Terra Nova Asset Life Extension Environmental Assessment Validation Report

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File No: 121415828

Final Report

August 28, 2019

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Abbreviations

AQMS	Air Quality Management System
ASP	Association of Seafood Producers
ALE	Asset Life Extension
bbl	barrel
CAAQS	Canadian Ambient Air Quality Standards
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_{2eq}	Carbon Dioxide Equivalents
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CWS	Canadian Wildlife Service
DFO	Fisheries and Oceans Canada
DREAM	Dose related Risk and Effect Assessment Model
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
ECCC	Environment and Climate Change Canada
ECRC	Eastern Canada Response Corporation
EEM	Environmental Effects Monitoring
EIF	Environmental Impact Factor
EIS	Environmental Impact Statement
EPP	Environmental Protection Plan
ESRF	Environmental Studies Research Fund
FEZ	Fisheries Exclusion Zone
FFAW-Unifor	Fish, Food and Allied Workers-Unifor
FPSO	Floating Production, Storage and Offloading
GHG	Greenhouse Gas
GWP	Global Warming Potential
H_2S	Hydrogen Sulfide
IBA	Important Bird Area
IPCC	Intergovernmental Panel on Climate Change
LET	Life Extension Turnaround
MODU	Mobile Offshore Drilling Unit
NAAQ	National Ambient Air Quality
NAFO	Northwest Atlantic Fisheries Organization
NO_2	Nitrous Dioxide
NO_X	Nitrogen Oxide
OA	Operations Authorization
OCI	Ocean Choice International
OEMS	Operational Excellence Management System

OIW	Oil In Water
OSRL	Oils Spill Response Limited
PM	Particulate Matter
SARA	*Species at Risk Act*
SRB	Sulfide Reducing Bacteria
SSP	SubSea Program
Suncor	Suncor Energy Inc.
t	Tonne
TN	Terra Nova
TPM	Total Particulate Matter
VEC	Valued Ecosystem Component
VFA	Volatile Fatty Acid
VME	Vulnerable Marine Area
VOC	Volatile Organic Compounds

1.0 INTRODUCTION

The Terra Nova (TN) Field is located on the Grand Banks, approximately 350 km east-southeast of St. John's, NL, centred at 46°28.53' N, 48°28.86' W (Figure 1-1), in approximately 95 m of water. Suncor Energy Inc. (Suncor), on behalf of its partners (i.e., Suncor Terra Nova Partnership, ExxonMobil Canada Properties, Equinor, Husky Oil Operations Limited, Murphy Oil Company Ltd., Mosbacher Operating Ltd., and Chevron Canada Limited), operates the TN floating, production, storage and offloading (FPSO) installation, which provides production facilities for the Field. A series of flexible risers and flowlines link the subsea infrastructure on the seabed to the FPSO to enable production.

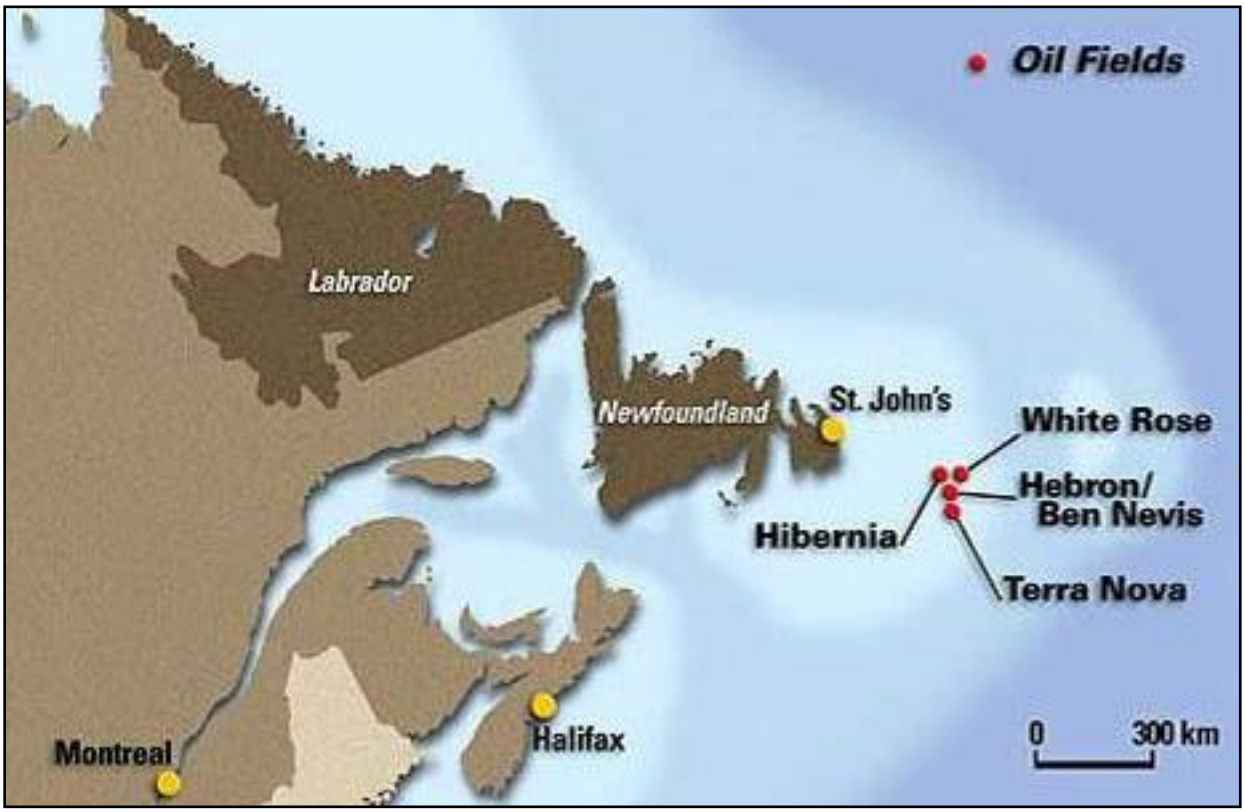

Figure 1-1 Location of Terra Nova Field in Offshore Newfoundland

1.1 Regulatory Context

1.1.1 Relevant Legislation

The TN Field development underwent an environmental assessment (EA) in 1996 and was subsequently reviewed under a Panel under the *Canadian Environmental Assessment Act*. The temporal scope of the 1996 EA stated that operations in the Field would end by December 31, 2019. The TN Field, which has been in production since 2002, is currently undertaking an Asset Life Extension (ALE) project to extend production and the field life. The Canada-Newfoundland and Labrador Offshore Petroleum Board

(C-NLOPB) has determined that as part of the ALE process, Suncor must provide a concise EA Validation Report to the C-NLOPB so they can ensure that the ongoing environmental mitigations remain valid and current. This EA Validation Report assesses the effects of extending the temporal scope of the Project.

There is no *Canadian Environmental Assessment Act, 2012* trigger for the TN ALE including change in temporal scope; therefore, this Project and EA Validation Report falls solely under the C-NLOPB process pursuant to the Canada-Newfoundland and Labrador Atlantic Accord Implementation Act and the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act*. The EA Validation Report focuses on the same Valued Ecosystem Components (VECs) as the original Environmental Impact Statement (EIS) (Petro-Canada 1996) and EA Updates (Suncor 2012, 2014, 2017a).

As per direction from the C-NLOPB, Suncor will conduct an EA Validation every five years. In accordance with the original TN EIS, and consistent with most EISs of long-term projects, decommissioning and abandonment will be conducted under the regulations and requirements at the time of decommissioning and will also be included in the appropriate end-of-field-life EA Validation Report. The current *Drilling and Production Guidelines* (C-NLOPB and Canada-Nova Scotia Offshore Petroleum Board 2017) requires that a Decommissioning and Abandonment Plan be submitted to the C-NLOPB, detailing how the marine installations / structures and equipment associated with a project will be removed from or abandoned at the site. Additionally, under the *Physical Activities Regulations* (Government of Canada, 2019) that accompany the *Impact Assessment Act*, decommissioning and abandonment of an existing offshore floating or fixed platform is considered an activity that would initiate an assessment.

1.1.2 Changes in Legislation

The most relevant legislative changes since the original EIS relate to air quality, especially as they pertain to air quality (greenhouse gas (GHG), air contaminants (e.g. volatile organic compounds (VOCs), nitrous oxide)) and species at risk / special areas, especially as they pertain to critical habitat. An overview of components important to the TN ALE is provided in Table 1.1. The new / revised legislation have more stringent requirements and the potential environmental effects associated with the regulations will be at minimum within the original predictions (and potentially less than predicted). The predictions of effects in the original EIS remain valid.

Table 1.1 Overview of Relevant Legislation Changes since the Original EIS

Topic	Legislation	Overview
Air Quality	Collaborative Air Quality Management System (AQMS)	While the AQMS consists of four elements, two of the elements are the most relevant to the Project: the new Canadian Air Quality Standards (CAAQS) for particulate matter less than 2.5 microns in diameter ($PM_{2.5}$) and ozone; and development and implementation of Base-Level Industrial Emissions Requirements. Threshold values for $PM_{2.5}$ and ozone (developed for years 2015 and 2020), new CAAQS for sulphur dioxide (with effective dates of 2020 and 2025), and new CAAQS for nitrogen dioxide (NO_X) (with effective dates of 2020 and 2025) are shown in Table 1.2.
Air Quality	*Multi-Sector Air Pollutants Regulations*	Established requirements for emissions of specific air pollutants and stipulates NO_X emission limits from boilers and heaters associated with oil and gas facilities.
Air Quality	*Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds* (Upstream Oil and Gas Sector).	As part of the Pan-Canadian Framework on Clean Growth and Climate Change, Canada has committed to reducing methane emissions from the oil and gas by 40% to 45% by 2025, relative to 2012 emissions (Government of Canada 2018). This Regulation comes into force January 1, 2020. The regulations apply to the industrial facilities producing or receiving at least 60,000 m^3 of hydrocarbon gas.
Air Quality	*Regulations Amending the Ozone-depleting Substances and Halocarbon Alternatives Regulations*	The regulations are intended to reduce the import and usage of halocarbons with high global warming potential (GWP) that are widely used as refrigerants. The regulations do not apply to existing halocarbon containing equipment; they pertain to new equipment purchased after the implementation of the regulation (January 1, 2020 for industrial applications).
Air Quality	Technical Paper on the Federal Carbon Pricing Backstop that includes an Output-Based Pricing System for industrial facilities	The Output-Based Pricing System aims to create an incentive for industrial GHG emitters to reduce their emissions, while also protecting emissions-intensive, trade-exposed industrial facilities from costs of a straight tax by exempting them from paying a carbon price on their fossil fuel consumption.
Air Quality	Update to Newfoundland and Labrador *Management of Greenhouse Gas Act*	Update includes offshore oil and gas production and drilling facilities (associated with production licenses) with annual GHG emissions >25, 000 tonnes carbon dioxide equivalent (CO_{2eq}). Compliance is based on a reduction from absolute benchmark emission with a phased in approach of 6% reduction in 2019 and 2% reduction per year until a total 12% reduction is reached in 2022.
Seabirds	*Migratory Bird Regulations* – Section 4 Scientific Permit (associated with the collection of dead migratory birds and capture, transfer or release of live migratory birds that land of the Assets and supply vessels)	In 2018, the Canadian Wildlife Service (CWS) applied an additional condition to the Scientific Permit. Non-oiled petrel species found dead or that die before release were to be identified, recorded, labelled, and stored on site until arrangements were made with the listed CWS contact for transfer to shore to CWS for further assessment.

Table 1.1 Overview of Relevant Legislation Changes since the Original EIS

Topic	Legislation	Overview
Species at Risk	*Species at Risk Act* (SARA)	The *Species at Risk Act* was promulgated in 2002. The purposes of the Act are to: • prevent wildlife species from being extirpated or becoming extinct, • provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity • manage species of special concern to prevent them from becoming endangered or threatened. The classification of species is initiated by Committee on the Status of Endangered Wildlife in Canada (COSEWIC), which assesses the status of each wildlife species identified to be at risk and determine existing and potential threats to those species. EAs typically focus on those species listed in SARA Schedule 1 (List of Wildlife Species at Risk), but often include those assessed as "at risk" by COSEWIC as well.

Table 1.2 Canadian Ambient Air Quality Standards

Air Contaminant	Time Averaging Period	CAAQS (µg/m^3)		
$PM_{2.5}$	24-Hour	28 µg/m³ (2015)	27 (2020)	
	Annual	10 µg/m³ (2015)	8.8 (2020)	
Sulphur dioxide	1-Hour	--	183 (2020)	170 (2025)
	Annual	--	13 (2020)	10 (2025)
Nitrogen dioxide	1-Hour	--	113 (2020)	79 (2025)
	Annual	--	32 (2020)	23 (2025)
Source: Canadian Council of Ministers of the Environment 2014				

1.1.2.1 Air Quality

As per the Canadian Environmental Assessment Agency (2003) guidance, where the GHG emissions are considered to be either "medium" (between 10,000 and 500,000 tonnes carbon dioxide equivalent (CO_{2eq}) per year) or "high" (>500,000 tonnes CO_{2eq} per year), a GHG Management Plan must be prepared. Suncor has a GHG Management Plan in place.

Suncor has been engaged in the development of recent regulations and plans to adjust and comply with the regulations that come into force during the life of the Project. However, it has been recognized that not all GHG reducing opportunities are feasible in the offshore environment due to the remote location. As such, Suncor must generate their own power and use fuel that is available (i.e., fuel gas which has the lowest GHG intensity available). As the production declines during the life of the field, Suncor expects

there may be an increase in GHG intensity, as it will take more energy to extract a barrel of oil out of the ground as the wells start to deplete. Additionally, the single gas compression train (system) design of the TN FPSO poses limitations. When there are system upsets and decreased reliability, there is the potential that the gas produced cannot be handled within the system and must be flared.

The oil and gas sector was the largest emitter of GHG emissions, releasing 27% of total national GHG emissions in 2017 (Environment and Climate Change Canada (ECCC) 2019). Of that 27%, conventional oil and gas extraction accounted for 16% of the GHG emissions (ECCC 2019).

Of the over 500 large emitter (≥ 50 kt of CO_2 eq) installations in Canada, Newfoundland and Labrador's eight large emitters (in 2013) were responsible for <2% of GHG emissions from that total group (Amec 2013). Of those eight large emitter installations, the offshore petroleum sector facilities were responsible for 34.4% of the GHG emissions (Amec 2013). In 2017, there were 10 large emitters in Newfoundland and Labrador, contributing approximately 2% to the national GHG emissions (ECCC 2019).

The Project, as reported to ECCC, emitted approximately 560,600 tonnes CO_{2eq} in 2016. ECCC reports an annual GHG emission value for the province of Newfoundland and Labrador of 10,300,000 tonnes of CO_{2eq} per year (ECCC 2018a). The predicted annual CO_{2eq} emissions for the Project therefore represent approximately 5.44% of Newfoundland and Labrador's average annual emissions. The Project's contribution to the national GHG emissions is approximately 0.078% and approximately 0.002% of the global total, representing a small fraction to both national and global totals.

Carbon dioxide (CO_2) is the largest component (79%) of GHG. Methane is the second largest GHG emission in Canada (110 Mt or 15% in 2013). The oil and gas sector contributed approximately 43% to methane emissions. Methane emissions from offshore Atlantic Canada oil and gas was 180,756 tonnes (0.18 Mt) of CO_2. This represents <0.07% of overall oil and gas sector methane emissions. In 2014, the three Newfoundland and two Nova Scotia production platforms contributed approximately 76.5% of the methane generated in Atlantic Canada. Therefore, the oil and gas sector contributed 0.9% of the 1.2% methane emissions in Atlantic Canada in 2014.This is primarily due to the need to generate power on site (i.e., no electrical connection to land). The majority of produced gas from the production fields is re-injected into the fields; however, the gas is also used to provide power to the production installations.

In summary, the 2017 reported GHG emissions from the existing TN Project fall within the range of those from the other existing oil developments, as reported to the 2017 National GHG Report, and represent only a small portion (0.08%) of the national total (716 megatonnes CO_{2eq}). The single gas compression train (system) design of the TN FPSO poses limitations and does contribute to flare gas emissions. No change is anticipated from the sustained production of TN field. No increase in production or changes in mode of operations from the original TN EA (Petro-Canada 1996) are expected.

