Equinor Canada Ltd.

Bay du Nord Development Project

Environmental Impact Assessment

July 2020

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RE-PM539-00019_02

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

List of Acronyms, Symbols, and Units

#	Number
$	Canadian Dollar
%	Percent
@	At
’	Minutes (Latitude or Longitude)
”	Seconds (Latitude or Longitude)
<	Less than
>	Greater than
±	Plus or Minus
≤	Less than or equal to
≥	Greater than or equal to
µg	Microgram
µm	Micrometre (micron)
µPa	Micropascals
º	Degrees
ºC	Degrees Celsius (0 ºC = 273.15 K)
ºN	Degrees North
ºT	Degrees To (Toward)
ºW	Degrees West
1SW	One Sea Winter
2D	Two-Dimensional
3D	Three-Dimensional
4D	Four-dimensional
A.D.	*Anno Domini*
AANDC	Aboriginal Affairs and Northern Development Canada
ACSS	Atlantic Canada Shorebird Survey
ADCP	Acoustic Doppler Current Profiler
ADEC	Alaska Department of Environmental Conservation
ADW	Approval to Drill a Well
AICFI	Atlantic Integrated Commercial Fisheries Initiative
AIOC	Alderon Iron Ore Corporation
AIP	Agreement-in-Principle
AL	Aliphatic

ALTRT	Atlantic Leatherback Turtle Recovery Team
AMAP	Arctic Monitoring and Assessment Programme
AMAR	Autonomous Multichannel Acoustic Recorder
Amec	Amec Environment and Infrastructure
AMIK	Agence Mamu Innu Kaikusseth
ANSMC	Assembly of Nova Scotia Mi'kmaq Chiefs
AOI	Area of Interest
AOSRT-JIP	Arctic Oil Spill Response Technology Joint Industry Program
Ap	April
API-IPIECA-IOGP	American Petroleum Institute, International Petroleum Industry Environmental Conservation Association and International Oil and Gas Productions
Apr	April
AQHI	Air Quality Health Index
AR	Aromatic
ASF	Atlantic Salmon Federation
ASP	Association of Seafood Producers
Au	August
Aug	August
AUV	Autonomous Underwater Vehicle
AZMP	Atlantic Zone Monitoring Program
bbl	Barrel (one barrel equals 42 US gallons or 35 imperial gallons, or approximately 159 litres)
BdN	Bay du Nord
boe	Barrel of oil equivalent
BOEM	Bureau of Ocean Energy Management
BoF	Bay of Fundy
BOP	Blowout Preventer
BP	BP Canada Energy Group ULC
BTEX	Benzene, toluene, ethylbenzene and xylene
BWTTS	Basin Wide Terminal and Transshipment Solution
C	Carbon
CA	Certifying Authority
CAAQS	Canadian Ambient Air Quality Standards
CAC	Criteria Air Contaminant
CALMET	A Diagnostic Three-Dimensional Meteorological Model

CALPUFF	Modeling System for Atmospheric Pollution Dispersion
CAM	Conseil des Atikamekws et des Montagnais
CBC	Canadian Broadcasting Corporation
CBdN	Core Bay du Nord
CCFAM	Canadian Council of Fisheries and Aquaculture Ministers
CCG	Canadian Coast Guard
CCME	Canadian Council of Ministers of the Environment
CCO	Chief Conservation Officer
C-CORE	Centre for Cold Oceans Resources Engineering
CDPDJ	Commission des droits de la personne et des droits de la Jeunesse
CEA Agency	Canadian Environmental Assessment Agency
CEAA 2012	*Canadian Environmental Assessment Act, 2012*
CEPA 1999	*Canadian Environmental Protection Act, 1999*
CFSR	Climate Forecast System Reanalysis
CH_4	Methane
CHARM	Chemical Hazard and Risk Management
Chl *a*	Chlorophyll *a*
CI	Confidence Interval
CIE	Conseil des Innu de Ekuanitshit and Mi'gmawei Mawiomi Secretariat
CIS	Canadian Ice Service
cm	Centimetre
CM	Current Monitoring
CMA	Census Metropolitan Area
CML	Common Mid-Point
C-NLOPB	Canada-Newfoundland and Labrador Offshore Petroleum Board
CNSOPB	Canada Nova Scotia Offshore Petroleum Board
CO	Carbon monoxide
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
COA	Contract of Affreightment
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
cP	Centipoise (unit of dynamic viscosity) (1 cP = 1 millipascal per second)
CPAWS	Canadian Parks and Wilderness Society
CSA 2001	*Canada Shipping Act, 2001*
CSAS	Canadian Science Advisory Secretariat

CSS	Cap Stack System
C_t	Sea Ice Concentration
CTD	Conductivity, Temperature and Dissolved Oxygen
CTS	Cuttings Transport System
cu.in.	Cubic Inch (1 cu. in. = 16.39 cm^3)
CV	Coefficient of Variation
CWHC	Canadian Wildlife Health Cooperative
CWS	Canadian Wildlife Services
CYP1A	Cytochrome P450 A1
d	Day
DA	Development Area
dB	Decibel
DCC	Defence Construction Canada
De	December
Dec	December
deg	Degrees
DFO	Fisheries and Oceans Canada
DG	Decision Gate
DMS	Degrees Minutes Seconds
DNA	Deoxyribonucleic acid
DND	Department of National Defence
DNV	Det Norske Veritas
DOEC	Department of Environment and Conservative
DP	Dynamic Positioning
DREAM	Dose Related Risk and Effects Assessment Model
Drilling EIS	Flemish Pass Exploration Drilling Program Environmental Impact Statement
DSL	Domestic Substance List
DU	Designatable Unit
DWH	Deep Water Horizon
dyne	Unit of Force (1 dyne = 10 micronewtons)
EA	Environmental Assessment
EBSA	Ecologically and Biologically Significant Area
EC	Environment Canada
EC50	Half Maximal Effective Concentration
ECCC	Environment and Climate Change Canada

ECMWF	European Center for Medium Range Weather Forecasting
ECRC	Eastern Canada Response Corporation
ECSAS	Eastern Canada Seabirds at Sea
EC-WG	Eastern Canada-West Greenland
EEM	Environmental Effects Monitoring
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EL	Exploration Licence
EMCP	ExxonMobil Canada Properties
EMPAAC	Eastport Marine Protected Areas Advisory Committee
ENGO	Environmental Non-Governmental Organization
EPCMP	Environmental Protection and Compliance Monitoring Plan
EPP	Environmental Protection Plan
Equinor Canada	Equinor Canada Ltd.
ESA	Endangered Species Act
ESRF	Environmental Studies Research Fund
EU	European Union
FAO	Food and Agriculture Organization
FCA	Fisheries Closure Area
Fe	February
Feb	February
FFAW-Unifor	Fish Food and Allied Workers-Unifor
FLO	Fisheries Liaison Officer
FLR	Department of Fisheries and Land Resources
FM	Frequency Modulation
FNI	Federation of Newfoundland Indians
FNQLEDC	First Nations of Québec and Labrador Economic Development Commission
FPSO	Floating Production, Storage, and Offloading
FSC	Food, social or ceremonial
Fugro	Fugro EMU Limited
FY	First-Year
GBMR	Grand Banks Marine Region
GBS	Gravity Based Structure
GCM	Global Climate Models
GDP	Gross Domestic Product

GEAC	Groundfish Enterprise Allocation Council
GEBCO	General Bathymetric Chart of the Oceans
GESAMP	United Nations Group of Experts on Scientific Aspects of Marine Environmental Protection
GFA	Graphical Forecast Area
GHG	Greenhouse Gas
GHGRP	Greenhouse Gas Emissions Reporting Program
GIMAT	Global Incident Management Assist Team
GLC	Ground-Level Concentrations
GMT	Greenwich Mean Time or Coordinated Universal Time
GNB	Government of New Brunswick
GNL	Government of Newfoundland and Labrador
GP	Gravel Pack
Gt	Gigatonne
H_2S	Hydrogen Sulphide
ha	Hectares
HADD	Harmful alteration, disruption or destruction
HAT	Highest Astronomical Tide
HBC	Hudson’s Bay Company
HC	Hydrocarbon
HNL	Heritage Newfoundland and Labrador
HP	High-Pressure
HQ	Hazard Quotient
HQP	Hydro-Québec Production
hr	Hour
Hs	Significant Wave Height
HSE	Heath, Safety, and Environment
HUC	Hook-up and Commissioning
Husky Energy	Husky Oil Operations Limited
HV-GB	Happy Valley-Goose Bay
HYCOM	Hybrid Coordinate Ocean Model
Hz	Hertz
I.	Island
IBA	Important Bird Area
IBDC	Innu Business Development Centre

iBoF	Inner Bay of Fundy
ICCAT	International Commission for the Conservation of Atlantic Tunas
ICOADS	International Comprehensive Ocean-Atmosphere Data Set
IIAS	Intergovernmental and Indigenous Affairs Secretariat
IIP	International Ice Patrol
IMO	International Maritime Organization
IMR	Inspection, Maintenance, and Repair
IMS	Incident Management System
IMT	Incident Management Team
in	Inch (2.54 cm)
INAC	Indigenous and Northern Affairs Canada
IOC	Iron Ore Company of Canada
IOGP	International Association of Oil & Gas Producers
IPCC	Intergovernmental Panel on Climate Change
IPIECA	International Petroleum Industry Environmental Conservation Association
IR	Information Required
ISB	*In situ* burning
ISO	International Standards Organization
ITOPF	International Tanker Owners Pollution Federation Limited
IUCN	International Union for Conservation of Nature and Natural Resources
IWC	International Whaling Commission
Ja	January
Jan	January
Jl	July
Jn	June
Jul	July
Jun	June
K	Degrees Kelvin
kg	Kilograms
kHz	Kilohertz
km	Kilometres
KMKNO	Kwilmu'kw Maw-klusuaqn Negotiation Office
kW	Kilowatt
L	Litres
LAT	Lowest Astronomical Tide

LFA	Lobster Fishing Area
LFUSCL	Labrador Fishermen's Union Shrimp Company Limited
LGL	LGL Limited
LIA	Labrador Inuit Association
LIL	Labrador Inuit Lands
LILCA	Labrador Inuit Land Claims Agreement
LISA	Labrador Inuit Settlement Area
LIV	Light Intervention Vessel
LMG	Listuguj Mi'gmaq Government
LMRP	Lower Marine Riser Package
LOMA	Large Ocean Management Area
LP	Low-Pressure
LSA	Local Study Area
Ltd	Limited
LTO	Landing and Take-Off
m	Metres
M2	Principal Lunar Semidiurnal Constituent
MAE	Government of Newfoundland and Labrador, Department of Municipal Affairs and Environment
MAH	Monocyclic Aromatic Hydrocarbons
MAMKA	Mi'kmaq Alsumk Moiwimsikik Koqoey Association
MANICE	Manual of Ice
MANMAR	Manual of Marine Observations
Mar	March
MAR	Mid-Atlantic Ridge
MARLANT	Maritime Forces Atlantic
MARPOL	International Convention for the Prevention of Pollution from Ships
Mbbl	Mega barrels of oil
MBCA	Migratory Birds Convention Act
MBES	Multibeam Echosounder
MBS	Migratory Bird Sanctuary
MCF	Mi'kmaq Commercial Fisheries Incorporated
MCPEI	Mi'kmaq Confederacy of Prince Edward Island
MD	Measured Depth
MEG	Monoethylene Glycol

MFA	Mid-Frequency Active
MFFP	Ministère des Forêts, de la Faune et des Parcs
MFN	Miawpukek First Nation
MFS	National Marine Fisheries Service
mg	Milligrams
MGS	Membertou Geomatics Solutions
MICOM	Miami Isopycnic-Coordinate Ocean Model
MICT	Regroupement Mamit Innuat Tribal Council
min	Minutes
MJ	Megajoules
ML	Local Magnitude Scale, or the Richter Scale
mm	Millimetre
MMAFMA	Mi'gmaq Maliseet Aboriginal Fisheries Management Association
mmdd	Month (2 Places) Day (2 Places)
MMEDC	Madawaska Maliseet Economic Development Corporation
MMFN	Madawaska Maliseet First Nation
MMO	Marine Mammal Observer
MMS	Mi’gmawei Mawiomi Secretariat
MNWA	Marine National Wildlife Area
MOG	Micmacs of Gesgapegiag
MOS	Marine Oil Snow
MPA	Marine Protected Area
Mr	March
MRCN	Musée régional de la Côte-Nord
MRI	Marshall Response Initiative
ms	Millisecond
MSC	Meteorological Service of Canada
MSC50	Meteorological Service of Canada 50 North Atlantic Wave Hindcast
MSL	Mean Sea Level
MSm^3	Mega Standard Cubic Metre
MSW	Multi-sea Winter
Mt	Megatonne
MTD	Mass-Transport Deposit
MTI	Mi'gmawe'l Tplu'Taqnn Incorporated

MUDMAP	Drilling Muds and Produced Water Transport, Dispersion, and Seabed Deposition Model and Analysis
MW	Megawatts
N	Nitrogen
n	Sample Size
n.d.	No Date
n.d.a.	No Date Associated
N/A	Not Applicable
N_2	Nitrogen Gas
N_2O	Nitrous Oxide
NAD	North American Datum
NAFO	Northwest Atlantic Fisheries Organization
$NaHSO_3$	Sodium bisulfite
NASA	National Aeronautics and Space Administration
NASCO	North Atlantic Salmon Conservation Organization
NB	New Brunswick
NBAPC	New Brunswick Aboriginal Peoples Council
NCC	NunatuKavut Community Council
NCR	National Research Council
NCS	Norwegian Continental Shelf
NE	Northeast
NEAFC	North East Atlantic Fisheries Commission
NEB	National Energy Board
NEEC	National Environmental Emergencies Centre
NEREIDA	NAFO Potential Vulnerable Marine Ecosystems - Impacts of Deep-Sea Fisheries (research expedition)
NG	Nunatsiavut Government
NGC	Nunatsiavut Group of Companies
NGO	Non-Governmental Organization
NHS	National historic Site
NL	Newfoundland and Labrador
NL ESA	Newfoundland and Labrador’s Endangered Species Act
NLAAQS	Newfoundland and Labrador Ambient Air Quality Standards
NLDEC	Newfoundland and Labrador Department of Environment and Conservation

NLDTCII	Newfoundland and Labrador Department of Tourism, Culture, Industry and Innovation
NLFD	Newfoundland and Labrador
nm	Nanometre
NM	Nautical Mile
NMCA	National Marine Conservation Area
NMFS	National Marine Fisheries Service
No	November
NO_2	Nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NORM	Naturally Occurring Radioactive Material
NOROG	Norwegian Oil and Gas Authority
NOTSHIP	Notice to Shipping
Nov	November
NO_X	Nitrogen oxides
NP	National Park
NPA	Navigation Protection Act
NPRI	National Pollutant Release Inventory
NR	Not Reported
NRA	NAFO’s Regulatory Area
NRC	National Research Council
NRCan	Natural Resources Canada
NS	Nova Scotia
NSMDC	North Shore MicMac District Council
NSMR	NL Shelf Marine Region
NTL	Newfoundland Transhipment Limited
NTU	Nephelometric Turbidity Unit
NW	Northwest
OA	Operations Authorization
OAA	Office of Aboriginal Affairs
OBC	Ocean Bottom Cables
OBIS	Ocean Biogeographic Information System
OBM	Oil-Based Mud
OBN	Ocean Bottom Nodes
oBoF	Outer Bay of Fundy

OBPS	Output-based pricing system
Oc	October
OCI	Ocean Choice International
OCNS	Offshore Chemical Notification Scheme
OCSG	Offshore Chemical Selection Guidelines
Oct	October
ODI	Ocean Data Inventory
OILMAPDeep	Deep Water Oil Spill Model and Analysis System
OIM	Offshore Installation Manager
OIW	Oil-in-Water
OLM	Ozone limiting method
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
OSRL	Oil Spill Response Limited
OSRP	Oil Spill Response Plan
OSV	Offshore supply vessel
OWTG	Offshore Waste Treatment Guidelines
Pa	Pascals
PA	Project Area
PAAN	Protected Areas Association of Newfoundland
PAH	Polycyclic aromatic hydrocarbons
PAL	Provincial Aerospace Ice and Environmental Services
Passamaquoddy	Peskotomuhkati Nation at Skutik
PBGB-LOMA	Placentia Bay Grand Banks-Large Ocean Management Area
PBGB-LOMAS	Placentia Bay Grand Banks-Large Ocean Management Area Secretariat
PCPA	Pest Control Products Act
PEI	Prince Edward Island
PERD	Program of Energy Research and Development
pH	"Power of Hydrogen", a scale for acidity of solutions
PIROP	Programme Intégré des Recherches sur les Oiseaux Pélagiques
PL	Production Licence
PLONOR	Pose Little or No Risk
PM	Particulate Matter
PM_{10}	Particulate Matter < 10 microns in diameter
$PM_{2.5}$	Particulate Matter < 2.5 microns in diameter

PNEC	Predicted No Effects Concentration
PNET	Predicted No Effects Threshold
ppb	Parts per Billion
ppm	Parts per Million
ppt	Parts per Thousand
PRV	Pressure Relief Valves
PSD	Particle Size Distribution
psi	Pound-Force per Square Inch (1 psi = 6894.76 Pa)
PSU or psu	Practical Salinity Unit
PTS	Permanent Threshold Shift
QC	Québec
QDC	Qalipu Development Corporation
QMF	Qalipu Marine Holdings
QMFN	Qalipu Mi’kmaq First Nation
QMFNB	Qalipu Mi'kmaq First Nation Band
QMS	Qalipu Management Services Incorporated
QPSS	Qalipu Project Support Services Limited
R&D	Research and Development
R.S.C.	Revised Statutes of Canada
$R_{95\%}$	The maximum range at which the given sound level would be received after exclusion of 5 percent of the farthest such points
RCM	Recording Current Meter
RCMP	Royal Canadian Mounted Police
RCP	Representative Concentration Pathways
RDCC	Resource Development Consultation Coordinators
RFB	Regional Fishery Bodies
RMA	Representative Marine Area
R_{max}	Maximum Range at Which the Given Sound Level Would be Received
RMRI	Risk Management Research Institute
rms	root-mean-square
ROV	Remotely Operated Vehicle
RP	Regroupement Petapan
RPS	Rural Planning Services (RPS Group plc)
RSA	Regional Study Area
RSF	Religious Society of Friends

RV	Research Vessel
s	Seconds
S.C.	Statutes of Canada
S2	Solar Semidiurnal Constituent
SAR	Species at Risk
SARA	Species at Risk Act
SAS	Synthetic Aperture Sonar
SBA	Significant Benthic Areas
SBM	Synthetic-Based Mud
SBP	Subbottom Profiler
SBV	Standby Vessel
SCAT	Shoreline Clean-up Assessment Technique
SDL	Significant Discovery Licence
SDS	Safety Data Sheet
Se	September
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SEL_{cum}	Received Sound Levels That Could Produce a Specified Effect
SEL_{SS}	Single Exposure Sound Exposure Level
SEM	Sikumiut Environmental Management Ltd.
Sep	September
SERPANT	Scientific and Environmental ROV Partnership using Existing Industrial Technology
SFA	Shrimp Fishing Area
SIMA	Spill Impact Mitigation Assessment
SIMAP	Spill Impact Model Application Package
SINTEF	Stiftelsen for industriell og teknisk forskning
Sm^3	Standard cubic metre
SNAc	Significant New Activity
SO_2	Sulphur dioxide
SOC	Synthetic Oil-on-Cuttings
SOCC	Species of Conservation Concern
SOCP	Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment
SO_x	Sulphur oxides

sp.	Species (singular)
SPE	Society of Petroleum Engineers
SPL	Sound Pressure Level
SPL_{0-p}	Zero-to-Peak Sound Pressure Level
SPL_{Peak}	Peak Sound Pressure Level
SPL_{rms}	Root-Mean-Square Sound Pressure Level
spp.	Species (multiple)
SSAC	Species Status Advisory Committee
SSDI	Subsea Dispersant Injection
ssp.	Subspecies
SSS	Sidescan Sonar
SST	Sea Surface Temperature
Stantec	Stantec Consulting Ltd.
STATLANT	Fisheries Catch Statistics
Statoil	Statoil Canada Ltd.
Stn	Station
SWIS	Subsea Well Intervention Services
t	Tonne
TCC	Torngasok Cultural Centre
TCII	Department of Tourism, Culture, Industry and Innovation
TD	Total Depth
TEK	Traditional Ecological Knowledge
TEWG	Turtle Expert Working Group
THC	Total Hydrocarbons
TK	Traditional Knowledge
TLH	Trans Labrador Highway
TLP	Tension Leg Platform
TNASS	Trans North Atlantic Sightings Survey
Tp	Peak Wave Spectral Period
TPH	Total Petroleum Hydrocarbons
TPM	Total Particulate Matter
TR	Traffic Route
TSP	Total Suspended Particles
TSS	Total Suspended Solids
TTS	Temporary Threshold Shifts

TVD	True Vertical Depth
UA	Unit Areas
UD	Utilization Distributions
UINR	Unama'ki Institute of Natural Resources
UK	United Kingdom
UNCBD	United Nations Convention on Biological Diversity
UNCED	United Nations Conference on Environment and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNESCO WHC	United Nations Educational, Scientific and Cultural Organization, World Heritage Convention
US (or U.S.)	United States (of America)
US EPA	United States Environmental Protection Agency
USA	United States of America
USEIA	United States Energy Information Administration
UTC	Coordinated Universal Time or Greenwich Mean Time
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
VACM	Vector-Averaging Current Meters
VBNC	Voisey's Bay Nickel Company Limited
VC	Valued Component
VHF	Very High Frequency
VM	Vessel Monitoring
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds
VOO	Vessels of Opportunity
VSD	Variable Speed Drive
VSP	Vertical Seismic Profiling
WAG	Water-alternating-gas
WBM	Water-Based Mud
WG-EAFM	Working Group on Ecosystem Approach Framework to Fisheries Management
WHR	Waste Heat Recovery
WHRU	Waste Heat Recovery Units
WHS	World Heritage Site

WHSRN	Western Hemisphere Shorebird Reserve Network
WM	Wave Monitoring
WNNB	Wolastoqey Nation in New Brunswick
WOCE	World Ocean Circulation Experiment
Wood	Wood PLC
WWF	World Wildlife Fund
XT	Christmas Tree
yr	Year

1.0 INTRODUCTION

Equinor Canada Ltd. (Equinor Canada), and its partner Husky Oil Operations Limited (Husky Energy), are proposing to develop the Bay du Nord field, which includes Bay du Nord, Bay de Verde and Bay de Verde East and the Baccalieu discovery (collectively the Core Bay du Nord [BdN] Development) offshore eastern Newfoundland and Labrador (NL) for the production of oil and gas. Herein, in particular instances, when reference is made to “the Operator” it refers to Equinor Canada.

The BdN Development Project (the Project) is defined as the development of the Core BdN Development and Project Area Tiebacks. The Core BdN Development will include the offshore construction and installation, hook-up and commissioning, production and maintenance operations, drilling and eventual decommissioning, as well as associated supporting surveys, field work, and supply and servicing activities. Project Area Tiebacks would occur if on ongoing internal assessments of known discoveries and/or exploration activities discover economically recoverable reserves that can be tied-back to the BdN production installation. Activities that would occur under Project Area Tiebacks are the same as for Core BdN Development, including offshore construction and installation of well templates, flowlines, umbilicals, and risers in the Project area connected to the existing production installation within the Core BdN Development Area.

The Project requires review and approval pursuant to the requirements of the *Canadian Environmental Assessment Act* (CEAA 2012) as it has been determined to constitute a “designated project” under Section 11 of the *Regulations Designating Physical Activities.* In addition, the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) requires that a project-specific environmental assessment (EA) be completed for offshore oil and gas development projects, pursuant to the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* and the *Canada-Newfoundland Atlantic Accord Implementation Act* (the Accord Acts) and to support a Development Application. It is intended that the EA review process for the Project will satisfy the requirements of CEAA 2012 and the C-NLOPB’s Accord Acts EA processes.

This Environmental Impact Statement (EIS) has been prepared in accordance with requirements of the above referenced EA legislation and processes, as well as the project-specific EIS Guidelines issued by the Canadian Environmental Assessment Agency (CEA Agency) on September 26, 2018, (CEA Agency 2018a; see Appendix A) and other generic EA guidance documents issued by the CEA Agency as referenced throughout.

As an introduction to the EIS, this Chapter identifies the Operator, provides a general overview of the Project, outlines the regulatory contexts for the Project, and describes the purpose of the EIS and the overall organization of the document.

1.1 Identification and Overview of the Operator

Equinor is a Norwegian-based energy organization with operations in more than 30 countries. Since 1972 Equinor has explored, developed, and produced oil and gas on the Norwegian Continental Shelf (NCS), where it is a leading operator. From the early 1990s, Equinor has built a global business with strongholds in Europe, Africa, North America and Brazil. Equinor strives to be an industry leader on safety and is actively shaping its portfolio to deliver high value with a low carbon footprint, and is committed to creating lasting value for communities. Equinor employs over 20,000 individuals worldwide and is a values-based organization where empowered people collaborate to shape the future of energy. Equinor's ambition is to be the world's most carbon-efficient oil and gas producer, as well as a driver of innovation in offshore wind. Through its subsidiaries, Equinor is the operator of 42 assets in the North Sea, the Norwegian Sea and the Barents Sea with over 50 years of oil and gas exploration and production experience. Internationally, Equinor is the operator of assets in Brazil, the United Kingdom, and the United States, and has interests in countries such as Algeria, Tanzania, Angola, and Russia. Equinor is 67 percent owned by the Norwegian State and is listed on the Oslo and New York Stock Exchanges. It is headquartered in Stavanger, Norway.

In 1996, Equinor established a Canadian headquarters in Calgary, Alberta, and a local office in St. John's, NL. Equinor Canada currently holds interest rights in the Canada-NL Offshore Area as well as offshore Nova Scotia. As of January 15, 2019, Equinor Canada is the operator of nine Exploration Licences (ELs) and five Significant Discovery Licences (SDLs), and is an interest holder in four ELs, 30 SDLs, and seven Production Licences (PLs) including Terra Nova, Hibernia, Hibernia South Extension, and Hebron production operations.

Equinor Canada holds a 65 percent interest in the BdN Development, and its partner, Husky Energy, holds a 35 percent interest. Equinor Canada is the Operator for the Project, and its offshore NL operations will be managed from its St. John's, NL office.

Equinor's approach to sustainability is based on the following principles and themes:

- Aiming for outstanding resource efficiency
- Preventing harm to local environments
- Low carbon – reducing CO_2 footprint
- Creating local opportunities
- Respecting human rights
- Being open and transparent

1.1.1 Equinor's Offshore Experience

Equinor was founded in Norway in 1972 and has since become the largest operator on the NCS. Equinor applies its extensive offshore experience from work on the NCS to its operations offshore NL, where the organization has been present since 1996. Equinor Canada undertook its first drilling and geophysical program activities offshore NL in 2008 and had its first offshore oil discovery in 2009 with Mizzen (SDL 1047/1048) in the Flemish Pass area. Following the Mizzen discovery, Equinor Canada continued its geophysical and exploration drilling activities. Additional geophysical surveys were undertaken offshore NL in 2011, 2012, and 2014. Further exploration drilling in the Flemish Pass area in 2013 resulted in the Harpoon (EL 1154) and Bay du Nord (SDL 1055) discoveries. Equinor Canada continued its exploration and appraisal drilling program in the Flemish Pass area through a 19-month drilling program which began in the fall 2015, during which a total of nine exploration and/or appraisal wells were drilled. The 19-month drilling program resulted in two oil discoveries at the Bay de Verde (SDL 1055) and Baccalieu (EL 1043) prospects. In 2017, Equinor Canada completed a two-well exploration drilling campaign offshore NL.

Worldwide, Equinor has considerable experience in drilling and production activities. It has been an operator in the NCS for over 40 years, and currently operates over 40 fields and platforms and is responsible for 70 percent of oil and gas production on the NCS. In 2017, Equinor produced, on average approximately 330,000 m^3 oil and gas per day. Internationally, Equinor has drilled more than 3,500 offshore wells with 150 wells in water depths greater than 500 m. Offshore NL, Equinor Canada has drilled more than 15 wells in the Flemish Pass area.

1.1.2 Equinor's Management System

Equinor Canada's offshore NL operations conform to the organization's corporate management system, which is the set of principles, policies, processes, and requirements that support the organization in fulfilling the tasks required to achieve its objectives. This management system has three main objectives:

1) Contribute to safe, reliable, and efficient operations and enable us to comply with external and internal requirements
2) Incorporation of Equinor values, people, and leadership principles in all Equinor activities
3) Excellent business performance through high-quality decision making, fast and precise execution, and continuous learning

The governing documentation in Equinor's management system is structured in three levels: (1) fundamentals, (2) requirements, and (3) recommendations.

Fundamentals are essential regulations for the organization and are valid throughout the entire Equinor organization. They describe what Equinor wants to achieve and include values, principles, commitments, and mandates.

Requirements are used to manage risks and to provide safe and efficient operations. They describe what the organization needs to comply with when performing tasks. Requirements are set out in various organization management and control documents, work processes, work requirement documents, technical requirement documents, system and operation documents, key control documents and emergency response plan documents.

Recommendations support people when performing tasks and enable compliance with fundamentals or requirements. They describe suggestions or proposals for the best course of action and are based on the collective learning and experience in the organization.

Equinor's management plan encompasses specific components including, but not limited to, pollution prevention policies and procedures, and plans for emergency response, spill response, waste management and environmental monitoring.

Compliance means to follow external and internal requirements to achieve set performance targets. The management system is used systematically in day-to-day work. Training in the use of the work processes is part of this systematic approach. When performing a specific activity, it is necessary to consider risks. A risk assessment may lead to a need for improvement or to evaluate an application for dispensation equivalency from governing documentation. Leadership is also required in order to achieve compliance. This includes communicating about the management system, acting as a role model, and coaching the organization in the use of the management system. Equinor regularly tests how well its management system is working through an assurance process, which includes self-assessments, verifications, and audits.

Equinor complies with applicable laws, acts in an ethical, sustainable and socially responsible manner, practises good corporate governance and respects internationally recognised human rights. Equinor maintains an open dialogue on ethical issues, both internally and externally. Open, honest, and accurate communication is essential to the organization's integrity and business success.

Equinor uses a variety of tools that will help to communicate required environmental commitments and mitigation measures identified for a project during its operations. Notwithstanding its internal processes and requirements for managing, monitoring, and reporting on its environmental performance, Equinor will also adhere to the applicable legislative and regulatory requirements that pertain to this Project, including terms and conditions imposed as conditions of associated EA review and approval for the Project, and will monitor and report on these in accordance with applicable regulatory procedures or other relevant requirements.

Information on Equinor Canada's environmental planning and management policies, systems, and procedures is provided in Chapter 2.

1.1.3 Equinor Canada Contacts

Equinor Canada operates an office in St. John's, NL where Equinor Canada's offshore NL activities are managed, and key technical staff located.

The principal Equinor Canada contacts concerning this Project and its EA are as follows:

Primary Contact for Environmental Assessment:

Stephanie Curran – BdN Safety and Sustainability Manager
Equinor Canada Ltd.
2 Steers Cove, St. John's, NL, A1C 6J5
Tel: 709-726-9091
Email: scurr@equinor.com

Primary Contacts for Bay du Nord Development and Offshore NL Operations:

Halfdan Knudsen – BdN Project Director
Unni Fjaer – Vice-President, Offshore NL
Equinor Canada Ltd.
2 Steers Cove, St. John's, NL, A1C 6J5
Tel: 709-726-9091

1.2 Project Location and Overview

This section provides a brief overview of the Project, including its overall location, planned components and activities and its environmental setting and context, as initial background for the EIS. Further details on each of these items are provided in subsequent chapters.

1.2.1 Project Location

The Project is located in the Flemish Pass area of the Canada-NL Offshore Area, approximately 500 km east-northeast of St. John's, NL (**Error! Reference source not found.**). As illustrated, the Project Area is located outside Canada's 200 nautical mile (NM) Exclusive Economic Zone (EEZ). A detailed description of the Project Area and Core BdN Development Area, including water depths, areas, applicable ELs and SDLs, corner point coordinates are provided in Section 2.4.

The assessment takes into consideration the Core BdN Development Area, as well as the broader Project Area, where Project Area Tiebacks would be undertaken. The assessment also considers related supply and support vessels and aircraft to and from the Project.

1.2.2 Key Project Components and Activities

The Project includes the subsea development and production of crude oil from a floating production, storage and offloading (FPSO) installation and the drilling of up to 40 wells. Planned and potential components and activities associated with the Project are listed below.

- Offshore construction and installation, hook-up and commissioning (HUC)
- Production and maintenance operations
- Drilling activities
- Supply and servicing
  - Offshore supply vessels (OSV)
  - Standby vessels (SBV)
  - Helicopter support
  - Crude oil shipping (including movement, hook-up / disconnect and offloading of crude oil to shuttle tankers within the Project safety zone)
- Supporting surveys
  - Geohazard / wellsite and seabed surveys
  - Geophysical surveys (2D/3D/4D seismic surveys, vertical seismic profiling (VSP))
  - Environmental surveys
  - Geotechnical and / or geological surveys
  - Remotely-operated vehicle (ROV) / autonomous underwater vehicle (AUV) / video surveys
- Decommissioning

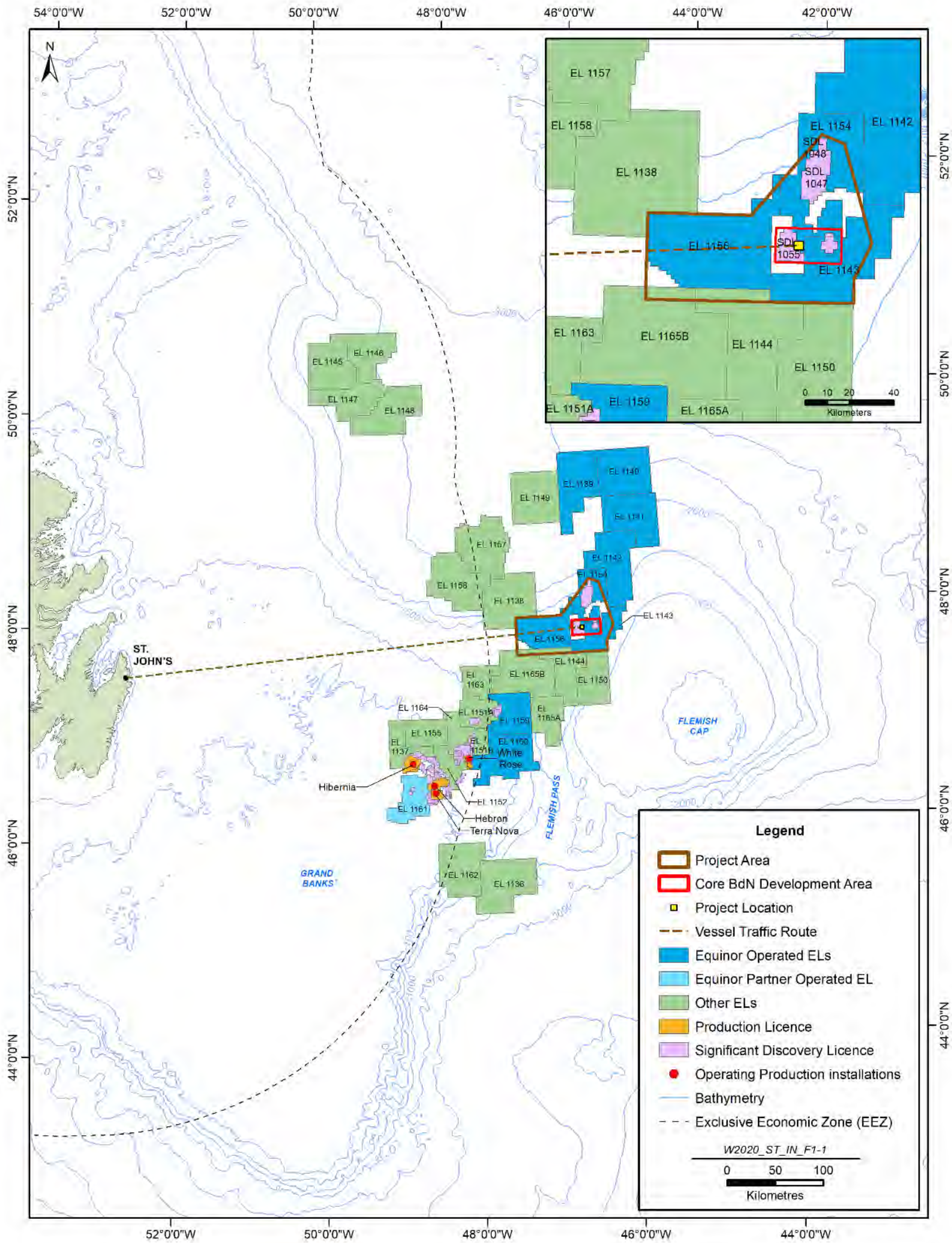


Figure 1-1 The Bay du Nord Development Project

Activities to support Project Area Tiebacks are included in the scope of the Project and would be a continuation of activities ongoing under the Core BdN Development or additional activities required to support tiebacks, and include:

- Offshore Construction and installation of subsea tiebacks (well templates; flowlines, umbilicals); HUC activities associated with additional subsea tiebacks to the exiting production installation
- Continuation of production and maintenance operations from the existing production installation
- Drilling activities from new well templates
- Continuation of supply and servicing
- Potential additional supporting surveys
- Decommissioning of subsea tiebacks

These activities associated with Project Area Tiebacks would be analogous to Core BdN Development offshore construction and installation scopes of work.

The Core BdN Development has a life of field between 12 and 20 years. Should Project Area Tiebacks occur, production could be extended out to the design life of the FPSO and subsea infrastructure, which is 30 years. Therefore, the overall Project temporal scope is 30 years.

A more detailed description of the Project, including its overall need, purpose and justification, location, key components and activities, Project alternatives, preliminary schedule, potential environmental emissions and their management, ongoing and future planning and design processes, is provided in Chapter 2.

1.3 Regulatory Framework and the Role of Government

The Project will require a number of approvals and authorizations under applicable regulatory processes, as summarized in the following sections.

1.3.1 Environmental Assessment under CEAA 2012

The federal EA process under CEAA 2012 focuses on potential adverse environmental effects that are within areas of federal jurisdiction, including: fish and fish habitat, migratory birds, federal lands, and other changes to the environment that are directly linked to or necessarily incidental to federal decisions about a project.

The *Regulations Designating Physical Activities (the Regulations)* enacted under CEAA 2012 identify the physical activities that constitute a "designated project" that may require a federal EA. Section 11 of the Regulations specify that offshore oil and gas development activities are subject to federal EA review and are defined as:

> *The construction, installation and operation of a new offshore floating or fixed platform, vessel or artificial island used for the production of oil or gas.*

The Project, therefore, constitutes a "designated project" under CEAA 2012. Equinor Canada submitted the Project Description (Equinor Canada 2018) to the CEA Agency in June 2018, which was subsequently made available for review by stakeholders, Indigenous groups and the public. Following that review period, on August 9, 2018, the CEA Agency determined that a federal EA was required for the Project and issued the associated Notices of EA Determination and EA Commencement. The EIS Guidelines were issued on September 26, 2018.

The Project will include environmental components, and requirements that fall within areas of federal jurisdiction. For example, Project activities are planned to take place within the offshore marine environment, which are considered "federal lands" under CEAA 2012. CEAA 2012 specifically defines "federal lands" as including:

- *(i) the internal waters of Canada, in an area of the sea not within a province,*
- *(ii) the territorial sea of Canada, in an area of the sea not within a province,*
- *(iii) the exclusive economic zone of Canada, and*
- *(iv) the continental shelf of Canada.*

The Canada-NL Offshore Area, as defined in the Accord Acts, includes those lands within Canada's EEZ or to the edge of the continental margin, whichever is greater. Therefore, pursuant to CEAA 2012, the Project will be carried out on federal lands.

The Project has the potential to interact with environmental components under federal jurisdiction such as fish and fish habitat, marine and migratory birds, and marine mammals and sea turtles. Permits and/or authorizations may be required under the federal *Fisheries Act*, *Migratory Birds Convention Act* (MBCA), *Species at Risk Act* (SARA) (see Section 1.3.4).

The Project Area is located within the Study Area for the Eastern Newfoundland Strategic Environmental Assessment (SEA) completed by the C-NLOPB in August 2014 (Amec 2014), which has comprised a key source of information for this EIS.

It is Equinor Canada's understanding that the Project will take place on lands that are currently proposed for a regional study as described in Sections 73 to 77 of CEAA 2012. The "Regional Environmental Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador" (CEA Agency 2018b) commenced in September 2018 and the proposed study area includes the BdN Project Area.

1.3.2 The Accord Acts

Oil and gas activities offshore NL are regulated by the C-NLOPB, a joint federal-provincial agency that is responsible, on behalf of the Governments of Canada and NL, for petroleum resource management in the Canada-NL Offshore Area. The Accord Acts, administered by the C-NLOPB, govern oil and gas activities in the region.

As indicated on the C-NLOPB's website, their role, under the Accords Act, is to regulate oil and gas exploration and development activity in the Canada-NL Offshore Area, overseeing compliance with regulatory requirements for worker safety, environmental protection and safety, conservation of the resource, land tenure, and Canada / NL benefits. These processes are administered under various legislation, regulations, guidelines and memoranda of understanding.

The C-NLOPB's responsibilities under the Accord Acts include:

- The issuance and administration of petroleum and exploration and development rights
- Administration of statutory requirements regulating offshore exploration, development, and production
- Approval of Canada-NL benefits and development plans

The Canada-NL Offshore Area, as defined in the Accord Acts, includes those lands within Canada's EEZ or to the edge of the continental margin, whichever is greater. The Project Area includes marine lands that fall within the C-NLOPB jurisdiction (see Figure 1-1).

1.3.2.1 Land Ownership and Licencing

The C-NLOPB administers a scheduled land tenure system for the issuance and administration of petroleum exploration and production rights in the Canada-NL Offshore Area.

Licences afford the holder the exclusive rights to explore for or produce petroleum resources in that area, and include ELs, SDLs, and PLs. ELs are issued for a term of nine years covering two periods. A well must be drilled or diligently pursed by the end of Period I in order to obtain tenure to Period II. If an exploration drilling program results in a significant discovery and a declaration of significant discovery is made, an interest owner is entitled to apply for an SDL. A significant discovery is defined in the Accord Acts as:

> *A discovery indicated by the first well on a geological feature that demonstrates by flow testing the existence of hydrocarbons in that feature and, having regard to geological and engineering factors, suggests the existence of an accumulation of hydrocarbons that has potential for sustained production.*

An SDL is the document of title by which an interest owner can continue to hold rights to a discovery area while the extent of that discovery is determined and, if it has potential to be brought into commercial production in the future, until commercial development becomes viable. An SDL is effective from the application date and remains in force for so long as the relevant declaration of significant discovery is in force, or until a PL is issued for the relevant lands. A PL confers:

1) The right to explore for, and the exclusive right to drill and test for, petroleum
2) The exclusive right to develop those portions of the offshore area in order to produce petroleum
3) The exclusive right to produce petroleum from those portions of the offshore area
4) Title to the petroleum so produced

A PL is effective from the date it is issued for a term of 25 years or for such period thereafter during which commercial production continues.

In issuing SDLs and or PLs, or when ELs are consolidated, areas not included in the new licence may be retained by the licence operator. In that instance, the remaining SDL or ELs are issued new numbers in accordance with the C-NLOPB licence administration procedures.

1.3.2.2 Other Licences, Authorizations, and Approvals

The issuance of a licence (i.e., EL, SDL, PL) does not, in and of itself, authorize the licence holder to carry out activities within the licence area. Petroleum-related work or activity in the Canada-NL Offshore Area requires an Operating Licence and an Operations Authorization (OA) issued by the C-NLOPB.

In accordance with the Accord Acts and Section 6 of the *Newfoundland Offshore Petroleum Drilling and Production Regulations* prior to the issuance of an OA, the following information must be submitted by an Operator and approved by C-NLOPB:

- EA Report
- Canada-NL Benefits Plan
- Safety Plan
- Environmental Protection Plan (EPP)
- Emergency Response and Spill Contingency Plans
- Evidence of Financial Responsibility
- Certificate of Fitness for the proposed equipment / facilities used to carry out the planned activities

The Accord Acts and the *Newfoundland Offshore Certificate of Fitness Regulations* require that an independent Certifying Authority (CA) is selected and carries out a Scope of Work that is approved by C-NLOPB. In order to achieve an OA for installation and operation of the production facilities, a Certificate of Fitness will be issued by the CA to confirm that the installation is designed, constructed, transported and installed in accordance with the regulations, is fit for the purpose for which it is to be used, and can be operated safely without polluting the environment.

The Accord Acts establish the requirements that proponents of offshore petroleum development projects must fulfil in order to obtain approval for a Development Plan. The following reports are required as part of the Development Application:

- Development Plan and Development Plan Summary
- Benefits Plan
- EIS
- Safety Analysis and Commitment
- Socioeconomic Impact Statement and Sustainability Report

This EIS required for the Project under CEAA 2012 will address associated EA requirements of the C-NLOPB Development Application and/or OA processes. It is understood that should Project Area Tiebacks be undertaken, Equinor Canada may be required to submit a Development Plan amendment, which would provide information regarding the development of resources from the new pool or field being tied-back to the existing production installation. Therefore, to ensure that the environmental effects associated with the development of new or additional resources from the existing production installation, the scope of the Project and scope of the Environmental Assessment includes the effects assessment for the activities associated with Project Area Tiebacks in accordance with the Scope of Environmental Assessment and Scope of Project outlined in the EIS Guidelines (CEA Agency 2018).

Other required C-NLOPB approvals may also include the approval of plans, procedures or other documents as specified by the relevant legislation or regulations. Additional oversight for environmental protection and safety of operations is provided in guidelines issued by the C-NLOPB, and jointly with the Canada-Nova Scotia Offshore Petroleum Board and/or National Energy Board (NEB), and through regulations enacted under the various legislation governing offshore petroleum activities.

Equinor Canada is also aware that the Frontier and Offshore Regulatory Renewal Initiative (FORRI) is ongoing and is likely to result in the development of a suite of new operational requirements for frontier and offshore oil and gas activities in Canada, termed the 'Framework Regulations'. Equinor Canada is also aware that concurrent to FORRI's work, the Atlantic Occupational Health and Safety Initiative is modernizing the occupational health and safety regulations for offshore oil and gas activities in Canada with the aim of enhancing the already high standards for safety, environmental protection, and resource management in offshore oil and gas areas of Canada. These reforms are anticipated to be in force in late 2020 at which time Equinor Canada will review and determine their applicability to the Project.

Another aspect of the C-NLOPB’s mandate is the administration of the provisions of the Accord Acts pertaining to industrial and employment benefits resulting from the exploration for, and development of oil and gas resources in the Canada-NL Offshore Area. The Accord Acts require that before work or activity is authorized in Canada-NL Offshore Area, a Canada-NL Benefits Plan must be submitted to, and approved by, the C-NLOPB. This Plan must identify and describe the measures to be taken regarding the employment of Newfoundlanders and Labradorians and other Canadians, as well as providing manufacturers, consultants, contractors and service companies in the province and other parts of Canada with full and fair opportunity to participate on a competitive basis in the supply of goods and services to such a project. Equinor Canada is committed to creating and optimizing opportunities and benefits for NL and Canadian workers and companies as part of its activities and operations in the Canada-NL Offshore Area, and to carrying out its business in full compliance with relevant *Canada-NL Benefits Plan Guidelines* and other applicable requirements.

1.3.3 Federal Funding

No federal funding has been requested nor provided to the proponent from any federal authority to support the Project.

1.3.4 Other Potential Regulatory Requirements and Interests

In addition to the CEAA 2012 environmental assessment and C-NLOPB regulatory approval processes, other federal permits and authorizations may be required by the Project. Federal and provincial government departments and agencies, which may have regulatory responsibilities, information, and advice regarding the Project pursuant to their associated legislation and mandates (see Table 1.1 below) include the following:

- Fisheries and Oceans Canada (DFO)
- Environment and Climate Change Canada (ECCC)
- Transport Canada
- Natural Resources Canada (NRCan)
- Department of National Defence
- NL Department of Municipal Affairs and Environment
- NL Department of Fisheries and Land Resources
- NL Department of Natural Resources

Other federal legislation, and regulations thereunder, which may be applicable to the Project and its EA include, but are not limited to:

- *Oceans Act* (S.C. 1996, c. 31)
- *Fisheries Act* (R.S.C., 1985, c. F-14)
- Canadian Environmental Protection Act (S.C. 1999, c. 33)
- Navigation Protection Act (R.S.C., 1985, c. N-22)
- Species at Risk Act (S.C.2002, c. 29)
- Migratory Birds Convention Act (S.C. 1994, c. 22)
- *Canada Shipping Act* (S.C. 2001, c. 26)
- Endangered Species Act (NL)
- Seabird Ecological Reserve Regulations (NL)

Transport Canada will be the “flag state regulator” for the FPSO, as the vessel will be Canadian flagged. There will be a number of licenses and certificates issued by Transport Canada or the Classification Society related to safety, security and pollution prevention. These certificates typically state how the vessel is equipped and what limitations there are, as opposed to a permit or an authorization for an activity. Examples of the types of licenses and certificates that may be issued include:

- Certificate of Canadian Ship Registry
- International Tonnage Measurement Certificate
- International Air Pollution Prevention Certificate
- International Oil Pollution Prevention Certificate
- International Sewage Pollution Prevention Certificate
- International Civil Liability for Oil Pollution Damage Certificate
- International Load Line Certificate
- International Ship Security Certificate
- Ship Station Radio License

- Cargo Ship Safety Equipment Certificate
- Cargo Ship Safety Construction Certificate
- ISM Certificate

A list of some of the key legislation, regulations and associated approvals that may be required in relation to offshore oil and gas activities are provided in Table 1.1. A reference in the EIS to legislation, regulations or guidelines refers to such legislation, regulations or guidelines as amended from time to time over the life of the Project. Figure 1-2 illustrates the regulatory approvals required for the Project.

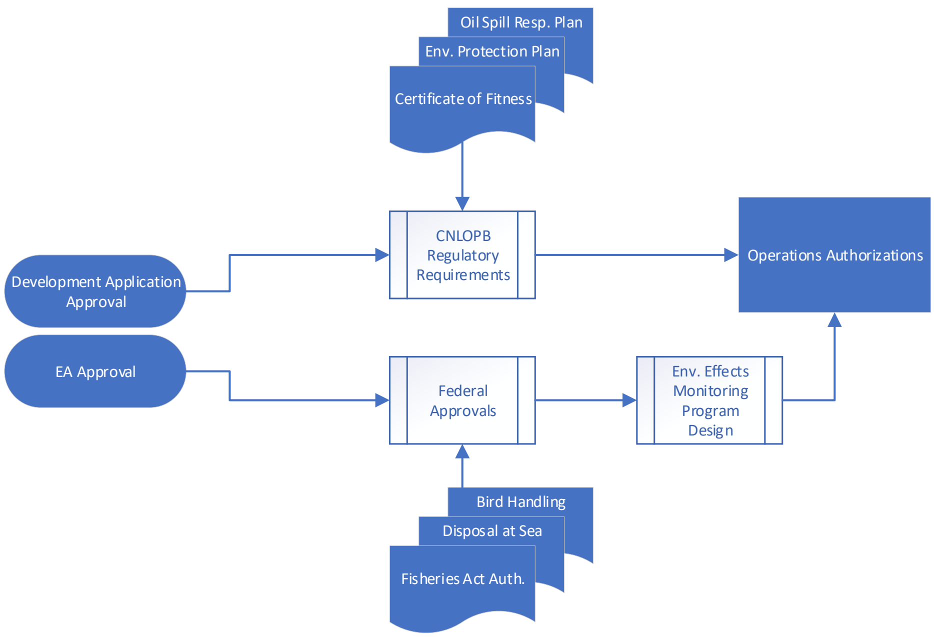


Figure 1-2 Regulatory Approvals for the BdN Development Project

Known and applicable government policies, resource management plans, planning or study initiatives that are related to the Project, and specifically its existing environmental setting and potential environmental effects and mitigation, are discussed where relevant in this EIS (Chapters 5 to 7). In addition, cases where legislation, regulations, policies or applicable national, provincial, or regional objectives and guidelines are relevant to, and have been considered and used in, the evaluation of the environmental effects are discussed in the relevant environmental effects assessment sections (Chapters 9 to 14) of this EIS.

The Project is located in the marine offshore environment and will not involve the development and use of new on-land or nearshore infrastructure or Project-related expansions or modifications to existing infrastructure. The NL Department of Municipal Affairs and Environment has confirmed that the Project does not require an EA under the provincial process, pursuant to Section 47 of the *Environmental Protection Act* (SNL 2002, cE-14.2). It is not anticipated that municipal permits or authorizations will be required, nor that associated land use plans or land zoning will be applicable.

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Specific to Oil and Gas Activities in the Canada-NL Offshore Area			
Accord Acts	C-NLOPB	The Accord Acts give the C-NLOPB the authority and responsibility for the management and conservation of the petroleum resources offshore NL in a manner that protects health, safety, and the environment while maximizing economic benefits. The Accord Acts are the governing legislation under which various regulations are established to govern specific petroleum exploration and development activities	The regulatory approvals and authorizations identified herein may also be required pursuant to Section 138(1)(b) of the *Canada-Newfoundland Atlantic Accord Implementation Act* and Section 134(1)(b) of the *Canada-Newfoundland and Labrador Atlantic Accord Implementation Newfoundland and Labrador Act* and the various regulations made under the Accord Acts.
Accord Act Regulations[1]	C-NLOPB	A number of existing Regulations made under the Accord Acts may be relevant to proposed offshore oil and gas activities, including the following: • Drilling and Production Regulations (and associated guidelines) • Certificate of Fitness Regulations • Petroleum Installations Regulations • Canada–NL Offshore Petroleum Administrative Monetary Penalties Regulations • Canada–NL Offshore Petroleum Cost Recovery Regulations • Canada–NL Offshore Petroleum Financial Requirements Regulations • Diving Certificates • Diving Operations Safety Transitional Regulations	The primary regulatory approvals required for a development project include, but is not limited to, the following: • Operating License • Operations Authorization • Approval to Drill a Well • Geophysical Program Authorization • A Certificate of Fitness will be required

1. As stated in Section 1.3.2.2 Equinor Canada is also aware that the Frontier and Offshore Regulatory Renewal Initiative (FORRI) is ongoing and is likely to result in the development of a suite of new operational requirements for frontier and offshore oil and gas activities in Canada.

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
		• Marine Installations and Structures Transitional Regulations • Occupational Health and Safety Transitional Regulations • Oil and Gas Operations Regulations • Oil and Gas Spills and Debris Liability Regulations • Petroleum Geophysical Operations Regulations	
Development Plan Guidelines	C-NLOPB	The Accord Acts establish the requirements that proponents of offshore petroleum development projects must fulfill in order to obtain approval for a Development Application. The Development Application is comprised of a Benefits Plan and a Development Plan with ancillary documents. To assist proponents in complying with these requirements, the Board has developed Development Plan Guidelines with the objective of providing greater: • Clarity in relation to the technical information required to be submitted by the proponent in support of the Development Plan; and, • Transparency, certainty and efficiency surrounding the review process to be followed when considering a proponent's Development Plan and Benefits Plan.	

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Offshore Waste Treatment Guidelines (OWTG)	C-NLOPB	These guidelines outline recommended practices for the management of waste materials from oil and gas drilling and production facilities operating in the Canada-NL Offshore Area. The OWTG were prepared in consideration of the offshore waste/effluent management approaches of other jurisdictions, as well as available waste treatment technologies, environmental compliance requirements, and the results of environmental effects monitoring programs in Canada and internationally. The OWTG specify performance expectations for the following types of discharges: • Emissions to air • Produced water and sand • Drilling muds and solids • Storage displacement water • Bilge water, ballast water and deck drainage • Well treatment fluids • Cooling water • Desalination brine • Sewage and food wastes • Water for testing of fire control systems • Discharges associated with subsea systems • Naturally occurring radioactive material	Adherence to Guidelines
Offshore Chemical Selection Guidelines for Drilling and Production Activities on Frontier Lands (OCSG)	C-NLOPB	These guidelines provide a framework for chemical selection that reduces the potential for environmental effects from the discharge of chemicals used in offshore drilling and production operations. An operator must meet the minimum expectations outlined in the OCSG as part of the authorization for work or activity related to offshore oil and gas exploration and production.	Adherence to Guidelines

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Compensation Guidelines Respecting Damage Relating to Offshore Petroleum Activity (Updated November 2017)	C-NLOPB	These guidelines describe compensation sources available to potential claimants for loss or damage related to petroleum activity offshore NL and outline the regulatory and administrative roles which the Board exercises respecting compensation payments for actual loss or damage directly attributable to offshore operators.	Adherence to Guidelines
Environmental Protection Plan Guidelines	C-NLOPB	These guidelines assist operators in developing Environmental Protection Plans (EPP) to meet the requirements of Sections 6 and 9 of the *Drilling and Production Regulations*	Adherence to Guidelines
Canada-Newfoundland and Labrador Benefits Plan Guidelines	C-NLOPB	Approval of a Benefits Plan is a pre-condition of the approval of a Development Plan. Approval of a Development Plan is a fundamental decision by the Board. It therefore must be approved by Ministers subsequent to the Board's approval. Approval of a Benefits Plan is not a fundamental decision, and therefore not subject to subsequent approval by Ministers.	Adherence to Guidance
Geophysical, Geological, Environmental and Geotechnical Program Guidelines (Updated April 2017)	C-NLOPB	These Guidelines have been prepared to assist Applicants who wish to conduct geophysical, geological, geotechnical, or environmental programs within the offshore area. They replace those issued by the C-NLOPB in January 2012	Adherence to Guidelines and associated Geophysical Program Authorization
Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP)	DFO / ECCC / C-NLOPB	The SOCP specifies the minimum mitigation requirements that must be met during the planning and conduct of marine geophysical surveys, in order to reduce effects on life in the oceans. These mitigation measures can be applied to VSP operations. These requirements focus on planning and monitoring measures to avoid interactions with marine mammal and sea turtle species at risk where possible and reduce adverse effects on species at risk and marine populations.	Adherence to SOCP

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Guidelines Respecting Financial Requirements (amended August 2017)	C-NLOPB	Operators wishing to conduct work or activity in the Canada-NL Offshore Area are required to provide proof of financial responsibility in a form and amount satisfactory to the Board. These regulations and guidelines provide guidance to operators in providing proof of financial requirements regarding authorization being sought for work or activity relating to drilling, development, decommissioning or other operations in the offshore areas.	Adherence to Guidelines
Other Guidelines	C-NLOPB	Other Guidelines administrated by the C-NLOPB that do or may apply to aspects of offshore oil and gas production projects and associated activities such as those being proposed as part of this Project include: • Administrative Monetary Penalty Guidelines • Atlantic Canada Standby Vessel Guidelines • Applications for Significant or Commercial Discovery Declarations • Cost Recovery Guidelines • Data Acquisition and Reporting Guidelines • Incident Reporting and Investigation Guideline • Measurement Under Drilling and Production Regulations • Monitoring and Reporting • Monthly Production Reporting for Producing Fields • NL Offshore Area Registration System • Physical Environmental Programs • Reporting Lift Gas Volumes • Research and Development Expenditures • Safety Plan Guidelines • Transboundary Crewing	Adherence to Guidelines as applicable

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Other Relevant Legislation			
CEAA 2012	CEA Agency	"The construction, installation and operation of a new offshore floating or fixed platform, vessel or artificial island used for the production of oil or gas." is included in the list of designated activities under CEAA 2012. The CEA Agency has determined that the Project requires an EA under CEAA 2012.	The Project is contingent upon EA approval (i.e., an EA Decision Statement that allows the Project to proceed).
Canadian Environmental Protection Act, 1999 (CEPA 1999)	ECCC	CEPA, 1999 pertains to pollution prevention and the protection of the environment and human health in order to contribute to sustainable development. Among other items, CEPA, 1999 provides a wide range of tools to manage toxic substances, and other pollution and wastes, including disposal at sea.	Disposal at Sea Permits (under the *Disposal at Sea Regulations* pursuant to CEPA, 1999) may be required in support of the Project.
Energy Safety and Security Act (S.C. 2015, c. 4)	NRCan	Introduced in Parliament as Bill C-22, *Energy Safety and Security Act* received Royal Assent on February 26, 2015 and came into effect on February 26, 2016. *Energy Safety and Security Act* aims to strengthen the safety and security of offshore oil production through improved oil spill prevention, response, accountability, and transparency and amends the Accord Acts and the *Canadian Oil and Gas Operations Act* with the intent of updating, strengthening, and increasing the level of transparency of the liability regime that is applicable to spills and debris in the offshore areas. The Act also promotes harmonization of the EA process for offshore oil and gas projects and includes provisions to allow the offshore petroleum boards to enable them to conduct EAs under CEAA 2012.	Financial Responsibility and Financial Resources requirements have increased. Specific additional relevance to be determined, but likely to have specific implications for spill prevention and response.

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Fisheries Act	DFO ECCC (administers Section 36, specifically)	The *Fisheries Act* contains provisions for the protection of fish, shellfish, crustaceans, marine mammals, and their habitats. Pursuant to the Section 35(2) of the *Fisheries Act*, works, undertakings or activities resulting in the death of fish or the harmful alteration, disruption or destruction of fish habitat are prohibited unless otherwise authorized. Section 36 of the *Fisheries Act* pertains to the prohibition of the deposition of a deleterious substance into waters frequented by fish.	Authorization from the Minister of Fisheries and Oceans under section 35(2) of the *Fisheries Act* may be required in support of the Project respecting activities that have been determined to affect fish habitat.
Migratory Birds Convention Act (MBCA)	ECCC	Under the MBCA, it is illegal to kill migratory bird species not listed as game birds or destroy their eggs or young. The Act also prohibits the deposit of oil, oil wastes or other substance harmful to migratory birds in waters or area frequented by migratory birds.	The salvage of stranded birds during offshore Project operations will require a handling permit under section 4(1) of the *Migratory Birds Regulations* pursuant to the MBCA.
Canada Shipping Act (CSA)	Transport Canada	The *Canada Shipping Act, 2001* and related regulations set out the requirements for safety and environmental protection for Canadian vessels and their operator	Project components and activities will be required to comply with the relevant requirements of the Act and its regulations.
Navigation Protection Act (NPA)	Transport Canada	The NPA came into force in April 2014 and replaced the former *Navigable Waters Protection Act*. The NPA is intended to protect specific inland and nearshore navigable waters (as identified on the list of "Scheduled Waters" under the NPA) by regulating the construction of works on those waters and by providing the Minister of Transport with the power to remove obstructions to navigation.	No applicable permitting requirements have been identified for the Project, as the Project Area is located offshore, outside of the Scheduled Waters specified in the NPA.
Oceans Act	DFO	The *Oceans Act* provides for the integrated planning and management of ocean activities and legislates the marine protected areas (MPA) program, integrated management program, and marine ecosystem health program. MPAs are designated under the authority of the *Oceans Act*.	No applicable permitting requirements have been identified for the Project.

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Species at Risk Act (SARA)	DFO / ECCC / Parks Canada	SARA is intended to protect species at risk in Canada and their “critical habitat” (as defined by SARA). The main provisions of the Act are scientific assessment and listing of species, species recovery, protection of critical habitat, compensation, permits and enforcement. The Act also provides for development of official recovery plans for species found to be most at risk, and management plans for species of special concern. Under the Act, operators are required to complete an assessment of the environment and demonstrate that no harm will occur to listed species, their residences or critical habitat or identify adverse effects on specific listed wildlife species and their critical habitat, followed by the identification of mitigation measures to avoid or reduce effects. All activities must be in compliance with SARA. Section 32 of the Act provides a complete list of prohibitions.	Under certain circumstances, the Minister of Fisheries and Oceans may issue a permit under section 73 of SARA authorizing an activity that has potential to affect a listed aquatic species, part of its critical habitat, or the residences of its individuals. However, such a permit is not anticipated to be required in support of the Project.
NL Endangered Species Act	NL Department of Fisheries and Land Resources	The provincial *Endangered Species Act* provides special protection for plant and animal species considered to be endangered, threatened, or vulnerable in the province. The Act applies to species, sub-species and populations that are native to the province but does not include marine fish, bacteria, and viruses. It also does not apply to introduced species, except in extraordinary circumstances. Designation under the Act follows recommendations from the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and/or the Species Status Advisory Committee (SSAC) on the appropriate assessment of a species. Currently there are 35 species, subspecies, and populations listed under the Act. Thirteen of these species are listed as endangered, nine are listed as threatened and thirteen are listed as vulnerable.	No applicable permitting requirements have been identified for the Project.

