Chevron will consult with the C-NLOPB to determine an appropriate course of action. This survey will also provide baseline data for coral and sensitive benthic habitat that may be present and be used to inform discussions on potential follow-up and monitoring with respect to drill waste discharges.	Section 2.10.3 Section 8.7 Section 11.3 Section 13.3 Section 16.4
23.	Lighting will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.	Section 2.10.3 Section 8.3 Section 9.3
24.	Supply vessel and MODU contractors will have a Maintenance Management System designed to direct the maintenance and efficient operation of the vessels and MODU, and equipment.	Section 2.10.3
25.	The loss of fish habitat will be mitigated through compliance with the *Fisheries Act.*	Section 8.3
26.	Chevron, in consultation with Environment and Climate Change Canada (ECCC) - Canadian Wildlife Services (CWS), will develop a protocol for systematic, daily searches for seabirds stranded on the MODU and supply vessels, which will include the documentation of search effort. Seabirds found will be recovered, rehabilitated, released and documented in accordance with the methods in *Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada* (ECCC 2017a). Chevron will provide training in these protocols and procedures. A Seabird Handling Permit will be obtained from ECCC-CWS annually. In accordance with ECCC-CWS requirements, an annual report and occurrence data that summarizes stranded and/or seabird handling occurrences will be submitted to ECCC-CWS.	Section 9.3 Section 11.3
27.	If flaring is required, Chevron will discuss flaring plans with the C-NLOPB including steps to reduce adverse effects on migratory birds. This may involve restricting flaring to the minimum required to characterize the wells' hydrocarbon potential and as necessary for the safety of the operation, reducing flaring during periods of migratory bird vulnerability, and the use of a water curtain to deter birds from the general vicinity of the flare.	Section 9.3
28.	Chevron will comply with Canadian regulations for engineering design, and adherence to international standards, where applicable.	Section 16.4
29.	Engineering design of a MODU will consider the type and magnitude of loads imposed by ice, snow, waves, tides, currents, wind, and operating ambient temperatures.	Section 16.4
30.	MODU selected will be a deep-water, all-weather MODU that is specifically designed to operate in extreme environments. Engineering design of a MODU should consider anticipated changes in atmospheric and oceanographic conditions due to climate change, such that structural integrity can be maintained throughout the structure's lifetime.	Section 16.4

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
31.	MODU will have capability to disconnect the riser from the well in a short period of time, to reduce the risk of damage to the well, riser, and MODU.	Section 16.4
32.	Adequate food and water supplies will be stored on the MODU to accommodate delays.	Section 16.4
33.	If required due to extreme weather, the riser will be disconnected from the well, and the MODU will be moved to reduce the risk of damage or injury.	Section 16.4
34.	Supply vessels and the MODU will have lightning protection systems to ground lightning electrical charges and transfer the energy to the sea water where it can be dissipated.	Section 16.4
Waste Management		
35.	Air emissions from the Project will adhere to applicable regulations and standards including the Newfoundland and Labrador (NL) *Air Pollution Control Regulations*, National Ambient Air Quality Objectives, Canadian Ambient Air Quality Standards, regulations under the International Convention for the Prevention of Pollution from Ships (MARPOL) and the intent of the Global Gas Flaring Reduction Partnership.	Section 2.10.3
36.	Offshore waste discharges and emissions associated with the Project (i.e., operational discharges and emissions from the MODU and supply vessels) will be managed in accordance with relevant regulations and municipal bylaws as applicable, including the Offshore Waste Treatment Guidelines (NEB et al. 2010) and MARPOL, of which Canada has incorporated provisions under various sections of the *Canada Shipping Act, 2001*. Waste discharges not meeting legal requirements will not be discharged to the ocean and will be brought to shore for disposal.	Section 2.10.3 Section 8.3
37.	Selection of drilling chemicals will be in accordance with the Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG; NEB et al. 2009), which provides a framework for chemical selection to reduce potential for environmental effects. During planning of drilling activities, where feasible, lower toxicity drilling muds and biodegradable and environmentally friendly additives within muds and cements will be preferentially used. Where feasible, the chemical components of the drilling fluids will be those that have been rated as being least hazardous under the Offshore Chemical Notification System scheme and pose little or no risk to the environment.	Section 2.10.3 Section 8.3
38.	Discharges of SBM mud and cuttings will be managed in accordance with the Offshore Waste Treated Guidelines (OWTG). SBM cuttings will only be discharged once the performance targets in OWTG of 6.9 g/100 g retained “synthetic on cuttings” on wet solids can be satisfied. The concentration of SBM on cuttings will be monitored on the MODU for compliance with the OWTG. In accordance with OWTG, no excess or spent SBM will be discharged to the sea. Spent or excess SBM that cannot be re-used during drilling operations will be brought back to shore for disposal.	Section 2.10.3 Section 8.3
39.	Excess cement may be discharged to the seabed during the initial phases of the well, which will be drilled without a riser. Once the riser has been installed, cement waste will be returned to the MODU. Cement waste will then be transported to shore for disposal in an approved facility.	Section 2.10.3
40.	Small amounts of produced water may be flared. If volumes of produced water are large, some produced water may be brought onto the MODU for treatment so that it can be discharged in line with the OWTG.	Section 2.10.3 Section 8.7

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
41.	Deck drainage and bilge water will be discharged according to the OWTG, which state that deck drainage and bilge water can only be discharged if the residual oil concentration of the water does not exceed 15 mg/L.	Section 2.10.3
42.	Foreign vessels operating in Canadian jurisdiction must comply with the Ballast Water Control and Management Regulations of the *Canada Shipping Act, 2001* during ballasting and de-ballasting activities.	Section 2.10.3 Section 8.3
43.	Putrescible solid waste, specifically food waste generated offshore on the MODU and supply vessels, will be disposed of according to OWTG and MARPOL requirements. Food waste will be macerated so that particles are less than 6 mm in diameter and then discharged. There will be no discharge of macerated food waste within 3 nm from land.	Section 2.10.3
44.	Sewage will be macerated to a particle size of <6 mm and discharged as per the OWTG.	Section 2.10.3 Section 8.3
45.	Cooling water will be discharged according to the OWTG which states that any biocides used in cooling water are selected in line with a chemical management system developed in line with the OCSG.	Section 2.10.3 Section 8.7
46.	Blowout preventer (BOP) fluids and other discharges from the subsea control equipment will be discharged according to OWTG and OCSG.	Section 2.10.3
47.	Liquid wastes, not approved for discharge in OWTG, such as waste chemicals, cooking oils or lubricating oils, will be transported onshore for transfer to an approved disposal facility.	Section 2.10.3
48.	Waste generated offshore on the MODU and supply vessels will be handled and disposed of in accordance with relevant regulations and municipal bylaws. Waste management plans and procedures will be developed and implemented to prevent unauthorized waste discharges and transfers.	Section 2.10.3 Section 8.3
49.	Biomedical waste will be collected onboard by the medical professional and stored in special containers before being sent to land for incineration.	Section 2.10.3 Section 8.7
50.	Transfer of hazardous wastes will be conducted according to the *Transportation of Dangerous Goods Act.* Applicable approvals for the transportation, handling and temporary storage of these hazardous wastes will be obtained as required.	Section 2.10.3
51.	Information on the releases, wastes and discharges will be reported as part of a regular environmental reporting program in accordance with regulatory requirements as described in the OWTG.	Section 2.10.3
Vertical Seismic Profiling (VSP) Surveys		
52.	Passive acoustic monitoring will be implemented.	Section 2.10.3.
53.	VSP activity will be planned and conducted in consideration of the Statement of *Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment* (DFO 2007). A ramp-up procedure (i.e., gradually increasing seismic source elements over a period of approximately 30 minutes until the operating level is achieved) will be implemented before VSP activity begins.	Section 2.10.3 Section 8.3 Section 10.3 Section 11.3
54.	Marine Mammal Observers (MMOs) will monitor and report on marine mammal and sea turtle sightings during VSP surveys to implement shutdown and ramp-up procedures.	Section 10.3
55.	MMOs will implement a pre-ramp up watch of 60 minutes prior to ramp-up. Ramp-up will be delayed if a marine mammal(s) or sea turtle(s) is detected within 500 m of the air gun array.	Section 10.3

