Suncor Exploration Drilling Project: Environmental Impact Statement

Chapter 17: Effects of Environment on the Project

Prepared for:
Suncor Energy

Prepared by:
Stantec Consulting Ltd.
141 Kelsey Drive
St. John's, NL A1B 0L2
Tel: (709) 576-1458
Fax: (709) 576-2126

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17.0 EFFECTS OF ENVIRONMENT ON THE PROJECT

As required under Section 19(1)(h) of CEAA 2012 and as specified in the EIS Guidelines (Part 2, Section 7.6.2; Appendix A), this chapter assesses and evaluates how local environmental conditions and natural hazards could adversely affect the Project, resulting in potential effects on the environment.

Appropriate understanding and careful consideration of environmental characteristics including winds, waves, currents, ice, precipitation, and other factors, such as seismicity, is required for offshore oil and gas exploration and production activities. Understanding these environmental characteristics enables offshore operations that are safe for workers, while also protecting the environment, equipment, and infrastructure. This includes avoiding or reducing the potential for incidents and accidents that may occur as a result of unplanned interactions between oil and gas operations and the physical environment of the applicable marine area.

17.1 Environmental Considerations

Key environmental factors that could potentially affect the Project include:

- Marine geology (sediment and seafloor instability; landslides)
- Climatology, weather and oceanographic conditions
- Marine icing, sea ice and icebergs

Much of the physical environment information presented herein is summarized from the in-depth description of the existing physical environment presented in Chapter 5 of this EIS, which should be consulted for further detail.

17.1.1 Marine Geology – Sediment and Seafloor Instability

The complex and dynamic seabed geomorphology of the eastern Newfoundland Offshore Area is primarily the product of modern oceanographic processes and past glacial activity. EL 1161 is within the Jeanne d'Arc Basin, a hydrocarbon prolific basin located on the eastern edge of the Grand Banks of Newfoundland (Grand Banks). The basin is a large asymmetric half-graben (trending north-northeast) that encompasses an area of approximate 14,000 km^2.

The surficial geology within EL1161 is comprised predominantly of Grand Banks Sand and Gravel, a basal transgressive deposit formed by winnowing of fines and is usually exposed between 90 and 110 m water depth or covered with a thin veneer of sand (Sonnichsen et al. 1994). The Grand Banks Drift seabed formation is highly irregular and underlies the Grand Banks Sand and Gravel as it extends into the EL. The Adolphus Sand Formation, which blankets the surrounding ELs, consists of a fine-grained sand matrix with minor gravel and shells (Sonnichsen et al. 1994).

Common offshore geohazards include slope instability, seismicity, sediment loading, shallow gas venting, gas hydrates, seabed instabilities and ice scour. Sediment failure is essentially a consequence of gradient, magnitude of seismic acceleration and sediment strength (IAAC 2021). Most continental margin sediments, except on slopes of more than a few degrees, are relatively stable and would require seismic accelerations associated with a large earthquake (magnitudes of five or greater) to fail (Nadim et al. 2005). NRCan analysis indicates that in any given area offshore Eastern Canada, there is a risk of a major landslide every 20,000 years and a minor one every few thousand years. Most of the large failures on the seabed date back more than 10,000 years during periods of glaciations when large amounts of sediment were deposited directly onto the slope of the continental shelf (NRCan 2013, in Amec 2014).

As documented in the Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador (IAAC 2021), slope stability risk within the Regional Assessment study area (which contains the Jeanne d'Arc Basin) is highest on the south side of the Orphan Basin and in the northern Flemish Pass. The steep slopes, abundant shallow gas and possibly greater seismicity make large landslides more frequent in the northern Flemish Pass and southern Orphan Basin and there is evidence of slope failures every 10,000 years or so. As a point of reference, for an offshore production facility with a life of 20 years, that corresponds to a one in 500 chance of a landslide (Cameron et al. 2014).