Table 1.1 Summary of Key Relevant Legislation, Regulations, and Guidelines

Legislation / Regulation / Guideline	Regulatory Authority	Overview	Potentially Applicable Permitting Requirement(s)
Seabird Ecological Reserve Regulations, NLR 66/97	NL Department of Fisheries and Land Resources	Prohibit or limit industrial development and certain activities that can cause disturbance to breeding seabirds, including hiking, boat traffic and low-flying aircraft near the colonies during the breeding season.	No applicable permitting requirements have been identified for the Project.

In planning and conducting its oil and gas activities, Equinor Canada will comply with applicable provincial and federal legislation, regulations, and guidelines, as well as applicable international conventions and standards. As described in Sections 1.1 and 2.2.1.1, the Operator also has in place its own comprehensive environmental policies, plans and procedures for planning and conducting its oil and gas activities, and requires its contractors to adhere to these as applicable.

1.4 Purpose and Organization of the EIS

The preparation and submission of the EIS is an important step in the EA review process for this Project. It provides the required information on the Project and its potential environmental effects and associated mitigation, including the:

- Project purpose
- Project description (components, activities, schedule)
- Project alternatives
- Changes to the Project that may be caused by the environment
- Existing environmental setting (biophysical and socioeconomic)
- Government, stakeholder, and Indigenous engagement activities, including the various comments provided
- Environmental effects of the Project (planned activities and potential malfunctions or accidents)
- Mitigation measures to avoid or reduce environmental effects
- Residual effects and their significance
- Cumulative environmental effects
- Proposed environmental monitoring and follow-up activities

The EIS will form the basis for further review, consideration and discussion of the Project and those items identified by regulatory agencies, Indigenous groups, stakeholders and interested public as part of the EA process. Based on the results of the EA and the associated reviews and input, the Government of Canada will eventually decide whether the Project can proceed, including associated terms and conditions.

The EIS has been prepared in accordance with the EIS Guidelines and is structured to provide the results of the assessment and other required information in a clear, concise, and well-organized manner, in keeping with current EA practice and with a view to ensuring overall readability and utility for stakeholders and Indigenous groups. EIS chapters and components have been planned and prepared as part of a fully integrated EIS document, with cross referencing throughout. Each chapter also contains its own list of references, including literature cited and personal communications. Appendix B is the Table of Concordance outlining the information requirements of the EIS Guidelines and identifying the locations in the EIS where each of these requirements are addressed.

Table 1.2 provides an overview of the overall structure of the EIS document.

Table 1.2 EIS Organization and Content

EIS Chapter	Overview
Chapter 1: Introduction	• Identifies the Operator, provides a general overview of the Project, outlines the regulatory context for the Project and its EA, and describes the purpose of the EIS and the overall organization of the document
Chapter 2: Project Description	• Sets the overall context for the Project by discussing its need, purpose and rationale and alternatives. It also provides a detailed description of the Project, including its location, key components and activities, schedule, potential environmental emissions and their management, ongoing and future planning and design processes, and the Operator's relevant environmental planning and management systems.
Chapter 3: Regulatory, Indigenous and Stakeholder Engagement	• Describes previous and ongoing governmental, Indigenous and stakeholder engagement initiatives related to the Project and its EIS, as well as identifying the comments raised regarding the Project and its potential effects and where and how these are addressed in the EIS
Chapter 4: Environment Assessment Scope, Approach, and Methodology	• Outlines the scope of the Project and its EA, including the factors considered, the scope of these factors, and the overall approach and methods used to conduct the assessment
Chapter 5: Existing Physical Environment	• These Chapters provide a description of the existing environmental setting for the Project, including the physical, biological and socioeconomic environments that overlap and may interact with the Project
Chapter 6: Existing Biological Environment	
Chapter 7: Existing Human Environment	
Chapter 8: Air Quality and Greenhouse Gas Emissions	• Provides an overview of the air emissions and dispersion modelling completed to quantify air contaminant emissions to atmosphere and ground-level concentrations from Project activities. A greenhouse gas emissions inventory was also developed for Project activities.
Chapter 9: Marine Fish and Fish Habitat: Environmental Effects Assessment	• These Chapters provide the detailed environmental effects assessments for the selected Valued Components (VCs) upon which the EIS is focused, each of which is addressed in a separate Chapter using the EA approach and methods described earlier
Chapter 10: Marine and Migratory Birds: Environmental Effects Assessment	
Chapter 11: Marine Mammals and Sea Turtles: Environmental Effects Assessment	
Chapter 12: Special Areas: Environmental Effects Assessment	
Chapter 13: Commercial Fisheries and Other Ocean Uses: Effects Assessment	

Table 1.2 EIS Organization and Content

EIS Chapter	Overview
Chapter 14: Indigenous Peoples: Environmental Effects Assessment	• Provides the detailed environmental effects assessments for this VC upon which the EIS is focused, each of which is addressed in a separate Chapter using the EA approach and methods described earlier
Chapter 15: Cumulative Environmental Effects	• Assesses and evaluates the potential environmental effects resulting from those of the Project in combination with other relevant physical activities that have been or will be carried out
Chapter 16: Accidental Events	• Describes and assesses possible accidental events and malfunctions that could occur as a result of the Project, including the results of associated modelling conducted for the Project and its EA. • It also describes relevant accident prevention and emergency response plans and procedures, and assesses and evaluates the potential effects of these possible accidental events for each VC
Chapter 17: Effects of the Environment on the Project	• Describes how environmental conditions and factors have or may influence the design and execution of the Project, and the various planning, design and operational measures that will be taken to help protect human health and safety and the environment in that regard
Chapter 18: EIS Summary and Conclusions	• Provides a summary of the key results and conclusions of the EIS

This EIS has been directed and submitted by Equinor Canada, as the Operator, and was prepared by an EIS Study Team comprised of personnel from Wood PLC (Wood), Stantec Consulting Ltd (Stantec), and LGL Limited (LGL). An overview of the key personnel that have been involved in the planning and writing of this EIS is provided in Appendix C.

1.5 References

Amec. 2014. Eastern Newfoundland Strategic Environmental Assessment: Final Report. Prepared for the Canada-Newfoundland and Labrador Offshore Petroleum Board, St. John’s, NL. Available at: https://www.cnlopb.ca/wp-content/uploads/enlsea/ch1-3.pdf.

CEA Agency. 2018a. Guidelines for the Preparation of an Environmental Impact Statement for the Bay du Nord Development Project Proposed by Equinor Canada Ltd. Available at: https://www.ceaa-acee.gc.ca/050/documents/p80154/125461E.pdf.

CEA Agency. 2018b. Regional Assessment of Offshore Oil and Gas Exploratory Drilling East of Newfoundland and Labrador. Available at: https://www.ceaa-acee.gc.ca/050/evaluations/document/exploration/80156?culture=en-CA.

Equinor Canada. 2018. Bay du Nord Development Project: Project Description Summary, June 2018. Available at: https://www.ceaa.gc.ca/050/documents/p80154/123011E.pdf.

2.0 PROJECT DESCRIPTION

This Chapter provides an overview of the proposed Bay du Nord (BdN) Development Project (the Project). It sets the overall context for the Project by discussing its need, purpose and rationale, benefits, and alternatives. It provides an overview and detailed description of the Project, including its location, key components and activities, preliminary schedule, potential waste discharges and emissions and their management, ongoing and future planning and design processes, and Equinor Canada's relevant environmental planning and management systems.

2.1 Project Scope

The BdN Development Project (the Project) is defined as the development of the Core BdN Development and Project Area Tiebacks. The Core BdN Development will include activities associated with the offshore construction and installation, hook-up and commissioning (HUC), production and maintenance operations, drilling and eventual decommissioning, as well as associated supporting surveys, field work, and supply and servicing activities. Project Area Tiebacks would only occur if exploration activities discover economically recoverable reserves that can be tied-back to the BdN production installation. Activities within the Project Area associated with Project Area Tiebacks include offshore construction and installation of well templates, flowlines, umbilicals, and risers to the existing BdN production installation within the Project Area, as well as associated supporting surveys. There are no land-based activities associated with this Project. The location of the proposed Project is illustrated in Figure 2-1. The Project scope includes the following components and activities:

Core Bay du Nord Development:

- Offshore construction and installation, and HUC
- Production and maintenance operations
- Drilling activities
- Supply and servicing
  - Offshore supply vessels (OSV)
  - Standby vessels (SBV)
  - Helicopter support
  - Crude oil shipping (including movement, hook-up / disconnect and offloading of crude oil to shuttle tankers within the Project safety zone)
- Supporting surveys
  - Geohazard / wellsite and seabed surveys
  - Geophysical surveys (2D/3D/4D seismic surveys; vertical seismic profiling (VSP))
  - Geotechnical / geological surveys
  - Environmental surveys
  - Remotely-operated vehicle (ROV) / autonomous underwater vehicle (AUV) / video surveys
- Decommissioning

Activities to support Project Area Tiebacks, should they arise, are included in the scope of the Project. The activities may be a continuation of those under the Core BdN Development and/or additional activities required to support tiebacks, and may include:

- Offshore Construction and installation of subsea tiebacks (well templates; flowlines, umbilicals); HUC activities associated with additional subsea tiebacks to exiting production installation
- Continuation of production and maintenance operations from the existing production installation
- Drilling activities from well templates in the Project Area
- Continuation of supply and servicing
- Potential additional supporting surveys, if required
- Decommissioning

The Project Area also includes lands adjacent to the Core BdN Development Area. Equinor Canada has majority interests in other exploration licenses (ELs) and significant discovery licenses (SDLs) in the area of the Project (Figure 2-1) with tieback opportunities. Should future resource potential be discovered in areas adjacent to the Core BdN Development Area, resources could be developed and produced from the production installation through the addition of subsea tiebacks and are therefore included in the Project. Information regarding Project Area Tiebacks can be found in Section 2.6.6.

The Core BdN Development has a life of field between 12 and 20 years. Should Project Area Tiebacks occur, production could be extended out to the design life of the FPSO, which is 30 years. Therefore, the overall Project temporal scope is 30 years.

Vessels to support the activities described above will be required throughout the life of Project as needed. Section 2.6.4 provides additional information on vessels that may be used to support Project activities.

The Project scope does not include the establishment or operation of Project-specific construction or fabrication facilities. Equinor Canada will not be constructing new fabrication or construction facilities for its own use as part of this Project. The production installation, subsea infrastructure, topsides and processing utilities will be constructed at existing fabrication yards either locally or internationally depending on capacity and fabrication requirements, and in compliance with the local benefits agreement, as a minimum.

The Project is located approximately 500 km offshore from St. John’s, Newfoundland and Labrador (NL). Crude oil will be offloaded from the production installation to shuttle tankers. Production operations offshore NL utilize the Basin Wide Terminal and Transshipment Solution (BWTTS), which is a fleet of modern shuttle tankers that ships crude to an existing transshipment terminal in NL or direct to market. The only transshipment terminal operating in Newfoundland is the Newfoundland Transshipment Terminal, located in Placentia Bay. Refer to Section 2.6.4.4 for additional information regarding shuttle tankers. The Project includes the offloading of crude to shuttle tankers and their movement and hook-up / disconnect within the Project safety zone. The transshipment of crude is not within the scope of the Project.

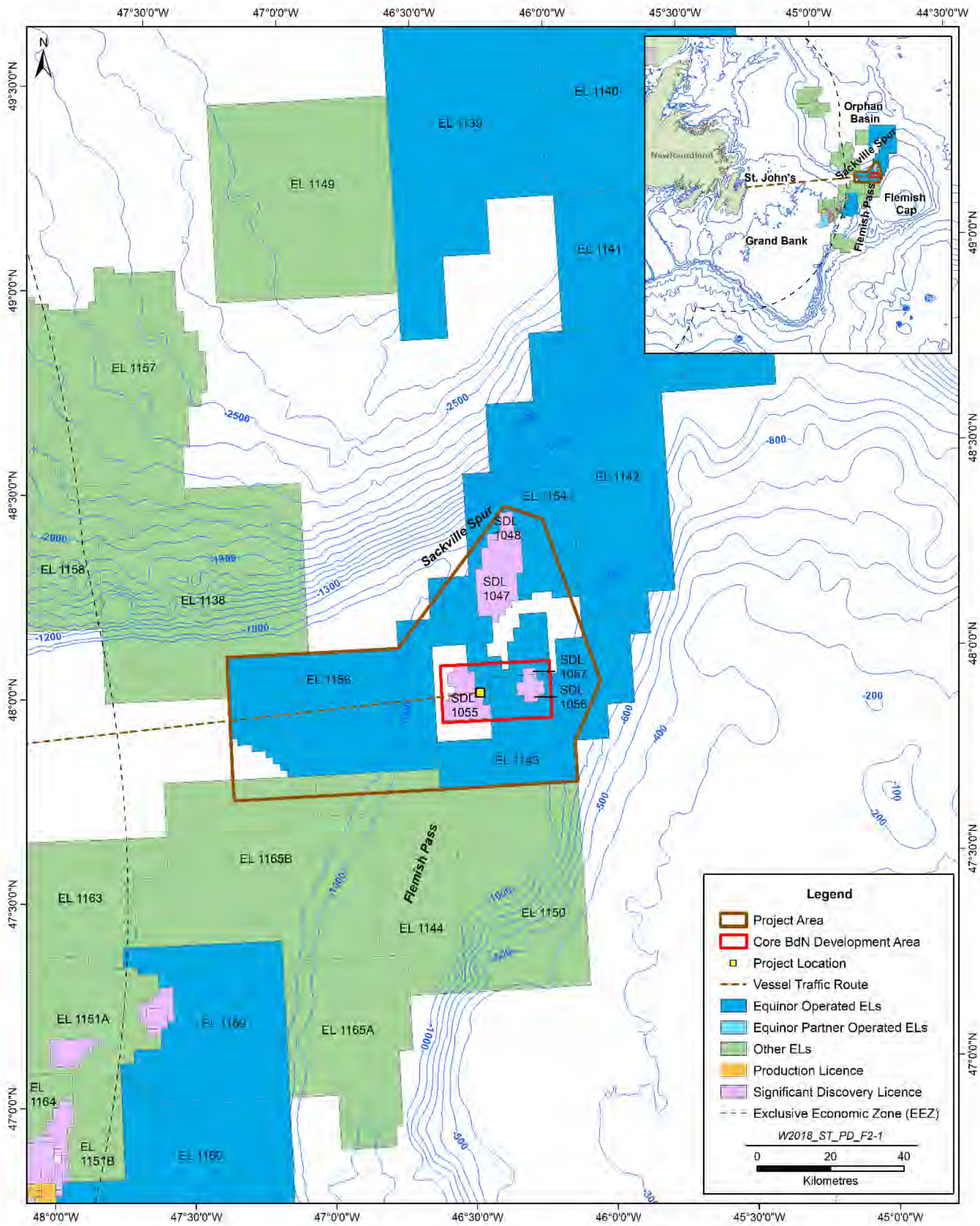


Figure 2-1 Project Area

Equinor Canada will rely on existing supply bases and shore base facilities on the island of Newfoundland that have been in operation since the 1970s, when offshore exploration activity began, to support the Project. Shore based facilities are owned and operated by independent third-party service providers and are subject to provincial and / or municipal regulatory requirements. These facilities provide services to multiple clients, including ongoing oil and gas operations, and are subject to specific regulatory requirements such as those imposed by the *Marine Transportation Security Act*. As this will be the fifth offshore development in NL, it is not anticipated that any significant construction or modifications would be required at contracted supply bases in support of the Project. Therefore, the supply base and associated activities are not considered within the scope of the Project.

Equinor Canada is not planning to construct or operate a new helicopter base nor modify an existing base to support the Project. Helicopters supporting the Project will transit to and from the Project using routes commonly used over the past 30 years of oil and gas activities and generally follow the shortest straight line between locations.

2.1.1 Timing of Project Activities

As described above, the Project consists of the Core BdN Development and Project Area Tiebacks. Table 2.1 provides an overview of the estimated timeframe for each of the Project phases and associated activities, as defined by the Project scope, and Figure 2-2 provides a high-level, preliminary schedule of proposed Project activities. Activities that may be carried out within each Project phase are described in Section 2.6. Note, the timing of these activities is based on current Project design, and they may commence earlier or later than indicated.

Table 2.1 Anticipated Timing of Project Activities

Project Phase	Anticipated Timeframe
Core BdN Development	
Offshore Construction and Installation and HUC	• Site surveys, commencing as early as 2021 • Offshore construction as early as 2023 • Approximately 5 years; seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of the year
Production and Maintenance Operations	• Commencement as early as 2026 • 12 to 20 years; year-round
Drilling Activities	• Commencement as early as 2024, • On average, drilling time is approximately 45-85 days per well (may be shorter for pilot wells and/or sidetracks) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2021 • Ongoing throughout life of Project; year-round

Table 2.1 Anticipated Timing of Project Activities

Project Phase	Anticipated Timeframe
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at anytime of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed) • Approximately 2 to 4 years; year-round
Project Area Tiebacks	*Extension of Project life to a maximum of 30 years*
Offshore Construction and Installation and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to five tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but activities could occur year-round • May occur at any time over life of Project
Production and Maintenance Activities	• Continuation of activities from existing FPSO out to end of Project life • Year-round
Drilling Activities from additional well templates	• Total timeframe for drilling depends on number of wells required • On average, drilling time is approximately 45-85 days per well • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project. • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Continuation of ongoing activities to end of Project life • Year-round
Supporting Surveys	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

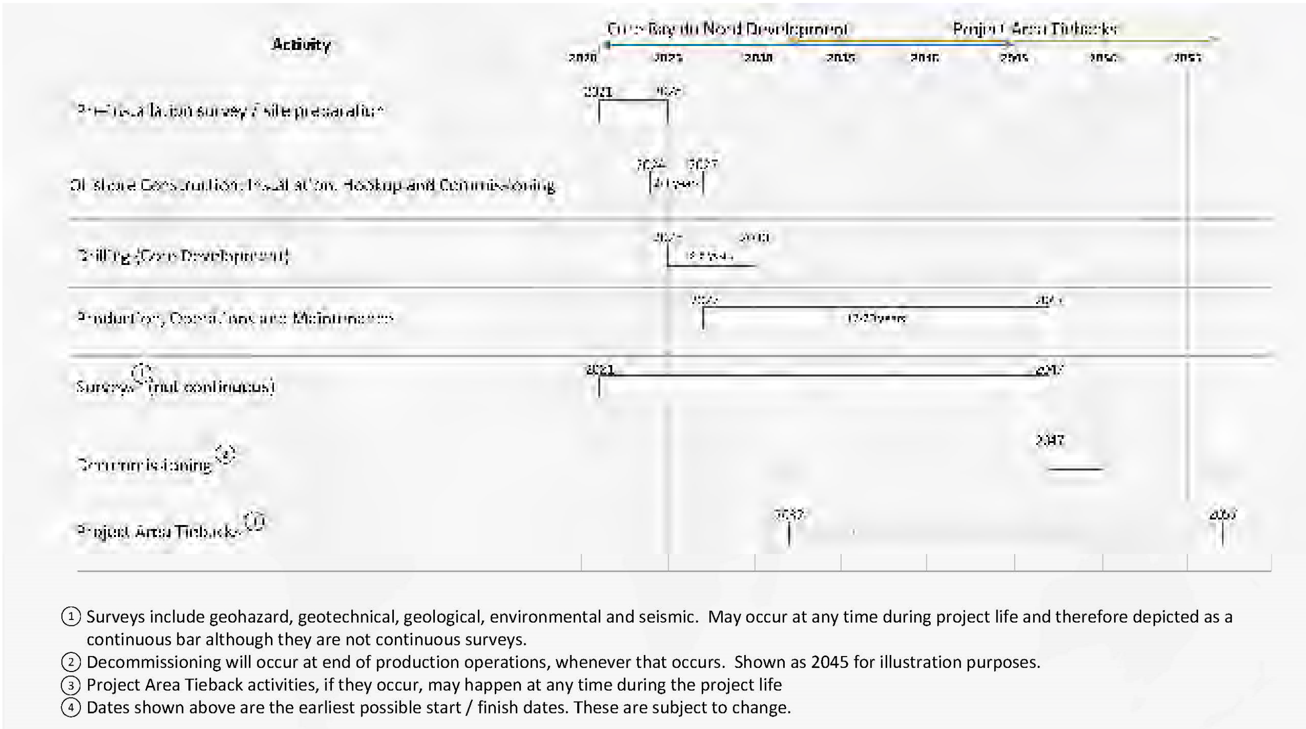


Figure 2-2 Preliminary Project Schedule – Earliest Possible Start Dates

2.2 Purpose of the Project

Since 2008, Equinor Canada has undertaken exploratory geophysical and drilling programs in the Flemish Pass and Jeanne d'Arc basins of the Canada-NL Offshore Area. These exploration activities have resulted in multiple oil discoveries: Mizzen in 2009, Harpoon and BdN in 2013, and Bay de Verde and Baccalieu in 2015/16. The purpose of the Project is to develop the Core BdN Development which includes Bay du Nord, Bay de Verde and Baccaileu.

Equinor Canada and Husky Oil Operations Limited (Husky Energy) made an application for a declaration of significant discovery to the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) based on the results of their exploration drilling program. In applying for the SDL, the operators continue to hold rights to the discovery area while its extent is determined and, if it has potential to be brought into commercial production until commercial development becomes viable. The C-NLOPB issued SDL 1055 (Bay du Nord L-76Z) to Equinor Canada (65 percent) and Husky Energy (35 percent) on November 17, 2017. SDL 1055 is 13,149 hectares (ha) in size with coordinates of: 48 10'N, 46 15'W; 48 00'N, 46 15'; and 48 00'N, 46 30'W (Figure 2.1). The C-NLOPB issued SDL 1056/7 (Baccalieu F-89) to Equinor Canada (65 percent) and Husky Energy (35 percent) on June 28, 2019. An SDL application for the Harpoon discovery is being progressed.

The Project will be a major contributor to the economic development of NL. The Project will be the province's fifth offshore oilfield development project. As such, it will build on and contribute to the multi-phase offshore petroleum industry in the province. In particular, the Project will provide substantial benefit through diversity programs, employment and training opportunities, business opportunities for the local service and supply community, and research and development (R&D) opportunities, further expanding the province's industrial capabilities.

During the operational phase, there will be employment opportunities in areas such as logistics, engineering and technical support, drilling and production, marine support vessels (e.g., helicopters, supply vessels, tankers), and catering. Opportunities during the construction and operational phases will further develop the capabilities of NL companies and individuals working on the Project, and thereby enable local companies and individuals to develop capabilities to compete internationally on future opportunities.

Throughout its operations, the Project will also contribute to energy diversity and supply and contribute substantial revenues to the Government of Newfoundland and Labrador through corporate taxes and royalty payments. If approved, the Project will extend the life of the offshore oil and gas industry in NL, representing an important next step in the development of a sustainable offshore oil and gas industry.

2.2.1 Environmental, Economic, and Social Benefits

The following sections describe some of the anticipated environmental, economic and social benefits of the Project.

2.2.1.1 Energy Diversification and Sustainable Development

The Project will be important in meeting future demand for energy sustainably, with low carbon dioxide (CO_2) intensity. This will assist in addressing provincial (NL Carbon Plan), Canadian (Pan-Canadian Framework on Clean Growth and Climate Change) and global (Paris Agreement) goals.

Population growth and increases in per capita income are the key drivers behind the growth in energy demand. The global population is predicted to reach 9.7 billion by 2050 (UNDESA 2015) and energy demand is forecasted to increase by 48 percent between 2012 and 2040 (USEIA 2016). The global energy mix continues to shift as the balance of energy demand and supply varies, economies expand and contract, and energy prices fluctuate. There is a continuing need for reliable and sustainable energy supplies.

One of the goals of NL's Energy Plan, "Focusing Our Energy" (Government of NL 2007), was to ensure that there is a secure, reliable, and competitively priced supply of energy for the current and future needs of the people of NL. In 2016, the NL Government launched "The Way Forward: A Vision for Sustainability and Growth in Newfoundland and Labrador" (Government of NL 2016), which will guide its actions to achieve greater efficiency, strengthen the province's economic foundation, enhance services, and improve outcomes to promote a healthy and prosperous province. One of the Government's commitments in this plan was to establish an Oil and Gas Industry Development Council to help position the province globally as a preferred location for oil and gas development. The Government also designated officials to be facilitators for early stage proponents within the mining, oil and gas, and renewable energy sectors.

As an operator, Equinor recognizes that oil and gas will be an important part of the energy mix for decades to come and that global energy systems must be transformed to become more sustainable. Equinor believes a low CO_2 footprint is a competitive advantage, providing the organization with attractive business opportunities in a transition to a lower emission economy. Equinor aims to be a part of a global energy transformation and continue to turn natural resources into energy for people and progress for society. Sustainability management is an integral part of Equinor's overall management system. The implementation of Equinor's sustainability strategy is guided by its Corporate Sustainability Unit and the strategy's progress is measured through performance indicators, which include:

- CO_2 emission reductions (tonnes CO_2)
- Serious oil and gas leakages (per year)
- Well control incidents
- Establishment of country sustainability plans in countries where our operations involve several business entities

Equinor also aims to be recognized as the worlds most carbon-efficient oil and gas producer, committed to creating lasting value for communities. Equinor actively works to reduce air emissions, including CO_2, nitrogen oxide (NO_X), sulphur oxide (SO_x) and non-methane volatile organic compounds (VOCs). Equinor's global strategy is to reduce CO_2 emissions by 3 million tonnes per year by 2030 (Equinor 2018a). Efforts to reduce direct emissions from projects include:

- Improving energy efficiency
- Reducing methane emissions
- Eliminating routine flaring
- Scaling up carbon capture and storage

Equinor works systematically to reduce CO_2 emissions and improve carbon efficiency in our operations and projects under development, including the Project.

The 2018 Generation Energy Council Report, "Canada's Energy Transition, Getting to our Energy Future, Together" (NRCan 2018) outlines four pathways for Canada's energy transition for Canada to reach its low-carbon future goals. One of these pathways is "producing cleaner oil and gas" by shrinking carbon footprint and increasing energy productivity. Equinor's corporate strategy and goals and the Project specifically aligns with Canada's ambitions to improve carbon efficiency in the oil and gas sector.

The 2005 Paris Agreement on climate change provides the prospect of improved policy support around the world for accelerating the shift to low-carbon solutions. Equinor has a key role to play in making this transition work and supports the associated development of viable policies and regulatory frameworks. In 2015, Equinor joined the Oil and Gas Climate Initiative, a voluntary Chief Executive Officer-led group that aims to accelerate and guide the industry's shift towards a low-carbon world.

2.2.1.2 Economic and Social Benefits

The Project will sustain and build on the benefits the offshore oil industry has already delivered to the province. Energy accounts for more of the province's exports than any other sector, and the Department of Finance has estimated that the oil and gas industry accounted for an average of 29.7 percent of the province's gross domestic product (GDP) over the 2010 to 2017 period. It also estimates that the direct and multiplier effects of oil and gas industry activity on the province in 2017 included generating 19,200 person-years of employment, 8.5 percent of the total, thereby reducing the unemployment rate by 2.7 percent (Stantec 2019).

The industry's activities and expenditures were also responsible for an estimated 8.4 percent of household incomes, 9.0 percent of retail sales, and 15.5 percent of housing starts in 2017, and resulted in the province's population being 24,300 larger than it would have otherwise been, by allowing people to stay here and attracting others to move and return to NL (Stantec 2019). In addition, the offshore oil and gas industry has generated billions of dollars in economic activity for the people of NL and Canada through taxes, royalties, and other payments (C-NLOPB 2018a).

The Project will sustain and further build offshore oil activity in the province, contributing to the goals set out in the Government of NL's "Advance 2030 Plan for Growth in the NL Oil and Gas Industry" (Government of NL 2018): multiple basins and projects, increased sustainable operations phase employment, a robust and innovative global supply and service sector, and the integration of oil and gas and renewables in a world-class energy cluster.

Equinor Canada is committed to creating and optimizing opportunities and benefits for NL and Canadian workers and companies as part of its activities and operations in the Canada-NL Offshore Area, and to carrying out its business in full compliance with the Atlantic Accord Acts and other applicable requirements. Through the Framework Agreement between Equinor Canada and the province of Newfoundland and Labrador, the Project will contribute the following:

- Estimated $3.5 billion in government revenue
- 22.3 million person hours of employment or 11,000 person years
- Approximately $300 million in R&D with a minimum of $75 million of that focused on R&D and education with a focus on subsea technology, digitalization, renewable energy solutions and ocean innovation
- Significant investment in new technology to increase the local supply capacity
- Establish an Integrated Operations Center with up to 50 positions in operations, logistics, engineering, health, safety and environment, information technology and other positions
- High-speed data transfer to shore as an enabler of digitalization
- Develop a supply and service forum to dedicate resources that will identify business opportunities and foster operator-supplier collaboration and global competitiveness

Consistent with the Atlantic Accord Acts requirement, before any work or activity is authorized in the Canada-NL Offshore Area, Equinor Canada will submit a Canada-NL Benefits Plan for review and approval of the C-NLOPB. This Plan will identify and describe the measures that will be taken regarding the employment of residents of NL, and other Canadians, further increasing local skills, capabilities, and experience. The Plan will also seek to ensure that manufacturers, consultants, contractors and service companies in the province and other parts of Canada have a full and fair opportunity to participate on a competitive basis in the supply of goods and services, further expanding NL's global supply and service sector.

This direct employment will result in further indirect and induced employment benefits within NL. Overall, the Project will make a major contribution to GDP, expenditures, and employment.

All of this will lead to economic growth and diversification, both by providing work in the oil industry and in other jurisdictions, and by the application of these capabilities in other industries, locally, nationally, and internationally.

2.2.1.3 Community Investment

In addition to the Project-specific environmental, economic, and social benefits for the province and its communities and citizens, Equinor Canada has made investments in youth talent development and the local NL society. The following are examples of Equinor Canada's commitments to local communities in NL:

- ArtsSmart grant program, including annual Equinor Canada ArtsSmart scholarship
- Supporting partner with the annual Marine Advanced Technology Education Centre's annual ROV competition
- Presenting sponsor of the Newfoundland and Labrador Folk Festival; sponsors the Equinor MusicNL NewFound Talent Contest for musicians 19 and under; hosts interactive workshop for youth
- Annual sponsor of Techsploration

2.3 The Bay du Nord and Baccalieu Discoveries

The Core BdN Development is composed of three reservoir intervals within fault-bounded structures called Bay du Nord, Bay de Verde, and Baccalieu (Figure 2-3). The main fault block is the Bay du Nord and Bay de Verde structures. The fault block to the east is the Baccalieu structure. The three stratigraphic units are the Late Jurassic Bay du Nord and Mizzen members and the early Cretaceous Baccalieu member.

The three vertically and laterally stacked reservoirs and multiple fault blocks result in multiple hydrocarbon columns with different oil-water contacts. The reservoir intervals have been penetrated by multiple exploration and delineation wells:

- BdN Member: penetrated by multiple wells with oil found within the BdN C-78 and L-76Z wells, and the Bay de Verde F-67 and F-67Z wells
- Mizzen Member: penetrated by multiple wells with oil found within the BdN C-78, C-78Z, L-76 andL-76Z wells, and the Bay de Verde F-67 and F-67Z wells
- Baccalieu Member: encountered in two wells with oil found in the Baccalieu F-89 well

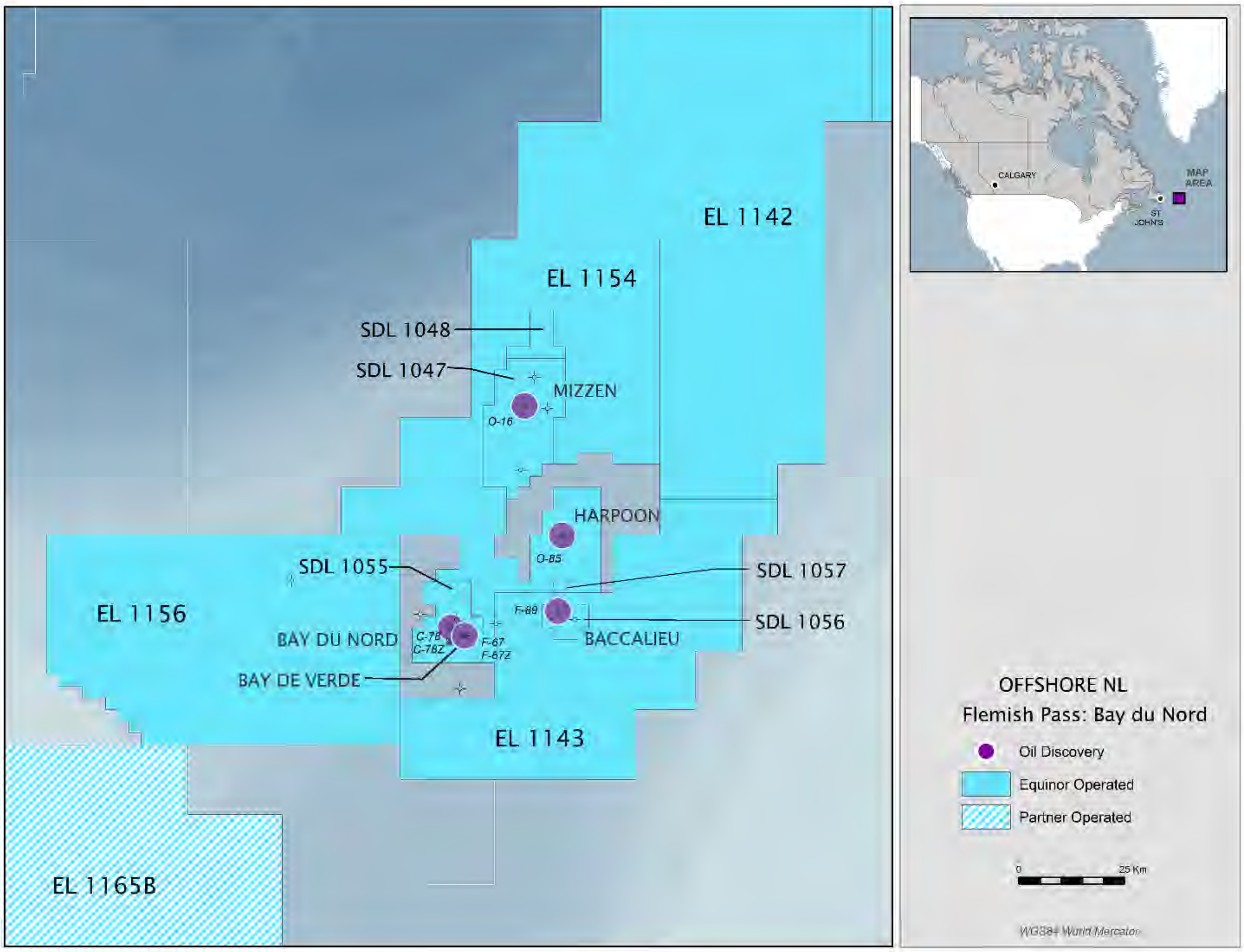


Figure 2-3 Location of the Bay du Nord Development Area

The main subsurface attributes in selecting a development concept include:

- A combination of high and low-quality reservoirs
- No gas cap
- Fluid properties - low solution gas-oil-ratio in a light crude
- High degree of faulting in the BdN field and a low probability of strong aquifer support
- High resource density

The high-quality reservoir in the BdN and Bay de Verde structures will allow for high initial production rates. The Project intends to use produced solution gas for fuel, artificial lift and for injection to displace oil. This is in addition to water injection. As gas is reinjected into the producing interval(s), the field gas-oil ratio will increase prior to decreasing as more gas is consumed for fuel. Development of the Baccalieu field may extend the Project's production plateau.

The field development strategy for the Core BdN Development is currently under evaluation. The field development is expected to include a combination of deviated and horizontal producers, water injectors, and water-alternating-gas (WAG) injectors. Total potential well count (which includes side tracks and pilot wells) for the Core BdN Development ranges from 10 to 40 wells, including five to 20 producing wells and five to 20 injection wells depending on the outcome of ongoing field development evaluations, delineation of the reservoirs through development drilling and evaluation of future improved oil recovery opportunities. The total well count is conservatively estimated to be 40 wells to include the possibility of side-tracks, pilot wells and additional production/injector wells depending on evaluation of improved recovery opportunities.

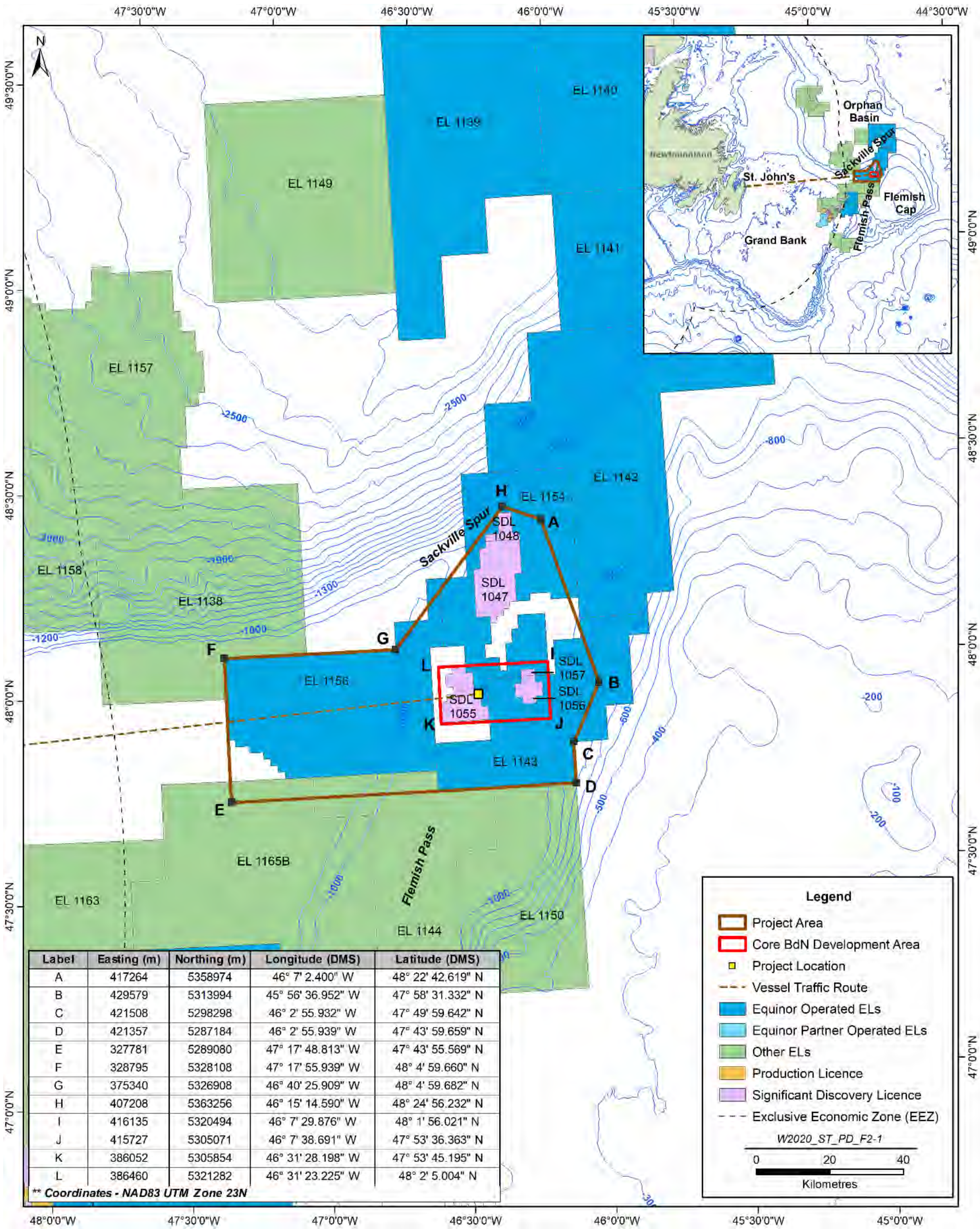
Pilot wells may be required to provide additional information on the reservoir, in particular the assessment of shallow hazards, before development wells are drilled. These wells are typically drilled at depth up to 500 m and within 2 5m of the template location. It is expected that resources will be developed via subsea wells, drilled from subsea templates and tied-back to a floating production installation through subsea flowlines and risers. Refer to Section 2.5 for details regarding Project concept selection and design.

2.4 Project Location

The Project is located in the Flemish Pass area of the Canada-NL Offshore Area, approximately 500 km east-northeast of St. John's, NL.

The Project Area is defined as the overall geographic area within which all planned Project-related components and activities will take place and is based on those aspects that are within the defined scope of the Project for environmental assessment (EA) purposes as detailed in Section 2.1 and Section 4.1. The Project Area includes all or portions of ELs 1143, 1154 and 1156, and SDLs 1047, 1048, 1055 and any SDLs that may be awarded within the foregoing ELs, or ELs that may be renamed on the issuance of SDLs. The Core BdN Development will occur primarily in the area currently defined by SDL 1055, SDL 1056/1057 and EL 1143 and EL 1157, within the Project Area (herein called the Core BdN Development Area). Equinor Canada recognizes that production activities are contingent on the requisite approvals and rights issuance granted by the C-NLOPB and/or governments (refer to Section 1.3).

Figure 2-4 illustrates the proposed Project Area, which is approximately 4,900 km^2 in size. The Core BdN Development Area is approximately 470 km^2. It is important to note that the footprint of the Project facilities on the seabed will, based on the current stage of design, cover approximately 7 km^2. The Project Area coordinates are provided in Table 2.2 and coordinates for the Core BdN Development Area are provided in Table 2.3. Water depths in the Core BdN Development Area range from approximately 1,000 m to 1,200 m, whereas water depths in the broader Project Area range from approximately 340 m to 1,200 m (Figure 2-5).



Label	Easting (m)	Northing (m)	Longitude (DMS)	Latitude (DMS)
A	417264	5358974	46° 7' 2.400" W	48° 22' 42.619" N
B	429579	5313994	45° 56' 36.952" W	47° 58' 31.332" N
C	421508	5298298	46° 2' 55.932" W	47° 49' 59.642" N
D	421357	5287184	46° 2' 55.939" W	47° 43' 59.659" N
E	327781	5289080	47° 17' 48.813" W	47° 43' 55.569" N
F	328795	5328108	47° 17' 55.939" W	48° 4' 59.660" N
G	375340	5326908	46° 40' 25.909" W	48° 4' 59.682" N
H	407208	5363256	46° 15' 14.590" W	48° 24' 56.232" N
I	416135	5320494	46° 7' 29.876" W	48° 1' 56.021" N
J	415727	5305071	46° 7' 38.691" W	47° 53' 36.363" N
K	386052	5305854	46° 31' 28.198" W	47° 53' 45.195" N
L	386460	5321282	46° 31' 23.225" W	48° 2' 5.004" N

*** Coordinates - NAD83 UTM Zone 23N*

Figure 2-4 Project Location and Project Area

Table 2.2 Proposed Project Area Coordinates

Corner Point	Coordinates – NAD 83 UTM ZONE 23N			
	Longitude (DMS)	Latitude (DMS)	Easting (m)	Northing (m)
1	46° 7' 2.400" W	48° 22' 42.619" N	417264	5358974
B	45° 56' 36.952" W	47° 58' 31.332" N	429579	5313994
C	46° 2' 55.932" W	47° 49' 59.642" N	421508	5298298
D	46° 2' 55.939" W	47° 43' 59.659" N	421357	5287184
E	47° 17' 48.813" W	47° 43' 55.569" N	327781	5289080
F	47° 17' 55.939" W	48° 4' 59.660" N	328795	5328108
G	46° 40' 25.909" W	48° 4' 59.682" N	375340	5326908
H	46° 15' 14.590" W	48° 24' 56.232" N	407208	5363256

Table 2.3 Proposed Core BdN Development Area Coordinates

Corner Point	Coordinates – NAD 83 UTM ZONE 23N			
	Longitude (DMS)	Latitude (DMS)	Easting (m)	Northing (m)
I	46° 7' 29.876" W	48° 1' 56.021" N	416135	5320494
J	46° 7' 38.691" W	47° 53' 36.363" N	415727	5305071
K	46° 31' 28.198" W	47° 53' 45.195" N	386052	5305854
L	46° 31' 23.225" W	48° 2' 5.004" N	386460	5321282

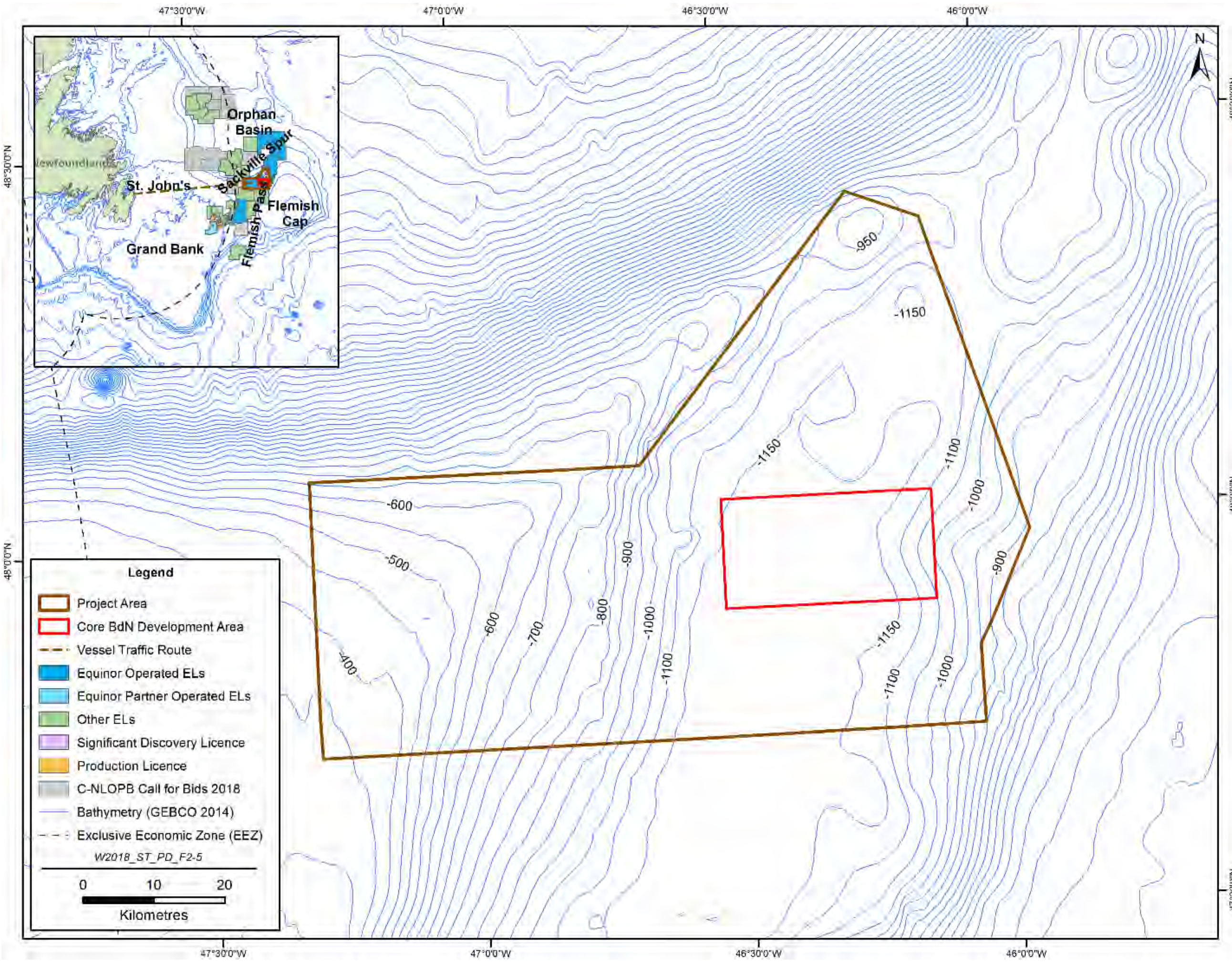


Figure 2-5 Bathymetry of Project Area

The "geographic coordinates" for the proposed location of the production installation are provided in Table 2.4. Note, Project design is ongoing, and these coordinates may change. If the coordinates do change, the location would likely remain within the Core BdN Development Area and certainly within the broader Project Area described above.

Table 2.4 Preliminary Location – Production Installation

Center Point Coordinates– NAD 83 UTM ZONE 23N			
Longitude (DMS)	**Latitude (DMS)**	**Easting (m)**	**Northing (m)**
46° 23' 0.887" W	47° 57' 49.647" N	396720	5313202

Equinor Canada has majority interests in other ELs and SDLs in the area of the Project (Figure 2-4) with Project Area Tiebacks. As stated above, the Project Area includes lands adjacent to the Core BdN Development Area. Should future resource potential be discovered in these areas, they could be developed and produced from the Project's existing production installation through the addition of subsea tiebacks (well templates connected back to existing production installation through flowlines, umbilicals). Based on current technology, tiebacks to the production installation and/or existing well templates may be feasible up to a distance of approximately 40 km. These adjacent licences are included in the Project Area given the potential for tiebacks.

2.4.1 Resource Use and Environmental Features

Resource use in and near the Project Area is characterized by commercial fishing and oil and gas exploration activities. Detailed information on commercial fishery activity within the Project Area is presented in Section 7.1and other petroleum-related marine activities are described in Section 7.2. The Project Area overlaps parts of Northwest Atlantic Fisheries Organization (NAFO) Unit Areas 3Li, 3Le and 3Ma. The primary harvested species (directed or as by-catch) in or near the Project Area include groundfish, such as redfishes, Greenland halibut (turbot), Atlantic cod, and American plaice (refer to Section 7.1). While various Indigenous groups hold commercial-communal fishing licences in NAFO Divisions 3L and 3M (see Section 7.3.8.1), including licences for swordfish and tuna, since DFO datasets do not distinguish between commercial and commercial-communal licensees, the current extent of commercial-communal fishing activity in the Project Area is not known. However, there is no reported commercial-communal fishing in the Core BdN Development Area and no reported domestic landings of swordfish or tuna from the Project Area between 2011 and 2016 (see Section 7.1.6.4). There are no documented food, social, or ceremonial (FSC) licences held by Indigenous groups within or in the vicinity of the Project Area and no known current use of lands and resources for traditional purposes by Indigenous peoples in the Project Area. Oil and gas exploration and production activities are the other main resource uses in the region; related activities include geophysical surveys and exploration drilling. Existing oil and gas production operations are located on the Grand Banks, offshore NL. The closest operating offshore oil and gas production facility is White Rose, which is approximately 180 km to the southwest of the proposed Core BdN Development Area. Terra Nova is approximately 230 km southwest, and Hibernia and Hebron are approximately 225 km southwest of the Core BdN Development Area.

Other activities may also take place in the region. General shipping traffic, fisheries survey programs undertaken by Fisheries and Oceans Canada (DFO) and/or industry, marine research surveys conducted by government and / or educational institutions, and naval training exercises are the primary examples. There are several marine cable networks in the region including a fibre optic cable network connecting the Hibernia and Hebron Platforms to the Avalon Peninsula. There is no other major existing infrastructure within or near the Project Area.

Chapter 12 provides an overview of special areas within the Local Study Area. In summary, the Core BdN Development Area overlaps with one NAFO Fisheries Closure Area (FCA) (i.e. Northwest Flemish Cap (10), one Ecologically and Biologically Significant Area (EBSA) (i.e., Slopes of the Flemish Cap and Grand Bank) identified by the United Nations Convention on Biological Diversity (UNCBD) and one Vulnerable Marine Ecosystem (VME) identified for the presence of sea pens. The Project Area overlaps with the same special areas as the Core BdN Development Area, as well as four other VMEs (three identified for sponges and one for large gorgonian corals). As the Project Area is completely outside of the Canadian Exclusive Economic Zone (EEZ), it does not intersect with any provincial or federal special areas. This includes EBSAs, which have been identified by DFO and redefined so that they no longer extend beyond the EEZ. Section 6.4 provides additional details on special areas.

2.5 Project Concept and Design

The following sections provide an overview of the preferred concept and design basis for the development of the Core BdN Development.

2.5.1 Concept Selection - Alternative Means of Offshore Development

As required under Section 3.2 of the Project-specific Environmental Impact Statement (EIS) Guidelines (Appendix A) and paragraph 19(1)(g) of the *Canadian Environmental Assessment Act 2012*, alternative means of carrying out the project that are technically and economically feasible, and associated environmental effects, are required to be considered.

In assessing a concept for the development of oil and gas in the Flemish Pass, the chosen concept had to meet certain criteria and standards. There are a number of development options used globally that were considered as potential options for the Core BdN Development. Equinor Canada evaluated each option according to the following factors:

- Water depth – approximately 1,200 m
- Distance offshore – approximately 500 km
- Minimum distance to existing offshore facilities – approximately 180 km
- Ability to store crude and offload to shuttle tankers offshore
- Ability to disconnect
- Protection from ice

The following alternative production installations were evaluated based on the above criteria:

1) Floating production, storage and offloading (FPSO)
2) Gravity base structure (GBS)
3) Tension-leg platform (TLP)
4) Semi-submersible platform
5) Spar platform with storage
6) Spar platform without storage

2.5.1.1 Floating Production Storage and Offloading Facility

FPSO facilities can process, store and offload crude oil from a single installation. Stand-alone drilling installation(s) would be required to drill the development wells. FPSOs are common installations used offshore either in shallow or deep water locations, and therefore could be suitable for the water depths in the Core BdN Development Area. While the FPSO would be moored in place, it would have the ability to disconnect and transit as a marine vessel in the event of a potential iceberg encroachment, extreme weather event, or if required for other purposes such as shore-based maintenance. The hull of the FPSO can be ice-strengthened to protect against ice. Stored crude oil can be offloaded to shuttle tankers. Decommissioning costs associated with a FPSO tend to be lower than other options as the FPSO can be easily moved off location. Decommissioned FPSOs could also be used in other locations or re-purposed for other marine use. Overall, an FPSO is technically and economically favourable compared to other options.

Potential environmental interactions associated with this option include, but are not limited to:

- Installing subsea infrastructure (e.g. moorings/anchors, flowlines)
- Atmospheric emissions
- Sound emissions
- Light emissions
- Flaring
- Marine discharges (e.g. produced water, cooling water, deck drainage)
- Accident events (e.g. spills)

2.5.1.2 Gravity Based Structure with Topsides

A GBS is typically a concrete structure which has direct contact with the seabed and is fixed in location. GBS installations are suitable for shallower locations (e.g. the Hebron GBS installation in the Jeanne d'Arc Basin, with a water depth of approximately 93 m [EMCP 2015]). Drilling and production activities can occur from a GBS installation. A GBS is typically unsuitable for deeper waters, such as those present in the Core BdN Development Area. For instance, the Troll A platform, located off the west coast of Norway, has a GBS substructure of 376 m. This GBS is the tallest concrete GBS platform in the world and is also considered one of the tallest structures moved by humans (Kvaerner n.d.). With a water depth of approximately 1,200 m, it is, therefore, technically not feasible to use a concrete GBS for the deep waters of the Core BdN Development. In terms of economic considerations, costs associated with constructing a concrete GBS for deep waters would be greater than the other options considered.

The potential environmental interactions associated with a GBS are similar to those related to the FPSO as listed above in Section 2.5.1.1, however, the footprint of a GBS constructed for a 1,200 m water depth would be likely be significantly larger compared to GBS installations currently operating offshore NL.

2.5.1.3 Tension Leg Platform

TLPs are suitable for deep water locations ranging from 300 m to 1,500 m, and therefore could be suitable for the deeper waters of Core BdN Development Area. TLPs have four buoyant pontoon-like pillars that support the topsides and are vertically moored to a foundation installed on the seabed. However, they do not have the ability to disconnect and relocate in the event of a potential iceberg encroachment. This type of installation is particularly suitable for hurricane-prone areas, such as the Gulf of Mexico, due to limited vertical movement. TLPs do not have on-board storage, and crude is typically transported via flowlines to other offshore installations or shore-based facilities. There would likely be a substantial amount of subsea infrastructure and associated protection measures (e.g., installing rock protection or concrete mattresses) required to transfer crude from a TLP at the Core BdN Development Area to shore (approximately 500 km) or to an existing production installation (at least 180 km). TLPs are therefore not technically, nor economically feasible as an option for the Core BdN Development.

The potential environmental interactions associated with TLPs are similar to those related with the FPSO discussed above in Section 2.5.1.1. However, installation of additional flowlines to carry crude and protection measures for those flowlines would likely have additional environmental interactions in terms of fish and fish habitat.

2.5.1.4 Semi-Submersible Platform

Semi-submersible platforms are suitable for deep water locations ranging from 300 m to 3,000 m, and therefore could be suitable for the water depths in the Core BdN Development Area. Semi-submersible platforms have buoyant pontoons and are moored to the seabed. They do not have the ability to disconnect and relocate in the event of a potential iceberg encroachment or extreme weather event. Semi-submersibles do not have on-board storage, and crude is typically transported via flowlines to other offshore installations or shore-based facilities. As noted above for TLPs in Section 2.5.1.3, this would require a substantial amount of subsea infrastructure and protection measures. Semi-submersible platforms are therefore not technically, nor economically feasible as an option for the Core BdN Development.

The potential environmental interactions associated with semi-submersibles are similar to those related to TLPs discussed above, including likely increase interactions with fish and fish habitat.

2.5.1.5 Spar Platform with Storage

Spar platforms are suitable for deep water locations ranging from 300 m to 3,000 m, and therefore may be suitable for the deeper waters of Core BdN Development Area. Spar platforms have a hollow cylindrical hull that is typically submerged into approximately 200 m of water. Spar platforms are similar to TLPs, but they have more conventional mooring systems. Spar platforms can move horizontally by adjusting the tension of mooring lines, however, horizontal movement is limited, and therefore do not have adequate capability to relocate in the event of a potential iceberg encroachment or extreme weather event. This type of installation is particularly suitable for hurricane-prone areas, such as the Gulf of Mexico, due to increased stability. Unlike semi-submersibles and TLPs, spar platforms can be designed to store crude. The hull is a hard tank that provides buoyancy and variable ballast control, the middle tank can be used for crude storage, and an additional tank can be used for ballast control. Spar platforms with storage typically use an oil-water displacement method for crude storage, which is an open system and has the potential to discharge oily water residue to the marine environment. Since a spar platform with storage is not readily mobile, it would need to be designed to withstand iceberg impacts. A spar designed and constructed to withstand iceberg impacts is not an economically feasible option for the Core BdN Development.

The potential environmental interactions associated with a Spar with storage are similar to those related to the FPSO discussed above in Section 2.5.1.1.

2.5.1.6 Spar Platform without Storage

A Spar platform without crude storage is similar to a Spar platform with storage, as discussed in Section 2.5.1.5, however, the potential environmental effect associated with the open crude storage system is not applicable.

Since there is no crude storage capability, and as discussed for the TLP and semi-submersible options, crude oil would have to be transported via flowlines to a storage vessel or to an onshore storage facility requiring substantial subsea infrastructure. Spar platforms without storage are therefore not technically or economically feasible as an option for the Core BdN Development.

The potential environmental interactions associated with Spar platforms without storage are similar to those related to the TLPs including likely increased interactions with fish and fish habitat.

2.5.2 Preferred Concept

The alternative means analysis for a production installation was based on the criteria outlined in Section 2.5.1 and considered the technical and economic feasibility of the option. The potential environmental interactions associated with each option were also taken into consideration.

Environmental effects associated with the FPSO are comparable to the GBS and Spar with storage. All other options were determined to have a greater potential environmental effect. Table 2.5 provides a summary of the technical and economic feasibility and environmental interactions of each option discussed above.

Table 2.5 Summary of Analysis of Alternative Means of Production Installation Concept Selection

Alternative Considered	Technical Feasibility	Economic Feasibility	Environmental Interactions
FPSO	Green	Green	Green
GBS	Red	Red	Green
TLP	Red	Red	Yellow
Semi-submersible	Red	Red	Yellow
Spar with storage	Yellow	Red	Green
Spar without storage	Red	Red	Yellow

Green – all criterial met; low environmental interactions
Yellow – not all criteria were met; intermediate environmental interactions
Red – no criteria were met; highest environmental interactions

Based on the above criteria and assessment of options, the FPSO with subsea development is the preferred development concept for the Core BdN Development. This EIS therefore considers the potential effects of the Core BdN Development with an FPSO as the production installation. The following sections provide an overview of the design criteria for the Project.

2.5.3 Project Design

The Core BdN Development is currently at a conceptual stage of planning, which means that details regarding Project design, reservoir management and production operations are under consideration. The following overview is a conceptual plan, which will be refined as the design progresses.

An overview of the design basis for the Core BdN Development is provided in Table 2.6. These design criteria may change as the reservoir depletion strategy and initial development phase are finalized. The design basis values listed are representative of peak production and provides for ranges in design criteria to allow for optimization to Project design. The EIS will, therefore, use the upper limit of these ranges in the associated environmental effects assessment.

Table 2.6 Bay du Nord Project – Design Basis

Component	Core BdN Development	Project Area Tiebacks
Facilities Design Life	25 to 30 years	Same as Core BdN Development
Field Life	12 to 20 years	Extension of core field life to maximum of 30 years
Area	Core BdN Development Area, see Figure 2-1	Project Area, including the Core BdN Development Area - see Figure 2-1
Project Area Water Depth (m)	1,000 to 1,200	340 to 1,200
Crude Oil Properties	approximately 35 API	Same as Core BdN Development
Production Installation		
FPSO	FPSO	Tie back to existing FPSO or to existing well template infrastructure
Crude Oil Production (m^3/d)	15,000 to 30,000	Maximum rates will be the same as Core BdN Development
Crude Oil Storage (m^3)	approximately 160,000	Maximum rates will be the same as Core BdN Development
Water Production (m^3/d)	30,000 to 50,000	Maximum rates will be the same as Core BdN Development
Cooling Water Intake (m^3/d)	20,000 to 80,000 High uncertainty as design is ongoing	Maximum rates will be the same as Core BdN Development
Seawater Injection (m^3/d)	32,000 Based on design capacity	Maximum rates will be the same as Core BdN Development
Gas Production (MSm^3/d)	2.0 to 2.8	Maximum rates will be the same as Core BdN Development
Gas Injection (MSm^3/d) (All gas not used as fuel)	2.5	Maximum rates will be the same as Core BdN Development
Fuel Gas (MSm^3/d)	0.1 to 0.3	Maximum rates will be the same as Core BdN Development
Crude Offloading Rate (m^3/hr)	Up to 8,000	Maximum rates will be the same as Core BdN Development

Table 2.6 Bay du Nord Project – Design Basis

Component	Core BdN Development	Project Area Tiebacks
Flaring Estimates (Sm^3/d) – low-pressure flare gas recovery assumed; non-routine/safety flaring only; start up rates may be higher	3,000 to 5,000 (average) May be higher in first year production	Maximum rates will be the same as Core BdN Development
Construction and Installation, and HUC		
Activities	Seasonal over 3 to 5 years	As required, depending on need for tiebacks
Subsea Infrastructure		
Subsea Well Templates, (combination of 4-slot, 6-slot and 8-slot templates and individual satellite wells) connected to FPSO via flowlines installed on seafloor	3 to 10	1 to 5, either connected back to FPSO or existing well template infrastructure
Riser Base	Up to 4	Number may increase depending on number of tiebacks
Drilling		
Total Number of Wells	Maximum 40 wells (including pilot wells and side tracks)	Up to an additional 20 wells
- Production Wells	5 to 20	Estimate 10 producers
- Injection Wells	5 to 20	Estimate 10 injectors Unknown
Supporting Surveys		
Activities	As required year-round, throughout life of Core BdN Development	As required year-round throughout extended life of Project

2.5.3.1 Production Installation

The proposed development concept is comprised of subsea installations tied back to a FPSO for crude production and storage and offshore offloading to shuttle tankers. Design is in the early stages and the information provided below may change as design progresses.