Furthermore, air quality parameters at the TN Field are not expected to be significantly influenced by emissions at Hebron. The TN ground-level concentrations were modelled as part the Hebron project EA (using 500 m grid spacing around Hebron and each of the Installations)and were found to meet the stipulated Canadian Ambient Air Quality Standards (CAAQS) Objectives for 1-hour, 24-hour, and annual time periods (Stantec 2010). There were no exceedances of the provincial and CAAQS Objectives.

1.1.2.2 Seabird Monitoring

The Canadian Wildlife Service (CWS) permit requirements (issued under section 4 of the Migratory Birds Regulations) have become more stringent with time and Suncor has adapted its bird handling and reporting protocol to meet the requirements of the Regulations.

1.1.2.3 Species at Risk

Fish, marine mammal and sea turtle species at risk are occasional visitors to the Project and Study Areas; there are no resident populations of species at risk in the Project or Study Areas. There is no critical habitat within the Project or Study Areas.

1.2 Consultation and Engagement

Suncor consulted with government agencies and other ocean users who may be affected by program activities. Stakeholders were identified as per the One Ocean Protocol for Consultation Meetings: Recommendations for the Fish and Petroleum Industries in Newfoundland and Labrador. Suncor consulted with the following:

- C-NLOPB
- ECCC
- Fisheries and Oceans Canada (DFO)
- Food, Fisheries and Allied Workers-Unifor (FFAW-Unifor)
- One Ocean
- Ocean Choice International (OCI)
- Association of Seafood Producers (ASP)

With the exception of confirming that any new wells would be drilled through existing templates (i.e., no new drill centres would be excavated), there were no concerns raised during consultation with fishers' groups. DFO noted that the proposed critical habitat for wolffish should be illustrated (while acknowledging that there was no critical habitat in the vicinity of the TN Field). Discussion with ECCC focused on reliance on environmental effects monitoring (EEM) results in description of fish habitat, new seabird handling guidance documents, and raised the issue of facility lighting and concerns with respect to storm petrels, all of which are addressed in this EA Validation Report.

Suncor has previously presented specific TN ALE project overviews to the C-NLOPB. The 2017 meeting dates and associated agenda topics are provided in Appendix A to illustrate some of the topics that have been reviewed.

1.3 Contacts

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2.0 PROJECT DESCRIPTION

The key component of the Project is extending the temporal scope of the project. The overall spatial boundaries remain unchanged from those assessed in Petro-Canada (1996).

2.1 Temporal and Spatial Boundaries

The temporal boundaries extend the life of the TN project beyond the previously assessed December 31, 2019 to anticipated end of life of production at the end of 2031 with decommissioning and abandonment activities to follow (see Section 2.2.2 for more detail of activities involved in the Project).

- The “Project Area” includes the Fisheries Exclusion Zone (FEZ) and the Far East Drill Centre (Table 2.1; Figure 2-1)
- The “Study Area” is the equivalent of the Transport Canada-designated 10-nm precautionary zone
- The “Regional Area” remains unchanged from the original EIS Study Area (as assessed in Petro-Canada (1996)) (Figure 2-2)

Table 2.1 Project Area Corner Coordinates

x_UTM (NAD 83 UTM zone22)	y_UTM (NAD 83 UTM zone22)	x_DEG	y_DEG
692487.1581	5152008.699	48° 29' 29.979" W	46° 29' 38.888" N
695434.2829	5151898.182	48° 27' 12.028" W	46° 29' 32.257" N
699007.6717	5149466.804	48° 24' 28.311" W	46° 28' 9.800" N
699044.5107	5148914.218	48° 24' 27.435" W	46° 27' 51.876" N
695318.6688	5147364.27	48° 27' 24.289" W	46° 27' 5.631" N
691723.565	5148017.836	48° 30' 11.680" W	46° 27' 30.497" N

2.2 Project Overview

2.2.1 Rationale and Objectives

Suncor has identified a business opportunity, the TN ALE, for sustained production of the existing field and further development of TN resources on the Production License beyond the current end of field life. The TN Jeanne d’Arc reservoir is forecast to have substantial uncaptured production potential if a 2020 end of life occurs. The selected concept for the TN ALE will increase the estimated ultimate recoverable oil of the field and extend field life.

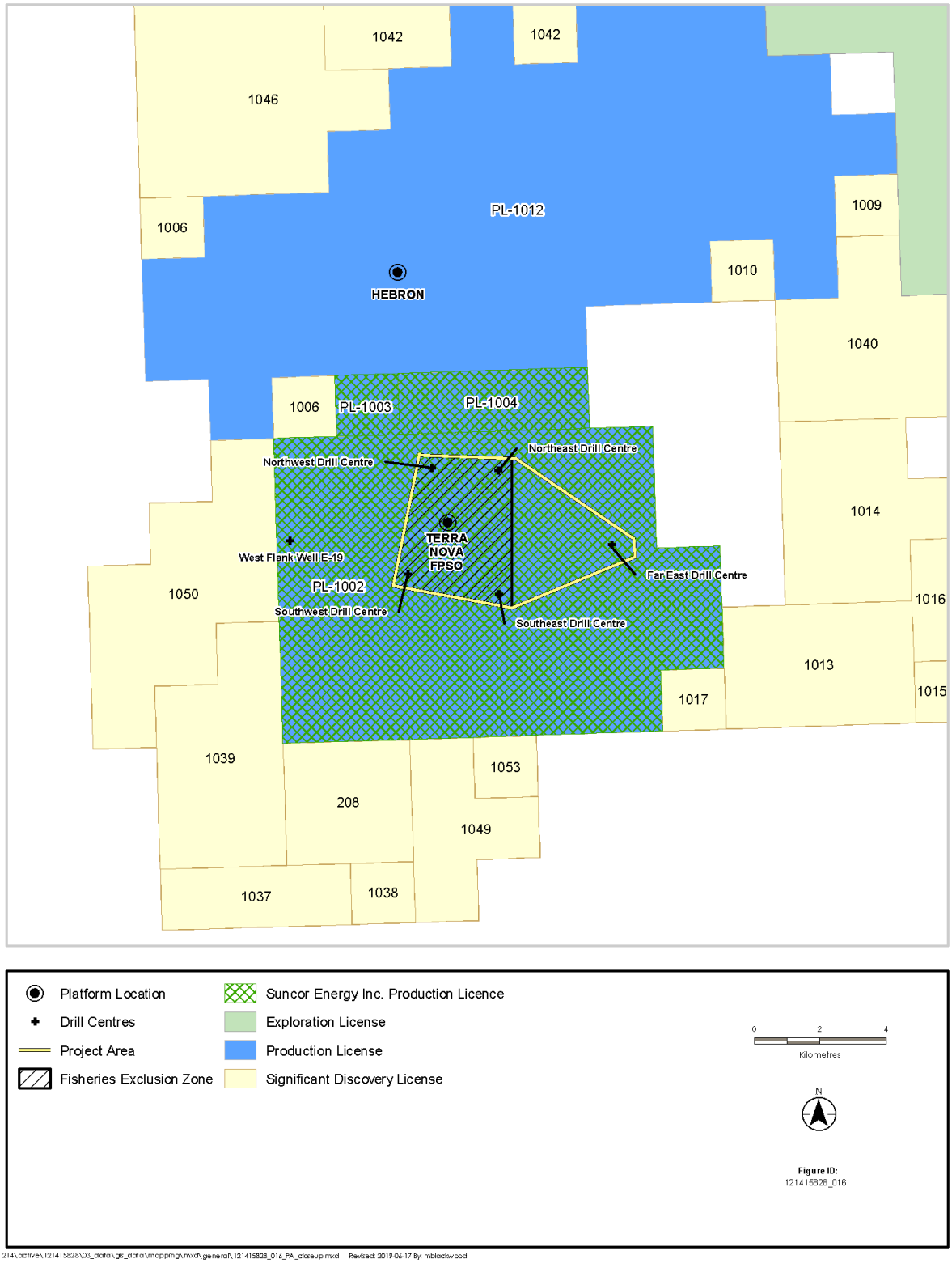


Figure 2-1 Project Area

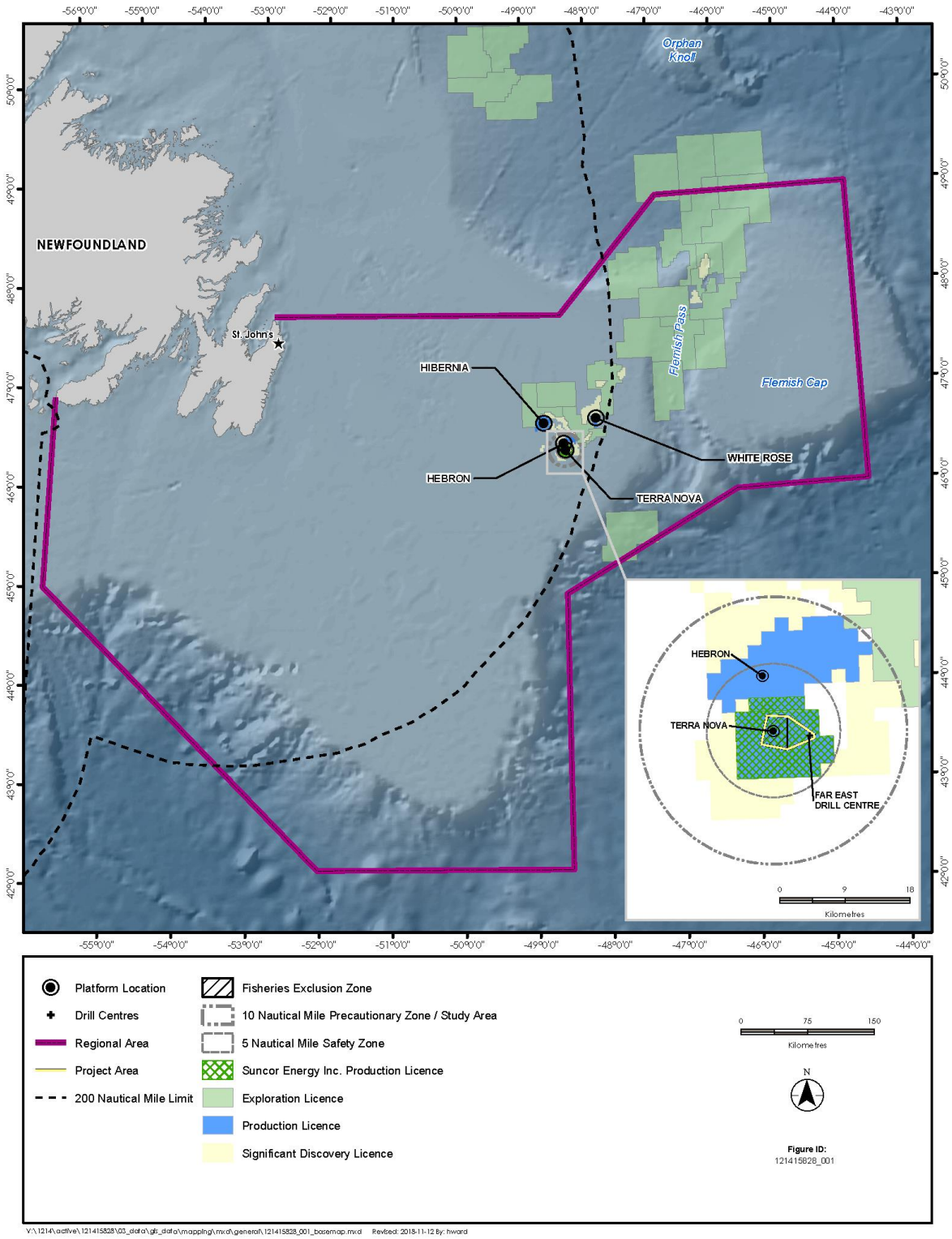


Figure 2-2 Projects, Assessment, and Regional Areas

2.2.2 Asset Life Extension and Terra Nova Drilling Program Extension

The ALE Program is supported by two sub-projects, the Life Extension Turnaround (LET) and SubSea Program (SSP).

2.2.2.1 Life Extension Turnaround

LET involves an off-station in 2020 with the FPSO scope of work executed in a European dry dock. In addition to the required life extension scopes, opportunities exist to increase the future production efficiency of the asset and lower the risk of failures by conducting reliability improvement and upgrade scopes of work during LET.

A large component of the work scope will focus on design and/or condition-based concerns with the FPSO structure and piping systems and the replacement of systems or equipment. Examples of the FPSO asset life extension scope include:

- main power generator low voltage wiring
- swivel seal replacements
- turbine air inlet replacement / repair
- turret drive unit inspection / replacement
- produced water system piping replacement
- turbine waste heat recovery unit replacement
- closed drains piping replacements
- flare tip heat shield replacement
- hull structural repairs in critical fatigue sensitive areas
- tertiary steel replacements (areas where coating repairs considered ineffective)
- repair bilge keels
- hull external coating replacement
- produced water caisson detailed inspection and repairs
- turret water seal replacement
- spider buoy stab pins, alignment
- pins and position indicators inspection
- turret lower bearing replacement
- turret moonpool anode replacement
- gas compression plc upgrades
- one subsea swivel repairs

There will be work scopes associated with regulatory and maintenance items, which include, but are not limited to:

- Torus IV connector flushing
- turret disconnect logic modifications
- general regulatory and turnaround maintenance
- external hull inspection
- fire suppression maintenance
- pressure vessel inspection
- mechanical inspection
- valve integrity test
- replace flare tip
- pipe and structure coating repair

The third and final component of the life extension scope focuses on production efficiency and reliability improvement.

- produced water draining
- high-pressure separator backpressure
- complete gas train debottlenecking
- install double block and bleed isolation valves at pressure safety valves (or remove redundant pressure safety valves)
- FPSO communications system upgrade
- accelerated turnaround maintenance

Normal operation and maintenance activities were assessed in the original EIS (Petro-Canada 1996). Suncor will submit an Offstation Production Suspension Plan to the C-NLOPB prior to the start of the LET activities.

2.2.2.2 SubSea Program

The SSP is planned to coincide with the LET and the work scope includes: a mooring system upgrade project; water injection riser #11 replacement project; spider buoy anode replacement project; subsea anode replacement; and blank choke inserts.

The mooring system upgrade project is a replacement of the dynamic sections of all nine mooring chain legs between the spider buoy to ground chain, inclusive of excursion limiter chains near the seabed, to meet the design life requirements of the ALE. The nine hawse pipes will also be replaced on the spider buoy chain supports. This scope requires a dive support vessel and potentially support from an anchor handling vessel.

The water injection riser #11 replacement project is a replacement of one water injection riser (riser #11). One end of the riser will connect to the existing spider buoy I-tube and the other end to the existing Water Injection Tee, which splits flow between the South East Drill Centre and South West Drill Centre water injection flowlines. This scope requires a dive support vessel complete with flexible pipe lay system (or alternatively a dive support vessel and construction support vessel). The preference is to have a single vessel execute this scope, but the vessel strategy will be confirmed during the vessel selection and procurement process.

The TN Asset contains cathodic protection systems associated with both the FPSO and subsea infrastructure, including the spider buoy anodes. A Life Extension Study by SOFEC (August 2018) outlined that an inspection of the spider buoys is required, and the results of the inspection will be used to define the scope of the spider buoy anode replacement project. Anodes will be then procured and installed by a remotely operated vehicle or diver during SSP.

During the dive support vessel campaign, risk blank choke inserts will be used, which provides additional isolation in event both required barriers are compromised, to further reduce risk to the divers.

Normal operation and maintenance activities including subsea activities were assessed in the original EIS (Petro-Canada 1996) and EA Updates (Suncor 2012, 2014, 2017a).

2.2.3 Terra Nova Drilling Program Extension

As part of its ongoing drilling program, Suncor will employ a mobile offshore drilling unit (MODU), to execute the TN drilling program extension, which has two distinct components: a producer-injector well pairing and the integrity remediation and reliability improvements. All wells associated with the TN drilling program extension will be drilled in existing drill centres within the FEZ, which is geographically consistent with the original EA, as are the specific drilling activities.

The Horst producer-injector well pair in the TN Horst region will pair an oil producer from the North East Drill Centre, G-90 3 sidetrack (G2 slot reclaim) with a water injector from South East Drill Centre, F-88 2 sidetrack (E1 slot reclaim). This work scope has been delayed until the next drilling campaign (anticipated 2020 execution).

The integrity remediation and reliability improvements targets integrity remediation and reliability improvements, and includes a water injection well Integrity work over, G-90 7 (F3), and gas lift valve replacements, F-100 4, L-98 9, and G-90 9.