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
56.	Shut down procedures will be implemented if a marine mammal or sea turtle listed as endangered or threatened on Schedule 1 of the *Species at Risk Act* (SARA), as well as any beaked whale species, is observed within 500 m of the air gun array.	Section 10.3
Supply and Servicing Operations		
57.	Supply vessels will follow established shipping lanes where they exist (i.e., in proximity to shore); where these do not exist, supply vessels will follow a straight-line approach to and from the Project Area. During transit to/from the Project Area, supply vessels will travel at vessel speeds not exceeding 22 km/hour (12 knots) except as needed in the case of an emergency.	Section 2.10.3 Section 10.3 Section 11.3 Section 12.3 Section 13.3.2
58.	In order to reduce the potential for vessel strikes during transiting activities outside the Project Area, supply vessels will reduce speed to a maximum of 13 km/hour (7 knots) when marine mammals or sea turtles are observed or reported within 400 m of a supply vessel, except if not feasible for safety reasons.	Section 2.10.3
59.	Vessel crew will keep a watch for marine mammals or sea turtles and reduce speed and/or alter course if practicable to avoid a collision.	Section 10.3
60.	In the event that a vessel strikes a marine mammal or sea turtle, Chevron will contact the C-NLOPB, DFO's Canadian Coast Guard Regional Operations Centre, as soon as reasonably practicable but no later than 24 hours following the collision. Indigenous groups will also be notified.	Section 2.10.3
61.	Lighting on supply vessels will be reduced to the extent that worker safety and safe operations is not compromised. Reduction of light may include avoiding use of unnecessary lighting, shading, and directing lights towards the deck.	Section 2.10.3 Section 9.3
62.	The supply vessels selected for this Project will be equipped for safe all-weather operations, including stability in rough sea conditions and inclement weather. In addition, measures to reduce superstructure icing hazards on supply vessels will be implemented as necessary and may include (DFO 2012): • Reducing vessel speed in heavy seas • Placing gear below deck and covering deck machinery, if possible • Moving objects that may prevent water drainage from the deck • Making the ship as watertight as possible • Manual removal of ice if required under severe icing conditions	Section 2.10.3 Section 16.4
63.	A supply vessel will remain on standby at the MODU at all times in the event that operational assistance or emergency response support is required.	Section 2.10.3
64.	Supply vessels will undergo Chevron's internal verification process, as well as additional external inspections / audits inclusive of the C-NLOPB pre-authorization inspection process, in preparation for the Project.	Section 2.10.3 Section 16.4
65.	Searches for stranded birds and recovery, rehabilitation, release and documentation of birds will be conducted on supply vessels as outlined above for the MODU.	Section 9.3
66.	The regional ECCC-CWS office will be contacted for separation distances and altitudes between helicopters transiting to and from the MODU and migratory bird nesting colonies, as per ECCC-CWS guidelines (Government of Canada 2018) and routes will comply with provincial Seabird Ecological Reserve Regulations, 2015. Specific details will be provided in the environmental protection plan (EPP).	Section 9.3 Section 11.3

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
67.	Supply vessel routes transiting to and from the MODU will be planned to avoid passing within 300 m of migratory bird nesting colonies during the nesting period and will comply with provincial Seabird Ecological Reserve Regulations, 2015 and federal guidelines in order to minimize disturbance to colonies (ECCC 2017b). Specific details will be provided in the EPP.	Section 9.3 Section 11.3
Well Abandonment		
68.	A seabed survey will be conducted at the end of the drilling program using a remotely operated vehicle (ROV) to survey the seabed for debris.	Section 2.10.3
69.	Once wells have been drilled to True Vertical Depth and well evaluation programs completed (if applicable), the well will be plugged and abandoned according to applicable Chevron practices and C-NLOPB requirements. The final well abandonment program has not yet been finalized; however, these details will be confirmed to the C-NLOPB as planning for the Project continues.	Section 2.10.3 Section 8.7 Section 11.3
70.	Well decommissioning will be carried out as per Chevron's internal procedures and with the *Newfoundland Offshore Petroleum Drilling and Production Regulations*.	Section 8.7
71.	Given the water depths in the Project Area, approval from the C-NLOPB may be sought in order to leave the wellheads in place. Other subsea infrastructure will be removed; the BOP will only be removed once the cement plugs are in place.	Section 8.7
72.	If wellheads are to be removed, a mechanical casing / wellhead cutting device from the MODU will be used. The seafloor will then be inspected by a ROV or other equipment to verify that no obstructions or equipment remain in place.	Section 8.7 Section 11.3
73.	Chevron will communicate the locations of abandoned wellheads (if applicable) to Indigenous and non-Indigenous fishers and the Canadian Hydrographic Services for future nautical charts.	Section 12.3 Section 13.3
Accidental Events		
74.	Chevron will implement multiple preventative and response barriers to manage risk of incidents occurring and mitigate potential consequences. Refer to Section 2.5 for specific information on well control and blowout prevention, and Section 15.4 for a description of Chevron's contingency planning and emergency response measures.	Section 15.5.1 Section 15.5.2 Section 15.5.3
75.	As noted in Section 15.4, the Project will include contingency plans for responding to specific emergency events, including potential spill or well control events. The contingency plans, such as an Oil Spill Response Plan, will be submitted to the C-NLOPB prior to the start of any drilling activity as part of the Operations Authorization process.	Section 15.5.1 Section 15.5.2 Section 15.5.3
76.	Chevron will undertake a Spill Impact Mitigation Assessment (SIMA) / Net Environmental Benefit Analysis (NEBA) as part of the Operations Authorization process with the C-NLOPB. The SIMA is a structured process that will qualitatively evaluate the risks and trade-offs of feasible and effective response options, when compared to no action. The SIMA process will inform the selection of an overall spill response strategy for the Project. If identified as a preferred response option, use of chemical dispersants would not occur without first obtaining regulatory approval.	Section 15.5.1 Section 15.5.2 Section 15.5.3 Section 15.5.5 Section 15.5.6
77.	In the unlikely event of a spill, specific monitoring (e.g., environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.	Section 15.5.1 Section 15.5.2 Section 15.5.3 Section 15.5.5 Section 15.5.6

Table 17.2 Summary of Standard and Project Specific Mitigation

No.	Proponent Commitments	EIS Reference
78.	An Indigenous Fisheries Communication Plan will be implemented, which would include procedures for informing Indigenous communities of an accidental event and planned response. Emphasis will be on timely communication, allowing fishers to haul out gear from affected areas, and reducing potential of fouling of fishing gear.	Section 15.5.5
79.	A Fisheries Communication Plan will be implemented, which would include procedures for informing Indigenous communities of an accidental event and planned response. Emphasis will be on timely communication, allowing fishers to haul out gear from affected areas, and reducing potential of fouling of fishing gear. This engagement will be coordinated through One Ocean, Fish, Food and Allied Workers-Unifor, Ocean Choice International, Association of Seafood Producers, and Groundfish Enterprise Allocation Council.	Section 15.5.6
80.	Chevron will maintain ongoing communications with the NAFO Secretariat, through DFO as the Canadian representative, regarding the occurrence of an accidental event, including timely communication on restricted access zones and applicable buffers.	Section 15.5.6
81.	Chevron will develop and implement a compensation program for damages resulting from Project activities. This compensation program will be developed in consideration of C-NLOPB guidelines, including the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (C-NLOPB and CNSOPB 2017).	Section 15.5.5 Section 16.6.6

17.2.2 Summary of Monitoring and Follow-up Requirements

Under CEAA 2012, a follow-up program is defined as a program for “verifying the accuracy of the environmental assessment of a designated project” and “determining the effectiveness of any mitigation measures.” Offshore Newfoundland and Labrador (NL) has a long history of oil and gas exploration and well-established oil production operations; therefore, most potential environmental interactions are well understood, and standard mitigation measures are well known. Proposed monitoring and follow-up programs are described below.