The FPSO will have the capacity to handle the requirements outlined in Table 2.6 including crude oil production, storage and export, gas management, water injection, and the management of produced water and other wastes for a production life of 30 years.

To operate in the Canada-NL Offshore Area, pursuant to the *Newfoundland Offshore Certificate of Fitness Regulations* under the Accord Acts and the C-NLOPB Operations Authorization (OA) requirements, the production installation requires a Certificate of Fitness to be issued from a recognized independent third-party Certifying Authority (CA). The purpose of this additional certification is to provide independent third-party assurance and verification that the production installation is fit for purpose, functions as intended, and remains in compliance with the regulations without compromising safety and polluting the environment

There will be no routine flaring from the production process. Flare gas from continuous low-pressure sources (e.g., produced water degassing, crude oil heater and gas from cargo tanks being displaced during production) will be recovered back to the process. This will eliminate the emissions associated with routine flaring. A pilotless flare design to reduce air, light and heat emissions typically experienced from a continuous pilot flare is currently being considered. Safety and regulatory compliance aspects will also need to be evaluated for the final flare design selection.

FPSO Design – Hull and Turret

Based on current design, the FPSO hull will support topsides process facilities, helideck, accommodations, life saving equipment and flare tower. The FPSO is connected to the mooring via the turret. Flowlines and umbilicals are tied-in via the turret. The FPSO will be designed to operate in the harsh environmental conditions of the Flemish Pass and to withstand (as a minimum) the loads and motions imposed by the following:

- The 100-year return period, extreme environmental conditions
- Sea ice and icebergs (ice-strengthening based on detailed analysis)

The following design goals for the FPSO are considered the minimum requirements to obtain safe and effective operations over the life of the field:

- Vessel and moorings designed in accordance with rules of a recognized Classification society and applicable regulations
- FPSO shall be of a disconnectable design
- Hull designed to withstand possible collision loads from vessels servicing the field and other vessels operating in the area
- Vessel motions designed to ensure safe and efficient operation of the vessel and have no significant adverse effect on production operations
- Vessel intact and damage stability will comply with classification society and flag state requirements
- Adequate propulsion for maneuvering to avoid icebergs after disconnection from mooring and riser system
- Corrosion protection for steel hull and turret for the full design life

Figure 2-6 is an illustration of the currently proposed FPSO for the Project.

Figure 2-6 Illustration of the Proposed BdN FPSO

Hull Marine Systems

Based on current design, marine systems integrated within the hull will likely include the following:

- Cargo handling system including discharge pumps and stern discharge system
- Ballast water handling
- Propulsion
- Hull power distribution
- Fire and gas detection system
- Firefighting system / pumps for machinery spaces and accommodation, cargo area and topside
- Inert gas system
- Cargo tank gas freeing system
- Crude oil washing system / tank cleaning
- Cargo tank level gauging
- Ballast tank level gauging
- Ballast tank hydrocarbon gas detection system
- Cargo tank heating system
- Fresh water and potable water production
- Sewage treatment system
- Oily water treatment system
- Seawater lift pumps
- Electrical power generation
- Boiler for steam and hot water production
- Fuel gas distribution system

- Potable and service water tanks
- Escape, evacuation, and rescue facilities
- Jet fuel storage
- Diesel fuel storage
- Hydraulic power units
- Heating, ventilating and air conditioning
- Full navigation bridge
- Chemical storage
- Compressed air and other utilities as required
- Telecommunications equipment

Turret

The turret maintains the position of the FPSO. It is comprised of two connectable pieces, a buoy moored to the seabed and the turret structure (geostationary and ship stationary components). The turret will be designed to meet specific operational requirements in terms of ability to disconnect; provide support, connection and maintain integrity for risers, umbilicals and power cables; and rotation/position maintenance of the FPSO.

The FPSO is connected to the mooring via 12 mooring lines from the turret. Depending on weather conditions, thrusters may be used to reduce tension of mooring lines, therefore thruster use will be intermittent throughout the year.

Crude Storage and Offloading

The FPSO will have tandem offloading to a shuttle tanker. The offloading system will be used to offload the oil from the FPSO storage tanks onto a shuttle tanker. Oil loading will be via a flexible hose floating on the water from the stern loading system of the FPSO to the bow loading system on the shuttle tanker. Hose length is estimated to be approximately 100 m. Crude will likely be offloaded at a rate of approximately 8,000 m^3/hr.

FPSO Topside Process Facilities

The main processing facility and associated process utilities will likely be comprised of the following:

- Separation system
- Gas compression and injection system
- Water injection system
- Oily water treatment system
- Flare system, including flare gas recovery
- Cooling water system
- Fire protection system
- Open and closed drains
- Fire and gas detection system
- Corrosion protection system

- Control and monitoring systems
- Chemical storage and injection
- Topsides electrical distribution system

Flare System

A flare tower will be provided to ensure the safe release and burning of hydrocarbons, as required. Current design options include a segregated flare system that includes a high-pressure (HP) and a low-pressure (LP) system. Pilot options for the HP / LP flare systems (continuous pilot versus pilotless) are under evaluation. The HP flare is for non-routine / safety flaring. Under normal operating conditions, no gas is flared via the HP flare. Primary sources of gas to the LP flare system would be produced water degassing and vapours generated in the cargo tanks. Gas from the LP flare system will be recovered during normal operations.

The flare will have a high-efficiency burner. Since it is early in the planning stages of the Project, the burner supplier has not been selected, and therefore the rating is not available at this time. However, most suppliers have their own burner technology that has been tested and quantified for liquid fallout (i.e., oil phase) and emissions. Documented fallout and combustion efficiencies for burners on the market from major supplies are typically 99.9 percent. Additional information on flaring is provided in Section 2.7.1.4.

Accommodations

Based on current design, accommodations are currently located at the stern FPSO. The hydrocarbon processing units will be located furthest away from the accommodation unit as is possible. The FPSO will be designed to accommodate a maximum of approximately 110 personnel. However, maximum personnel offshore would likely only occur during commissioning, turnaround and high-level maintenance activities. During normal operations, the number of personnel on board are expected to be significantly less than the maximum of approximately 110. Utilities, such as the galley, food storage areas, change rooms and laundry, potable water and sewage treatment will be sized accordingly. Other facilities provided will include office, recreational, medical centre, and entertainment amenities.

Helideck

The helideck will be designed to comply with governing legislation and will be capable of accepting loads from search and rescue helicopters. Refueling facilities will be installed.

Mechanical Handling

Offshore rated cranes of sufficient type and number will be provided to allow safe and efficient re-supply, operation and maintenance of the FPSO.

Telecommunications

Telecommunications systems, to provide communication between the FPSO and onshore support, will be provided either through a fibre optic cable or satellite communications. Options for fibre optic cable include installing a dedicated system from shore or connecting to an existing offshore marine fibre optic cable system. Since it is early in the planning of the Project, the routing of a potential fibre optic cable has not been determined. If a fibre optic cable is installed from the island of Newfoundland at the closest point, it would be approximately 500 km in length.

2.5.3.2 Subsea Infrastructure

Subsea infrastructure will likely consist of the following:

- Well templates with wellhead and wet trees (production, water and gas injection)
- Production and water injection manifolds
- Flowlines (gas injection, production, water injection)
- FPSO / turret moorings
- Riser bases
- Umbilicals
- Fibre optic cable

Subsea infrastructure will be designed to operate in deep water, as maximum water depths in the Core BdN Development Area and Project Area are approximately 1,200 m.

For the subsea development component, drilling will be conducted within subsea well templates from either a drillship or a semi-submersible drilling unit. Well templates will include all infrastructure and equipment necessary for the safe and efficient operation and control of the subsea wells and transportation of production and injection fluids (subsea system). They may be housed to provide protection against dropped objects or other external interference. Current design plans for subsea development consists of multiple wet tree developments with production, water, and gas injection wellheads; flowlines; risers and subsea infrastructure, grouped together in well templates. Between three and 10 well templates, with a combination of 4-slot, 6-slot and 8-slot templates, and/or individual wells are currently planned. Due to the water depth in the Core BdN Development Area, there is no plan to use excavated drill centres for iceberg protection, such as those that are used in the shallower Jeanne d'Arc Basin area, to house the subsea well equipment.

The flowline corridors will include a production flowline, a water injection flowline, gas injection flowline and umbilicals. Each flowline/umbilical will need a corridor of approximately 10 m between each flowline for a total width of the corridor of approximately 30 m to 40 m.

Well templates may be 4-, 6-, and/or 8-slot templates. A 4-slot template is approximately 24 m (length) x 21 m (width) x 17 m (height), whereas an 8-slot template is 48 m (length) x 21 m (width) x 17 m (height). Figure 2-7 is an illustration of subsea well templates used for other projects and do not necessarily represent well template design for the Project.

Figure 2-7 Illustration of Representative Subsea Well Templates – 4-slot (left) and 8-slot (right)

Figure 2-8 provides a schematic of a layout of typical subsea development and is representative of the proposed Core BdN Development.

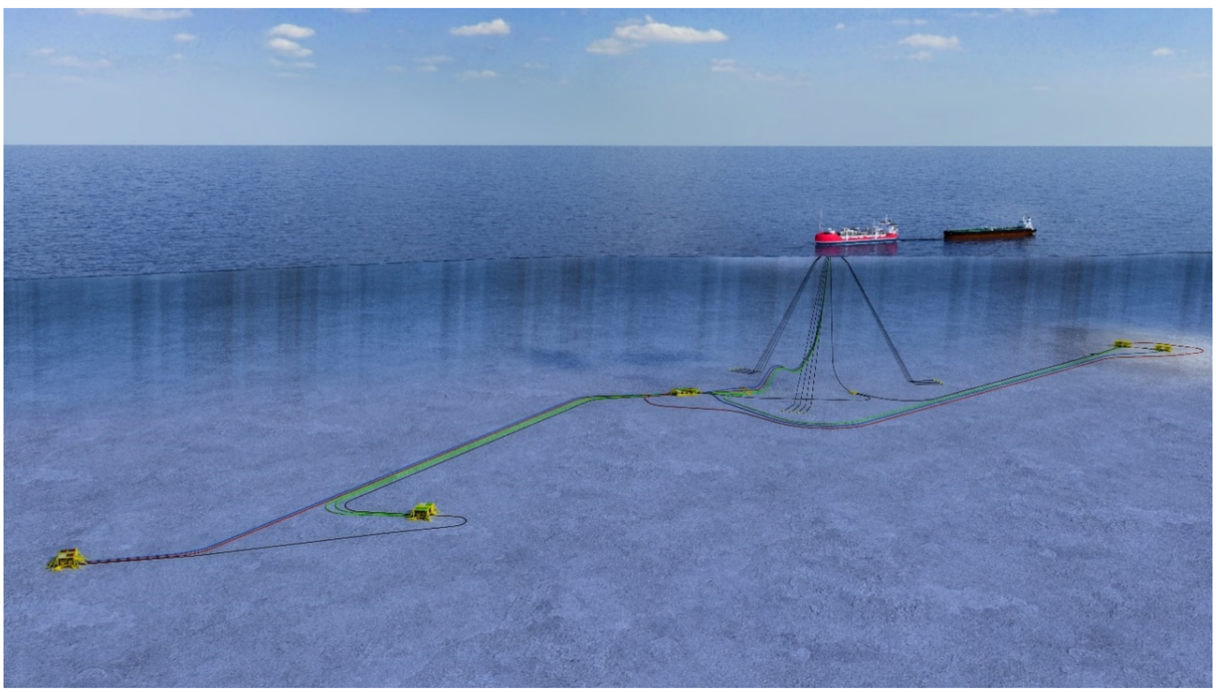


Figure 2-8 Illustration of a Typical Subsea Development - Representative of the Core BdN Development (Not to Scale)

2.5.3.3 Drilling Installation

Wells will be drilled and completed using one or more drilling installations suitable for year-round execution in environmental conditions of the Project Area. Drilling activities may be undertaken by either a floating semi-submersible or a drillship, depending on availability and operability offshore

NL. As drilling installations are procured through a competitive bid process, the type of installation is not known at this point. A schematic of a semi-submersible and drillship is provided in Figure 2-9. For the purposes of the EA, including the assessment of cumulative effects, the effects assessment considers the operation of up to two drilling installations actively engaged in drilling activities in the Project Area at any one time. The following sub-sections provide summaries of each type of unit along with an example of a semi-submersible (West Hercules) and a drillship (Stena Carron) that have previously been used in the Canada-NL Offshore Area. They are provided as examples for EA purposes only as Equinor Canada has yet to contract a drilling installation for the Project.

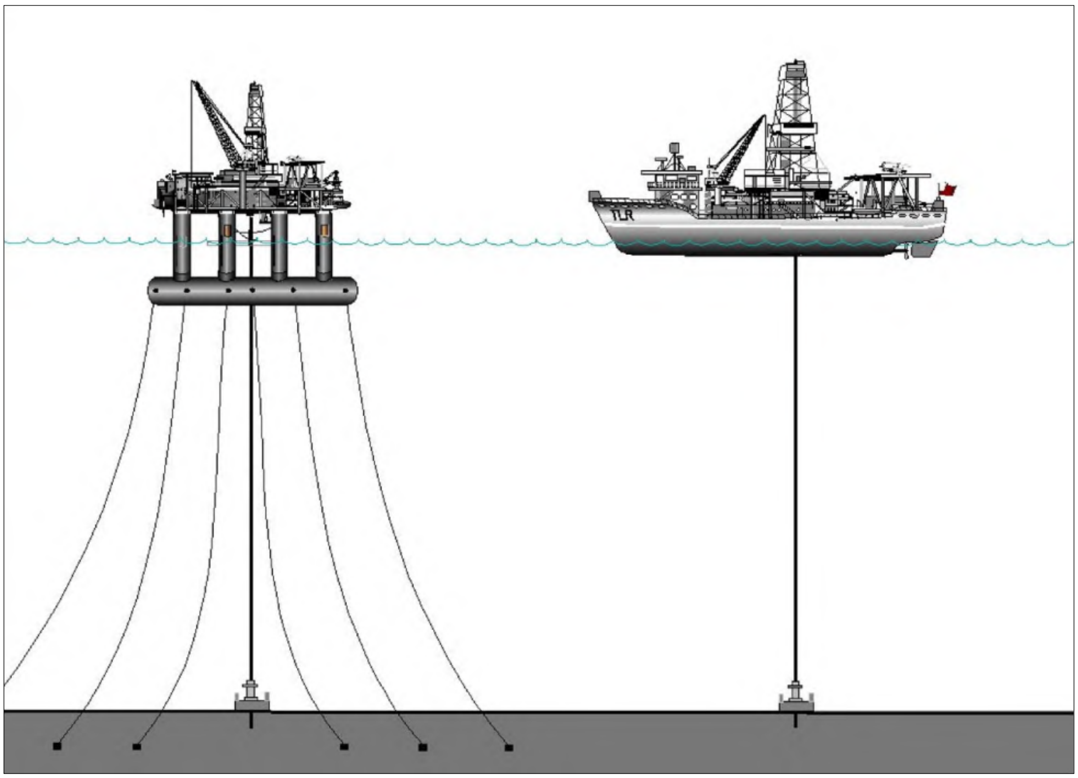


Figure 2-9 Schematic of an Anchored Semi-submersible and a Drillship

Drilling Installation Selection and Regulatory Approval Process

Equinor Canada's drilling installation selection process includes consideration of several factors: drilling target depth, water depth at drilling location, oceanographic and meteorological conditions, and technical capability. The drilling installation must be winterized as year-round drilling will be undertaken. Equinor's global drilling installation intake process includes confirmation that the contracted drilling installation conforms to company practices and industry standards. To operate in the Canada-NL Offshore Area, pursuant to the *Newfoundland Offshore Certificate of Fitness Regulations* under the Accord Acts and the C-NLOPB OA requirements, a drilling installation requires a Certificate of Fitness to be issued from a recognized independent third-party CA. The purpose of this additional certification is to provide independent third-party assurance and verification that the drilling installation is fit for purpose, functions as intended, and remains in compliance with the regulations without compromising safety and polluting the environment.

For drilling installations operating in the Canada-NL Offshore Area, Equinor Canada requires that the drilling installation meet certain specifications as indicated in the list below:

- Dynamic Positioning (DP) system
- Drilling derrick
- Ballast control
- Power system
- Storage for drilling materials and equipment - including fuel oil, drilling muds, cement and tubulars
- Storage of reagents used for drilling - these may include bulk cement, bulk bentonite / barite, and liquid muds
- Storage for subsea equipment - including well control equipment and marine risers
- Accommodations – typically can accommodate up to 160 persons
- Waste management facilities- including the treatment of wastes for offshore disposal and temporary storage of waste for shipment to shore.
- Helideck with refueling capabilities
- Cranes
- Emergency and life-saving equipment, including lifeboats and rafts for emergency evacuation
- Water- supply / storage of drinking water and/or processing water system

Semi-submersible Drilling Installation

A semi-submersible consists of vertical pillars extending up from a horizontal system of pontoons to an upper deck. The upper deck contains drilling equipment, other equipment and material storage areas, and personnel quarters. Semi-submersible drilling installations can either be moored in position over the drilling site using mooring lines and anchors (generally in water depths < 500 m) or maintained on station by a DP system (generally in water depths > 500 m). In DP mode, position is maintained by the drilling installation's thrusters, controlled by a computerized DP system and acoustic positioning system. Energy signals are sent from the acoustic positioning system to transponders (receivers) on the seafloor and back to the drilling installation. This system improves underwater positioning accuracy and redundancy to keep the drilling installation on position. The positioning maintenance method is typically determined based on the location of the well and the water depth. Figure 2-10 is a photo of the West Hercules, a semi-submersible that has operated in the Canada-NL Offshore Area.

Source: Seadrill (2017)

Figure 2-10 West Hercules – Example of a Semi-Submersible

Drillship

A drillship is a self-propelled ship-shape drilling installation with larger storage capacity than a semi-submersible for drilling ultra-deep water wells. Drillships, like semi-submersibles, also use DP systems to maintain position at the well site and to rotate the ship into prevailing weather. Figure 2-11 is a photo of the Stena Carron, owned by Stena Drilling and which has operated in the Canada-NL Offshore Area.

Source: Stena Drilling (2017)

Figure 2-11 Stena Carron - Example of a Drillship

2.5.4 Safety and Anti-Collision Zones

The subsea infrastructure will be demarcated by a safety zone, pursuant to the *Offshore Petroleum Drilling and Production Regulations* (O.C. 2009-386). The safety zone does not prohibit entry by other ocean users; it is a zone in which the operator (Equinor Canada) has a duty to take reasonable measures to warn persons who are in charge of vessels and aircraft of the safety zone boundaries, of the facilities within the safety zone and of any related potential hazards (e.g., the presence of subsea infrastructure). In accordance with the *Newfoundland Offshore Petroleum Drilling and Production Regulations,* the safety zone extends 500 m from the edge of the installations. The safety zone will surround all subsea infrastructure, the FPSO and its moorings, and the drilling installation. The safety zone will be established as subsea infrastructure is installed on the seafloor. The safety zone is approximately 30 km².

In accordance with Canadian and International maritime regulations, an anti-collision zone will be established within the safety zone around the FPSO and its anchors, and the drilling installation when on-site. Vessels are not permitted within the anti-collision zone without the permission of the Offshore Installation Manager (OIM). This zone will extend 50 m from the anchor pattern of the FPSO and 500 m from the drilling installation when using a DP system. It will be approximately 8.5 km² for the FPSO and 1 km² for drilling installation.

Figure 2-12 provides a schematic of the proposed safety zones and anti-collision zone based on current Project design. Communications regarding the safety zone and anti-collision zone will be sent out to mariners via the Canadian Coast Guard navigational warning (NAVWARN) and via Notice to Mariners (NOTMAR). The coordinates will be provided to Canadian Hydrographic Services, NAFO and One Ocean.

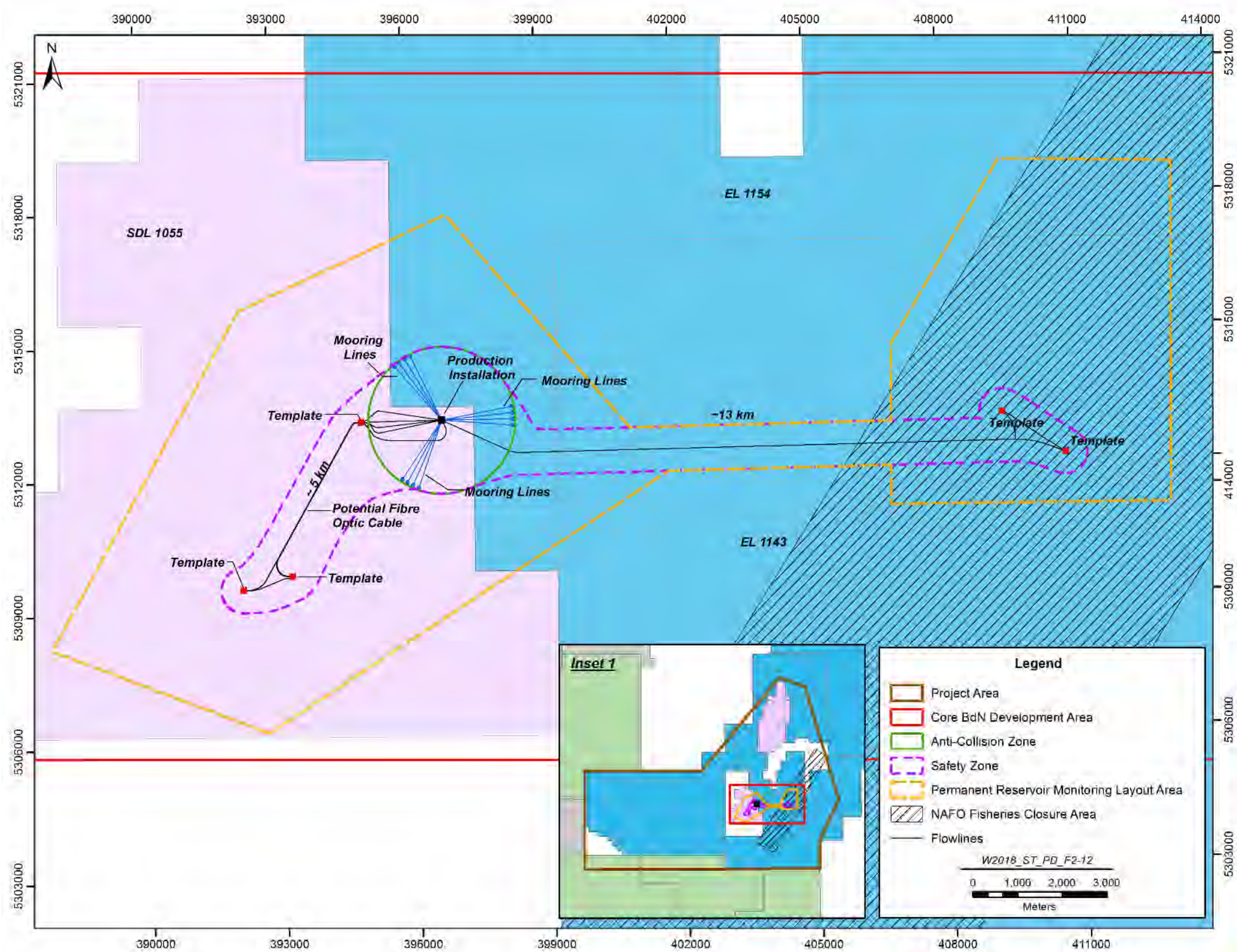


Figure 2-12 Proposed Project Conceptual Safety Zone and Anti-Collision Zone – Core BdN Development Area

2.5.5 Project Personnel

Professional, technical, and administrative staff will be required onshore in the Equinor Canada St. John's, NL office and offshore for the FPSO and drilling installation. As described in Section 2.5.3.1, the FPSO will be designed to accommodate a maximum of approximately 110 personnel. For drilling operations, the drilling installation contractor employs most of the personnel associated with a drilling program. Typically, between 120 to 160 persons may work on the drilling installation. Contractors will also be retained for specific work components, including but not limited to supply and operation of supply vessels, helicopter services, warehousing and supply base support.

2.6 Project Phases and Activities

The Core BdN Development includes the offshore construction and installation and HUC, production and maintenance operations, drilling, and decommissioning. The Project includes all components and activities, including supporting activities, associated with offshore drilling and production operations such as geophysical surveys (e.g., VSP, 3D/4D, wellsite) vessel operations, ROV / AUV / video surveys, and, environmental and geotechnical surveys.

The Project may also include Project Area Tiebacks, which would include activities such as construction and installation of subsea infrastructure (well templates and flowlines tied-back to existing FPSO or well templates), drilling, geophysical surveys, geotechnical surveys, and/or environmental surveys.

Detailed information on proposed Project activities are provided in the following subsections.

2.6.1 Offshore Construction and Installation, Hook-up and Commissioning

Offshore construction and installation, and HUC refers to activities that will occur offshore at the Core BdN Development Area. The offshore construction and installation phase may include pre-construction surveys, site preparation, and the installation of subsea equipment.

Activities will be carried out by construction, pipelaying vessels and/or activity-specific vessels. Section 2.6.4 provides a list of vessels likely to be engaged in construction and installation activities. ROV and/or AUV activities will likely be used to support construction and installation activities. Offshore construction and installation activities will likely be carried out over three to five years, with site preparation and surveys in the first one to two years, which may be 'summer' seasons due to weather limitations associated with the offshore field season.

Discharges and emissions associated with construction, installation and HUC are described in Section 2.8.

2.6.1.1 Offshore Site Preparation

Pre-clearance surveys to determine the presence of seabed and/or subsurface obstructions may be required prior to installation activities. Such surveys are similar to geotechnical, geophysical or well site surveys described in Section 2.6.5, and may involve the use of ROV and/or AUV equipment. Vessels engaged to carry out and / or support these activities are listed in Section 2.6.4.

2.6.1.2 Installation of Subsea Infrastructure

Offshore construction and installation will consist of the installation of the subsea infrastructure. Subsea construction vessels will support the installation of the equipment and a diving support vessel may be required to support the hook-up of the equipment.

The list of subsea infrastructure components to be installed is provided in Section 2.5.3.2 above and may include well templates, flowlines, umbilicals, risers, moorings, and fibre optic cables.

Well templates, riser bases, and moorings will be permanently positioned on the seafloor likely via suction pile driving. The suction pile driving concept consists of a large diameter cylinder sealed at the top end and the open end is driven into the seabed by extracting water from the cylinder internals. As the cylinder is driven into the seabed, water, along with disturbed sediment is extracted and deposited on the seabed adjacent cylinder. It is estimated that it may take up to 12 hours to install each suction anchor.

Flowlines, umbilicals, and cables will likely be laid directly on seafloor or laid via trenching. As described above in Section 2.5.3, excavated drill centres are not required due to the water depth. The need for protection of the subsea infrastructure (well templates and flowlines / umbilicals / cables) from dropped objects or other interference will be assessed. Protection measures, if required, for flowlines and/or the fibre optic cable may include the following options:

- Rock placement
- Concrete mattresses
- Trenching

If it is determined that a fibre optic cable will be used as the telecommunications system, within the Project Area, the following activities will occur.

- Ship-towed trough to clear cable path
- Cable laying vessel to install cable
- Tie-in of cable at seafloor (using a ROV) and to FPSO

The installation of a fibre optic system is typically completed by specialized telecommunications installation companies using specialized vessels (e.g., cable laying vessels).

2.6.1.3 Transit and Installation of the FPSO

The FPSO will transit to the Project site via international shipping lanes and will be under its own power operating as a marine vessel. Base case is for the FPSO to transit to the Project site without support vessels. However, the requirement for support vessels will be determined as detail design and planning progresses.

Ideal weather conditions for transiting the FPSO to its offshore location is typically from May through September. Detailed contingency planning will be developed to manage the move in the event of bad weather. Continuous weather forecasting will be undertaken during the move.

When the FPSO is positioned on site, the subsea equipment in the well templates will be connected (tied-in) to it. Once installation is complete, flooding and leak-testing, as described below, will be carried out.

2.6.1.4 Hook-up and Commissioning

Hook-up includes tie-in and connection operations to connect flowlines and umbilicals between subsea templates, between templates and the FPSO, and the connection of the moorings to the FPSO / turret. A diving support vessel may be required to support the hook-up activities.

Flowlines will be flooded, and leak-testing will be performed. The following is a description of typical flooding and leak testing activities, which is subject to possible changes as design and detailed engineering progresses. All chemicals that are intended for discharge will be screened per Equinor's global chemical management processes and the Offshore Chemical Selection Guidelines (OCSG) (NEB et al. 2009) (see Section 2.7.5). The preferred option is to choose the lowest risk chemicals, which will be considered during detailed engineering and design. The need for higher risk chemicals (e.g., corrosion inhibitors) may be required and will determined during detailed design and in consultation with the C-NLOPB.

To prevent corrosion in the flowlines after installation and prior to start of production, the flowlines will be filled with fresh water containing oxygen scavenger (e.g., sodium bisulfite). There is a possibility that the gas injection flowlines will be filled with seawater rather than fresh water as described. In this case smaller amounts of biocides may be added to prevent biofouling and bacterial growth.

After hook-up, the flowlines will likely be flooded with a mixture of monoethylene glycol (MEG) and water. The MEG / water mixture is used to control hydrate formation. MEG has low toxicity towards marine biota and is readily biodegradable. Dyes are also added to be able to better detect and locate possible leakages during pressure testing of the flowlines.

A plug of gel may be used to establish a viscous barrier to prevent seawater from flowing into the flowlines during subsea connection activities. The gel is a water-soluble mixture of water and chemicals that will be discharged during commissioning with the MEG / water mixture.

Based on current preliminary design information, estimated total discharges to sea of chemicals involved during hook-up and commissioning are the following:

- Oxygen scavenger (e.g., sodium bisulfite) – maximum 300 ppm and approximately 900 kg to 1,000 kg
- Dye (substance not finally decided) – maximum 100 ppm and approximately 300 kg to 400 kg
- MEG / water mixture (typically 60/40) – approximately 2,500 m^3 to 3,000 m^3

Dewatering of the subsea system is achieved by replacing the water volume by nitrogen gas (N_2). At production start-up this volume of inert nitrogen gas will be discharged to sea (approximately 5,500 $m^3$to 6,000 m^3).

HUC activities are estimated to last for four months or longer depending on operational and/or technical issues. Activities may occur at any time of the year.

2.6.2 Production and Maintenance Operations

The following activities are typically carried out during normal production and maintenance operations on a FPSO:

- Separation of well fluids
- Gas compression and reinjection
- Operation of produced water treatment system
- Seawater injection
- Power generation
- Operation of utilities system, including but not limited to heating, cooling, ventilation, power, and corrosion protection systems if required
- Desalination of seawater for potable water
- Waste generation and disposal
- Operation of seawater systems (cooling, firewater, etc.)
- Operation of oil storage and offloading
- Maintenance and inspection activities, including welding and x-ray inspection
- Flaring in connection with start-up, emergency and maintenance activities (vessel depressurization, etc.)
- Cargo / fuel / chemical handling

The well fluids arriving from the reservoir to the FPSO will be a mixture of oil, water and gas. The main purpose of the topsides process facilities on the FPSO is to separate these fluids into oil, water and gas, respectively. Oil is the targeted commercial product of the process and will, following the separation process, be routed to the crude oil storage in the hull of the FPSO for subsequent transfer to shuttle tanker.

Gas will follow the liquid flow of oil and water from the reservoir as an associated component, partly dissolved and partly mixed in with the fluids. As the pressure of the arriving fluids is reduced during the separation process, the gas will boil off, and will be collected for further use. There is no option available for export of natural gas from the Project Area to a commercial market. Hence, all produced gas will have to find utilizations at the producing field. A relatively small portion of the produced gas will be used as fuel for power generation onboard the FPSO. The remaining gas volume (90 to 95 percent) will be re-compressed and reinjected into the reservoir for pressure support. No routine flaring of produced gas will take place.

Gas will be collected from the first and second stage separators and routed to the injection compression train where the pressure of the gas is successively increased to the required pressure for injection into the reservoir. Gas from the first stage separator will be routed directly to the low-pressure suction side of the injection train. Gas from the second stage separator will be routed through a set of re-compressors to the same injection compressor train.

As the design of the Project is in the early stages, compression equipment has not been selected. Equinor Canada will provide details on compression equipment and emissions to C-NLOPB, which may occur through the Development Application phase or the OA application phase.

The produced water is separated from the oil by means of the density difference between oil and water. The separation takes place in separation vessels providing sufficient holding times for the separation to occur (see Section 2.7.1.5). After separation, the produced water is routed to the produced water treatment facilities for removal of sand and remaining oil content before discharge overboard.

The estimated oil production rates from the Bay du Nord facilities requires pressure support in the reservoir to compensate for the pressure depletion taking place during production. WAG injection wells are included in the design. Approximately 2.5 MSm^3/d of gas from the crude oil separation process and around 32 000 m^3/d of seawater will be injected into the reservoir for pressure support.

The water injection system may be combined with a process cooling system. Topsides process cooling will be based on direct seawater cooling, with return seawater being injected in the reservoir for pressure support. The volume of cooling water is uncertain as design is ongoing. Between 20,000 m^3/d to 80,000 m^3/d of seawater could be used. The cooling water may be treated with biocides to prevent corrosion and the bacterial / marine growth. Information regarding biocides is provided in Section 2.8.2.1. Excess cooling water not required for water injection will be discharged to the marine environment with the produced water. Based on current design, the discharge is expected to be at approximately 15 m to 20 m depth, depending on ballasting.

Produced water and gas management options are further discussed in Section 2.7.1. The assessment of alternatives for management of produced water will be further discussed in the Development Application required under the Atlantic Accords Acts.

Power generation on the FPSO will be provided by reciprocating dual fuel (gas / diesel) engines or dual-fuel turbines. Gas will be supplied from the processing of the crude oil. Diesel will be supplied via supply vessels on an as-needed basis. It is estimated that approximately 80 MSm^3 gas will be required on an annual basis. Diesel will only be used if fuel gas is off-spec, or when the FPSO is not receiving well fluids, and may be up to 1,800 m^3 to 2,400 m^3 annually.

Maintenance of process and utility systems include regularly scheduled major shutdowns / turnarounds in line with established industry / company practice. Maintenance activities during turnarounds are normally pre-planned based on condition monitoring of major equipment and may include total overhaul of major equipment including exchange of worn parts or correcting suboptimal settings (e.g., exchange of compressor casings and bundles, exchange of pump impellers) This may involve taking equipment to shore for repair or replacement. Also work requiring cold platforms for safety reasons (e.g., welding), where no crude processing is occurring, is carried out during turnarounds. In addition, marine systems and the hull will be maintained according to the class society and flag state requirements. Well workovers are discussed in Section 2.6.3.3.

Pressure and leak testing of the subsea systems including flowlines will be carried out during commissioning (see Section 2.6.1.4). No testing is planned during the operational phase other than routine inspections such as checking for lack of cover, free-spans and evidence of interaction from other ocean users. The flowlines will be designed to accommodate "intelligent pigging" inspection if necessary, whereby a remote sensing "pig" will be conveyed through the flowline to undertake checks on and confirmation of flowline integrity and condition.

Ongoing Project design will investigate options to minimize flaring. There will be no routine flaring of produced gas from the FPSO. Excess produced gas (i.e., gas which is not used for power generation) will be reinjected into the reservoir. During start up, shutdown, well clean-up activities, and during upset process conditions, depressurization of process segments may be required for safety reasons, and gas will be sent to the flare. Additional information on flaring is provided in Section 2.7.1.4.

Potable water will be produced from a desalination system onboard the FPSO. It is estimated that up to 10 m^3/d on average of seawater will be desalinated.

Crude oil will be offloaded to shuttle tankers. Crude oil will be shipped via shuttle tankers to an existing transshipment facility or directly to international markets.

Discharges and emissions associated with production operations are discussed in Section 2.8, below.

2.6.3 Drilling Activities

The drilling of development wells prior to and after the installation of the FPSO includes the mobilization and operation of drilling installations, drilling and completion activities, wellbore clean-up and preparation and well decommissioning or suspension. Development drilling in the Project Area will be undertaken with one or more drilling installations, either semi-submersibles or drillships. These activities and associated equipment are described in the following sections.

As described in Section 2.3, the Core BdN Development will involve the drilling of up to 40 wells, and Project Area Tiebacks could include the drilling of an additional 20 wells, with a combination of production and injection wells. Wells will either be drilled using templates (multiple wells drilled in one location) or at individual well locations (satellite wells). To enhance production ramp-up, pre-drilling of up to 10 wells (prior to FPSO hook-up) is being considered. It is estimated that drilling may occur in campaigns where a set number of wells would be drilled per campaign. The timeframe for the drilling campaign would depend on the number of wells to be drilled. For the Project, on average the total time for the drilling and completions of producer and injector well types is approximately 45-85 days and less drilling time is required for pilot and sidetrack wells. To account for the total well number for the Core BdN Development (up to 40 wells) and Project Area Tiebacks (up to 20 wells) drilling may occur at any time over the life of the Project but will not be continuous over the Project life. Well location planning is ongoing to optimize resource recovery, and therefore well locations have not yet been finalized.

Well flow testing is not typically carried out for development drilling. However, if a well flow test is required, it is Equinor Canada's preferred option to carry out a well flow test without flaring. If a well flow test is required, it is likely that the test flow will be routed to the FPSO, however, the drilling installation would have the capacity to carry out flaring associated with a flow test.

2.6.3.1 Mobilization of the Drilling Installation

Commencing as early as 2022, a drilling installation will be mobilized to the Project location. Depending on the type of drilling installation selected, it may be towed or self-propelled. For the Core BdN Development, where water depths are approximately 1,100 m to 1,200 m, the drilling installation will hold positioning via a DP system. In the larger Project Area, where water depths are shallower, the drilling installation may be anchored at location.

Detailed information regarding mobilization of a drilling installation can be found in Equinor Canada's Flemish Pass Exploration Drilling EIS (herein referred to as the Drilling EIS) (Section 2.5.2.2; Statoil 2017) and includes the installation of acoustic transponders where a DP system is used by the drilling installation, or setting of anchors, if in shallower waters.

2.6.3.2 Well Drilling and Completion

Wells may be drilled at varying water depths within the Project Area. The following information provides a general overview of the requirements and sequence for drilling a well - drill the well, complete the well, and install the christmas tree (XT).

As the Project is in the early stages of design, well design and locations have not been finalized. However, the information provided below is representative of the well design at decision gate (DG) 1 maturity (as described in the Project Description (Equinor 2018b)). Well design considers many factors including water depth, reservoir potential, geological properties of the reservoir, and purpose of the well. Once finalized, the well design will be submitted for approval to the C-NLOPB as required per the OA requirements and the Approval to Drill a Well application process. Each well is drilled in sections, gradually reducing the size of the wellbore with increased depth of the well, as illustrated in **Error! Reference source not found.**.

Table 2.7 Typical Well Design Various Water Depths

Well Section	Hole Size	Casing / Liner Size	True Vertical Depth (TVDss)	Drilling Fluid Type
Wells in 1,100 m to 1,200 m water depth				
Conductor	42”	36” / 30”	1180-1280	WBM
Surface	26”	22” / 20”	1900	WBM
	17 ½” / 17”	13 3/8” / 13 5/8”		
Intermediate Hole	17 ½” / 17”	13 3/8” / 13 5/8”	3030	SBM
	12 ¼”	9 7/8” / 9 5/8”		
Production Hole	8 ½”	5 ½” / 6 5/8” Screens	3145	SBM
[1] WBM - Water-based mud [2] SBM - Synthetic-based mud				

As noted in Section 2.6.3, it is estimated to take approximately 45 to 85 days to drill and complete a development well for the Project, which is based on guidance from Equinor Canada's drilling subject matter experts. The time to drill and complete each well is dependent on drilling and completion design, weather, technical requirements and logistics. The C-NLOPB posts drilling information on their website (Schedule of Wells; C-NLOPB n.d.), which includes spud and termination dates. Based on this information, the average duration to drill a development well for all offshore operators is approximately 81 days.

Drilling can be divided into two stages – drilling with and without a riser. A riser is a large diameter tubular that connects the circulation system of the drilling installation to the wellhead creating a closed loop for returns (e.g. fluids, cuttings and excess cement) as they are pumped down the well and returned back to the drilling installation for processing (refer to Section 2.8.2.1 for more information regarding drilling waste management). Until the wellhead is installed the riser cannot be installed.

The first section of a well is typically referred to as the conductor section. This section is drilled riserless with water-based mud (WBM), which consists primarily of seawater, and WBM cuttings are discharged at the seafloor as they are circulated out of the hole. Once reaching the section total depth (TD) and prior to pulling the drill string out of the hole, the wellbore volume is displaced with a weighted WBM to mitigate against collapse of the wellbore during casing and cementing operations. During casing and cementing operations, the weighted WBM is displaced from the wellbore to the seafloor. The top of the conductor casing string includes the wellhead housing which is installed several metres above the seafloor. The next section, often referred to as the surface section, is also drilled riserless with returns to the seabed. Total WBM displaced is approximately 500 m^3. At the top of the surface casing string is the wellhead which extends approximately 1 m above the wellhead housing. Once the wellhead is installed, the blowout preventer (BOP) is placed below the string of riser and connected to the wellhead. The remaining sections of the well are drilled to predefined depths, typically using synthetic-based mud (SBM) as the drilling fluid, with casings installed as required per well design.

Drilling activities may also include batch drilling, which is the process of consecutively drilling the top hole sections for multiple wells. During batch drilling activities, the conductor and surface hole sections are drilled without risers using WBM, as described above. The number of top hole sections to be batch drilled at any one time will be determined to optimize drilling installation efficiency and overall logistics. Advantages associated with the batch approach include:

- Riserless operations are less weather sensitive – complete batch set of top holes during winter season, reservoir drilling during more favorable summer season
- Rhythm / repetition for crews – increased familiarity and efficiency
- Simplified logistics and pit management / cleaning
- Opportunity to "hop" (transit with BOP below drilling installation) between wells, reducing BOP running time
- Improved health, safety, and environment (HSE) associated with reduced BOP / riser running

Batch drilling may reduce the overall duration of the drilling program, and therefore has the potential to have a positive effect on drilling timelines and schedule.

Once the well has reached the planned TD and the target reservoir(s) is exposed the well will be cleaned up to remove all remaining cuttings and displaced with a compatible completion fluid (refer to Section 2.8.2.1). The selected completion solution is designed to facilitate the production of the wellbore fluids (i.e., oil and/or gas) while maintaining wellbore stability and preventing the production of water and sand. The final completion design for the Project has not been finalized, however, the most likely solutions are stand alone screens and/or Gravel Pack (GP). In either case, the completion will require a sand control solution across the reservoir interval to assist in mitigating the production of sand which may damage the equipment in the well and on the FPSO while allowing the reservoir fluids to flow back to surface. The management of produced sand is addressed in Section 2.8.2. In the case of GP, specific size gravel is mixed into a fluid and pumped downhole around the screens to fill the annular space between the wall of the well and the exterior of the screens, further preventing the production of sand particles. Once the well is completed, the subsea XT and manifold are installed on the wellhead. The XT is an integral part of the well barrier system and houses all the valves and piping which connect the well to the subsea production system and to the FPSO.

2.6.3.3 Well Workover and Well Intervention Activities

A workover or intervention program may be established to complete remedial work if there are issues with a well after initial drilling and completion. Where possible these types of programs are executed by vessels (i.e., inspection, maintenance, and repair (IMR) vessels or light intervention vessels (LIV)) unless the work requires the full functionality of a drilling installation. The work may involve re-evaluating a production reservoir, clearing sand from producing zone, replacing downhole equipment, deepening a well, acidizing or fracturing, or improving the drive mechanism amongst other tasks. The preferred option is for well clean up / workovers to be done through the FPSO thereby likely reducing overall Project emissions. However, if required, the option is available to flare from the drilling installation during well clean-up and/or well flow testing.

2.6.4 Supply and Servicing

Offshore production activities are supported by various logistical activities, including existing onshore supply base and warehousing, OSV, SBVs, and helicopters and airports.

2.6.4.1 Onshore Supply Base

A supply base provides temporary storage, refueling, staging and loading of materials and supplies to support offshore drilling and production activities. Supply base facilities have operated on the island of Newfoundland since the 1970s when offshore exploration activity began.

Existing supply bases servicing the offshore petroleum sector are located on the Avalon Peninsula. Supply bases on the Avalon Peninsula provide similar services to the supply base in the port of St. John’s (e.g., wharfage, office space, bulk storage, crane support, and other services), however, they do not provide fueling services. OSVs will typically refuel in St. John’s before transiting offshore.

Therefore, for the purposes of EA, it is assumed that OSV traffic will be transiting from the port of St. John's to the offshore location, as this is the only existing supply base capable of supplying all services to vessels (notably fuel supply).

2.6.4.2 Offshore Supply and Support Vessels

Throughout the life of field for the Core BdN Development Area, and if Project Area Tiebacks occur, various types of vessels will be engaged to support the Project. The following is a list of vessels likely to be engaged to support Project activities, as required depending on Project activities and needs. The list is not inclusive of all vessels.

- Offshore supply vessels (OSV) and Stand-by vessels (SBV)
- Offshore construction vessels
- Light intervention vessels (LIV)
- Inspection, maintenance, and repair (IMR) vessels
- Accommodation vessels
- Cable / pipe / flowline laying vessels
- Other support / supply vessels
- Vessels for geotechnical, seabed surveys, and/or environmental surveys
- Geophysical survey vessels
- Vessels for ROV / AUV / video surveys
- Ice management vessels
- Diving vessels, if required
- Support / picket vessels for any of the above, if required

The number of estimated OSVs, including SBVs, and estimated monthly transits associated with each Project phase is outlined in Table 2.8. These numbers are estimates only and may changes as Project design and operational plans are finalized

Table 2.8 Estimated Vessels and Monthly Transits

Project Phase	Estimated # of Support Vessels	Estimated # of Transits per Month
Offshore construction and installation	1-2	4-8
HUC	2-3	4-8
Production and maintenance operations	2-3	4-8
Drilling	2-3	4-8
Potential Overlapping Activities		
HUC and drilling	3-6	4-16
Drilling and production and maintenance operations	2-5	4-16
Project Area Tiebacks	2-5	4-16

Some of the Project phases will overlap in time and the estimates provided assume that vessel numbers will be additive. In the estimated provided, it is assumed that there is one SBV, and the remaining vessels are OSVs transiting to shore. In certain cases (e.g., drilling and production), two SBVs may be required, depending on the distance between the FPSO and drilling installation. The estimates include two SBVs with the remainder as OSVs. However, it is likely that these numbers will decrease as synergies are realized.

Vessels to support Project activities will be contracted from third-party suppliers. Supply vessels contracted by Equinor Canada will be required to have valid marine certification (i.e., Certification of a supply vessel as a Passenger Vessel from Transport Canada) and meet regulatory requirements as set out by Canada and international organizations, as well as meeting Equinor's global marine-vessel vetting requirements.

From 2010 to 2017, between 1,300 and 1,601 (1,344 in 2017) vessel transits in and out of the port of St. John's, NL were recorded, of which between 653 and 1,027 annual transits were offshore energy vessels (R. McCarthy, pers. comm. 2018). Based on the estimated level of vessel transits per month, as outlined in Table 2.8, the Project is not expected to result in a significant increase to the average number of vessel transits to the port of St. John's, NL.

Supply vessels supporting the Project will transit in a straight-line approach to and from port to the Project location, a common industry practice for energy efficiency employed for over 30 years by operators with facilities offshore NL. Section 16.6 provides information on vessel-related incidents that have occurred offshore NL.

2.6.4.3 Helicopters

Helicopter support will be used for the transport of crew and supplies to and from the Project. Helicopter support operate out of the St. John's International Airport. Currently Cougar Helicopters services the existing production operations offshore NL. For those operations, total offshore helicopter trips (return) from the Cougar Helicopters base in St. John's from 2006 to 2017 was 18,374, with annual number of flights ranging from 857 in 2009 to 2,123 in 2017 (L. Efford pers. comm. 2018). Helicopter support will be supplied by a third-party licensed operator under contract to Equinor Canada.

During offshore construction and installation, OSVs will provide support and helicopter transit may be required for crew changes. During drilling, before the FPSO arrives on site, up to 10 trips per week are anticipated. When the FPSO arrives on site for HUC activities, and when drilling and production activities occur simultaneously, it is anticipated that helicopter transits could increase up to 15 times per week. When only production activities are ongoing, it is estimated that helicopter transits will be up to five trips per week. During high-level maintenance activities and turn-arounds, helicopter traffic may increase, but it is anticipated that it would be within the levels estimated during simultaneously drilling and production operations. Note that helicopter transit does not occur every day as flights may be grounded due to weather and/or technical matters. Aviation is regulated by Transport Canada and includes regulations and operational requirements for helicopter flight traffic. The C-NLOPB has also implemented specific operations requirements for helicopter flight traffic (e.g., lighting, hours of operation) when servicing offshore installations.

2.6.4.4 Shuttle Tankers

As outlined in Section 2.1, the base case for the Project is to utilize shuttle tankers to offload crude from the FPSO and transport it to an existing transshipment facility. Equinor Canada, however, may ship direct to international markets. Production operations offshore NL utilize the BWTTS, which is a fleet of modern shuttle tankers that ships crude to an existing transshipment terminal in NL or direct to market. For Project operations, the preferred option is for Equinor Canada to utilize the tankers servicing offshore NL production operations.

There are currently three dedicated shuttle tankers, operated by a third-party, providing crude shipment from the existing four offshore production operations (i.e. Hibernia, Terra Nova, White Rose and Hebron) to an existing transshipment facility. The existing shuttle tankers are relatively new and were constructed between 2016 and 2018. Shuttle tankers have a double hull design and a storage capacity of 960,000 barrels (bbl) (approximately 150,000 m^3).

The transportation route of shuttle tankers will be from the transshipment facility to the offshore NL area. As outlined in Table 2.6, crude oil storage on the FPSO is estimated to be approximately 160,000 m^3. The final storage capacity will determine if shuttle tankers will go direct from the transshipment facility, or if split loading with other offshore production facilities will occur. Based on the anticipated crude oil storage volume the frequency of shuttle tanker offloading is estimated as once per four to seven days at peak production.

Ballast and bilge water management for shuttle tankers will be the same as supply and servicing vessels and outlined in Section 2.8.2.

Information regarding offloading is outlined in Section 2.5.3.1. Bunkering of fuel required for the shuttle tankers will not occur in the Project Area.

Once the shuttle tanker leaves the Project safety zone, it is under the responsibility of the third-party owners of the shuttle tankers, outside the care and control of the Project. Equinor Canada and/or Husky Energy will be the charterer and under a Contract of Affreightment (COA) with the shuttle tanker operator. The shuttle tankers are subject to international maritime requirements (i.e., International Maritime Organization (IMO)) and must adhere to the regulatory framework of the IMO as well as those of its flag state.

The information above is based on the current shuttle tanker fleet and may change over the potential 30-year temporal scope of the Project. The BWTTS is responsible for selecting the shuttle tanker supplier / operator and the fleet of shuttle tankers that service the NL offshore area.

2.6.5 Supporting Surveys

Throughout the Project, supporting surveys may be required to support production and drilling activities. These include geophysical surveys (e.g., 2D/3D/4D seismic, VSP, wellsite geohazard), geotechnical and/or geological surveys, environmental surveys, and ROV/AUV/video surveys. The Project also includes the ancillary facilities and activities typically associated with an offshore oil and gas production operation. Vessels to support these activities are described in Section 2.6.4.2.

Geohazard / Wellsite and Seabed Surveys: Geohazard/wellsite surveys are used to identify anomalies beneath the seafloor (e.g., shallow gas deposits) and hazards (e.g., large boulders, ocean debris, shipwrecks) to optimally place the wells to allow for safe and efficient drilling. Seabed surveys may be required to collect detailed bathymetry, fish habitat information (e.g., corals, sponges) and seabed characteristics of the area to assist in subsea infrastructure layout and design. These surveys typically take between five and 21 days to complete, but the overall duration can be shorter or longer depending on the data requirements and weather /operational delays. They may involve the mapping of the seabed through the use of seismic sound sources, multibeam echosounder (MBES), sidescan sonar (SSS), synthetic aperture sonar (SAS) subbottom profiler (SBP), video and other non-invasive equipment. The equipment is deployed either as hull-mounted equipment, on a towfish or on ROV / AUVs. Equipment may be towed by the vessel (e.g., sound source and/or streamers) or hull-mounted. Geohazard surveys may not be required for each well location; existing geophysical data may be used to analyze potential geohazards. These surveys may occur at any time of the year over the temporal scope of the Project.

Geophysical Surveys: Over the life of the Project, seismic surveys, a type of geophysical survey, may be undertaken to access and revalidate previous seismic data. Any required 2D/3D/4D surveys will take place within the Project Area.

While not anticipated to be carried out during the Project, 2D seismic surveys tend to cover relatively large geographical areas, in order to identify sites or zones that may warrant further investigation, and they are therefore of relatively short-term duration at any given location. These surveys typically use one sound source array and often employ a single streamer, with survey lines being widely spaced (usually several kilometres apart) and laid out in various directions.

3D surveys are typically more focussed and tend to cover smaller geographical areas than 2D surveys. Multiple sound source arrays are typically used, and the vessel could tow between eight and 16 streamers.

4D surveys, also known as ‘time lapse seismic’, simply means that successive 3D survey data sets for the same area are interpreted to define changes in the reservoir over time. A typical application of this technique is using previous 3D seismic data and comparing it with a recently acquired 3D survey. Therefore, the activities associated with a 4D survey are similar to a 3D survey (multiple sound source arrays and streamers), and the data collected is then compared to previous 3D seismic data for the same area. Options for 3D/4D seismic surveys includes the use of hydrophones (ocean bottom cables (OBC) or ocean bottom nodes (OBN)) installed on the seafloor or towed behind a vessel. The Project is considering permanent reservoir monitoring, where the OBC/OBN are installed on the seafloor and removed at decommissioning, or conventional seismic using towed streamers or temporary OBNs. Permanent reservoir monitoring seismic surveys are estimated to take approximately two weeks to complete and could be carried out twice per year. Conventional seismic surveys could be between two and four weeks and occur as frequently as once per year in early Project life, with reduced frequency in later years. Timing and duration of these seismic surveys are estimated and will be finalized during Project design. If permanent reservoir monitoring is chosen, the area occupied on the seabed by the installed OBC/OBN could be approximately 135 km^2. The coordinates will be provided to Canadian Hydrographic Services, NAFO, and One Ocean. See Section 2.7.6 for a discussion of alternative methods for 4D seismic survey under consideration.

VSP is a tool used to further define the depth of geological features and potential petroleum reserves by obtaining high resolution images of the target. VSP surveys will be conducted as required throughout the Project life. It is estimated that one to two VSP surveys could be carried out for the Core BdN Development Area. VSP surveys are similar to surface geophysical surveys in that a sound source and a receptor (or hydrophone) is required to measure the refraction and reflection of the sound waves, thereby providing data that can be interpreted to delineate geological features used to identify potential hydrocarbon deposits. VSP differs from surface geophysical surveys in that it is conducted in a vertical wellbore using hydrophones inside the wellbore and a sound source near the surface at or near the well; a VSP is quieter and more localized than a surface geophysical survey, being smaller in size and volume. Up to 12 individual smaller sound sources may be used for VSP, each of which has a maximum volume of 250 cubic inches and is generally placed 5 m to 10 m below the water surface. Additionally, a VSP is shorter in duration than surface geophysical surveys, with VSP operations usually taking less than 48 hours per well to complete the profiling. During a VSP program, various VSP configurations are used depending on the objectives. For example, an offset VSP is the conventional configuration, in which the energy source is positioned directly above the hydrophone(s), typically close to the wellbore. A walkaway VSP is where the sound source is towed from a vessel and is moved progressively away from the hydrophones, generally resulting in higher resolution than surface data and providing more continuous coverage than an offset VSP. VSP surveys may be carried out at any time of the year.

Geophysical activities for the Project will be planned and conducted in consideration of the Statement of Canadian Practice with respect to the Mitigation of Seismic Sound in the Marine Environment (SOCP, DFO 2007; and appended to the Geophysical, Geological, Environmental and Geotechnical Program Guidelines (C-NLOPB 2018b)). As Project design is ongoing, the timing of surveys is unknown; sound sources used for either the 4D seismic or VSP surveys will be determined at time of planning the surveys. If a VSP is required, specific details of the VSP operations for the Project will depend on the geological target and the objectives of the VSP in question.

Environmental Surveys: These surveys are conducted to collect samples to analyze the physical, chemical, and biological aspects of an area. Sampling is typically carried out from a support / supply vessel or a dedicated vessel suitable to the survey. Environmental surveys may include oceanography, meteorology, and ice / iceberg surveys. It can also include biota, water, and sediment sample collection, and ROV-video or drop camera surveys. Environmental surveys may occur throughout Project life at any time of the year using vessels of opportunity associated with the Project, typically taking between five to 21 days to complete.

Geotechnical / Geotechnical Surveys: These surveys measure the physical properties of the seabed and subsoil through the collection of sediment samples and in-situ testing. Methods to collect the samples typically include drilled boreholes or gravity coring. In-situ testing is done through cone penetration testing and pore pressure measurements. Installation of piezometers in boreholes to measure soil properties may also be carried out. Piezometers could be left in place to collect data for up to 12 months or longer. Geotechnical surveys may occur throughout the Project life at any time of the year, using dedicated vessels provided by marine geotechnical specialist suppliers.

ROV / AUV Surveys: These surveys are used to conduct visual inspections (camera equipped) of facilities and/or carry out repairs of subsea equipment. ROV / AUV surveys may also be used during pre-drill surveys and before marine installations to determine presence / absence of physical objects on the seafloor. They may also be used during any or all of the surveys described above. They will be conducted throughout the Project-life at any time of the year using vessels of opportunity associated with the Project.

2.6.6 Project Area Tiebacks

Equinor Canada, along with its partner, Husky Energy, may choose to undertake additional exploration and / or delineation activities (i.e., drilling, geophysical surveys) to further develop possible recoverable reserves. Equinor Canada has controlling interest in other ELs and SDLs within this radius and within the Project Area (Figure 2-1) that may have Project Area Tiebacks. Other operators may acquire licenses in the future within the tieback threshold distance.

The Core BdN Development could be expanded if it is proven through these exploration / delineation activities that economically recoverable oil accumulation exists in fields within a current tieback threshold distance (approximately 40 km) of the FPSO. The FPSO will be designed to accommodate tiebacks. Preliminary Project design currently has a turret designed for 12-slots that can be used to connect subsea infrastructure to the FPSO. Up to 8-slots are expected to be utilized for the Core BdN Development which would leave at least four slots available for tieback opportunities. Nominally this could be between one to five subsea developments depending on their configuration. For instance, a tieback may be from a new well template connected back to the FPSO via a new flowline, or a tieback may be a new well template connected to an existing Core BdN Development well template via a flowline. Figure 2-13 illustrates examples of potential Project Area Tiebacks.

Activities associated with Project Area Tiebacks will likely be the same as those activities undertaken during the Core BdN Development and may include:

- Installation of subsea tieback(s) (well templates and flowlines)
- Continuation of production and maintenance operations from the existing production installation
- Drilling activities associated with the drilling of up to 20 additional wells (total) in well templates
- Continuation of supply and servicing
- Additional supporting surveys, if required
- Decommissioning

Should tiebacks occur, all production operations would occur from the existing FPSO, extending production out to the design life of the production installation, which is 30 years. Therefore, the overall Project temporal scope is 30 years.

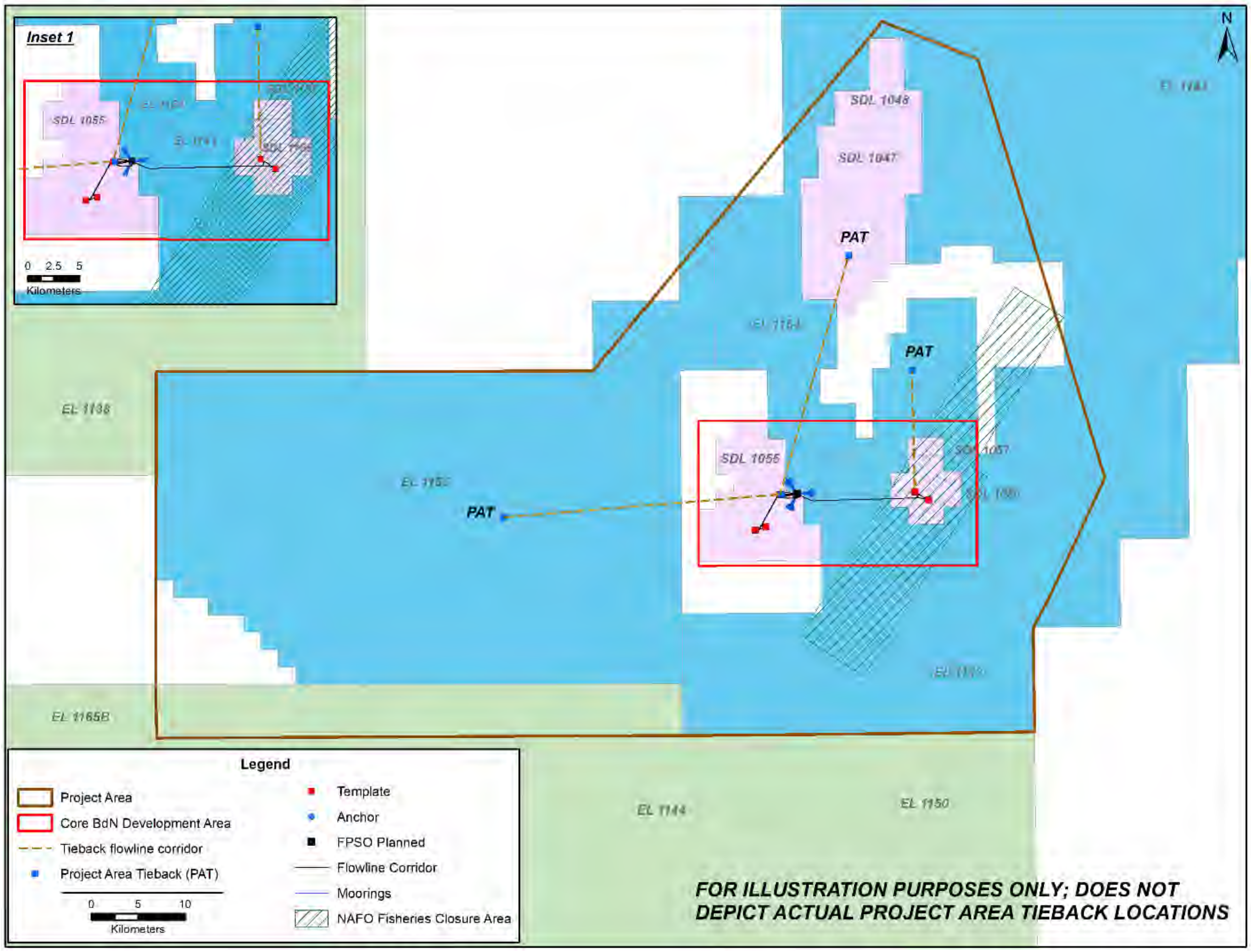


Figure 2-13 Illustration of Example Project Area Tiebacks

Offshore construction and installation and hook-up and commissioning activities would be the same as those described under Section 2.6.1 to 2.6.5 for Core BdN Development. Subsea infrastructure (well templates and flowlines) would be installed on the seafloor and tied-back to the FPSO and/or existing well templates. Flowlines would have to be tested and commissioned, as described under Section 2.6.1. However, there would not be commissioning activities on the FPSO, as it is already in operation.