The original TN EA Decision 97.02 report included reference to a total of 36 wells for the Field, with an addition 16 added in the TN EA Revision Decision 2005.02 report (C-NLOPB 2005), for a total of 52 approved wells. At the end of 2018, there were a total of 47 wells (defined as a hole that is drilled to and reaches a specific target) drilled in the Field. While development drilling peaked from 2001 to 2007, future Field drilling activities will continue, but at much lower levels than seen during the initial development of the Field. Any future wells will be drilled in existing drill centres (i.e., no new drill centres will be excavated) and the total number of wells will not exceed the number of currently approved wells without prior approval and assessment, as necessary.

2.2.4 Logistics

The original EIS determined there were no significant adverse residual effects associated with logistics for the Project. There is no anticipated change in the number of supply / standby vessels or helicopters as originally assessed in TN EA (Petro-Canada (1996). Therefore, the residual environmental effects assessment remain valid (i.e., residual effects are predicted to be not significant).

2.2.5 Waste Management

There is no anticipated change in the discharges (primarily drill cuttings and produced water) as assessed in the original EIS and the Terra Nova Produced Water Increase Environmental Assessment (Petro-Canada 2009), as well as EA Updates (Suncor 2012, 2014, 2017a). In accordance with the Offshore Waste Treatment Guidelines (National Energy Board et al. 2010), waste streams are described in the Environmental Protection Plans (EPPs) for production and drilling, which are submitted as part of the Operations Authorization (OA) process.

2.2.6 Air Emissions

Since the main sources of emissions have not changed throughout the life of the Project, there is no anticipated change in the effects assessed in the TN EA (Petro-Canada (1996).

2.3 Technologies Implemented / Investigated by Suncor to Reduce Releases to the Environment

Suncor has investigated and, where technically and fiscally feasible, implemented a number of technologies to reduce the effects of the TN project on the environment. These include, but are not limited to, the information that follows associated with air emissions and produced water management.

- In the report to the C-NLOPB on the Greenhouse Gas Emission Abatement Measures of the Terra Nova FPSO (TN-PE-EV15-X00-175), Suncor provided an update to the original Condition 19 report. The update summarized the emission abatement techniques employed on the TN FPSO, as well as those opportunities to further improve the emissions performance of the facility, highlighting the significant reduction in flare emissions (48% reduction from 2002 emissions) and the Flare Management Strategy.
- The Flare Gas Recovery Feasibility Study (TN-AB-PR15-M04-002) conducted in 2013. The flare gas recovery technology assessed was determined to be unfeasible at that time.
- Suncor was engaged with ECCC during the development of the *Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector)* Registration SOR/2018-66. Two main points for the TN FPSO are methane emissions from storage tanks and gas leaks. Technologies available on the TN FPSO (Hydrocarbon Blanket Gas and Recovery System and gas detection) meet the new regulatory requirements (as per details below). Studies were undertaken by Suncor which, then led to the implementation of the new technologies.
  - The Hydrocarbon Blanket Gas and Recovery System was installed on the TN FPSO in 2012 and commissioned for usage in 2013 in the Cargo tanks (storage tanks). When this system is operating, it forms a closed loop, resulting in the elimination of vented gas to the environment (i.e., zero emissions when the system is 100% reliable).
  - The gas detection systems (required to satisfy the requirements of *Newfoundland Offshore Petroleum Installations Regulations* and the *Nova Scotia Offshore Petroleum Installations Regulations*) on the TN FPSO (the Enhanced Laser Diode Spectroscopy technology), is considered to be the best available in the market; the system detects approximately 80% all gas leaks.
- Suncor has recognized the high global warming potential (GWP) and greenhouse gas emissions associated with refrigerant releases, and have taken measures to minimize emissions. Halocarbon containing equipment with capacity of >100 kg have been replaced by smaller units (e.g. 25 kg units in tandem). Additionally, the halocarbon product (FM-200) previously used in the fire suppression system has been replaced with a carbon dioxide based product (with a lower global warming potential).
- To enhance the oil in water quality of produced water (i.e., reduce the amount of oil), Suncor conducts ongoing produced water system maintenance and modifications, including but not necessarily limited to the following:
  - During the 2006 turnaround modifications were made to the chemical injection system, the structured packing of the MP separator was replaced, and nucleonic profilers were installed. These modifications served to improve the overall reliability of the system, as well as the ability to monitor performance.
  - In 2009, the liners for the hydrocyclones were replaced, improving oil in water separation efficiency.
  - The hydrocyclones were inspected in the 2015 turnaround and the liners were cleaned to improve the oil in water separation efficiency. A recommendation has been put forward to increase the inspection frequency of the hydrocyclone liners to every two years (based on efficiency testing) and to clean liners as required.

- An internal review has been completed with the recommendation to install an oil in water analyzer (new technology). The analyzer has been purchased and installation has been initiated.
- The water level transmitters have been replaced in the MP1 and test separators, providing a more accurate determination of produced water levels, which are critical to the improved oil in water performance.
- Since the submission of the original TN EIS, Suncor has continuously managed produced water oil in water (OIW) content. While the regulatory discharge limit for produced water has changed over time, the oil in water content has been consistently below the 30-day weighted average regulatory limit (Figure 2-3).

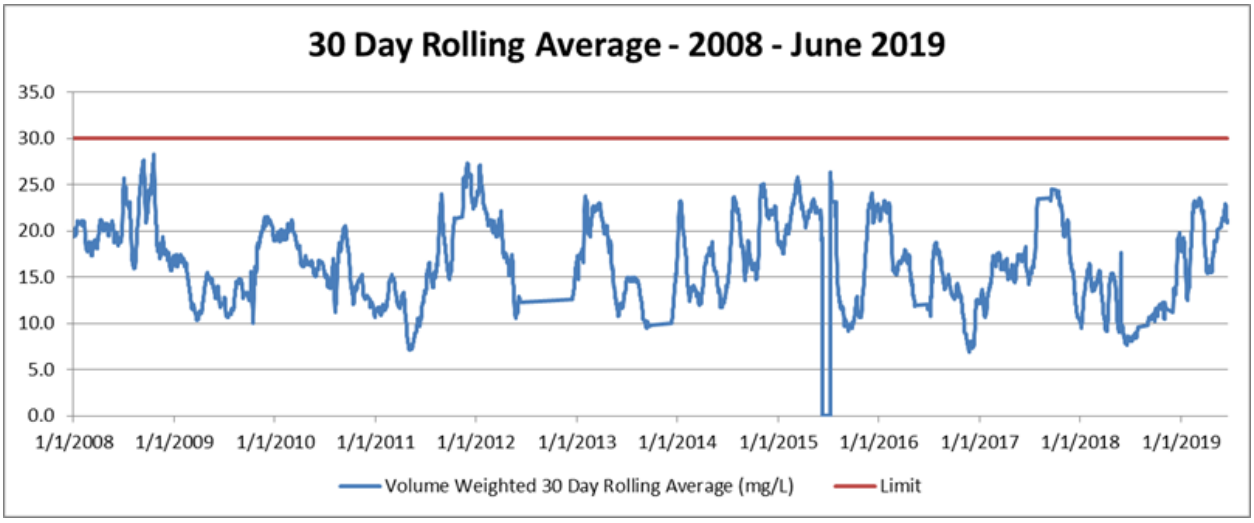


Figure 2-3 OIW 30 Day Rolling Average 2008-2019

- A produced water study was completed in 2013 to identify technically and economically feasible options for improving the produced water quality and efficiency (Stantec 2013a). Centrifugation, gas flotation and filtration treatment technologies were assessed. A modified gas floating system which utilizes the existing degas vessel was suggested as an alternate technology. However, following subsequent review, the technology was deemed unfeasible.
- As part of Suncor's environmental improvement plan projects for 2015, a sheen management trial using Breaxit EC6048A was conducted to determine the suitability of the product for sheen dispersion. However, the results of the trial were inconclusive. While the chemical did assist with dispersion of oil in surface water, the level of effectiveness attributed to the chemical dispersion versus natural dispersion could not be determined.
- In order to evaluate the potential environmental impact of produced water discharges, the Environmental Impact Factor (EIF) approach was developed for operators on the Norwegian Continental Shelf. The EIF method utilizes the numerical model DREAM (Dose related Risk and Effect Assessment Model), and provides a quantitative measure to identify individual contributors to the overall environmental risk of the discharge which then can be used to systematically identify process improvements to achieve reduction of impacts. As part of its Produced Water Management Strategy, Suncor is committed to undertaking an annual risk analysis of produced water discharge using the EIF, which may also be applied when a chemical substitution is proposed for treatment products of the produced water system. The results of the annual EIF reports consistently indicate that process chemicals pose greater risk for environmental impact than the hydrocarbon constituents (aliphatics, BTEX, napthalenes, PAH and phenols) of the produced water stream.

- Suncor evaluates options for chemical minimization and substitution where feasible. Note that the dosing and substitution of chemicals cannot only focus on environmental fate. Technical and economic aspects to ensure effective operation of the produced water system and FPSO and reservoir integrity must also be considered. Production Chemical Project was selected as one of the East Coast Environmental Improvement Plan projects for 2015. The project involved a review of the production chemicals in use, the associated dosing concentration, and potential substitution options. As a result of the project:
  - An effectiveness review was completed for a water clarifier which was subsequently removed from the process;
  - A bench top testing (bottle testing) was conducted to determine the most effective target dosage for biocide treatment; and
  - Alternate and more environmentally friendly demulsifiers have been tested. The report and recommendation from the testing was reviewed in 2016.
- In addition, there are ongoing reviews of the various process chemicals, and trials conducted to determine the injection point that provides the most efficient use of the chemical, with lower dosage rates, thus reducing the overall amount of chemical used.
- In 2018 comprehensive work was completed to identify a replacement Corrosion Inhibitor. Additional assessment (field trial(s)) is required in advance of production selection and substitution.
- Routine chemical “health checks” are conducted with live production fluids, onboard the TN FPSO with the goal of maintaining or improving the production system performance and a reduction in produced water OIW content. These health checks typically involve testing separation chemistries such as demulsifiers and where warranted, polishing chemicals such as water clarifiers. The end result is to qualify the incumbent product against newly derived chemistry, or other similar based products to ensure that the most suitable product is being utilized in the production system. Should an improvement opportunity be found through this test work, a subsequent field trial recommendation is made for the new product.
- Suncor conducted an analysis of the technical and economic feasibility of re-injecting produced water from the TN Field (Terra Nova Produced Water Increase Environmental Assessment, April 30, 2009). Based on the analyses, produced water re-injection was determined to be not economically or technically feasible for the TN Project because of considerable technical and economic risk in the areas of souring, scaling and corrosion. Despite not re-injecting produced water, TN has been experiencing biological influenced reservoir souring impacts to operation since 2010. Subsequently, several operational and equipment changes have been completed to reduce the risk of a hydrogen sulfide (H_2S) safety event within the operation. In 2012, the flexible production flow lines were replaced with tolerance of 1,000 ppm H_2S in bore, meaning concentrations of H_2S at or below this level will not influence material integrity.

  Produced water contains two key components, ionic species and carbon species. The ionic components (e.g. sodium, chloride, and sulphate ion) are common to the injection seawater and do not additionally impact reservoir souring in a significant way. Carbon species are often found in the form of a volatile fatty acid (VFA), acetate, propionate, etc. These VFA components are easier to digest for the bacteria and in the anaerobic environment of the reservoir, sulfide reducing bacteria (SRB) are the key members. The VFA will promote increased SRB activity within the reservoir leading to elevated H_2S levels, if produced water is re-injected into the reservoir.

  TN controls the H_2S levels in wellbore, flow line and surface equipment through dilution with gas lift and controlling production rate. The H_2S within the current production is the result of SRB activity on the residual whole oil within the oil pay sections not swept by water injection. With the current system of seawater injection into oil pay sections, the H_2S levels within the reservoir have been determined to

be well above the 1,000 ppm. Adding additional VFA with the injection of produced water will increase SRB activity and increase the H_2S within the reservoir fluids. This increase in H_2S will demand more gas lift gas to maintain dilution within the tubing, riser and production equipment to meet current material and safety limits governing operations with H_2S. Gas lift and gas handling within on the TN FPSO are finite and as such, can only dilute H_2S in the gas phase so far before a well must be shut in to meet the limits defined.

Nitrate injection has been started and is showing some success, addition of more VFA will add to that burden of control and require additional nitrate injection. The injection rate for nitrate was based on the injection of low VFA seawater and is intended to control SRB within the reservoir section. The addition of VFA from produced water re-injection would mean an increase in nitrate injection across the field beyond the current system design.

The construction of the TN water injection system is such that select wells cannot be dedicated at any one type of service, so it is not possible to divert produced water to a single well.

Additionally, the produced water re-injection would lead increased H_2S in the produced water stream to levels potentially above the design criteria of the topsides equipment.

Suncor has also developed the following strategies to address various discharges and emissions:

- East Coast Produced Water Management Strategy (OD-PE-OP26-X00-001)
- East Coast Greenhouse Gas Management Strategy (OD-PE-OP26-X00-002)
- Terra Nova Flare Management Strategy (TN-PE-OP26-X00-002)

2.4 Studies Conducted by Suncor since the Original TN EIS

Suncor has conducted a number of studies, in addition to EA amendments (for increased produced water discharge (Suncor 2009) and H_2S exposure (Terra Nova Field Environmental Assessment Update (TN-PE-EV01-X00-001)) and updates. These include:

- Lorax Environmental. 2006a. A Rhodamine Dye Study of the Dispersion of Produced Water Discharged from the Terra Nova FPSO. Prepared for Petro-Canada, St. John's, NL.
- Lorax Environmental. 2006b. Calibration and Validation of a Numerical Model of Produced Water Dispersion at the Terra Nova FPSO. Prepared for Petro-Canada, St. John's, NL.
- Mathieu, A., J. Hanlon, M. Myers, W. Melvin, B. French, E.M. DeBlois, T. King, K. Lee, U.P. Williams, F.M. Wight, G.G Janes. 2011. Studies on fish health around the Terra Nova oil development site on the Grand Banks before and after release of produced water. Pp. 375-399. In: K. Lee and J.M. Neff, (eds.). Produced Water: Environmental Risks and Mitigation Technologies, Springer-Verlag New York. xviii + 608 pp.
- Environmental Risk Analysis for Terra Nova Produced Water, Quantification Using EIF
  - Reports years 2007, 2009 (2008 data), 2012 to 2017
- Deep-Sea Research II Special Issue *Environmental Effect of Offshore Drilling in a Cold Ocean Ecosystem, A Ten-year Monitoring Program at the Terra Nova Offshore Oil Development*, which provides the following papers:
  - DeBlois, E.M., J.W. Kiceniuk, M.D. Paine, B.W. Kilgour, E. Tracy, R.D. Crowley and G.G. Janes. 2014b. Examination of body burden and taint for Iceland scallop (*Chlamys islandica*) and American plaice (*Hippoglossoides platessoides*) near the Terra Nova Offshore oil development

over ten years of drilling on the Grand Banks of Newfoundland, Canada. Deep-Sea Research II, 110: 65-83.
- DeBlois, E.M., M.D. Paine, B.W. Kilgour, E. Tracy, R.D. Crowley and G.G Janes. 2014a. Alterations in bottom sediment physical and chemical characteristics at the Terra Nova offshore oil development over ten years of drilling on the Grand Banks of Newfoundland, Canada. Deep-Sea Research II, 110: 13-25.
- DeBlois, E.M., E. Tracy, G.G. Janes, R.D. Crowley, T.A. Wells, U.P. Williams, M. D. Paine, A. Mathieu, B.W. Kilgour. 2014c. Environmental Effects Monitoring at the Terra Nova Offshore Oil Development (Newfoundland, Canada): Program Design and Overview. Deep-Sea Research II, 110: 4-12.
- Neff, J., K. Lee, E.M. DeBlois and G.G. Janes. 2014a. Environmental effects of offshore drilling in a cold ocean ecosystem: A ten-year monitoring program at the Terra Nova offshore oil Development off the Canadian East Coast. Deep-Sea Research II, 110: 1-3.
- Paine, M.D., E.M. DeBlois, B.W. Kilgour, E. Tracy, P. Pocklington, R.D. Crowley and G.G. Janes. 2014a. Effects of the Terra Nova offshore oil development on benthic macroinvertebrates over ten years of development drilling on the Grand Banks of Newfoundland, Canada. Deep-Sea Research II, 110: 38-64.
- Paine, M.D., M.A. Skinner, B.W. Kilgour, E.M. DeBlois, E. Tracy. 2014b. Repeated measures regression designs and analysis for environmental effects monitoring programs. Deep-Sea Research II, 110: 84-91.
- Whiteway, S.A., M.D. Paine, T.A. Wells, E.M. DeBlois, B.W. Kilgour, E.J. Tracy, R.D. Crowley, U.P. Williams and G.G. Janes. 2014. Toxicity assessment in marine sediment for the Terra Nova environmental effects monitoring program (1997-2010). Deep-Sea Research II, 110: 26-37.