Failures in the Orphan Basin have resulted from earthquakes with magnitudes ranging from 5.6 to 7.6 (IAAC 2021; Cameron et al. 2014; Piper et al. 2018). Piper and Campbell (2005) indicate gas hydrates may also act as a trigger for failure in the Flemish Pass as observed by a pattern of younger debris-flow deposits in the central region of the area. Major sediment failures have occurred along the Flemish Pass, approximately 27,000 and 20,500 years ago, and are believed to have been a result of earthquake triggers (Cameron et al. 2014).

Oil and gas activities have been conducted safely in areas where submarine landslides have occurred. As an example, Ormen Lange is a gas field located in 850 to 1,100 m water depth in the southern part of the Norwegian Sea at the site of a submarine clay landslide. The slide occurred approximately 8,200 years ago and was likely triggered by an extremely strong, low-probability earthquake combined with excess pore pressure (Kvalstad et al. 2005; Leynaud et al. 2007). The slide area was approximately 90,000 m^2, moving a volume of 3,500 km^3 approximately 800 km out into deep water (Solheim et al. 2005; Statoil 2011). The slide generated a tsunami approximately 10 m to 20 m high that made landfall on the Norwegian coast (Norsk Oljemuseum 2011), Scotland, and the Faeroes (Nadim et al. 2005). A slide risk assessment conducted for the area indicated only natural causes (e.g., an extremely strong earthquake) would be a realistic trigger mechanism and the annual probability of a slide with a run out of the field development area is almost zero (Scandpower Risk Management AS 2004). As such, hazards related to the Ormen Lange subsea processing facilities from landslide risks were determined to be negligible (Nadim et al. 2005; Lloyd's Register Consulting 2013).

Given the location of EL 1161 with the Jeanne d'Arc Basin on the Grand Banks and its basically flat topography, there is little risk posed by landslides in the Project Area.

17.1.1.1 Potential Effects of Sediment and Seafloor Instability on the Project

Sediment and seafloor instability could cause damage to, or failure of, essential Project components / infrastructure (e.g., the drill string, wellhead, and/or BOP). As such, avoidance of geohazards associated with sediment and seafloor instability is critical to the success of drilling programs and to reduce the risk of accidental events.

Mitigation to reduce risks associated with sediment and seafloor instability is discussed in Section 17.2.

17.1.2 Climatology, Weather and Oceanographic Conditions

The Project Area is located within one of the harshest and most variable environmental operating areas in the world. The Newfoundland Grand Banks can be affected from storms that originate from the ocean or from the North American continent. Continental and marine storms have different characteristics and each varies in predictability.

Most of the observed precipitation events are in the form of rain, snow, and drizzle, while other precipitation types, such as mixed rain, freezing rain, and hail, occur less frequently. Rain occurs approximately 9.0% to 15.3% of the time for all months of the year and occurs 11.7% of the time on an annual basis. Snow is most likely to occur in February at 16.3% of the time but may reach 2.9% as early as November and 3.7% as late as April, with an annual average occurrence of 4.9%. Hail is infrequent for the Project Area, with the greatest occurrence at 0.5% in January. The occurrence of thunderstorms is greatest at about 0.1% of the time in August.

Over areas of the Grand Banks with water depths less than 100 m, including the Project Area, mean currents are generally weak and are dominated by wind-induced and tidal current variability (Seaconsult Ltd. 1988). An analysis of current meter measurement statistics from the BIO ODI (Gregory 2004) indicate current speeds are generally greatest in the late summer through early winter with average monthly mean speeds up to 5.3 cm/s in October and maximum monthly mean speeds of 24.6 cm/s in September.

17.1.2.1 Extreme Weather Conditions

Based on MSC50 hindcast data (Swail et al. 2006), monthly mean hourly wind speeds (1-hour average wind speeds for a height of 10 m above sea level) range from 6.1 m/s in July to 11.0 m/s in January with winds most frequently from the west in the fall and winter and from the southwest in spring and summer. In July winds are from the southwest for 38% of the time and from the southwest quadrant 76% of the time. In January winds are from the west 29% of the time and from the southwest through northwest quadrants 66% of the time. Monthly maximum wind speeds range from 19.2 m/s in July (from the west) to 32.4 m/s in February (from the northwest). Extreme wind speeds in the Project Area range from 23.8 m/s to 34.2 m/s for the 1-year and 100-year return periods, respectively.