The only change to production and maintenance operations would be the extension of these activities to the 30-year timeframe from the base case of 12 to 20 years, as described in Section 2.6.2. Since the FPSO is designed to a set crude production rate and waste discharge volumes, there is no anticipated changes to the rates of production or the associated waste discharge volumes. The only change would be the temporal scope of operations occurring out to 30 years.

Section 2.6.4 describes supply and servicing operations and tanker operations. Again, these activities would be same should Project Area Tiebacks occur. It is not anticipated that there would be additional OSVs, helicopters or tankers beyond the ranges of vessels described above in Section 2.6.4. The temporal scope of these activities would be extended from12 to 20 years to 30 years.

Should Project Area Tiebacks occur, up to an additional 20 wells (e.g., 10 producing wells and 10 injector wells) may be drilled from well templates (4-, 6- or 8-slot) and/or satellite wells as described in Section 2.6.3. Drilling activities would be the same as those described above, with drilling activities likely to occur at any time of the year over the life of the Project. Depending on the number of wells required, these wells may be drilled within a single or multiple drilling campaigns. Drilling of wells could occur during the same timeframe as Core BdN Development activities.

Should supporting activities be required, they would be the same as those described in Section 2.6.5. Activities could be carried out year-round.

Table 2.6 in Section 2.5.3 provides an overview of the Core BdN Development and activities to be carried out if Project Area Tiebacks are undertaken. Timing and temporal scope of these activities is also listed.

2.6.7 Decommissioning

The end of field-life will either be at the end of the Core BdN Development (approximately 12 to 20 years) or up to 30 years with the addition of Project Area Tiebacks. At the end of field-life, Equinor Canada will decommission the Project in accordance with regulatory requirements in place at the time of decommissioning. It is anticipated that decommissioning will be carried out over multiple seasons likely within a two- to four-year timeframe. Decommissioning of the FPSO may occur at anytime of the year.

2.6.7.1 FPSO and Subsea Infrastructure

The following applies to both the Core BdN Development and Project Area Tiebacks.

As a base case, the FPSO will be decommissioned and removed from the Project location. All floating equipment (turret, mooring lines) will be removed.

Subsea infrastructure, including flowlines and well templates may be removed or left in place. These options will be further examined at the time of decommissioning in consultation with C-NLOPB and other regulatory authorities such as DFO. Over time, and depending on protection measures (if required), they may have become fish habitat and the effects of removing them would have to be assessed.

A decommissioning plan will be developed and submitted for C-NLOPB review and approval as end of field life approaches. This plan will include alternative options such as removal of flowlines and well templates and/or leaving subsea infrastructure in place. For the purposes of EA, effects assessment of both alternatives are being considered in this EIS, to the degree applicable.

2.6.7.2 Well Suspension, Abandonment and, Decommissioning

The following applies to both the Core BdN Development and Project Area Tiebacks.

Abandonment involves the isolation of the wellbore by placing cement and/or mechanical plugs at required depths in the wellbore, thereby separating and isolating subsurface zones to prevent subsurface fluids from escaping and the subsequent removal of the wellhead. Well abandonment will adhere to the requirements set out under the *Newfoundland Offshore Petroleum Drilling and Production Regulations*. Operators are required to provide detailed plans for monitoring suspended wells to the C-NLOPB and are also required to provide information regarding the suspension or abandonment methods to ensure the wells are adequately isolated, which in turn will prevent hydrocarbons from entering the environment.

There may be instances when it is necessary to re-enter the wellbore such as, but not limited to additional testing, data collection and technical aspects. In such circumstances, the well is not abandoned but suspended with the same safeguards regarding wellbore isolation in place. If suspension occurs a temporary debris cap may be installed to protect the wellhead connector. Based on historic data, wells are typically suspended for two to three years, however, prior to suspending a well, Equinor Canada is required to obtain approval from the C-NLOPB by submitting a Notification to Suspend/Abandon, which is required to indicate the anticipated duration of suspension. This aligns with the requirements in the *Newfoundland Offshore Petroleum Drilling and Production Regulations*.

The wellhead is typically removed during decommissioning. Removal of the wellhead, either by mechanical cutting inside the casing or using an external mechanical cutter, varies depending on water depth. Refer to Section 2.5.2.7 of the Drilling EIS (Statoil 2017) for the wellhead removal strategy. In the event of tiebacks in water depths greater than 1,500 m, wellheads will not be removed; typical target height of remaining stub in deeper water is 3 m, however, it may vary between 2 m and 5 m. Explosives will not be used to remove wellheads.

Monitoring of abandoned wells consists of completing ROV surveys to ensure the areas are free of leaks, damage, equipment and obstructions. Conformation of location coordinates may also be completed during ROV surveys. Abandonment is designed to be permanent/indefinite and there is no requirement for monitoring, which aligns with the *Newfoundland Offshore Petroleum Drilling and Production Regulations*.

In the case of a well suspension, cement or mechanical plugs are installed to prevent the influx of formation fluids into the well as an interim measure prior to decommissioning.

2.7 Alternative Means of Carrying Out the Project

Section 19(1)(g) of CEAA 2012 requires that every EA of a designated project take into account alternative means of carrying out the project that are considered technically and economically feasible and consider the environmental effects of any such alternative means.

Consistent with the Operational Policy Statement: Addressing “Purpose of” and “Alternative Means” under CEAA 2012 (CEA Agency 2015) and the EIS Guidelines (Appendix A), the process for consideration of alternative means of carrying out the Project includes the following steps:

- Identification of alternative means of carrying out the Project
- Consideration of the environmental effects of alternative means which are deemed to be technically and economically feasible
- Selection of the preferred alternative means of carrying out the Project, based on the relative consideration of effect
- Assessment of environmental effects of the preferred alternative

The following alterative means were taken into consideration for the following Project aspects (items marked with (*) are required under the EIS Guidelines (Appendix A)):

Production Installation and Subsea Infrastructure

- Choice of production installation*
- Power generation
- Energy efficiency
- Gas management and flare gas recovery
- Disposal of produced water*
- Disposal of produced sand*
- Location of final effluent discharge points*
- Chemical selection*
- Choice of subsea infrastructure*
- Subsea hydraulic systems
- Protection of subsea infrastructure
- Subsea flowline protection
- Alternative ways to light the platform at night*
- Alternatives to flaring at night*
- Timing and approach of development, commissioning and maintenance activities, in relation to fishing activities*
- Decommissioning

Drilling Installation

- Choice of drilling installation*
- Water management and location of final effluent discharge points*
- Chemical selection*
- Choice of drilling fluids*
- Management of drilling waste*
- Alternative ways to light the platform at night*

Seismic Surveys

- Choice of technology / method used for subsea vertical profiling and seismic testing*
- Timing of seismic surveys*

The alternatives, as listed above, are identified, and if determined to be technically and economically feasible without affecting safety and reliability of operations, are evaluated in terms of their potential environmental effects. If an option is not considered to be technically feasible, no further assessment is undertaken. Alternative technology considered must be available in the market and proven for use in a similar operating environment. Economic feasibility includes consideration of capital and operational expenditures. Effects on expenditures can be direct (e.g., equipment and personnel requirements) or indirect (e.g., schedule delays).

Based on the alternatives analyses, the preferred option is selected, and this preferred option is then carried through the EIS as a Project component/activity for a more detailed assessment (see Chapter 4). The Project is in the early stages of design, which means that Project design and operational aspects are still under review. In those cases where design is ongoing, and the preferred option has not been decided, for the purposes of the EIS, the effects assessment of alternatives will consider the following:

- Where one option is likely to have a greater environmental interaction and/or effect, that option will be assessed
- Where options are likely similar in potential environmental effects, effects of the options will be considered in the effects assessment analysis, as appropriate

Several of these Project aspects are not finalized. Further details of design will be identified in the Development Application process under the C-NLOPB. In assessing alternative means, each of the identified alternative means of carrying out the Project are evaluated, and the associated results are summarized in this section.

2.7.1 Production Operations

2.7.1.1 Production Installation Selection

The production installation options taken into consideration included FPSO, GBS, Semi-submersible, Spar with storage, Spar without storage and TLP. The concept selection of alternatives is detailed in Sections 2.5.1 and 2.5.2 and it was determined that the FPSO is the preferred development concept for the Core BdN Development. The EIS therefore considers the potential effects associated with this type of production installation.

2.7.1.2 Power Generation

There are two different power generation solutions under consideration for the FPSO.

One option is based on eight dual fuel reciprocating engines located in the FPSO hull. Each engine would have 7 megawatts (MW) of power for total installed power of 56 MW. The peak load during operations is estimated to be 43 MW, while power consumption during normal operations will be in the range of 24 MW to 36 MW.

An alternative power solution is based on using gas turbine generation. This option involves one 50 MW to 60 MW gas turbine located on the FPSO topside. The rated power output for this type of turbine is 52 MW and supplies the same power as above. Gas turbines are the most common type of power generation in the oil and gas industry.

Both alternatives are dual fuel solutions (i.e. capable of running on natural gas and diesel fuel). In normal operations gas fuel is assumed for both alternatives.

The energy conversion efficiencies from fuel to electricity for reciprocating engines and gas turbines are approximately 49 percent and 35 percent, respectively. CO_2 emissions from electrical power generation are around 20 percent lower with reciprocating engines than for the turbine alternative.

Both alternatives currently meet IMO (Tier III) and Canadian regulatory requirements with respect to NO_x emissions. Once selected, specifications for the equipment will be provided to ECCC.

All or part of the heat demand on the FPSO will be met by waste heat recovery units (WHRU) installed in the exhaust stacks of either the engines or the turbine. Approximately 10 MW to 12 MW could be recovered in the reciprocating engines option, while a significantly larger amount of heat is available from the turbine option. Heat balance evaluation is part of the ongoing design considerations. A gas fired heater is included in the design and will supply any additional heat required beyond waste heat recovery (WHR).

As shown in Table 2.9, both options are still under consideration and will include maintenance requirements and overall operating costs in determining the best option for the Project. Air emissions estimates for both options are provided in Chapter 8.

Table 2.9 Comparison of Power Generation with Reciprocating Engines and Gas Turbine

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
Reciprocating engines	YES	UNCERTAIN	YES	Higher energy conversion efficiency than gas turbines Lower greenhouse gas (GHG) emissions	Under investigation
Gas turbine	YES	YES	YES	Slightly larger GHG footprint than reciprocating engines Larger WHR potential than reciprocating engines	Under investigation

2.7.1.3 Energy Efficiency

The production and processing of crude oil on the FPSO will involve the use of several large and energy demanding equipment units (e.g., gas compressors and water injection pumps). The size of equipment will be determined by the maximum flow through the equipment.

During the operating life of the field, flow rates may be lower than the design maximum. To optimize energy efficiency for varying flow rates, Equinor Canada is considering variable speed drive (VSD) on gas compressors and water injection pumps as an alternative to the default fixed speed set-up. It is estimated that this measure could reduce power consumption on the FPSO by approximately 5 MW to 7 MW with a corresponding reduction of CO_2 emissions of approximately 25,000 tonnes CO_2/year on average.

WHR from power generating equipment is an important energy saving measure on the FPSO. The total heat demand on the FPSO is currently unknown as design is ongoing. The largest heat consumer on the FPSO will be the crude oil heater, which boils off associated gas in order to meet export specifications for crude oil. In addition, there are a number of smaller heat consumers in the hull (e.g., crude oil storage system). In normal operations, the heat demand will, to the largest possible extent, be covered by WHR (see Section 2.7.1.2). Recoverable heat in the reciprocating engines power solution is estimated at 10 MW to 12 MW, with a corresponding CO_2 reduction of approximately 50,000 to 60,000 tonnes CO_2/year on average, compared to production of the same amount of heat in a gas fired heater. The heat recovery potential in the gas turbine case is significantly larger than for the engines case and can be utilized if the heat demand corresponds. Total heat demand and heat balance evaluations are part of ongoing engineering considerations to arrive at the most optimal power and heat concept for the Project.

The evaluation of energy efficiency measures considered for this Project is summarized in Table 2.10.

Table 2.10 Evaluation of Energy Efficiency Measures

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
VSD on gas compressors	YES	YES	YES	Reduced environmental footprint	Under investigation
VSD on water injection pumps	YES	YES	YES	Reduced environmental footprint	Under investigation
WHRU on all power generating engines/turbine	YES	YES	YES	Reduced environmental footprint	Under investigation
No WHRU, all heat provided by gas fired heaters	YES	YES	YES	Increased CO2 emissions	✗

2.7.1.4 Gas Management and Flare system – Flare Gas Recovery

The World Bank provides definitions for routine flaring, non-routine flaring and safety flaring (World Bank 2016). In its technical guidance documents, Equinor includes non-routine and safety flaring under the category of non-routine flaring. Definitions of flaring and examples are provided in Table 2.11.

Table 2.11 World Bank Definitions of Flaring

Definition	Examples
Routine flaring of gas at oil production facilities is flaring during normal oil production operations in the absence of sufficient facilities or amenable geology to reinject the produced gas, utilize it on-site, or dispatch it to a market. Routine flaring does not include safety flaring, even when continuous	• Flaring from oil/gas separators • Flaring of gas production that exceeds existing gas infrastructure capacity • Flaring from process units such as oil storage tanks, tail gas treatment units, glycol dehydration facilities, produced water treatment facilities, except where required for safety reasons
Safety flaring of gas is flaring to ensure safe operation of the facility.	• Gas stemming from an accident or incident that jeopardizes the safe operation of the facility • Blow-down gas following emergency shutdown to prevent over-pressurization of all or part of the process system • Gas required to maintain the flare system in a safe and ready condition (purge gas/make-up gas/fuel gas) • Gas required for a flare's pilot flame • Gas produced as a result of specific safety-related operations, such as safety testing, leak testing, or emergency shutdown testing; • Gas containing H_2S, including the volume of gas added to ensure good dispersion and combustion • Gas containing high levels of volatile organic compounds other than methane.;
Non-routine flaring of gas is all flaring other than routine and safety flaring. Non-routine flaring is typically intermittent and of short duration. It is either planned or unplanned.	• Temporary (partial) failure of equipment that handles the gas during normal operations, until their repair or replacement, e.g. failure of compressors, flowline, instrumentation, controls • Temporary failure of a customer's facilities that prevents receipt of the gas • Initial plant/field startup before the process reaches steady operating conditions and/or before gas compressors are commissioned • Startup following facility shutdowns • Scheduled preventive maintenance and inspections • Construction activities, such as tie-ins, change of operating conditions, plant design modifications

Table 2.11 World Bank Definitions of Flaring

Definition	Examples
	• Process upsets when process parameters fall outside the allowable operating or design limits and flaring is required to stabilize the process again • Reservoir or well maintenance activities such as acidification, wire line interventions • Exploration-, delineation-, or production-well testing or cleanup following drilling or well work-over

The primary purpose of the flare system is to provide safe disposal of releases from pressure relief valves (PRVs) and depressurizations following emergency shutdown to prevent over-pressurization of all or part of the process system. Emergency flare loads shall always have a free flow-path to the flare, available at all times, for safety reasons.

No routine flaring of produced gas (i.e. continuous flaring of produced gas) will occur during normal operations. All produced gas not used as fuel at the FPSO will be reinjected into the reservoir.

Planned, non-routine flaring will occur during initial start-up of the facility and during shut-down and start-up activities related to planned maintenance turnarounds. Scheduled maintenance turnarounds involving facility shut-down are typically carried out every 3-5 years. These non-routine flaring events will typically be of short duration and will be governed by Equinor best practices to reduce overall flaring duration before shut-down. A flaring and venting plan is required to be submitted to the C-NLOPB as part of the Operations Authorization (OA) process.

The FPSO topside facilities will be designed to minimize hydrocarbon release from flaring during normal operations. Flare gas recovery systems are not sized for non-routine / safety flare loads. The design of a flare gas recovery systems shall be such that the integrity of the flare system is not compromised.

There are two separate flare sub-systems associated with the FPSO, one HP system and one LP system. The HP flare system provides capacity for full pressure relief and depressurization of the process facility in case of an emergency. The LP flare system collects gas from continuous low-pressure sources.

After the initial two stage separation process, significant volumes of gas will remain in the oil and water phases. This gas content will further decrease by heating of the oil in the crude oil heater (to meet export specifications), or as a result of the further pressure decreases towards atmospheric pressure in the produced water degassing vessel or in the cargo tanks (blanket gas). These gas releases are continuous and are collected in the LP flare header. The gas can (1) be burned in the LP flare; (2) be recovered and used as fuel gas or, (3) be recompressed and reinjected to the reservoir.

Recovery of the LP flare gas is the base case technical design for the Project. There will be no continuous flow of gas to the flare tip in normal operation. In this case a pilot flare or a type of ballistic spark ignition must be provided to ignite the gas in case of emergency flaring taking place. A design which includes a pilot flare would be consistent with standard industry practice. A pilot flare would be a very minor contribution to the overall air emissions from the FPSO. However, Equinor Canada is investigating the use of a pilotless flare design, to further minimize flaring (see Section 2.7.1.7).

Since flaring will only occur during non-routine / safety events, for safety reasons flaring would have to proceed at the time these events occur and be uninterrupted and therefore cannot be limited to daytime hours. There are no alternatives to flaring at night for non-routine/safety events. Pilotless flare option would reduce night illumination from the FPSO.

Alternative options for flare gas handling are assessed in Table 2.12.

Table 2.12 Comparison of Flare Gas Recovery Options

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
LP flare gas burning	YES	YES	YES	Increase in GHG emissions, larger environmental footprint than alternatives	✗
LP flare gas recovery, pilot flare	YES	YES	YES Increased overall costs	Minor air emissions from pilot flare in normal operations	✓
LP flare gas recovery, pilotless design	YES	YES	UNCERTAIN Increased costs compared to pilot flare	No emissions to air in normal operation	Under investigation

2.7.1.5 Produced Water Management

Produced water is typically the largest volume waste stream associated with oil and gas production (Zheng et al. 2016), and includes a combination of extracted oil/gas, formation water, injection water and/or process water (NEB et al. 2010). Produced water discharge rates associated with the Project are estimated to range from 30,000 m^3/d to 50,000 m^3/d. Volumes of produced water are anticipated to be on the lower end in the initial stages of production and increase over time.

The EIS Guidelines require Equinor Canada to identify and consider the environmental effects of alternative means of carrying out the Project, that are technically and economically feasible, including produced water management.

The base case for the Project is the treatment of produced water, using best treatment practices that are commercially available and economically feasible and discharge to sea at a water depth of approximately 20 m. A three-stage water treatment process has been selected, consisting of hydrocyclones, compact floatation units and a final de-gassing drum. The oil-in-water concentration at discharge is expected to be less than the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010) performance target of 30 mg/L (monthly rolling average).

In Norway, the current discharge limit for oil-in-water concentrations in produced water is 30 mg/L (Nesse et al. 2016), which is consistent with the OWTG (NEB et al. 2010). In the late 1990s Norway implemented initiatives to reduce oil in water discharge, and since the early 2000s there has been a significant improvement in oil-in-water performance for produced water (Nesse et al. 2016).

New installations in the Norwegian Continental Shelf (NCS) are applying a best available technology assessment and risk evaluation to determine a suitable produced water management strategy (e.g., treat and discharge or reinjection) (Nesse et al. 2016). Production facilities discharging produced water on NCS achieve oil-in-water concentrations lower than 30 mg/L, and some facilities have an annual average of 15 mg/L (Nesse et al. 2016). (Nesse et al. (2016) concluded that there is no single technique that can be considered a generic best available technology for produced water management as all fields have to be assessed on a site-specific basis, which also aligns with the OSPAR Commission (2002).

There are several aspects to consider when determining technically and economically feasible options for produced water management, including, but not limited to:

- Produced water is treated using best available technologies
- Seawater or a combination of produced water and seawater is injected to maintain reservoir pressure and maximize oil recovery
- Resource conservation

The following options were considered for produced water management and are outlined in the subsequent sections:

1) Discharge produced water to the marine environment
2) Reinject produced water into other (disposal) formations
3) Reinject produced water to the reservoir for production pressure maintenance

The assessment of alternatives for management of produced water will be further discussed in the Development Application for the BdN Development Project required under the Atlantic Accords Acts.

Discharge to the Marine Environment

The base case for the Project is to treat produced water using best available technologies with discharge to the marine environment. As outlined above, a three-stage treatment process has been selected and may consist of hydrocyclones, compact flotation units and de-gassing drum. In addition, de-sanding equipment may also be present upstream of hydrocyclones to reduce suspended solids in produced water.

Several aspects will be taken into consideration during the design and operations phase, including, but not limited to:

- Water treatment systems incorporating best available technologies to remove oil to a concentration in consideration of the discharge limits in the OWTG (NEB et al. 2010), as well as removing suspended solids
- Discharge point is located in an area that does not affect other water intake sources or the ventilation system if evaporation occurs
- As indicated in Section 2.6.3, the discharge depth will be at approximately 20 m below sea level surface
- A sampling port is available upstream of the discharge point and downstream of the last treatment unit, and prior to co-mingling with cooling water (seawater)
- Mechanisms are in place to analyze the oil-in-water concentrations every 12 hours
- A compliance monitoring plan is prepared and implemented

Reinject into a Disposal Formation

As outlined above, produced water production rates are estimated to range from 30,000 m^3/d to 50,000 m^3/d. Project field life is 12 to 20 years (Core BdN Development).

Based on data acquired from previous drilling and seismic programs in the Project Area, geologic formations capable of accepting these anticipated volumes of produced water over the Project life were not identified.

If a suitable geologic formation was available, there is a significant, unacceptable risk of over-pressuring the disposal formation, which could cause out of zone injection and has the potential for produced water to migrate to the seabed surface. Based on the information above, reinjecting produced water into a disposal formation is not technically feasible, and therefore the economics were not required to be assessed for this option.

Reinject into the Reservoir for Pressure Maintenance

Produced water reinjection as an option for pressure maintenance would require that it be mixed with seawater prior to injecting. Prior to reinjection, the produced water would have to be treated to the same level as if discharged overboard (as outlined above). The primary risks associated with produced water reinjection are formation plugging and fracturing. Other risks may include scaling and souring, however, for the Project these risks are comparable for produced water or seawater reinjection. The economic costs of produced water reinjection are also considered. An overview of the evaluation is provided below.

Well Injectivity and Formation Plugging

Plugging and fractured injection effects are important mechanisms for water injection wells and the resultant injectivity. Injection water quality can have a significant effect on the degree of well and formation plugging. Retaining high injectivity is a necessity for the technical and economic viability of the Project and for resource conservation.

Produced water reinjection generally increases the suspended solids of the injected water resulting in increased plugging and fracture growth within the reservoir. Warmer injection temperatures (typically associated with produced water injection) decreases a reservoir's thermal stress contrast compared to cold water injection hence reducing injectivity.

Injection modelling simulations have been performed for a number of fluid injection scenarios. The objectives of the study were to investigate the evolution of fracture growth over time. It should be noted that high rate injection without fracturing is uncommon, regardless of water quality. As such, modelling is not to determine if fractured injection will occur but rather the severity of fractured injection based on water quality. The simulations indicated that seawater injection is feasible in all scenarios. However, it was observed that fracture length and or uncontained fractured growth increases significantly with high suspended solid content water attributed to produced water reinjection. Increased fracture length and uncontained fracture growth may result in poor injection conformance and/or injection into undesirable zones.

Due to the presence of thin sand intervals and/or less permeable sands in portions of the reservoir, the rate of produced water reinjection would be lower than injecting seawater only, which may reduce resource recovery and/or economic viability from these sands.

Common Subsea Injection System

A common subsea injection system will be used for the BdN reservoir, Baccalieu reservoir and Project Area Tiebacks, and therefore the same water quality will be sent to all locations. Some locations have thinner sand intervals and/or less permeable sands making them more susceptive to formation plugging and uncontained injection, as discussed in the section above. Implementing separate subsea injection systems for seawater and produced water and varying by location depending on the reservoir characteristics in that location, is not economically feasible as infrastructure, equipment (e.g., risers, flowlines, pumps, etc.) and injection wells would have to be duplicated. This would impact the economic viability of the Project.

Summary

Based on the risk of plugging and fracturing, it is not technically or economically feasible to implement produced water reinjection due to the potential risk to the resource, as well as the economic viability of duplicating reinjection infrastructure and equipment. Evaluations have concluded that there are unacceptable risks with adopting produced water reinjection, and therefore the base case is to treat and discharge produced water using best available treatment technologies. The EIS considers the potential environmental effects associated with produced water discharge to the marine environment (Table 2.13).

Table 2.13 Produced Water Management Alternatives

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
3-stage treatment and discharge to sea	YES	YES	YES	Discharge of treated produced water containing residual oil	✓
Produced water reinjection to disposal formation	YES	NO	N/A	N/A – Not feasible due to absence of suitable geologic formations	
Produced water reinjection with the seawater injection	YES	NO	N/A	N/A	✗

2.7.1.6 Location of Produced Water Discharge Points

The produced water discharge point is located at the bottom of the FPSO hull at 15-20 m below sea level depending on FPSO loading conditions. This location, low in the hull, is the preferred location (as opposed to higher in the hull near the surface) as it reduces the potential for surface sheening events. Therefore, options for alternatives to produced water discharge location are not considered.

2.7.1.7 Lighting

Seabird and migratory birds may be attracted by the lighting at the FPSO. Effects associated with this interaction are discussed in Section 10.2.2. In addition, large accumulations of birds at the FPSO may cause operational challenges. Measures to reduce or mitigate the potential attraction of marine and migratory birds are being evaluated for inclusion into the design of the FPSO.

Lighting is required under Canadian and international law for maritime, crew safety and helicopter landings. Deck lighting is required 24 hours per day. Therefore, depending on the location on the FPSO, a reduction and/or an elimination of lighting as an alternative means may not be practical given the possibility of compromising the safety of operating personnel and third-party navigators.

Nevertheless, within the limitations given, measures to reduce the attraction of seabirds are being investigated and include reducing/turning off major light sources for short periods, and installation of directional / shielded lighting. Multiple sets of lighting with varying intensity with a fail safe or motion sensor-based return to maximum lighting may be considered. Equinor Canada will engage ECCC regarding lighting design when additional information and options for lighting design are available.

Spectral modified lighting, which uses green light (approximately 510 nm) has been tested on offshore platforms and has demonstrated a reduced effect on migratory bird attraction (Marquenie et al. 2014). However, this technology has not been proven to be technically or economically feasible at a commercial scale. Although this form of lighting has been shown to satisfy regulatory requirements in some industries, implementation in the offshore oil and gas industry is restricted by commercial availability of appropriately certified lighting, limited capability in extreme weather, safety concerns related to helicopter approach / landing, and lower energy efficiency (Marquenie et al. 2014). Other considerations include effects of spectral modified lighting on workers and helicopter landing especially in lower visibility conditions.

Reducing the intensity and/or turning off major light sources for short periods, direction shielded lighting and multiple sets of lighting with varying intensity depending on activity are options that will be considered during the design of the FPSO in areas where modified lighting would not compromise safety of operations and navigational requirements.

Flaring of gas at the FPSO is another source of lighting that may contribute to the attraction of birds. As discussed above in Section 2.7.1.4, no routine flaring during normal operations will occur and a pilotless flare ignition system is being evaluated.

Table 2.14 summarizes the comparison of lighting options.

Table 2.14 Comparison of Lighting Options

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
Spectral modified lighting	YES	NO	N/A	N/A	✗
Reduced/no lighting for periods of time	UNCERTAIN	UNCERTAIN	YES	May reduce attraction	Under investigation
Multiple sets of lighting with varying intensity/characteristics, e.g. reduced lighting, emergency lighting, etc.	UNCERTAIN	UNCERTAIN	UNCERTAIN	May reduce attraction	Under investigation
Direction shielded lighting	YES	YES	YES Increased cost	May reduce attraction	Under investigation
LP flare gas recovery	YES	YES	YES Increased cost	May reduce attraction	✓
LP flare gas recovery, pilotless design	YES	YES	YES Increased cost	May reduce attraction	Under investigation

2.7.1.8 Produced Sand

Refer to Section 2.8.2.1 on information regarding produced sand management.

2.7.2 Subsea Infrastructure Selection

2.7.3 Protection of Subsea Infrastructure

Subsea infrastructure (e.g. flowlines, well templates, riser bases) is the only option for development for this Project. This section considers options for the protection of the subsea infrastructure. Equinor Canada is evaluating the need for subsea infrastructure protection. In determining the need for protection measures, the level and types of historical fishing effort in the Project and Core BdN Development Areas will be considered. Options for trawl protection will be in consideration of Equinor's global experience.

2.7.3.1 Subsea Flowline Protection

Protection of flowlines from dropped objects or interference with other ocean users include trenching, rock protection and laying of concrete mattresses over the flowlines. Depending on the potential for interference (dropped objects or other users), and design of the flowlines, no additional protection of the flowlines may also be an option.

Trenching involves the use of specialized vessel that pulls an underwater plough to form a trench/furrow and lays the flowline into the furrow. For this option to be used, the seabed must be soft and easy to trench. Potential interactions and/or effects on fish habitat may occur.

Rock protection of flowlines typically includes the placement of rocks over flowlines, using a specialized vessel. Potential interactions and/or effects on fish habitat may occur, however, the rock barrier may offer new fish habitat on the seafloor.

Concrete mattresses are large blocks of concrete which are laid over flowlines. As in the other protection measures, potential interactions and/or effects on fish habitat may occur and concrete mattresses may form new fish habitat.

Table 2.15 provides an overview of the alternatives associated with subsea infrastructure protection

Table 2.15 Subsea Flowline Protection Options

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
No protection	YES	YES	YES	Potential damage to flowlines by dropped objects or other interference	Under investigation

Table 2.15 Subsea Flowline Protection Options

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
Trenching	YES	Uncertain; additional information on seabed properties required	Uncertain	Potential interference/effects on fish habitat	Under investigation
Rock Protection	YES	YES	YES	Potential interference/effects on fish habitat Potential creation of fish habitat	Under investigation
Concrete Mattresses	YES	YES	YES	Potential interference/effects on fish habitat Potential creation of fish habitat	Under investigation

As there is no preferred option for flowline protection and combinations of the options may also be used, the options discussed above will be included in the effects assessment analysis, as applicable.

2.7.3.2 Well Template Protection

Well template design may include protection measures to reduce impacts from dropped objects or other ocean users. Equinor Canada is evaluating the need for protection of the well templates. If well template protection is required, it will be built into the well template housing assembly.

2.7.4 Drilling Operations

2.7.4.1 Drilling Installation Selection

There are three main types of drilling installations which are used for offshore drilling: a jack-up, a semi-submersible, and a drillship. The technical feasibility of each of these alternatives is largely dependent on drilling water depths and met-ocean conditions.

Jack-ups rest on the seafloor and are therefore restricted to shallow water depths making them unsuitable for the Project, which features water depths of up to 1,200 m.

Semi-submersibles can be used in either shallow or deep waters; they can be moored via anchors in shallower waters or use DP to maintain location in deep water. Moorings and anchors are unsuitable in the Core BdN Development Area due to water depths of up to 1,200 m, and therefore a semi-submersible with DP is a more suitable application. However, in the larger Project Area, where water depths range from approximately 340 m to 1200 m, mooring and anchors may be suitable in the shallower depths. Drillships also use DP to maintain their location. In deeper waters (> 500 m), semi-submersibles or drillships are the preferred drilling installation.

The selected drilling installations must be capable of drilling year-round in the environmental conditions predominant in the North Atlantic. Over the life of the Project, there may be multiple drilling installations actively engaged in drilling activities in the Project Area at any one time. The process for drilling installation selection will evaluate technical feasibility in consideration of previous operating history, water depths and environmental operating conditions in the Project Area. Additional factors, such as safety and environmental performance, automation, digitalization and contract competitiveness will also be taken into consideration when selecting the drilling installation(s). Table 2.16 provides a comparison of drilling installation options.

Table 2.16 Comparison of Drilling Installation Options

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
Semi-submersible	YES	YES	YES	Both semi-submersible and drillship options considered acceptable assuming appropriate controls are implemented	✓
Drillship	YES	YES	YES		
Jack-up	YES	NO	Not a feasible option		

Since the preferred option is not yet chosen, both semi-submersibles and drillships are considered in assessment of potential environmental effects. Where one type of drilling installation may have a larger environmental footprint that option will be used in the assessment (i.e., a drillship tends to be "noisier" than a semi-submersible and was used as the option in sound modelling in Appendix D).

2.7.4.2 Water Management and Location of Final Effluent Discharge Points

As described in the Drilling EIS (see Section 2.10.1.4; Statoil 2017), the discharge points on a drilling installation are fixed and cannot be changed or re-configured. A drilling installation has yet to be selected for the Project. Therefore, alternative locations for effluent discharge points are not available. Typically, effluent discharge points are located near or under the water's surface. Similarly, the water management system (e.g., intake, storage, distribution, discharge) will be dependent on the configuration of the drilling installation's water system, and alternative systems will not be available. A Certificate of Fitness for the drilling installation will be required and obtained from a CA, in accordance with requirements of the Accord Acts and an OA from the C-NLOPB, to confirm that the effluent discharge and water management system comply with relevant legislation.

2.7.4.3 Chemical Selection

Chemicals used for drilling activities will be subjected the same chemical selection and management process outlined in Section 2.7.5.

2.7.4.4 Drilling Fluids Selection

Drilling fluid, also known as drilling mud, is required to lubricate the drill bit and carry the drill cuttings out of the well while drilling. Drilling fluid selection is part of the well design process and evaluated on a section by section basis. Drilling fluids are typically a combination of different products including base fluid, viscosifiers, weighting agents and other additives to ensure the well can be drilled safety and efficiently. The selection and use of drilling fluids will meet internal Equinor requirements, as well as the requirements outlined in the OCSG (NEB et al. 2009).

The well design will typically recommend the use of WBM (primarily seawater) for the riserless hole sections, while for the sections with riser installed the evaluation will consider both WBM and SBM as drilling fluids.

Although the drilling fluid recommendation has not yet been finalized for the Project, considerations will be given to internal best practice, offset well history performance, and local regulatory requirements pertaining to the Project Area. Proven in previous drilling campaigns, similar to the Project Area, the use of WBM/seawater during riserless drilling and SBM in subsequent sections is the preferred option.

The use of SBM is superior to WBM for the following technical reasons:

Wellbore stability

SBM provides greater hole stability and maximizes the opportunity for casing strings to be installed and properly cemented at the desired depths. The use of WBM would likely result in increased hole washouts, which would increase the volumes of drilling fluid and drill cuttings to be discharged to the environment. The use of WBM would also likely result in increased drilling-related issues such as stuck pipe and hole collapse, thereby increasing operational and scheduling costs.

Gas hydrate inhibition

There is an increased risk of hydrate formation in and around the wellhead and BOP stack with the additional free water available in WBM. SBM is designed to, and has proven to, mitigate against hydrate formation at the expected temperatures and wellhead pressures, thereby reducing potential safety concerns while drilling.

Casing wear

Casing wear is a measure of the remaining wall thickness and is affected by several factors – string tension, side wall force and friction. SBM is more conducive to drilling the planned wellbore when compared to WBM minimizing trajectory corrections and reducing side wall forces. Friction is better managed with use of SBM due to it having a lower coefficient of friction and a higher lubricity value than WBM. In extended drilling operations the use of SBM is a measure to mitigate against accelerated casing wear and the loss of integrity of casing.

<u>Reusable fluid</u>

SBM typically has a longer usable shelf life than WBM and the potential for reuse of SBM is much greater than WBM.

As described in Section 2.8.2, for the use of SBM, the best available treatment technology that is economical and commercially available will be used on-board the drilling installation to achieve the synthetic oil-on-cuttings (SOC) target level in the OWTG (NEB et al. 2010).

A high-level comparison between WBM and SBM is provided in Table 2.17. The final selection of drilling fluids will be conducted in accordance with the OCSG (NEB et al. 2009) and their management will be carried out in accordance with the OWTG (NEB et al. 2010). The EIS considers the use of both fluids in the assessment of potential environmental effects.

Table 2.17 Comparison of Water-based and Synthetic-based Drilling Muds

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
WBM	YES Use and management in accordance with OWTG and OCSG	NO Technically inferior in deeper sections of well	NO Potential economic increases if used in deeper sections of well	WBM acceptable for upper hole sections; SBM acceptable for lower well sections. For both options, it is assumed appropriate controls are implemented and OCSG is followed. Both options considered in assessment of potential environmental effects	✓ Use of WBM for upper well sections when drilling without riser installed
SBM	YES	YES Technically superior for deeper sections of well	YES		✓ SBM to be used at lower well sections with riser installed.

2.7.4.5 Drilling Waste Management

The management of drill cuttings will be dependent on the selected drilling fluids and will be managed in accordance with the OWTG (NEB et al. 2010). There are three potential options for the management of drilling waste: disposal at sea, shipping waste to shore, and reinjection of waste.

In accordance with the OWTG, WBM and associated cuttings can be discharged at sea without treatment. During riserless drilling of the first two sections of a well, the WBM and cuttings cannot be returned to the drilling installation for collection and disposal by an alternate method (i.e., ship to shore). The only technically and economically feasible option for the management of WBM and cuttings is when the flow stream of the fluid and cuttings directly disperses at the seafloor. No other options are assessed.

The discharge of WBM and associated cuttings at the seafloor can include use of a cuttings transfer system. This system typically includes a wellhead interface module, suction hose with pump, discharge hose and discharge module. The discharge point can be up to 500 m from the well template. The use of a cuttings transport system (CTS) will be determined during detail design stage of the Project and is often used to prevent the buildup of cuttings around the well template location.

The options for disposal of SBM drill cuttings include overboard discharge after treatment on-board the drilling installation, reinjection into a disposal well or shipped to shore for disposal at an approved waste management facility.

Information regarding the treatment of SBM cuttings is provided in Section 2.8.2, below. Equinor Canada will assess available drill cuttings treatment technology with the goal of using the best available proven technology that is commercially available and economically feasible.

In the case of onshore disposal, the cuttings would have to be shipped to the island of Newfoundland, and then transported to the nearest waste treatment facility in NL or eastern Canada. There are additional safety and environmental risks associated with the increased handling, transfer and transportation of SBM cuttings. While ship-to-shore reduces potential effects on the marine environment, there is the potential for increased environmental effects due to increased transport-related air emissions. There is also potential for additional effects related to the onshore treatment and disposal (e.g., potential habitat loss). With respect to economic feasibility, there are increased costs associated with transportation and operational delays if waiting on a supply vessel to ship the material.

Reinjection involves processing cuttings waste into a slurry and pumping it into a dedicated disposal well. The slurrification and reinjection of drill cuttings for a stand alone deep water subsea development is not technically or economically feasible. The process involves direct access to a disposal well or injection zone, which is not feasible in the case of a floating (non-fixed) drilling installation. There are also no injection zones identified in the Core BdN Development Area.

The preferred alternative for the Project is the disposal of WBM at sea and treatment of SBM cuttings on the drilling installation prior to discharge at sea. The recovered SBM is reconditioned and reused until it is spent, at which point it is returned to shore for disposal at an approved facility. A comparison of drilling waste disposal options is provided in Table 2.18.

Table 2.18 Comparison of Drilling Waste Disposal Options

Fluid Type	Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
WBM	Disposal at Sea	YES	YES Will only be used during riserless drilling; therefore, cannot be returned to drilling installation for collection	N/A	Localized effects on seafloor	✓ Disposal at sea during riserless drilling
	Disposal on shore	YES	NO Will only be used during riserless drilling; therefore, cannot be returned to drilling installation for collection	✗ Not considered as an option as not technically feasible		
	Offshore reinjection	YES	NO	✗ Not considered as an option as not technically feasible		
SBM	Disposal at Sea	YES	YES	YES	Localized effects on seafloor	✓
	Disposal on shore	YES	YES	NO Increased costs due to increased transportation and operational delays	Increase in GHG emissions, larger environmental footprint	✗
	Offshore reinjection	YES	NO	✗ Not considered as an option as not technically feasible		

2.7.4.6 Lighting

Options to reduce lighting on the FPSO are discussed in Section 2.7.1.7, above. Drilling installations are chosen based on a competitive bid process and typically are existing installations built to international standards and requirements to operate in various jurisdictions. Options for lighting mitigations on drilling installations are not feasible (as discussed in Section 2.10.1.3 of the Drilling EIS; Statoil 2017). In addition, drilling, in comparison to the operation of the FPSO will be a short-term activity. Options for lighting alternatives on the drilling installation are not considered.

2.7.4.7 Flaring during Development Drilling

During development drilling, flaring is not typically carried out. As described in Section 2.6.2, it is anticipated that one formation flow test will be required for the Project. Depending on the type of data required, either a formation flow test with flaring using production equipment onboard the drilling installation, or a Formation Testing While Tripping, where production equipment is not required, and flaring is not carried out, may be undertaken. When well fluids are sent through the wellbore and to the drilling installation for testing, it is in a closed casing and does not interact with the surrounding marine environment.

Alternative to flaring are discussed in detail in Section 2.10.1.6 of the Drilling EIS (Statoil 2017). However, for development drilling, the preferred option is to send all fluids to the FPSO, however the option to flare from the drilling installation would be maintained.

2.7.5 Chemical Selection

As stated previously, the Project is in the early stages of project design and information regarding chemicals for production and / or drilling activities are yet to be determined. However, in terms of chemical selection, Equinor has established chemical selection and management processes, which will be used during project design, crude processing planning, and well planning and design. The chemical selection and management process is aligned with the OCSG (NEB et al. 2009), and other regulatory requirements (Table 2.19) to enable the selection of chemicals that, once discharged at sea, would have the least effect on the receiving environment.

Table 2.19 Legislation and Guidelines for Offshore Chemical Management

Legislation	Regulatory Authority	Relevance
Canadian Environmental Protection Act (CEPA)	Environment and Climate Change Canada (ECCC)	Provides for notification / control of certain manufactured and imported substances. It includes the Domestic Substances List (DSL), which is a list of substances approved for use in Canada. Schedule 1 of the DSL includes substances considered toxic and associated restrictions or phase-out requirements.
Fisheries Act	DFO; ECCC	Prohibits deposition of deleterious substances into fish-bearing waters.
Hazardous Product Act	Health Canada	Chemical classification and hazard communication standards.
Migratory Birds Convention Act, 1994	ECCC	Prohibits deposition of harmful substances into waters / areas frequented by migratory birds.

Table 2.19 Legislation and Guidelines for Offshore Chemical Management

Legislation	Regulatory Authority	Relevance
Pest Control Products Act	Health Canada	Regulates importation, sale, and use of pest control products including biocides used in offshore oil and gas operations.
OCSG (NEB et al. 2009)	National Energy Board (NEB), C-NLOPB and Canada Nova Scotia Offshore Petroleum Board (CNSOPB)	Framework for selection of drilling and production chemicals for use and potential discharge in the offshore marine environment.

The OCSG (NEB et al. 2009) provides a procedure and criteria for offshore chemical selection. Its objective is to promote the selection of lower toxicity chemicals to reduce the potential environmental effects of a discharge where technically feasible. The OCSG chemical selection process is presented in Figure 2-13.

2.7.5.1 Proposal for Use: Initial Screening and Regulatory Controls Identification

As shown in Figure 2-14 (Steps 1-4), the proposed chemical is screened to determine whether it is restricted for use by other legislation, as identified in Table 2.19. Screening includes specific aspects of the use of the chemical, including likely volume demand and discharge assumptions.

In line with the regulations, certain restrictions, controls and prohibitions may be placed on:

- Chemicals used as a biocide
- Chemicals that have not been approved for use in Canada (i.e., are not registered on the DSL) or have not been used previously for the purpose which is proposed
- Chemicals that are identified as toxic under Schedule 1 of CEPA. In the event that a proposed chemical is listed under Schedule 1 of CEPA, Equinor Canada will consider alternative means of operation, and / or will evaluate less toxic alternatives

2.7.5.2 Chemicals Intended for Marine Discharge: Toxicity Assessment

For those chemicals that are proposed for discharge to marine environment, further assessment is undertaken (Steps 5-10). This assessment evaluates the potential toxicity of the proposed chemicals (and any constituents of the chemical as applicable), and to establish if additional restrictions, controls or prohibitions are required.

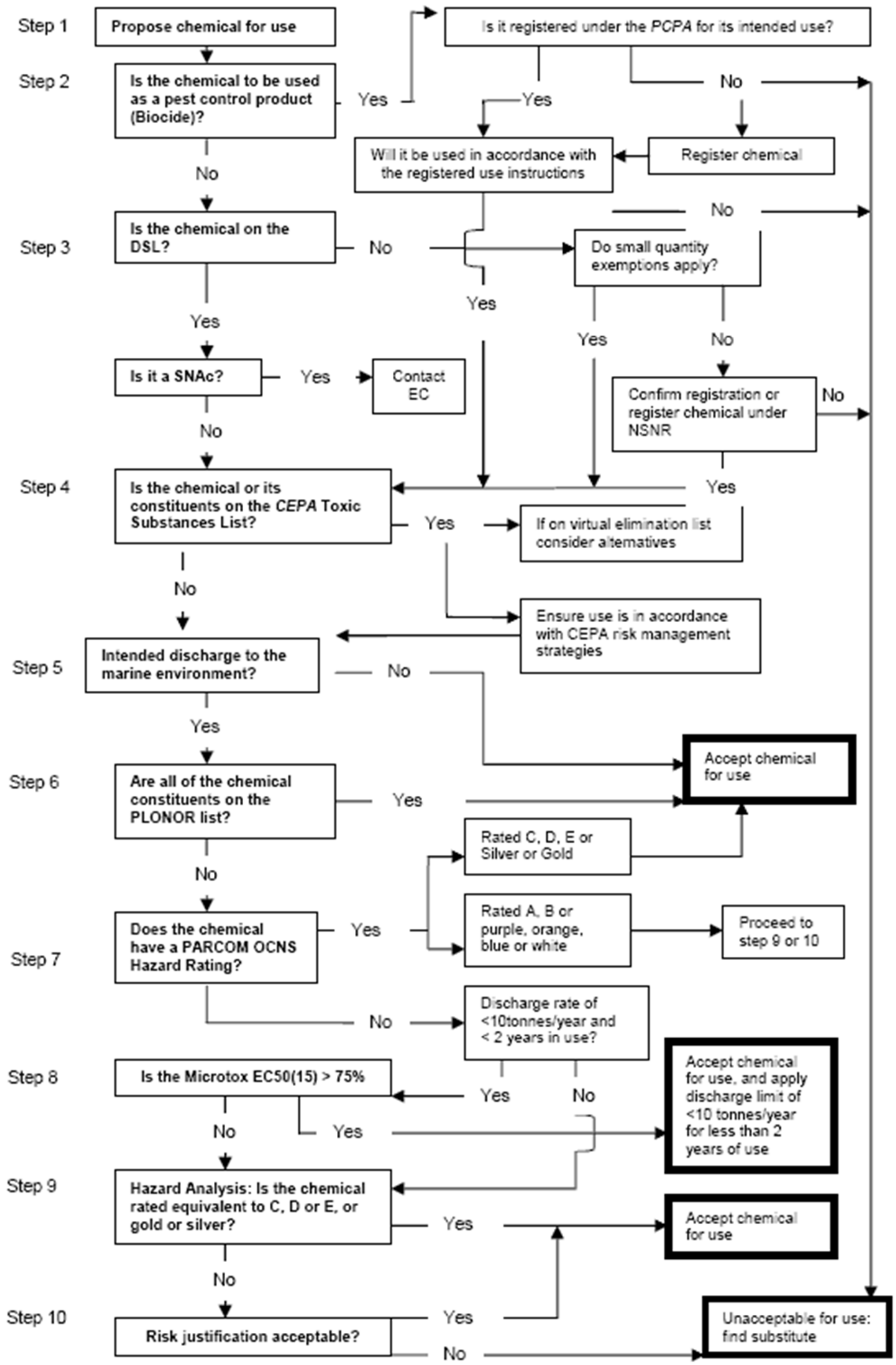


Figure 2-14 Chemical Selection Flowchart (NEB et al. 2009)

As outlined in Figure 2-14, chemicals intended for discharge to the marine environment are reviewed against various criteria. Chemicals intended for discharge to the marine environment must:

- Be included on the OSPAR list of substances that Pose Little or No Risk (PLONOR) to the environment, or
- Meet certain requirements for hazard classification under the Offshore Chemical Notification Scheme (OCNS); or
- Pass a Microtox test (i.e., toxicity bioassay); or
- Undergo a chemical-specific hazard assessment in accordance with the OCNS model; or
- Demonstrate that the risk of its use is justified through demonstration to the C-NLOPB that discharge of the chemical will meet OCSG objectives

Each criterion, as outlined below, is reviewed for applicability before preceding to the next step.

- OSPAR PLONOR List: If a proposed chemical is included on the OSPAR PLONOR list, it will be considered acceptable for use and discharge in line with OCSG.
- OCNS Hazard Classification: if the proposed chemical that is intended for discharge to the marine environment is not included on the OSPAR PLONOR list, it is reviewed to determine the OCNS hazard rating. This scheme ranks chemical products per a hazard quotient (HQ) based on a range of physical, chemical and ecotoxological properties of products, including toxicity, biodegradation and bioaccumulation information.
- The Chemical Hazard and Risk Management (CHARM) model is used to determine the HQ, which is then used to rank chemicals into groups, linked to their expected hazard rating. If the chemical that is proposed for use is ranked as being least hazardous under OCNS (i.e., C, D or E, gold or silver), the chemical is considered acceptable for use and discharge.
- Microtox Test and Chemical-Specific Hazard Assessment: Where a proposed chemical intended for discharge does not have an OCNS rating, Equinor Canada will work with the chemical contractors to undertake toxicity testing (Microtox test) to determine the potential toxicity of the chemical. If the chemical passes the test and is considered non-toxic, restrictions may be required on discharge volumes and time limits in line with the OCSG. If the chemical does not pass the test, it will be subject to a hazard assessment as per OCSG to determine suitability for use.
- Risk Justification: Where a proposed chemical intended for discharge is not ranked as C, D or E, or gold or silver under the OCNS, Equinor Canada will consider alternative means of operation, and / or will evaluate less toxic alternatives. If it is not possible to identify alternatives, a hazard assessment to determine its suitability of use in line with the OCSG will be undertaken. The hazard assessment process is documented and provided to the C-NLOPB to allow them to evaluate whether that the objectives of OCSG have been met.

Since the BdN Project is in the early design stages, it is not known the volumes and/or specific chemicals that could be used for production and drilling activities. Chemicals intended for discharge to the marine environment will be detailed in the Environmental Protection Plan (EPP), which is submitted to the C-NLOPB for review and acceptance as part of the regulatory requirements for an OA.

Based on Equinor's global production and drilling experience, the following categories of chemicals are anticipated to be required during the Project, which may be discharged to the marine environment. The list is not all-inclusive and will be finalized during Project design.

- Biocides or antibacterial chemicals
- Oxygen scavengers
- Corrosion inhibitors
- Emulsifiers
- Hydrate inhibitors
- Drilling completion fluids, including sweeps and displacement fluids
- Well treatment fluids
- (BOP) fluids
- Cement slurry
- Hydraulic oil
- Fire suppressants

Safety Data Sheets (SDS) for chemicals will be available on board the drilling installation and the FPSO.

2.7.6 Seismic Surveys

As described in Section 2.6.5 Equinor Canada is considering 4D seismic surveys to provide data on the reservoir as production continues. Two options are considered (1) permanent reservoir monitoring where OBCs or OBNs are installed on the seafloor for the duration of the project, or (2) conventional seismic using either temporary OBNs or towed streamers. Surveys using OBC or OBNs provide better data and tend to be higher in cost than surveys using towed streamers but may provide greater economic value to the Project overall due to improved resource recovery.

Conventional seismic surveys typically involve the use of specialized vessels to tow multiple streamers from the rear of the vessel. Use of specialized vessels to tow steamers would limit the timing of surveys as it would depend on the availability of the seismic vessels. Conventional seismic surveys could be between two and four weeks and occur as frequently as once per year in early Project life, with reduced frequency in later years. Timing and duration of surveys are estimated and will be finalized during Project design.

Permanent reservoir monitoring provides flexibility in the timing of seismic surveys, as a specialized vessel is not required to tow the streamers; the seismic sound source could be towed from a Project OSV. It is estimated that surveys would be between one to two weeks and be carried out approximately two times per year.

While the preferred option is to use fixed hydrophones, Equinor Canada has not made final decision regarding which option will be undertaken. For the purposes of EA, both options will be assessed in the EIS (Table 2.20).

Table 2.20 4D Seismic Survey Options

Option	Legal Acceptability	Technical Feasibility	Economic Feasibility	Potential Environmental Issues	Preferred Option
Permanent reservoir monitoring	YES	YES	Likely higher cost than conventional seismic but better field data may improve resource recovery	More frequent surveys; seabed interference	Under investigation
Conventional seismic – temporary OBNs	YES	YES	Likely higher cost than conventional seismic but better field data may improve resource recovery	More frequent surveys, seabed interference	Under investigation
Conventional seismic – towed streamers	YES	YES	YES, but data quality is lower than in fixed seismic	Less frequent; no seabed interference	Under investigation

2.7.7 Timing and Approach of Project Activities in Relation to Fishing Activities

As discussed in Section 7.1, there is no domestic commercial fishing activity within the Core BdN Development Area and fishing activity in the Project Area is focused primarily in the western and northern sections. Since very limited commercial fishing activity occurs in the area, and with ongoing communication with fishers (see Chapters 13 and 14), interactions with fishing activities are anticipated to be negligible. Therefore, alternatives to the timing and approach of proposed activities is not required.

2.7.8 Decommissioning

Refer to Section 2.6.7 for decommissioning options.

2.8 Waste Discharges and Emissions

The primary waste streams from the Project are categorized as follows:

- Air emissions
- Liquid wastes
- Drilling and completion waste
- Heat, light and sound
- Hazardous and non-hazardous waste

The OWTG (NEB et al. 2010) provide performance targets for overboard discharges from production and drilling operations. In accordance with the OWTG and where applicable, discharges will be treated using best treatment practices that are commercially available and economically feasible before being released overboard. The Project's EPP, as required by the OA, will provide details regarding the management of wastes, discharges and emissions for the Project. The EPP will be prepared in accordance with the *Drilling and Production Regulations* and associated guidelines and submitted to the C-NLOPB for acceptance as a requirement of the OA application process. As described in Section 2.7.5, chemicals used for drilling operations will be screened in accordance with Equinor Canada's chemical management and selection process that adheres to the OCSG (NEB et al. 2009). The chemical selection and management process will be included in the EPP.

The volumes of wastes are unknown as the Project is in the early stages of design. The quantity of waste will depend on final design of the FPSO, choice of drilling installation, production process design, well design, and numbers of personnel on the FPSO and/or drilling installation. Estimated volumes of wastes are provided based on operational experience of other Equinor-operated FPSOs.

The following sections provide an overview of waste management for the Project.

2.8.1 Air Emissions

The Project will operate in accordance with the *Canadian Environmental Protection Act*, through the National Ambient Air Quality Objectives for specified criteria air contaminants, the Ambient Air Quality Standard for fine particulate ($PM_{2.5}$), and the IMO relevant regulations and emission limits under MARPOL. The IMO is also considering mandatory energy efficiency measures on vessels and data collection systems, which will further reduce GHG emissions in the offshore. On a federal level, through the Pan-Canadian Framework on Clean Growth and Climate Change, GHG emission reduction targets have also been set and include the following:

- A 17 percent reduction below the 2005 emission levels by 2020 (under the 2009 Copenhagen Accord)
- A 30 percent reduction below the 2005 emission levels by 2030

Provincially, air emissions, including CACs, are regulated under the NL *Air Pollution Control Regulations* and GHGs under the *Management of Greenhouse Gas Act*. The Government of NL is pursuing regulatory amendments to the Accord Acts to include GHG regulation in the offshore area. It is anticipated that regulatory amendments will be achieved prior to Project commencement and as such the Project will be required to meet the performance targets set out under the provincial regulations.

The sulphur content in diesel fuel associated with project vessels will meet the *Sulphur in Diesel Fuel Regulations* and will comply with the sulphur limits in fuels for large marine diesel engines, per the *Vessel Pollution and Dangerous Chemicals Regulations* under the *Canada Shipping Act, 2001*.

Air emission components associated with the Bay du Nord development project, including CACs and GHGs emissions, are CO_2, NO_X, SO_X, methane (CH_4), VOC, carbon monoxide (CO), nitrogen oxide (N_2O) and particulate matter (PM). The main sources of air emissions are the following:

- Power generation at the FPSO
- Drilling and well operations
- Marine operations – offshore construction and installation

- Flaring
- Vessel transport
- Helicopter
- Shuttle tanker

As illustrated in Figures 2-15 and 2-16, which show estimated yearly CO2 emissions for power generations options, the largest source of CO_2 emissions is associated with power generation on the FPSO, which contributes approximately 85 percent of the total CO_2 and GHG emissions over the lifetime of the field. In the initial stages of the Project during drilling (approximately three to five years in duration) and later in the field life, if undertaken during Project Area Tiebacks, the contribution to air emissions from power generation from the drilling installation are more notable, but much less than power generation on the FPSO. As noted in Section 2.7.1.2, power generation options being evaluated for the Project are reciprocating engines and/or a gas turbine. Emissions from offshore construction activities show a similar increase in the early Project phases and again should Project Area Tiebacks occur, but emission volumes are much less. Minor contributions from flaring, OSV and SBVs, helicopters and shuttle tankers will apply throughout the lifetime of the Project.

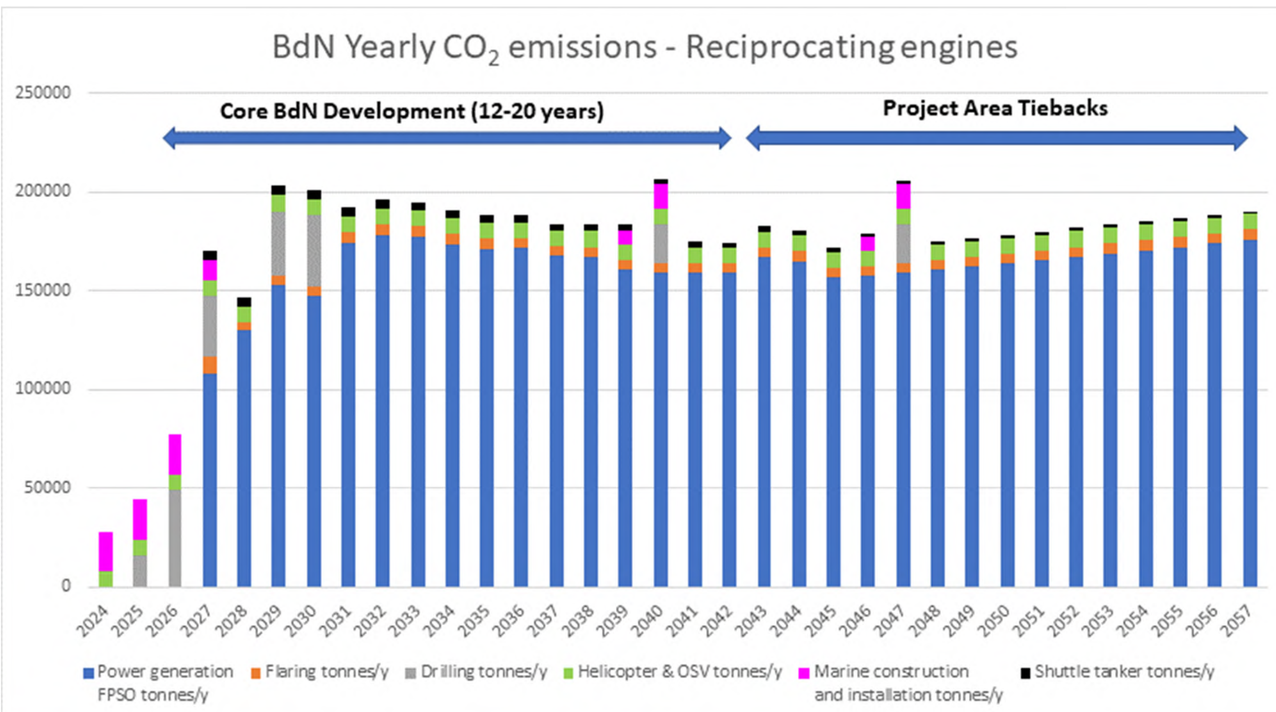


Figure 2-15 Lifetime Estimated CO_2 Emissions from the Project (based on preliminary design as of November 2018) – Reciprocating Engines Option

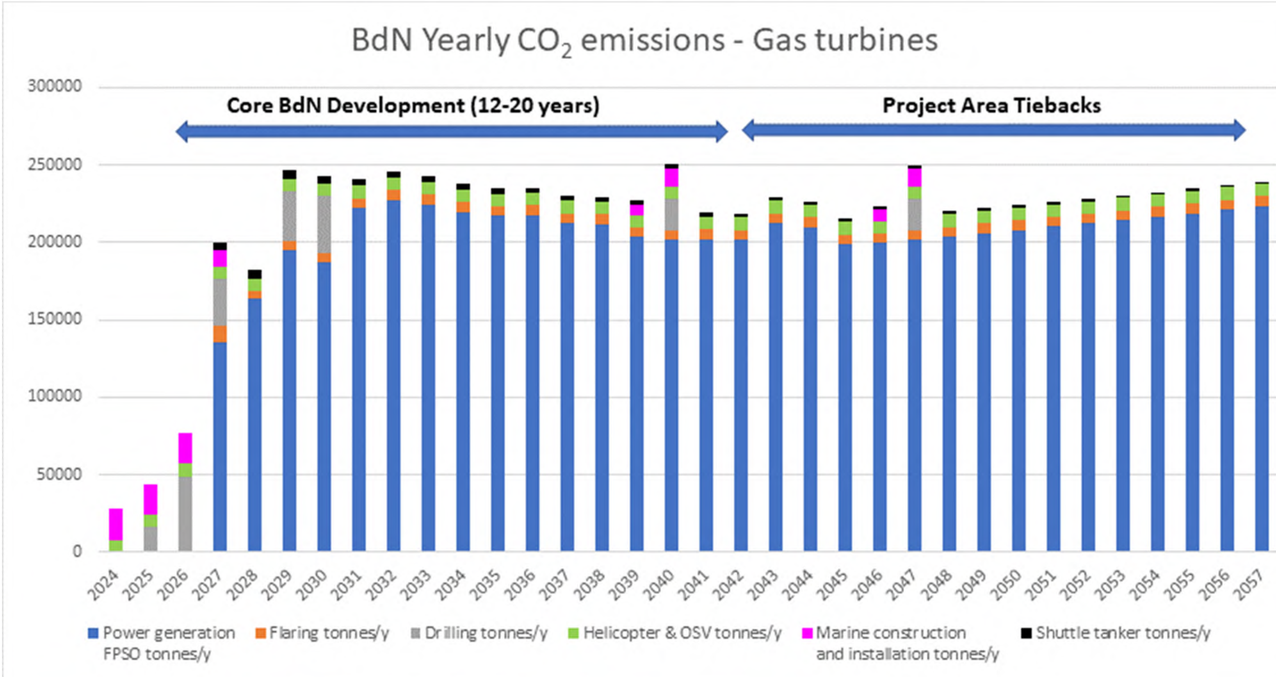


Figure 2-16 Lifetime Estimated CO_2 Emissions from the Project (based on preliminary design as of November 2018) – Gas Turbines Option

Fuel at the FPSO in normal operation is produced gas, while diesel is used at the drilling installation, marine construction and installation vessels, OSVs and shuttle tankers. The relative contribution by the various emission source varies by air pollution component. Typically, diesel has higher emissions of NO_x and SO_x than produced gas.

The discussion in the following sections provides an overview of air emissions associated with the project. Chapter 8 provides an estimate of all emissions and results of air emissions modelling.

2.8.1.1 Production Installation

Air emissions from the FPSO will occur continuously, starting when the facility arrives at the Project location and throughout the 30-year duration of the Project.

Project activities that will result in air emissions include:

- Power generation (CO, NO_2, total particulate matter (TPM), SO_2 (if diesel fuel), GHGs)
- Flaring (CO, NO_2, TPM, SO_2, GHGs)

As stated above, the primary source of emissions is from power generation. Power generation on the FPSO will be provided by reciprocating dual fuel (gas/diesel) engines or dual-fuel turbines. Gas is the primary fuel for power generation and will be supplied from the processing of the crude oil. Diesel will be used if gas is temporarily unavailable.