- Distribution of Well Cuttings and Produced Water for the Terra Nova Development (Seaconsult 1998)
- Flare Gas Recovery Feasibility Study (TN-AB-PR15-M04-002) was conducted in 2013.
- A study on reduced emissions completions / vapour recovery and gas detection on the TN FPSO (Barua et al. 2015).
- An assessment of Best Available Technology associated with the drilling cutting (solids control equipment selection process) during the intake of the Transocean Barents drill rig in 2017.

Suncor also participates in Environmental Studies Research Fund (ESRF) and Petroleum Research Newfoundland and Labrador research projects (and advancement of scientific knowledge). Suncor is involved in all ESRF projects for the East Coast as they are a funding operator and they have participated on the Management Board since the 1990s. Examples of relevant ESRF studies include:

- Source Apportionment of Volatile Organic Compounds and Aerosols on Sable Island (Gibson and Craig 2018)
- Acoustic Monitoring Along Canada's East Coast: August 2015 to July 2017 (Delarue et al. 2018)
- Effectiveness of Observers in Visually Detecting Dead Seabirds on the Open Ocean (Fifield et al. 2017)
- Biodegradation of Naturally and Chemically Dispersed Crude Oils and Scotian Shelf Condensate from Atlantic Canada (National Research Council Canada and Centre for Offshore Oil, Gas and Energy Research 2015)
- Refinement and Validation of Numerical Risk Assessment Models for use in Atlantic Canada (Niu and Lee 2013)
- Biological Effects of Produced Water from Offshore Canadian Atlantic Oil and Gas Platforms on Various Life Stages of Marine Fish (Courtenay et al. 2013)
- Effects of Offshore Oil and Gas Production on Air Quality in Canada’s East Coast Offshore Areas (Stantec 2013b)

- Proceedings of the International Produced Water Conference: Environmental Risks and Advances in Mitigation Technologies (Lee and Neff 2011)
- An Integrated Approach to Oil Spill Preparedness and Response (Leslie Grattan & Associates and the Institute for the Advancement of Public Policy, Inc. 2010)
- Effects of Sheens Associated with Offshore Oil and Gas Development on the Feather Microstructure of Pelagic Seabirds (O'Hara and Moradin 2010)
- Modelling Seabird Oil Spill Mortality Using Flight and Swim Behaviour (Fifield et al. 2009a)
- Offshore Seabird Monitoring Program (Fifield et al. 2009b)
- Environmental Persistence of Drilling Mud and Fluid Discharges and Potential Impacts (Centre for Offshore Oil, Gas and Energy Research 2009)
- Cuttings Treatment Technology Evaluation (Jacques Whitford Stantec Limited 2009)
- Workshop on Dispersant Use in Eastern Canada (Trudel 2004)
- Pollution Prevention Opportunities in the Offshore Oil and Gas Sector - Final Report (Dillon Consulting Limited 2004)
- Mapping the Spawning Times and Locations for Ten Commercially Important Fish Species Found on the Grand Banks of Newfoundland (Ollerhead et al. 2004)
- Environmental Effects Monitoring for Exploration Drilling (Buchanan et al. 2003)
- Workshop on Offshore Oil and Gas Environmental Effects Monitoring (Armsworthy et al. 2003)
- Sheens Associated with Produced Water Effluents – Review of Causes and Mitigation Options (ERIN Consulting Ltd. and OCL Services Ltd. 2003)

3.0 EXISTING ENVIRONMENT

This EA Validation Report focuses on those aspects of the environment that have substantially changed since the original EIS, specifically commercial fisheries, special areas, and species at risk. The atmospheric environment section has also been updated to capture recent climate data and evolving regulatory controls. A high-level overview description is provided of marine fish and fish habitat (including species at risk), marine and migratory birds (including species at risk), and marine mammals and sea turtles (including the species at risk) as there has been little change in the species that occur with the Project Area and Study Area. There are no sensitive areas within the Project Area or Study Area.

3.1 Atmospheric Environment

Atmospheric Environment was not a VEC in the original EIS; however, the atmospheric environment was described in Section 3.1 of the original EIS (Petro-Canada 1996). The Original EIS contained an “air emissions” section in the assessment for drilling / construction and production activities but did not include a section for “air quality”.

3.1.1 Air Quality

The existing ambient air quality within the Project Area can be generally categorized as very good, with only occasional exposure to exhaust products from existing offshore oil production facilities (i.e., Hibernia, White Rose, and Hebron), supply ships and other vessels in the area. Each platform would generally be downwind of another, less than 15% of the time. This region also receives long-range air contaminants from the industrial mid-west and northeastern seaboard of the United States (ExxonMobil Properties Canada 2011).

The National Pollutant Release Inventory program is legislated under the *Canadian Environmental Protection Act* and requires each facility within Canada meeting specified reporting triggers, to report their emissions to ECCC on an annual basis. An overview of the criteria air contaminant emissions reported from the operation of existing TN operations for the last five reporting years (2013-2017) is provided in Table 3.1. Applicable federal air quality criteria considered in this EA Validation Report are the National Ambient Air Quality Objectives (NAAQ), Canada Wide Standards, and the CAAQS. Air emissions related to peak operation of the TN FPSO would meet the NAAQ Objectives for each time period. The maximum predicted ground-level contaminants at TN are provided in Table 3.2.

Table 3.1 Terra Nova Reported Criteria Air Contaminant Emissions (National Pollutant Release Inventory Reporting)

Year	Air Emissions (tonnes/year)					
	CO	**NO_2**	**TPM**	**PM_{10}**	**$PM_{2.5}$**	**VOC**
2017	694	2,183	208	204	204	2,642
2016	439	2,219	118	115	115	116
2015	566	2,065	160	154	154	644
2014	666	2,387	205	202	202	241
2013	551	2,028	152	143	143	1,173

Source: ECCC 2018b

CO = Carbon monoxide; NO2 = nitrogen dioxide; TPM = total particulate matter; PM_{10} = Particulate matter less than 10 microns in diameter; $PM_{2.5}$ = Particulate matter less than 2.5 microns in diameter; VOC = volatile organic compound

Table 3.2 Terra Nova Maximum Predicted Ground-level Concentrations – Peak Operation

Contaminant	Averaging Period	Maximum Predicted GLC (µg/m³)	NAAQ Objectives (Max acceptable (µg/m³)
NO_2	1-hour Maximum	28.0	400
	24-hour Maximum	5.17	200
	Annual Average	0.14	100
Carbon Monoxide	1-hour Maximum	6.3	35,000
	8-hour Maximum	1.8	15,000
	Annual Average	0.0	NA
Total Suspended Particulate	1-hour Maximum	0.8	NA
	24-hour Maximum	0.15	120
	Annual Average	0	70
VOCs A	1-hour Maximum	0.477	NA
	24-hour Maximum	0.062	NA
	Annual Average	0.001	NA

Source: ExxonMobil Canada Properties 2011

A VOCs are presented in mg/m³

3.1.2 Greenhouse Gases

Suncor (2018a) has a corporate greenhouse gas (GHG) emission goal of reducing their emission intensity of the production of oil and petroleum products by 30% (2014 emissions) by 2030 from harnessing changes in technology and making improvements by innovation. To achieve this goal, Suncor is annually investing approximately $200 million to support research and technology development (Suncor 2018b). While the corporate reduction goal is 30%, each of Suncor's diverse operating assets assesses and develops asset specific reduction strategies (e.g., 5%, 25%) in support of the overall company GHG emission goal. For example, a small emissions business unit such as the East Coast TN FPSO may only have marginal / incremental reductions.

As the Project will emit >500,000 tonnes (t) CO_{2eq}/year (threshold for classification as a GHG large emitter), Suncor will continue to review their GHG Management Strategy every three years throughout the life of the Project and follow procedures outlined in the 2008 Report to the C-NLOPB on the Greenhouse Gas Emission Abatement Measures of the TN FPSO (TN-PE-EV15-X00-175). This report summarizes the emission abatement techniques currently employed on the FPSO and the opportunities to further improve the emissions performance of the FPSO. The GHG emissions estimates for the FPSO for the 2007 reporting year were calculated to be 752,000 t CO_{2eq}, representing a 48% decrease in emissions from 2002 (first full year of production). The principal sources of GHG releases contributing to this estimate are emissions from flaring and the main power generators, with minor contributions from tank venting, fugitive emissions and miscellaneous diesel consumption sources.

3.2 Marine Fish and Fish Habitat

Marine fish and fish habitat were described in detail in Sections 4.1 to 4.8 of the original EIS (Petro-Canada 1996). A variety of fish species occur in offshore Newfoundland. Commercially important fish species that exist within the Regional Area include yellowtail and witch flounder, redfish, roughhead and roundnose grenadier, Atlantic and Greenland halibut, skate, capelin, and mackerel (Amec 2014; Suncor 2017b). While American plaice and Atlantic cod were historically abundant within the Regional Area, they are currently under moratoria, as are redfish (in Northwest Atlantic Fisheries Organization (NAFO) Divisions 3LN) and witch flounder (in NAFO Divisions 3NO). Non-commercial fish species commonly found within the Regional Area include sand lance, Arctic cod, sculpin, and alligatorfish (Husky Energy 2012). By-catch recorded during EEM programs conducted from DFO research vessels (2002 to 2008) recorded snow crab, shrimp, Atlantic cod, Arctic cod, capelin, American plaice, yellowtail flounder, witch flounder, squid, Iceland scallop, sand lance, thorny skate, sea star, sculpin, snakeblenny, toad crab, alligatorfish, seasnails, sea urchin, sand dollar, eelpouts, radiated shanny, and spiny lumpfish (Suncor 2010). The status of marine fish species at risk are listed in Section 3.5.

The benthic species in the Regional Area include various species of polychaete worms (the dominant in faunal or infauna group of organisms (DeBlois et al. 2014a), amphipods, echinoderms, cumaceans, and clams (DeBlois et al. 2014a; Suncor 2017b); the same species have been found in the Hebron field (Stantec 2016). Corals are limited in the Project and Study Areas due the predominantly sandy substrate (DeBlois et al. 2014a); coral communities have been identified in the Regional Area.

Suncor's EEM programs have been conducted since production began in 2000. Nine collection and reporting cycles have been conducted from 2000 to 2014 (the report on the 2017 cycle is not yet public). The EEM program includes a sediment and water component. Key findings include:

- the dispersion of drill cuttings in the Project Area was consistent with model estimates (Seaconsult 1998) (i.e., fines content decreases with distance from drill centres) (DeBlois et al. 2014a)
- sediment contamination decreased in direct response of reduced drilling (DeBlois et al. 2014a)
- sediment quality triad results (contamination, toxicity and benthic biota effects) indicated reduced sediment quality at one station less than 150 m from a drill centre in some sampling years
- effects on some benthic invertebrate biota (abundance, biomass, richness, diversity, toxicity to laboratory amphipod cultures) were detectable 1 to 2 km from drill centres in some sampling years but such effects were weak or absent beyond less than 150 m from drill centres (Paine et al. 2014a)

3.3 Marine and Migratory Birds

Marine-related birds were described in detail in Section 4.9 of the original EIS (Petro-Canada 1996). The Grand Banks provide important habitat for millions of marine birds, representing over 60 species (Husky Energy 2012). Species observed within the Project and Study Areas include gannets, phalaropes, gulls, petrels, alcids, and shearwaters (Amec 2014). Many of the pelagic seabirds that are resident in the Regional Area year-round (such as northern fulmar and black-legged kittiwakes (ExxonMobil Canada Properties 2011)) and their numbers are supplemented by the many migratory birds that use the Regional Area to forage and breed in summer. For example, most of the world's population of greater shearwater migrate to moult and feed during summer months and Leach's storm-petrel migrate from coastal colonies (ExxonMobil Canada Properties 2011). July to September represents the peak seabird density, large numbers of which occur on the shelf edges (Lock et al. 1994, in LGL Limited 2008). Migration south for the winter reduces the densities of seabirds during the fall and winter (Fifield et al. 2009, in Amec 2014), although hundreds of thousands of birds do use the Grand Banks during winter (ExxonMobil Canada Properties 2011). The status of marine and migratory bird species at risk are listed in Section 3.5.

An onboard observer on the TN FPSO conducts seabird observations for Suncor Energy in the TN field as per the Eastern Canada Seabirds at Sea program protocol. As an example, during January 1, 2017 to December 31, 2017, a total of 11,730 individual seabirds were recorded during 732 seabird observation sessions. Poor visibility (≤1 nm) in poor weather conditions (rain, snow, mist, or fog) resulted in no seabird sightings in 20% of all observations. No seabirds were recorded in approximately 43% of the observations. Approximately 31% of all birds sighted were black-legged kittiwake; great black-backed gulls were the second-most commonly sighted birds (approximately 28%) (PAL Aerospace 2018). Leach's storm-petrel were observed during September. The number of different bird species observed offshore from the TN FPSO typically increases in the last quarter of the year due to the migration of birds south for the winter.

A Leach's storm-petrel recovery and release program is also conducted on the TN FPSO. The data, filed with ECCC and C-NLOPB, indicate that there is no pattern to the number of birds found on the TN FPSO (or on a MODU if operating in the TN Field) in any one year. Other species recorded during the recovery and release program on the TN FPSO include greater shearwater, peregrine falcon, Canada goose, ruddy turnstone, American bittern, thick-billed murre, common murre, unknown murre species, boreal owl,

dovekie, Atlantic puffin, unknown tern species, unknown gull species, and a short-eared owl from a MODU operating in the TN field. A number of herring gulls were found dead on the TN FPSO and a glaucous gull and two great black-backed gulls were found dead on a MODU in the TN field during 2007; these deaths occurred during period of Avian Cholera outbreak among offshore birds.

3.4 Marine Mammals and Sea Turtles

Marine mammals were described in detail in Section 4.10 of the original EIS (Petro-Canada 1996). Approximately 20 species of marine mammals (including whales, dolphins, porpoises, and seals) are known to occur within the Regional Area. Species observed during seismic surveys conducted in the Jeanne d'Arc Basin include humpback whale, sei whale, fin whale, minke whale, long-finned pilot whale, common dolphin, Atlantic white-sided dolphin, white-beaked dolphin, harp seal (ExxonMobil Canada Properties 2011). Many marine mammal species feed in the area on a seasonal basis, with highest numbers occurring in the summer and fall (Husky Energy 2012), although some species such as minke and humpbacks whales may occur year-round. Harp and hooded seals that use ice as an overwintering and whelping area may occur within the Regional Area during years with heavy pack ice conditions (DFO 2000, in Amec 2014). The status of marine mammals and sea turtles species at risk are listed in Section 3.5.

3.5 Species at Risk

Species at risk / of conservation status are not described in the original EIS (Petro-Canada 1996) but are discussed in EA Updates (Suncor 2012, 2014, 2017). The federal *Species at Risk Act* (SARA), which is the means to both designate and provide protection to rare, endangered and threatened species, was not promulgated at the time of the original assessment of the TN Project. Table 3.3 provides the species listed under SARA Schedule 1 or assessed as at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). None of the species have SARA-designated critical habitats designated within or near the Project or Study Areas.