Tropical storm systems can affect the Newfoundland offshore anytime during the Atlantic hurricane season (June 1 to November 30), but most activity generally occurs in the late summer to early fall. An analysis of tropical storm history indicates 37 storms passed near the Project Area during the period 1992 to 2021. Five of the 37 storms were of hurricane strength when they passed near the Project Area, with the most recent being Gonzalo, which passed 92.6 km (50 NM) to the northwest of the Project Area midday on

October 19, 2014. Prior to Gonzalo in 2014 the last hurricane that tracked near the Project Area was Alex on 6 August 2004 with maximum sustained surface winds of 139 km/hr (75 knots). Historically, the largest reported sustained surface wind speed, within the 278 km (150 NM) search area, for those 37 storms was 148 km/hr (80 knots) (extratropical cyclone) for Irene (October 19, 1999).

Rapidly deepening storm systems known as weather bombs frequently cross the Grand Banks (Husky Energy 2018). These storms explosively deepen in the warm waters off Cape Hatteras and move northeast across the Grand Banks (Oceans Ltd. 2010). Wind speeds of 49.4 m/s were recorded at Hibernia as one such storm moved through the area on February 11, 2003 (Oceans Ltd. 2016). Anemometers on all Grand Banks platforms (i.e., Henry Goodrich, Terra Nova, and Hibernia) registered their maximum anemometer wind speeds during the storm gusts (Husky Energy 2018).

Ocean waves are created by wind at the air/water interface. Based on MSC50 hindcast data (Swail et al. 2006), monthly mean significant wave heights in the Project Area range from approximately 1.7 m in July to 4.0 m in January. Waves are predominantly from the southwest from spring through summer and shift to the southwest through northwest for fall and winter. The most severe sea states occur in December through February when maximum significant wave heights reach up to 14.0 m. The largest waves are from the southwest with associated peak periods in the 14 to 16 s range. Maximum significant wave height is lowest in July (6.1 m), with an associated peak period of 10.8 s. Extreme significant wave heights for the Project Area range from 9.5 m to 15.3 m for the 1-year and 100-year return periods, respectively.

Storm surge, or the abnormal rise of seawater level generated by a storm, can pose a threat to infrastructure in coastal areas, particularly during high tide. The predicted 100-year return period storm surge in the northwest Atlantic at MSC50 Node M6010432 is 90 cm (Bernier and Thompson 2006).

17.1.2.1.1 Potential Effects of Extreme Weather Conditions on the Project

Adverse weather and oceanographic conditions (e.g., high winds, large waves, low visibility or freezing precipitation) may affect Project activities (e.g., the movement and positioning of the MODU, transportation and receipt of personnel, equipment and other materials, and drilling operations).

Extreme wind and waves have the potential to increase stress on surfaces, superstructures and vessels and disrupt scheduling of marine operations. High wind and wave conditions could delay loading and offloading of cargo to the MODU, or the operation of the MODU itself. In the unlikely event of a spill, it could also affect spill response operations, including the availability and effectiveness of response methods.

Thunderstorms, which can occur at any time of the year (albeit infrequently), could affect aircraft movements, due to the potential for lightning strikes, strong downbursts of wind, and hail.

Mitigation to reduce risks associated with operating in extreme weather is discussed in Section 17.2.

17.1.2.2 Fog and Other Environmental Factors Reducing Visibility

Visibility is affected by the presence of fog, the number of daylight hours, and the frequency and type of precipitation. The Project Area and surrounding areas have some of the highest occurrence rates of marine fog in North America. Advection fog is particularly heavy in spring and summer when the air-sea temperature differences are greatest. The frequency distribution of visibility from ICOADS, 1980 to 2019, indicates visibility within the Project Area varies considerably throughout the year. Visibility in the ICOADS dataset, where observations span 1 January 1980 to 30 June 2019, is classified as very poor (<0.5 km), poor (0.5 to 1 km), fair (1 to 10 km) or good (greater than 10 km). The annual distribution of visibility is as follows: very poor 18% of time, poor 3% of the time, fair 17% of the time, and good 62% of the time. Visibility is best from September through March when fair or good visibility (greater than 1 km) occurs approximately 87 to 91% of the time each month. Visibility is poorest in July, with very poor visibility occurring 45% of the time.