17.2.2.1 Marine Fish and Fish Habitat

As noted in mitigation #22, Chevron will conduct an imagery-based seabed survey at the proposed well sites to confirm the absence of sensitive environmental features, such as habitat-forming corals or Species at Risk (SAR) prior to drilling. Chevron will also conduct a visual survey of the seafloor using an ROV after drilling activities (refer to mitigation #68) to assess the visual extent of sediment dispersion and validate drill waste modelling predictions. The specific details of the follow-up program will be determined in consultation with the C-NLOPB and DFO in consideration of the pre-drill survey results. While drilling activities are taking place for the first well in the EL, surveys will be implemented to verify the accuracy of the environmental assessment as it pertains to underwater sound levels. The program will be developed in consultation with DFO and the C-NLOPB.

In the unlikely event of a spill, specific monitoring (e.g., environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

17.2.2.2 Marine and Migratory Birds

For the duration of the drilling program for each well:

- Daily, systematic searches will be conducted for stranded birds on the MODU and supply vessels, and this effort documented, by trained personnel in accordance with facility-specific search protocols (refer to mitigation #26 and 65);
- Recovery, rehabilitation, release and documentation of stranded birds will be conducted according to *Procedures for Handling and Documenting Stranded Birds Encountered on* Infrastructure *Offshore Atlantic Canada* (ECCC 2017b) and associated permit conditions under the *Migratory Birds Convention Act* (MBCA) authorizing the capture and handling of migratory birds;
- Results of the monitoring program will be shared with the regulators to help further improve the understanding of bird strandings and mortality in the NL offshore area.

In the unlikely event of a spill, specific monitoring (e.g., environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

17.2.2.3 Marine Mammals and Sea Turtles

Chevron will develop a marine mammal and sea turtle monitoring plan to be implemented during VSP surveys as outlined in Sections 10.3.1.2 and 10.3.2.2. The plan will include MMO requirements, shutdown, and ramp-up procedures and reporting requirements. A report of the observational program will be submitted annually to the C-NLOPB and DFO, including documentation of marine mammal and sea turtle sightings.

In the unlikely event of a Project vessel collision with a marine mammal or sea turtle, Chevron will contact DFO through their 24-hour emergency contact number (1-888-895-3003).

In the unlikely event of a spill, specific monitoring (e.g., environmental effects monitoring) and follow-up programs may be required and will be developed in consultation with applicable regulatory agencies.

17.2.2.4 Special Areas

As noted in mitigation #22, Chevron will conduct an imagery-based seabed survey at the proposed well site(s) to confirm the absence of sensitive environmental features, such as habitat-forming corals or SAR prior to drilling. Chevron also plans to conduct a visual survey of the seafloor using an ROV after drilling activities to assess the visual extent of sediment dispersion and validate drill waste modelling predictions (refer to mitigation #68). The specific details of the follow-up program will be determined in consultation with the C-NLOPB and DFO in consideration of the pre-drill survey results.

17.2.2.5 Indigenous Communities and Activities

The implementation of the Project's Indigenous Fisheries Communication Plan (refer to mitigation #10) will allow for ongoing feedback from Indigenous fishing interests about the implementation and effectiveness of related mitigation measures, and about changes in fishing activities or science research relevant to the Project Area. Instances of suspected gear damage will be communicated to Chevron and will be followed up through the operator gear compensation program as initiated by a claimant (refer to mitigation #9).

17.2.2.6 Commercial Fisheries and Other Ocean Users

The implementation of the Project's Fisheries Communication Plan (refer to mitigation #11) will allow for ongoing feedback from fishing interests about the implementation and effectiveness of related mitigation measures, and about changes in fishing activities or science research relevant to the Project Area. Instances of suspected gear damage will be communicated to Chevron and will be followed up through the operator gear compensation program as initiated by a claimant (refer to mitigation #9).

In the unlikely event of a spill, specific monitoring and follow-up programs may be required and will be developed in consultation with regulatory agencies, Indigenous communities, and fisheries stakeholders as applicable.

17.3 Residual Environmental Effects

Chapters 8 to 13 of this EIS present the residual environmental effects for routine operations for each VC. Table 17.3 summarizes the residual effect findings for each VC and indicates the significance of these effects. Chapter 15 of this EIS presents the residual environmental effects for accidental events for each VC. Table 17.4 summarizes the residual effect findings for each VC and indicates the significance of these effects. Where an effect is predicted to be significant (refer to Chapters 8-13 for significance criteria for each VC), the likelihood of that effect occurring is also presented.

Table 17.3 Summary of Residual Effects for Routine Operations

Valued Components	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation Reference (refer to Table 17.2)	Residual Effect Characterization					Ecological / Socio Economic Context	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Geographic Extent	Duration	Frequency	Reversibility			
Marine Fish and Fish Habitat	s. 5(1)(a)(i)	Change in Risk of Mortality or Physical Injury	Presence and Operation of a MODU	Refer to Section 8.3	L	PA	ST	IR	R	D	N	N/A
			VSP		L	PA	ST	IR	R	D	N	N/A
			Discharges		L	PA	MT-LT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of a MODU		L	PA-LAA	MT	IR	R	D	N	N/A
			VSP		L	PA	ST	IR	R	D	N	N/A
			Discharges		L	PA	MT-LT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST-LT	IR	R	D	N	N/A
			Supply and Servicing		L	LAA	MT	IR	R	D	N	N/A
Marine and Migratory Birds	s. 5(1)(a)(iii)	Change in Risk of Mortality or Physical Injury	Presence and Operation of a MODU	Refer to Section 9.3	L	LAA	ST	IR	R	D	N	N/A
			VSP		N-L	PA	ST	IR	R	D	N	N/A
			Discharge		L	PA	ST	IR	R	D	N	N/A
			Well Testing and Flaring		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing		L	LAA	ST	IR	R	D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of a MODU		L	LAA	ST	IR	R	D	N	N/A
			VSP		N	PA	ST	UL	R	D	N	N/A
			Discharge		L	PA	ST	UL	R	D	N	N/A
			Well Testing and Flaring		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing		L	LAA	ST	IR	R	D	N	N/A
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	Change in Risk of Mortality or Injury	Presence and Operation of a MODU	Refer to Section 10.3	N	PA	ST-MT	UL	R	D	N	N/A
			VSP		N-L	PA	ST-MT	UL	R	D	N	N/A
			Well Abandonment		N-L	PA	ST	UL	R	D	N	N/A
			Supply and Servicing		N-L	LAA	ST-MT	UL	R	D	N	N/A
		Change in Habitat Quality and Use	Presence and Operation of a MODU		L	PA-LAA	ST-MT	IR	R	D	N	N/A
			VSP		L	PA	ST-MT	IR	R	D	N	N/A
			Discharge		N	PA	ST	UL	R	D	N	N/A
			Well Abandonment		N	PA	ST	UL	R	D	N	N/A
			Supply and Servicing		L	LAA	ST-MT	IR	R	D	N	N/A