No routine flaring will occur at the FPSO (refer to Sections 2.6.2 and 2.7.1.4). Non-routine / safety flaring may take place throughout the life of the field if depressurization is required during process upsets, well-clean up and during start-up and shut-down of process systems. Emissions from flared gas will vary from year to year. Based on Equinor's global experience, it is estimated that emissions from flared gas will be in the order of 2 to 5 percent of the emissions from power generation. Until gas injection comes on stream, somewhat higher flaring activity may be expected during the first year of production. In accordance with Section 6(e) of the Newfoundland Offshore Petroleum Drilling and Production Regulations, Equinor Canada will submit a flaring plan to the C-NLOPB as part of the OA process. The flaring plan will outline the estimated rate, quantity, and timeframe of proposed flaring during Project.

2.8.1.2 Drilling Installation

Drilling activities are estimated to occur for approximately three to five years at the early stages of the Project and later, if Project Area Tiebacks occur. The primary source of air emissions from the drilling installation will be from power generation. As stated previously, during well-clean up activities, where fluids from the wellbore are flared, the base case is to do these activities to the FPSO. In addition, it is not anticipated that well formation testing with flaring will be required. However, the drilling installation will maintain the ability to flare during well clean-up and formation flow tests, if required. Air emissions associated with drilling are the same as those listed above for the FPSO. If formation flow testing with flaring is required, the emissions and estimates associated with this activity would the same as those described in the Drilling EIS (refer to Section 2.5.2.4 in Statoil 2017).

2.8.1.3 Marine Construction and Installation Vessels

Air emissions from marine installation vessels will take place during the initial construction and installation period (2020 to 2024) and later in the Project life if Project Area Tiebacks are carried out. Emissions associated with vessels include CO, NO_2, TPM, SO_2, VOCs, and GHGs.

2.8.1.4 OSV, Shuttle Tanker and Helicopter

Air emissions from OSVs, shuttle tankers and helicopters will occur throughout the 30-year lifetime of the Project. The main source of air emissions is power generation, reciprocating diesel engines in OSVs and shuttle tankers, and jet-fuelled turbine engines for helicopters and include CO, NO_2, TPM, SO_2, VOCs, GHGs.

2.8.2 Liquid Wastes

The water management system for the FPSO will manage the following systems: potable water, produced water, cooling water, bilge and deck drainage water, ballast water, grey / black water (sewage), cooling water, and fire control water. For the drilling installation, the management system will be dependent on its configuration system, but will, at a minimum likely manage the following: potable water, bilge and deck drainage, ballast water, grey / black water, and fire control water.

Liquid wastes will be generated on both the FPSO, the drilling installation and vessels involved, and will be treated using best treatment practices and managed in accordance with the OWTG (NEB et al. 2010). As the Project is in the early stages of design, anticipated volumes as indicated below will depend on final design of the FPSO and are subject to likely change. Table 2.21 provides an overview of estimated liquid wastes associated with the Project, which includes the Core BdN Development and Project Area Tiebacks, including the FPSO, subsea system, drilling installation and vessels.

Table 2.21 Estimate of Volumes of Discharges for the Project

Discharge	Location	Volume	Comments
FPSO and Subsea Facilities			
Produced water	FPSO	30,000 to 50,000 m^3/d	The largest source of waste discharge to the marine environment from the Project. Produced water will be treated prior to discharge. See further details in Section 2.8.2.1.
Produced sand	FPSO	Minor, not quantified	Sand cleaning package included in design (sand cyclones). Produced sand will be discharged to the marine environment if oil concentration is lower than 1 percent by weight on dry sand, otherwise it will be shipped to shore for disposal to a licensed facility.
Cooling water	FPSO	0- 80,000 m^3/d	Seawater with a temperature of approximately 35°C at discharge. Volumes uncertain and depend on temperatures of arriving well fluids during production. See further details in Section 2.8.2.1.
Hydraulic fluid	FPSO – discharge at subsea well templates (operation of valves at subsea wellheads and manifolds)	15 - 80 m^3/year	Open hydraulic system. Each valve movement will lead to a small volume of hydraulic fluid being released to the marine environment. Based on global Equinor experience, such operations will on average result in the discharge of 1.5 to 2 m^3/year per wellhead of hydraulic fluid in a subsea system similar to the one planned for the Project. Total number of wells for the Core BdN Development is between 10 to 40, which equates to approximately 15 m^3 to 80 m^3 of hydraulic fluid discharged per year. The hydraulic fluid is water-based and consists of 90 percent water and glycol, the remaining 10 percent is mainly synthetic oils. The hydraulic fluid will be screened in accordance with Equinor Canada's chemical management and screening system (refer to Section 2.7.5 for more information).

Table 2.21 Estimate of Volumes of Discharges for the Project

Discharge	Location	Volume	Comments
Commissioning and pressure testing of subsea flowlines	FPSO – discharge at subsea well templates	Total volume all flowlines – 3000 m³	Preliminary design estimates; volumes may change. Chemicals may include MEG, dyes, oxygen scavengers (see Section 2.6.1.4).
Drilling Installation			
Drilling mud and cuttings • WBM/Seawater • SBM	Drilling installation	Volumes per. well 350 m³ 380 m³	A combination of WBM / seawater and SBM will be used to drill wells. WBM is comprised primarily of seawater as a base fluid with additions of barite. The SBM is a synthetic oil with a base fluid made up of internal olefins, alpha olefins, polyalphaolefins, paraffins, esters or blends of these materials. Offshore NL, most operators currently use PureDrill IA35-LV as the base fluid for SBM. Drilling wastes will be managed in accordance with the OWTG. See further details in Section 2.8.2.2
Well completion fluid	Drilling installation	50 - 200 m³	The completion fluid will be either a brine or oil-based fluid with low solids, containing small quantities of chemicals to protect the well. At well start-up completion fluid will be routed to the test separator or first stage separator at the FPSO and discharged via the produced water treatment system. See further details in section 2.8.2.2.
Cement	Drilling installation	50 – 400 m³	See further details in section 2.8.2.2.
BOP fluids	Drilling installation – discharge subsea at well locations	< 10 m³/well	The BOP fluids typically consist of a mixture of water and glycol (90/10) and will be discharged to the sea at the well locations. See further details in section 2.8.2.2.
All Installations (i.e. FPSO, Drilling Installation and Vessels)			
Deck drainage water • Uncontaminated • Contaminated	FPSO, drilling installation and other vessels	Not quantified. Depending on precipitation and sea spray intensity.	Uncontaminated deck drainage is routed directly to the marine environment. Contaminated deck drainage is routed to the closed drain system followed by cleaning in available water treatment systems before discharge to marine environment.

Table 2.21 Estimate of Volumes of Discharges for the Project

Discharge	Location	Volume	Comments
Bilge water	FPSO, drilling installation and other vessels	<1 m³/d (FPSO) Less for other vessels and installations	Small volumes stemming from machinery spaces in offshore facilities and support vessels. The FPSO and drilling installation will have available water treatment systems before discharging to the marine environment. Bilge water on vessels will either be contained and treated before discharge or contained and shipped to shore for treatment. Compliance with MARPOL 73/78b (vessels) and OWTG (FPSO and drilling installation).
Ballast water	FPSO, drilling installation and other vessels	Highly variable. Total ballast tank volume at the FPSO is approx. 60,000 m³.	Uncontaminated seawater. All ballast systems are closed and separated from systems containing crude oil or contaminants of any other type
Grey / black water (sewage)	FPSO, drilling installation and other vessels	10-15 m³/d (FPSO)	Grey water will be generated from galley, washing, and laundry facilities, and black water will be generated from the accommodation areas (sewage). Sewage and grey water will be managed in consideration of the OWTG and discharged to sea.
Other liquid wastes	FPSO, drilling installation and other vessels	No discharge	Hazardous liquid wastes such as waste chemicals, cooking oils or lubricating oils are stored and transported to shore for disposal at an approved facility

Best treatment practices for liquid wastes discharges to the marine environment will be outlined in Equinor Canada's EPP, which will be submitted to the C-NLOPB for review and approval as part of the OA application.

The following sections provide an overview of the largest and most important sources of liquid wastes that are specific to either the FPSO or the drilling installation

2.8.2.1 Production Installation

The primary liquid wastes associated with the operation of the FPSO are produced water and cooling water.

Produced Water

As described in Section 2.7.1.5, the base case is to treat produced water and discharge to sea. The oil-in-water concentration at discharge will as a minimum be in consideration of the OWTG (NEB et al. 2010) performance target of 30 mg/L (monthly rolling average). The produced water treatment process that has been selected for the Project is in line with the best treatment practices that are commercially available and economically feasible.

Cooling Water

Cooling water will be used for process cooling purposes on the FPSO. The cooling water system is combined with the seawater injection system which is needed to provide pressure support in the reservoir. Cooling water volumes in excess of required injection water volumes will be discharged to sea. The cooling water will be co-mingled with the produced water prior to discharge. Cooling water may be treated with biocides or through electrolysis to prevent microbiotic growth and biofouling. If biocides are used, they will be selected using Equinor Canada's chemical selection system and consistent with the OCSG (NEB et al. 2009) and will be discharged in accordance with the OWTG (NEB et al. 2010). The temperature of the combined discharge of cooling water and produced water will be approximately 35°C.

Disposal of Produced Sand

A sand cleaning package is included in the topside process design (sand cyclones). Options for produced sand management include disposal to sea if oil concentration is lower than 1 percent by weight on dry sand or collected and shipped to shore for disposal at an approved waste management facility.

2.8.2.2 Drilling Installation

The primary waste associated with drilling and completing a well are drill mud and cuttings, completion fluids, cement and BOP fluids.

Drill Mud and Cuttings

A combination of WBM and SBM will be used to drill the wells in the Project Area. Waste generated from drilling and completing an injector, producer or pilot well include drilling muds and cuttings that retain a portion of the drilling mud as well as completion fluid (typically a brine). These wastes will be managed in accordance with the OWTG (NEB et al. 2010).

WBM is comprised primarily of water, barite with salt or fresh water as the base fluid. The base fluid in SBM is a synthetic oil which can be made up of internal olefins, alpha olefins, polyalphaolefins, paraffins, esters or blends of these materials. Offshore NL, most operators currently use PureDrill IA35-LV as the base fluid for SBM.

WBM and SBM additives typically include barite, bentonite or other clays, silicates, lignite, caustic soda, sodium carbonate/bicarbonate, inorganic salts, surfactants, corrosion inhibitors, lubricants and other additives for unique drilling problems such as viscosity and mobility (Thomas 1984; GESAMP 1993). Barite (barium sulphate) is used to control mud density, which helps balance formation pressures within the well. Bentonite clay is a viscosifier, which thickens the mud to suspend and carry drill cuttings to the surface. The results of drilling cuttings dispersion modeling are provided in Section 9.2.3.2.

Chemicals used in drilling muds (SBM and WBM) are screened in accordance with Equinor Canada's chemical screening and management practices per the OSCG and are classified under the offshore chemical notification system as substances which pose little or no risk to the environment.

WBM cuttings associated with riserless drilling will be discharged at depth (refer to Section 2.7.4.1). SBM cuttings will be treated using best treatment practices that are commercially available and economically feasible, in accordance with the OWTG (NEB et al. 2010). The drilling installation will be equipped with solids control equipment to treat SBM cuttings prior to discharge. Typical SBM discharge points may range from 4 m to 20 m below sea surface, however, it depends on the drilling installation. Typically, a combination of shale shakers and cuttings dryers / centrifuges are used to collect the SBM from the cuttings. Shale shakers are a system of fine and course mesh screens that collect cuttings while enabling the fluid to pass through for collection and reuse or disposal. The cuttings are sent to a cuttings dryer or high-speed centrifuge which separates the drilling fluid from the cuttings. The treated cuttings are discharged overboard when the base oil retained on cuttings is below a threshold of 6.9g / 100g oil on wet solids. Excess or spent SBM that can no longer be used is sent to shore for disposal at an approved waste management facility. Per the C-NLOPB OA process, Equinor Canada will assess available drill cuttings treatment technology with the intent of using the best available proven technology bearing in mind that technologies may change over the duration of the Project.

Estimated drill mud and cuttings discharge volumes for different hole sections and mud type are summarized in Table 2.22. It is estimated that approximately 400 m³/well of seawater and/or whole WBM may be discharged when the riser is installed, and the mud system is switched to SBM.

Table 2.22 Estimated Drill Mud and Cuttings Discharge Volumes Per Well

	Hole Section	Volume of cuttings (m³)	Expected Mud Type
Conductor	42"	80	Seawater / WBM
Surface	26"	270	Seawater / WBM
Intermediate 1	17 1/2"	270	SBM
Intermediate 2	12 1/4"	60	SBM
Reservoir	8 1/2"	50	SBM
	Total Seawater/WBM	350	
	Total SBM	380	

Comments
- Volumes above represent the well with the highest expected discharge volumes
- Volume calculation assumes cutting density of 2.6
- Volume calculation assumes 20 percent washout in Seawater/WBM sections and 10 percent washout in SBM sections
- Volume calculation assumes 70 percent mud adherence in SBM sections

Completion Fluid

After each well has been drilled the mud will be removed and replaced with an inhibited completion fluid. The completion fluid is likely be a brine fluid with low solids, or an oil-based fluid, which contains small quantities of chemicals to protect the well. These chemicals may include a corrosion inhibitor, an oxygen scavenger and a biocide. Similar to drilling fluids, the completion fluid may also consist of a synthetic-based fluid rather than the brine. The composition of the completions fluids will be based on compatibility testing with the anticipated formations and well materials to ensure the fluid does not prohibit or reduce production from the well. Volumes of completion fluid are uncertain at this stage and will be determined once well design is complete. It is estimated that completion fluid volumes may range from 40 m^3 to 160 m^3 per well.

Cement

Cement constitutes a part of the well barrier envelope and is used during casing installation and plug and abandonment. Details regarding cementing operations are described in the Drilling EIS (Section 2.9.3.2; Statoil 2017). After every cementing operation, the cement unit must be cleaned to prevent cement from hardening in the mixing tanks and liners. Each cleaning operation typically results in a discharge of approximately 1.5 m^3 of water (80 percent) and residual cement slurry (20 percent) below sea surface. For a typical well there are three to four casing cement jobs and several plug and abandonment (two to six) plugs. During initial commissioning and testing of a cementing unit, a small volume “test mix” may also be performed (< 10 m^3) which is also discharged to sea. Unused cement bulks and cementing additives are returned to shore for future re-use or disposed of at an approved facility.

When drilling riserless through the hardened cement, particles are discharged to the seabed. When drilling with the riser installed, drilled cement is processed by shakers, similar to the drill cuttings, and discharged overboard or captured in cutting skips and transported to shore. Although unlikely, cement unit failures, premature set up of cement, or environmental conditions (weather) may require a cement job to be aborted. If this occurs when drilling riserless, the cement is circulated out of the well to seabed. In this instance, approximately 50 m^3 to 410 m^3 of cement slurry and water-based spacer fluids could be discharged depending on the section size. However, if the riser is installed, the cement is circulated out of well via the riser and may be discharged at surface.

BOP Testing Fluids

To facilitate proper functioning of the BOP for safe well operations, a regular program of function testing and pressure testing the BOP mechanism is required. Function testing is carried out every seven days, while pressure testing is carried out every 14 to 21 days, depending on ongoing drilling operations. BOP systems use a water-based hydraulic fluid. Typically, the BOP fluid consists of fresh water and a solution of water-based Erifon and glycol. Occasionally, it may be required to disconnect the Lower Marine Riser Package (LMRP) from the subsea BOP and move the drilling installation to a safe location when weather events pass through the area, or to pull the BOP to surface if maintenance is required. When the BOP is disconnected, the fluid contained in the subsea accumulator bottles may be discharged. The total estimated control fluid discharged in each disconnection of the LMRP is approximately 0.7 m^3. The total estimated control fluid discharged in each BOP pull is approximately 3.3 m^3. BOP fluids are screened for acceptability prior to use.

2.8.3 Heat, Light, and Sound Emissions

Heat will be generated primarily through power generation and exhaust from the FPSO and drilling installation, and non-routine/safety flaring from the FPSO. With the use of WHRU on the FPSO, heat emissions will be reduced.

Light emissions will be generated at night from deck lighting on the FPSO, the drilling installation, vessels and when non-routine/safety flaring is required. Equinor Canada is investigating options to reduce light emissions from the FPSO (refer to Section 2.7.1.7).

Sound will be generated underwater during regular production and drilling operations, vessel operations, and geophysical surveys. The level of sound will be dependent final design of the FPSO, the drilling installation used, and vessels contracted to support the Project. The extent to which sound travels is determined by water depth, salinity, and temperature. Underwater sound generated during production operations are continuous, whereas sound from a 4D seismic program is impulse sound and emitted over a shorter period of time. Sound attenuation modelling was undertaken to assist with the effects assessment. Details on the sound modelling are provided for in Section 4.3.4.3 and Appendix D.

Atmospheric sound is not of concern for the Project given the anticipated low levels of atmospheric sound emissions, the limited transmission of underwater sound above the surface and location of receptors. Helicopter traffic will generate atmospheric sound at the airport, in transit and at the FPSO and/or drilling installation. However, with the use of the existing St. John's International Airport potential effects on human receptors is reduced. Helicopters are required to avoid important bird areas, so potential interactions with birds are reduced. Given the distance from the Project Area to shore (approximately 500 km) and occupational and safety requirements on the drilling installation, there will be no likely interaction with human receptors.

2.8.4 Hazardous and Non-hazardous Wastes

As outlined above, Equinor Canada's EPP will include plans for the management of waste material for the Project. Hazardous wastes generated during the Project, including dangerous goods, will be stored in designated areas in appropriate containers/containment for transport to shore in compliance with the *Transportation of Dangerous Goods Act* and its regulations. Applicable approvals for the transportation, handling and temporary storage, of these hazardous wastes will be obtained as required. Biomedical waste will be collected onboard by health professionals and stored in special containers before being sent to land for incineration. Non-hazardous wastes generated during the Project that are not allowed to be disposed overboard, will be stored in appropriate containers onboard, and transported back to shore. Hazardous and non-hazardous wastes shipped to shore for disposal will be collected onshore by a third-party contractor for disposal of the waste at an approved facility and in compliance with federal and provincial regulations and requirements.

For the FPSO and drilling installation, hazardous wastes that require management may include oily wastes (e.g., filters, rags and waste oil), waste chemicals and containers, batteries, and spent drilling fluids. Non-hazardous wastes may include domestic wastes, packaging material, scrap metal and other recyclables such as waste plastic.

The occurrence of naturally occurring radioactive material (NORM) in volumes of any significance is not anticipated. If NORM be encountered, appropriate waste handling and management will be implemented.

2.9 Summary of Changes to the Project

Since the Project Description (Equinor 2018b) was submitted in June 2018, there have been some changes to the Project scope, due to progress with Project design, and are as follows:

- Well count – number of wells for the Core BdN Development is estimated to be 10 to 40 wells; Project Description listed it as 10 to 30 wells.
- Number of subsea well templates – the Project Description stated 5 to 10 well templates, this has changed to 3 to 10 well templates.
- Permanent reservoir monitoring nor conventional 4D seismic was not considered an option at the time the Project Description was submitted. It is included as an option and included in the effects assessment, as applicable.

As noted throughout Chapter 3, the various governmental, Indigenous, and stakeholder, engagement initiatives undertaken as part of this EIS have yielded useful and informative perspectives related to the Project and its potential environmental effects. These inputs have helped shape the nature and focus of the EIS regarding selection of Valued Components, the specific content and focus of the description of the existing environment (Chapters 5 to 7) and the environmental effects assessments (Chapters 9 to 14).

For the most part, however, these engagement initiatives to date did not result in the identification or elaboration of new and / or previously unidentified environmental components or issues of concern, over and above those specified in the EIS Guidelines and considered in the EIS.

Equinor Canada will, however, continue to review governmental, Indigenous, and stakeholder inputs and perspectives as the planning and implementation of the Project progresses, and will consider them in its Project-related planning and decision-making, as applicable.

2.10 Environmental Planning and Management

Equinor Canada has a clear goal to facilitate sustainable development and is committed to reducing environmental effects. This section introduces Equinor's Safety and Sustainability policy, the management system and how it will be implemented for the Project.

Equinor Canada will implement and adhere to relevant environmental mitigation requirements outlined in applicable legislation and regulations, including those committed to in this EIS, and eventually required as enforceable conditions of an EA approval. This will include requiring its contactors and subcontractors to implement and adhere to those mitigation measures and compliance standards that apply to their specific work scopes, which will be required and enforced through its relevant commercial and contractual arrangements with these providers of goods and services to the Project.

Equinor's Safety and Sustainability policies are two of several policies included in the Equinor Book (Equinor 2018c), which forms the foundation of how we conduct our business. We will use natural resources efficiently and will provide energy which supports sustainable development.

2.10.1 Our Approach to Safety

We will ensure safe operations which protect people, the environment, communities and material assets. We believe that accidents can be prevented.

<u>We are committed to:</u>

- Integrating safety in the way we do business
- Improving safety performance in all our activities
- Demonstrating the importance of safety through hands-on leadership and behaviour
- Openness in all safety issues and active engagement with Indigenous groups and stakeholders

<u>How we work:</u>

- We take responsibility for the safety of ourselves and others
- We work systematically to understand and manage risk
- We provide our people with the necessary resources, equipment and training to deliver in accordance with their designated responsibilities
- We cooperate with our contractors and suppliers on the basis of mutual respect
- We stop unsafe acts and operations
- We aim for a safe and attractive working environment characterized by respect, trust and cooperation
- We monitor risk related to the working environment, and we monitor the occupational health of our people
- We establish work processes as well as goals and performance indicators to control, measure and improve these processes
- We run safety improvement processes based on surveys and risk assessments, and we involve our people in this work
- If accidents occur, our emergency response organization will do its utmost to reduce injury and loss. Saving lives is our highest priority
- We transform lessons learned into improved safety measures through continuous learning

2.10.2 Our Approach to Sustainability

We contribute to sustainable development through our core activities wherever we work. We use natural resources efficiently and provide energy which supports sustainable development.

We are committed to:

- Integrating sustainability in the way we do business
- Contributing to the development of sustainable energy systems and technology
- Making decisions based on the way they affect our interests as well as the interests of the societies and the ecosystems in which we operate
- Respecting human rights and labour standards
- Ensuring anti-corruption and transparency on all sustainability issues and active engagement with Indigenous groups and stakeholders
- Contributing to local content by developing skills and opportunities in the societies in which we operate

How we work:

- We identify and manage environmental and social risks and opportunities based on Indigenous and stakeholder dialogue, as well as risk and impact assessments
- We apply clean and efficient technologies to reduce the negative environmental impact of existing operations
- We work to limit GHG emissions
- We respect international labour standards and the rights of Indigenous peoples
- We promote transparency through support for international industry standards, and by publishing our income, expenditures and taxes in all the countries in which we operate
- We hire and develop local people and promote local sourcing
- We ensure that local suppliers comply with applicable laws and meet our expectations and standards
- We work with others to help establish sustainable local enterprises and support the efforts of our suppliers to close gaps in order to meet our standards
- We exchange experience with national partners and support education and skill building in oil- and gas-related disciplines to build lasting capacity
- We undertake sustainable social investment projects in affected communities so that they can share in the benefits provided by our activities

2.10.3 The Equinor Canada Management System

The Equinor Canada management system defines how we work and describes how we lead and perform our activities. Our management system has three main objectives:

1) Contribute to safe, reliable and efficient operations and enable us to comply with external and internal requirements
2) Help us to incorporate our values, people and leadership principles in everything we do
3) Support our business performance through high-quality decision-making, fast and precise execution, and continuous learning)

Commitment to and compliance with our management system are a requirement.

Sustainability in Equinor Canada means responsible environmental, social and economic performance enabling business resilience. The sustainability function in Equinor Canada includes these elements:

- Balance reliable energy supply and climate impact
- Aim for outstanding resource efficiency
- Prevent harm to local environment
- Create lasting local value
- Respect for human rights
- Lead an open and transparent business

The Equinor Canada environmental management system is fully compatible with recognized environmental management standards including International Standards Organization (ISO) 14001.

2.10.4 Environmental Planning

As part of its project planning and as a requirement of the C-NLOPB OA process, Equinor Canada will submit the following documents to the C-NLOPB:

- Safety Plan
- EPP, which may include:
  - Environmental Effects Monitoring (EEM) Plan
  - List of environmentally critical components
  - Summary of environmental risk and prevention measures
  - Chemical management and selection procedures
  - Environmental compliance monitoring procedures
- Demonstrating financial obligations, including a compensation plan respecting damages related to offshore activity
- Flaring and Venting Plan
- Oil Spill Response Plan (OSRP)
- Emergency Response Plan
- Spill Impact Mitigation Analysis (SIMA) (previously referred to as Net Environmental Benefit Analysis)

2.10.4.1 Project Planning, Assessment, and Implementation: Application of the Precautionary Principle

The consideration of environmental issues from the earliest stages of Project planning and design and throughout eventual implementation is an integral and fully integrated part of Equinor Canada's approach to its petroleum development programs and other activities.

As illustrated throughout this EIS, potential environmental issues and interactions that may be associated with the Project can be avoided or reduced through the use of thorough planning and sound operational practices and procedures, supported by standard mitigation measures that are well established and outlined in relevant regulatory procedures and guidelines, and which have been routinely and effectively applied to similar offshore development programs carried out in the Canada-NL Offshore Area and internationally for decades. For this Project, these standard mitigation measures will be implemented through and/or supplemented by Equinor Canada-specific policies and procedures that have been identified through this EIS, and through the various post-EA regulatory review processes that will apply to the Project (see Section 1.3). The Project will not likely result in significant adverse environmental effects due to the implementation of these environmental protection measures.

In planning and designing the Project and throughout the course of the EA, including the environmental effects analysis and the identification of mitigation included in this EIS, Equinor Canada has applied a precautionary approach to assessing and attempting to avoid or reduce adverse environmental effects. This has included consideration of the precautionary principle, which was defined by the 1992 Rio Declaration on Environment and Development (Principle 15) as follows:

> *Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation. (UNCED 1992).*

The application of a precautionary approach is reflected in a number of aspects of Project planning and design, and in the conduct of the EA reported herein. Some examples of this precautionary approach are provided below:

1) In many cases, the EIS environmental analysis, including the effects predictions and the planned application of mitigation, are quite conservative and therefore precautionary in nature. They inherently assume, for example, that an environmental component is present in the area and within the Project’s environmental zone of influence, and therefore, is “available” for a Project-VC interaction. In reality, in many cases the likely abundance and spatial and temporal distributions and movements of the VCs limits the potential for interactions and effects with the Project’s short-term activities and relatively localized disturbances.
2) Similarly, and in keeping with the spirit of the precautionary principle as defined above, many of the mitigation measures identified in the EIS are committed to and will be implemented even where it is not certain that a Project-related interaction and resulting effect will occur.
3) Also, for some key potential environmental issues, such as accidental events, the EIS has involved the completion and use of conservative environmental modelling and analysis, including in the associated oil spill modelling (see Chapter 16 and associated Appendix E), which is based on an “unmitigated” spill events. In reality, such a spill is both extremely unlikely to occur, and would be responded to immediately by Equinor Canada through the various response plans and procedures described in this EIS. SBM spills were also modelled and outlined in Chapter 16 and Appendix F.

In addition to Equinor Canada-derived and implemented mitigation measures and precautionary approaches, an added layer of such precaution comes from the various post-EA regulatory review and planning processes that will apply to this development program. The regulatory review and approval processes and other requirements that apply to oil and gas activities in the Canada-NL

Offshore Area are amongst the most rigorous and stringent in the world, and operators are required to demonstrate that they have the ability and capacity to undertake such activities in a safe and environmentally responsible manner through various project design measures, operational procedures, and response mechanisms. As part of its regulatory review and decision-making in this jurisdiction, for example, the C-NLOPB receives and considers information from operators that detail the equipment and procedures involved, and the qualifications and training of personnel.

Equinor Canada will obtain the required permits, approvals and authorizations for the Project, and the company and its contractors will comply with these and relevant regulations and guidelines in planning and implementing the Project that is the subject of this EIS. This includes the various mitigation measures identified and committed to in the sections that follow, the implementation and effectiveness of which will be directed, managed and monitored in accordance with Equinor Canada's applicable policies and procedures.

2.10.5 Environmental Management

Where the environmental effects analyses have identified potentially significant environmental effects that cannot be avoided, mitigation measures have been proposed. Such measures should remove, reduce or manage the effect to a point where the residual significance of that environmental effect is reduced to an acceptable level. Mitigation has also been recommended in order that environmental effects remain 'not significant'. Sections 9.1.15 to 14.1.15 provide a summary of mitigation and management measures identified during the EIS process on a topic by topic basis.

These commitments will be integrated into the EPP. The full EPP will be implemented in accordance with the relevant regulatory requirements and submitted to the C-NLOPB in accordance with its OA requirements. The EPP is a working document that details:

1) Roles, responsibilities and chain of command and contractors or subcontractors in respect of environmental management for the protection of the environment and operation of the Project
2) Mitigation measures as identified in the EIS to prevent significant adverse effects to the receiving environment
3) Pollution prevention measures
4) Measures to reduce, recycle, reuse and dispose of waste streams

2.10.6 Environmental Monitoring

Monitoring is an important activity for measuring performance against the environmental regulatory and corporate requirements. Monitoring enables the assessment of progress against goals as well as the gathering of information to track overall environmental performance. There are three inter-related drivers in such monitoring:

- Regulatory requirements
- Corporate and Project expectations and goals
- Validation of EIS predictions

Monitoring can therefore be split into two broad categories: compliance monitoring; and potential EEM.

Compliance monitoring involves the monitoring of emissions, discharges, and waste generations against performance standards or regulatory requirements as set out the Project EPP. Details of compliance monitoring and reporting is described in Section 18.4.

EEM, if required, will be used to validate EIS predictions. If required, an EEM Plan will be submitted to C-NLOPB for review and acceptance prior to the start of the Project. Further information is provided in Sections 9.6 to 11.6 and 12.5 to 14.5.

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3.0 REGULATORY, INDIGENOUS, AND STAKEHOLDER ENGAGEMENT

Engagement is a key component of Equinor Canada's approach to the planning and implementation of its oil and gas projects and other business activities. A number of engagement initiatives have been undertaken in relation to the Project and this Environmental Impact Statement (EIS), with further engagement in progress or being planned. This includes discussions with relevant government departments and agencies, Indigenous groups and stakeholder organizations.

This Chapter describes previous and ongoing engagement initiatives related to the Project and its EIS. It also identifies the various questions and comments raised regarding the Project, as well as indicating where and how these are addressed in the EIS.

3.1 EIS Guidelines

On September 26, 2018, the Canadian Environmental Assessment Agency (the CEA Agency) issued EIS Guidelines for the Project (Appendix A). The EIS Guidelines specify various information requirements and potential issues that are to be addressed in the EIS, including required information and analysis around the description of the Project, aspects of the existing biophysical and socioeconomic environments, Indigenous and stakeholder engagement, potential environmental issues and interactions, mitigation, and other items. The EIS Guidelines have therefore formed a key part of the issues scoping component of EIS planning and preparation.

The EIS Guidelines outline a number of general principles and specific requirements regarding public participation and engagement with Indigenous groups as part of the environmental assessment (EA) process for the Project. Specifically, Section 4 of the EIS Guidelines states:

> *The EIS will describe the ongoing and proposed public participation activities that the proponent will undertake or that it has already conducted on the project. It will provide a description of efforts made to distribute project information and provide a description of information and materials that were distributed during the consultation process. The EIS will indicate the methods used, where the consultation was held, the persons and organizations consulted, the concerns voiced and the extent to which this information was incorporated in the design of the project as well as in the EIS. The EIS will provide a summary of key issues raised related to the project and its potential effects to the environment as well as describe any outstanding issues and ways to address them.*

With respect to Indigenous groups identified in the EIS Guidelines (Part 2, Section 5; Appendix A), the CEA Agency provides direction on engagement.

> *[T]he proponent will structure its engagement activities to provide adequate time for groups to review and comment on the relevant information. Engagement activities are to be appropriate to the groups' needs, arranged through discussions with the groups and in keeping with established consultation protocols, where available. The EIS will describe all efforts, successful or not, taken to solicit the information required from groups to support the preparation of the EIS. With respect to engagement activities, the EIS will document:*

(I) the engagement activities undertaken with each group prior to the submission of the EIS, including the date and means of engagement (e.g. meeting, mail, telephone);

(II) document the main issues and comments raised during the engagement activities by each group and the proponent's responses (effort should be made to collating like issues together along valued components identified in the EIS);

(III) any future planned engagement activities;

(IV) where and how Indigenous groups' perspectives were integrated into and/or contributed to decisions regarding the project, design, construction, operation, decommissioning, maintenance, follow-up and monitoring and associated potential effects (paragraph 5(1)(c)) and the associated mitigation utilized to manage those effects. The effects and mitigation measures should be clearly linked to valued components in the EIS as well as to specific project components or activities; and

(V) how engagement activities by the proponent allowed groups to understand the project and evaluate its impacts on their communities, activities, potential or established Aboriginal or Treaty rights. Where impacts are identified, provide a discussion of how those would be managed or mitigated (and provide this information for each Indigenous group separately).

This EIS has been completed and submitted in accordance with the above referenced EIS Guidelines. A detailed Table of Concordance identifying where each Guideline requirement is addressed in the EIS is provided in Appendix B.

3.2 Government Departments and Agencies

Equinor Canada recognizes that a number of federal and provincial government departments and agencies have specific responsibilities or interests, stemming from their respective mandates and legislative requirements, related to the Project and its potential environmental effects.

In planning and developing the EIS, Equinor Canada engaged with regulatory agencies to share information on the Project, obtain relevant environmental baseline information for the EIS and identify potential concerns.

A summary of Project-related engagement activities, up to December 31, 2018, involving federal and provincial government departments and agencies is provided in Table 3.1, with a focus on any meetings and other associated discussions. Table 3.1 includes information on timing, the specific departments and agencies involved, engagement method and the general purpose and focus of each session. Engagement initiatives with government departments and agencies have included discussions and ongoing information sharing through various means (e.g. letters, email, telephone conversations), the results of which have also been considered in the scope and content of the EIS as applicable.

Table 3.1 Engagement with Government Departments and Agencies

Date	Organization	Type of Engagement	Purpose and Focus
May 16, 2018	CEA Agency	Outgoing Letter	Draft Project Description transmitted to the CEA Agency for review.
May 31, 2018	CEA Agency	Incoming Letter	The CEA Agency indicated the draft Project Description had been reviewed and provided comments for Equinor Canada to consider for the revised Project Description.
June 13, 2018	CEA Agency	Outgoing Letter	Revised Project Description sent to the CEA Agency for review.
June 13, 2018	CEA Agency	Incoming Email	The CEA Agency acknowledged receipt of revised Project Description.
June 26, 2018	CEA Agency	Incoming Email	Email chain regarding Indigenous engagement. Equinor Canada to provide engagement log on monthly basis with a follow up conference call as necessary.
July 6, 2018	Fisheries and Oceans Canada (DFO), Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB)	Outgoing Email	Equinor Canada 2018 Seabed Survey Plan sent to DFO and C-NLOPB; Equinor Canada requested a meeting to discuss the plan.
July 17, 2018	CEA Agency	Outgoing Email	Request to the CEA Agency for comments on the revised Project Description.
July 18, 2018	CEA Agency	Incoming Email	The CEA Agency provided comments received on the Project Description from the following from regulatory agencies: NL Department of Municipal Affairs and Environment; Industry Canada; Health Canada; C-NLOPB; Environment and Climate Change Canada (ECCC); Transport Canada; DFO; Parks Canada.
July 18 to 26, 2018	CEA Agency	Incoming Email	The CEA Agency provided comments received on the Project Description from the following Indigenous groups: Première Nation des Innus de Nutashkuan; Les Innus de Ekuanitshit; Qalipu Mi’kmaq First Nation Band; Mi’gmawei Mawiomi Secretariat; Nunatsiavut Government; Wolastoqey Nation in New Brunswick; Kwilmu'kw Maw-klusuaqn Negotiation Office; Mi'gmawe'l Tplu'Taqnn Inc.; Miawpukek First Nation; NunatuKavut Community Council.

Table 3.1 Engagement with Government Departments and Agencies

Date	Organization	Type of Engagement	Purpose and Focus
July 18, 2018	CEA Agency	Incoming Email	The CEA Agency provided comments received on the Project Description from a member of the public.
July 20, 2018	CEA Agency	Incoming Email	The CEA Agency provided comments received on the Project Description from a member of the public.
July 26, 2018	C-NLOPB, DFO	In-Person Meeting	Meeting to discuss the 2018 Equinor Canada 2018 Seabed Survey Plan.
July 26, 2018	ECCC	In-Person Meeting	Meeting to provide a general overview of the Project and obtain confirmation / clarification regarding Ocean Disposal requirements
July 26, 2018	ECCC	Incoming Email	Follow-up to meeting. ECCC provided the most recent version of the Characterization Guidance for Dredged Material for Open Water Disposal –Guidance for Atlantic Region Disposal at Sea Applications (June 2018).
July 26, 2018	ECCC	Incoming Email	ECCC provided a link to an industrial gas incinerator vendor for information; indicated it is not known if this equipment is applicable to Bay du Nord (BdN) Project.
July 27, 2018	DFO	Incoming Email	DFO forwarded four questions / clarifications regarding Equinor Canada 2018 Seabed Survey Plan that were brought forward in the July 26 meeting.
July 31, 2018	DFO	Outgoing Email	Response to DFO questions / clarifications regarding upcoming Equinor Canada 2018 Seabed Survey Plan.
August 1, 2018	DFO	Incoming Email	Confirmation of receipt of July 31 response to questions.
August 2, 2018	CEA Agency	Outgoing Email	Transmittal of June and July Indigenous engagement logs to the CEA Agency.
August 9, 2018	CEA Agency	Incoming Email	Email containing links to the Draft EIS Guidelines and Notice of Commencement; provided electronic version of Guidelines.

Table 3.1 Engagement with Government Departments and Agencies

Date	Organization	Type of Engagement	Purpose and Focus
August 10, 2018	CEA Agency	Conference Call	Phone call to discuss June to July Indigenous engagement activities and upcoming activities, including meetings/conference calls with Mi’kmaq Confederacy of Prince Edward Island, Wolastoqey Nation in New Brunswick, Woodstock First Nation, Miawpukek First Nation, Nunatsiavut Government, Innu Nation, NunatuKavut Community Council and Elsipogtog First Nation. Parties commit to continued monthly phone calls following submission of engagement logs.
September 5, 2018	CEA Agency	Outgoing Email	Transmission of August Indigenous engagement log to the CEA Agency.
September 5, 2018	CEA Agency, C-NLOPB, DFO, ECCC, Health Canada, Natural Resources Canada (NRCan), Transport Canada	Workshop	Spill modelling workshop hosted by Equinor Canada, ExxonMobil Canada Ltd. and Nexen Energy ULC.
September 7, 2018	CEA Agency	Conference Call	Phone call to discuss August Indigenous engagement activities and upcoming engagement, including planned meetings with Qalipu Mi’kmaq First Nation Band, Miawpukek First Nation, Innu Nation, Nunatsiavut Government, NunatuKavut Community Council and Elsipogtog First Nation. The CEA Agency indicated satisfaction with progress of engagement, including Indigenous Knowledge studies. The CEA Agency advised that regional assessment is underway and Indigenous groups have been asked to comment on draft Committee Agreement.
September 26, 2018	CEA Agency	Outgoing Email	E-mail chain regarding call to discuss recent engagement activities, including correspondence with Mekap'sk Mi’kmaq Band.
September 29, 2018	CEA Agency	Incoming Phone Call	Equinor Canada provided update on engagement activities with Indigenous groups and discussed upcoming workshops.
October 1, 2018	CEA Agency	Outgoing Email	Transmission of September Indigenous engagement log to the CEA Agency.

Table 3.1 Engagement with Government Departments and Agencies

Date	Organization	Type of Engagement	Purpose and Focus
October 5, 2018	CEA Agency	Incoming Email	E-mail chain regarding inclusion of Mekap'sk Mi’kmaq Band in engagement activities.
October 8, 2018	CEA Agency	Incoming Phone Call	Monthly call with the CEA Agency to discuss Indigenous engagement activities, issues and concerns.
October 12, 2018	CEA Agency	Outgoing Email	Transmission of materials for Quebec City workshop.
October 17, 2018	CEA Agency	In-Person Meeting	Meeting with the CEA Agency in Halifax to discuss BdN EIS.
October 24, 2018	CEA Agency	Outgoing Phone Call	Discussion with the CEA Agency regarding recent correspondence from Miawpukek First Nation and collection of Indigenous Knowledge.
October 25, 2018	ECCC, C-NLOPB, CEA Agency	In-Person Meeting / Conference Call	Meeting to provide a Project overview, as well as environment and regulatory focus areas associated with BdN EIS.
November 1, 2018	DFO, C-NLOPB, CEA Agency	In-Person Meeting / Conference Call	Meeting to provide a Project overview, as well as environment and regulatory focus areas associated with BdN EIS.
November 1, 2018	CEA Agency	Outgoing Email	Transmission of Indigenous engagement log for October and offer of call to discuss.
November 2, 2018	CEA Agency	Outgoing Phone Call	Phone call to discuss Indigenous engagement efforts during October. Discussed status of response to Miawpukek First Nation draft Engagement Plan, update on scholarship request, contact with Passamaquoddy of Maine, status of workshop report, Indigenous Knowledge collection efforts and Regional EA.
November 2, 2018	CEA Agency	Outgoing Email	Transmission of draft e-mail to Passamaquoddy of Maine for review of references to the CEA Agency.
November 15, 2018	CEA Agency	Outgoing Phone Call	Phone call with the CEA Agency to discuss recent conference call with Mekap'sk Mi’kmaq Band, recent correspondence from Miawpukek First Nation regarding the Husky Oil Operations Ltd. (Husky Energy) EIS and Participant Funding Program.
November 26, 2018	CEA Agency	In Person Meeting / Conference Call	Meeting to discuss the upcoming EIS review process.

Table 3.1 Engagement with Government Departments and Agencies

Date	Organization	Type of Engagement	Purpose and Focus
November 27, 2018	CEA Agency	Outgoing Email	Provided the CEA Agency with feedback associated with the EIS review process.
December 3, 2018	CEA Agency	Outgoing Email	Transmission of Indigenous engagement log for November and offer of call to discuss.
December 4, 2018	CEA Agency	Incoming Email	Scheduling a phone meeting regarding Indigenous engagement logs for November.
December 14, 2018	CEA Agency	Outgoing Email	Transmission of the Workshop Report (Appendix G).

3.3 Indigenous Groups

Equinor Canada is committed to conducting its business in a manner that promotes sustainable development by minimizing harm to the environment, contributing to local communities, respecting human and Indigenous rights and adhering to openness and transparency in its operations. As part of this commitment, Equinor Canada respects the asserted and established Aboriginal and Treaty Rights of Indigenous peoples in Canada as protected by section 35 of the *Constitution Act, 1982* and acknowledges that its activities may have potential impacts on these rights. Equinor Canada also recognizes that Indigenous groups or organizations may have questions or concerns regarding the potential environmental effects of the Project, including any associated implications of these effects upon their communities, interests and activities as referred to in paragraph 5(1)(c) of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012).

Consistent with its corporate values (Courageous, Open, Collaborative and Caring), Equinor Canada is committed to ensuring that all Indigenous groups whose rights or interests may potentially be affected by its operations are appropriately informed and meaningfully engaged regarding the company's ongoing and planned activities.

Those Indigenous groups that may be potentially affected by the Project have been identified in the EIS Guidelines as including:

Newfoundland and Labrador

- Labrador Inuit (Nunatsiavut Government)
- Labrador Innu (Innu Nation)
- NunatuKavut Community Council (NCC)

Nova Scotia

- Eleven Mi'kmaq First Nation groups represented by Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO):
  - Acadia First Nation
  - Annapolis Valley First Nation
  - Bear River First Nation
  - Eskasoni First Nation
  - Glooscap First Nation
  - Membertou First Nation
  - Paqtnkek Mi'kmaw Nation
  - Pictou Landing First Nation
  - Potlotek First Nation
  - Wagmatcook First Nation
  - Waycobah First Nation
- Millbrook First Nation
- Sipekne'katik First Nation

New Brunswick

- Eight Mi'gmaq First Nations groups represented by Mi'gmawe'l Tplu'taqnn Inc. (MTI):
  - Fort Folly First Nation
  - Eel Ground First Nation
  - Pabineau First Nation
  - Esgenoôpetitj First Nation
  - Buctouche First Nation
  - Indian Island First Nation
  - Eel River Bar First Nation
  - Metepnagiag Mi'kmaq First Nation
- Elsipogtog First Nation
- Five Maliseet First Nation groups represented by the Wolastoqey Nation in New Brunswick (WNNB):
  - Kingsclear First Nation
  - Madawaska Maliseet First Nation
  - Oromocto First Nation
  - Saint Mary's First Nation
  - Tobique First Nation
- Woodstock First Nation
- Peskotomuhkati Nation at Skutik (Passamaquoddy)

Prince Edward Island

- Two Mi’kmaq First Nation communities represented by the Mi’kmaq Confederacy of Prince Edward Island (MCPEI):
  - Abegweit First Nation
  - Lennox Island First Nation

Quebec

- Three Mi’gmaq First Nation groups represented by the Mi’gmawei Mawiomi Secretariat (MMS):
  - Micmas of Gesgapegiag
  - La Nation Micmac de Gespeg
  - Listuguj Mi’gmaq Government
- Les Innus de Ekuanitshit
- Première Nation des Innus de Nutashkuan

Section 5 of EIS Guidelines directs Equinor Canada to engage with these named Indigenous groups to obtain their views on:

1) The Project
2) The effect of changes to the environment on Aboriginal peoples (health and socioeconomic conditions; physical and cultural heritage, including any structure, site or thing of historical, archaeological, paleontological or architectural significance; current use of lands and resources for traditional purposes) pursuant to paragraph 5(1)(c) of CEAA 2012
3) Potential adverse impacts of the Project on asserted or established Aboriginal or Treaty rights in respect of the Crown’s duty to consult, and where appropriate, accommodate Indigenous peoples

In addition to the groups listed above, the EIS Guidelines also direct Equinor Canada to engage with Miawpukek First Nation (MFN) and Qalipu Mi’kmaq First Nation (QMFN) Band for purposes of good governance to discuss the potential effects of the Project as described under paragraph 5(1)(c) of CEAA 2012. Equinor Canada has engaged with all the named groups and, while not required to do so by the EIS Guidelines, in response to community requests has also provided Project-related information to Mekap’sk Mi’kmaq Band as well as to the Passamaquoddy of Maine (Pleasant Point and Indian Township).

3.3.1 Approach to Indigenous Engagement: General Objectives and Activities

Consistent with the EIS Guidelines, Equinor Canada’s engagement activities have been directed at establishing open, meaningful communication and information exchange through continuing dialogue with the various Indigenous groups.

To achieve this objective, Equinor Canada has built upon the insights and information acquired during its ongoing engagement efforts in the context of the Flemish Pass Exploration Drilling EIS (herein referred to as the Drilling EIS) (Statoil 2017). As the Project will be located in the same area as assessed in the Drilling EIS, due to the functionally similar nature of the two activities, Equinor Canada has used the insights and information acquired during its engagement in the context of the Drilling EIS as a starting point in the identification and assessment of the Project's potential effects upon Indigenous rights and interests. Engagement related to the Project has provided an opportunity for Equinor Canada and the various Indigenous groups to discuss issues and concerns previously raised with respect to exploration drilling as well as new issues associated with the Project.

Generally, Equinor Canada's engagement approach has been structured taking into account the nature, location and scale of the Project, the location and interests of each Indigenous group and any guidance provided by the CEA Agency. Equinor Canada has made considerable efforts to provide Indigenous groups with opportunities both to learn about the Project, including its location, design, potential effects and proposed mitigation measures and to provide input respecting the potential effects of the Project upon Indigenous rights and interests.

To this end, Equinor Canada has provided relevant Project-related information in an ongoing, timely, accessible and culturally appropriate manner to each Indigenous group or representative organization as appropriate in order to:

- Enhance its understanding of how these groups may potentially be affected by Project activities
- Listen and respond to questions and concerns raised by the groups
- Work with groups to identify and develop potential measures to avoid or mitigate adverse effects, if any, upon asserted or established Indigenous rights and the interests referred to in CEAA 2012 section 5(1)(c)

As the EIS Guidelines require Equinor Canada to engage with a wide range of Indigenous groups located throughout the Atlantic region and characterized by distinct languages, histories and cultures, the approach to engagement, including the timing and nature of specific engagement activities, has been developed, where possible, through discussion and agreement with each of the groups. However, while the frequency and nature of engagement has been tailored to the needs, interests and circumstances of the groups, including the requirements of any applicable consultation protocols, generally during the development of the EIS Equinor Canada has:

- Provided the groups with relevant Project-related information (e.g., PowerPoint presentations, reports and summaries, translated as necessary and appropriate) on a timely basis through written correspondence, e-mails, telephone calls and meetings
- Made considerable efforts to meet with the various groups by mutually acceptable means and at mutually convenient times and locations (in person, by phone, by Skype or other mutually acceptable means)
- Structured engagement processes to the extent possible to provide adequate time for Indigenous groups to review and comment on the relevant information

Indigenous groups have been given reasonable opportunities to provide Equinor Canada with their views on:

- Indigenous activities or interests in or near the Project Area or elsewhere that might be relevant to the assessment of the Project and its potential effects
- The effects of changes to the environment on their health and socioeconomic conditions, physical and cultural heritage and current use of lands and resources for traditional purposes pursuant to paragraph 5(1)(c) of CEAA 2012
- The potential impacts of the Project on potential or established section 35 rights

In addition, Equinor Canada has invited each group to share Indigenous Knowledge relevant to the existing environment, the assessment of the potential effects of the Project and proposed mitigation measures and has taken any relevant Indigenous Knowledge to which it has access or that has been acquired through engagement or through publicly available materials into account in the Project assessment. Throughout the engagement process, Equinor Canada has identified, documented and responded to questions or concerns about the Project and its potential impacts, including whether and how these might have implications for Indigenous groups and their activities and interests.

Feedback obtained during this phase of engagement has been incorporated into the EIS as applicable and appropriate, and the EIS documents concerns and priorities raised and demonstrates how these have influenced Project planning and/or been considered in the EIS. Section 3.3.1.2 provides a summary of issues and concerns raised during engagement and where, as appropriate, they have been addressed in the EIS.

3.3.2 Engagement Activities

Equinor Canada's engagement efforts with the Indigenous groups named in the EIS Guidelines commenced on June 21, 2018 when Equinor Canada contacted each group to advise that the Project Description had been filed with the CEA Agency. Subsequently, on June 25, 2018, a letter was sent to each of the Indigenous groups providing an overview of the Project together with a map and inviting comments and concerns. Since that time, Equinor Canada has maintained regular contact with each group through meetings, phone-calls and e-mails to provide ongoing Project-related information and to discuss issues and concerns. Equinor Canada has made considerable efforts to work with each group to determine the appropriate level and frequency of engagement, taking into account any engagement processes that may have been established by an Indigenous group.

While the intensity of engagement has varied in accordance with the preferences of groups, the engagement process has been based upon consistent and regular contact and information exchange designed to enable each group or representative organization to understand the Project and identify its potential impacts upon their communities, activities and asserted or established Indigenous rights. Considerable efforts have been made to provide each Indigenous group with opportunities to ask questions or provide comments regarding the Project and its potential effects and to comment on proposed mitigation measures.

Engagement activities have included the ongoing provision of Project update information and the EA process through e-mails or phone calls. In addition, Equinor Canada has met or offered to meet in person or by conference call with each community or representative organization and has provided relevant information in the form of Project summaries, explanatory maps and graphics, and PowerPoint presentations related to Equinor Canada, the Project and applicable regulatory processes, translated as necessary.

To facilitate the incorporation of Indigenous perspectives into the identification and assessment of environmental effects and development of mitigation measures, in addition to individual meetings with various groups, Equinor Canada held three half-day workshops (in St. John's, Quebec City and Moncton) in October 2018 with the various groups to discuss potential environmental effects and proposed mitigation measures. Groups, including those who did not participate, were provided with workshop materials and follow-up information and given an opportunity to submit written comments respecting potential effects and associated mitigation measures. As appropriate and applicable, the information generated at the various workshop sessions has been incorporated into this EIS. Workshop materials and the final Workshop Report are included in Appendix G. Equinor Canada also provided Indigenous groups with an advance copy of relevant community baseline information for review and comment. and where responses were provided by Indigenous groups, this information was incorporated into the description of community/groups baseline conditions (see Chapter 7).

With respect to Indigenous Knowledge, Equinor Canada has invited each group to share Indigenous Knowledge relevant to the Project and EIS through the negotiation of agreements or through the sharing of previous reports or existing databases. While there has been no uptake of these offers to date, to supplement its understanding of relevant Indigenous Knowledge acquired during regular engagement activities, Equinor Canada commissioned a desktop Indigenous Knowledge Study (Appendix H), summarizing publicly available information relating to Indigenous Knowledge and also used information contained in an Indigenous Knowledge study by MTI, prepared in the context of the Drilling EIS. As relevant and appropriate, the various EIS chapters incorporate traditional knowledge provided during engagement activities or set out in the desktop Indigenous Knowledge Study (Appendix H) or contained in other available sources.

Equinor Canada has kept detailed records of its engagement activities, logging interactions with, and documenting the issues raised by, each Indigenous group. These records have been shared and discussed with the CEA Agency on a regular basis.

A complete inventory of engagement activities, up to December 2019, with each of the named groups as well as a summary of Key Issues and Questions raised by each Indigenous group, Equinor Canada's responses and corresponding sections in the EIS are outlined in Tables 3.2 to 3.35. As noted above, during the preparation of the EIS, Equinor Canada engaged with Indigenous groups as part of information gathering for the preparation of the EIS. Issues and concerns raised by Indigenous groups through all the engagement activities are listed in the tables below in a summary format, and the corresponding EIS section where the issue / concern is addressed is provided. A summary of workshop issues and concerns, Equinor Canada's responses, and corresponding sections in the EIS are set out in Table 3.36.

Table 3.2 Engagement with Nunatsiavut Government

Date	Activity	Purpose and Focus
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter including Project summary and map.
June 29, 2018	Outgoing Phone Call	Follow-up phone call to discuss next steps in engagement. Left voicemail.
July 6, 2018	Outgoing Phone Call	Follow-up phone call to discuss next steps in engagement. Left voicemail.
July 18, 2018	Outgoing Phone Call	Follow-up phone call to discuss next steps in engagement. Left voicemail.
July 23, 2018	Outgoing Email	Email requesting President or designate contact for Equinor Canada to discuss next steps in engagement.
August 2, 2018	Incoming Phone Call	Parties discussed next steps in engagement including timing of an in-person meeting and conference call.
August 2, 2018	Outgoing Email	Follow-up email confirming substance of phone call of August 2.
August 8, 2018	Outgoing Email	Proposal to meet with Nunatsiavut Government in Goose Bay week of September 17.
August 24, 2018	Incoming Email	Confirmation of availability to meet in Goose Bay on September 17.
August 27, 2018	Outgoing Email	Discussion of possible meeting dates.
August 27, 2018	Incoming and Outgoing Emails	Email correspondence to confirm date, time and location of meeting in Goose Bay
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss BdN Project, potential effects and proposed mitigation.
September 6, 2018	Incoming Email	Regarding meeting venue, agenda and materials.
September 6, 2018	Outgoing Email	Confirmation of venue and details regarding expense reimbursement.
September 12, 2018	Outgoing Email	Transmission of meeting materials (i.e. PowerPoint presentation, agenda) and discussed logistical details.
September 13, 2018	Incoming and Outgoing Emails	Reimbursement instructions, estimate of costs and completed forms.
September 14, 2018	Outgoing Email	Confirmation of meeting details.

Table 3.2 Engagement with Nunatsiavut Government

Date	Activity	Purpose and Focus
September 17, 2018	In-Person Meeting	Delivery of PowerPoint presentation and Project overview. Discussion of issues of concern and next steps in engagement.
September 18, 2018	Outgoing Email	Follow-up to meeting providing link to information and confirming next steps in engagement.
October 11, 2018	Workshop	Half day workshop in St. John's to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 12, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
October 15, 2018	Incoming Email	Transmitting materials regarding geophysical testing.
October 18, 2018	Outgoing Email	Confirmation of geophysical testing information and commitment to circulate internally.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Request for any additional comments on environmental effects/mitigation measures.
November 14, 2018	Incoming Email	Received Nunatsiavut Government's edits to community profile in Chapter 7.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing E-mail	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.3 Nunatsiavut Government Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Project Schedule – questions concerning timing of key Project activities	Details respecting the Project schedule, including timing of key Project activities and regulatory processes have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, Project details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings. A full discussion of the Project schedule and associated activities and milestones is contained in EIS Chapter 2.	Section 2.1.1

Table 3.3 Nunatsiavut Government Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Treatment of Discharges (Produced Water) and potential impacts on fish and fish habitat	Equinor Canada will treat produced water as well as other discharges using best treatment practices that are commercially available and economically feasible. A description of the proposed treatment package for produced water is provided in Section 2.7.1.5 of the EIS. All discharges will be treated in accordance with applicable regulatory requirements and the OWTG. The potential impacts of emissions and discharges on Fish and Fish Habitat are identified and assessed in Chapter 9.	Section 2.7.1.5 Section 9.3.2.4 Section 9.4.2.2 Section 9.2.3.2 Section 9.2.3.3
Accidents and Malfunctions (spill modelling) – information about possible spill trajectory and spill response	Chapter 16 provides a description of potential accidental events and malfunctions. Equinor Canada has undertaken spill fate and effects modelling of representative worst-case spills, including an unmitigated subsurface blow-out. The results of modelling predict that the greatest concentration of surface hydrocarbons will be at the release site and the majority will be transported east and south. In the extremely unlikely event of a subsurface blowout, and without the application of mitigation measures, modelling indicates that less than one percent of the total volume released is predicted to make contact with the shore line and most of that oil is predicted to make contact on the Avalon Peninsula and localized areas of the Burin Peninsula. Oil making contact with the shoreline would be highly weathered, and degraded and patchy and discontinuous. Equinor Canada's spill response measures are set out in Chapter 16 and additional information on Well Intervention Response Strategies and related matters is contained in Appendices P and Q. Equinor Canada is prepared to effectively respond to an oil spill offshore and is equipped with the necessary response tools, personnel and strategies. A key focus is on prevention. Spill prevention will be incorporated into Project design and operations and facilities, processes and management system procedures are intended to reduce or eliminate the chance of a spill. All plans respecting a response to accidental events are submitted to the C-NLOPB for review and approval as part of the regulatory authorizations process.	Section 16.1 Section 16.4.3 Section 16.4.4 Section 16.7.3 Appendix P Appendix Q
Impact of Project on subsistence and commercial fish species	Through its ongoing engagement activities as well as information contained in the Indigenous Knowledge Desktop study, Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. Information on fish species of either traditional or commercial importance has been incorporated into baseline information (see Chapters 6 and 7) and the potential effects (both direct and indirect) of the Project upon marine fish and fish habitat, commercial and subsistence fisheries and associated mitigation measures are discussed in Chapters 9, 13 and 14 respectively.	Section 9.5.5 Section 9.5.6 Section 13.1.5 Section 13.2 Section 13.4 Section 13.5 Section 14.1.5 Section 14.1.5.1 Section 14.1.5.2

Table 3.3 Nunatsiavut Government Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
	These chapters conclude that no potential effects upon subsistence fishing activities from routine Project activities are predicted. While no significant adverse effects upon commercial fish species or the commercial fisheries are predicted, proposed mitigation measures for commercial fisheries will include the following: • Ongoing communication with commercial fishers regarding planned Project activities, including notification of coordinates of safety and/or anti-collision zones. • Ongoing communications with the NAFO Secretariat, through Fisheries and Oceans Canada (DFO) regarding planned Project activities, including timely communication of the anti-collision and/or safety zones. • Ongoing communication with regulatory agencies to share information regarding the timing and location of activities. • Implementation of a standard marine communication protocol to promote safe practices between commercial fishing enterprises, other marine users and BdN operations. • Issuance of Notices to Shipping and Notices to Mariners (where appropriate) regarding planned Project activities. • Compensation for damage or loss in accordance with C-NLOPB Guidelines in accordance. The effects of accidents and malfunctions upon subsistence and commercial fisheries are identified and assessed in Chapter 16.	

Table 3.4 Engagement with Innu Nation

Date	Activity	Purpose and Focus
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor
June 21, 2018	Outgoing Email	Notification of filing of BdN Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter including Project summary and map.
June 27, 2018	Outgoing Phone Call	Follow-up to discuss next steps in engagement. Left voicemail.
June 28, 2018	Outgoing Phone Call	Follow-up to discuss next steps in engagement. Left voicemail.
July 6, 2018	Outgoing Phone Call	Follow-up phone call to discuss next steps in engagement and scheduling of an in-person meeting.

Table 3.4 Engagement with Innu Nation

Date	Activity	Purpose and Focus
July 6, 2018	Outgoing Email	Expressing commitment to engage and to continue to provide Innu Nation with information. Confirmation of availability for an in-person meeting.
August 6, 2018	Outgoing Email	Follow-up requesting a phone call to set up an in-person meeting in September.
August 8, 2018	Outgoing Email	Proposal to meet in Goose Bay during the week of September 17.
August 9, 2018	Incoming Email	Committing to respond to meeting request during week of August 13.
August 9, 2018	Outgoing Email	Regarding meeting in Goose Bay.
August 27, 2018	Outgoing Email	Follow-up email regarding proposed meeting in Goose Bay the week of September 17
August 27, 2018	Incoming Email	Commitment to discuss proposed Goose Bay meeting with leadership.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss BdN Project, potential effects and proposed mitigation.
September 10, 2018	Outgoing Email	Confirmation of availability to meet in in Goose Bay on September 17. Offer to hold conference call if in-person meeting not possible.
September 10, 2018	Incoming Email	Confirmation of interest in meeting and undertaking to provide potential dates.
September 11, 2018	Incoming and Outgoing Emails	Email chain arranging meeting between Equinor Canada and Innu Nation in Goose Bay on September 18.
September 11, 2018	Outgoing Email	Email transmitting PowerPoint presentation for discussion at September 18 meeting.
September 14, 2018	Outgoing Email	Confirmation of time and location of September 18 meeting.
September 14, 2018	Outgoing Email	Transmission of meeting agenda.
September 18, 2018	In-Person Meeting	Delivery of PowerPoint presentation and Project overview. Discussion of issues of concern and next steps in engagement.
September 19, 2018	Outgoing Email	Follow-up to meeting providing link to information and confirming next steps in engagement.
October 19, 2018	Workshop	Half day workshop in Moncton to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.