17.1.2.2.1 Potential Effects of Fog and Other Factors Reducing Visibility on the Project

Fog is a common occurrence in the region, and can be dangerous for offshore operations, particularly when ice or other hazards and human activities are present. Environmental conditions resulting in poor visibility can hinder offshore supply vessel and helicopter transportation, potentially resulting in delay of supply and personnel movement to and from the MODU. Poor visibility could also increase the potential for accidental events (e.g., a vessel or helicopter collision).

Mitigation to reduce risks associated with fog is discussed in Section 17.2.

17.1.2.3 Seismic Events and Tsunami

Canada’s eastern continental margin is tectonically passive, and seismicity is relatively rare throughout much of the region. One of the major tectonic features of the Jeanne d’Arc Basin is the Murre fault, which bounds the basin on its west side and separates pre-Mesozoic metamorphosed Precambrian and Paleozoic basement rocks from Mesozoic strata within the basin (Hurley et al. 1992). Other major tectonic features of the basin include the Cumberland Belt Transfer Zone, which bounds it to the north, the Voyager fault which bounds it to the east and the Egret Fault in the south (Hurley et al. 1992; Tankard and Welsink 1987).

Based on the probability of earthquake occurrences across Canada, the Jeanne d’Arc Basin is classified as having a low to moderate seismic hazard (IAAC 2021; NRCan 2018a; 2018b). According to the National Earthquake Database, no seismic events with a magnitude greater than 5 were recorded within 278 km (150 NM) of the site between 1985 and 2022 (NRCan 2022).

Tsunamis are long-period gravity waves generated in a body of water by an impulsive disturbance that vertically displaces the water column. Tsunamis can be generated by earthquakes, landslides, volcanic eruptions and even explosions or the impact of cosmic bodies such as meteorites (Husky Energy 2018). The tsunami hazard along the Atlantic Coast of Canada is relatively low. A preliminary tsunami hazard assessment of the Canadian coastline conducted by Leonard et al. (2012), indicates an expected recurrence of wave runup exceeding 1.5 m every 300 to 1,700 years. Larger runup greater than 3 m would have a recurrence interval of approximately 600 to 4,000 years.

Given the relatively short duration of Project activities, the probability of a major seismic event or tsunami occurring during the life of the Project is considered low.

17.1.2.3.1 Potential Effects of Seismic Events and Tsunami on the Project

A seismic event could disrupt Project activities and increase the risk of potential accidental events. A seismic event could also contribute to sediment and seafloor instability.

As described above, the likelihood of a tsunamis affecting the Project Area has been assessed and considered low. In the deep ocean, tsunamis have a low wave height and very long wave period and pose little hazard to floating or fixed offshore structures (e.g., ISO 2005). Tsunamis can be extremely destructive when reaching the coastline; when reaching shallow water, the tsunami wave can break and wash inland with great power. For offshore structures the greatest hazard from tsunamis results from water inflow and outflow in the form of waves and currents. Waves can be significant in shallow water when encountering shoaling effects causing substantial actions on structures. For offshore, the potential for a tsunami wave breaking when propagating from the deep Atlantic Ocean over the Grand Banks was recently assessed and found to be unlikely (IR-104-02 in Husky Energy 2018). The assessment found that while a 'typical' submarine earthquake generated tsunami in the Atlantic Ocean, with associated wave height of 1 m (wave period of 200 s; wavelength of 40 km), may increase in height to from 2.2 to 3.2 m (wavelength decrease to 4 to 8 km) due to shoaling effects of encountering the shallower Grand Bank, it would still not steepen enough to break (IR-104-02 in Husky Energy 2018): these ratios of wave height to wavelength are much less than 1/7, the limiting steepness for wave breaking.