Table 17.3 Summary of Residual Effects for Routine Operations

Valued Components	Area of Federal Jurisdiction (CEAA, 2012 s.5 “environmental effect”)	Potential Effect	Project Activity	Mitigation Reference (refer to Table 17.2)	Residual Effect Characterization					Ecological / Socio Economic Context	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Geographic Extent	Duration	Frequency	Reversibility			
Special Areas	s. 5(1)(b)(i)	Change in Habitat Quality	Presence and Operation of a MODU	Refer to Section 11.3	L-M	LAA	ST	IR	R	D	N	N/A
			VSP		L	PA	ST	IR	R	D	N	N/A
			Discharge		L-M	PA	ST-MT	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST	IR	R	D	N	N/A
			Supply and Servicing		L	LAA	ST	IR	R	D	N	N/A
Indigenous Communities and Activities	s.5(1)(c)(i) s.5(1)(c)(iii)	Change in Health and Socio-economic Conditions	Presence and Operation of a MODU	Refer to Section 12.3	N-L	RAA	ST	IR	R	D	N	N/A
			VSP		N-L	RAA	ST	IR	R	D	N	N/A
			Discharge		N-L	RAA	MT	IR	R	D	N	N/A
			Well Testing and Flaring		N-L	RAA	ST	IR	R	D	N	N/A
			Well Abandonment		N-L	RAA	MT-LT	IR	R	D	N	N/A
			Supply and Servicing		N-L	RAA	ST	IR	R	D	N	N/A
	s.5(1)(c)(i) s.5(1)(c)(iii)	Change in Current Use of Lands and Resources for Traditional Purposes	Presence and Operation of a MODU		N-L	RAA	ST	IR	R	D	N	N/A
			VSP		N-L	RAA	ST	IR	R	D	N	N/A
			Discharge		N-L	RAA	ST	IR	R	D	N	N/A
			Well Testing and Flaring		N-L	RAA	ST	IR	R	D	N	N/A
			Well Abandonment		N-L	RAA	ST	IR	R	D	N	N/A
			Supply and Servicing		N-L	RAA	ST	IR	R	D	N	N/A
Commercial Fisheries and Other Ocean Users	s. 5(2)(b)(i)	Change in Availability of Resources	Presence and Operation of a MODU	Refer to Section 13.3	L	PA	ST	IR	R	D	N	N/A
			VSP		L	PA	ST	IR	R	D	N	N/A
			Discharge		L	PA	ST	IR	R	D	N	N/A
			Well Abandonment		L	PA	ST-P	IR	R-I	D	N	N/A
			Supply and Servicing		L	LAA	ST	IR	R	D	N	N/A
					Magnitude: N: Negligible L: Low M: Moderate H: High	**Geographic Extent:** PA: Project Area LAA: Local Assessment Area RAA: Regional Assessment Area	**Duration:** ST: Short-term MT: Medium-term LT: Long-term P: Permanent	**Frequency:** UL: Unlikely S: Single event IR: Irregular event R: Regular event C: Continuous	**Reversibility:** R: Reversible I: Irreversible	**Ecological/Socio-Economic Context:** D: Disturbed U: Undisturbed	**Significance:** S: Significant N: Not Significant	**Likelihood:** U: Unlikely L: Likely N/A: Not applicable

Table 17.3 Summary of Residual Effects for Routine Operations

Valued Components	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Project Activity	Mitigation Reference (refer to Table 17.2)	Residual Effect Characterization					Ecological / Socio Economic Context	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Geographic Extent	Duration	Frequency	Reversibility			

Key/Note:

VC specific definitions included for each VC in Chapters 8-13.

Environmental Effects under CEAA 2012:

5(1)

(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:
- (i) fish as defined in section 2 of the *Fisheries Act*,
- (ii) aquatic species as defined in subsection 2(1) of the *Species at Risk Act*,
- (iii) migratory birds as defined in subsection 2(1) of the *Migratory Birds Convention Act*, 1994, and
- (iv) any other component of the environment that is set out in Schedule 2 of [CEAA 2012];

(b) a change that may be caused to the environment that would occur
- (i) on federal lands,
- (ii) in a province other than the one in which the act or thing is done or where the physical activity, the designated project or the project is being carried out, or
- (iii) outside Canada; and

(c) with respect to Aboriginal peoples, an effect occurring in Canada of any change that may be caused to the environment on
- (i) health and socio-economic conditions,
- (ii) physical and cultural heritage,
- (iii) the current use of lands and resources for traditional purposes, or
- (iv) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Certain additional environmental effects must be considered under section 5(2) of CEAA 2012 where the carrying out of the physical activity, the designated project, or the project requires a federal authority to exercise a power or perform a duty or function conferred on it under any Act of Parliament other than CEAA 2012.

5(2)

(a) a change, other than those referred to in paragraphs (1)(a) and (b), that may be caused to the environment and that is directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the physical activity, the designated project or the project; and

(b) an effect, other than those referred to in paragraph (1)(c), of any change referred to in paragraph (a) on
- (i) health and socio-economic conditions,
- (ii) physical and cultural heritage, or
- (iii) any structure, site or thing that is of historical, archaeological, paleontological or architectural significance.

Table 17.4 Summary of Residual Effects for Accidental Events

Valued Components	Area of Federal Jurisdiction (CEAA, 2012 s.5 "environmental effect")	Potential Effect	Accidental Event Scenario	Mitigation Reference (refer to Table 17.2)	Residual Effect Characterization					Ecological / Socio Economic Context	Significance of Residual Effect	Likelihood of Significant Effect
					Magnitude	Geographic Extent	Duration	Frequency	Reversibility			
Marine Fish and Fish Habitat	s. 5(1)(a)(i)	Change in Risk of Mortality or Physical Injury / Change in Habitat Quality and Use	Well Blowout Incident	Refer to Section 15.5.1	M-H	RAA	ST-MT	S	R	D	N	N/A
			Marine Diesel Spill		M	RAA	ST-MT	S	R	D	N	N/A
			SBM Spill		L	LAA	ST-LT	S	R	D	N	N/A
Marine and Migratory Birds	s. 5(1)(a)(iii)	Change in Risk of Mortality or Physical Injury / Change in Habitat Quality and Use	Well Blowout Incident	Refer to Section 15.5.2	H	RAA	ST-MT	S	R	D	S	U
			Marine Diesel Spill		L	LAA	ST	S	R	D	S	U
			SBM Spill		L	LAA	ST	S	R	D	N	N/A
Marine Mammals and Sea Turtles	s. 5(1)(a)(ii)	Change in Risk of Mortality or Physical Injury / Change in Habitat Quality and Use	Well Blowout Incident	Refer to Section 15.5.3	M	RAA	MT-LT	S	R	D	N	N/A
			Marine Diesel Spill		L	LAA	ST	S	R	D	N	N/A
			SBM Spill		L	LAA	ST	S	R	D	N	N/A
Special Areas	s. 5(1)(b)(i)	Change in Habitat Quality	Well Blowout Incident	Refer to Section 15.5.4	M-H	RAA	ST-LT	S	R	D	S	U
			Marine Diesel Spill		L-M	LAA-RAA	ST-MT	S	R	D	N	N/A
			SBM Spill		L	LAA	ST-LT	S	R	D	N	N/A
Indigenous Communities and Activities	s.5(1)(c)(i) s.5(1)(c)(iii)	Change in Health and Socio-economic Conditions / Change in Current Use of Lands and Resources for Traditional Purposes	Well Blowout Incident	Refer to Section 15.5.5	M-H	RAA	MT-LT	S	R	D	S	U
			Marine Diesel Spill		N-L	RAA	ST-MT	S	R	D	N	N/A
			SBM Spill		N-L	RAA	ST	S	R	D	N	N/A
Commercial Fisheries and Other Ocean Users	s. 5(2)(b)(i)	Change in Availability of Resources	Well Blowout Incident	Refer to Section 15.5.6	H	RAA	LT	S	R	D	N	N/A
			Marine Diesel Spill		L	RAA	ST-MT	S	R	D	N	N/A
			SBM Spill		L	LAA	ST	S	R	D	N	N/A

Notes:

* In certain scenarios, effects may extend beyond the RAA.

See Table 17.3 for key.