Table 3.3 Current Listings of SARA and COSEWIC Species Relevant to the Terra Nova Field

Common Name	Scientific Name	SARA Status	COSEWIC Status
Marine Fish			
Northern wolffish[1]	*Anarhichas denticulatus*	T	T
Spotted wolffish[1]	*Anarhichas minor*	T	T
Atlantic wolffish[1]	*Anarhichas lupus*	SC	SC
Atlantic cod (NL population)	*Gadus morhua*	--	E
Porbeagle shark	*Lamna nasus*	--	E
White shark (Atlantic population)	*Carcharodon carcharias*	E	E
Roundnose Grenadier	*Coryphaenoides rupestris*	--	E
Cusk	*Brosme brosme*	--	E

Table 3.3 Current Listings of SARA and COSEWIC Species Relevant to the Terra Nova Field

Common Name	Scientific Name	SARA Status	COSEWIC Status
Shortfin mako shark (Atlantic population)	*Isurus oxyrinchus*	--	E
American eel	*Anguilla rostrata*	--	T
White hake (Atlantic and Northern Gulf of St. Lawrence population)[2]	*Urophycis tenuis*	--	T
Thorny skate	*Amblyraja radiata*	--	SC
Roughhead grenadier	*Macrourus bersgla*	--	SC
Atlantic bluefin tuna	*Thunnus thynnus*	--	E
American plaice (NL Population)	*Hippoglossoides platessoides*	--	T
Winter skate (Eastern Scotian Shelf and Newfoundland population)[3]	*Leucoraja ocellata*	--	E
Acadian redfish (Atlantic population)	*Sebastes fasciatus*	--	T
Deepwater redfish (Northern population)	*Sebastes mentella*	--	T
Atlantic salmon (various populations)	*Salmo salar*	E (Inner Bay of Fundy population)	E / T / SC populations
Spiny dogfish (Atlantic population)	*Squalus acanthias*	--	SC
Basking shark (Atlantic population)	*Cetorihinus maximus*	--	SC
Smooth skate (Funk Island Deep population)	*Malacoraja senta*	--	E
Smooth skate (Laurentian-Scotian population)	*Malacoraja senta*	--	SC
Lumpfish	*Cyclopterus lumpus*		T
Marine Mammals			
Blue whale (Atlantic population)[4]	*Balaenoptera musculus*	E	E
North Atlantic right whale[5]	*Eubalaena glacialis*	E	E
Fin whale (Atlantic population)[6]	*Balaenoptera physalus*	SC	SC
Killer whale (NW Atlantic and Eastern \ Arctic population)	*Orcinus orca*	--	SC
Sowerby's beaked whale[7]	*Mesoplodon bidens*	SC	SC
Northern bottlenose whale (Davis Strait-Baffin Bay-Labrador Sea and Scotian Shelf[8] populations)	*Hyperoodon ampullatus*	E (Scotian Shelf population)	E (Scotian Shelf population) SC ((Davis Strait-Baffin Bay-Labrador Sea population)
Harbour porpoise (Northwest Atlantic subspecies)	*Phocoena phocoena*	T (on Schedule 2)	SC

Table 3.3 Current Listings of SARA and COSEWIC Species Relevant to the Terra Nova Field

Common Name	Scientific Name	SARA Status	COSEWIC Status
Beluga whale (St. Lawrence Estuary population)	*Delphinapterus leucas*	E	E
Sei Whale (Atlantic population)	*Balaenoptera borealis*		E
Sea Turtles			
Leatherback sea turtle[9]	*Dermochelys coriacea*	E	E
Loggerhead sea turtle (Atlantic Population)	*Caretta caretta*	E	E
Marine Birds			
Ivory gull[10]	*Pagophila eburnean*	E	E
Red-necked phalarope	*Phalaropus lobatus*	SC	SC
Peregrine falcon *anatum/tundris*[11]	*Falco peregrinus anatum/tundris*	SC	SC

Source: Government of Canada 2018

E = Endangered; T = Threatened; SC = Special Concern; -- = no status

Recovery Strategy / Management Plan / Action Plan:

1 DFO 2018a; 2 DFO 2019a; 3 DFO 2019b; 4 DFO 2018b; 5 DFO 2016a; 6 DFO 2017a; 7 DFO 2017b; 8 DFO 2017c; 9 DFO 2018c; 10 Environment Canada 2014; 11 ECCC 2017

Recent engagement with ECCC indicated that COSEWIC will likely conduct an assessment of Leach's storm-petrel given the observed decline in their population on the East Coast.

3.6 Special Areas

Special areas are not described in the original EIS (Petro-Canada 1996); this is a recent valued component in EA. Special areas are defined as those areas deemed important or essential habitat to support any of the marine resources identified in the Regional Area. There are no special areas within the Project or Study Areas. Special areas within the Regional Area are listed in Table 3.4 and numbered with reference to Figure 3-1.

The offshore and near-shore marine environments of Newfoundland and Labrador are important for ecological, historical, or socio-economic reasons. In total, there are 38 special areas inside the Regional Area, covering approximately 47% (201,455 km²) of the combined areal extent of the sensitive areas (Figure 3-1).

Ecological reserves are provincially-designated areas that contain a portion of the marine environment within their boundary to protect and conserve important seabird species and their habitat. Ecological reserve are protected under the Newfoundland and Labrador *Wilderness and Ecological Reserves Act (1980)*.

Table 3.4 Special Areas Inside the Regional Area

Name	Special Area Type	Jurisdiction	Area within Regional Area (km²)	Total Area (km²)	% of Total Area within Regional Area (%)	Nearest Distance to Project Area (km)	Map Reference No. (Figure 3-1)
Slopes of the Flemish Cap and Grand Bank	EBSA	National	73,551.39	87,932.73	84%	65	35
Significant Benthic Area	Other	National	7725.45	59,069.20	13%	65	38
Flemish Pass / Eastern Canyon	NAFO VME	International	5,418.23	5,418.23	100%	66	3
Northeast Shelf and Slope	EBSA	National	6,308.96	13,884.86	45%	73	31
Lilly Canyon - Carson Canyon	EBSA	National	120.08	120.08	100%	85	32
Virgin Rocks	EBSA	National	6,842.50	6,842.50	100%	99	30
Spotted Wolffish Critical Habitat	Proposed Species at Risk Habitat	National	108.12	93,627.25	12%	103	37
Southeast Shoal and Tail of the Banks	EBSA	National	30,934.96	30,934.96	100%	151	29
Beothuk Knoll	NAFO VME	International	114.3	308.54	37%	158	4
Northeast Newfoundland Slope - Tobin's Point 1	Marine Refuge	National	447.31	54,097.41	1%	165	14
Northwest Flemish Cap	NAFO VME	International	60.68	60.68	100%	169	13
Beothuk Knoll	NAFO VME	International	339.61	339.61	100%	170	11
Southeast Shoal and Adjacent Areas on the Tail of the Grand Bank	CBD EBSA	International	16,333.66	16,333.66	100%	189	36
Northwest Flemish Cap	NAFO VME	International	316.55	316.55	100%	201	10
Tail of the Bank	NAFO VME	International	143.54	143.54	100%	218	2

Table 3.4 Special Areas Inside the Regional Area

Name	Special Area Type	Jurisdiction	Area within Regional Area (km²)	Total Area (km²)	% of Total Area within Regional Area (%)	Nearest Distance to Project Area (km)	Map Reference No. (Figure 3-1)
Sackville Spur	NAFO VME	International	991.73	991.73	100%	230	6
Northwest Flemish Cap	NAFO VME	International	35.21	35.21	100%	255	12
Northern Flemish Cap	NAFO VME	International	128.19	128.19	100%	292	9
Northern Flemish Cap	NAFO VME	International	259.17	259.17	100%	300	7
Eastern Avalon	EBSA	National	35.6	35.6	100%	313	34
Northern Flemish Cap	NAFO VME	International	98.34	98.34	100%	317	8
Witless Bay Islands	IBA	National	53.54	62.05	86%	318	17
Witless Bay Ecological Reserve	Ecological Reserve	Provincial	29.03	29.03	100%	319	26
Quidi Vidi Lake	IBA	National	0.23	7	3%	322	20
Mistaken Point	IBA	National	97.17	102.75	95%	334	21
Cape St. Francis	IBA	National	23.84	70.18	34%	335	19
Northeast Flemish Cap	NAFO VME	International	467.44	2,898.33	16%	363	5
The Cape Pine and St. Shotts Barren	IBA	National	27.21	57.4	47%	366	18
Southwest Shelf Edge and Slope	EBSA	National	16,643.90	16,643.90	100%	383	28
Placentia Bay Extension	EBSA	National	7,693.18	7,693.18	100%	400	33
Placentia Bay	IBA	National	1,374.25	1,398.93	98%	400	22
Cape St. Mary's	IBA	National	273.19	329.61	83%	410	1

Table 3.4 Special Areas Inside the Regional Area

Name	Special Area Type	Jurisdiction	Area within Regional Area (km²)	Total Area (km²)	% of Total Area within Regional Area (%)	Nearest Distance to Project Area (km)	Map Reference No. (Figure 3-1)
Division 3O Coral	Marine Refuge	National	10,336.31	10,336.31	100%	411	16
3O Coral Closure	NAFO VME	International	14,057.05	14,057.05	100%	411	15
Cape St. Mary's Ecological Reserve	Ecological Reserve	Provincial	53.66	53.66	100%	415	25
Corbin Island	IBA	National	3.49	5.26	66%	497	23
Lawn Bay Ecological Reserve	Ecological Reserve	Provincial	3.63	3.63	100%	525	27
Middle Lawn Island	IBA	National	4.18	4.18	100%	528	24

EBSA = Ecologically and biologically Significant Area
CBD = Convention on Biological Diversity
DFO = Fisheries and Oceans Canada
NAFO = Northwest Atlantic Fisheries organization
VME = Vulnerable Marine Ecosystem
IBA = Important Bird Area

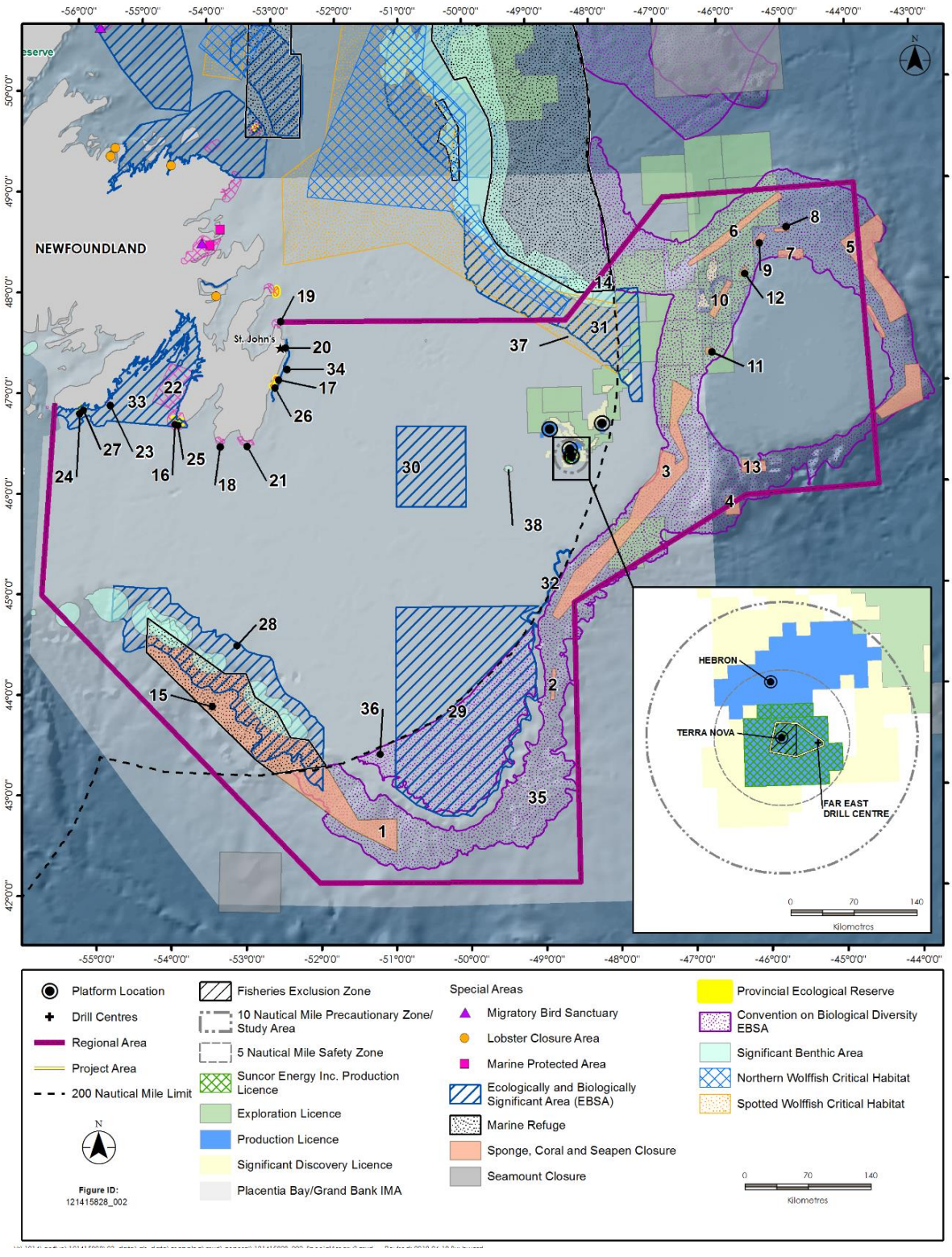


Figure 3-1 Location of Project Area, Study Area, and Regional Area and Special Areas

Ecologically and biologically sensitive areas (EBSAs) are national marine areas with high ecological or biological activity (relative to their surrounding environment); these areas are identified and ranked in importance by DFO (DFO 2005). Eleven of the twenty-five EBSAs are inside the Placentia Bay / Grand Banks Integrated Management Area.

There are five United Nations Convention on Biological Diversity EBSAs in Offshore Newfoundland and Labrador. Nominated locations for EBSAs are considered and then evaluated based on select environmental criteria to identify important ocean habitat areas in international waters. The Study Area contain two of the EBSAs.

There are 41 Important Birds Areas (IBAs) in Newfoundland Labrador (of the 597 IBAs in Canada). IBAs are a national designation of areas identified as having national, continental or worldwide significance for birds that are threatened, have a restricted range or habitat or occur in large groups (IBA Canada 2018). IBAs can also comprise portions of provincial Ecological Reserves or Migratory Bird Sanctuaries. Marine refuges are national fisheries closure areas protected under the *Oceans Act* (Government of Canada 2017) to provide long-term biodiversity conservation, four of which are fully within the Newfoundland and Labrador Shelves bioregion (DFO 2016b), These areas can be closed to either bottom-contact fishing or all fishing.

NAFO Vulnerable Marine Ecosystems (VMEs) are international areas (i.e., outside the Canadian Exclusive Economic Zone) that contain benthic environments that are sensitive to bottom fishing due to unique features that are important for biodiversity such as seamounts and canyons or contain sensitive species such as corals, sponges, and sea pens (FAO 2016).

3.7 Commercial Fisheries

The fisheries were described in detail in Section 4.8 of the original EIS (Petro-Canada 1996). No commercial fisheries are conducted within the Project Area and only snow crab have been harvested adjacent to a small portion of the Study Area. The NAFO data are summarized by NAFO Divisions that fall within the Regional Area, including 3L, 3M, 3N, 3O.

3.7.1 Current Domestic Fisheries within the Regional Area

Between 2012 and 2016, there was an overall decline of 28% in the total weight of all species harvested in the Regional Area (primarily driven by snow crab catch), with the overall weight decreasing from a maximum of 41,110 t in 2012 to a minimum of 29,460 t in 2016. The total value of all commercial fishing within the Regional Area between 2012 and 2016 remains more constant, having a total value of $151,934,123 in 2012, and $157,143,217 in 2016. The value was at its highest in 2015 at $159,830,602, and at its lowest in 2014 at $131,830,066, a total variance of almost 18%.

A breakdown of the annual total weight for the top 15 species indicates that snow crab represents 77.6% of the total weight caught within the Regional Area between 2012 and 2016, followed by Atlantic cod at 10.8%. This higher representation of Atlantic cod is likely due to the commercial fishery that exists for the species in NAFO Subdivision 3Ps. Between 2012 and 2016 there is a decrease in weight of snow crab, from 30,977 t in 2012 to 21,017 t in 2016, a decrease of 32%. For Atlantic cod, the annual landed weight increased by 50%, from 3,310 t in 2012 to 4,960 t in 2016.

For value, snow crab represents 90% of the total value over the five-year period, while Atlantic cod represents 3.5%. The landed value of snow crab fluctuates over time, with a high in 2014 of $151,200,136 and a low in 2013 of $128,873,422. The trend for Atlantic cod follows suit with the weight trend, increasing by 55% from $3,858,520 in 2012 to 8,656,245 in 2016. There are also NAFO quotas for white hake (in 3NO) and squid (NAFO Subareas 3+4) (NAFO 2015).