Mitigation to reduce risks associated with seismic events and tsunamis is discussed in Section 17.2.

17.1.3 Marine Icing, Sea Ice and Icebergs

Marine icing can result from freezing precipitation or a combination of low ambient air temperature, low sea surface temperatures, and wind-induced sea spray. Vessel icing in the Project Area is most likely to occur between November and May and is greatest in February when the icing potential approaches 32%. Icing potential decreases after February in response to warming air and sea surface temperatures, reducing to 5% in April. The frequency of occurrence for moderate, heavy, or extreme icing potential is greatest in February at 11%. Extreme icing potential is greatest in February at 1.8%. No icing potential is reported for June through October. Annually, the frequency of occurrence of icing is 7.2%, with 5.0% of that being light icing.

Large variations in sea extent in the Project Area are common from year to year, as well as in any given year, on time scales of days to weeks and over comparatively small geographic scales. For any given week in the ice season, sea ice is more likely of greater concentration and thickness in the west and less severe farther offshore to the east (CIS 2011). With each passing week, there is potential that thicker sea ice to the west and north will continue to drift farther offshore (south and east). For most of the Project Area the frequency of presence of sea ice during February through April is 1% to 15%, or about as frequent as every six or seven years. A review of the CIS weekly sea ice charts for 2011 to 2018 indicates only one occurrence of sea ice in the Project Area. While there are some weeks from 2011 to March 2022 during which the sea ice reaches the edge of the Project Area, the ice does not enter. Further information on regional ice conditions in this area is provided in the Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador (IAAC 2021). There is potential for landfast ice to form nearshore and extend from a few metres to several hundred kilometres offshore.

A query of both the National Research Council Program of Energy Research and Development (NRC-PERD) iceberg database (Sudom et al. 2014; NRC 2019) and the International Ice Patrol (IIP) database (IIP 1995) yields a total of 1,830 iceberg sightings in the Project Area over the past 30 years, 1992 to 2021. Icebergs have been observed in the Project Area in all months except October and November. Of the icebergs in the 1992 to 2021 query for the Project Area, approximately 17.8% are growlers or bergy bits, 66.7% are small or medium, 14.2% are large, and 1.4% are very large.

17.1.3.1 Potential Effects of Marine Icing, Sea Ice and Icebergs on the Project

Marine icing is an important design consideration as it can cause a significant increase in a vessel's weight and can alter its center of gravity, which in turn can impact vessel speed, maneuverability and cause problems with cargo-handling equipment (DFO 2012). Ice and snow build-up on the MODU and support vessels is primarily a safety issue for personnel, with the risk of falling ice and snow from overhead. Delays from vessel icing can occur if operations are slowed (or suspended) to remove ice accumulations.

The primary risk from sea ice is at the ocean surface (e.g., vessel collision). Icebergs and sea ice can hinder offshore supply vessel transportation, potentially resulting in delay of supply and personnel movement to and from the MODU. The MODU can also be affected by icebergs should ice management strategies fail. Sea ice and icebergs can also increase the risk of an accidental event (e.g., a vessel collision). Although landfast ice may pose a potential risk for potential vessel traffic routes near the coastline of eastern NL, it is unlikely to be a factor in the Project Area itself.

Mitigation to reduce risks associated with marine icing, sea ice, and icebergs is discussed in Section 17.2.

17.1.4 Climate Change

Given that the temporal scope of the exploration drilling program on EL 1161 extends to 2029, it is unlikely that the physical environment in the Project Area will experience substantial climate change impacts beyond what are presently found in recent trends and interannual variability. Climate change is therefore unlikely to have a direct and significant effect on the Project beyond the overall design and planning measures being undertaken to address the physical environmental parameters discussed above.

17.2 Mitigation

Mitigation measures and compliance with regulatory requirements planned by Suncor to manage effects of the environment on the proposed drilling program to acceptable levels are presented below.