17.4 Summary of Predicted Environmental Changes and Effects and Their Relationship to Federal Jurisdiction and Decisions

To satisfy sections 5(1) and 5(2) of CEAA 2012, the EIS assesses and evaluates the potential environmental changes and resulting environmental effects that may result from the Project. Table 17.3 summarizes residual environmental effects from routine Project-related activities and Table 17.4 summarizes residual environment effects from accidental events. Table 17.5 summarizes the changes that may be caused by the Project on the components of the environment listed in sections 5(1)(a) and (b) of CEAA 2012, including those that are directly linked or necessarily incidental to federal decisions that would allow the Project to proceed. The changes noted in Table 17.5 are detailed below in Sections 17.4.1 through 17.4.3. Conclusions in this section are summarized from the analyses in Chapters 8 through 16 and are categorized as follows:

- changes to components of the environment within federal jurisdiction
- changes to the environment that would occur on federal lands, in another province, or outside Canada
- changes to the environment that are directly linked or necessarily incidental to federal decisions

Table 17.5 Summary of Changes to the Environment from Routine Activities and Unplanned (Accidental) Events

Topic	Changes
Changes to Components of the Environment within Federal Jurisdiction	
Marine Fish and Fish Habitat (including species at risk)	• Change in Risk of Mortality or Physical Injury • Change in Habitat Quality and Use
Marine and Migratory Birds (including species at risk)	• Change in Risk of Mortality or Physical Injury • Change in Habitat Quality and Use
Marine Mammals and Sea Turtles (including species at risk)	• Change in Risk of Mortality or Physical Injury • Change in Habitat Quality and Use
Changes to the Environment that Would Occur on Federal or Transboundary Lands	
Special Areas	• Change in Habitat Quality
Commercial Fisheries and Other Ocean Users	• Change in Availability of Resources
Indigenous Communities and Activities	• Change in Health and Socio-economic Conditions • Change in Current Use of Lands and Resources for Traditional Purposes
Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions	
Accord Acts Authorizations (Operations Authorization and Well Approval under the Accord Acts and *Newfoundland and Labrador Offshore Petroleum Drilling and Production Regulations*)	• Operations Authorizations and Well Approvals under the Accord Acts sanction offshore exploration drilling projects in their entirety. Therefore, the changes to the environment associated with Project activities and components are directly linked or necessarily incidental to these authorizations.
Authorization under section 35(2)(d) of the *Fisheries Act* (if applicable)	• Change in risk of mortality or physical injury and/or change in habitat quality and use that constitutes serious harm to fish that are part of or support a commercial, recreational, or Indigenous fishery, or to fish that support such a fishery.

17.4.1 Changes to Components of the Environment within Federal Jurisdiction

An environmental assessment is required, under section 5(1)(a) of CEAA 2012, to consider changes that may be caused to the following components of the environment that are within federal jurisdiction (i.e., within the legislative authority of Parliament): fish, as defined in section 2 of the *Fisheries Act;* aquatic species, as defined in section 2(1) of SARA; and migratory birds, as defined in section 2(1) of the MBCA. An assessment for these components is provided in Chapter 8 (Marine Fish and Fish Habitat), Chapter 9 (Marine and Migratory Birds), and Chapter 10 (Marine Mammals and Sea Turtles) and is summarized below.

As evaluated in Chapter 8, Project components and activities that occur in the marine environment have the potential to interact with the biological and physical components of the marine ecosystem, including the marine fish, marine plants, and the associated habitats which they depend on. A change in risk of mortality or physical injury for individual marine fish may result from the presence and operation of a MODU (light and sound emissions), VSP surveys (underwater sound), Project-related discharges (crushing or smothering from waste management activities) and well abandonment. A change in habitat quality and use for marine fish may result from the operation and presence of the MODU (light and sound emissions), VSP surveys (sounds emissions), Project-related discharges (alteration of habitat quality), well abandonment (underwater sound and/or change in benthic habitat), and supply and servicing operations (underwater sound). The primary interactions that may have adverse environmental effects on marine fish and fish habitat include underwater sound, lighting, and discharges in the environment associated with the Project, including those that may interact with sensitive benthic organisms and habitats (e.g., cold-water corals, sea pens, and sponges). With the implementation of applicable mitigation measures and adherence to industry standards, however, the residual effects are predicted to be low in magnitude, restricted primarily to the Project Area but could extend into the LAA during supply vessel operations. Potential mortality would be limited to benthic invertebrates within a localized footprint from burial and within a short distance from high levels of underwater sound. The number of individuals, or area of habitat that may be affected by Project activities, is not expected to have an overall or population-level effect on marine fish and fish habitat, and planned Project activities will not result in a detectable decline in overall abundance or changes to the spatial and temporal distributions of fish populations in the Project Area, LAA, or RAA. The potential for interactions between marine fish SAR and Project activities is considered low; therefore, the Project is not predicted to have implications on the overall abundance, distribution, or health of marine fish SAR or their eventual recovery. With implementation of mitigation and environmental protection measures, the residual environmental effects on marine fish and fish habitat (including SAR) are predicted to be not significant.

Potential effects pathways for a change in risk of mortality or physical injury and/or change in habitat quality and use for marine fish and fish habitat due to an oil spill include: reduction of water and/or sediment quality; reduced primary productivity due to a reduction in air-water gas exchange and light penetration; and lethal and sublethal effects from acute or chronic exposure to water-soluble fractions of hydrocarbons. The risk of exposure of fish and invertebrates to an oil spill depends on the type of oil and volume released, but also on the habitat these species occupy, their behaviour, the time of year, their life history, and the general health of the population at the time of the spill. Fish kills are typically brief and localized following a discrete spill event due to the rapid loss of the acutely lethal low-molecular weight components of oil as a result of dilution and weathering (Lee et al. 2015), the ability of motile species to detect and avoid impacted areas, and the ability of phytoplankton, zooplankton, and adult fish to metabolize hydrocarbons (Wolfe et al. 1996; Graham et al. 2010). Although the areas of potential effects delineated by the modelling results are relatively large (refer to Section 15.3 of the EIS), substantial portions of these areas would have low probabilities of occurrence of effects exceeding applicable thresholds even if the release is allowed to continue unmitigated. The implementation of mitigation measures would further reduce the already relatively low probabilities of oil extending beyond the RAA or reaching nearshore areas. In the unlikely event of a subsea blowout, mitigation (including emergency response measures, such as containment [e.g., capping stack] and recovery operations) would be implemented well before 160 days (model duration) elapse, thereby likely reducing the magnitude, duration, and geographic extent of the spill and associated residual environmental effects. With implementation of mitigation and environmental protection measures, the residual environmental effects from an accidental event on marine fish and fish habitat (including SAR) are predicted to be not significant.

As evaluated in Chapter 9, routine Project activities and components can interact with migratory birds and their associated habitat due to attraction of birds to artificial lighting on the MODU and supply vessels, operational discharges during well drilling and testing operations (including flaring), underwater sound emissions from VSP operations, and interactions with supply vessels and helicopter activities during supply and servicing. The greatest potential for environmental effects on marine and migratory birds is related to artificial lighting associated with presence and operation of a MODU, which may result in nocturnal attraction and stranding of birds (including Leach's storm-petrels) on the MODU. This will be mitigated through the development and implementation of protocols and training for systematic, daily searches, and for recovery, rehabilitation, and release of birds adhering to protocols detailed in ECCC's *Procedures for Handling and Documenting Stranded Birds Encountered on Infrastructure Offshore Atlantic Canada* (ECCC 2017b). Although Project-related components, activities and emissions may result in some localized, short-term interactions with marine and migratory birds in parts of the Project Area and LAA, primarily as a result of bird attraction to offshore lighting and other components, the Project is not predicted to result in a detectable decline in overall bird abundance or changes in the spatial and temporal distributions of bird populations within this area. The potential for interactions between individuals of species at risk and the Project is limited, and no identified critical habitat is present in the Project Area, LAA, or RAA. The Project is therefore not predicted to jeopardize the overall abundance, distribution, or health of SAR. With mitigation and environmental protection measures, the residual environmental effects on marine and migratory birds (including species at risk) are predicted to be not significant.