Table 3.4 Engagement with Innu Nation

Date	Activity	Purpose and Focus
October 23, 2018	Outgoing Email	Request for clarification on the next steps in engagement.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Follow up to workshop, transmitting invoicing information and requesting further comments regarding potential effects / mitigation measures.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.5 Innu Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Section Reference
Need for Ongoing Engagement (Information exchange)	Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of such information-sharing processes will be developed through discussions with the various groups.	Section 3.3 Section 3.3.1 Section 18.3 Section 18.4.1 Section 18.4.2 Section 18.5.1
Publication of Monitoring Reports	Monitoring reports will be published in accordance with applicable regulations or as may be required by any conditions included in the environmental Assessment Decision Statement issue by the CEA Agency. Section 18.4 provides a complete listing of proposed environmental monitoring and observation programs for routine Project activities.	Section 18.4
Accidents and Malfunctions – ecosystem impacts	Chapter 16 of the EIS contains an assessment of the potential environmental effects of accidents and malfunctions upon the marine ecosystem and human users, based upon various worst-case unmitigated spill modelling scenarios (batch spills, SBM spills, subsurface blow-outs and vessel collisions).	Section 16.7

Table 3.5 Innu Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Section Reference
Spill Modelling methodology	Chapter 16 provides a description of potential accidental events and malfunctions. Three-dimensional oil spill trajectory and fate modelling and analyses for worst-case unmitigated subsurface blowouts and batch spills of crude oil and marine diesel to support the evaluation of environmental effects of accidental events were performed, using the nearfield OILMAPDeep blowout model and the far-field Spill Impact Model Application Package (SIMAP) trajectory, fate, and effects model. The goal of modelling was to describe a range of possible consequences and exposures of oil releases under various representative scenarios, including that of an unmitigated subsurface blowout. Modelling was based on extremely conservative assumptions and approaches: • Extremely low probability worst case subsurface blowout rates were modelled, with the probability of occurrence of 1 in 207,000,000 to 1 in 414,000,000 • 95th percentile (i.e., worst case scenario) simulation of the results of the 171-172 deterministic model simulations were selected • Batch spill scenarios modelled were very conservative with volumes being greater than the maximum volume of similar spills reported to the C-NLOPB since 1997 • Worst-case environmental (weather) conditions were selected for modelling the batch spill scenarios • All modelled scenarios were 'unmitigated' which assumes no spill response measures were taken. In an actual event, spill response measures would be implemented that would likely reduce the impact of a release.	Section 16.4

Table 3.6 Engagement with NunatuKavut Community Council (NCC)

Date	Activity	Purpose and Focus
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of BdN Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter including Project summary and map.
June 27, 2018	Outgoing Phone Call	Follow-up phone call. Left voicemail.

Table 3.6 Engagement with NunatuKavut Community Council (NCC)

Date	Activity	Purpose and Focus
June 28, 2018	Outgoing Phone Call	Follow-up phone call to discuss potential meeting, availability of Indigenous Knowledge information and issues of concern with the Project Description. Follow-up call planned for week of July 2.
July 6, 2018	Outgoing Phone Call	Follow-up phone call. Left voicemail.
July 18, 2018	Outgoing Phone Call	Follow-up phone call. Left voicemail.
July 23, 2018	Incoming and Outcoming Emails	Follow-up to June 28 phone call and discussion of meeting in Goose Bay.
July 23, 2018	Outgoing Email	Regarding conference call proposed for July 25.
July 25, 2018	Conference Call	Discussion of next steps in engagement and timing of an in-person meeting. Discussion of possible Indigenous Knowledge study based on migratory marine species. Discussion of implementation of Accord Acts and possible economic opportunities related to the Project.
July 25, 2018	Outgoing Email	Confirmation of intent to meet in September; and commitment to continue to provide NCC with relevant Project-related information. Request for a phone call in August to discuss Project and process for sharing Indigenous Knowledge.
August 6, 2018	Outgoing Email	Requesting call to discuss an in-person meeting in Goose Bay, as well as the process of collection of Indigenous Knowledge.
August 8, 2018	Incoming and Outgoing Emails	Email chain regarding possible meeting in Goose Bay during the week of September 17.
August 8, 2018	Incoming Email	NCC to respond to meeting request within one week.
August 14, 2018	Incoming and Outgoing Emails	Email chain regarding August 15 phone call to discuss an in-person meeting and Indigenous Knowledge.
August 15, 2018	Outgoing Phone Call	Phone call to discuss meeting and Traditional Ecological Knowledge (TEK). Left voicemail.
August 27, 2018	Outgoing Email	Email proposing meeting in Goose Bay week of September 17.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss BdN Project, potential effects and proposed mitigation.
September 5, 2018	Outgoing Phone Call	Discussion with NCC about timing and structure of proposed meeting in Goose Bay.

Table 3.6 Engagement with NunatuKavut Community Council (NCC)

Date	Activity	Purpose and Focus
September 5, 2018	Outgoing Email	Follow-up to phone call identifying potential dates for meeting and including proposed agenda items and PowerPoint presentation.
September 12, 2018	Outgoing Email	Proposing possible meeting times in Goose Bay.
September 13, 2018	Incoming and Outgoing Emails	Email chain confirming availability to meet on September 17.
September 17, 2018	In-Person Meeting	Delivery of PowerPoint presentation and Project overview. Discussion of issues of concern and next steps in engagement.
September 18, 2018	Outgoing Email	Follow-up to meeting providing link to information and confirming next steps in engagement
October 11, 2018	Workshop	Half day workshop in St. John's to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 12, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Follow up to workshop, transmitting invoicing information and requesting further comments regarding potential effects / mitigation measures.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.7 NunatuKavut Community Council (NCC) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Accidents – potential impacts of spills on ecosystem	Chapter 16 of the EIS contains an assessment of the potential environmental effects of accidents and malfunctions upon the marine ecosystem and human users, based upon various spill modelling scenarios (batch spills, SBM spills, subsurface blow-outs and vessel collisions).	Section 16.7

Table 3.7 NunatuKavut Community Council (NCC) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Project Description – relationship to exploration Drilling	Details respecting the Project, including Equinor's exploration drilling activities, have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, Project details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings (see Appendix G). Three Workshops were held in October 2018 at which a Project update was presented. Chapter 2 of the EIS presents a detailed description of preliminary Project components and phases. Equinor's offshore experience globally and in offshore NL, including exploration drilling, is discussed in Chapter 1 of the EIS.	Section 2.1 Section 2.2 Section 2.3 Section 2.6.6
Engagement with Indigenous Groups	Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of such information-sharing processes will be developed through discussions with the various groups.	Section 3.3 Section 3.3.1 Section 18.3 Section 18.4.1 Section 18.4.3 Section 18.5.1
Economic Opportunities associated with Project	As part of the Development Application to be submitted to C-NLOPB, Equinor Canada will prepare a Benefits Plan and an associated Gender Equity and Diversity Plan. These plans will outline economic opportunities associated with the Bay du Nord Project.	Not within the scope of the EIS Guidelines

Table 3.8 Engagement with Miawpukek First Nation (MFN)

Date	Activity	Purpose and Focus
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor
June 21, 2018	Outgoing Email	Notification of filing of BdN Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter including Project summary and map.
July 4, 2018	Outgoing Phone Call	Follow-up to letter discussing: possible meeting and next steps in engagement. MFN identified same issues of concern as those associated with the Flemish Pass Drilling Project.
July 6, 2018	Outgoing Email	Follow-up to phone call regarding potential meeting dates.
July 10, 2018	Incoming Email	Request for information session prior to meeting with Chief.
July 12, 2018	Outgoing Email	Agreement in principle to an information session but requested a call to discuss.

Table 3.8 Engagement with Miawpukek First Nation (MFN)

Date	Activity	Purpose and Focus
July 31, 2018	Outgoing Email	Request for call during week of July 20 to discuss information sharing session.
July 31, 2018	Incoming and Outgoing Emails	Email chain regarding call to discuss information sharing session. Call proposed for the week of August 6.
August 6, 2018	Outgoing Phone Call	Call with MFN to discuss holding an in-person meeting. Tentative agreement to meet on either September 12 or 13 in Gander or St. John's. Meeting will consist of a PowerPoint presentation followed by a discussion of issues and concerns. Equinor Canada to follow-up with confirmation and MFN to check internal availability and estimate costs of participation.
August 6, 2018	Outgoing Email	Email confirming substance of telephone call.
August 8, 2018	Outgoing Email	Confirmation of availability to meet on proposed dates.
August 8, 2018	Incoming Email	Proposal to meet on September 13; location to be determined.
August 8, 2018	Incoming Email	Confirmation of meeting date of September 13 in St. John's. MFN requested draft agenda. MFN to provide list of attendees and associated budget.
August 10, 2018	Incoming and Outgoing Emails	Email chain regarding logistics and details of September 13 meeting.
August 15, 2018	Outgoing Email	Commitment to contact MFN on August 27 to finalize details of meeting.
August 16, 2018	Incoming Email	Proposed budget for meeting in St. John's September 13.
August 27, 2018	Incoming and Outgoing Emails	Email chain regarding phone call to discuss meeting budget
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss BdN Project, potential effects and proposed mitigation.
August 29, 2018	Outgoing Phone Call	Discussion with MFN regarding draft budget. Equinor Canada to discuss rationale for budget internally and respond formally to Shared Value Solutions by early the next week.
September 5, 2018	Outgoing Email	Formal response to budget request from MFN.
September 5, 2018	Incoming Email	MFN response to Equinor Canada regarding budget.
September 5, 2018	Incoming Email	Requesting meeting details and proposing agenda.

Table 3.8 Engagement with Miawpukek First Nation (MFN)

Date	Activity	Purpose and Focus
September 7, 2018	Outgoing Email	Email with meeting details and response to MFN agenda proposal.
September 11, 2018	Outgoing Email	Email transmitting PowerPoint presentation and agenda for September 13 meeting.
September 13, 2018	In-Person Meeting	Delivery of PowerPoint presentation and Project overview. Discussion of issues of concern and next steps in engagement.
September 15, 2018	Outgoing Email	Follow-up to September 13 meeting.
September 20, 2018	Outgoing Email	Draft meeting notes provided for review.
September 20, 2018	Outgoing Email	Draft Engagement Plan submitted for review
September 20, 2018	Incoming and Outgoing Emails	Email chain regarding draft Engagement Plan.
October 3, 2018	Outgoing Email	Offer to fund Indigenous Knowledge study of marine species of concern by offshore operators, including Equinor Canada.
October 9, 2018	Incoming Email	Email transmitting revised meeting notes.
October 10, 2018	Outgoing Email	Regarding arrangements for external participation in half day workshop in St. John's.
October 10, 2018	Outgoing Phone Call	Regarding arrangements for call-in participation in half day workshop in St. John's.
October 10, 2018	Outgoing Email	Electronic transmission of workshop materials to MFN external participants.
October 10, 2018	Incoming Email	MFN response to October workshop materials, indicating that workshop does not constitute consultation and requesting enhanced funding for Indigenous Knowledge study.
October 11, 2018	Workshop	Half day workshop in St. John's to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 12, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
October 12, 2018	Incoming Email	Response to workshop materials and commitment to provide revised Engagement Plan in near future.
October 23, 2018	Incoming Email	Email transmitting revised Engagement Plan for review and comment by Equinor Canada.
October 23, 2018	Outgoing Phone Call	Discussion regarding received Engagement Plan and to seek clarification on requested TK funding. MFN clarified that funding requested would be in addition to funding requested from operators. MFN requests response by November 14.

Table 3.8 Engagement with Miawpukek First Nation (MFN)

Date	Activity	Purpose and Focus
October 29, 2018	Outgoing Email	Transmission of revised notes from September 13 meeting to MFN for review and comment.
October 30, 2018	Outgoing Email	Transmission of agreed-upon meeting notes from September 30 meeting.
October 31, 2018	Incoming Phone Call	Phone call requesting slight revision to meeting notes; an update on the status of the scholarship request (from September 13 meeting) was also requested. Equinor Canada committed to follow-up regarding status of scholarship request.
November 2, 2018	Outgoing Phone Call	To discuss scholarship request; left voicemail.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 7, 2018	Outgoing Phone Call	To discuss scholarship request; Equinor Canada was advised that Chief is out of town for the week.
November 8, 2019	Incoming Phone Call	Discussion with Chief regarding scholarship request; Equinor Canada advised that the scholarship request will be considered as part of preparation of Development Application and associated Benefits and Diversity Plans. Equinor Canada also advised the response to draft Engagement Plan would be forthcoming.
November 8, 2018	Outgoing Email	Follow up to workshop, transmitting invoicing information and requesting further comments regarding potential effects/mitigation measures.
November 9, 2018	Outgoing Email	Information regarding sea icing and the floating production, storage and offloading (FPSO) installation.
November 9, 2018	Incoming Email	Response to Equinor Canada's email regarding sea icing and the FPSO.
November 14, 2018	Incoming and Outgoing Emails	Email chain to schedule conference call regarding Equinor Canada redraft of the Engagement Plan transmitted by MFN on October 23.
November 16, 2018	Outgoing Email	Email transmitting re-draft of Engagement Plan
November 20, 2018	Outgoing Phone Call	Discussion of Equinor Canada's re-draft of Engagement Plan.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.8 Engagement with Miawpukek First Nation (MFN)

Date	Activity	Purpose and Focus
August 1, 2019	Incoming and Outgoing Emails	Email from MFN requesting a meeting to discuss status of Project, future consultation and community investments. Equinor Canada's agreement to request.
August 2, 2019	Conference Call	Discussion of purpose of meeting and associated agenda. Meeting confirmed for August 15, 2019
August 15, 2019	In person Meeting	Meeting between representatives of MFN and Equinor Canada to discuss status of Bay du Nord and associated regulatory processes, funding, future consultation and plans associated with the Development Application - Gender Equity and Diversity Plan and Benefits Plan
August 16, 2019	Incoming and Outgoing Emails	Follow up to meeting and providing MFN with copy of presentation and associated materials
August 27, 2019	Outgoing Email	Providing MFN with copy of draft meeting notes for review and comment
September 4, 2019	Incoming Email	MFN providing proposed revision to draft meeting notes
September 6, 2019	Outgoing Email	Equinor Canada's acceptance of MFN's proposed revision
September 19, 2019	Outgoing Email	Email circulating final agreed-upon meeting notes
December 17,2019	Outgoing Email	Email transmitting draft of Engagement Plan

Table 3.9 Miawpukek First Nation (MFN) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Equinor's Corporate Structure, Experience and Policies	Details of Equinor's corporate structure, experience, values and policies were summarized in a power point presentation transmitted to each Indigenous group (see Appendix G) and discussed at in-person meetings. Equinor's corporate structure, experience and policies are fully described in Chapter 1 of the EIS.	Section 1.1
Project Concept and Design – footprint, number of wells, oil transport, safety zone, tiebacks, spill response plan, flowlines and pipelines	Details respecting the Project, including Project concept and design, have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, Project details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings (see Appendix G). Three Workshops were held in October 2018 at which a Project update was presented. Chapter 2 of the EIS contains	Section 2.5

Table 3.9 Miawpukek First Nation (MFN) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
	a detailed description of preliminary Project components, phases and activities.	
Impact on Commercial and FSC fisheries	Through its ongoing engagement activities as well as information contained in the Indigenous Knowledge desktop study, Equinor is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. Information on species of either traditional or commercial importance has been incorporated into baseline information (see chapters 6 and 7). Potential effects (direct and indirect) on of the Project upon marine fish and fish habitat and commercial and subsistence fisheries and associated mitigation measures are discussed in Chapters 9, 13 and 14 respectively. These chapters conclude that no effects upon FSC subsistence fisheries from routine Project activities are predicted. While no significant effects upon commercial fish species or the commercial fisheries are predicted, proposed mitigation measures for commercial fisheries will include the following: • Ongoing communication with commercial fishers regarding planned Project activities, including notification of coordinates of safety and/or anti-collision zones • Ongoing communications with the NAFO Secretariat through Fisheries and Oceans Canada (DFO) regarding planned Project activities, including timely communication of the anti-collision and/or safety zones • Ongoing communication with regulatory agencies to share information regarding the timing and location of activities • Implementation of a standard marine communication protocol to promote safe practices between commercial fishing enterprises, other marine users and BdN operations • Issuance of Notices to Shipping and Notices to Mariners (where appropriate) regarding planned Project activities • Compensation for damage or loss in accordance with C-NLOPB Guidelines	Section 7.3.8 Section 9.5.5 Section 9.5.6 Section 13.1.5 Section 13.2 Section 13.4 Section 13.5 Section 14.1.5.1 Section 14.1.5.2
Vessel Traffic – noise and discharges and impact on salmon	Potential environmental effects of vessel traffic (noise and discharges) upon marine fish, including salmon are identified and assessed in Chapter 9. The effects of sound were identified and assessed based on sound propagation modelling which included an assessment of the potential effects of vessel traffic sounds on fishes and invertebrates. Given the transitory nature of fish and the demonstrated avoidance behavior in response to sound, Equinor Canada predicts that it is unlikely that fish would remain in the vicinity of sound long enough to result in injury.	Section 9.3.5.3 Section 9.4.5.1

Table 3.9 Miawpukek First Nation (MFN) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Spills – treatment and response	Chapter 16 provides a description of potential accidental events and assessment of potential effects of a variety of spills on valued ecological components. Equinor Canada's proposed mitigations and spill response measures are set out in Chapter 16 and additional information on Well Intervention Response Strategies and related matters is contained in Appendices P and Q. Equinor Canada is prepared to effectively respond to an oil spill offshore and is equipped with the necessary response tools, personnel and strategies. A key focus is on prevention. Spill prevention will be incorporated into Project design and operations and facilities, processes and management system procedures are intended to reduce or eliminate the chance of a spill. All plans associated with a response to accidental events are submitted to the C-NLOPB for review and approval as part of the regulatory authorizations process.	Section 16.1 Appendix P Appendix Q
Sound – effects on marine life	Equinor Canada has conducted sound propagation modelling to assess the potential impacts of sound on marine life from various Project activities, including sound associated with vessel traffic. The potential effects of sound on marine fish, invertebrates, marine mammals and marine and migratory birds are identified and assessed in chapters 9, 10 and 11 respectively of the EIS. Sound monitoring during seismic surveys will be carried out. Section 18.4.2 provides information on sound monitoring.	Section 9.3.2.3 Section 9.3.3.3 Section 9.3.4.1 Section 9.3.5.4 Section 10.3.1.1 Section 10.3.5.1 Section 10.4.5 Section 11.3.1.1 Section 11.3.2.1 Section 11.3.3.1 Section 11.3.4 Section 18.3 Section 18.4.2 Section 18.5.1 Section 9.4.1.3 Section 9.4.3.3 Section 9.4.4.1 Section 9.4.5.1 Section 11.3.5 Section 11.4.2.1 Section 11.4.3.1 Section 11.4.4.1 Section 11.4.5
Community Investment	As part of the Development Application to be submitted to C-NLOPB, Equinor Canada will prepare a Benefits Plan and a Gender Equity and Diversity Plan. These plans will outline economic opportunities associated with the Bay du Nord Project	Not within the scope of the EIS

Table 3.9 Miawpukek First Nation (MFN) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Safety and Environment – compliance with regulatory standards	Equinor is committed to becoming an industry leader on safety and will comply with all regulatory standards respecting worker and environmental safety, as outlined in Chapter 1 of the EIS. Relevant legislation is listed in Chapter 1 and in addition, in accordance with the Atlantic Accord Acts and Section 6 of the Newfoundland Offshore Petroleum Drilling and Production Regulations, a Safety Plan must be approved by the C-NLOPB prior to the issuance of an Operations Authorization.	Section 1.3.2.2 Section 1.3.4
Future Indigenous Engagement	Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of such information-sharing processes will be developed through discussions with the various groups.	Section 14.1.5.3 Section 14.5
Incorporation of Indigenous Knowledge	Equinor Canada has made every reasonable effort to collect and incorporate traditional Indigenous knowledge into the EIS. Equinor Canada has invited Indigenous groups to provide traditional knowledge during the course of engagement and has, in addition, offered to enter into agreements for the collection of Indigenous knowledge. Equinor Canada also commissioned an Indigenous Knowledge Desktop Study. Information contained in this study, together with information from other sources, was taken into account in the development of the ecosystem approach throughout the EIS and was used to identify species of interest to Indigenous groups.	Section 14.1.4 Section 14,1,5,2 Appendix H
Impact of Project on Indigenous Rights	Information regarding Indigenous rights is included in Chapters 7 and 14 of the EIS. It is Equinor Canada's understanding that none of the identified groups have asserted or established Indigenous rights to, in or near the lands and waters of the LSA, including the Core BdN Development Area and the Project Area. Additionally, none of the Indigenous groups has identified any current use of lands and resources for traditional purposes or other forms of traditional activities in the LSA. There is also no overlap between the traditional territory of any of the 41 Indigenous groups listed in the EIS Guidelines and the Core BdN Development Area, the Project Area, or the LSA. However, Equinor Canada will continue to engage with Indigenous groups to further understand if there are any potential adverse impacts to Indigenous rights.	Section 14.1.5.1 Section 14.4.2 Section 14.1.5.2

Table 3.10 Engagement with Qalipu Mi'Kmaq First Nation (QMFN) Band

Date	Activity	Purpose and Focus
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter including Project summary and map.
June 27, 2018	Outgoing Phone Call	Follow-up to discuss next steps, no answer.
June 28, 2018	Outgoing Phone Call	Follow-up to discuss structure and timing of meeting between Equinor Canada and QMFN.
July 5, 2018	Incoming Email	Discussion of timing of meeting and confirmation that no major concerns to date.
July 5, 2018	Outgoing Email	Commitment to provide information to QMFN and offer to meet in person or by phone to provide overview of Project.
July 23, 2018	Outgoing Email	Transmission of Bay du Nord PowerPoint presentation and request for phone call to discuss Indigenous Knowledge and Accord Acts
August 6, 2018	Outgoing Email	Follow-up to request phone call to discuss process for sharing Indigenous Knowledge.
August 14, 2018	Incoming and Outgoing Emails	Email chain to schedule a conference call September 5 to discuss Bay du Nord Project and the process for sharing Indigenous Knowledge.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 4, 2018	Incoming Email	Request to reschedule conference call from September 5 to September 7.
September 7, 2018	Conference Call	Conference call to provide Project overview, discuss integration of Indigenous Knowledge and next steps in engagement. Issues identified regarding environmental effects monitoring (EEM), cumulative effects and potential impact on marine habitat.
September 7, 2018	Outgoing Email	Follow-up to conference call confirming understanding on future engagement. Call requested to discuss Indigenous Knowledge and response to questions about species and sediment quality.
September 12, 2018	Incoming Email	QMFN confirmed engagement approach and provide contact information for business and employment managers and directors.

Table 3.10 Engagement with Qalipu Mi'Kmaq First Nation (QMFN) Band

Date	Activity	Purpose and Focus
September 12, 2018	Outgoing Email	Confirming availability for follow-up conference call.
October 5, 2018	Incoming and Outgoing Emails	QMFN not able to attend half-day workshop on Bay du Nord Project so Equinor Canada agreed to provide workshop notes and schedule follow-up phone call.
October 12, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Email transmitting invoicing information and inviting further comments on potential effects/proposed mitigation.
November 8, 2018	Incoming Email	Confirming accuracy of community baseline information.
November 8, 2018	Incoming Email	Providing comments on Worksheets and potential effects and proposed mitigation measures.
December 11, 2018	Outgoing Email	Email regarding following up in 2019 to discuss Accord Acts.
December 12, 2018	Incoming Email	Acknowledgement of email regarding Accord Act discussion.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.11 Qalipu Mi'Kmaq First Nation (QMFN) Band Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Environmental Effects Monitoring (scope)	Detailed information respecting follow-up and monitoring programs is contained in Chapter 18 of the EIS. The design of follow-up monitoring programs will be undertaken following finalization of Project design, taking into account Agency guidance, the terms of the EIS Decision Statement and relevant regulatory requirements. The follow-up monitoring program will be developed in consultation with the C-NLOPB and relevant government departments (e.g., DFO, ECCC). In addition, Indigenous groups and key stakeholders will be engaged, as appropriate. Preliminary discussions with Indigenous groups respecting proposed monitoring measures were held at three Workshops	Section 18.4

Table 3.11 Qalipu Mi'Kmaq First Nation (QMFN) Band Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
	in October and Indigenous groups which did not participate in person were invited to provide comments in writing. The scope of follow-up monitoring programs will take into consideration the results of other offshore environmental effects monitoring programs (both previous and ongoing), employ technology specifically suited to the monitoring of a production project at 1200 m water depths and utilize Equinor's global experience in EEM, ongoing research and new technologies.	
Cumulative Effects on marine ecosystem	Equinor Canada has identified and assessed cumulative effects using the approach described in relevant CEA Agency guidance documents by considering the impact of the Project in combination with other past, present and future activities in the region upon each VC. As is the case with the assessment of intra-Project effects, an ecosystem approach will be adopted. The results of this assessment are set out in Chapter 15 of the EIS and it is Equinor Canada's conclusion that that the Project is not likely to result in any significant adverse cumulative effects upon the marine ecosystem in combination with other projects and activities that have been or will be carried out in the RSA.	Section 15.2.6 Section 15.3.6 Section 15.4.6 Section 15.5.5 Section 15.6.5 Section 15.7.5
Effects on species of concern (Salmon, American eel)	Through its ongoing engagement activities as well as information contained in the Indigenous Knowledge Desktop Study, Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. During its ongoing engagement, Indigenous groups have placed particular emphasis upon salmon and American eel as species of cultural importance. Information on species of either traditional or commercial importance has been incorporated into baseline information (see chapters 6 and 7). Potential effects (direct and indirect) of the Project upon marine fish and fish habitat and subsistence fisheries and associated mitigation measures are discussed in Chapters 9 and 14 respectively. These chapters predict that no significant direct effects upon marine fish or fish habitat or any indirect effects (cultural, social, health or socio-economic) upon Indigenous persons are predicted to result from routine Project activities. The effect of accidents and malfunctions upon marine fish and fish habitat and Indigenous persons are discussed in Chapter 16.	Section 9.5.5 Section 9.5.6 Section 14.1.5.1 Section 14.1.5.2
Lack of capacity - funding	Questions associated with provision of capacity funding to Indigenous groups to participate in the environmental assessment process have been referred to the CEA Agency	Not within the scope of the EIS

Table 3.11 Qalipu Mi'Kmaq First Nation (QMFN) Band Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Project design and components	Details respecting the Project, including Project concept and design, have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, Project details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings (see Appendix G). Three Workshops were held in October 2018 at which a Project update was presented. Chapter 2 of the EIS presents a detailed description of preliminary Project design and components.	Section 1.2.2 Section 2.5 Appendix A.3

Table 3.12 Engagement with Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO)

Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO): Aggregate body representing the Assembly of Nova Scotia Mi'kmaq Chiefs (ANSMC) representing: Acadia First Nation, Annapolis Valley First Nation, Bear River First Nation, Eskasoni First Nation, Glooscap First Nation, Membertou First Nation, Paqtnkek Mi'kmaw Nation, Pictou Landing First Nation, Potlotek First Nation, Wagmatcook First Nation, and Waycobah First Nation. For all engagement with KMKNO, Equinor Canada understands that KMKNO is acting on behalf of the groups listed here. Key Issues and Questions raised communicated by KMKNO rather than constituent member communities. *Correspondence is with KMKNO unless indicated otherwise.* Millbrook First Nation and Sipekne'katik First Nation pursue consultation and negotiation independently of KMKNO.		
Date	**Activity**	**Purpose and Focus**
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Incoming Letter	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Acadia First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Annapolis Valley First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Bear River First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Eskasoni First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Glooscap First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Membertou First Nation	Project Description notification letter, Project summary and map.

Table 3.12 Engagement with Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO)

Date	Activity	Purpose and Focus
June 25, 2018	Outgoing Letter to Paqtnkek First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Pictou Landing First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Potlotek First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Wagmatcook First Nation	Project Description notification letter, Project summary and map.
June 25, 2018	Outgoing Letter to Waycobah First Nation	Project Description notification letter, Project summary and map.
June 27, 2018	Outgoing Email	Follow-up to Project Description letter to discuss next steps.
July 4, 2018	Incoming Email	Requesting possible meeting dates.
July 4, 2018	Outgoing Email	Proposing phone call to discuss meeting dates and logistics.
July 4, 2018	Incoming Email	Confirmation of phone call on July 10.
July 10, 2018	Outgoing Phone Call	To discuss timing of an in-person meeting, including with fisheries coordinator.
July 10, 2018	Outgoing Email	Follow-up email to phone call committing to provide possible dates for an in-person meeting in July.
July 13, 2018	Incoming and Outgoing Emails	Discussion of potential meeting dates in late July as mutually convenient.
July 17, 2018	Outgoing Email	Proposal to meet on July 24 in Truro.
July 18, 2018	Incoming and Outgoing Emails	Confirming meeting time and location and providing call-in information.
July 23, 2018	Outgoing Email	Transmission of PowerPoint in advance of in-person meeting.
July 24, 2018	In-Person Meeting	Delivery of PowerPoint presentation and Project overview. Discussion of issues of concern and next steps in engagement.
July 25, 2018	Outgoing Email	Email providing KMKNO with requested information and agreement by Equinor Canada to develop a draft Engagement Plan.
August 8, 2018	Incoming and Outgoing Emails	Transmission of draft Engagement Plan.
August 15, 2018	Outgoing Email	KMKNO confirms receipt of Engagement Plan and indicates that will respond by end of August.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.

Table 3.12 Engagement with Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO)

Date	Activity	Purpose and Focus
September 20, 2018	Outgoing Email	Proposing phone call to discuss draft Engagement Plan.
September 20 to 28, 2018	Incoming and Outgoing Emails	Email chain regarding call to discuss Engagement Plan.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments. Equinor Canada offered to schedule a conference call to discuss and committed to providing KMKNO with a copy of the final Workshop Report.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Email transmitting invoicing materials and asking for any further comments on potential effects/proposed mitigation.
November 8, 2018	Incoming and Outgoing Emails	Email chain acknowledging receipt of invoicing materials. Offer by Equinor Canada to hold call with new consultation representative to provide background on community engagement to date.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.13 Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Environmental Effects Monitoring – form, scope and frequency	Detailed information respecting follow-up and monitoring programs is contained in Chapter 18 of the EIS. The design of follow-up monitoring programs will be undertaken following finalization of Project design, taking into account Agency guidance, the terms of the EIS Decision Statement and relevant regulatory requirements. The follow-up monitoring program will be developed in consultation with the C-NLOPB and relevant government departments (e.g., DFO, ECCC). In addition, Indigenous groups and key stakeholders will be engaged, as appropriate. Preliminary discussions with Indigenous groups respecting proposed monitoring measures were held at three Workshops in October and Indigenous groups which did not participate in person were invited to provide comments in writing. The scope of such programs will take into consideration the results of other offshore environmental effects monitoring	Section 18.4

Table 3.13 Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
	programs (both previous and ongoing), employ technology specifically suited to the monitoring of a production project at 1200 m water depths and utilize Equinor's global experience in EEM, ongoing research and new technologies.	
Cumulative Effects	Equinor Canada has identified and assessed cumulative effects using the approach described in relevant CEA Agency guidance documents by considering the impact of the Project in combination with other past, present and future activities in the region upon each VC. As is the case with the assessment of intra-Project effects, an ecosystem approach has been adopted. The results of this assessment are set out in Chapter 15 of the EIS and it is Equinor Canada's prediction that that the Project is not likely to result in any significant adverse cumulative effects upon the marine ecosystem or upon human uses within that ecosystem in combination with other projects and activities that have been or will be carried out in the RSA.	Section 15.2.6 Section 15.3.6 Section 15.4.6 Section 15.5.5 Section 15.6.5 Section 15.7.5
Scale of offshore operations in Norway vs. NL	During an in-person meeting with KMKNO, Equinor Canada provided KMKNO with a graphic illustrating the relative intensity of oil and gas operations in offshore Norway and the North Sea in comparison with current activities in offshore NL. Details respecting Equinor and Equinor Canada's corporate structure, policies, values and global offshore experience have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, corporate details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings (see Appendix G). Equinor's offshore experience is described in Chapter 1 of the EIS.	Section 1.1
Environmental Effects – Ballast water and introduction of invasive species through ballast water	Equinor Canada considers prevention to be key in controlling the introduction and spread of aquatic invasive species. Although the likelihood that a Project vessel will result in the introduction and spread of an invasive species is relatively low, ballast water will be managed in consideration of applicable Canadian and international ballast water management requirements to reduce the potential spread of invasive species. Ballast water management is addressed in Chapter 2 and potential effects are discussed in Chapter 9.	Section 2.8.2 Section 9.3.4.1 Section 9.4.4.1
Decommissioning – removal of seabed infrastructure and impact on habitat	As stated in Section 9.2.6.2 of the EIS, there are two options for decommissioning of subsea infrastructure – leave the infrastructure in place or removal of the infrastructure. The effects of each alternative are described and assessed in Section 9.2.6.2 of the EIS.	Section 9.3.6 Section 9.4.6

Table 3.13 Kwilmu'kw Maw-klusuaqn Negotiation Office (KMKNO) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Spills – effects on biophysical environment and human health	Equinor Canada has conducted spill modelling, using a worst-case scenario (unmitigated blow-out). The potential effects of spills on the biophysical environment and human health are discussed in Chapter 16.	Section 16.7
Communal Commercial Fisheries, including effects on commercial species (snow crab) and compensation for losses	Current communal commercial fishing activities are described in Chapter 7 and the potential effects of the Project upon communal commercial fisheries is discussed in Chapter 13. No significant impacts upon communal commercial fisheries, including snow crab fisheries, are predicted. Equinor Canada will develop and implement a compensation program for damages experienced by commercial and communal commercial fishers which result from Project activities. The program will be developed in consideration of the C-NLOPB Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (2017). The proposed compensation regime is discussed in greater detail in Chapters 13 and 16.	Section 7.3.8.1 Section 13.1.5.1 Section 13.2.4.2 Section 14.1.5.2 Section 16.7.8 Section 16.7.9
Ongoing information sharing with Indigenous groups	Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of engagement processes will be developed through discussions with the various groups.	Section 14.1.5.3 Section 14.5

Table 3.14 Millbrook First Nation Engagement

Date	Activity	Purpose and Focus
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, Project summary and map
July 18, 2018	Outgoing Phone Call	Follow-up phone call. No answer and voicemail not available. Sent follow-up email requesting call.
July 23, 2018	Incoming and Outgoing Emails	Email chain regarding scheduling of call to discuss next steps in engagement on Bay du Nord.
August 10, 2018	Outgoing Phone Call	Phone call to discuss next steps in engagement No answer.

Table 3.14 Millbrook First Nation Engagement

Date	Activity	Purpose and Focus
August 10, 2018	Outgoing Email	Email reiterating Equinor Canada's interest in engaging with Millbrook and offering to schedule a conference call.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 20, 2018	Outgoing Email	Email transmitting PowerPoint presentation and proposing a conference call. No response.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments. Equinor Canada offered to schedule a conference call to discuss and committed to providing Millbrook with a copy of the final workshop report. No response received.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	E-mail transmitting invoicing materials and inviting additional comments on potential effects/proposed mitigation measures.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.15 Millbrook First Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
None identified to Proponent		n/a

Table 3.16 Engagement with Sipekne'katik First Nation

Date	Activity	Purpose and Focus
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, Project summary and map.

Table 3.16 Engagement with Sipekne'katik First Nation

Date	Activity	Purpose and Focus
July 18, 2018	Outgoing Phone Call	Number not in service. Sent email requesting new contact information.
July 18, 2018	Outgoing Email	Email requesting a phone call to discuss next steps in engagement.
July 23, 2018	Incoming and Outgoing Emails	Email chain regarding scheduling a phone call to discuss the Bay du Nord Project and engagement
July 31, 2018	Outgoing Email	Request to schedule a phone call the week of July 30 or August 6, 2018.
August 10, 2018	Outgoing Email	Email regarding release of EIS Guidelines and proposing a conference call the week of September 3.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 20, 2018	Outgoing Email	Transmission of PowerPoint presentation and proposal for a conference call.
October 19, 2018	Workshop	Half day workshop in Moncton to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments. Equinor Canada offered to schedule a conference call to discuss and committed to providing Sipekne'katik with a copy of the final workshop report. No response received.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Email inviting additional comments on potential environmental effects/proposed mitigation measures.
November 13, 2018	Incoming and Outgoing Emails	Email chain regarding review of worksheets from the Moncton workshop.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA
April 30, 2019	Outgoing Email	Email to new consultation contact, advising of status of Bay du Nord Project EA and offering to discuss by phone. No response

Table 3.17 Sipekne'katik First Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
None identified to Proponent		n/a

Table 3.18 Engagement with Mi'gmawe'l Tplu'taqnn Inc. (MTI)

Date	Activity	Purpose and Focus
Mi'gmawe'l Tplu'taqnn Inc. (MTI): Aggregate body for Fort Folly First Nation, Eel Ground First Nation, Pabineau First Nation, Esgenoôpetitj First Nation, Buctouche First Nation, Indian Island First Nation, Eel River Bar First Nation, Metepnagiag Mi'kmaq First Nation regarding engagement. For any engagement with MTI, Equinor Canada understands that MTI is acting on behalf of these groups. Key Issues and Questions Raised are those identified by MTI and not by member communities. Correspondence is with MTI unless indicated otherwise. Elsipogtog First Nation is not represented by MTI and is engaged directly through Kopit Lodge.		
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, including Project summary and map.
June 27, 2018	Outgoing Email	Request to schedule a follow-up phone call on June 28.
June 25, 2018	Outgoing Letter to Buctouche First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Eel Ground First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Eel River Bar First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Esgenoôpetitj First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Fort Folly First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Indian Island First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Metepenagiag First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Pabineau First Nation	Project Description notification letter, including Project summary and map.
June 28, 2018	Conference Call	Phone call to discuss next steps in engagement and possible dates/subject matter for meeting with MTI representatives.

Table 3.18 Engagement with Mi'gmawe'l Tplu'taqnn Inc. (MTI)

Date	Activity	Purpose and Focus
June 28, 2018	Outgoing Email	Review of issues raised during conference call and confirmation of a follow-up call by July 5.
June 28, 2018	Incoming Email	Confirming intent to provide possible meeting dates and issues to discuss by July 5.
July 6, 2018	Incoming and Outgoing Emails	Email chain regarding possible dates for meeting. Phone call scheduled for July 10 to determine meeting date and issues to be discussed.
July 10, 2018	Outgoing Phone Call	Discussion of potential meeting dates and meeting agenda.
July 10, 2018	Outgoing Email	Email confirming July 19 meeting date and request for call to discuss details.
July 11 – July 13, 2018	Incoming and Outgoing Emails	Email chain confirming conference call on July 13, meeting agenda, location, participants and other details.
July 19, 2018	In-Person Meeting	Delivery of PowerPoint presentation and Project overview. Discussion of issues of concern and next steps in engagement.
July 23, 2018	Outgoing Email	Follow up to meeting and request for phone call to discuss next steps.
July 30, 2018	Incoming and Outgoing Emails	Email chain regarding call on August 2.
August 2, 2018	Phone Call	Follow-up to meeting to Project update, identify matters for information exchange and discuss engagement process. Agreement to hold monthly calls.
August 2, 2018	Incoming Email	Transmission of meeting notes.
August 2, 2018	Outgoing Email	Transmission of meeting notes and examples of Indigenous Knowledge studies
August 7, 2018	Outgoing Email	Email providing information about Sami and Salmon, as requested at July 19 meeting.
August 14, 2018	Incoming Email	Email providing copy of Indigenous Knowledge Study prepared for Exploration Drilling Program.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 6, 2018	Conference Call	Monthly call to provide status report on Project and related matters. Parties discussed the desktop Indigenous Knowledge Study, EIS Guideline comment period, and October workshop.

Table 3.18 Engagement with Mi'gmawe'l Tplu'taqnn Inc. (MTI)

Date	Activity	Purpose and Focus
October 4, 2018	Conference Call	Second monthly call to provide status report on Project and related matters. Parties discuss draft Project EIS Guidelines, Participant Funding Program, and upcoming workshop.
October 19, 2018	Workshop	Half day workshop in Moncton to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
November 1, 2019	Conference Call	Third monthly project update call, as per agreement. Parties discussed workshop, time to provide additional comments, and compilation of Indigenous community baseline information. MTI will resend workshop worksheets to Fisheries Director for review and comment and will check baseline information for accuracy. December monthly call to be rescheduled for second week in December. Revised invitation for December call sent out on November 2.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Email transmitting invoicing information and inviting further comments on potential environmental effects/proposed mitigation.
December 10, 2018	Outgoing Phone Call	Monthly update phone call. Discussed topics such as status of EIS and workshop report. No issues identified by MTI.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report which is included in Appendix G.
January 3, 2019	Outgoing Email	Scheduling of Project update call
January 15, 2019	Conference Call	Project update discussion and capacity funding
January 24, 2019	Incoming and Outgoing Emails	Discussion of request for capacity funding
January 25, 2019	Conference Call	Call to discuss funding request. MTI asked to provide list of ongoing community initiatives. Parties agree that monthly calls not necessary while EA ongoing. Calls on an as-needed basis. No list of community initiatives subsequently provided.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.19 Mi'gmawe'l Tplu'taqnn Inc. (MTI) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Marine Protected Areas and potential interaction with the Project	Marine Protected Areas and other Special Areas in the RSA are described in Chapter 6. The potential effects of the Project upon Special Areas are identified and assessed in Chapters 12 and 16.	Section 6.4.2.2 Section 12.2 Section 16.7.7 Section 12.3
Marine Mammals – potential impacts on right whales, with emphasis on ship strikes	The potential impacts of the Project upon marine mammals, including right whales, are identified and assessed in Chapter 11. It is the opinion of Equinor Canada that the likelihood of ship strikes of right whales is low due to the projected low volume and frequency of Project-related vessel traffic. Furthermore, the vessel traffic corridor is not within specific areas that have been identified as marine mammal breeding grounds, feeding concentrations, and/or migration routes Consistent with International Regulations for Preventing Collisions at Sea, 1972 with Canadian Modifications, Rule 5, every vessel shall maintain a proper lookout at all times. Project vessels will alter course and/or reduce speed if a marine mammal(s) (or sea turtle) is detected ahead of the vessel. While it is highly unlikely that surface active groups of North Atlantic right whales will occur along the vessel traffic route to the Project Area, if one is detected by Project vessel crew, the sighting(s) will be reported to DFO.	Section 11.5.3 Section 11.1.5.1 Section 11.3.1.1 Section 11.3.4.1 Section 11.3.5.1 Section 11.4.5.1
Fish and Fish Habitat – potential impact on salmon migrating through/overwintering in Project Area	As a result of its ongoing engagement activities, including the Indigenous Knowledge Desktop Study, Equinor Canada is aware of the traditional, social and cultural importance of salmon to Indigenous groups. Equinor Canada has identified and assessed the potential impacts of the Project upon the various Atlantic salmon populations, including those which may migrate through or overwinter in the Project Area. As stated in the EIS, it is Equinor Canada's conclusion that the potential for interactions with the relevant salmon populations and the Project is limited. While the Project may result in limited localized interactions with individual salmon, it is not predicted to have overall ecological or population-level effects and will not result in a detectable decline in overall abundance or changes in the spatial and temporal distribution of salmon populations in the area. Baseline information on various salmon populations is contained in Chapter 6 and the potential effects of the Project upon these populations is identified and assessed in Chapter 9. Effects of accidents and spills upon marine fish and fish habitat, including salmon are discussed in Chapter 16. The cultural and traditional significance of salmon to Indigenous peoples is described in Chapter 7 and potential indirect effects upon Indigenous peoples resulting from direct effects to salmon are identified and assessed in Chapter 14.	Section 9.5.5 Section 14.1.5,1 Section 14.1.5.2 Section 16.7.4

Table 3.19 Mi'gmawe'l Tplu'taqnn Inc. (MTI) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Environmental Effects Monitoring – scope and nature	Detailed information respecting follow-up and monitoring programs is contained in Chapter 18 of the EIS. The design of follow-up monitoring programs will be undertaken following finalization of Project design, taking into account Agency guidance, the terms of the EIS Decision Statement and relevant regulatory requirements. The follow-up monitoring program will be developed in consultation with the C-NLOPB and relevant government departments (e.g., DFO, ECCC). In addition, Indigenous groups and key stakeholders will be engaged, as appropriate. Preliminary discussions with Indigenous groups respecting proposed monitoring measures were held at 3 Workshops in October and Indigenous groups which did not participate in person were invited to provide comments in writing. The scope of such programs will take into consideration the results of other offshore environmental effects monitoring programs (both previous and ongoing), employ technology specifically suited to the monitoring of a production project at 1200 m water depths and utilize Equinor's global experience in EEM, ongoing research and new technologies.	Section 18.4
Indigenous Engagement	Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of engagement processes will be developed through discussions with the various groups.	Section 14.1.5.3 Section 14.5
Decommissioning – seabed infrastructure	As stated in Section 9.2.6.2 of the EIS, there are two options for decommissioning of subsea infrastructure – leave the infrastructure in place or removal of the infrastructure. The effects of each alternative are described in Section 9.2.6.2 of the EIS.	Section 9.3.6 Section 9.4.6
Effects of Environment on Project – disconnection in rough weather	In accordance with the Newfoundland Offshore Certificate of Fitness Regulations, the FPSO and drilling installation(s) are required to have a Certificate of Fitness, which requires that the installation be designed with potential environmental loads imposed by earthquakes and other naturally occurring phenomena being taken into account. The FPSO and/or drilling installation(s) are capable of disconnection in a short period of time, if necessary. Effects of the environment on the Project are assessed in Chapter 17.	Section 17.3.2

Table 3.19 Mi'gmawe'l Tplu'taqnn Inc. (MTI) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Produced Water – level of hydrocarbons and dispersion area	Equinor Canada has modelled the dispersion of produced water and the identification and assessment of effects is contained in chapter 9. Appendix J provides the complete produced water modelling report. Modelling was based upon a worst-case scenario (produced water with a residual oil-in-water content of 30 mg/l). The effects assessment of produced water includes the effects of residual oil and other contaminants in treated produced water, effects of discharging high temperature water, and discharging water with higher salinity. Using the results of the modelling, the ZOI for produced water would be confined to within 100 m of the location of the FPSO.	Section 9.3.2.4 Section 9.4.2.1 Appendix J
Emergency Response – budget, procedures, minimum requirements	Equinor is committed to becoming an industry leader on safety and will comply with all regulatory standards respecting worker and environmental safety, as outlined in Chapter 1 of the EIS. Relevant legislation is listed in Chapter 1 and in addition, in accordance with the Atlantic Accord Acts and Section 6 of the Newfoundland Offshore Petroleum Drilling and Production Regulations, a Safety Plan must be approved by the C-NLOPB prior to the issuance of an Operations Authorization. Equinor Canada's spill response measures are set out in Chapter 16 and additional information on Well Intervention Response Strategies and related matters is set out in Appendices P and Q. Equinor Canada is prepared to effectively respond to an oil spill offshore and is equipped with the necessary response tools, personnel and strategies. All plans surrounding a response to accidental events are submitted to the C-NLOPB for review and approval as part of the regulatory authorizations process. Financial requirements for operators respecting liability for damages attributable to the Project are governed by Regulations passed pursuant to the Atlantic Accord Acts and the Guidelines Respecting Financial Requirements (C-NLOPB 2017).	Section 1.3 Section 16.1 Appendix P Appendix Q
Indigenous groups – Sami in Norway and role in management of salmon resources	Equinor Canada supplied MTI with relevant articles respecting the role of Sami in Norway in relation to the management of salmon resources.	Not within the scope of the EIS Guidelines

Table 3.20 Engagement with Elsipogtog First Nation

Date	Activity	Purpose and Focus
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, including Project summary and map.
July 18, 2018	Outgoing Phone Call	Follow up to Project Description correspondence and discussion of next steps. Elsipogtog requested that a formal letter, regarding next steps, be sent to Kopit Lodge for consideration at a weekly meeting. Elsipogtog will provide Equinor Canada with a copy of the consultation protocol.
July 18, 2018	Outgoing Letter	As per request, letter to Kopit Lodge requesting consideration of the next steps in engagement process.
July 18, 2018	Incoming Letter	Letter containing consultation protocols and agreeing to next steps.
July 23, 2018	Outgoing Email	Email confirming interest in meetings and commitment to requested meeting costs.
July 25, 2018	Incoming Email	Kopit Lodge to provide possible meeting dates following internal meetings on July 30.
July 31, 2018	Outgoing Email	Email proposing a meeting in Elsipogtog on September 2 or 3.
July 31, 2018	Incoming Email	Kopit Lodge indicated it is not available to meet until the end of September.
July 31, 2018	Outgoing Email	Equinor Canada confirmed availability to meet at the end of September.
August 24, 2018	Incoming Email	Regarding potential meeting dates.
August 27, 2018	Outgoing Email	Email proposing to meet during the week of September 24 or later.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
August 27, 2018	Incoming and Outgoing Emails	Email regarding potential meeting dates in September and participation in October workshops.
August 28, 2018	Incoming and Outgoing Emails	Email chain regarding proposal to meet on September 24.
September 11, 2018	Incoming and Outgoing Emails	Email chain regarding phone call to discuss timing, agenda and structure of September 24 meeting.

Table 3.20 Engagement with Elsipogtog First Nation

Date	Activity	Purpose and Focus
September 12, 2018	Outgoing Phone Call	To confirm meeting date, time, location and content.
September 13, 2018	Outgoing Email	Transmission of reimbursement instructions.
September 19, 2018	Incoming and Outgoing Emails	Email chain regarding meeting details
September 20, 2018	Outgoing Email	Transmission of meeting agenda and PowerPoint presentation.
September 24, 2018	In-Person Meeting	Meeting to provide overview of Bay du Nord Project and discuss next steps. Discussion included capacity funding, engagement, salmon, American eel, monitoring, cumulative effects, spills and spill response.
September 25, 2018	Incoming Email	Follow-up email acknowledging meeting and expressing intention to continue information sharing.
September 26, 2018	Outgoing Email	Follow-up email expressing commitment to continued information sharing.
October 19, 2018	Workshop	Half day workshop in Moncton to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
October 22, 2018	Incoming Email	Email thanking Equinor Canada for information.
October 22, 2018	Incoming Email	Email stating that while the workshop was informative, it is not to be considered consultation.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	E-mail inviting additional comments on potential environmental effects/proposed mitigation measures. ***No further comments received***
December 14, 2018	Outgoing Email	Transmission of the Workshop Report which is included in Appendix G.
April 1, 2019	Incoming Letter	Requesting information on new exploration licences
April 8, 2019	Outgoing Email	Clarification on new licences and EA
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.21 Elsipogtog First Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Decommissioning – monitoring of abandoned wells	Decommissioning is discussed in depth in Chapter 2. Well abandonment will adhere to the requirements set out under the Newfoundland Offshore Petroleum Drilling and Production Regulations. Pursuant to these regulations, operators are required to provide detailed plans for monitoring suspended wells to the C-NLOPB. Operators are also required to provide C-NLOPB with information regarding suspension or abandonment methods designed to ensure the wells are adequately isolated, which in turn will prevent hydrocarbons from entering the environment. Financial requirements for operators respecting liability for damages attributable to the Project are governed by Regulations passed pursuant to the Atlantic Accord Acts and the Guidelines Respecting Financial Requirements (C-NLOPB 2017).	Section 2.6.7
Indigenous Engagement – form, activities, funding	Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of engagement processes will be developed through discussions with the various groups. Questions respecting capacity funding to participate in the EA process have been referred to the CEA Agency.	Section 14.1.5.3 Section 14.5
Cumulative Effects – Impacts on traditional territory	Equinor Canada has identified and assessed cumulative effects using the approach described in relevant CEA Agency guidance documents by considering the impact of the Project in combination with other past, present and future activities in the region upon each VC. As is the case with the assessment of intra-Project effects, an ecosystem approach has been adopted. The results of this assessment are set out in Chapter 15 of the EIS. With respect to potential impacts on traditional territories, since the closest Indigenous community is located approximately 630 km from the Project area and since there is no overlap between the Project Area or LSA with the traditional territory of any Indigenous group, no cumulative effects on traditional territories are predicted.	Section 15.2.6 Section 15.3.6 Section 15.4.6 Section 15.5.5 Section 15.6.5 Section 15.7.5
Species of concern – Salmon, American eel	Through its ongoing engagement activities as well as information contained in the Indigenous Knowledge Desktop Study (Appendix H), Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. During its ongoing engagement, Indigenous groups have placed particular emphasis upon salmon and American eel as species of cultural importance. Information on species of either traditional or commercial importance has been incorporated into baseline information (see chapters 6 and 7). Potential effects (direct and indirect) of the Project upon fish and fish habitat and subsistence fisheries and associated mitigation measures are discussed in Chapters 9 and 14 respectively. As indicated in these	Section 6.1.9.2 Section 6.1.9.6 Section 7.3.8.2 Section 9.5.5 Section 9.5.6 Section 14.1.5.1 Section 14.1.5.2 Section 16.7.4.3 Section 16.7.9.3 Appendix H

Table 3.21 Elsipogtog First Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
	chapters, no significant direct effects upon marine fish or fish habitat are predicted to result from routine Project operations and no indirect effects (health, cultural or socio-economic) associated with Indigenous uses or culture are predicted to result from routine Project activities. The effect of spills on fish, fish habitat and Indigenous persons are discussed in Chapter 16.	
Indigenous Rights	Information respecting Indigenous and treaty rights is included in Chapter 7 of the EIS. It is Equinor Canada's understanding that none of the Indigenous groups listed in the EIS Guidelines have asserted or established Indigenous rights to, in or near the lands and waters of the LSA, including the Core BdN Development Area and the Project Area. Additionally, none of the Indigenous groups has identified any current use of lands and resources for traditional purposes or other forms of traditional activities in the LSA. There is also no overlap between the traditional territory of any of the 41 Indigenous groups listed in the EIS Guidelines and the Core BdN Development Area, the Project Area, or the LSA. However, Equinor Canada will continue to engage with Indigenous groups to further understand if there are any potential adverse impacts upon Indigenous rights.	Section 7.3

Table 3.22 Engagement with Wolastoqey Nation of New Brunswick (WNNB)

Wolastoqey Nation of New Brunswick (WNNB): Aggregate body for Kingsclear First Nation, Madawaska Maliseet First Nation, Oromocto First Nation, Saint Mary's First Nation, and Tobique First Nation regarding engagement. Key Issues and Questions Raised are those identified through engagement with WNNB and not by constituent member communities. Correspondence is with WNNB unless indicated otherwise.

Date	Activity	Purpose and Focus
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 14, 2018	Outgoing Email to Kingsclear First Nation	Introduction of Equinor Canada's Sustainability Advisor.
June 14, 2018	Outgoing Email to Madawaska Maliseet First Nation	Introduction of Equinor Canada's Sustainability Advisor
June 14, 2018	Outgoing Email to Oromocto First Nation	Introduction of Equinor Canada's Sustainability Advisor
June 14, 2018	Outgoing Email to Saint Mary's First Nation	Introduction of Equinor Canada's Sustainability Advisor
June 14, 2018	Outgoing Email to Tobique First Nation	Introduction of Equinor Canada's Sustainability Advisor.

Table 3.22 Engagement with Wolastoqey Nation of New Brunswick (WNNB)

Date	Activity	Purpose and Focus
June 18, 2018	Incoming e-mail from Kingsclear First Nation	Response to introduction email.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 21, 2018	Outgoing Email to Kingsclear First Nation	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 21, 2018	Outgoing Email to Madawaska Maliseet First Nation	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 21, 2018	Outgoing Email to Oromocto First Nation	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 21, 2018	Outgoing Email to Saint Mary's First Nation	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 21, 2018	Outgoing Email to Tobique First Nation	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter to Kingsclear First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Madawaska Maliseet First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Oromocto First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Saint Mary's First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Tobique First Nation	Project Description notification letter, including Project summary and map.
July 10, 2018	Outgoing Email	Email requesting a phone call to discuss possible meeting with all Resource Development Consultation Coordinators (RDCCs) in a single location.
July 10, 2018	Incoming Email	Response to meeting request, including material regarding WNNB consultation protocol.
July 10, 2018	Outgoing Email	Confirming receipt of email and availability to speak with consultation coordinator.
July 10, 2018	Incoming Email	Requesting call with Equinor Canada on July 16.
July 10, 2018	Outgoing Phone Call to Kingsclear First Nation	Call to discuss next steps in engagement. No answer, left message.

Table 3.22 Engagement with Wolastoqey Nation of New Brunswick (WNNB)

Date	Activity	Purpose and Focus
July 10, 2018	Outgoing Phone Call to Madawaska Maliseet First Nation	Parties discussed Project. No serious issues but Madawaska Maliseet First Nation identified possible interactions with an Aboriginal Right (salmon using Flemish Pass as a feeding ground) and expressed interest in discussing mitigation measures and economic opportunities. [all subsequent engagement conducted through WNNB]
July 16, 2018	Conference Call	Discussion of approach to engagement with WNNB member communities and proposal to meet in central location on July 24. Commitment that Equinor Canada will continue to provide relevant information.
July 16, 2018	Outgoing Email	Email confirming substance of conference call and providing links to information requested by WNNB.
July 30, 2018	Incoming Email	Proposing an in-person meeting on August 30 in Fredericton.
July 30, 2018	Outgoing Email	Confirming availability to meet on August 30.
July 30, 2018	Incoming Email	Email regarding costs of meeting and of travel to meeting by RDCCs.
August 8, 2018	Outgoing Email	Confirmation of meeting time and location and draft agenda.
August 10, 2018	Outgoing Email	Request for number of call-in participants.
August 13, 2018	Incoming and Outgoing Emails	E-mail chain confirming agenda, meeting details and participants. Confirmation of agenda and participants.
August 14, 2018	Outgoing Email	Transmission of information regarding reimbursement procedures.
August 16, 2018	Outgoing Email	Transmission of PowerPoint presentation and draft agenda for August 30 meeting.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
August 30, 2018	In-Person Meeting	Delivery of power point presentation and discussion of issues of concern and next steps in engagement.
September 5, 2018	Outgoing Email	Follow up to meeting and confirming next steps in engagement.
September 10, 2018	Outgoing Email	Requested information from WNNB on any salmon studies demonstrating that salmon feed in the Project Area.
September 10, 2018	Incoming Email	Response from WNNB including reference to salmon study.

Table 3.22 Engagement with Wolastoqey Nation of New Brunswick (WNNB)

Date	Activity	Purpose and Focus
October 19, 2018	Workshop	Half day workshop in Moncton to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Email inviting additional comments on potential environmental effects and proposed mitigation measures.
November 15, 2018	Incoming and Outgoing Emails	Email chain regarding timing to provide revised baseline information.
November 22, 2018	Incoming Email	Transmission of edits to EIS baseline descriptions and cover letter.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.23 Wolastoqey Nation of New Brunswick (WNNB) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Commercial Fisheries – compensation for gear damage	Equinor Canada will develop and implement a compensation program for damages experienced by commercial and communal commercial fishers which result from Project activities. The program will be developed in consideration of the C-NLOPB Compensation Guidelines Respecting Damages Relating to Offshore Petroleum Activities (2017). The proposed compensation regime is discussed in greater detail in Chapters 13 and 16.	Section 7.3.8.1 Section 13.2.1.1 Section 13.3 Section 13.3.1 Section 16.7.8
Fish and Fish Habitat – impact on salmon from routine operations and accidents	Through its ongoing engagement activities as well as information contained in the Indigenous Knowledge Desktop Study, Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. During its ongoing engagement, Indigenous groups have placed particular emphasis upon salmon and American eel as species of cultural importance. Information on species of either traditional or commercial importance has been incorporated into baseline information (see chapters 6 and 7). Potential effects (direct and indirect) of the Project upon marine fish and fish habitat and	Section 9.4 Section 14.1.5.1 Section 14.1.5.2 Section 16.7.4.3 Section 16.7.9.3 Appendix H

Table 3.23 Wolastoqey Nation of New Brunswick (WNNB) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
	subsistence fisheries and associated mitigation measures are discussed in Chapters 9 and 14 respectively. As indicated in these chapters, no significant direct effects upon marine fish or fish habitat or any indirect effects (cultural, social, health or socio-economic) upon Indigenous persons are predicted to result from routine Project activities. The effect of accidents and malfunctions upon marine fish and fish habitat and Indigenous persons are discussed in Chapter 16.	
Company and Operations	Details respecting Equinor's corporate structure, experience, values and policies have been provided to Indigenous groups during ongoing engagement activities, including in a power point presentation which was transmitted to each Indigenous group and discussed at in-person meetings. Equinor Canada and its operations are fully discussed in Chapter 1 of the EIS.	Section 1.1
Effect of Environment on the Project - icebergs	Chapter 17 identifies and assesses potential effects of the Environment upon the Project, including icing and icebergs. Equinor Canada will monitor installations for icing conditions and accumulation rates, as applicable. Measures to reduce icing include removal and/or melting of the ice. Equinor Canada will implement an ice management plan, which will outline ice and iceberg observations, and protocols for disconnection of the FPSO. Equinor Canada is evaluating options for iceberg detection, such as ice detection radar and use of satellite imaging data. The FPSO will be ice-strengthened and vessels and shuttle tankers will be capable of operating in ice-prone waters.	Section 17.2.3 Section 17.3.3
Project Description – Equinor's offshore operations, number of wells, annual production levels	Details respecting Equinor's offshore operations (international and Canadian) have been provided to Indigenous groups during ongoing engagement activities, including in a power point presentation (see Appendix G) which was transmitted to each Indigenous group and delivered at in-person meetings. Equinor Canada's offshore operations are described in Chapter 1.	Section 1.1.1 Section 2.5.3
Environmental Effects Monitoring	Detailed information respecting follow-up and monitoring programs is contained in Chapter 18 of the EIS. The design of follow-up monitoring programs will be undertaken following finalization of Project design, taking into account Agency guidance, the terms of the EIS Decision Statement and relevant regulatory requirements. The follow-up monitoring program will be developed in consultation with the C-NLOPB and relevant government departments (e.g., DFO, ECCC). In addition, Indigenous groups and key stakeholders will be engaged, as appropriate. Preliminary discussions with Indigenous groups respecting proposed monitoring measures were held at three Workshops in October and Indigenous groups which did not participate in person were invited to provide comments in writing.	Section 18.4

Table 3.23 Wolastoqey Nation of New Brunswick (WNNB) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
	The scope of such programs will take into consideration the results of other offshore environmental effects monitoring programs (both previous and ongoing), employ technology specifically suited to the monitoring of a production project at 1200 m water depths and utilize Equinor Canada's global experience in EEM, ongoing research and new technologies.	
Produced Water and treatment of radioactive materials	Equinor Canada will treat produced water as well as other discharges using best treatment practices that are commercially available and economically feasible. A description of the proposed treatment package for produced water is provided in Section 2.7.1.5 of the EIS. All discharges will be in accordance with applicable regulatory requirements and the OWTG. Equinor Canada's EPP will include plans for the management of waste materials generated during the Project (both hazardous and non-hazardous materials), such as oily wastes, waste chemicals and containers, domestic wastes etc. All wastes will be managed in accordance with the OWTG. The occurrence of naturally occurring radioactive material (NORM) in volumes of waste of any significance is not anticipated. If radioactive material is encountered, appropriate waste handling and management will be implemented. Waste treatment is discussed in Chapter 2.	Section 2.7.1.5 Section 2.8.4
Sedimentation – impact on habitat, corals and sponges	Equinor Canada conducted a coral and sponge survey of the Core BdN Area in 2018. This survey is described in Chapter 6 which provides an overview of the existing biological environment within the Project and study areas, including background information on factors that may influence sponge distribution including sedimentation. Potential effects of suspended sediments and sedimentation upon the benthic habitat are identified and described in Chapters 9 and 12. The follow-up monitoring program implemented by Equinor Canada will focus upon sensitive marine environments. As the program is not yet designed, issues such as drill cuttings dispersion, sedimentation, produced water dispersion and sound emissions may be included. Details on follow-up monitoring are contained in Chapter 18.	Section 9.3.3.4 Section 9.4.3.4 Section 12.3.1.1 Section 12.2.3.1 Section 12.3.6.2 Section 12.4.1.1 Section 12.4.3.1 Section 12.4.6.1 Section 18.4
Project Concept and Design – activities including vessel traffic	Details respecting Project concept and design and activities, including vessel traffic, have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, Project details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings (see Appendix G). Three Workshops were held in October 2018 at which a Project update was presented. Chapter 2 of the EIS presents a detailed description of preliminary Project design and components.	Section 2.5

Table 3.23 Wolastoqey Nation of New Brunswick (WNNB) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Accidents and Malfunctions – potential effects and emergency response	The potential effects of accidents and malfunctions and Equinor Canada's emergency response plans are set out in Chapter 16. Equinor Canada is committed to becoming an industry leader on safety and will comply with all regulatory standards respecting worker and environmental safety, as outlined in Chapter 1 of the EIS.A key focus is on prevention. Spill prevention will be incorporated into Project design and operations and facilities, processes and management system procedures are intended to reduce or eliminate the chance of a spill. Proper environmental operating practices will be assured through regular inspections and audits of the drilling installation and FPSO and through ongoing training of offshore workers, including specific training in oil spill prevention, reporting and response requirements, and procedures. Oil spill prevention, response, and overall preparedness approaches for the Project will be further developed and defined as the various regulatory review and approval processes move forward. Equinor Canada will develop and implement a Project Oil Spill Response Plan which will be submitted to the C-NLOPB as part of the Operations Authorization (OA) application process described in Chapter 1. Details of this plan and other emergency response measures are set out in Chapter 16 and additional information on Well Intervention Response Strategies and related matters is set out in Appendices P and Q. Equinor is prepared to effectively respond to an oil spill offshore and is equipped with the necessary response tools, personnel and strategies.	Section 16.1 Section 16.7 Appendix P Appendix Q
Carbon Emissions	Equinor strives to be an industry leader on safety and is actively shaping its portfolio to deliver high value with a low carbon footprint. Equinor's approach to sustainability is based in part upon low carbon and reducing the CO2 footprint of its operations. An air emissions and dispersion modelling study to estimate the Project-related quantities of air contaminants and greenhouse gases and to predict associated ground-level concentrations of air contaminants in the vicinity of the Project was undertaken. A summary of study results as well as other information respecting air contaminants and greenhouse gases is presented in Chapter 8 and in the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K.	Chapter 8 Appendix K

Table 3.23 Wolastoqey Nation of New Brunswick (WNNB) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Flaring	In accordance with Section 6(e) of the Newfoundland Offshore Petroleum Drilling and Production Regulations, Equinor Canada will submit a flaring plan to the C-NLOPB as part of the OA process. Routine flaring will not occur. Non-routine and/or safety flaring, when required, will be very short in duration (a few hours) and will occur during initial start-up of the facility and during shut-down and start-up activities related to planned maintenance turnarounds. Estimated emissions from non-routine/safety flaring are provided EIS S. 2.8.1 and S. 8.5.	Section 2.7.4.7 Section 2.8.1 Section 8.5.3.1
Abandoned Wells – liability for abandoned wells	Regulations passed pursuant to the Atlantic Accord Acts and Guidelines Respecting Financial Requirements (C-NLOPB 2017) require an Operator to demonstrate that it is capable of acting in a responsible manner for the life of the proposed activity. Pursuant to the NL Offshore Petroleum Drilling and Production Regulations, a Decommissioning and Abandonment Plan based on an approved Development Plan must be submitted to C-NLOPB. The plan must consider any new regulatory requirements, best practices, or international laws or agreements to which Canada is bound that have come into force since the Development Plan was approved and a new environmental assessment may be required. Under section 9 of the C-NLOPB Guidelines Respecting Financial Responsibility, the operator must file proof of financial resources to cover the costs of abandonment, including any potential liability. Wells, once abandoned, continue to be subject to the provisions of the Atlantic Accord Acts respecting liability for losses or damages resulting from the discharge, emission or escape of oil and gas.	Not within the scope of the Guidelines
Incorporation of Indigenous Knowledge	Equinor Canada has made every reasonable effort to collect and incorporate traditional Indigenous knowledge into the EIS. Equinor Canada has invited Indigenous groups to provide traditional knowledge during the course of engagement and has in addition, offered to enter into agreements with various groups for the collection of Indigenous knowledge. Equinor Canada also commissioned an Indigenous Knowledge Desktop Study. Information contained in this study, together with information provided during engagement and information from other sources, has been taken into account in the development of the ecosystem approach throughout the EIS and was used to identify species of interest to Indigenous groups.	Section 14.1.4 Section 14.1.5.2 Appendix H

Table 3.24 Meetings and Discussions with Woodstock First Nation

Date	Activity	Purpose and Focus
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, summary and map.
July 10, 2018	Outgoing Phone Call	Follow-up to letter. No answer, left message.
July 10, 2018	Outgoing Email	Follow-up to phone call, requesting phone call to discuss next steps in engagement.
July 18, 2018	Outgoing Phone Call	Follow-up phone call. No answer, left message.
July 18, 2018	Incoming Email	Advising of availability for a call July 19 or 20, or early the following week.
July 18, 2018	Outgoing Email	Proposing a phone call early in the week of July 23.
August 6, 2018	Incoming and Outgoing Emails	Email chain regarding scheduling an in-person meeting in Woodstock August 29.
August 8, 2018	Outgoing Email	Confirmation of August 29 meeting.
August 16, 2018	Outgoing Email	Transmission of PowerPoint presentation.
August 16, 2018	Incoming Email	Regarding meeting venue.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
August 29, 2018	In-Person Meeting	Presentation of Bay du Nord Project overview. Discussion of issues of concern, particularly the potential impact on salmon and American eel. Limited discussion of cumulative effects and activities in NS offshore. Agreement to provide periodic Project updates.
August 29, 2018	Outgoing Email	Confirming agreed-upon engagement process.
October 19, 2018	Workshop	Half day workshop in Moncton to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.