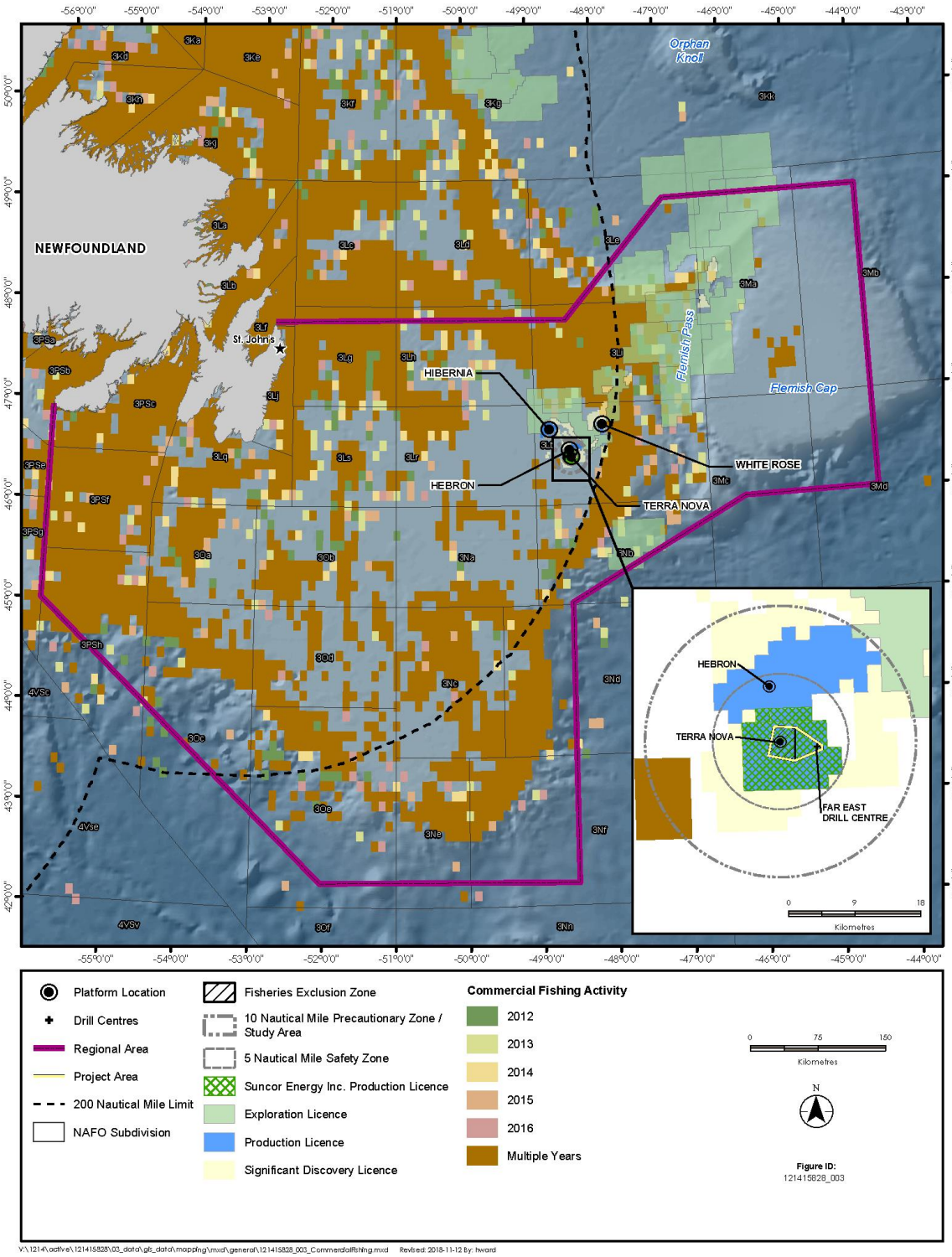
3.7.2 Location and Timing of Harvest

Using the geospatial data provided by DFO, Figure 3-2 shows domestic harvesting locations in the Regional Area from 2012-2016 for all species, showing overlap of locations fished in multiple years. The figure provides a general indication of the important fishing areas in the Regional Area; mainly the shelf slopes along the Flemish Pass and Grand Banks, and the nearshore areas surrounding the Avalon Peninsula. As illustrated in the figure, there is little commercial fishing activity near the existing oil and gas platforms along the Grand Banks, including the Project Area and Study Area. Data indicate that the most intense harvesting period, representing 65% of the total yearly harvest effort, occurs during the months of April, May, June, and July. Just 11% of the yearly harvest occurs in January, February, and March, and 26% in the remaining months (i.e., August to December).

3.8 Climate Change

Projections show that temperatures are rising, precipitation is increasing, and extreme weather events are becoming more intense. Climate change is characterized by the change in meteorological patterns to surface temperature, precipitation, or frost days averaged over a long period (i.e., on the order of decades). Climate change can affect air temperature, precipitation patterns, wind, storms, water temperature, waves, currents, sea level, sea ice, and icebergs (BP Canada Energy Group ULC 2018).

While the extended temporal scope of the Project is near term and a relatively short timeframe, the effects of climate change, are already being observed in current climate conditions in terms of higher temperatures, changing precipitation patterns, more storm events (with increasing storm intensity).



Source: DFO 2018d

Figure 3-2 Commercial Fishing Activity within the Regional Area, 2012-2016, All Species

Two atmospheric patterns, the North Atlantic Oscillation and the Atlantic Multidecadal Oscillation, as well as ocean currents in the Atlantic Ocean create the differences in pressures and temperatures and ocean currents and are the primary drivers of the meteorological conditions in the Regional Area. The east coast of Newfoundland and Labrador Air has seen an increase in temperatures of 0.90±0.37°C and 0.75±0.34°C for coastal and Atlantic Ocean stations, respectively, between 1900-2010 (Savard et al. 2016). Newfoundland and Labrador temperatures are projected to increase by 1.6 to 3.8°C by 2050 (Savard et al. 2016), with higher magnitude increases in winter than in summer and fall (Finnis 2013). Precipitation rates are also expected to be highest in winter for the region, although winter precipitation may include more rain (including freezing rain) due to predicted higher temperatures (Finnis 2013). Recent climate change projections suggest that changes in wind speed and direction is unlikely to change substantially due to climate warming (Amec Foster Wheeler 2017; Salon et al. 2017), although storm frequency in the region may be affected (Salon et al. 2017).

Ocean warming occurs primarily in the upper ocean (i.e., 0 to 700 m) and bottom water temperature warming is also likely (Intergovernmental Panel on Climate Change (IPCC) 2014). Temperature increases of 1.4°C and 1.6°C at the surface and bottom, respectively, are anticipated from 2011 to 2069 (Han et al. 2018). Mean sea level rose globally by 0.19 m between 1901 and 2010 (IPCC 2014). Between 2011 and 2069, it is predicted that St. John's will experience a rise in sea level by 0.11 m (Han et al. 2018). Warmer temperatures in winter have decreased the duration of the ice-covered season, as well as decreasing ice cover thickness and duration. The east coast region has recorded a 1.53% decrease in annual average sea ice over between 1998 to 2013 (Savard et al. 2016). The number of icebergs vary greatly from year to year (Bigg 2015). On an annual basis prior to the ice season, the Grand Banks Ice Management Plan (OD-PE-EV02-001) is presented to relevant personnel to provide an overview of the ice management process, which includes but is not limited to, resources available to identify and manage ice, and communication requirements.

Section 5.8.4 of the original EIS (Petro-Canada 1996) discussed the potential effects of atmospheric climate change on the Project. The original EIS indicated that atmospheric climatic change leads to changes in the marine climate (i.e., to the ice, wave or meteorological regime) that could necessitate changes in operational procedures. The original EIS predicted that changes in the physical or biological oceanographic regime of the Grand Banks will not affect the zone of influence or effects of the discharge of drilling muds and cuttings, produced water or other oily discharges, or the zone of noise effects. To date, the environmental effects monitoring (Section 4.2.1) results have confirmed that the zone of influence and effects of discharge streams at Terra Nova are within the levels predicted in the original EIS.

The design and operation of the TN Field incorporates metocean criteria for the offshore conditions expected for the area and metocean conditions are continuously monitored to ensure safe operations. Engineering design, operational procedures, and mitigation measures will continue to reduce potential adverse effects to the Project. For example, following the 2018 storm season, the Terra Nova FPSO Contingency Plans (TN-PE-PR03-X00-027) were reassessed. The operational plans associated with severe weather (Severe Weather Management, Severe Weather Station Keeping) were modified and pre-post storm inspection checklists formalized to ensure effective measures are proactively taken to manage risks associated with severe weather.

4.0 ENVIRONMENTAL EFFECTS ASSESSMENT

4.1 Routine Activities

There is no change in the routine activities that will be undertaken on an ongoing basis (or engendered by the upgrade activities described in this report (see Section 2.2.2)) as assessed in the original EIS (Petro-Canada 1996), produced water increase EA (Petro-Canada 2009), and EA Updates (Suncor 2012, 2014, 2017a); only the temporal scope of the Project is changing to extend the life of the Project. In general, the environmental effects assessment and mitigative measures previously identified in the EIS and EA Updates with respect to routine activities remain valid for the currently proposed TN ALE Project; however, they will continue over a longer time frame. Cumulative effects are discussed in Section 4.3. An updated environmental effects assessment associated with potential accidents and malfunctions is presented in Section 4.4.

The original EIS assessment of environmental effects is summarized in Table 4.1. The original EIS defined a significant impact as one with a rating of major or moderate or that it is minor with a medium- or long-term and a regional impact. A not significant impact was defined as one with a rating of negligible or is minor, short term, and local or sublocal in nature.

Table 4.1 Summary of Original TN EIS Impacts of Routine Activities

VEC / Activity	Magnitude	Duration	Geographical Extent
Fish and Fish Habitat and Fishery			
Presence of Structures (safety zone, artificial reef effect, subsea structures, surface structures)	Negligible to moderate	Long-term	Local
Lights and Beacons	N/A		
Drilling Mud	Negligible to major	Short-term to medium term	Sublocal to local
Other Fluids and Solids (e.g., cooling water, deck drainage, bilge water, cement, sanitary and domestic waste, produced water)	Negligible to minor	Short-term to long-term	Sublocal to local
Atmospheric Emissions	Negligible		
Noise (from drilling rigs, FPSO, support vessels, and helicopters)	Negligible to minor	Short-term	Sublocal
Decommissioning	Negligible to minor	Short-term to long-term	Sublocal
Marine Related Birds			
Presence of Structures (safety zone, artificial reef effect, subsea structures, surface structures)	Negligible		
Lights and Beacons	Negligible		

Table 4.1 Summary of Original TN EIS Impacts of Routine Activities

VEC / Activity	Magnitude	Duration	Geographical Extent
Drilling Mud	Negligible (little or no interaction)		
Other Fluids and Solids (e.g., cooling water, deck drainage, bilge water, cement, sanitary and domestic waste, produced water)	Negligible		
Atmospheric Emissions	Negligible		
Noise (from drilling rigs, FPSO, support vessels, and helicopters)	Negligible (as long as colonies are avoided)		
Decommissioning	Minor	Short-term	Sublocal
Marine Mammals			
Presence of Structures (safety zone, artificial reef effect, subsea structures, surface structures)	Negligible		
Lights and Beacons	N/A		
Drilling Mud	Negligible (little or no interaction)		
Other Fluids and Solids (e.g., cooling water, deck drainage, bilge water, cement, sanitary and domestic waste, produced water)	Negligible		
Atmospheric Emissions	Negligible		
Noise (from drilling rigs, FPSO, support vessels, and helicopters)	Negligible to minor	Short-term to long-term	Sublocal to local
Decommissioning	Minor	Short-term	Sublocal

Definitions:

Magnitude

Major Impact: An impact resulting in a >10% change in the carrying capacity of the environment, size of an animal population, size of a resource harvest or commercial fishery, or attribute of another VEC

Moderate Impact: An impact resulting in a 1% to 10% change in the carrying capacity of the environment, size of an animal population, size of a resource harvest or commercial fishery, or attribute of another VEC

Minor Impact: An impact resulting in a <1% change in the carrying capacity of the environment, size of an animal population, size of a resource harvest or commercial fishery, or attribute of another VEC

Negligible Impact: Impacts with essentially no effects

Geographical Extent

Regional impact: An impact that affects the region, defined for the TN EIS as the Grand Banks and the entire nearshore area adjacent to the Grand Banks and the onshore facilities

Local Impact: An impact at the local level, defined for the original EIS as the areas within 1 to 10 km from development activities

Sublocal Impact: An impact on the biophysical environment within 1 km of development activities

Duration

Long-term Impact: An impact that lasts for more than five years

Medium-term Impact: An impact that lasts one to five years

Short-term Impact: An impact that lasts less than one year

The assessment of significance was applied after the application of mitigation measures, which reduced the magnitude of all activities to none or negligible. Therefore, the original EIS determined there were no significant adverse residual effects associated with the Project's routine activities.

Routine drilling and production activities will be unchanged from those assessed in the original EIS and the EA Updates. The TN EEM program results have demonstrated that the effects of discharges associated with drilling and production have not exceeded those anticipated in the original EIS, nor are they expected to be exceeded over the extended life of the Project, given expected levels of production and drilling activity. Drilling activity within the TN Field will be considerably less in the future than during the field's development. EEM program will continue to monitor the effects of operational drilling and produced water discharges to validate EA predictions.

Suncor assessed the effects of maximum projected daily volume of produced water discharge (30,000 m^3/day) and determined that the residual environmental effects of the Project are predicted to be not significant for birds and other wildlife potentially exposed to sheens from produced water discharges (Petro-Canada 2009). The volume of produced water discharged is not expected to exceed previously assessed values for the life of the project. However, since 2009, new literature has been published on potential effects of produced water on seabirds.

Sheens have been shown to affect the structure and function of seabird feathers (O'Hara and Morandin 2010), which have the potential to result in water penetrating plumage and displacing the layer of insulating air, resulting in loss of buoyancy and hypothermia. This can in turn cause a heightened metabolic rate as well as behavioural changes such as increased time spent preening at the expense of foraging and breeding, and potentially death, especially in the winter months when conditions are colder, and thermoregulation is most difficult (Morandin and O'Hara 2016). When oiled adults return to the nest to incubate eggs or to feed and brood nestlings, oil is transferred from the breast plumage of adults to nestlings and eggs. Chicks and eggs are most susceptible to negative effects of exposure to oil (Morandin and O'Hara 2016). Recognizing the potential for sheens to affect seabirds in direct contact, Morandin and O'Hara (2016) could not conclude whether the effects of sheens on individuals have had long-term population effects through small reductions in adult fecundity or survivorship. In an effort to monitor the potential effect of sheening on seabirds, an observation of the area of produced water discharge will be included in the daily deck survey for stranded seabirds (see Section 4.2.3).

Even with the best available water treatment plants, nearly all offshore installations usually have faint but visible streaks of sheen extending for hundreds of metres downwind. With a calm sea state, a produced water sheen can form, but due to natural weathering processes, sheens are typically short-lived (Neff 1990). The high surface-to-volume ratios that characterize sheens contribute to relatively rapid volatilization, dissolution and dispersion of sheen components.

Therefore, the residual environmental effects assessment from Project activities and components on biological VECs (marine fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles), including mitigation measures, remain valid (i.e., residual effects are predicted to be not significant).

There is no critical habitat designated under SARA within the Project Area. Extending the life of the TN field will pose no substantial additional risk to species at risk compared with current routine operations at TN. In general, the potential effects on at-risk marine fish, marine birds, marine mammals, and sea turtles is similar to not at-risk species. The residual environmental effects assessment of a change to species at risk from Project activities and components identified in the original EIS and EA Updates, including mitigation measures, are predicted to remain valid (i.e., residual effects are predicted to be not significant).

There are no special areas within the Project Area that could be affected by routine activities related to the Project. Routine drilling and production activities will be unchanged from those assessed in the original EIS and EA Updates, the residual environmental effects assessment of a change to special areas from Project activities and components identified in the original EIS and EA Updates, including mitigation measures, are predicted to remain valid (i.e., residual effects are predicted to be not significant).