Accidental spill scenarios have potential to result in a change in risk of mortality or physical injury and/or a change in habitat quality and use for marine and migratory birds. Change in risk of mortality or physical injury to marine birds from exposure to hydrocarbons is manifested as hypothermia and drowning leading to death, and sub-lethal effects of lower reproductive rates or premature death. Hydrocarbon spills are not likely to cause a permanent change in habitat quality and use for marine and migratory birds. Prey availability may be reduced, or birds may avoid affected habitat. However, spill cleanup and natural weathering processes are likely to result in the eventual recovery of such habitat. A subsea blowout scenario has the greatest potential for causing environmental effects to marine and migratory birds. The actual effects of a blowout incident would largely depend on the duration and volume of the spill, as well as the environmental conditions at the time of the spill. In the event of a well blowout, Chevron would attempt direct intervention measures where appropriate and in consultation with regulators (e.g., capping stack, dispersants). Based on the characterization of residual effects, a precautionary conclusion is drawn that the residual adverse environmental effect of a blowout incident, large batch spill, or vessel spill is predicted to be significant for marine and migratory birds, but not likely to occur. The magnitude and extent of potential effects would be reduced with the application of spill response measures, therefore the risk of adverse effects on secure and at-risk to marine and migratory birds would be reduced.

As evaluated in Chapter 10, routine Project activities and components have the potential to interact with marine mammal and sea turtle species due to underwater sound produced by operation of the MODU, VSP survey, supply vessels, and helicopter overflights. These potential sources of disturbance, as well as operational discharges, could result in direct or indirect (e.g., changes in habitat quality) effects on marine mammals and sea turtles. There is also the risk of mortality or physical injury as a results of vessel collisions. The greatest potential for environmental effects on marine mammals and sea turtles related to underwater sound is from the MODU and supply vessels and to a lesser extent from the short duration VSP surveys and use of explosives (if required). It is possible that marine mammals may exhibit localized and temporary avoidance of the MODU, supply vessels, VSP survey, and detonations. Similarly, in the unlikely event that a sea turtle occurred in the Project Area, there could be localized avoidance of Project activities. The risk of injury and mortality from ship strikes is considered low, particularly since supply vessels will travel at 12 knots and will maintain a constant course and speed whenever possible. Similarly, the likelihood of a marine mammal and sea turtle incurring permanent hearing impairment and physical injury from exposure to air gun pulses from VSP surveys and explosive charges is low, given the short duration of the activity and the implementation of mitigation measures. The potential for interactions between most SAR and the Project is limited, although there is greater potential for Project interactions with fin and northern bottlenose whales. Nonetheless, effects would be temporary, negligible to low in magnitude given the planned mitigation measures, and there is no identified critical habitat in the Project Area, LAA, or RAA. The Project is therefore not predicted to jeopardize the overall abundance, distribution, or health of SAR. With mitigation and environmental protection measures, the residual environmental effects on marine mammals and sea turtles (including SAR) are predicted to be not significant.

Accidental spills have potential to result in a change in risk of mortality or physical injury and/or a change in habitat quality and use for marine mammals and sea turtles. The extent of potential effects will depend on how the spill trajectory and the VC overlap in both time and space (Frasier et al. 2020). Marine mammals and sea turtles may be exposed to oil via a combination of pathways (inhalation, ingestion, aspiration, and adsorption). Marine mammals and sea turtles that are closer to the site of the blowout are most likely to be exposed to a more constant flow and higher concentrations of recently released oil, as compared to species that are more prevalent in the nearshore. The likelihood, however, of a subsea blowout occurring is extremely low. In an actual event, emergency response measures would likely reduce the magnitude, duration and geographic extent of the spill, and therefore reduce the potential impacts on marine mammals and sea turtles. Based on consideration of the information presented in Section 15.5.3, the residual adverse environmental effects from the accidental event scenarios on marine mammals and sea turtles are predicted to be not significant.

17.4.2 Changes to the Environment that would Occur in Federal Lands, in Another Province, or Outside Canada

An environmental assessment is required, under section 5(1)(b) of CEAA 2012, to consider changes that may be caused to the environment that would occur on federal lands, in another province, or outside of Canada. Project activities and components described within the scope of this EIS have the potential to result in changes to the environment that would occur on federal lands, including federal submerged lands (i.e., the seabed) and the federal waters and airspace above those lands.

The EL is located offshore eastern Newfoundland in the Flemish Pass area, outside Canada's 200 nm EEZ. The Government of Canada manages fish stocks within the 200 nm EEZ from the Canadian coastline. Within these areas, the Canadian federal *Fisheries Act* provides protection to fisheries by managing the fish resources and habitats that support these activities. NAFO is an intergovernmental fisheries science and management body for fisheries resources in the Northwest Atlantic, including outside the Canadian EEZ. Therefore, routine Project activities have the potential to occur both inside and outside of Canada resulting in environmental changes and direct interactions that will extend to the environment outside NL or outside the marine waters under the jurisdiction of Canada. In addition to the direct environmental effects of the Project components and activities, the Project may also affect migratory species (such as fish, marine mammals, or birds) that extend to and/or move outside the areas under the jurisdiction of Canada, as described in Chapters 6 and 8 through 11.

Changes to marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles addressed above in Section 17.4.1, will also occur on federal submerged lands and in federal waters. This section, therefore, focuses on special areas, commercial fisheries and other ocean users, and Indigenous people and communities, with greater detail provided in Chapter 11 (Special Areas), Chapter 12 (Indigenous Communities and Activities), and Chapter 13 (Commercial Fisheries and Other Ocean Users).

As evaluated in Chapter 11, routine Project-related activities have the potential to affect the features of special areas which provide important ecological and biological functions for the species that use these areas. A change in habitat quality of special areas could potentially occur because of Project activities affecting the marine environment. The primary pathway for Project-related activities to affect the physical quality of special areas is the presence and operation of a MODU (light and sound emissions), the discharge of drill muds and cuttings and other emissions (localized effects on water and sediment quality), VSP surveys (underwater sound), supply vessel operations (underwater sound associated with vessel movement), and well abandonment (underwater sound and change in benthic habitat). Many of the offshore activities and associated disturbances will be localized, short-term and at a specific location. The implementation of mitigation measures will reduce direct or indirect potential effects on special areas identified for the presence of sensitive benthic habitats and marine species. Drilling sites will represent small areas of disturbance to benthic habitats within the extensive areas of marine environment of special areas in the offshore. Discharges, including drill cuttings, will be treated as per regulations and best practices prior to discharge. Special areas within the LAA have also been identified based on the presence of sensitive benthic habitats and to a lesser extent on fish and fish habitat, birds, marine mammals and sea turtles, and commercial fisheries. Routine Project activities in the LAA (e.g., supply and servicing) will not result in direct contact with the seabed and will therefore not physically disturb benthic animals or their habitats. With mitigation and environmental protection measures, the residual environmental effects on special areas are predicted to be not significant.

Special areas may be vulnerable to an accidental event, as degradation of their conditions may affect habitat quality and associated biological life cycles or cultural aspects. In the unlikely event of an accidental release of hydrocarbons, potential effects on special areas include degradation of the integrity of a special area such that it no longer fulfills the biological, ecological, or cultural function for which it was designated. Therefore, the assessment of accidental events on special areas is directly linked to that of the marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles VCs, particularly for accidental events where the physical effects on the biological resources found in these areas represent the potential effects of greatest concern. Overall, it is predicted that the residual adverse environmental effects associated with most accidental event scenarios on special areas will not be significant. However, should surface oil affect a large portion of the Seabird Foraging Zone in the Southern Labrador Sea Convention on Biological Diversity (CBD) Ecologically or Biologically Significant Area (EBSA) it could significantly affect the biological and ecological integrity of this special area. The implementation of mitigation measures would reduce the overall interaction with and extent/magnitude of effects from surface oiling for marine and migratory birds including those in the Seabird Foraging Zone in the Southern Labrador Sea CBD EBSA.

As evaluated in Chapter 12, the EIS Guidelines identify 41 Indigenous groups in Eastern Canada which may have an interest in the Project. The Project Area is located approximately 609 km from the nearest Indigenous community on the Island of Newfoundland (Miawpukek First Nation). There are no known physical and cultural sites, including structures, sites, or things of historical, archaeological, paleontological, or architectural significance within the Project Area or the LAA. Therefore, there are no pathways of effects from routine Project activities to changes in structures, sites or things of historical, archaeological, paleontological, or architectural significance due to the offshore location of the Project and localized extent of routine Project interactions.