Table 3.24 Meetings and Discussions with Woodstock First Nation

Date	Activity	Purpose and Focus
November 8, 2018	Outgoing Email	E-mail inviting additional comments on potential environmental effects/proposed mitigation measures.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.25 Woodstock First Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Project Operations and Activities – number of wells, drilling depths, project footprint	Details respecting Project operations and activities have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, Project details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings (see Appendix G). Three Workshops were held in October 2018 at which a Project update was presented. A detailed description of Project operations and activities is contained in Chapter 2 of the EIS.	Section 2.5
Indigenous Engagement – capacity funding to participate in EA process	Questions related to the provision of capacity funding to enable Indigenous groups to participate in the environmental assessment process are referred to the CEA Agency.	Not within the scope of the Guidelines
Marine Protected Areas – impact of Project	Marine Protected Areas and other Special Areas in the RSA are described in Chapter 6. The potential effects of the Project upon Special Areas are identified and assessed in Chapter 12.	Section 12.2 Section 12.3
Spills and impacts on traditional waters	Accidents and malfunctions are discussed in Chapter 16. Spill modelling of a representative range of worst-case scenarios was conducted for the Project, including unmitigated subsurface blowouts at two locations in the Project Area (the worst-case scenario with between a one in 207,000,000 to one in 414,000,000 chance of occurrence). It is Equinor Canada's conclusion that even in such a worst-case scenario (without the application of mitigation and response measures) given prevailing currents there is only a very low probability that a very small amount of oil (less than 1% of released oil) would make shoreline contact to the west of the Project Area. Most of that contact is predicted to occur on the Avalon Peninsula and localized areas of the Burin Peninsula. No contact with the traditional waters of any Indigenous group is predicted.	Section 16.7.9

Table 3.25 Woodstock First Nation Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Impact on Corals and Sponges	The function and ecological role of corals and sponges, including habitat, is discussed in chapter 6. Chapter 9 provides an effects assessment of project activities on Marine Fish and Fish Habitat, including corals and sponges. The relationship between corals and sponges and EBSAs, SBAs and VMEs is described in Section 12.2 of the EIS. Chapter 16 assesses the effects of accidents and malfunctions, including the effects of an unmitigated subsurface blowout on Marine Fish and Fish Habitat, including corals and sponges. Recognizing the important role played by corals and sponges in the marine ecosystem, Equinor Canada has completed a seabed survey (detailed in Section 6.1.1.5) to provide a better dataset for assessing coral and sponge densities in the Project Area. Upon completion of final subsea layout design, the area occupied by the final layout design will be compared against the layout used in the 2018 survey. Based on the final design, if there are areas where subsea infrastructure will be installed on the seafloor that were not captured by the 2018 survey, these areas will be surveyed to collect coral, sponge and/or sea pens data.	Section 9.3.3.4 Section 9.4.3.4 Section 12.3.1.1 Section 12.3.3.1 Section 12.2.4 Section 12.3.6.1 Section 12.4.1.1 Section 12.4.3.1 Section 12.4.4 Section 12.4.6.1 Section 16.7.4

Table 3.26 Engagement with Peskotomuhkati Nation at Skutik (Passamaquoddy)

Date	Activity	Purpose and Focus
June 14, 2018	Outgoing Email	Introduction of Equinor Canada’s Sustainability Advisor
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, summary and map.
July 18, 2018	Outgoing Phone Call	Follow-up to Project Description correspondence.
July 18, 2018	Incoming Phone Call	Discussion of Chief’s schedule and potential timing of an in-person meeting.
July 18, 2018	Outgoing Email	Indicating interest in discussing next steps in engagement.
August 6, 2018	Outgoing Email	Proposal for an in-person meeting on August 28 or 29.
August 9, 2018	Outgoing Phone Call	Follow-up phone call regarding proposed in-person meeting on August 28 or 29.
August 13, 2018	Incoming Phone Call	Confirmation of interest in meeting in St. Stephen on August 28, 2018.

Table 3.26 Engagement with Peskotomuhkati Nation at Skutik (Passamaquoddy)

Date	Activity	Purpose and Focus
August 16, 2018	Outgoing Email	Transmission of PowerPoint presentation and confirmation of time and location of meeting.
August 16, 2018	Incoming Email	Confirmation of date and time of meeting.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
August 28, 2018	In-Person Meeting	Presentation of Bay du Nord Project overview. Discussion of issues of concern, particularly the potential impact on herring and gaspereau. Equinor Canada agrees to provide periodic Project updates.
August 28, 2018	Outgoing Email	Confirming next steps in engagement.
September 13, 2018	Outgoing Email	Email providing link to spill reporting by C-NLOPB as committed at August 28 meeting.
October 19, 2018	Workshop	Half day workshop in Moncton to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials and inviting additional comments.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	E-mail transmitting invoicing material and inviting additional comments on potential environmental effects/proposed mitigation measures
November 9, 2018	Incoming Email	Confirming accuracy of baseline information.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.27 Peskotomuhkati Nation at Skutik (Passamaquoddy) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Direct and indirect impacts of spills on Marine Species of traditional/commercial importance – herring, gaspereau, mackerel	Through its ongoing engagement activities as well as information contained in the Indigenous Knowledge desktop study, Equinor Canada is aware of the social, cultural, traditional and economic importance of marine fish and fish habitat to Indigenous groups. Information on species of either traditional or commercial importance such as herring, gaspereau and mackerel has been incorporated into baseline information (see chapters 6 and 7). Potential effects (direct and indirect) on of the Project upon fish and fish habitat, commercial fisheries and subsistence fisheries and associated mitigation measures are discussed in Chapters 9, 13 and 14 respectively. Potential cumulative effects upon fish and fish habitat are identified and assessed in Chapter 15 and the potential impact of spills upon both commercial and subsistence fisheries is discussed in Chapter 16.	Section 14.2.4.1 Section 16.7.4 Section 16.7.8 Section 16.7.9
Marine Mammals – right whales, harbour porpoises – ship strikes	The potential impacts of the project upon marine mammals, including right whales, are identified and assessed in Chapter 11. It is Equinor Canada's assessment that the likelihood of ship strikes of right whales is low due to the projected low volume and frequency of Project-related vessel traffic. Furthermore, the vessel traffic corridor is not within specific areas that have been identified as marine mammal breeding grounds, feeding concentrations, and/or migration routes. Consistent with International Regulations for Preventing Collisions at Sea, 1972 with Canadian Modifications, Rule 5, every vessel shall maintain a proper lookout at all times. Project vessel will alter course and/or reduce speed if a marine mammal(s) (or sea turtle) is detected ahead of the vessel. While it is highly unlikely that surface active groups of North Atlantic right whales will occur along the vessel traffic route to the Project Area, if one is detected by Project vessel crew, the sighting(s) will be reported immediately to DFO.	Section 11.5.2 Section 11.1.5.1 Section 11.3.1.1 Section 11.3.4.1 Section 11.3.5.1 Section 11.4.4.1
Standards for oil transport/loading	Oil transport and loading is described in Chapter 2. The Project is located approximately 500 km offshore from St. John's. Crude oil will be offloaded from the production installation to shuttle tankers. Production operations offshore NL utilize the Basin Wide Terminal and Transshipment System (BWTTS) which is a fleet of modern shuttle tankers that ships crude to an existing transshipment terminal in NL or direct to market. The shuttle tankers are subject to international maritime requirements (i.e., International Maritime Organization or IMO) and must adhere to the regulatory framework of the IMO as well as those of the vessel's flag state.	Section 2.6.4.4

Table 3.28 Engagement with Mi'kmaq Confederacy of Prince Edward Island (MCPEI)

Mi'kmaq Confederacy of Prince Edward Island (MCPEI): *Aggregate body for the Abegweit First Nation and Lennox Island First Nation with regard to engagement Key Issues and Questions Raised are those identified through engagement with MCPEI and not by constituent member communities.* ***Correspondence with MCPEI unless otherwise indicated.***		
Date	**Activity**	**Purpose and Focus**
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, including summary and map.
June 25, 2018	Outgoing Letter to Abeqweit First Nation	Project Description notification letter, including Project summary and map.
June 25, 2018	Outgoing Letter to Lennox Island First Nation	Project Description notification letter, including Project summary and map.
July 10, 2018	Outgoing Phone	Phone call to discuss the next steps in engagement. No answer, left message.
July 10, 2018	Outgoing Email	Follow-up email requesting an opportunity to discuss the next steps in engagement.
July 18, 2018	Outgoing Phone Call	Phone call. No answer, left message.
July 23, 2018	Outgoing Email	Follow-up email requesting an opportunity to discuss the next steps in engagement.
July 30, 2018	Incoming Email	Email from MCPEI requesting a conference call.
July 30, 2018	Outgoing Email	Email confirming availability for a conference call August 2, 2017.
July 30, 2018	Incoming and Outgoing Emails	Email chain regarding rescheduling conference call to August 13, 2018.
August 9, 2018	Outgoing Email	Transmission of PowerPoint presentation and draft agenda for August 13 conference call.
August 9, 2018	Incoming Email	Confirming receipt of materials and agreeing to revisions to agenda.
August 13, 2018	Conference Call	Conference call to provide BdN Project overview and discuss issues of concern to MCPEI and the engagement process. Parties agreed that Equinor Canada will continue to provide relevant Project-related information. Conference calls will be held at Project milestones, although frequency and scope of engagement would be revisited if circumstances require. No major issues noted; concern expressed for possible impacts on migratory species (salmon) due to spills, lack of

Table 3.28 Engagement with Mi'kmaq Confederacy of Prince Edward Island (MCPEI)

		capacity funding and questions about modelling that would be done for EIS.
Date	**Activity**	**Purpose and Focus**
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 5, 2018	Outgoing Email	Follow-up to conference call outlining next steps in engagement.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials, inviting additional comments, and offering conference call to discuss. Equinor Canada also committed to providing workshop report when all comments have been received.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Email transmitting invoicing information (regarding workshop) and inviting additional comments on potential effects and proposed mitigation measures.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.29 Mi'kmaq Confederacy of Prince Edward Island (MCPEI) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Applicable Regulatory Regime – role of C-NLOPB	Information on the applicable regulatory regime, including the role of the C-NLOPB, is contained in Chapter 1.	Section 1.3.2
Project Description – location, components and activities	Details respecting Project location, components and activities have been provided to Indigenous groups during Equinor Canada's ongoing engagement activities. In addition, Project details were summarized in a power point presentation which was provided to each Indigenous Group and discussed at in-person meetings (see Appendix G). Three Workshops were held in October 2018 at which a Project update was presented. A detailed description of Project location, components and activities is contained in Chapter 2 of the EIS.	Section 2.4 Section 2.5 Section 2.6

Table 3.29 Mi'kmaq Confederacy of Prince Edward Island (MCPEI) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Spills and Safety Record	The potential effects of accidents and malfunctions and Equinor Canada's emergency response plans are set out in Chapter 16. Equinor Canada is committed to becoming an industry leader on safety and will comply with all regulatory standards respecting worker and environmental safety, as outlined in Chapter 1 of the EIS. A key focus is on prevention. Spill prevention will be incorporated into Project design and operations and facilities, processes and management system procedures in order to reduce or eliminate the chance of a spill. Proper environmental operating practices will be assured through regular inspections and audits of the drilling installation and FPSO and through ongoing training of offshore workers, including specific training in oil spill prevention, reporting and response requirements, and procedures. Oil spill prevention, response, and overall preparedness approaches for the Project will be further developed and defined as the various regulatory review and approval processes move forward. Equinor Canada will develop and implement a Project Oil Spill Response Plan which will be submitted to the C-NLOPB as part of the Operations Authorization (OA) application process described in Chapter 1. Details of this plan and other emergency response measures are set out in Chapter 16 and additional information on Well Intervention Response Strategies and related matters is set out in Appendices P and Q. Equinor Canada is prepared to effectively respond to an oil spill offshore and is equipped with the necessary response tools, personnel and strategies.	Section 16.1 Section 16.3 Appendix P Appendix Q
Spill trajectory / modelling	Accidents and malfunctions are discussed in Chapter 16. Spill modelling of a representative range of unmitigated worst-case scenarios was conducted for the Project, (the worst-case subsurface blowout scenario with between a one in 207,000,000 to one in 414,000,000 chance of occurrence). It is Equinor Canada's conclusion that even in such a worst-case scenario (without the application of mitigation and response measures) given prevailing currents there is only a very low probability that a very small amount of oil (less than 1% of released oil) would make shoreline contact to the west of the Project Area. Most of that contact is predicted to occur on the Avalon Peninsula and localized areas of the Burin Peninsula. No contact with the traditional waters of any Indigenous group is predicted.	Section 16.4

Table 3.29 Mi'kmaq Confederacy of Prince Edward Island (MCPEI) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Offloading and Transport of Oil	Oil transport and loading is described in Chapter 2. The Project is located approximately 500 km offshore from St. John's. Crude oil will be offloaded from the production installation to shuttle tankers. Production operations offshore NL utilize the Basin Wide Terminal and Transshipment System (BWTTS) which is a fleet of modern shuttle tankers that ships crude to an existing transshipment terminal in NL or direct to market. The shuttle tankers are subject to international maritime requirements (i.e., International Maritime Organization or IMO) and must adhere to the regulatory framework of the IMO as well as those of its flag state.	Section 2.1
Air Emissions - modelling	To support the regulatory review of the Project, an air emissions and dispersion modelling study was conducted. The purpose of the study was to estimate the Project-related quantities of air contaminants and greenhouse gases (GHGs) released to the atmosphere and to predict associated ground-level concentrations of air contaminants in the vicinity of the Project. A summary of study results as well as other information respecting air contaminants and greenhouse gases is presented in Chapter 8 and in the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K.	Section 8.5.1.1 Section 8.5.2.1 Section 8.5.3.1 Section 8.5.4 Section 8.6.1 Appendix K
Impacts on salmon – species of traditional importance	Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. In particular, Indigenous groups have emphasized the traditional cultural importance of salmon during Equinor Canada's ongoing engagement activities. Salmon is also a species of concern identified in the Indigenous Knowledge Desktop Study. Information on the various uses of salmon and other species of concern by Indigenous peoples has been incorporated into Chapter 7. Potential direct effects of the Project upon fish and fish habitat, including salmon, resulting from routine Project activities are identified and assessed in Chapter 9 and potential effects resulting from accidents and malfunctions are identified and assessed in Chapter 16. Associated indirect effects upon Indigenous people (subsistence fishing, health, socio-economic and cultural effects) related to potential direct effects upon salmon are identified and assessed in Chapters 14 and 16. These chapters conclude that no significant direct effects upon marine fish or fish habitat or indirect effects (health, cultural or socio-economic) upon Indigenous peoples are predicted to result from routine Project activities.	Section 14.1.5 Section 16.7.4 Section 16.7.9 Appendix H

Table 3.29 Mi'kmaq Confederacy of Prince Edward Island (MCPEI) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Application of Mitigation Measures	Each VC chapter contains VC-specific mitigation measures which are summarized in Chapter 18. Mitigation measures provided in the EIS are derived from regulations, regulatory guidelines and industry best practices, and in particular instances, developed specifically for the BdN Development. Mitigations are designed to reduce adverse impacts upon marine ecosystems, including vulnerable marine ecosystems. These mitigation measures have been implemented offshore Newfoundland, including deep waters such as the Orphan Basin, in previous exploration drilling programs and ongoing development projects. In addition, potential mitigation measures have been discussed with various Indigenous groups during three Workshops which were held in 2018. Equinor Canada and its contractors will comply with all applicable mitigation measures which will be implemented and tracked in accordance with Equinor Canada's existing policies and procedures. Mitigation measures will be integrated into the Project's Environmental Protection Plan (EPP) which will be submitted to the C-NLOPB as part of the Operations Authorization process. An Environmental Effects Monitoring (EEM) program will be developed, intended, in part, to monitor the effectiveness of mitigation measures.	Section 18.2
Indigenous Engagement – Capacity Funding	Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of engagement processes will be developed through discussions with the various groups. Questions related to the provision of capacity funding to enable Indigenous groups to participate in the environmental assessment process are referred to the CEA Agency.	Not within the scope of the EIS Guidelines

Table 3.30 Engagement with Mi'gmawei Mawiomi Secretariat (MMS)

Date	Activity	Purpose and Focus
Mi'gmawei Mawiomi Secretariat (MMS): Aggregate body for Micmas of Gesgapegiag, La Nation Micmac de Gespeg and Listuguj Mi'gmaq Government regarding engagement.		
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, including summary and map.

Table 3.30 Engagement with Mi'gmawei Mawiomi Secretariat (MMS)

Date	Activity	Purpose and Focus
July 25, 2018	Outgoing Email	Requesting a conference call to discuss next steps.
August 10, 2018	Outgoing Email	Reiterating wish to engage and proposing a conference call in September.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 20, 2018	Outgoing Email	Email reiterating wish to engage and proposing a conference call. PowerPoint presentation attached for information.
October 16, 2018	Workshop	Half day workshop in Quebec City to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 22, 2018	Outgoing Email	Follow-up to workshop transmitting workshop materials, inviting additional comments, and offering conference call to discuss. Equinor Canada also committed to providing workshop report when all comments have been received.
October 23, 2018	Outgoing Email	Email requesting call to suggest possible sharing of Indigenous Knowledge.
November 8, 2018	Outgoing Email	Email transmitting invoicing information and inviting additional comments on potential effects and proposed mitigation measures.
December 14, 2018	Outgoing Email	Transmission of the Workshop Report which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.31 Mi'gmawei Mawiomi Secretariat (MMS) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Impacts on Salmon and other species of cultural significance	Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. In particular, Indigenous groups have emphasized the traditional cultural importance of salmon during Equinor Canada's ongoing engagement activities. Salmon is also a species of concern identified in the Indigenous Knowledge Desktop Study. Information on the various uses of salmon and other species of concern by Indigenous peoples has been incorporated into Chapter 7. Potential direct effects of the Project upon fish and fish habitat, including salmon, resulting from routine Project activities are identified and assessed in Chapter 9 and potential effects resulting from accidents and malfunctions are identified and assessed in Chapter 16. Associated indirect effects upon Indigenous people (subsistence fishing, health, socio-economic and cultural effects) related to potential direct effects upon salmon are identified and assessed in Chapters 14 and 16. These chapters conclude that no significant direct effects upon marine fish or fish habitat or indirect effects (health, cultural or socio-economic) upon Indigenous peoples are predicted to result from routine Project activities.	Section 14.1.5.1 Section 13.1.5.2 Section 16.7.4 Section 16.7.9 Appendix H

Table 3.32 Engagement with Les Innus de Ekuanitshit (Innu First Nation of Ekuanitshit)

Date	Activity	Purpose and Focus
June 13, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 14, 2018	Outgoing Letter	Project Description notification letter, including summary and map.
July 17, 2018	Incoming Letter	Letter seeking clarification of EIS scope regarding salmon prior to discussing next steps in engagement.
July 30, 2018	Outgoing Email	E-mail response clarifying salmon populations that will be considered in EIS.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 22, 2018	Outgoing Email	Proposal to hold conference call to provide Project overview.

Table 3.32 Engagement with Les Innus de Ekuanitshit (Innu First Nation of Ekuanitshit)

Date	Activity	Purpose and Focus
October 5, 2018	Outgoing Email	Transmission of translated PowerPoint presentation and offer to meet by phone to discuss.
October 24, 2018	Outgoing Email	Email transmitting workshop materials, inviting further comments, and offering a conference call to discuss. Commitment to provide workshop report when completed and translated.
November 2, 2018	Incoming Letter	Indicating that would advise Equinor Canada of interest in conference call when Participant Funding decision made by the CEA Agency and reiterating importance of salmon. No further expression of interest
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
December 22, 2018	Outgoing Email	Transmission of the Workshop Report, which is included in Appendix G.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA

Table 3.33 Les Innus de Ekuanitshit (Innu First Nation of Ekuanitshit) Issues and Concerns

Key Issues and Questions Raised	Response	EIS Reference
Impacts on Salmon and other species of cultural importance	Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. In particular, Indigenous groups have emphasized the traditional cultural importance of salmon during Equinor Canada's ongoing engagement activities. Salmon is also a species of concern identified in the Indigenous Knowledge Desktop Study. Information on the various uses of salmon and other species of concern by Indigenous peoples has been incorporated into Chapter 7. Potential direct effects of the Project upon fish and fish habitat, including salmon, resulting from routine Project activities are identified and assessed in Chapter 9 and potential effects resulting from accidents and malfunctions are identified and assessed in Chapter 16. Associated indirect effects upon Indigenous people (subsistence fishing, health, socio-economic and cultural effects) related to potential direct effects upon salmon are identified and assessed in Chapters 14 and 16. These chapters conclude that no significant direct effects upon marine fish or fish habitat or indirect effects (health, cultural or socio-economic) upon Indigenous peoples are predicted to result from routine Project activities.	Section 14.1.5.1 Section 14.1.5.2 Section 16.7.4 Section 16.7.9 Appendix H

Table 3.34 Engagement with Première Nation des Innus de Nutashkuan

Date	Activity	Purpose and Focus
June 14, 2018	Outgoing Email	Introduction of Equinor Canada's Sustainability Advisor.
June 14, 2018	Incoming Email	Email acknowledging introduction.
June 21, 2018	Outgoing Email	Notification of filing of Bay du Nord Project Description with the CEA Agency.
June 25, 2018	Outgoing Letter	Project Description notification letter, including summary and map.
August 27, 2018	Outgoing Email	Invitation to attend half day workshop to discuss Bay du Nord Project, potential effects and proposed mitigation.
September 22, 2018	Outgoing Email	Invitation to schedule a conference call in early October to provide Project overview. Commitment to provide translated PowerPoint presentation.
September 24, 2018	Incoming Email	Declining invitation for conference call as update would be provided at workshop in Quebec City.
October 5, 2018	Outgoing Email	Transmission of PowerPoint presentation and offer of phone call to discuss.
October 16, 2018	Workshop	Half day workshop in Quebec City to discuss potential environmental effects and proposed mitigation measures associated with the Project. Refer to Appendix G for workshop materials.
October 24, 2018	Outgoing Email	Email transmitting workshop materials and inviting further comment. Commitment to provide workshop report when completed and translated.
October 24, 2018	Incoming Email	Nutashkuan acknowledge receipt of workshop materials.
November 6, 2018	Outgoing Email	Transmission of community baseline (Chapter 7) for review and comment.
November 8, 2018	Outgoing Email	Email transmitting invoicing material and inviting any additional comments on potential environmental effects and proposed mitigation measures.
November 13, 2018	Incoming Email	Nutashkuan commit to prompt reply regarding EIS community profile information.
November 14, 2018	Incoming Email	Email containing Nutashkuan's proposed revisions to community profile.
December 22, 2018	Outgoing Email	Transmission of the Workshop Report which is included in Appendix G.

Table 3.34 Engagement with Première Nation des Innus de Nutashkuan

Date	Activity	Purpose and Focus
December 28, 2018	Incoming Email	Acknowledgement of receipt of Workshop Report.
April 10, 2019	Outgoing Email	Advising of MOU between CEAA and C-NLOPB and status of Bay du Nord Development Project EA
April 11, 2019	Incoming Email	Acknowledgement of receipt of EA update email

Table 3.35 Première Nation des Innus de Nutashkuan Issues and Concerns

Issues and Questions Raised	Response	EIS Reference
Impacts on Salmon and other Species of Concern	Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups. In particular, Indigenous groups have emphasized the traditional cultural importance of salmon during Equinor Canada's ongoing engagement activities. Salmon is also a species of concern identified in the Indigenous Knowledge Desktop Study. Information on the various uses of salmon and other species of concern by Indigenous peoples has been incorporated into Chapter 7. Potential direct effects of the Project upon fish and fish habitat, including salmon, resulting from routine Project activities are identified and assessed in Chapter 9 and potential effects resulting from accidents and malfunctions are identified and assessed in Chapter 16. Associated indirect effects upon Indigenous people (subsistence fishing, health, socio-economic and cultural effects) related to potential direct effects upon salmon are identified and assessed in Chapters 14 and 16. These chapters conclude that no significant direct effects upon marine fish or fish habitat or indirect effects (health, cultural or socio-economic) upon Indigenous peoples are predicted to result from routine Project activities.	Section 14.1.5.1 Section 14.1.5.2 Section 16.7.4 Section 16.7.9 Appendix H

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
Atmospheric Conditions: • Air and sound emissions • Use of technology, monitoring • Climate change and greenhouse gases	• The impacts of sound emissions on marine fish and fish habitat, marine and migratory birds and marine mammals and sea turtles are identified and assessed in Chapters 9, 10 and 11, respectively. Equinor Canada has conducted sound propagation modelling and has concluded that with the application of appropriate mitigation measures, there are no significant effects upon any of these VCs. • An environmental effects monitoring program will be implemented to verify the EIS effects predictions. Indigenous groups will be engaged in the development of the EEP as appropriate. • With respect to air emissions, and greenhouse gases, an air emissions and dispersion modelling study was conducted to estimate the Project-related quantities of air contaminants and greenhouse gases (GHGs) released to the atmosphere and to predict associated ground-level concentrations of air contaminants in the vicinity of the Project. A summary of study results as well as other information respecting air contaminants and greenhouse gases is presented in Chapter 8 and in the Technical Data Report for Air Quality and Greenhouse Gases in Appendix K. • There will be no routine flaring. • Equinor Canada will employ best treatment practices that are commercially available and economically feasible to address discharges and emissions	Section 5.7.1 Section 8.5 Section 8.6 Section 9.3.2.3 Section 9.3.3.3 Section 9.3.4.1 Section 9.3.5.4 Section 9.4.1.3 Section 9.4.3.3 Section 9.4.4.1 Section 9.4.5.1 Section 10.3.1.2 Section 10.3.2.2 Section 10.3.3.2 Section 10.3.4 Section 10.3.5 Section 11.3.1.1 Section 11.3.2.1 Section 11.3.3.1 Section 11.3.4 Section 11.3.5 Section 11.4.2.1 Section 11.4.3.1 Section 11.4.4.1 Section 11.4.5 Appendix K
• Indigenous People Interactions • Focus on shoreline interactions • Species of concern (salmon, American eel, right whales) • Effects of spills on coastal communities	• The EIS considers interactions in the Core BdN Area, the Project Area, the Local Study Area and the Regional Study Area (RSA). As defined in Chapter 14, the RSA for Indigenous Peoples an overall region of eastern Canada that generally encompasses each of the Indigenous communities and their activities throughout NL, the Maritime provinces and Québec, including those parts of traditional lands and waters included in the RSA. As a result, Chapters 14 and 16 take into account potential shoreline interactions with the traditional lands and waters of the various Indigenous groups. • Through its ongoing engagement activities, Equinor Canada is aware of the social, cultural and traditional importance of fish and marine mammal species, particularly salmon, American eel and right whales, to Indigenous groups in the Atlantic regions. Information on species of traditional importance has been incorporated into baseline information (Chapters 6 and 7). The effects of the Project upon marine fish and fish habitat, marine and migratory birds and marine mammals and associated effects on Indigenous peoples are identified and discussed in Chapters 9, 10, 11 and 14. These chapters conclude that no significant direct effects upon marine	Section 6.1.9.2 Section 6.1.9.6 Section 6.3.7.2 Section 7.3.8.2 Section 9.5.5 Section 9.5.6 Section 10.3.4.2 Section10.3.5.1 Section 10.4.4.2 Section 10.4.5 Section 11.5.2 Section 14.1.1.1 Section 14.1.5.2 Section 16.7.9 Appendix H

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
	fish or fish habitat, marine and migratory birds or marine mammals or indirect effects (health, cultural or socio-economic) upon Indigenous peoples are predicted to result from routine Project activities. • The effects of spills (including unmitigated subsurface blowouts) have been the subject of modelling. A subsurface blowout is extremely unlikely and, in any event, less than .1% of released oil is predicted to make shoreline contact, with most of that contact occurring on the Avalon Peninsula and localized areas of the Burin Peninsula. No contact with the traditional lands or waters of any Indigenous group is predicted.	
• Marine and Migratory Birds: • bird deterrent technology • impact of lighting, flaring, seismic testing • bird searches	The potential effects of the Project upon marine and migratory birds have been identified and assessed in Chapter 10. Bird deterrent technology is not recommended by ECCC. However, a number of mitigation measures are proposed, including the following: • reduction of lighting on the FPSO subject to worker and operational safety • engagement with ECCC and evaluation of lighting reduction options • no routine flaring and recovery of low pressure flare gas • use of common traffic routes for vessels and helicopters • helicopter and vessel transit routes will adhere to periods of avoidance and specific set-back distances to reduce disturbances to established migratory bird colonies • avoidance of low-level flight aircraft operations The potential effects of lighting, flaring and underwater sound associated with seismic surveys upon marine and migratory birds, are assessed in Chapter 10. Equinor Canada will develop a protocol for systematic searches for, and documentation of stranded seabirds in consultation with Environment and Climate Change Canada (ECCC) Canadian Wildlife Service (CWS). All occurrences will be documented and reported to ECCC.	Section 10.1.5.2 Section 10.3.1.2 Section 10.3.2.2 Section 10.3.3.2 Section 10.3.4 Section 10.3.5 Section 10.4.1.2 Section 10.4.2.2 Section 10.4.3.2 Section 10.4.4 Section 10.4.5
• Discharges, including Produced Water • commitment to use best available technology and monitoring • Sedimentation	Equinor Canada will treat produced water as well as other discharges using best treatment practices that are commercially available and economically feasible. A description of the proposed treatment package for produced water is provided in Section 2.7.1.5 of the EIS. All discharges will be in accordance with applicable regulatory requirements. Equinor Canada's EPP will include plans for the management of waste materials generated during the Project (both hazardous and non-hazardous materials), such as oily wastes, waste chemicals and containers, domestic wastes etc. All wastes will be managed in accordance with the OWTG.	Section 2.7.1.5 Section 9.3.3.4 Section 9.4.3.4 Section 12.2.3.1 Section 12.3.1.1 Section 12.3.6.2 Section 12.4.1.1 Section 12.4.3.1 Section 12.4.6.1 Section 18.2 Section 18.4

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
	As the follow-up monitoring program is not yet designed, issues such as drill cuttings dispersion, sedimentation, produced water dispersion and sound emissions may be included. Indigenous groups will be engaged as appropriate in the development of follow-up monitoring programs. Details on follow-up monitoring are contained in Chapter 18.	
Marine Mammal and Sea Turtles • mitigation measures • effects of sound • injury and mortality (vessel strikes) and use of marine mammal observers • Need to take into account the significance of marine mammals (e.g. seals and walrus) as an important food source for Inuit and need to recognize the cultural importance of marine mammals • Need for continuous monitoring of discharges	• Potential mitigation measures are set out in Workshop materials and in Chapter 11 of the EIS. An inventory of potential mitigation measures were provided to each Indigenous group for review and comment (see Appendix G). • The primary sensory cues for marine mammals are auditory. A 50 km zone of influence, which borders the entire Project Area, was used in the EIS to assess effects of sound upon marine mammals. It is Equinor Canada's conclusion that the potential for injuries resulting from sound is limited due to the localized nature of the sound and the transient nature of marine mammals. • Injuries to/mortality of marine mammals resulting from vessel strikes are considered unlikely. There are no specific areas along the vessel traffic route that have been identified as marine mammal breeding grounds, feeding concentrations, and/or migration route. Consistent with International Regulations for Preventing Collisions at Sea, 1972 with Canadian Modifications, Rule 5, every vessel shall maintain a proper lookout at all times. Project vessel will alter course and/or reduce speed if a marine mammal(s) (or sea turtle) is detected ahead of the vessel. • Equinor Canada is aware of the cultural importance of specific marine mammals to Indigenous groups as a result of its ongoing engagement activities, including the October workshops and through information contained in the Indigenous Knowledge Desktop Study. Species of interest to Indigenous groups are described in Chapter 7 and effects upon those species and upon associated Indigenous interests are identified and assessed in Chapters 11 and 14 respectively. • The vast majority of oceangoing vessels in Canada are not required to have dedicated marine mammal observers. Based on the low risk of ship strikes, the low numbers of reported ship strikes, and given that the vessel-traffic corridor is not within specific areas that have been identified as marine mammal breeding grounds, feeding concentrations, and/or migration routes, dedicated onboard MMOs on vessels supporting the BdN project are not deemed necessary.	Section 7.3 Section 11.1.5.1 Section 11.3.1.1 Section 11.3.2.1 Section 11.3.3.1 Section 11.3.4 Section 11.3.4.1 Section 11.3.5 Section 11.3.5.1 Section 11.4.2.1 Section 11.4.3.1 Section 11.4.4.1 Section 11.4.5 Section 11.4.5.1 Section 14.2.1.1 Section 14.2.2.1 Section 14.2.3.1 Section 14.2.3.2 Section 14.2.4 Section 14.2.4.2 Section 14.2.4.2 Section 14.2.5.1 Section 14.2.5.2 Section 18.4 Appendix G

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
	• All discharges will be in accordance with applicable regulatory requirements. Equinor Canada's EPP will include plans for the management of waste materials generated during the Project (both hazardous and non-hazardous materials), such as oily wastes, waste chemicals and containers, domestic wastes etc. All wastes will be managed in accordance with the OWTG.	
Indigenous Peoples – species of cultural importance, communal-commercial fisheries	• Through its ongoing engagement activities and based on information contained in the Indigenous Knowledge Desktop Study, Equinor Canada is aware of the social, cultural, traditional and economic importance of fish and fish habitat to Indigenous groups, in particular salmon and American eel. • Information on species of traditional or cultural importance has been incorporated into baseline information (Chapters 6 and 7). The effects of the Project upon species of cultural importance and associated effects upon Indigenous peoples are identified and assessed in Chapters 9, 10, 11 and 14. These chapters conclude that no significant direct effects upon species of traditional or cultural importance (including species associated with FSC harvesting) or indirect effects (health, cultural or socio-economic) upon Indigenous peoples are predicted to result from routine Project activities. • Equinor Canada is aware that many Indigenous groups hold commercial communal licences for a variety of species in NAFO Divisions 3L and 3M, including commercial-communal licences for Atlantic bluefin tuna and swordfish. Equinor Canada is also aware that revenue from commercial-communal fisheries is an important source of funding for Indigenous community services and programs. Baseline information respecting commercial fish species and communal commercial fisheries is set out in Chapter 7 and the potential effects of the Project upon communal commercial fisheries is discussed in Chapter 13. Available data does not indicate any domestic commercial or commercial-communal fishing activity in the Core BdN Area. Levels of harvesting are generally low in the Project Area and concentrated in the western and northern portions. There are no recorded landings of either tuna or swordfish in the Project Area between 2011 and 2016.	Section 6.1.9.2 Section 6.1.9.6 Section 7.3.8.2 Section 9.5.5 Section 9.5.6 Section 13.1 Section 14.1.5.1 Section 14.1.5.2 Section 16.7.4 Section 16.7.8 Section 16.7.9 Appendix H

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
Accidents and Malfunctions – spill communications, spill response measures	The potential effects of accidents and malfunctions and Equinor Canada's emergency response plans are set out in Chapter 16. Equinor Canada is committed to becoming an industry leader on safety and will comply with all regulatory standards respecting worker and environmental safety, as outlined in Chapter 1 of the EIS. A key focus is on prevention. Spill prevention will be incorporated into Project design and operations and facilities, processes and management system procedures are intended to reduce or eliminate the chance of a spill. Proper environmental operating practices will be assured through regular inspections and audits of the drilling installation and FPSO and through ongoing training of offshore workers, including specific training in oil spill prevention, reporting and response requirements, and procedures. Oil spill prevention, response, and overall preparedness approaches for the Project will be further developed and defined as the various regulatory review and approval processes move forward. Equinor Canada will develop and implement a Project Oil Spill Response Plan which will be submitted to the C-NLOPB as part of the Operations Authorization (OA) application process described in Chapter 1. Details of this plan and other emergency response measures are set out in Chapter 16 and additional information on Well Intervention Response Strategies and related matters is set out in Appendices P and Q. Equinor is prepared to effectively respond to an oil spill offshore and is equipped with the necessary response tools, personnel and strategies.	Section 16.1 Appendix P Appendix Q
Cumulative Effects • General approach • Impacts on Marine Fish and Fish Habitat	Equinor Canada has identified and assessed cumulative effects using the approach described in relevant CEA Agency guidance documents by considering the impact of the Project in combination with other past, present and future activities in the region upon each VC. As is the case with the assessment of intra-Project effects, an ecosystem approach has been adopted. The results of this assessment are set out in Chapter 15 of the EIS.	Section 15.1 Section 15.2
Engagement • ongoing communications • capacity funding • impacts on Indigenous rights	• Equinor Canada is committed to continuing to provide opportunities to Indigenous groups for information-sharing and exchange as requested or required in the post-EIS period in order to discuss issues and concerns. The specifics of engagement processes will be developed through discussions with the various groups. As appropriate, Indigenous groups will be engaged during the development of follow-up monitoring programs. • Questions related to the provision of capacity funding to enable Indigenous groups to participate in the environmental assessment process are referred to the CEA Agency.	Section 14.4 Section 14.1.5.1 Section 14.1.5.2 Section 14.1.5.3 Section 14.4.2

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
	• It is Equinor Canada's understanding that none of the Indigenous groups listed in the EIS Guidelines have asserted or established Indigenous rights to, in or near the LSA. However, Equinor Canada will continue to engage with Indigenous groups to further understand if there are any potential adverse impacts to Indigenous rights.	
Commercial fisheries • Mitigation • Compensation	While baseline information respecting Indigenous commercial communal fishers details commercial fishing activities undertaken in or near the Project area, the assessment of impacts of the Project upon fish and fish habitat will consider both impacts from operations and accidental events throughout the RSA. If an effect on species might have an indirect effect on communal commercial fishing outside the Project area that will be noted. Should a fisher experience loss or damage as a result of either routine Project activities or accidents, losses will be compensated through a program which will be developed in consideration of the C-NLOPB's guidelines (founded on the Canada-Newfoundland and Labrador Atlantic Accord Implementation Acts). In addition to the compensation programs, mitigation measures applicable to commercial fishers which are identified in the EIS include: • Ongoing communication with commercial fishers regarding planned Project activities, including notification of coordinates of safety and/or anti-collision zones. • Ongoing communications with the NAFO Secretariat, through Fisheries and Oceans Canada (DFO) regarding planned Project activities, including timely communication of the anti-collision and/or safety zones • Ongoing communication with regulatory agencies to share information regarding the timing and location of activities • Implementation of a standard marine communication protocol to promote safe practices between commercial fishing enterprises, other marine users and BdN operations. • Issuance of Notices to Shipping and Notices to Mariners (where appropriate) regarding planned Project activities	Section 13.1.5.2 Section 13.2.4.1 Section 14.1.5.3 Section 16.7.8 Section 18.2

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
Fish and Fish Habitat • Data collection – new data for corals and sponges • Effects of discharges on corals and sponges • Use of dispersants • Fish taint – prey species • Invasive species	• Equinor Canada has completed a seabed survey (detailed in Section 6.1.1.5) to provide a better dataset for assessing coral and sponge densities in the Project Area. Upon completion of final subsea layout design, the area occupied by the final layout design will be compared against the layout used in the 2018 survey. Based on the final design, if there are areas where subsea infrastructure will be installed on the seafloor that were not captured by the 2018 survey, these areas will be surveyed to collect coral, sponge and/or sea pens data. • No significant effects upon sponges and corals associated with discharges are predicted. However, Equinor Canada will employ mitigation measures designed to reduce potential impacts to marine ecosystems, including VMEs. These mitigation measures have been implemented offshore Newfoundland, including deep waters such as the Orphan Basin, in previous exploration drilling programs and ongoing development projects. In addition, Equinor Canada has also committed to measures which are not industry standard offshore NL – e.g., the use of cuttings transfer system to relocate water-based cuttings discharges, as listed in Section 9.1.5.2. This mitigation is widely used offshore Norway in sensitive areas where coral reefs and colonies are present. If DFO determines that a Fisheries Act Authorization is required respecting the harmful alteration, disruption, or destruction (HADD) of fish habitat associated with the Project, compensation for the loss of habitat would reduce the overall impact on the affected area (s). An Environmental Effects Monitoring program will be developed to monitor the efficacy of mitigation measures. • There are two spill-treating agents (dispersants) approved for use in Canada. The approval process for these spill-treating agents considered their toxicity. Information on the environmental effects of dispersants is provided in Sections 16.7.4.4; 16.7.5.4, 16.7.6.5, and 16.7.8.2 of the EIS. The toxicity and potential environmental effects of dispersants on Marine Fish and Fish Habitat are considered in Section 16.7.4.4 of the EIS. Dispersants and their environmental effects considerations are also considered in spill response tactics (Table 16.1 of the EIS) and further information on considerations and application is provided in EIS Appendix P Well Intervention Response Strategies and Appendix Q Additional Spill Response Information. • Effects of a release of hydrocarbons on fish and fish habitat (including prey species) and associated effects on	Section 2.8.2 Section 6.1.1.5 Section 9.3.3.4 Section 9.4.3.4 Section 16.7.4.4 Appendix P Appendix Q

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
	commercial fisheries and Indigenous peoples are discussed in Chapter 16. • Equinor Canada considers prevention to be key in controlling the introduction and spread of aquatic invasive species. Although the likelihood that a Project vessel will result in the introduction and spread of an invasive species is relatively low, ballast water will be managed in consideration of applicable Canadian and international ballast water management requirements to reduce the potential spread of invasive species. Ballast water management is addressed in Chapter 2 and potential effects of ballast water are discussed in Chapter 9.	
Traditional Knowledge	With respect to Indigenous Knowledge, Equinor Canada has invited each group to share Indigenous Knowledge relevant to the Project and EIS through the negotiation of agreements or through the sharing of previous reports or existing databases. While there has been no uptake of these offers to date, to supplement its understanding of relevant Indigenous Knowledge acquired during regular engagement activities, Equinor Canada commissioned a desktop Indigenous Knowledge Study (Appendix H), summarizing publicly available information relating to Indigenous Knowledge. As relevant and appropriate, the various EIS chapters incorporate traditional knowledge provided during engagement activities or set out in the desktop Indigenous Knowledge Study (Appendix H).	Appendix H
Special Areas – • Need to include full listing of all existing and proposed MPAs as well as NAFO divisions, vessel traffic routes and crab areas • Species presence – northern bottlenose whale • Figures should show NAFO division, crab area and vessel traffic routes	• Special Areas are discussed in Chapter 12. Special areas are those areas which have been identified by Canadian and International regulatory bodies based on defining environmental features including the presence of sensitive habitats, supporting life stages of marine and/or migratory species and/or the presence of fish, marine mammals, marine birds, etc. The EIS includes the consideration of identified special areas within the Project RSA, as applicable. Figures are included which show the location of Special Areas in relation to Project Area and other key items such as NAFO Divisions, vessel traffic routes, licences and other production facilities. • Baseline information respecting species observed in Special Areas, including the northern bottlenose whale, is set out in Chapter 6 and potential effects upon fish and fish habitat, marine mammals and migratory birds within Special Areas are identified and assessed in Chapter 12.	Section 6.3.7.5 Section 6.4.2.2 Section 6.2.4.2 Section 12.2 Section 12.3

Table 3.36 October 2018 Workshop Issues and Concerns

Issues and Concerns	Response	EIS Reference
Effects of environment on Project – sea icing on FPSO	• In order for sea spray icing or atmospheric icing to occur, certain meteorological conditions (wind, humidity, precipitation, temperature) must be present. The FPSO is designed in accordance with recognized standards to handle certain extreme icing loads, including the buildup of ice, should it occur. Operating experience for other drilling and production facilities in the offshore area indicates that the observed icing is significantly less than allowed in the design of the facilities. However, if the meteorological conditions are present, visual monitoring for the buildup of icing will be carried out, and if required, the ice will be removed. • Effects of the environment on the Project are described and assessed in Chapter 17.	Section 17.3.3
Assessment Methodology – • need for ecosystem approach	Equinor Canada has adopted an ecosystem approach to the environmental assessment of the Bay du Nord Project. The EIS is organized by individual VC and effects assessment to provide a well-structured document and to explicitly address the VC's identified as per the EIS Guidelines. This does not mean that the VC's have been assessed in isolation; they have also been assessed in consideration of the interactions and inter-relationships between VC's. The interconnections between the physical, biological and human environment have been considered in the EIS and are summarized in each respective VC chapter. Overall the EIS is based on the interactions between project activities and select VC's using source-pathway-receptor relationships. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not impact significance determinations, as the potential effects (via direct and indirect pathways) on each VC has been assessed.	Section 4.2

The engagement activities listed in the preceding tables, as well as ongoing activities, are designed to:

- Provide Indigenous groups with clear and timely information on the proposed Project, including the purpose, location, associated components and activities and schedule (with information being provided in French where applicable)
- Provide communities with the opportunity to share information specific to the potential impact the Project may have on Aboriginal or Treaty rights and associated potential environmental effects

- Identify, document, and respond to any questions or concerns about the Project and its potential impacts, including whether and how these might have implications for Indigenous groups and their activities and interests including activities and interests referred to in CEAA 2012 5(1)(c)
- Collect and exchange information on any Indigenous activities or interests in or near the Project Area or elsewhere that might be relevant to the assessment of the Project and its potential effects, as well as relevant Indigenous Knowledge about the existing environment

Equinor Canada is committed to establishing and maintaining relationships with Indigenous peoples that are based upon mutual respect and understanding and will continue to provide opportunities for information-sharing and exchange in the post-EIS submission period. The specific nature, frequency, subject matter and format of such future engagement will be determined through discussion with the various Indigenous groups. Equinor Canada will continue to engage with all groups so that information is provided and that Indigenous groups have the opportunity to express concerns and identify interests. Equinor Canada will continue to document engagement activities and provide the CEA Agency with engagement records until the issuance of the EA decision. As per Section 9.1 of the EIS Guidelines, Equinor Canada will continue to engage with Indigenous groups and stakeholders in the development of monitoring programs.

3.4 Stakeholder Groups

As part of the EIS preparation, Equinor Canada has also engaged with key stakeholders and environmental non-government organizations (ENGOs) that have traditionally been engaged in or expressed an interest in offshore oil and gas operations in NL and their potential effects. These organizations include Nature Newfoundland and Labrador (Nature NL), World Wildlife Fund (WWF), Canadian Parks and Wilderness Society (CPAWS), Protected Areas Association of Newfoundland (PAAN), and Sierra Club NL Chapter (Table 3.37). It is Equinor Canada’s understanding that PAAN is no longer active; however, engagement activities are included in Table 3.37 below.

Fish harvesters and processors constitute a key stakeholder group, with which Equinor Canada has ongoing communication and engagement to keep them apprised of offshore oil and gas activity in their fishing areas and to address any concerns they may have. Fish harvesters engaged in fishing offshore NL are represented by the Fish, Food and Allied Workers-Unifor (FFAW-Unifor). Fish processors include Ocean Choice International (OCI), Association of Seafood Producers (ASP), and Groundfish Enterprise Allocation Council (GEAC). One Ocean is the liaison organization established by and for the fishing and petroleum industries of NL. Its objective is to assist the fishing and petroleum industries in understanding each sector’s operational activities. Members of the One Ocean Board and working group include representatives from FFAW-Unifor, fish processors, and offshore oil and gas industry.

A complete inventory of engagement activities, up to December 31, 2018, with the various stakeholder groups is contained in Table 3.37. A summary of the key questions and issues raised through these engagement activities and where these issues are addressed in the EIS is provided in Table 3.38.

Table 3.37 Meetings and Discussions with Stakeholder Organizations

Date	Organization	Activity	Purpose and Focus
May 25, 2018	FFAW-Unifor	Outgoing Email	Update on 2018 scope of work along with current information on commercial fisheries locations and traffic area.
May 25, 2018	ASP	Outgoing Email	Update on 2018 scope of work along with current information on commercial fisheries locations and survey area.
May 25, 2018	OCI	Outgoing Email	Update on 2018 scope of work along with current information on commercial fisheries locations and survey area.
May 25, 2018	GEAC	Outgoing Email	Update on 2018 scope of work along with current information on commercial fisheries locations and survey area.
June 19, 2018	FFAW-Unifor	Incoming Email	Request for information on 2018 exploration work in EL 1154 and the company conducting the work.
June 21, 2018	One Ocean	Outgoing Email	Advising that Project Description had been filed with the CEA Agency; Equinor Canada will provide additional Project information and discuss engagement.
June 26, 2018	One Ocean	Outgoing Email	To advise that Project Description has been published on CEA Registry and to provide link.
July 3, 2018	FFAW-Unifor	Outgoing Phone Call	Discussed engagement strategy. Due to fishing seasons, a meeting before September was unlikely. Spills and dispersants would be major concern. Planned a one-on-one meeting for July 30 to present Project overview and plan for fall meeting. Follow up e-mail to confirm substance of phone call.
July 3, 2018	Sierra Club	Outgoing Email	Provided link to Project description and requested meeting.
July 3, 2018	WWF	Outgoing Email	Provided link to Project description and requested meeting.
July 3, 2018	PAAN	Outgoing Email	Provided link to Project description and requested meeting.
July 3, 2018	CPAWS	Outgoing Email	Provided link to Project description and requested meeting.
July 3, 2018	Nature NL	Outgoing Email	Provided link to Project description and requested meeting.
July 3, 2018	OCI	Outgoing Phone Call	To discuss offer of meeting to provide Project overview. Follow-up confirmatory e-mail.
July 5, 2018	OCI	Outgoing Email	E-mail chain regarding scheduling meeting to discuss Project. Meeting confirmed for July 11 at OCI office.

Table 3.37 Meetings and Discussions with Stakeholder Organizations

Date	Organization	Activity	Purpose and Focus
July 11, 2018	One Ocean	Outgoing Email	E-mail chain with One Ocean to discuss meeting with OCI. Commitment to provide follow-up note.
July 11, 2018	OCI	In-Person Meeting	Meeting with OCI to provide overview of Bay du Nord Project and discuss issues of concern.
July 27, 2018	One Ocean	Outgoing Email	Invitation to attend meeting at FFAW-Unifor office on July 31, 2018.
July 30, 2018	FFAW-Unifor	Outgoing Email	E-mail chain with FFAW-Unifor (July 27-July 30) regarding in-person meeting. Agreed to meet on July 31 at FFAW offices to present Project overview and discuss issues of concern.
July 30, 2018	One Ocean	Incoming Email	Confirmed attendance at meeting at FFAW-Unifor office on July 31.
July 31, 2018	FFAW-Unifor	In-Person Meeting	Delivered Power Point providing overview of Bay du Nord Project and discussed issues and next steps.
September 11, 2018	All NGOs	Outgoing Email	Advised that draft Guidelines published for public review and comment. Requested meeting in early October.
September 11, 2018	FFAW-Unifor	Outgoing Email	Requested call to discuss meeting with fishers in the fall.
September 11, 2018	CPAWS	Incoming Email	Confirmed interest in and availability for meeting in early October.
September 13, 2018	FFAW-Unifor	Outgoing Email	Transmitted one-page Project description for circulation to fishers.
October 5, 2018	One Ocean	Outgoing Email	Advised of the CEA Agency Participant Funding Program.
October 5, 2018	All NGOs	Outgoing Email	Advised of the CEA Agency Participant Funding Program.
October 9, 2018	FFAW-Unifor	Outgoing Phone Call	Discuss timing of meeting with FFAW-Unifor to discuss Project. No answer, left message.
October 10, 2018	FFAW-Unifor	Outgoing Email	Email chain regarding scheduling of meeting with fishers in late October.
October 30, 2018	FFAW-Unifor	Outgoing Phone Call	Phone call to discuss scheduling of meeting with fishers, likely to be held post-EIS submission due to other commitments
November 2, 2018	All NGOs	Outgoing Email	Email proposing a meeting of all NGOs on November 15.
November 2, 2018	Nature NL	Incoming Email	Nature NL will discuss meeting request at November 7 board meeting.

Table 3.37 Meetings and Discussions with Stakeholder Organizations

Date	Organization	Activity	Purpose and Focus
November 2, 2018	FFAW-Unifor	Outgoing Phone Call	Phone call to discuss scheduling meeting with fishers. Left message.
November 2, 2018	FFAW-Unifor	Outgoing Email	Follow-up email indicating likely timing of submission of EIS and asking to schedule a meeting with fishers.
November 2, 2018	FFAW-Unifor	Outgoing Email	Email advising the deadline for applications for the CEA Agency Participant Funding in November 5.
November 2, 2018	All NGOs	Outgoing Email	Email to all NGOs to advise the deadline for applications for the CEA Agency Participant Funding in November 5.
November 8, 2018	Ocean Choice International	Outgoing Email	Email inviting OCI to meet and discuss the Project, potential effects and proposed mitigation measure. OCI response is affirmative.
November 8, 2018	Nature NL	Outgoing Email	Email asking if the Nature NL board is interested in meeting.
November 9, 2018	CPAWS	Outgoing Email	Transmit copy of meeting invitation to NGOs
November 14, 2018	All NGOs	In-Person Meeting	Meeting with NGOs to provide Project overview, discuss potential environmental effects and mitigation measures, and respond to issues of concern. Main issues included fish and fish habitat, marine mammals, EEM, cumulative effects and accidental events.
November 14, 2018	All NGOs	Outgoing Email	Meeting follow-up thanking participants and providing link to the CEA Agency website.
November 14, 2018	CPAWS	Outgoing Email	Offer to arrange follow-up phone call with CPAWS.
November 15, 2018	CPAWS and WWF	Outgoing Email	Email providing contact information for the CEA Agency Participant Funding Program.
November 16, 2018	All NGOS	Outgoing Email	Transmittal of draft meeting notes, inviting comments and corrections.
November 16, 2018	OCI	Outgoing Email	Follow-up to November 8 email to gauge interest in meeting regarding potential effects and proposed mitigation measures.
November 19, 2018	CPAWS	Incoming and Outgoing Emails	Email chain regarding scheduling a second meeting with CPAWS.
November 19, 2018	CPAWS	Outgoing Email	Meeting invitation to CPAWS to participate in a separate briefing November 22.

Table 3.37 Meetings and Discussions with Stakeholder Organizations

Date	Organization	Activity	Purpose and Focus
November 22, 2018	CPAWS	In-Person Meeting	Equinor Canada delivered PowerPoint presentation and discussed potential impacts and mitigation measures associated with fish and fish habitat, marine mammals, migratory birds and commercial fisheries. Also discussed accidental events and Equinor Canada provided an overview of spill modelling and spill response protocols.
November 22, 2018	CPAWS	Outgoing Email	Follow-up email including worksheets and Project figures. Invitation to provide additional comments or information.
November 22, 2018	CPAWS	Incoming and Outgoing Emails	Email chain regarding submission of comments on worksheet.
November 22, 2018	OCI	Incoming and Outgoing Emails	Email chain regarding scheduling of meeting in mid-December.
November 26, 2018	CPAWS	Incoming Email	E-mail with comments on proposed environmental effects and mitigation measures, including Marine Fish and Fish Habitat and Marine and Migratory Birds.
December 4, 2018	WWF	Incoming Email	Email from WWF advising that they received participant funding and inquired about timelines associated with EIS submission, public comment, etc.
December 4, 2018	WWF	Outgoing Email	Responded to WWF's email regarding EA process and timelines.
December 11, 2018	OCI	Outgoing Phone Call	Phone call to schedule an in-person meeting to provide a Project update and discuss potential environmental effects and proposed mitigation measures associated with the Project.
December 17, 2018	OCI	In-Person Meeting	Equinor Canada delivered a PowerPoint presentation and discussed potential impacts and mitigation measures associated with commercial fisheries. OCI indicated that they will be collecting baseline water chemistry data and Equinor Canada inquired whether they could share the data. Both parties agreed to engage on this topic in 2019.

Table 3.38 Stakeholder Organizations Issues and Concerns

Key Questions and Issues Raised	Where Addressed in the EIS
Marine Fish and Fish Habitat	Chapter 9
Potential changes to dissolved oxygen concentrations associated with drill cuttings, and whether it will be measured during EEM	Section 9.6
Marine and Migratory Birds	Chapter 10
Marine Mammals	Chapter 11
EEM	Chapter 9, 10, 11
Commercial fisheries	Chapter 13
Cumulative effects	Chapter 15
Accidental events	Chapter 16
Use of dispersants	Chapter 16

These stakeholder engagement activities have also included additional discussions and ongoing information sharing through various other means (e.g., letters, emails, telephone conversations), the results of which have also been considered in the scope and content of the EIS as applicable.

3.5 References

Statoil. 2017. Flemish Pass Exploration Drilling Program – Environmental Impact Statement. Prepared by Amec Foster Wheeler and Stantec Consulting. St. John's, NL Canada. November 2017.

4.0 ENVIRONMENTAL ASSESSMENT SCOPE, APPROACH, AND METHODS

This Chapter outlines the scope and focus of the Environmental Impact Statement (EIS), as well as describing the approach and methods used to conduct the environmental effects assessment.

4.1 Scope of the Environmental Assessment and Factors Considered

This EIS has been planned, prepared, and submitted in accordance with requirements of the *Canadian Environmental Assessment Act, 2012* (CEAA 2012) as well as the Project-specific EIS Guidelines (Appendix A) issued by the Canadian Environmental Assessment Agency (the CEA Agency) on September 26, 2018 and other generic environmental assessment (EA) guidance documents issued by the CEA Agency as cited herein.

The scope of the Project for the purposes of the EA includes each of the components and activities defined and described in Chapter 2 of this EIS and as specified in Section 3.1 of the EIS Guidelines.

Section 2 of CEAA 2012 defines "environment" as follows:

> *[E] environment means the components of the Earth, and includes*
>
> *(a) land, water, and air, including all layers of the atmosphere;*
> *(b) all organic and inorganic matter and living organisms; and*
> *(c) the interacting natural systems that include components referred to in paragraphs (a) and (b)*

CEAA 2012 also includes the following requirements related to assessing the environmental effects of a designated project, which are relevant to the overall scope of the assessment, and which have guided the planning and development of the EIS (Section 5(1) of CEAA 2012):

> *5 (1) For the purposes of this Act, the environmental effects that are to be taken into account in relation to an act or thing, a physical activity, a designated project, or a project are*
>
> *(a) a change that may be caused to the following components of the environment that are within the legislative authority of Parliament:*
>
> *(i) fish and fish habitat as defined in subsection 2(1) of the Fisheries Act,*
> *(ii) aquatic species as defined in subsection 2(1) of the Species at Risk Act,*
> *(iii) migratory birds as defined in subsection 2(1) of the Migratory Birds Convention Act, 1994, and*
> *(iv) any other component of the environment that is set out in Schedule 2;*
>
> *(b) a change that may be caused to the environment that would occur*
>
> *(i) on federal lands,*
> *(ii) in a province, other than the one in which the act or thing is done or where the physical activity, the designated project or the project is being carried out, or*
> *(iii) outside Canada; and*

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

In addition, other types of environmental effects must be considered under Section 5(2) of CEAA 2012 where the carrying out of the physical activity, the designated project or the project requires a federal authority to exercise a power or perform a duty or function conferred on it under another Act of Parliament. In the case of this Project, Equinor Canada will require authorizations from the Canada-Newfoundland and Labrador Offshore Petroleum Board (C-NLOPB) under the Accord Acts in order for the Project to proceed and may require permits and/or authorizations from other federal authorities as summarized in Section 1.3. Therefore, the following environmental effects are also taken into account in the EIS:

> *(a) a change, other than those referred to in paragraphs (1)(a) and (b), that may be caused to the environment and that is directly linked or necessarily incidental to a federal authority's exercise of a power or performance of a duty or function that would permit the carrying out, in whole or in part, of the physical activity, the designated project, or the project; and*
> *(b) an effect, other than those referred to in paragraph (1)(c), of any change referred to in paragraph (a) on*
>
> > *(i) health and socio-economic conditions,*
> > *(ii) physical and cultural heritage, or*
> > *(iii) any structure, site or thing that is of historical, archaeological, paleontological, or architectural significance.*

As defined in Section 19(1) of CEAA 2012 and specified in Section 3.2 of the EIS Guidelines, the following factors are considered and addressed in the EIS:

- environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other physical activities that have been or will be carried out;
- the significance of the effects referred to above;
- comments from the public;
- mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project;
- the requirements of the follow-up program in respect of the project;
- the purpose of the project;
- alternative means of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;

- any change to the project that may be caused by the environment; and
- the results of any relevant regional study pursuant to CEAA 2012.