There are currently no commercial fishing operations taking place within the 10 nm precautionary zone, the 5 nm safety zone, and FEZ of the TN Field. Ongoing mitigation measures, including those proposed in the original EIS and EA updates remain generally applicable for the TN ALE Project. Early and ongoing communication between Suncor with groups such as One Ocean, FFAW-Unifor, OCI, Canadian Association of Prawn Producers, and Atlantic Groundfish Council (formerly the Groundfish Enterprise Allocation Council) will help reduce the potential for interaction with commercial fish harvesters and fishing activity from components such as supply vessels transiting fishing grounds. Vessels will follow established routes that commercial fishers are aware of due to the existing history of the TN field in offshore Newfoundland and Labrador. The residual environmental effects assessment of a change to commercial fisheries from Project activities and components identified in the original EIS and EA Updates, including mitigation measures, are predicted to remain valid (i.e., residual effects are predicted to be not significant).

The residual environmental effects assessment of a change in air quality from Project activities and components identified in the original EIS and EA Updates, including mitigation measures, are predicted to remain valid (i.e., residual effects are predicted to be not significant).

The residual environmental effects assessment from Project activities and components identified in the original EIS (including mitigation measures / response measures) are predicted to remain valid.

4.2 Monitoring and Follow-up

The original TN EIS made the following commitments to monitoring[1]:

- The EEM will monitor oil concentrations in sediments and effects on benthic animals
- As most of the oily water discharge will be produced water, the EEM will determine oil concentrations in water at various distances from the discharge
- A program to monitor tainting in fish will be implemented.

4.2.1 Environmental Effects Monitoring

Suncor currently conducts an EEM program every three years. Suncor will continue to conduct its EEM program on the same cycle for the duration of the new life of Project. Suncor will also update its EEM design as required to reflect any approved changes to its design. Results of the EEM programs conducted to date have been incorporated into this EA Validation Report, as relevant.

Suncor's EEM programs have been conducted since production began in 2000. Nine collection and reporting cycles have been conducted from 2000 to 2014 (the report on the 2017 cycle is not yet public). The EEM program includes a sediment and water component and a commercial fish component. The first ten years of TN EEM data were published in the *Deep-Sea Research II* journal in December 2014. The special edition, entitled *Environmental Effect of Offshore Drilling in a Cold Ocean Ecosystem, A Ten Year Monitoring Program at the Terra Nova Offshore Oil Development*, consists of six papers focusing on differing aspects of the EEM program, including: EEM program design, sediment physical and chemical characteristics, sediment toxicity, benthic invertebrate structure, plaice and scallop chemical body burden and taste (taint), and statistics used to assess effects.

The six studies support the effects predictions of the original EIS, primarily as they relate to effects from synthetic-based mud discharge (they are relatively minor); and biological effects have been limited and highly localized (when they occurred).

Key findings from Suncor's EEM sediment (and water) EEM program include:

- the dispersion of drill cuttings in the Project Area was consistent with model estimates (Seaconsult 1998) (i.e., fines content decreases with distance from drill centres) (DeBlois et al. 2014a)
- sediment contamination decreased in direct response of reduced drilling (DeBlois et al. 2014a)
- sediment quality triad results (contamination, toxicity and benthic biota effects) indicated reduced sediment quality at one station less than 150 m from a drill centre in some sampling years
- effects on some benthic invertebrate biota (abundance, biomass, richness, diversity, toxicity to laboratory amphipod cultures) were detectable 1 to 2 km from drill centres in some sampling years but such effects were weak or absent beyond less than 150 m from drill centres (Paine et al. 2014a)

[1] There were no monitoring commitments made for marine-related birds or marine mammals. Regardless, Suncor conducts and reports on regular searches for stranded birds on the FPSO (and supply vessels).

Key findings from Suncor's EEM commercial fish program include (DeBlois et al. 2014b):

- barium and hydrocarbon contamination was detected in Icelandic scallop visceral tissue, and also reduced in association with reduced drilling activity, but, at no time was scallop edible tissue (adductor muscle tissue) subject to taint
- with the exception of one instance in 2000, of detection of liver contamination with hydrocarbons in one fish, American plaice demonstrated no evidence of tissue contamination nor was taint detected at any time
- bioindicator analysis of American plaice demonstrated no differences between fish taken in the Project Area versus fish taken at a reference site 20 km southeast of the Project Area

To date, effects at TN have not exceeded levels predicted in the original TN EIS. Figure 4-1 illustrates EEM results from 2000 to 2014 and includes baseline results from 1997. Any project effect exceeding predicted levels would be identified in red in Figure 4-1.

	Response Variable	1997	2000	2001	2002	2004	2006	2008	2010	2012	2014
Sediment Component	Hydrocarbons										
	Barium										
	Other physical and chemical variables (particle size, metals other than barium, organic and inorganic carbon)										
	Bacterial luminescence (Microtox)										
	Laboratory amphipod survival										
	Benthic community structure										
Water Component	Physical characteristics: oxygen, temperature, salinity, pH										
	Chemical characteristics: metals and hydrocarbons										
	Chlorophyll concentration										
Commercial Fish Componel	American plaice and Iceland scallop metals and hydrocarbon body burden										
	Taste tests on American plaice and scallop (triangle and hedonic scaling tests)										
	Fish health indices on American plaice (haematology, tissue histopathology, mixed function oxygenase activity										

Project effect, or potential project effect, within predicted levels
Effect of note but with no clear association with the project
No detectable effect

Figure 4-1 Environmental Effects Monitoring Summary of Results, 1997 to 2014

Drilling activities at TN decreased after 2007. Subsequent to this, there was an overall improvement in sediment quality and decreases in $>C_{10}$-C_{21} hydrocarbon concentrations in scallop tissue, providing evidence of recovery after a decrease in drilling activity.

4.2.2 Environmental Protection Plans

Suncor will continue to apply mitigation measures committed to in the original TN EIS and EA updates. Suncor's Drilling and Production EPPs reflect Suncor's commitment to continual improvement in its management of the effects of TN production and drilling activities on the environment. The EPP provides a focused document to:

- ensure that TN production and drilling activities proceed with minimal adverse environmental effects
- establish and monitor compliance against environmental performance objectives relating to TN production and drilling activities

The EPPs are intended to provide a guide to the various documents, systems, and safe work practices that enable mitigative measures to be applied to ensure emissions to the environment from production and drilling activities are maintained at or below acceptable levels, monitored for compliance and reported to the C-NLOPB.

4.2.3 Other Mitigation Measures

Since the original TN EA and subsequent EA updates, Suncor has implemented numerous technologies (see Section 2.3) and applied various mitigation and monitoring measures. This section is intended to highlight select measures associated with:

- Seabirds
- Produced water
- Oil spill response capabilities

Suncor is required to conduct a seabird monitoring program. An onboard observer on the TN FPSO conducts seabird observations for Suncor in the TN field as per the Eastern Canada Seabirds at Sea program protocol. Additionally, Suncor is licensed by CWS and holds a scientific permit, which authorizes Suncor and nominees (e.g., TN FPSO, Barents MODU) to collect dead migratory birds and capture, transfer or release live migratory birds that land on the installations and vessels, in accordance with CWS guidance. An example of both the observational data and seabird stranding is provided in Section 3.3.

It is acknowledged that monitoring is conducted during daylight hours and storm-petrels are nocturnal and typically fly at night. Suncor will therefore initiate systematic deck searches for stranded birds by trained observers. These systematic searches should occur near dawn, with search efforts documented and observations recorded (including notes of efforts when no birds are found) as per the "Procedures for handling and documenting stranded birds encountered on infrastructure offshore Atlantic Canada" (ECCC 2017).

As part of these daily surveys, the observer will also check for seabirds on the water near the produced water discharge location and include observations in their daily reports.

In addition, the sheen report notifications that are reported to the C-NLOPB have been revised to include seabird observations noted at the time of the sheen

Suncor constructed a state-of-the-art facility, the Seabird Cleaning and Rehabilitation Centre ("Seabird Centre"), which became operational in 2004, to provide humane and timely attention to birds that have either been injured or oiled as a result of Suncor's activities on the East Coast. The Seabird Centre is licensed by the CWS and holds an emergency rehabilitation level 1 permit, with approval to handle a maximum of 10 birds at any one time. Suncor has been issued a permit by the Government of Newfoundland and Labrador Department of Municipal Affairs and Environment for the seabird rehabilitation operations. The Seabird Centre is under the authority of a licensed Veterinarian and has all the requirements for assessing, treating, cleaning, and short-term rehabilitation of birds. To promote the long-term rehabilitation and release of the birds, Suncor has also established a relationship with the Newfoundland and Labrador Environmental Association's Wildlife Response Centre (in Ship Cove, NL), which maintains a separate rehabilitation permit with CWS.

While Suncor has neither committed to nor initiated the following, there is potential to investigate or support research options in support of the following mitigation measures that focus on lighting:

- Investigate linear-type fixture mountings (versus directional lighting) where it is safe to do so
- Reduce floodlights and point source-type lighting through use of shields and deflectors to that light is pointed inward to the extent that platform illumination and safety is not compromised (especially in outer perimeter lighting)
- Investigate the use of "Dark Sky Compliant" lighting where applicable, avoiding the spill-over of light
- Investigate reduction of 'red-spectrum' emitting lighting with 'white' content lighting were possible
- Investigate substitution of high-pressure sodium lighting where possible with more of the whitish type light

As part of its Produced Water Management Strategy, Suncor has committed to undertaking an annual risk analysis of produced water discharge using the EIF. The EIF report findings, such as the oil-in-water content and options for chemical reduction and substitution, are discussed and evaluated at an annual multidisciplinary meeting and actioned based on feasibility. Additional information pertaining to the produced water management (including EIF) is available in Section 2.3.

To reduce the potential environmental impact of an oil spill, Suncor has proactively completed agreements with both industry partners and oil spill response providers in an effort to reduce emergency response time. Suncor currently has Mutual Emergency Assistance Agreements with East Coast operators that entails the release of personnel, vessels, and equipment by the parties to the Agreement(s), for logistics support (e.g., medevacs) and the exchange of operational information (e.g., ice management data). Suncor currently has arrangements with two oils spill response providers. Suncor has a standing offer contract with the Eastern Canada Response Corporation (ECRC) for the provision of spill training services (Tier 1 vessel training) and spill response services when specifically requested. Suncor also has a Participant Associate membership with Oil Spill Response Limited (OSRL). OSRL provides an international response capability to its members including access to oil spill response equipment (including capping stacks), aerial dispersant capability, a technical advisory service to provide on-site advice, OSRL's Global Response Network in the event of a major event and global oiled wildlife response service support. OSRL also offers oil spill response training programs.

Oil spill response capabilities have been significantly enhanced since the original TN EIS submission. In 2009, Suncor, Husky and HMDC (East Coast Operators) jointly acquired a Tier 2/3 offshore oil spill

containment system. The system, identical to the Norwegian Standard System, consists of a Framo Transrec 150 weir skimmer and a 400-m Norlense 1200L self-inflating boom. Deck mounts have been installed on designated vessels, improving the efficiency of mobilization and deployment of existing Tier 1 response equipment and the Norwegian Standard System. A review of the use of chemical dispersants as an oil spill countermeasure has been completed, which include, but are not limited to the following: crude oil testing (via full scale trials at the Ohmsett test facility, and Swirling Flask tests) indicating that the crude is dispersible in cold water conditions; a Net Environmental Benefit Analysis study, sponsored by Canadian Association of Petroleum Producers, in support of dispersant use has been prepared (and East Coast Operators are currently responding to Regulator comments); and field research indicating that the mixing energy provided by open ocean conditions considerably increases the window of opportunity for dispersant usage. Additionally, Suncor is an active participant in the Joint Operator Steering Committee, an East Coast Operator working group developed through Canadian Association of Petroleum Producers, to review oil spill response issues and improvements. Operators have worked together to assess potential changes to their own or joint oil spill preparedness and response programs including dispersant usage, equipment enhancements and purchases, modification or maintenance, exercises, training, plan/procedure revisions and research and development.

4.3 Cumulative Environmental Effects Assessment

The primary other ocean user within the Study Area is the Hebron project, which is 9 km from TN, within the TN Transport Canada-designated 10-nm precautionary zone, which was not a project foreseen in the original EIS.

The original TN EIS assessed cumulative impacts and determined that the TN Project would be negligible in terms of presence of structures (safety zone), traffic, underwater sound, and produced water discharge.

Given that the TN ALE will not alter cumulative effects conditions for marine fish and fish habitat, from those that have previously been assessed and determined to be not significant, the cumulative effects of the TN ALE are likewise considered to be not significant. There are no commercial fisheries within the Project or Study Areas. Therefore, the Project will not result in cumulative effects to commercial fisheries. Notwithstanding a lack of historical fishing effort within the Project Area, if fishers also avoid the area because of the FEZ, this could contribute to a small cumulative effect (not significant) in combination with other restricted fishing areas associated with other offshore projects and activities.

Using a conservative attraction distance of 16 km (Rodriguez et al. 2015), and assuming that both projects may therefore attract birds over a diameter of 32 km around their respective platforms, the potential ‘cumulative effect area’ for two projects could conceivably extend over a combined diameter of 64 km. The Hebron platform is 9 km away from the TN platform; therefore, there will be overlap in the attraction-distance radii and the current combined effect diameter for lighting attraction is estimated to be 41 km for the two projects. It is important to note that this discussion of cumulative effects describes the current conditions and that the extension will not add any additional sources of lighting or flares to the current levels, only extend the timeframe over which they are operating. This will result in some additional cumulative bird mortality and injury over this time period, although monitoring on board the FPSO has shown that these numbers, particularly Leach’s storm-petrel, will be relatively low and likely not significant

(Section 3.3). No additional cumulative effects on marine and migratory birds are expected as a result of this Project extension, beyond those that have previously been assessed; cumulative effects on marine birds and migratory birds are therefore considered not significant.

The extension of the life of the Project will not introduce any new sources of underwater sound over existing conditions, nor will it change the type of sounds, or the sound pressure levels. Based on the Quijano et al. (2017) recorded levels of 110 to 120 dB re 1 µPa recorded in the vicinity of the production platforms, the National Oceanic and Atmospheric Administration's (National Oceanic and Atmospheric Administration No Date) threshold for marine mammal behavioural disturbance to continuous (i.e., non-impulsive) sound (120 dB re 1 µPa) would suggest that marine mammals may already be exposed to sound levels capable of causing behavioural disturbance within 35 km of existing production platforms. While marine mammals have the capability to avoid the Project and Study Areas, sightings in the area suggest that not all individual animals avoid this area. Given that the TN ALE will not alter existing conditions related to cumulative effects for marine mammals and sea turtles, from those that have previously been assessed and determined to be not significant, the cumulative effects of the TN ALE are likewise considered to be not significant.

As the only change to the Project is its temporal scope, the potential cumulative effects on at-risk marine fish, marine birds, marine mammals, and sea turtles is the same as not at-risk species (Section 4.2); that is, the cumulative effects on species at risk are considered to be not significant.

There are no sensitive areas within the Project or Study Areas. Therefore, the Project will not result in cumulative effects to special areas.

Ambient air quality in the Project Area reflects the influence of emissions from other past and current projects and activities occurring within and outside of the Regional Area. The Hibernia, White Rose, and Hebron production projects are the most substantial source of air emissions within the Regional Area. Other past and current sources of emissions within the Regional Area include those from offshore petroleum exploration and production facilities, aircraft traffic, and engine emissions from vessels engaged in fishing, tourism, geophysical surveys, supply and servicing of offshore petroleum exploration and production facilities, military activities, and domestic and international shipping. Long-range transport of airborne pollutants also contributes additional loading to the airshed from sources located on the eastern seaboard of the United States and Canada, outside of the Regional Area. It is assumed, for the purposes of this cumulative effects assessment, that these existing activities will continue to be carried out and to produce emissions at current levels.

The 2017 reported GHG emissions from the existing TN Project fall within the range of those from the other existing oil developments, as reported to the 2016 National GHG Report, and represent only a small portion (0.08%) of the national total (716 megatonnes CO_{2eq}).

4.4 Accidental Events Environmental Effects Assessment

4.4.1 Spill Probabilities

The original TN EIS developed spill probabilities based on worldwide frequencies of various sizes of blowouts. Well-years was chosen as the more reasonable exposure parameter. The frequency of extremely large oil spills (greater than 150,000 bbl) from oil-well blowouts that occurred during production or workovers was 2/200 000 or 1.0×10^{-5} blowouts per well-year. For very large spills (greater than 10,000 bbl) the number was 2.5×10^{-5} blowouts per well-year.