Supply vessels and helicopters will be used to transport personnel, equipment, and materials to and from the MODU during the offshore drilling initiative according to work schedules and rotations, workforce numbers, distances, and other factors. Supply vessels typically make regular trips to the drilling unit throughout a drilling program, and a dedicated stand-by vessel will attend to the rig.

Helicopter and vessel support for the Project would originate in St. John's, from third-party suppliers operating from existing licensed / permitted facilities. While the rig is on location, a dedicated stand-by vessel will be stationed near the rig for emergencies and for secondary storage of well tubulars and drilling mud if required. A second vessel will be servicing the rig by transporting equipment and people (in the event helicopters cannot fly) to and from the rig. It is anticipated that two to three sailings per week will be required, but more is possible if a rig crew change is required. Supply vessels will require certification and approval in order to work in Newfoundland waters.

17.2.1 Marine Geology – Sediment and Seafloor Instability

The wells associated with this Project may be drilled using either a semi-submersible rig or referred to generically as a MODU. The final selection of a rig will be dependent on rig availability and other factors.

MODUs used offshore NL are required to adhere with relevant regulatory requirements, including the *Newfoundland Offshore Certificate of Fitness Regulations*, which includes the issuance of a Certificate of Fitness from an independent, third-party Certifying Authority. This authority must confirm the MODU meets the associated regulatory requirements, is fit for purpose, can function as intended, and is able to do so without compromising the safety of workers or having a detrimental impact on the environment. Relevant modifications and repairs are also reviewed and must be accepted by the Certifying Authority for continued validity of the certificate. The Certificate of Fitness will be required before the C-NLOPB issues an OA, which is required for exploration drilling programs.

The potential for shallow gas, large objects or other geohazards will be determined based on wellsite surveys and the interpretation of existing seismic data. Wells will be positioned to avoid geohazards and the location, design, and/or operational plan will be adjusted to reduce risks to an acceptable level.

Wellsite selection considers potential geohazards that could pose a potential hazard to drilling activity of top hole operations before the BOP is installed, typically from the seabed to 900 to 1,200 m depth below mudline. Included among potential geohazards are shallow gas pockets, which could be the result of gas that is trapped in the shallow sediments originating from deeper gas reservoirs or from biogenic activity in the shallow sediments. A geohazard review uses processed 3D and 2D seismic data and existing regional data, such as geotechnical cores and offset wells where available. Suncor will conduct detailed geohazard assessments for each proposed wellsite and if a risk of shallow gas is observed, the well location may be moved or a pilot hole may be drilled to avoid drilling a large-diameter hole through a shallow gas zone. Riserless well control precautions such as tabletop drills with crew and kill mud are typically in place regardless of whether or not the potential for shallow gas has been identified, to enable swift and effective response if required.

17.2.2 Climatology, Weather and Oceanographic Conditions

Meteorological and oceanographic conditions in the Project Area represent key considerations in the planning and execution of the offshore exploration and support activities that comprise this Project. Physical environment data observations, weather forecasting, and reporting will be conducted in consideration of the Offshore Physical Environmental Guidelines (NEB et al. 2008).

17.2.2.1 Extreme Weather, Fog and Other Environmental Factors Reducing Visibility

The Project will comply with Canadian regulations and international standards (where applicable) to mitigate risks associated with extreme weather and oceanographic conditions. These regulations and standards include considerations and requirements related to operations in various environmental conditions (e.g., average and extreme ambient temperatures, precipitation, ice accretion, wind, waves, tides, currents, sea ice, icebergs, and combinations thereof).

Marine weather observations, forecast bulletins, special weather statements, watches, alerts, and warnings are issued by ECCC via the MSC's Automated Telephone Answering Device, ECCC's Graphical Forecast Area, weather radio (continuously broadcast over VHF or FM radio), and regional storm prediction centres. Furthermore, the NL weather office in Gander provides year-round marine weather and wave height information for waters around NL. Weather forecasting services will be contracted to provide forecasts specific to the Project Area. These forecasts will be monitored by the appropriate personnel onboard the MODU, support vessels and aircraft, as well as by onshore operations and logistics teams, each of whom have the authority to suspend or modify operations if forecasted adverse weather conditions could compromise the safety of personnel or operations.