Given the distance of the Project offshore and the limited geographic extent of predicted atmospheric and marine discharges arising from routine Project activities, effects from routine activities are unlikely to affect the physical or social health and wellbeing of Indigenous communities, except potentially indirectly as a result of effects on commercial communal or food, social, ceremonial (FSC) fishing, hunting, or other harvesting activities. The Project could affect commercial communal fisheries resources by direct or indirect effects on fished species or through effects on fishing activity (e.g., displacement from fishing areas, gear loss or damage, availability of fisheries resources). Although there is no known FSC fishing or harvesting taking place in the Project Area, routine Project activities could interact with migratory fish, bird or mammal species that may be harvested by Indigenous communities from onshore / nearshore harvesting sites. Adverse effects on fishing or harvesting activities could indirectly lead to changes in health and socio-economic conditions or cultural heritage of affected Indigenous communities. These effects are not predicted to occur to the extent that there would be a measurable change in revenue that could result in a change in health or socio-economic conditions for an Indigenous community. Similarly, the Project could interact with marine biota that could be considered important from a food, social or ceremonial perspective, although Project activities are not predicted to cause a change in quantity, quality or availability of traditional lands and resources that could result in a change in current use of lands and resources for traditional purposes. With mitigation and environmental protection measures, residual environmental effects on Indigenous communities and activities are predicted to be not significant.

As evaluated in Chapter 13, routine Project activities have the potential to interact directly with commercial fisheries, through displacement from fishing grounds and loss or damage to gear, and indirectly from physical or behavioural effects on commercially fished species, such as changes in fish health or quality, fish avoiding popular fishing grounds due to underwater sound, or changes in water quality. These direct and/or indirect effects have the potential to result in economic loss to commercial fisheries. For other human components and activities, behavioural effects on fish could indirectly affect research activities, and oil and gas activities may also limit certain areas for research or military exercises, which may result in changes in schedules, or relocation of vessels to alternate areas. The Project can result in residual adverse effects through a change in availability (including a change in quality of marine resources) that exist within the LAA. This includes resources that may be used for commercial fishing activity, offshore marine research, and military training exercises. The designated safety zone while drilling is occurring will result in restricted access for less than 0.01% of the Project Area. Residual adverse effects from routine Project activities on commercial fisheries, however, are not anticipated to result in the displacement of local fishers or prohibit the use of portions of the areas currently used for fishing for all or most of the season. A change in availability of fishing resources is not predicted, such that current levels within the RAA are affected for more than one fishing season. Likewise, for other ocean users, it is not expected they will be displaced or unable to use substantial portions of the areas currently used for one or more years or that economic losses due to relocation will be unmitigated. With the implementation of mitigation, such as communication with commercial fishers and other ocean users, and environmental protection measures, residual adverse environmental effects on commercial fisheries and other ocean users are predicted to be not significant.

Accidental spills can potentially affect Indigenous and non-Indigenous fisheries resources (e.g., direct and indirect effects on fished species) and/or fishing activity (e.g., displacement from fishing areas, gear loss or damage) in such a way that it may affect commercial, commercial communal, or FSC fishing. The extent of potential effects will depend on how the spill trajectory and Indigenous activities and species of interest intersect in space and time.

Although there is limited fishery activity in the vicinity of the Project Area, an oil spill could potentially extend to other parts of the RAA or even beyond RAA boundaries to reach harvesting areas, or affect species of interest that could be migrating through or using the spill-affected area. Surface oiling could have a short-term effect on commercial and commercial-communal fisheries due to the exclusion of fishing in areas where oil exceeds a thickness of 0.04 µm (a visible sheen). Affected areas would be closed to fishing to prevent human contact with spilled oil and consumption of potentially contaminated food sources. Fishery closures are intended to reduce risk of contamination of gear and protect consumers from consumption of potentially contaminated resources; however, they also have the potential to result in economic impacts.

Effects may also occur due to reduced consumer confidence and marketability of seafood following a spill (ITOPF 2011). The uptake of oil by exposed fish may pose a potential threat to human consumers and affect the marketability of catches. Physical contamination of fishing gear can also occur and in some cases, result in transfer of oil to the catch (ITOPF 2011). Although tainting of seafood is reversible through depuration, concerns and altered consumption patterns may linger after seafood has been determined safe for consumption, leading to potential continued economic losses (Yender et al. 2002; ITOPF 2011) that can have adverse economic effects.

The Project is not located within an area of high harvesting activity, and oil spill trajectory modelling has shown that in the unlikely event of a blowout incident, prevailing winds and currents are most likely to force released oil to the east, away from Canadian shorelines. Depending on the season, stochastic modelling predicted the average probability of shoreline oiling ranging from 1.9% (summer) to 8.7% (winter). Depending on the time of year and environmental conditions, areas susceptible to shoreline oiling included the entire east coast and much of the west coast of Newfoundland, the Avalon Peninsula, the southern shores of Labrador reaching into the Gulf of St. Lawrence, and Sable Island. Oil that reached shore was expected to be patchy, discontinuous, and weathered, as it would have taken a minimum of 10 days (and frequently much longer) to reach shore. In consideration of the result of spill modelling exercises and planned mitigation and financial compensation, the overall predicted residual environmental effects from an accidental event scenario on commercial fisheries and other ocean users is considered not significant. A compensation program will be developed in consideration of C-NLOPB guidelines, including the Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (C-NLOPB and CNSOPB 2017).

For Indigenous communities, effects to commercial communal and/or FSC fisheries could potentially affect the physical or social health and well-being of affected Indigenous communities. In the event of a spill, an effect on fished species or implementation of fishery closure could affect health and/or socio-economic conditions of Indigenous communities through reduced fisheries revenue, change in cultural practices and heritage, and/or direct (e.g., direct contact) or indirect exposure (e.g., ingestion of contaminated food) to contaminants. Based on Project-specific modelling, oil intersection with areas traditionally fished for commercial communal and/or FSC fisheries is unlikely; however, there is a possible interaction with species of interest to Indigenous communities, as a species may potentially move through a spill affected area prior to being harvested in a non-affected area. This may include fish species, as well as marine mammals (e.g., seals) and marine and migratory bird species (e.g., murres). The magnitude of effects on marine species depends on the timing of a spill and extent to which the spill trajectory may intersect with areas inhabited by marine species. Dispersed oil is unlikely to reach nearshore and coastal areas where birds may congregate (e.g. near breeding colonies) but fish, bird, and marine mammal species may migrate through affected areas offshore. Although human health risk will be mitigated through fisheries closure and ongoing monitoring (e.g., toxicity testing) as applicable, socio-economic and health conditions could be adversely affected, such that there is a detectable and sustained decrease in the quality of life of a community should Indigenous communities lose access to traditional use areas, sustain economic losses as a result of fisheries closures, and/or experience a reduced supply of resources for resulting in food insecurity for community members. Therefore, a significant adverse effect is conservatively predicted for Indigenous communities and activities. However, the likelihood of a significant adverse environmental effect occurring is low given the low probability of a blowout to occur (refer to Section 15.3.2.2) and the response measures that will be implemented to mitigate potential effects.

17.4.3 Changes to the Environment that are Directly Linked or Necessarily Incidental to Federal Decisions

An environmental assessment is required under section 5(2)(a) of CEAA 2012 to consider additional changes that may be caused to the environment and that are directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the designated project. The primary regulatory approvals necessary to conduct an offshore drilling program are an Operations Authorization (Drilling) and a Well Approval (Approval to Drill a Well) pursuant to the Accord Acts and their regulations. A *Fisheries Act* authorization is not expected to be required in support of the Project, as Project activities and components are not predicted to result in "serious harm to fish" (i.e., the death of fish or any permanent alteration to, or destruction of, fish habitat). Although drilling discharges will result in localized alteration of benthic habitat, these effects will not be permanent and are not anticipated to affect commercial, recreational, or Indigenous fishery species. In advance of drilling, Chevron will conduct seabed surveys at the proposed well sites to confirm the absence of sensitive environmental features (e.g., habitat-forming coral or species at risk) at the chosen drilling locations.