Thirty-nine wells were assessed in the original EIS. The exposure for the Project in the original EIS was 312 well-years. Using the 1996 worldwide spill frequency statistics as a basis for prediction, the estimated spill frequencies reported in the original EIS were:

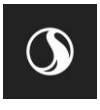
- Extremely large oil spills (>150,000 bbl) from blowouts during a drilling operation, based on an exposure of wells drilled: $39 \times 3.9 \times 10^{-5} = 1.5 \times 10^{-3}$ or a 0.15% chance over the entire drilling period
- Very large oil spills (>10,000 bbl) from drilling blowouts based on an exposure of wells drilled: $39 \times 7.8 \times 10^{-5} = 3.0 \times 10^{-3}$ or a 0.30% chance over the drilling period
- Extremely large oil spills (>150,000 bbl) from production and workover blowouts, based on an exposure of well-years: $312 \times 1.0 \times 10^{-5} = 3.1 \times 10^{-3}$ or a 0.31% chance over the Project's lifetime (20 years)
- Very large oil spills (>10,000 bbl) from production and workover blowouts, based on an exposure of well-years: $312 \times 2.5 \times 10^{-5} = 7.8 \times 10^{-3}$ or a 0.78% chance over the Project's lifetime (20 years)

For the TN Development, the estimated frequency of any spills larger than 1,000 and 10,000 bbl was $312 \times 3.6 \times 10^{-5} = 1.1 \times 10^{-2}$ (1.1% chance) and $312 \times 1.3 \times 10^{-5} = 4.1 \times 10^{-3}$ (0.41% chance), respectively. The predictions were $312 \times 1.7 \times 10^{-2} = 5.3$ spills less than 50 barrels over the course of the development.

For a production of 400 million barrels produced, the spill frequency prediction for the TN Development during tanker offloading was $1.4 \times 0.400 = 0.56$ large spills over the course of the 15- to 18-year development, or an approximately 50:50 chance of occurrence. The size of an offloading spill was likely to be in the 4,000-bbl (636,000 L) range, which is relatively small compared to other types of potential large spills.

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. Approximately 86% of the total volume of oil spillage occurred during development and production activities. Offshore exploration activities over the time period 1997 through 2018 also resulted in 11 synthetic-based fluid (synthetic-based mud) spills for a total of 776 bbl. Development and production activities resulted in the spillage of 1,314 bbl of SBM in 44 incidents.

The estimated probabilities that the existing TN ALE wells would have a blowout or a non-blowout release depend on the type of release. Probabilities do not indicate the release volume or imply the release would be a worst-case discharge. Based on worldwide spill frequency statistics to 2012 (Holand 2013), the overall mean probabilities of a spill (based on data to 2012) from each individual or specific well range from 0.000017 to 0.00033 for a subsurface blowout and 0.00003 to 0.00027 for a well release. There is an additional chance of a blowout after production, during the abandonment period, and in the post-



abandonment period. This is estimated to be 0.000005 per well-year. Overall, for the TN ALE wells, there is about a 1 in 190 to 1 in 14 chance that there would be a subsurface blowout at one of the wells at the TN site over the course of the next 40 years. However, the volumes of these releases will most likely be small. A blowout does not necessarily mean a worst-case discharge.

In the event that a spill does occur, the spill will not necessarily involve the maximum amount of outflow. In fact, most spills are small and only very rarely does a spill result in a volume that would be classified as very large or extremely large. If a spill does occur from the well, there is a distribution of potential spill volumes ranging from small to extremely large.

Non-blowout releases tend to involve relatively small volumes of considerably <1 bbl to approximately 100 bbl, because they do not involve uncontrolled flow. Blowouts involve flow at a certain rate for a few hours to a number of days, depending on the time to natural bridging or successful intervention. The total volume is dependent on flow duration and rate, which varies from a few bbl per day to as high as 20,000 m^3 (125,796 bbl) per day.

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

There is a possibility of corrosion in the hydrocarbon zone of the tubing and casings of the wells, which might cause spillage or leakage. If this spillage were to occur it would likely occur through small orifices (pinholes) in the tubing or wellbore of 0.002 to 2 mm in diameter, with spillage rates being dependent upon reservoir pressure.

The probabilities calculated in the original EIS remain valid.

4.4.2 Spill Trajectories

The TN crude modelled in the original TN EIS had a high pour point (equaling the average summer water temperature). It also formed very stable water-in-oil emulsions when spilled, even when the oil is fresh (which has implications for spill behaviour, particularly survival time). The remainder of the spill-related physical properties of the modelled TN crude were typical of a medium-gravity crude oil. The original TN EIS modelled five release scenarios:

- Subsea blowout, 4,800 m^3 /day for 90 days
- Subsea blowout, 4,800 m^3 /day for 45 days
- Subsea blowout, 7,150 m^3 /day for 7 days
- Surface blowout, 7,150 m^3 /day for 7 days
- Batch spill during transfer, 800 m^3 instantaneous release

The active spill duration of the models used in the original EIS are similar to those used in current spill models (typically 30 to 35 days and 98 to 120 days). One component that current models include in their

scenarios is running the model for an additional period after the active spill ends to track the movement of the last oil released from the wellsite; that component is missing from the original TN EIS model. All modelling is conducted based on a credible worst-case, unmitigated approach for each spill scenario (i.e., no spill response measures were applied during the accidental release).

The original TN EIS predicted that less than 1% of trajectories were predicted to reach the Newfoundland shore (predominantly the southeast Avalon), within 10 to 29 days and only in the November to March period. Based on recent spill modelling conducted for various exploration drilling projects, most shoreline contact occurred during the winter period, with minimum time to shore ranging from 27 to 78 days (depending on modelling location) and 0.01% to 0.5% of the total release volume anticipate to reach shore. Oil that did reach shore as predicted to be highly weathered, patchy, and discontinuous.

The oil currently produced at TN was slightly less dense (0.8540 g/cm³ @ 16°C vs. 0.8621 g/cm³ @ 15°C) and less viscous (14.89 cP @ 16°C vs. 15.47 cP at 25°C) than used in the TN spill model. These differences are small and both oils would be predicted to have similar behaviour, which would mainly be driven by their potential to form highly viscous and stable emulsions even when fresh, resulting in persistent oil on the surface.

4.4.3 Assessment of Accidental Oil Spill

All modelling is conducted as an unmitigated accident (i.e., no spill response measures are applied for the duration of the spill). Residual effects of an accidental event spill are assessed after the application of mitigation measures. Suncor has an Oil Spill Response Plan (TN-IM-EV03-X00-004, M9) filed with the C-NLOPB; this document is reviewed every three years to incorporate new response technologies that may become available (e.g., use of dispersants). The Oil Spill Response Plan outlines Suncor's objectives and approach, response strategy, the three tiers of response management, response countermeasures, waste storage and disposal, training and exercises, and regulatory considerations. A brief overview is provided in Section 4.2.3.

The environmental effects from the original TN EIS oil spill models are summarized in Table 4.2. The original TN EIS predicted that spilled oil would be swept by currents and wind until it gradually dispersed in the water, diffused on the surface to low concentration, or contacted land. TN oil spills were predicted to be highly persistent, with survival times of weeks and even months. It was predicted that TN spills would be very resistant to dispersion; therefore, the impact on fish would likely be low, but oil on the surface might affect the fishery.

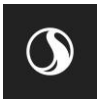


Table 4.2 Original TN EIS Worst-Case Oil Spill Assessment

Environmental Component	Crude Oil Transfer (batch) Spill (800 m^3)	Subsea Blowout (7,150 m^3/day for 7 days)	Subsea Blowout (4,800 m^3/day for 45 days)	Subsea Blowout (4,800 m^3/day for 90 days)	Surface Blowout (7,150 m^3/day for 7 days)
Fish and Fish Habitat and the Fishery	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor	Negligible to Minor
Marine-related Birds (seabirds, waterfowl, and other marine-related species)	Negligible	Negligible to Minor-Major	Negligible to Minor-Major	Negligible to Minor-Major	Negligible to Minor-Major
Marine Mammals	Negligible	Negligible	Negligible	Negligible	Negligible

Based on recent spill modelling conducted for various exploration drilling projects in shallow water (Husky exploration drilling project (Husky Energy 2018) and ExxonMobil's Eastern Newfoundland exploration drilling project (specifically EL 1137) (ExxonMobil 2017)), similar impacts are predicted using modelling programs such as SIMAP and OILMAPDeep. Of the two shallow-water drilling EAs currently under review, one predicted the same effects from an accidental spill (i.e., no significant adverse residual effects on marine fish and fish habitat and marine mammals and significant adverse residual effects on the marine birds and the fishery) (Husky Energy 2018) and one predicted significant residual adverse effects on marine birds only (ExxonMobil 2017).

The residual environmental effects assessment of an oil spill resulting from Project activities and components identified in the original EIS (including mitigation measures / response measures) are predicted to remain valid.

5.0 SUNCOR'S OPERATIONAL EXCELLENCE MANAGEMENT SYSTEM

The execution of the TNALE Program will be conducted in a manner consistent with Suncor's Operational Excellence Management System (OEMS), which is Suncor's enterprise-wide management system that organizes and links all standards, systems and processes required to manage operational risks, prevent and mitigate environmental impacts and deliver safe, reliable operations. OEMS is based on the Plan-Do-Check-Act continual improvement cycle and follows the internationally recognized management system standards and specifications ISO 14001 and 9001.

The OEMS sets high-level, company-wide mandatory management system requirements with respect to the foundational non-financial risk management processes necessary for a business to achieve operational excellence. Each element of Suncor's OEMS describes the company-wide requirements and expectations for managing operational and asset integrity risks inherent in the business.

Each business area within Suncor accepts responsibility for managing the impact of its activities and products on people, the environment, property and corporate assets. To accomplish this, senior leaders in each organizational and functional unit must:

- develop, implement and maintain appropriate systems, processes, procedures and tools to enable organizational units to meet the OEMS requirements
- understand the operational risks associated with its activities and products
- regularly report performance against defined objectives and specific performance measures
- seek input and feedback from internal and external stakeholders
- self-assess and audit the integrity and effectiveness of its systems against OEMS requirements
- identify opportunities for continual improvement

Risk factors and business requirements within some of Suncor's organizational units will require the development and implementation of issue-specific, dedicated systems, programs and models such as:

- Process Safety Management Program - systems and controls that ensure process hazards are identified, understood and controlled
- Suncor's Asset Development and Execution Model - a framework for consistent development, and sustainment of physical assets consisting of an integrated 5-stage gate process supported by solid project governance
- Suncor's Well Delivery Model - the end-to-end process that takes well planning developed as part of the Evaluate Exploration Acreage or Evolve Life of Field Concepts processes and delivers either a new or modified or abandoned well
- business unit or business area specific management systems (e.g., East Coast Management System Manual (OD-PE-QM04-X00-001)
- programs to ensure the effective implementation of Operational Excellence during non-routine projects

Through OEMS, Suncor has implemented numerous measures intended to minimize the environmental, health, safety, navigational and aesthetic impacts. Examples of these programs include but are not limited to:

- completion of regulatory consultations to ensure regulatory expectations and requirements are understood and implemented into project planning, including obtaining necessary regulatory authorizations and permits
- development and implementation of Environmental Protection Plans and Production Suspension Plan for Suncor's East Coast operations that include procedures relating to chemical management, effluent discharges, waste management, seabird handling / release and rehabilitation, oil spill response, fisheries liaison and compensation and environmental effects monitoring
- development and implementation of a Safety Plan that outlines organizational structure, roles and responsibilities, risk management procedures, legal and other requirements, environmental and health and safety commitments, goals and targets, management of change, learning and competence, contractor management including vessel selection and audit process, emergency management and response procedures, quality management processes, bridging processes to contractor management systems, diving procedures, vessel mobilization procedures and safety meetings
- completion of risk management processes such as Process Hazard Analyses and Hazard Identification and Risk Assessment before the project mobilizes for the offshore phase
- implementation of emergency management procedures relating to oil spill response, crisis management, operational emergencies, security and business continuity
- implementation of simultaneous operations procedures to ensure identification of TN Field control and coordination of vessels working in and around the Field
- placement of Suncor Company Representatives on project vessels to ensure project oversight and effective implementation of Suncor policies and procedures, including OEMS

6.0 CONCLUSIONS

Under the direction of the C-NLOPB, Suncor has created the validation report which:

- Describes the current and planned project activities and confirms that they remain within the scope of the original EA
- Re-states the EA predictions and confirms that the validity of the EA predictions has been confirmed by the EEM program
- Confirms that the EA predictions remain valid, including for the proposed future temporal extension of the project and related activities
- Provides a summary of technologies evaluated to reduce or eliminate releases to the environment for technical implementation and feasibility
- Describes how the adaptive management of requirements of the Species at Risk Act into program activities has been considered (knowing there is currently no critical habitat and no resident species at risk in the project area)
- Includes a review of currently application regulations, identifies changes relevant to the regulatory context of the 1996 EIS, and discusses the potential impact of the regulatory changes to the validity of the EA
- Provides an overview of additional environmental mitigation that have been implemented since the original EA approval

Given that there is no change in the Project activities – only the temporal scope of the Project, the potential effects on the established VECs have not materially changed nor is there a need to consider new VECs. No new SARA species at risk or critical habitats have been designated within the area of proposed activities that require changes in Suncor's plans or mitigation measures. Suncor's EEM program clearly demonstrates that there have been limited biological effects resulting from the operation of the TN FPSO, and those effects have been highly localized (Neff et al. 2014).

In addition to the mitigation measures committed to in the original EIS and EA Updates or subsequently implemented in response to regulatory requirements, Suncor initiatives, and/or engagements with stakeholders (e.g., the fishing industry), Suncor will:

- Investigate or support research regarding the feasibility of altering the lighting on the TN FPSO, insofar as it does not affect the safety and navigational requirements of the operations
- update its GHG Management Plan to meet its commitments under Newfoundland and Labrador's new carbon tax requirements.

Based on the project description, review of the original EIS (Petro-Canada 1996), the TN produced water increase EA (Petro-Canada 2009), EA Updates (Suncor 2012, 2014, 2017a), and application of mitigation measures described therein, the assessment of effects in the original EIS remain valid for the temporal extension of operations at the TN Field, as described

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APPENDIX A

Specific TNALE Project Overviews Presented to C-NLOPB

DATE	AGENDA
13-Feb-17	Well Life
	Torus Connector, XT & HOSTS
	Risers/Flowlines & Umbilical's
	Turret & Moorings
	Hull Strength & Fatigue
	System Reviews
	Review potential 2020 LE Turnaround scope
27-Feb-17	SOFEC study updates – Turret & Moorings
	LR Qualification Update - Moorings
	AIG study update – Hull & Topside Structures
	Review potential 2020 LE Turnaround scope
1-Mar-17	Well Life
	Torus Connector, XT & HOSTS
	Risers/Flowlines & Umbilical's
	Turret & Moorings
	Hull Strength & Fatigue
	System Reviews
	Review potential 2020 LE Turnaround scope
13-Mar-17	Terra Nova Obsolescence Strategy
	Terra Nova Obsolescence Plan
	Review potential 2020 LE Turnaround scope
20-Mar-17	SOFEC study updates – Turret – 20min
	SOFEC study updates – Moorings - 20min
	AIG study update – Hull – 20min
	AIG study update –Topside Structures 10min
	Review potential 2020 LE Turnaround scope 10min
27-Mar-17	Well Life
	XT & HOSTS
	Risers/Flowlines & Umbilical's
	Review potential 2020 LE Turnaround scope
28-Mar-17	Terra Nova Obsolescence Strategy
	Terra Nova Obsolescence Plan
	Review potential 2020 LE Turnaround scope
10-Apr-17	Well Life
	XT & HOSTS
	Risers/Flowlines & Umbilical's
	Review potential 2020 LE Turnaround scope

DATE	AGENDA
17-Apr-17	Insulation system study update (Bilfinger)
	Coating system specification update
	Review potential 2020 LE Turnaround scope
25-Apr-17	Systems Reviews (Integrity)
	Review potential 2020 LE Turnaround scope
8-May-17	LET Drivers and Objectives Summary
	Scope Details and Justifications
	ALE Projects
	Critical Integrity Scope
	Opportune Maintenance
	Reliability Improvement/Upgrade
	Subsea/ALE Project
	Schedule Summary
6-Nov-17	ALE Governance Overview
	Stakeholder Management
	Concept Alternatives
	Scope Overview