Visibility forecasts inform personnel of expected conditions at scheduled departure, transit and arrival times. The selection criteria for vessels engaged in Project activities will include year-round operation at the water depths and environmental conditions prevalent in the Project Area and larger RAA. The MODU and supply vessels will have obstruction lights, navigation lights, and/or foghorns. Radio communication systems will be in place to contact other marine vessels, shore base, and supply vessels.

Helicopter support from St. John's will be the primary method to transport personnel to and from the rig. For offshore flying, helicopters need visual confirmation at 0.25 nautical miles (approximately 500 m) out and need a visibility of 1 km, or greater, to land. If helicopters cannot fly because of poor visibility or from high winds, consideration will be given to transport by vessel depending on the long-term weather forecast and the urgency to get people to the rig. Emergency response, safety procedures, and protocol will be in place for the transport of personnel offshore.

17.2.2.2 Seismic Events and Tsunamis

Given the relatively short time period associated with the drilling of each well, the probability of a major seismic event (and resulting landslides or tsunamis) occurring during the life of the Project is very low. In accordance with the *Newfoundland Offshore Certificate of Fitness Regulations*, the MODU will be designed with good engineering practice that accounts for potential environmental loads imposed by earthquakes and other naturally occurring phenomena.

Given the relatively short duration of planned Project activities at any one location and the low probability of tsunami occurrence, it is unlikely that a tsunami would occur during Project operations. In accordance with the Certificate of Fitness, the MODU will have the capability of quickly disconnecting a riser from the well, which would help mitigate potential damage in the event of a tsunami.

17.2.3 Marine Icing, Sea Ice and Icebergs

The MODU will be selected in accordance with recognized standards to handle certain extreme icing loads, including the buildup of ice, should it occur. Operating experience for other drilling and production facilities in the offshore area indicates observed icing is significantly less than allowed for in the design of the facilities. However, if meteorological conditions are present for vessel icing, visual monitoring for ice buildup will be carried out, and if required, the ice will be removed.

In accordance with the Offshore Physical Environmental Guidelines (NEB et al. 2008), a project-specific Ice Management Plan will be developed to include procedures related to ice detection, monitoring and assessment, as well as the physical management of icebergs, and will outline procedures for the implementation of disconnection and movement of the MODU due to presence of an iceberg. The Ice Management Plan will be submitted to the C-NLOPB for acceptance as part of the OA process.

There is a proven coordinated ice management approach amongst offshore oil and gas operators in NL. Physical management for sea ice is also commonplace in Canadian waters, and typically involves using support vessels to break up large ice floes that meet or exceed the design limits of support vessels or the MODU. By closely monitoring regional and local marine weather and ice conditions and receiving customized and frequently updated weather forecasts and alerts, Project personnel will be able to make informed decisions to address such adverse weather conditions. Forecasts will be monitored by appropriate personnel onboard the MODU, support vessels and aircraft, as well as by onshore operations and logistics teams, each of whom have the authority to suspend or modify operations if forecasted adverse weather conditions could compromise the safety of personnel or operations. Procedures will be in place for the safe disconnect and movement of the MODU while leaving the well in a safe and stable condition.

17.3 Residual Effects Summary

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

- Damage to Project components or activities resulting in adverse effects to human health and safety
- Damage to Project components or activities resulting in environment risks
- Damage of Project components or activities resulting in effects on overall Project costs or schedule

Key environmental factors, as described above, that may affect the Project include severe and/or extreme weather conditions, sea ice, icebergs, superstructure icing, and oceanographic conditions. Seismicity and geological stability are also considerations, although such events have a low probability of occurrence. Engineering design, operational procedures, and mitigation measures will reduce potential adverse effects to the Project.

Based on the definition of significant adverse residual effects defined above, and application of risk mitigation including adherence to the *Newfoundland Offshore Certificate of Fitness Regulations*, *Newfoundland Offshore Petroleum Installations Regulations*, and the Offshore Physical Environmental Guidelines, significant adverse residual effects of the environment on the Project are not likely to occur.

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