This section focuses on changes to the environment other than those referred to under section 5(1)(a) and (b) of CEAA 2012, which are considered in Sections 17.4.1 and 17.4.2, respectively, of this EIS.

The atmospheric environment (i.e., air quality, light and sound and greenhouse gas) is discussed extensively in this EIS primarily in terms of physical pathways. Air quality is discussed both in terms of Project related emissions (Section 2.8.1) and ambient conditions (Section 5.5). Greenhouse gases (GHGs) are discussed in Section 2.8.1. Light is discussed in Section 2.8.6. Underwater sound is discussed in Sections 2.8.5.1 and 2.8.5.2 and Appendix E, with atmospheric sound discussed in Section 2.8.5.3.

With a two wells per year assumption, it is estimated that up to 12,944 tonnes of carbon dioxide equivalent (CO_2e) could be released from non-routine flaring during well flow testing, per year. NL's annual GHG emissions is 10,300 kilotonnes CO_2e per year, as reported for 2016 (ECCC 2018). Therefore, the estimate for the Project represents approximately 0.12% of the province's annual GHG emissions. GHG reduction targets set by the Government of NL Climate Change Action Plan (2011) are as follows: 10% below 1990 levels by 2020; and 75% to 85% below 2001 levels by 2050. It is not expected that the Project's emissions will affect regional, provincial or federal emission targets, as CO_2e predictions represent a very minor increment to existing CO_2e levels for the Province.

Project activities that will result in air emissions include the fuel combustion from engines associated with the MODU, supply vessels, fixed and mobile deck equipment, and helicopters, and flaring during well test activity, if well testing is required. Chevron will comply with the provincial Air Pollution Control Regulations, Ambient Air Quality Objectives under the *Canadian Environmental Protection Act*, regulations under MARPOL, and the intent of the Global Gas Flaring Reduction Partnership (which seeks to increase the use of associated natural gas and thus reduce flaring and venting).

The MODU, supply vessels, and air gun source array during VSP operations will generate underwater sound. The type of MODU and the method of positioning (i.e., direct positioning or mooring system) will influence the level of underwater sound generated by a MODU. Continuous underwater sound will be generated by the MODU, whereas underwater sound from VSP operations is a temporary sound source. The extent to which sound travels is determined by environmental conditions, including water depths, salinity and temperature.

The MODU and supply vessel navigation and deck lighting will be operating 24 hours a day and thus generate artificial lighting throughout drilling and supply vessel operations as a requirement for maritime safety and crew safety. Flaring activity that is carried out during well flow testing will generate light and thermal emissions on the MODU on a temporary basis, at the end of drilling operations. During this time (one to three-month period), it is possible that there could be several, intermittent, short periods of flaring, lasting up to two or three days. The Project Area, an otherwise dark-sky site, will experience an increase in night-time light levels, where the MODU will be illuminated at night.

An environmental assessment is also required under section 5(2)(b) of CEAA 2012 to consider the effects of changes to the environment that are directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the designated project, if any of the following are affected:

- health and socio-economic conditions
- physical and cultural heritage and any structure, site or thing that is of historical, archaeological, paleontological or architectural significance

Project-related changes to the environment that are linked to federal decisions and that are required under the Accord Acts and the *Fisheries Act* are summarized in Table 17.6. Operations Authorizations and Well Approvals under the Accord Acts sanction offshore exploration drilling projects in their entirety. Therefore, Project activities and components are directly linked or necessarily incidental to these authorizations.

Project activities and components are not expected to result in changes to the environment that would have an effect on health conditions; physical and cultural heritage; or any structure, site or thing that is of historical, archaeological, paleontological or architectural significance for Indigenous or non-Indigenous people given the distance of the Project offshore NL. Effects on socio-economic conditions, however, may occur from the following potential changes to the environment:

- Change in risk of mortality or physical injury for fish
- Change in habitat quality and use for fish
- Change in availability of resources (for commercial and Indigenous fisheries)
- Change in traditional use for Indigenous people

Potential changes to the environment are, however, anticipated to be temporary and localized around the MODU and supply vessels, and other suitable fish habitat and fishing areas are readily available throughout the RAA. Therefore, these potential changes to the environment are not anticipated to substantially affect socio-economic conditions for commercial or Indigenous fishers (refer to Chapters 12 and 13).

Table 17.6 Summary of Changes to the Environment that are Potentially Contingent on Federal Decisions

Federal Decision	Changes (Potential Environmental Effects)	Affected VCs
Accord Acts Authorizations (Operations Authorization and Well Approval under the Accord Acts and *Newfoundland and Labrador Offshore Petroleum Drilling and Production Regulations*)	Change in Risk of Mortality or Physical Injury	• Marine Fish and Fish Habitat • Marine and Migratory Birds • Marine Mammals and Sea Turtles
	Change in Habitat Quality and Use	• Marine Fish and Fish Habitat Marine and Migratory Birds • Marine Mammals and Sea Turtles
	Change in Habitat Quality	• Special Areas
	Change in Availability of Resources	• Commercial Fisheries and Other Ocean Users
	Change in Health and/or Socio-economic Conditions or Change in Current Use of Lands and Resources for Traditional Purposes	• Indigenous Communities and Activities
Fisheries Act Authorization (Authorization for Serious Harm to Fish under section 35(2)(d) of the *Fisheries Act*)	Change in Risk of Mortality or Physical Injury	• Marine Fish and Fish Habitat
	Change in Habitat Quality and Use	• Marine Fish and Fish Habitat

17.5 Conclusions

Table 17.7 summarizes the significance of residual effects for each VC for routine operations, cumulative effects and accidental events, and, where applicable, the likelihood of significant residual adverse environmental effects occurring.

The environmental effects assessment for each VC examines the degree and nature of change to, and resulting effects on, the existing environment that may occur as a result of planned Project activities. The characterization of range of magnitude (range of natural variability) considers the reasonable worst-case scenario and is therefore considered to provide a conservative indication of effects. Mitigation has been proposed to reduce or eliminate adverse environmental effects for components of the Project scope (Table 17.2). They include both general Project mitigation measures and best management practices, as well as VC-specific mitigation measures. With the implementation of these proposed mitigation measures, residual adverse environmental effects of routine Project activities and components are predicted to be not significant for all VCs.

Table 17.7 Summary of Residual Environmental Effects for Routine Operations, Accidental Events and Cumulative Effects

VC	Routine Operations	Accidental Effects		Cumulative Effects
	Significance of Residual Environmental Effect	Significance of Residual Environmental Effect	Likelihood of Significant Effect	Significance of Residual Environmental Effect
Marine Fish and Fish Habitat	N	N	N/A	N
Marine and Migratory Birds	N	S	U	N
Marine Mammals and Sea Turtles	N	N	N/A	N
Special Areas	N	S	U	N
Indigenous Communities and Activities	N	S	U	N
Commercial Fisheries and Other Ocean Users	N	N	N/A	N

Key:
N = Not significant residual environmental effect (adverse)
S = Significant residual environmental effect (adverse)
U = Unlikely
N/A = Not Applicable

In the unlikely event of a Project-related accidental event resulting in the large-scale release of oil into the marine environment, a significant adverse effect is predicted for marine and migratory birds, special areas, and Indigenous communities and activities under certain circumstances. In the event of a well blowout, Chevron would attempt direct intervention measures where appropriate and in consultation with regulators (e.g., capping stack, dispersants). The magnitude and extent of potential effects would be reduced with the application of spill response measures; therefore, the risk of adverse effects would be reduced.

The Project is predicted to result in, and contribute to, several economic, social, and technological benefits realized on local, regional and national levels. Chevron has a National Social Performance Strategy that focuses our support to local partners to strengthen communities. Chevron will submit a Benefits Plan will address how Chevron will develop and implement an education, training, research and development expenditure program in NL; and will describe the consultative, monitoring, and reporting procedures that Chevron intends to establish to help achieve these commitments.

17.6 References

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