These factors have been considered and addressed in establishing the scope, focus, spatial and temporal boundaries of the analysis and the overall content of this EIS. The EIS has been prepared in compliance with the requirements of CEAA 2012, the EIS Guidelines, and the Accord Acts. A detailed Table of Concordance outlining these requirements and indicating where and how each item is addressed in the EIS is provided in Appendix B of this EIS.

4.2 Identification and Selection of Valued Components

EAs typically identify and focus on components of the environment that are of ecological or socioeconomic importance and/or which can serve as indicators of environmental change, and which have the potential to be affected in some way by the proposed Project under assessment. These are known as Valued Components (VCs) and may include both biophysical and socioeconomic aspects of the environment. The VC approach is a useful, effective, and widely accepted way of ensuring that an EA focuses on components and issues that are most relevant to the Project and its potential effects.

For the Bay du Nord (BdN) EIS, the identification and selection of the VCs was based on a number of key considerations and inputs including the EIS Guidelines, regulatory guidance, and Indigenous and stakeholder engagement (Chapter 3). Specifically, Commercial Fisheries and Other Ocean Uses and Marine Fish and Fish Habitat VCs address the issues / concerns raised by fisheries organizations and Indigenous groups related to commercial and commercial-communal fishing. Marine Fish and Fish Habitat, Marine and Migratory Birds, Marine Mammals and Sea Turtles with the inclusion of species at risk (SAR), were also identified as VCs and address the issues of concern raised by environmental organizations and Indigenous groups from a harvesting, social, and cultural perspective. Special Areas was also a VC of interest identified by environmental non-governmental organizations (ENGOs) and Indigenous groups. Specific details regarding feedback from Indigenous groups and stakeholders and where in the EIS they are addressed is provided in the tables within Sections 3.3.1.2 and 3.4.

The selection of VCs was ultimately informed by consideration of the nature and characteristics of the Project, its existing environmental settings, experience and knowledge from similar offshore oil and gas projects, interests and concerns identified by Indigenous groups and the professional experience of Equinor Canada and the EIS Study Team.

The following VCs are considered in this assessment:

1) Marine Fish and Fish Habitat (including SAR)
2) Marine and Migratory Birds (including SAR)
3) Marine Mammals and Sea Turtles (including SAR)
4) Special Areas
5) Indigenous Peoples
6) Commercial Fisheries and Other Ocean Uses

The rationale for the selection of these VCs is further described in Table 4.1.

Table 4.1 Identified VCs and the Rationale for their Selection

Valued Component	Rationale
Marine Fish and Fish Habitat (including SAR)	• The consideration of Marine Fish and Fish Habitat within a single VC is in keeping with current and standard practice, and provides for a more comprehensive, holistic approach while at the same time reducing unnecessary repetition • Fish resources are an important consideration in the EA of the proposed activities that occur within, and that may affect, the marine environment • Fish and fish habitat are protected under the *Fisheries Act* • This VC includes relevant fish species, plankton, algae, benthos, and relevant components of their habitats (such as water and sediment), given the clear interrelationships between these environmental components • This VC is included due to its important ecological function and the socio-economic importance of commercial fisheries resources • The VC gives specific consideration to particular species that have been identified by regulatory agencies, Indigenous groups or stakeholder groups • Specifically, Indigenous groups identified Atlantic salmon, American eel, swordfish, bluefin tuna, cod, snow crab and herring as fish species that are important and valued for commercial and/or traditional (food, social, and ceremonial (FSC)) purposes (Chapters 3, 7) • The VC gives consideration to marine fish SAR, including but not limited to wolffish, white shark, Atlantic salmon, American eel, redfish, grenadier, and white hake • Although the EIS Guidelines specify “marine plants” as potential VC for the EIS, these have been considered as part of the overall Marine Fish and Fish Habitat VC • This VC is included in the EIS as specified by the EIS Guidelines, and to address the requirements of Section 5(1)(c) of CEAA 2012
Marine and Migratory Birds (including SAR)	• Birds are important from an ecological, social, and economic perspective, as they often function near the top of the food chain, and may be vulnerable to certain types of environmental disturbance • Migratory birds are protected under the *Migratory Birds Conservation Act* • A variety of avifauna species inhabit the marine environments off eastern NL at various times of the year • The VC gives consideration to marine and migratory bird SAR, including Ivory gull, Barrow’s goldeneye, and harlequin duck • They are also an important resource for various recreational and tourism related pursuits • Indigenous groups indicated that marine and migratory bird species are used for traditional land and resource activities (see Chapters 3, 7) • This VC is included in the EIS as specified by the EIS Guidelines, and to address the requirements of Section 5(1)(c) of CEAA 2012

Table 4.1 Identified VCs and the Rationale for their Selection

Valued Component	Rationale
Marine Mammals and Sea Turtles (including SAR)	• Marine mammals (including whales, dolphins, and seals) are an important element of the environmental and socio-cultural settings of the province and elsewhere in Atlantic Canada • These species are important from an ecological perspective, with a number of marine mammal species having been designated as SAR under Canadian legislation • The VC gives specific consideration to particular species that have been identified by regulatory agencies, Indigenous groups or stakeholder groups • Indigenous groups identified that certain marine mammals (e.g. right whales) were of cultural importance and certain Indigenous groups engage in a subsistence seal harvest (see Chapter 3) • Although sea turtles are generally uncommon in the region, they are also included as part of this VC given their rare and protected status • The VC gives consideration to marine mammal and sea turtle SAR, including blue whale, northern bottlenose whale, fin whale, North Atlantic right whale, beluga whale, and leatherback and loggerhead sea turtle • This VC is included in the EIS as specified by the EIS Guidelines, and to address the requirements of Section 5(1)(c) of CEAA 2012
Special Areas	• Several locations within the Canada-NL Offshore Area and beyond have been designated as special or sensitive areas due to their ecological characteristics and importance • Some of these areas are protected under provincial and/or federal legislation and others are protected under international maritime agreements • This VC is included in the EIS as specified by the EIS Guidelines, and to address the requirements of Section 5(1)(c) of CEAA 2012
Commercial Fisheries and Other Ocean Uses	• Marine commercial fisheries are key elements that have shaped the history and socioeconomic character of NL and are important aspects of the current economic and socio-cultural fabrics of the province and other parts of Canada • Commercial fisheries in this region involve a range of species and gear types at various times of the year. Fishing activities are undertaken in and around the Project by fishing interests from NL (including several Indigenous organizations), Canadian, and international fishing enterprises • Other activities take place in parts the vicinity of the Project and adjacent areas on either a year-round or seasonal basis, including other oil and gas related activities, general vessel traffic, research, and military exercises • This VC is included in the EIS as specified by the EIS Guidelines, and to address the requirements of Section 5(1)(c) of CEAA 2012

Table 4.1 Identified VCs and the Rationale for their Selection

Valued Component	Rationale
Indigenous Peoples	• Indigenous groups reside in NL, the Maritimes provinces (Nova Scotia, New Brunswick, Prince Edward Island) and parts of Quebec • The proposed Project is located approximately 640 km to 2,000 km from Indigenous communities and their traditional territories. However, the Project may potentially affect marine-associated species and other resources that are harvested in commercial-communal fisheries and may potentially affect species that may migrate through the Project Area to the traditional territories of Indigenous groups and which are harvested in an Aboriginal or treaty rights-based fishery or are of cultural importance • This VC is included in the EIS as specified by the EIS Guidelines, and to address the requirements of Section 5(1)(c) of CEAA 2012

SAR designated under federal and/or provincial legislation are included under the respective VC for Marine Fish and Fish Habitat, Marine and Migratory Birds, and Marine Mammals and Sea Turtles. Within these VC Chapters, SAR are given special attention and emphasis in the identification, analysis and evaluation of potential environmental effects and required mitigation measures. Table 4.2 links each of these identified VCs to the various environmental components and issues that are specified under Section 5 of CEAA 2012. Although the EIS provides individual environmental effects assessments for each VC (Chapters 9 to 14), it is done with consideration of the interactions and interrelationships between these environmental components through a holistic, ecosystem-based approach.

Table 4.2 Identified VCs and Potential Considerations Relevant to CEAA 2012

CEAA 2012 Requirement	CEAA 2012 Section	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Commercial Fisheries and Other Ocean Uses	Indigenous Peoples
Fish, Fish Habitat, Marine Plants, and Aquatic Species, including SAR	5(1)(a)(i) 5(1)(a)(ii)	●		●	+	+	+
Migratory Birds including SAR	5(1)(a)(iii)		●		+		+
Project Activities Occurring on Federal Lands	5(1)(b)(i)	●	●	●	●	●	●
Transboundary Issues[1]	5(1)(b)(ii)						
Health and Socioeconomic Conditions for Aboriginal and Non-Aboriginal People	5(1)(c)(i) 5(2)(b)(i)	+	+	+		●	● / +

Table 4.2 Identified VCs and Potential Considerations Relevant to CEAA 2012

CEAA 2012 Requirement	CEAA 2012 Section	Marine Fish and Fish Habitat	Marine and Migratory Birds	Marine Mammals and Sea Turtles	Special Areas	Commercial Fisheries and Other Ocean Uses	Indigenous Peoples
Physical and Cultural Heritage, or Resources of Historical, Archaeological, Paleontological, or Architectural Significance [2]	5(1)(c)(ii) 5(1)(c)(iv) 5(2)(b)(ii) 5(2)(b)(iii)						●
Current Use of Lands and Resources for Traditional Purposes by Aboriginal Groups [2]	5(1)(c)(iii)						+
Other Changes to the Environment Directly Related or Necessarily Incidental to a Federal Authority's Exercise of a Power or Performance of a Duty or Function in Support of the Project	5(2)(a)	●					

Notes:
● Represents a direct relationship
+ indicates an indirect relationship
[1] Routine Project activities are not anticipated to result in changes to the environment outside NL, or outside the marine waters under the jurisdiction of Canada
[2] Given the location of the Project offshore, routine Project activities are not anticipated to result in changes to the environment that would have an effect on physical and cultural heritage areas or resources of historical, archaeological, paleontological, or architectural significance.

In summary, the identification of the VCs upon which the EIS is focussed, and the consideration of each of the various sub-components that comprise each of these VCs in the effects analyses, has been informed by the specific issues and concerns raised by government agencies, stakeholder organizations, and Indigenous groups that have participated in the various engagement activities outlined in Chapter 3. In the latter case, VC selection involved the consideration of available information and perspectives from these Indigenous groups regarding their activities and interests in respect of the potentially affected environment. This includes inputs received from each group through direct engagement (Chapter 3) and/or as reflected in available information on the community / group and its activities (Section 7.3).

Section 7.3.8.1 of the EIS Guidelines lists "air quality and greenhouse gas emissions" as a suggested VC that may be considered in the EIS. Specifically, the EIS Guidelines identify it as one of the "other valued components that may be affected as a result of a federal decision or due to effects on federal lands, another province or outside Canada." These components have not been considered as a specific, individual VC per se in the environmental effects assessment, but rather aspects of the atmospheric environment were addressed as part of the overall discussion of potential Project-related environmental emissions and their management (Section 2.8.1). Predicted levels of criteria air contaminants emissions are provided in Chapter 8, in comparison to applicable federal and/or provincial air quality standards, include air dispersion modelling. Greenhouse gas estimates, including and their contribution to provincial and/or federal targets, are also included. Chapter 2 also provides a description and discussion of the various mitigations that will be put into place related to Project-related air quality and GHG emissions.

Section 7.3.8.4 of the EIS Guidelines identifies the "Human Environment" as a potential VC and lists various associated socioeconomic components for inclusion. Although not considered a separate VC for the BdN environmental effects assessment, relevant aspects of the human environment that are listed in this section of the EIS Guidelines and which have the potential to be affected by the Project are considered and addressed as part of the Commercial Fisheries and Other Ocean Uses and Indigenous Peoples VCs identified above. This includes other commercial and recreational ocean users, physical heritage items (e.g., shipwrecks) and other components that are required to be considered under the relevant provisions of Section 5(1)(c) of CEAA 2012. Human health is considered within those VCs to the extent that it may be affected by the Project's planned activities or unplanned events, such as through direct interaction with fishing activities and equipment or through resource tainting in the event of a spill. However, given the location the Project is approximately 500 km from shore, and thus, at considerable distance from communities or human activities, adverse effects on human health are not anticipated. Similarly, given the nature and location of the Project, adverse effects on other components of the human environment, such as onshore or nearshore aspects of physical and cultural heritage, rural and urban settings, and other aspects of existing socioeconomic conditions in eastern NL and beyond are not anticipated, and so these are not considered in the EIS.

4.3 Environmental Effects Assessment (Planned Project Components and Activities)

The following sections describe the EA approach and method used to conduct the environmental effects assessments presented in this EIS, including each of the key stages and components. The EA structure and methods used are in keeping with current EA approaches and practice in Canada, including under CEAA 2012.

As specified in Part 1, Section 4.3 of the EIS Guidelines, the EA approach and method used for the EIS addresses each of the following general items:

- *identifying the activities and components of the project;*
- *predicting potential changes to the environment;*
- *predicting and evaluating the likely effects on identified VCs;*
- *identifying technically and economically feasible mitigation measures for any significant adverse environmental effects;*
- *determining any residual environmental effects;*
- *considering cumulative effects of the project in combination with other physical activities that have been or will be carried out; and*
- *determining the potential significance of any residual environmental effect following the implementation of mitigation measures.*

The description of the existing environment as presented in Chapters 5 to 7 of the EIS forms the baseline from which Project-related environmental changes and resulting effects on the VCs are assessed and evaluated, including the corresponding identification and development of technically and economically feasible mitigation to avoid or reduce potential adverse effects. The assessment of potential environmental effects is, therefore, based on the approach of identifying and describing whether, how and to what degree the "without Project" conditions for the identified VC may change as a result of the Project.

The environmental effects assessments for each VC follow the EA methods and specific stages outlined below, with each step of the analysis completed and reported in its own individual sub-section.

4.3.1 Environmental Assessment Study Areas and Effects Evaluation Criteria

4.3.1.1 Study Areas

Study areas (spatial and temporal boundaries) have been established to direct and focus the environmental effects assessment for each VC. The boundaries are informed by the nature, scale, timing and other characteristics of the Project and the existing environmental setting, and potential environmental interactions. In addition, the boundaries for the EIS include consideration of relevant CEA Agency guidance, and the results of Equinor Canada's engagement with government departments and agencies, Indigenous and stakeholder groups.

It is within the spatial and temporal boundaries, as described below, that the potential environmental effects on the VC resulting from planned Project components and activities and their significance are assessed and evaluated.

Spatial Boundaries

Four types of spatial assessment boundaries are used in the EIS to reflect the various means by which the Project may interact with and potentially change the environment and are defined in Table 4.3. Figure 4-1 illustrates the spatial boundaries of these Study Areas used in the EIS.

Table 4.3 Environmental Assessment Study Areas

Spatial Study Areas	Description
Core BdN Development Area	• The Core BdN Development Area encompasses the immediate area in the Core BdN Development activities and components may occur and includes the area within which direct physical disturbance to the receiving environment may occur. It occupies an offshore area of approximately 470 km², encompassing the planned and potential location of the FPSO and supporting subsea infrastructure and activities. • The actual footprint of Project facilities within the Core BdN Development Area is approximately 7 km². • The safety zone demarcating the spatial extent of subsea infrastructure will be approximately 30 km² (see Section 2.5.4). • The anti-collision zone ranges from approximately 1 km² (drilling installation) to 8.5 km² (FPSO) (see Section 2.5.4).
Project Area	• The Project Area is defined as the overall geographic area within which all planned Core BdN Development and Project Area Tiebacks will occur. It has been established to include those aspects that are within the defined scope of the Project for EA purposes, as detailed in Section 2.1 and Section 4.1 of this EIS and reflects the current stage of Project planning and design activities could take place during its various phases. • The Project Area considers all activities that may be carried out over the life of the Project and includes lands adjacent to the Core BdN Development Area. Should additional resource potential be discovered, these lands could be developed and produced from the BdN FPSO through the addition of subsea tiebacks. Equinor Canada has majority interests in other exploration licenses (ELs) and significant discovery licenses (SDLs) (i.e., ELs 1143, 1154 and 1156, and SDLs 1047, 1048, 1055 and SDLs that may be awarded within the foregoing ELs) in the Project Area. These lands may be included in Project Area Tiebacks and are therefore included in the Project Area. • The Project Area comprises an offshore area approximately 4,900 km^2 in size, encompassing the Core BdN Development Area as defined above.
Local Study Area (LSA)	• These boundaries are defined on a VC-specific basis and encompass the overall geographic area over which all planned and routine Project-related environmental interactions (including emissions and other disturbances) may occur. The LSA defined for each VC is inclusive of the Core BdN Development and Project Areas. • The LSA represents the predicted environmental zone of influence of the Project's Core BdN Development and Project Area Tiebacks activities, including the vessel traffic route, within which Project-related environmental changes to the VC in question may occur and can be assessed and evaluated. • For each VC, the LSA depends on the geographic extent of an environmental disturbance or change and may vary based on its specific nature, timing, or location. • Therefore, while the LSA for each VC has been defined to conservatively account for the overall zone of influence of potential Project activities at location within the Project Area, in some cases these environmental changes may occur only within a portion of the LSA itself.

Table 4.3 Environmental Assessment Study Areas

Spatial Study Areas	Description
Regional Study Area (RSA)	• In addition to Core BdN Development and Project Area Tieback activities and their potential environment interactions, from an ecological and socioeconomic perspective the environmental effects assessments also considers the characteristics, distributions, and movements of individual VCs under consideration, including the larger regional areas within which they occur and function • The EA assesses potential effects to marine biota (individuals and populations) and human activities which are known or likely to occur in the LSA for each VC, but also considers the overall extent of affected individuals and populations during the time period at which they may be affected by Project activities. • It should be noted that this RSA has been defined and used as a general guide and area of focus for the EA and represents the amalgamated consideration of each of the VCs under consideration and the various factors noted above. The environmental effects assessment considers specific areas within the larger RSA as relevant and appropriate to the specific environmental component or interaction in question. In addition, it considers and describes environmental components and potential effects that may extend outside this area where relevant, based on the nature and coverage of the environmental baseline datasets and mapping used (see discussions at the beginning of Chapters 5, 6 and 7, for examples) • The RSA for all VCs with the exception of Indigenous Peoples, was defined in consideration of the following factors - The possible movement patterns of the marine fish, birds, mammals, and sea turtles that occur in the respective LSAs for each VC over the time periods and durations for which they may be affected by planned Project activities (which may, in some cases extend up to several hundred kilometers) - The larger distribution and geographic extent of fishing and other human activities surrounding the Project Area/LSA for regional context purposes - The predicted zone of influence of a potential oil spill event, as summarized in Section 16.4, and specifically, the maximum cumulative surface oil thickness for the 95th percentile surface oil exposure case at the ecological threshold of 10 g/m^2 (0.01 mm) (i.e., worst-case). The 95th percentile case is selected from 172 model runs that capture the seasonal and annual variability in currents, winds, and ice cover The RSA captures the marine waters offshore eastern NL, including all of part of Northwest Atlantic Fisheries Organization (NAFO) Divisions 2J, 3J, 3K, 3L, 3M, 3N and 3O • The RSA for Indigenous Peoples was defined in consideration of the following - As described in Section 14.1, the Indigenous Peoples VC considers the location and overall geographic extent of the various Indigenous communities and activities that comprise the VC, as well as the distribution and movements of the various marine-associated resources that are used in the current use of land and resources for traditional purposes by these communities. Therefore, for this VC, the RSA includes an overall region of eastern Canada that generally encompasses each of the Indigenous communities and their activities throughout NL, the Maritime provinces and Quebec.

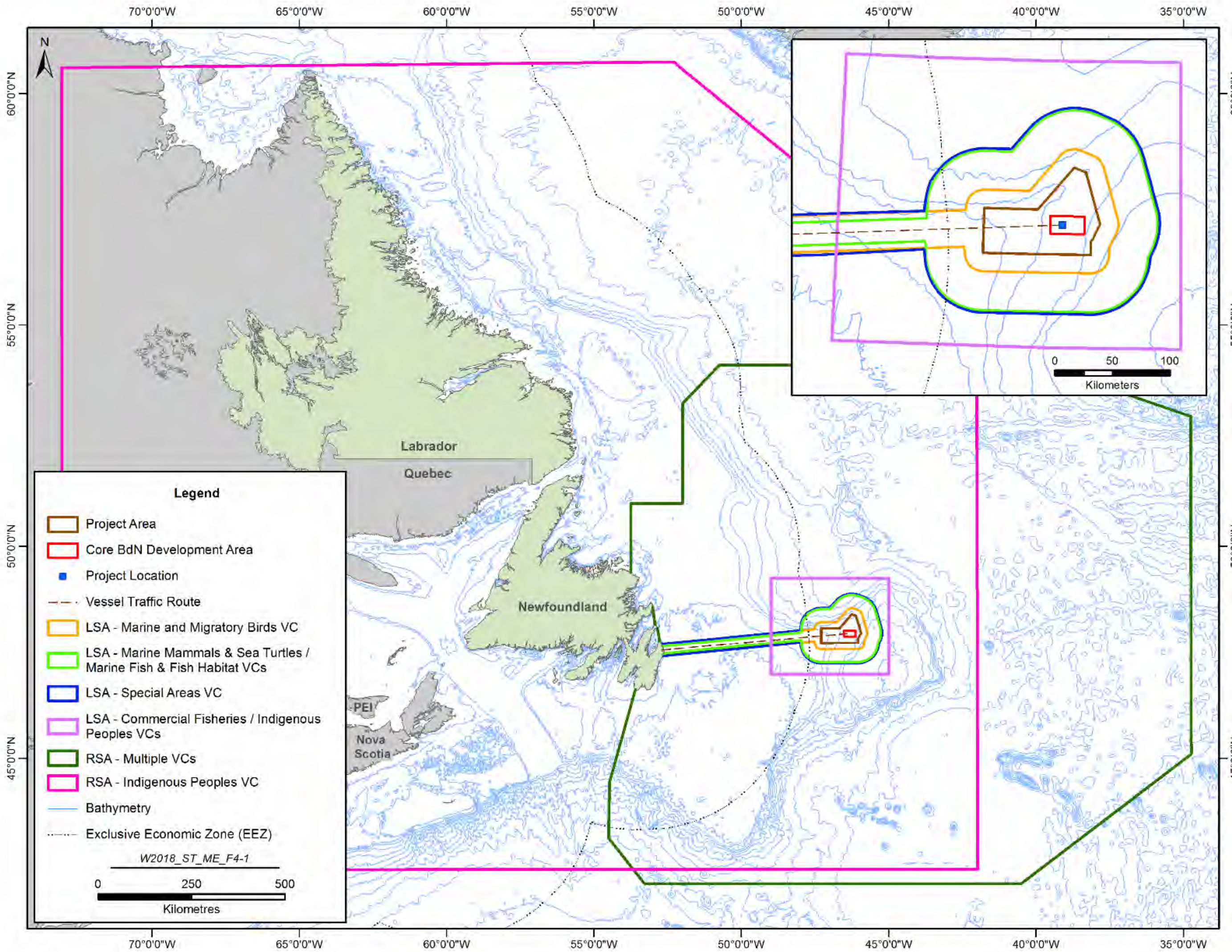

Figure 4-1 Summary of Environmental Assessment Study Areas

Temporal Boundaries

The temporal boundaries for the effects assessment encompass the frequency and duration of Project-related activities in the Project Area, as well as the likely timing of resulting environmental effects. In conducting the assessment, consideration is also given to the timing of VC presence within the Project and Study Areas, including important or sensitive periods.

The defined temporal boundaries of the Project and its phases are provided in Table 4.4.

Table 4.4 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Core BdN Development Phases	
Offshore Construction, Installation, Hook-up and Commissioning (HUC)	• Site surveys commencing as early as 2021 • Offshore construction as early as 2023, but may occur later • Approximately 5 years; seasonal to year-round • Offshore HUC – likely to be carried out over a four-month timeframe; any time of year
Production and Maintenance Operations	• Commencement as early as 2026 • 12 to 20 years; year-round
Drilling Activities	• Commencement as early as 2024 • On average, drilling time is approximately 45-85 days per well (may be shorter for pilot wells and/or tiebacks) • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Commencing as early as 2021 • Ongoing throughout life of Project; year-round
Supporting Surveys	• Commencing as early as 2021 • Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing either at end of Core BdN Development phase or at end of Project life if Project Area Tiebacks are developed. • Approximately 2 to 4 years; seasonal or year-round
Project Area Tiebacks	*Extension of Project life to a maximum of 30 years*
Offshore Construction and Installation, and HUC of subsea tiebacks	• As required, depending on need for tiebacks • Up to five tiebacks could be undertaken with associated subsea infrastructure • Likely seasonal activity, as with Core BdN Development, but activities could occur year-round • May occur at any time over life of Project
Production and Maintenance Operations	• Continuation of activities from existing FPSO out to end of Project life • Year-round

Table 4.4 Temporal Boundaries by Project Phase

Project Phase	Temporal Extent of Phase
Drilling Activities	• Total timeframe for drilling depends on number of wells required; • On average, drilling time is approximately 45-85 days per well • Likely to occur in campaigns, with a set number of wells drilled per campaign • Drilling may occur at any time over life of Project • Drilling will be carried out year-round when it occurs
Supply and Servicing	• Continuation of ongoing activities to end of Project life • Year-round
Supporting Surveys	• Ongoing throughout life of Project • Short-term (e.g., weeks to months) • Activities may be carried out at any time of the year
Decommissioning	• Commencing at end of Project life • Approximately 2 to 4 years; year-round

4.3.1.2 Significance Criteria

The determination of significance under CEAA 2012 includes considering whether the predicted residual environmental effects of the Project are adverse, significant, and likely. When a project is predicted to have adverse environmental effects, as defined in Section 5 of CEAA 2012, an EA examines whether the project is likely to cause significant residual adverse environmental effects after taking into account the implementation of technically and economically feasible mitigation measures. In this EIS, the definition and determination of effects significance is based on the guidance provided in the CEA Agency's "*Operational Policy Statement, Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects under the Canadian Environmental Assessment Act, 2012"* (CEA Agency 2015).

Significance definitions are developed and used on a VC-specific basis within this EIS. Significant environmental effects are considered to be those adverse effects that will cause a change in the VC that will alter its status or integrity beyond an acceptable level. An environmental effect that does not meet the defined criteria is considered not significant.

The development of the significance criteria used in this assessment includes consideration of (where available and relevant) applicable legislation and regulations, standards, guidelines, objectives and/or policies and management plans relevant to such determinations.

For the biophysical VCs, the significance definitions include such factors as potential detectable declines in the overall abundance of marine biota or changes in their spatial and temporal distributions in the assessment areas over multiple generations, possible adverse effects to the overall abundance, distribution and health of a SAR and its eventual recovery, and changes to the ecological and socio-cultural characteristics of special marine areas and thus to their overall integrity or value. For the socioeconomic VCs, significance is linked to the potential for, and degree and duration of, detectable effects on people and communities, including on the overall nature, location or timing of activities and their economic and cultural value, on people's health and well-being, and other relevant concepts and considerations as appropriate. VC-specific significance definitions are provided in each VC chapter.

4.3.2 Potential Environmental Changes, Effects, and Associated Parameters

In order to identify and focus on key environmental issues and interactions in the EIS, the effects assessment initially identifies the various questions and issues that have been raised with regard to the Project and its potential effects on each VC. This includes those issues that have been referenced in the EIS Guidelines, through Equinor Canada's regulatory, Indigenous, and stakeholder engagement activities (as outlined in Chapter 3).

The potential environmental effects of project activities and components were identified and scoped using generally accepted methodology. In accordance with Part 2, Section 3.2 of the EIS Guidelines, the effects assessment of project activities has been based on those discharges/activities "with the greatest potential to have environmental effects." Scoping of Project – VC interactions is an approach which is consistent with standard, accepted EA methodology and in alignment with the underlying intent of the Agency's Reference Guide *Determining Whether a Designated Project is Likely to Cause Significant Adverse Environmental Effects*. This approach enables the assessment to be focussed on those Project – VC interactions which are of greatest importance, based on available knowledge, scientific literature, Indigenous knowledge, professional judgement, previous experience (both of Equinor Canada and of other offshore operators) and key issues as identified by Indigenous peoples, stakeholders and the public. Such an approach will facilitate the integration of project planning and design with mitigation and follow-up measures to result in a comprehensive environmental planning process.

In preparing the EIS, Equinor Canada conducted a preliminary, high level assessment of anticipated interactions (pathways) between various project activities and phases and the identified environmental receptors (the VCs). The purpose of this exercise has been to identify interactions of greatest importance and to eliminate analysis of certain potential Project-VC interactions that are known to have no or negligible adverse effects or, in certain instances, those that are already well-regulated or managed under other established processes.

The environmental effects assessment identifies and focuses on likely key environmental interactions between the Project and the VC, and then, on associated Project-induced environmental changes (such as changes to fish habitat due to Project-related disturbances) and resulting effects of these changes on the VC. An overview of the identified potential interactions between the VC and each of the main Project components and activities is provided (in table form) to focus and frame the environmental effects assessment. The rationale for identifying key potential interactions is provided in each of the VC chapters. If a project-VC interaction is omitted from further analysis, a rationale is provided.

4.3.3 Environmental Effects Assessment and Mitigation

The environmental effects assessment for each VC predicts and evaluates the nature and degree of changes to, and resulting effects on, the existing environment that may potentially occur as a result of planned Project activities. The current condition of the pre-Project environment as a result of other natural and anthropogenic factors - and thus, its likely sensitivity or resiliency to further disturbance or change - has been integrally considered in the environmental effects analyses presented in this EIS. The assessment is also based on a recognition that environmental components and systems are not static, but rather are constantly changing over time both naturally and as a result of human activities and influences.

The application of mitigation measures is also considered in a fully integrated manner in the environmental effects assessment for each VC. This includes technically and economically feasible mitigation measures that are or can be incorporated into Project planning and design, as well as those that are identified as part of the effects analysis to avoid or reduce potential adverse environmental effects. Where applicable, the EIS also discusses cases where the implementation of identified mitigation may be the responsibility of parties other than the Operator as well as instances where potential mitigation measures were considered and rejected, including the rationale for these decisions.

Relevant information and findings from scientific literature, results of environmental effects monitoring from similar activities, and other sources of information, including Indigenous knowledge (where available) are used to guide and inform the assessment and evaluation of environmental effects and the identification and proposal of mitigation. The effects assessment includes relevant literature that is publicly available up to February 28, 2020.

The environmental effects assessment is therefore focused on assessing and describing the likely residual environmental effects of the Project – namely, those which may occur following the implementation of mitigation measures. The effects assessment for each VC is structured to consider and address the planned Project components / activities associated with the two broad phases of the Project: Core BdN Development and Project Area Tiebacks:

- Core BdN Development
  - Offshore Construction and Installation and HUC
  - Production and Maintenance Operations
  - Drilling Activities
  - Supply and Servicing
  - Supporting Surveys
  - Decommissioning
- Project Area Tiebacks
  - Offshore Construction and Installation and HUC of Subsea Tiebacks
  - Ongoing Production and Maintenance Operations
  - Drilling Activities
  - Ongoing Supply and Servicing
  - Supporting Surveys

The effects assessment considers the effect or change that may be associated with, or cause by, each applicable Project-VC interaction. Where applicable and available, relevant scientific, community, stakeholder, and Indigenous Knowledge in used in the analysis of possible Project-related environmental changes to the VC that may result through one or more mechanisms or pathways. It also recognizes and considers the interactions and interrelationships between environmental components and systems and predicted environmental effects, where relevant. The predicted residual environmental effects of the Project are determined based on a number of standard and widely accepted environmental effects criteria listed and defined in Table 4.5. The level of confidence in each environmental effects prediction is indicated throughout, and is based on available scientific literature, modelling predictions, data gaps and the experience and professional judgement of the EIS team. Assumptions are also defined and discussed and justified, where relevant. The summary statement characterizes the predicted residual (after the application of the relevant mitigation measures) environmental effects of Project's activities on the VC.

Although not a specific effects "rating" per se, the current condition of an environmental component as a result of natural and/or anthropogenic factors, and thus, its resulting resiliency or sensitivity to further change (ecological / socioeconomic context) is considered integrally as part of the prediction of environmental effects.

For the biological VCs (i.e., Marine Fish and Fish Habitat, Marine and Migratory Birds, and Marine Mammals and Sea Turtles), associated SAR are addressed in a fully integrated manner within the larger VCs themselves. Each VC Chapter provides a summary discussion of the various relevant SAR, including an overview of those that have the potential to interact with the Project, and a species by species summary of the Project's potential for effects on these species and associated mitigation.

The evaluation of significance is based on the VC-specific significance definitions developed and presented at the beginning of the VC chapter. Key sources of uncertainty or assumptions made in defining and determining environmental effects significance are also presented and justified where relevant. If significant effects are predicted, the likelihood of their occurrence is discussed.

Table 4.5 Characterizations of Environmental Effects

Characterization	Description	Definition of Categories
Nature/Direction of effect	The long-term trend of the residual environmental effect relative to baseline conditions	• **Positive** – a residual environmental effect that moves the change of the VC in a direction that is beneficial to the VC relative to baseline conditions • **Adverse** - a residual environmental effect that moves the change of the VC in a direction that is harmful to the VC relative to baseline conditions • **Neutral** – no change in the VC relative to baseline conditions

Table 4.5 Characterizations of Environmental Effects

Characterization	Description	Definition of Categories
Magnitude of effect	The degree of change of the VC relative to baseline conditions	*For all VCs:* • **Negligible**: Although there is potential for a Project-VC interaction, there would be no change in the VC relative to baseline conditions *For the biophysical VCs:* • ***Low***: A change that is considered within the range of natural variability, with no associated adverse effect on the viability of the affected population. • ***Medium***: A change that is considered beyond the range of natural variability, but with no associated adverse effect on the viability of the affected population. • ***High***: A change that is considered beyond the range of natural variability, with an adverse effect on the viability of the affected population. *For the socioeconomic VCs:* • Low: A change that is within the range of natural variability, with no associated adverse effect on the overall nature, intensity, quality, health or value of the affected component or activity. • Medium: A change that is beyond the range of natural variability, but with no associated adverse effect on the overall nature, intensity, quality, health or value of the affected component or activity. • High: A change that is beyond the range of natural variability, with an adverse effect on the overall nature, intensity, quality, health or value of the affected component or activity.
Geographic Extent of effect	The spatial area within which the residual environmental effect will likely occur	• Less 1 km^2 • Less than 10 km^2 • Less than 100 km^2 • Less than 1,000 km^2 • Less than 10,000 km^2 • Greater than 10,000 km^2
Duration of effect	The period of time required the change in VC returns to its baseline condition, or the residual effect can no longer be measured or otherwise perceived	• Short Term - less than 12 months (1 year) • Medium Term - 1 to 5 years • Long Term - more than 5 years • Permanent - recovery to baseline conditions unlikely

Table 4.5 Characterizations of Environmental Effects

Characterization	Description	Definition of Categories
Frequency of effect	Identifies how often a residual effect will likely occur	• Unlikely • Occurs once – effect occurs one time • Occurs sporadically – effect occurs episodically, a no set schedule • Occurs regularly – effect occurs at regular intervals • Occurs continuously – effect occurs continuously
Reversibility of effect	Pertains to whether the change in the VC can return to baseline conditions after the Project/activity stops	• Reversible: Will eventually recover to baseline conditions • Irreversible: Permanent
Confidence	Level of confidence or certainty in the predictions of significance.	Generally speaking, there is high confidence in significance predictions associated with a robust level of knowledge in the existing conditions, modelling and/or effectiveness of mitigation. Assigning a medium or lower level of confidence indicates a lesser level of knowledge, predictive tools and/or confidence in mitigation measures. The level of confidence in the effects prediction: *L:* Low level of confidence *M:* Moderate level of confidence *H:* High level of confidence

The interconnections between the physical, biological and human environment have been integrally considered in the EIS. Overall the EIS is based on the interactions between project activities and select VC's using source-pathway-receptor relationships as addressed in each VC chapter. The source is tied to various project activities, and the potential effect on a receptor may be direct or indirect via a pathway. The ecosystem approach recognizes these linkages, or pathways. The ecosystem linkages do not affect significance determinations, as the potential effects (via direct and indirect pathways) on relevant VCs have been assessed. As summary of the activities-pathways-receptors and linkages between ecosystem components of the VC is provided in tabular format for each VC chapter.

Each VC Chapter also provides a preliminary overview of environmental monitoring and/or follow-up programs that may be required or proposed respecting the VC. As the Project is currently in the planning stages, it is not feasible or possible to set out the particulars of follow-up or environmental observational monitoring programs. Follow-up monitoring will be developed upon finalization of Project design in consultation with the C-NLOPB and relevant government departments (e.g., DFO, ECCC) and through engagement with Indigenous groups and stakeholders, as appropriate. The contents of these programs will be informed by the EA Decision Statement and relevant regulatory requirements.

Where applicable, follow-up monitoring is identified in each VC effects assessment chapter. Information respecting proposed follow-up and monitoring programs is set out in Section 18.4 and includes, as applicable and available:

- Rationale and objectives;
- Planning and design;
- Key areas of focus;
- Implementation and schedule;
- The format, use and sharing of study results; and
- Evaluation of the results of monitoring programs

4.3.4 Project-Specific Modeling

In order to support effective and realistic assessment of the effects of the BdN Project, Equinor Canada undertook several modelling studies to understand the fate and behaviour certain discharges and emissions. The EIS Guidelines required that modelling of drill cuttings and accidental events be included in the EIS, however, underwater sound modelling, produced water dispersion modelling and fate and effects modelling of synthetic-based mud (SBM) spill were also undertaken. Figure 4-2 identifies the locations of the various modelling sites used (as appropriate).

The modelling locations illustrated in Figure 4-2 for the Core BdN Development Area were chosen based on the activity to be modelled and in consideration of the location of sensitive or special areas. For produced water dispersion modelling and sound modelling, the model location is at the proposed location of the FPSO. Drill cuttings and spill modelling locations are a special area in the Core BdN Development Area, a NAFO fisheries closure area (FCA) for the protection of sea pens, in accordance with the EIS Guidelines. A second location for spill trajectory modelling and sound modelling is in the shallower waters of the Project Area in consideration of Project Area Tiebacks.

These models are applicable to the effects assessment of various VCs and are summarized below. As referenced, the model reports are included as appendices to this EIS.

In addition, air quality dispersion modelling was conducted to predict ground-level concentrations (i.e., sea level) of those contaminants of interest to the Project that could then be compared to provincial and national air quality standards and objectives.

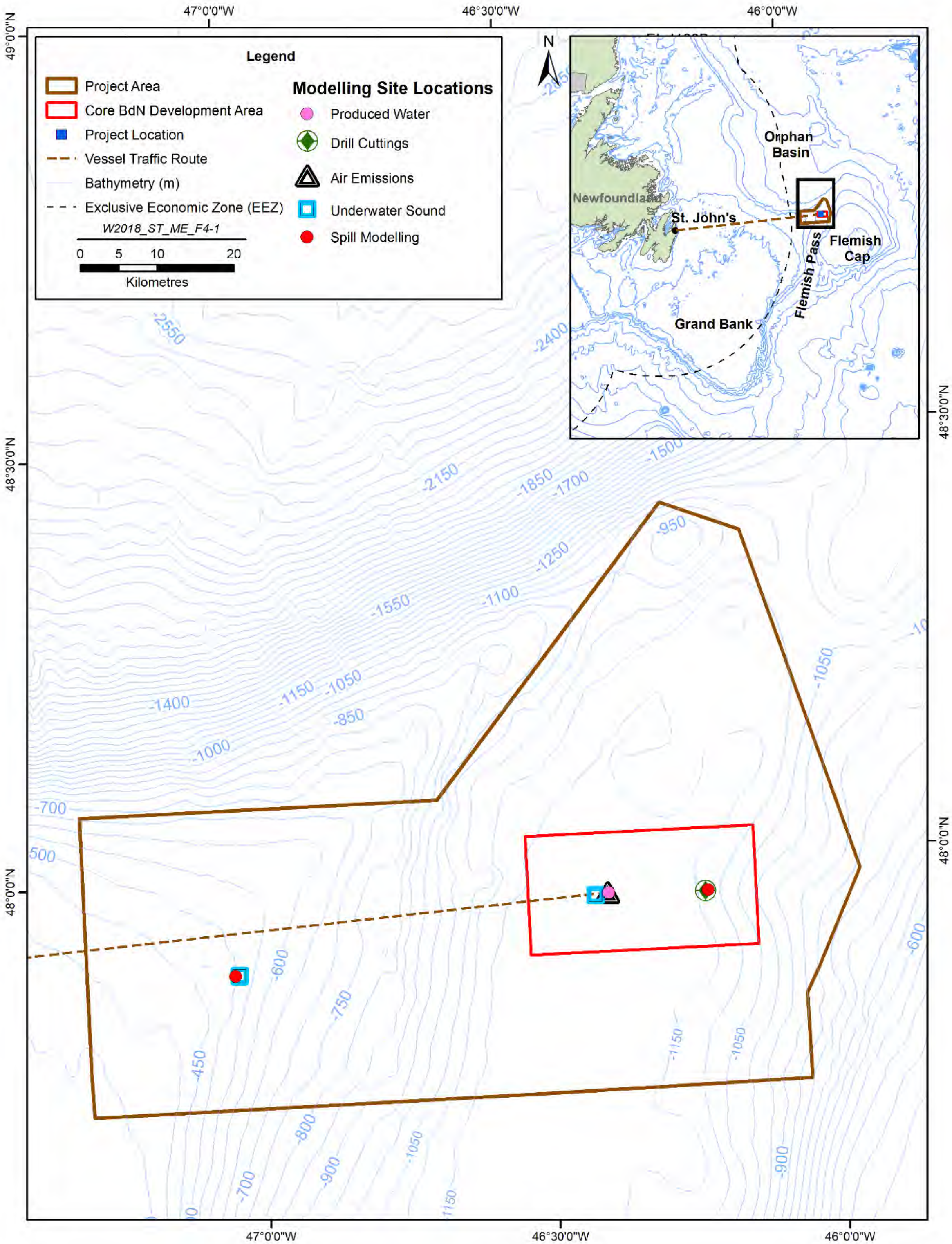

Figure 4-2 Modelling Site Locations

4.3.4.1 Drill Cuttings Dispersion Modeling

The Drill Cuttings Dispersion Model (Appendix I) was completed by Wood PLC (Wood) to characterize the release of drill cuttings associated drilling activities during the Project. Drill cuttings are the small pieces of rock, ranging in size from coarse sand to fine silts and clays, created when a drill bit penetrates rock. The material is forced up the well as drilling proceeds. The composition of the drill cuttings is dependent on the stratigraphy of the area, the type of drill bit used, the type of drilling mud used and the nature of treatment, if required, applied prior to discharge to the ocean.

For the Project, drill muds used are likely to be a combination of water-based muds (WBM) or SBM. WBMs are used for the initial sections of the well before the riser is installed. WBM and cuttings are discharged at the seafloor in accordance with the Offshore Waste Treatment Guidelines (OWTG) (NEB et al. 2010). SBMs are used for the deeper sections of the well after the riser is installed. SBM associated cuttings are then returned to the drilling installation where the drilling fluids and cuttings are separated; the cuttings are treated prior to discharge overboard and the drilling fluids (muds) are recycled for reuse. The drill cuttings composition along with water depth and ocean current determine the deposition of the cuttings on the seafloor.

A numerical model developed by Wood was used to model the dispersion of cuttings associated with the Project. The model simulates the movement of dispersed drill cuttings materials in three dimensions through the water column, following release from the drilling installation until settling on the seafloor. Key inputs include particle size distribution (PSD) estimates for cuttings and ocean currents. The primary outputs are predicted deposition patterns of cuttings on the seafloor including weight, density, and thickness of cuttings. The model used by Wood is an industry standard model and has been widely used to support in environmental assessments of offshore drilling and/or development projects.

To account for various drilling scenarios – single verses multiple well drilling - two scenarios were modeled: deposition from a single well and deposition from drilling eight wells from a single location (i.e., worst-case) in the Core BdN Development Area (Table 4.6). As noted above, the modelling location is located within the NAFO Fisheries Closure Area (FCA) and is representative of drilling in a Special Area (see Chapter 12 of the EIS). The modelling location (at 1,170 m) is representative of water depths within the Core BdN Development Area, which range from approximately 1,000 m to 1,200 m. Ocean currents, both speed and direction, are expected to be comparable over this region (see Section 3.3, Appendix I for details). Therefore, conditions at the modelling site are representative for all drilling locations in the Core BdN Development Area.

Table 4.6 Location and Scenarios for Drill Cutting Dispersion Modeling

Variable	Site Location				
	Latitude		Longitude	Easting_U23	Northing_U23
	47° 57' 31.8" N		46° 12' 40.9" W	409566.79	5312433.28
	1 Well Scenario		8 Well Scenario		Cuttings Release Location
	Depth (m) (MD-MSL)[1]	Cuttings Volume per Well (m^3)[2]	Depth (m) (MD-MSL)[1]	Cuttings Volume per Well (m^3)[2]	
Seabed depth at modeling location: 1,170 m					
Well Hole Section / Size					
Conductor - 42" (1067 mm)	1,245	118	1,245	118	Seabed[3]
Surface - 26" (660 mm)	1,905	400	1,905	400	Seabed[3]
Intermediate 1 - 17.5" (445 mm)	3,485	270	3,485	96	Below sea surface[4]
Intermediate 2 - 12.25" (311 mm)	4,204	60	N/A	N/A	Below sea surface[4]
Reservoir / Production - 8.5" (216 mm)	4,721	50	4,721	87	Below sea surface[4]
Total WBM Cuttings (Conductor and Surface Sections)	-	518	-	518	-
Total SBM Cuttings (Intermediate and Reservoir/ Production Sections)	-	380	-	183	-
Total Cuttings	**-**	**898**	**-**	**701**	**-**

Notes:
1. MD is measured depth (length of the wellbore), datum MSL is mean sea level
2. Cuttings volumes include a washout factor which varies with the formation and section: WBM mud has a higher outwash factor than SBM, and typical range is 10 or 20 percent.
3. WBM cuttings from conductor and surface sections are released estimated at 0.2 m above the seafloor assuming a Cuttings Transport System (CTS) employed with 10" (0.25 m) outlet hose resting on the seafloor, for single well and template drilling. WBM cuttings includes 167 m^3 of barite, apportioned between the 42" and 26" sections: approximately 38 and 129 kg/m^3 respectively. Specific weight for drill cuttings is assumed to be 2,596 m^3 and for barite 4,198 kg/m^3.
4. SBM (Paradril-IA LV) cuttings from intermediate and reservoir sections are released from the drilling installation at an estimated 14 m below the sea surface.

As drilling may potentially occur year-round, stochastic simulations were used that consider ocean currents over an entire year. Results presented include cuttings footprints and statistics on percent of material settled and mean and maximum cuttings thicknesses. Drill cuttings thickness is compared against conservative and average burial depths of 1.5 mm and 6.5 mm respectively. These thresholds are considered to be the predicted no-effect threshold (PNET) for non-toxic sedimentation based on benthic invertebrate species tolerances to burial, oxygen depletion and change in sediment grain size (Kjeilen-Eilertsen et al. 2004; Smit et al. 2006; 2008). The stochastic analysis post processing calculated thickness, and probability values for exceedances above PNET for each model grid cell.

4.3.4.2 Produced Water Plume Dispersion Modeling

Produced water release modeling was conducted by Elisabeth Deblois Inc. to examine the distribution of produced water discharge from the FPSO location (Section 2.7.1.5) (full report in Appendix J). The produced water modeling exercise used the Dose Related Risk and Effects Assessment Model (DREAM). DREAM was developed by SINTEF in Trondheim, Norway, and is used globally to assess the distribution of produced water discharges (SINTEF 2018). Six scenarios for produced water release were simulated and are summarized in Table 4.7.

The model was used to examine the distribution of individual constituents within a produced water plume by taking into account their physical properties. Relevant properties incorporated in simulations include: concentration on release, density, solubility, vapour pressure, degradation rate, and oil to water partitioning coefficient.

Constituents examined in modeling exercise for the Project are those identified as relevant in OSPAR (2012). Special attention was given to dispersed oil, but results are also presented for other constituents. In all cases, constituent concentrations in the water column were compared to predicted no-effects concentrations (PNEC) as provided in OSPAR (2012) to provide a spatial and temporal estimate of concentrations that exceed no-effects concentrations (i.e., concentrations that might lead to an effect). OSPAR (2012) predicted no-effects concentrations are based on laboratory studies toxicity tests, usually at three trophic levels (algae, zooplankton and fish). As such, they are general and can be used as a first gauge of potential effects.

DREAM simulations for produced water generally are carried out during times when biological resources are most vulnerable, either because of sensitivity of life stages or because of low turbulent mixing and possibility of higher levels of exposure, or both. This approach is conservative in that it provides worst-case-scenario estimates. As stated in Appendix J, since most plankton would be in the water column in Spring, June (with the lowest wind speed of the two Spring months) was selected for modeling, in keeping with the worst-case scenario approach.

Table 4.7 Location and Scenarios for Produced Water Plume Dispersion Modeling

Modeling Inputs	Latitude	Longitude	Easting_U23		Northing_U23	
Modeling Location	47°57'49.65"N	46°23'0.89"W	396719.94		5313202.1	
	Scenarios					
	Produced Water without Cooling Water		**Produced Water with Cooling Water**		**Produced Water Flow of 50,000 m³/day**	
	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6
Oil in water Concentration (ppm)	15	30	15	30	30	30
Total Flow of Release (m^3/day)	30,000	30,000	55,000	55,000	50,000	75,000
Depth of Release (m below sea surface)	20	20	20	20	20	20
Release Pipe Diameter (m)	0.6	0.6	0.6	0.6	0.6	0.6
Vertical Angle of Release (°)	180	180	180	180	180	180
Temperature of Total Flow (°C)	40	40	37.7	37.7	40	40
Salinity of Total Flow (ppt)	33	33	33	33	33	33
Produced Water Flow (m^3/day)	30,000	30,000	30,000	30,000	50,000	50,000
Cooling Water Flow (m^3/day)	0	0	25,000	25,000	0	25,000
Time of year*	June	June	June	June	June	June
*Based on data inputs for current, temperature, and salinity data from June 2015						

4.3.4.3 Underwater Sound Modeling

Project-specific underwater sound modeling for Project activities was completed by Jasco to support the assessment of potential environmental effects (see Appendix D for full report).

Activities carried out through the life of the Project will introduce sound into the marine environment. The sound emissions from the following activities were modelled:

- Sound from 3D seismic operations
- Sound from a geohazard survey using a sub-bottom profiler and multi-beam sonar
- Sound associated with the operation of the FPSO and drilling installation

The location, depth, and modeled timing for the underwater sound modeling is provided in Table 4.8.

Table 4.8 Location for Underwater Sound Modeling Scenarios

Scenario	Time of Year	No. of Scenarios Modelled	No. and Type of Sound Sources	Site	Water Depth (m)	Location			
						Latitude	Longitude	Easting_U23	Northing_U23
Seismic survey	February / August	4	1 (5,085 in3 air source array)	Site 1	1,180	47°57'42.00"N	46°24'24.02"W	394992.36	5312997.09
				Site 2	500	47°53'23.98"N	47° 2'0.02"W	348003.07	5306074.93
Geohazard survey	February	2	2 (subbottom profiler and multi-beam echosounder)	Site 1	1,180	47°57'42.00"N	46°24'24.02"W	394992.36	5312997.09
Vessel Operations	February / August	6	3 (FPSO; Drillship; and FPSO and Drillship)	Site 1	1,180	47°57'42.00"N	46°24'24.02"W	394992.36	5312997.09

The goal of the modelling study was to estimate the root-mean-square (rms) pressure level, referred to as sound pressure level (SPL). The modelling also calculated the sound exposure level (SEL) field for a 24-hour period (for vessels) or a section of a survey track for seismic and geohazard surveys. The SEL field was reviewed against the impact thresholds outlined in the National Marine Fisheries Service's document 2018 Revision to the Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0): Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts (NMFS 2018). Peak SPL field was also calculated for the impulsive sources (i.e., seismic survey source and geohazard survey source).

The study included use of several modeling programs developed by Jasco, including the Airgun Array Source Model and Marine Operations Noise Model. Results of the modelling study are presented as sound field contour maps and tables of maximum and 95 percent distances to sound level thresholds for the SPL fields, and as schematics of threshold contours and tables of Safe Distances to the specific thresholds for sound exposure levels.

4.3.4.4 Spill Trajectory and SBM Spill Modelling

A summary of the spill trajectory modelling and SBM spill modelling is provided in Sections 16.4 and 16.5, respectively. Appendix E is a detailed spill trajectory model report for unmitigated batch and subsurface blowout releases. For a detailed report on SBM spill modelling, refer to Appendix F.

4.3.4.5 Air Dispersion Modeling

To provide estimates of air emissions associated with the Project, an emissions inventory was prepared, dispersion modelling was conducted, and an analysis on greenhouse gases (GHGs) was completed (see Appendix K). After careful consideration of the Project activities, the primary air contaminant and GHG emissions of interest to the modeling were selected and include:

- Criteria air contaminants (CACs):
  - Carbon monoxide (CO)
  - Nitrogen dioxide (NO_2)
  - Sulphur dioxide (SO_2)
  - TSP
  - Particulate matter less than 10 microns in diameter (PM_{10})
  - Particulate matter less than 2.5 microns in diameter ($PM_{2.5}$)
- GHGs:
  - Carbon dioxide (CO_2)
  - Nitrous oxide (N_2O)
  - Methane (CH_4)

Emissions for the following Project activities were estimated:

- Offshore construction and installation and HUC
- Concurrent drilling and production operations
- Accidental release events

Air dispersion modelling was conducted for the operation of Project vessels to predict ground-level concentrations of the contaminants of interest from the Project. The latest version of the CALPUFF dispersion model (version 7.2.1) was used to predict the ground-level concentrations (GLCs). The CALPUFF computational domain covered a 20 km by 20 km area centered near the Project. This domain was within a 50 km by 50 km CALMET meteorological grid prepared for the study. The locations and variables included in the model are provided in Table 4.9. The predicted concentrations were compared to NL and Canadian Ambient Air Quality Standards (CAAQS). The CAAQS were developed by the Canadian Council of Ministers of the Environment (CCME) to reduce emissions and ground-level concentrations of various air contaminants nationally. Details on the models used and results are provided in the modeling report in Appendix K.

Table 4.9 Air Emission Modelling Scenarios

Timing for all Scenarios		Latitude	Longitude	Easting_U23	Northing_U23
• Non-winter • Winter (without snow cover)	Location:	47° 57' 49.65" N	46° 23' 0.89" W	396720.00	5313202.00
Scenario	**Base Elevation (m)**	**Stack Elevation (m)**	**Stack Diameter (m)**	**Stack Gas Exit Velocity (m/s)**	**Stack Gas Exit Temperature (K)**
Scenario 1 – Hook up and Commissioning					
FPSO	0	48.9	0.90	18.4	414
Drilling Installation	0	42.7	1.00	24.4	598
Supply and Support Vessels	0	36.0	0.50	15.0	414
Shuttle Tanker	0	45.5	0.90	20.0	413
Helicopters (Landing and take-off; (LTO))	0	43.4	0.66	20.0	720
Flaring (FPSO)	0	67.1	0.32	9.04	1199
Scenario 2 – Power Option 1					
FPSO	0	48.9	0.90	18.4	414
Drilling Installation	0	42.7	1.00	24.4	598
Supply and Support Vessels	0	36.0	0.50	15.0	414
Shuttle Tanker	0	45.5	0.90	20.0	413
Helicopters (LTO)	0	43.4	0.66	20.0	720
Flaring (FPSO)	0	67.1	0.32	9.04	1199

Table 4.9 Air Emission Modelling Scenarios

Scenario	Base Elevation (m)	Stack Elevation (m)	Stack Diameter (m)	Stack Gas Exit Velocity (m/s)	Stack Gas Exit Temperature (K)
Scenario 3 – Power Option 2					
FPSO	0	48.9	0.90	18.4	414
Drilling Installation	0	42.7	1.00	24.4	598
Supply and Support Vessels	0	36.0	0.50	15.0	414
Shuttle Tanker	0	45.5	0.90	20.0	413
Helicopters (LTO)	0	43.4	0.66	20.0	720
Flaring (FPSO)	0	67.1	0.32	9.04	1199
Scenario 4 – Accidental Event Flaring					
FPSO	0	48.9	0.90	18.4	414
Drilling Installation	0	42.7	1.00	24.4	598
Supply and Support Vessels	0	36.0	0.50	15.0	414
Shuttle Tanker	0	45.5	0.90	20.0	413
Helicopters (LTO)	0	43.4	0.66	20.0	720
Flaring (FPSO)	0	67.1	22.0	9.04	1199
Scenario 5 – Accidental Event 2 – FPSO Operating on Diesel 7 days per year					
FPSO	0	48.9	0.90	18.4	414
Drilling Installation	0	42.7	1.00	24.4	598
Supply and Support Vessels	0	36.0	0.50	15.0	414
Shuttle Tanker	0	45.5	0.90	20.0	413
Helicopters (LTO)	0	43.4	0.66	20.0	720
Flaring (FPSO)	0	67.1	0.32	9.04	1199

Table 4.9 Air Emission Modelling Scenarios

Scenario	Base Elevation (m)	Stack Elevation (m)	Stack Diameter (m)	Stack Gas Exit Velocity (m/s)	Stack Gas Exit Temperature (K)
Scenario 6 – Normal Operations					
FPSO	0	48.9	0.90	18.4	414
Drilling Installation	0	42.7	1.00	24.4	598
Supply and Support Vessels	0	36.0	0.50	15.0	414
Shuttle Tanker	0	45.5	0.90	20.0	413
Helicopters (LTO)	0	43.4	0.66	20.0	720
Flaring (FPSO)	0	67.1	0.32	9.04	1199

4.4 Cumulative Environmental Effects

As required under Section 19(1) of CEAA 2012, the EIS assesses and evaluates cumulative environmental effects that are likely to result from the Project in combination with other physical activities that have been or will be carried out, as well as the significance of these potential effects. The cumulative effects assessments for all VCs are reported together in Chapter 15, which includes a detailed description of the approach and methods used (Section 15.1).

4.5 Accidental Events

The EIS also assesses and evaluates the potential environmental effects that may be associated with possible accidental events that may occur as a result of the Project. Effects assessments for all VCs are reported in Section 16.7.

4.6 Effects of the Environment on the Project

The EIS provides an assessment of the potential effects of the environment on the Project, as required by Section 7.6.2 of the EIS Guidelines. Chapter 17 provides an overview of the manner in which local conditions and natural hazard (such as severe or extreme weather conditions and other external events) could adversely affect the Project, and how this in turn could result in effects to the environment. This analysis also includes an associated discussion of how these or other environmental conditions and factors have or will influence the design and execution of the Project (such as ice conditions, weather, geology), as well as associated planning, design and operational measures that will be taken to help protect the environment.

4.7 References

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5.0 EXISTING PHYSICAL ENVIRONMENT

The following sections provide an overview of relevant components of the existing physical environment of the Project and surrounding areas, including aspects of its geology, bathymetry, climatology, oceanography and ice conditions. Although the various physical components and processes that are described in this chapter are not Valued Components (VCs) for the purposes of the environmental effects assessment, this information is provided as background and context for the EIS, and in accordance with the requirements and specifications of the EIS Guidelines. Some of these environmental features and processes are also relevant to understanding and assessing the potential environmental interactions, and associated environmental changes and pathways, that may lead to potential effects on one or more of the VCs under consideration.

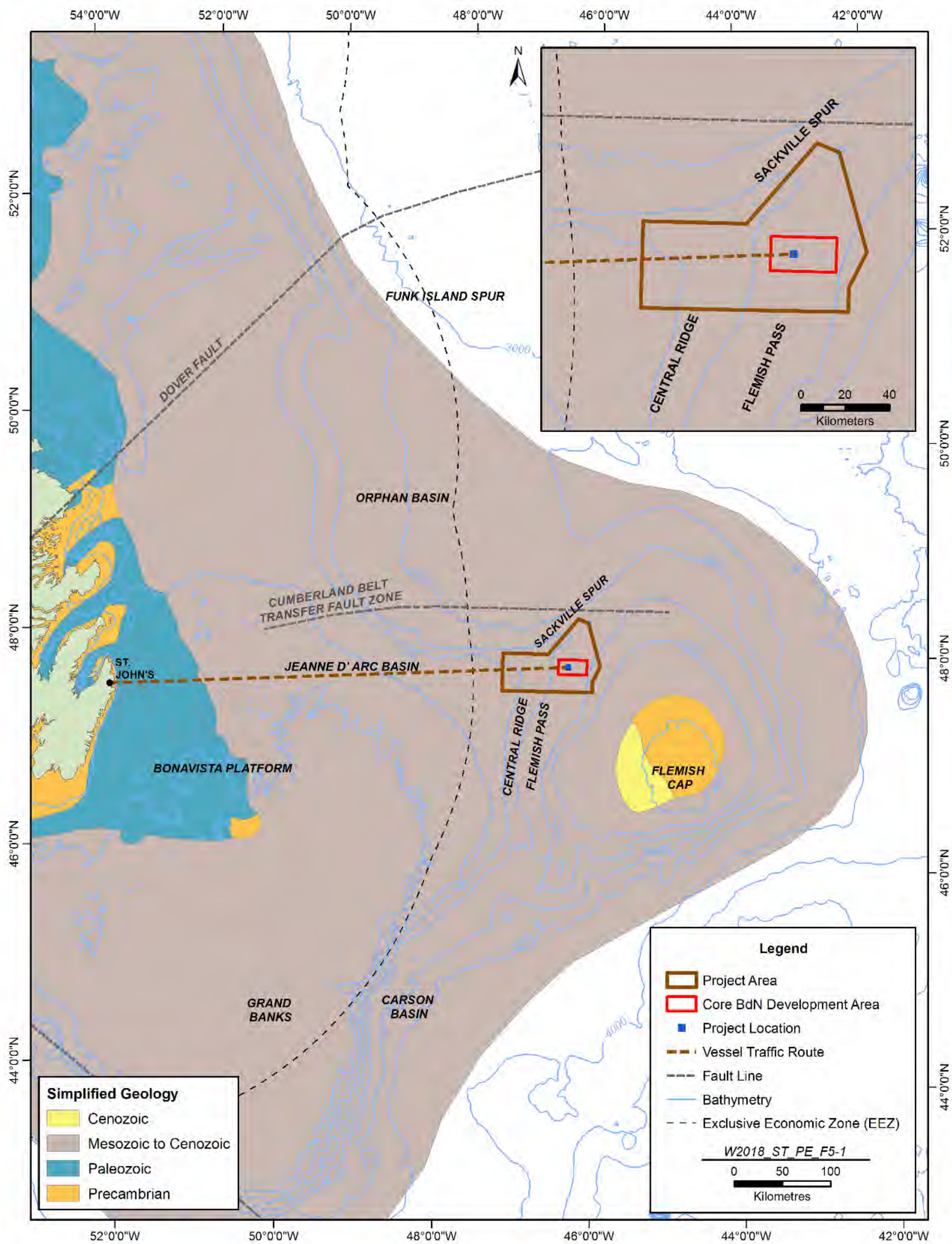
The most direct relevance of this information for the environmental assessment (EA) is in assessing and evaluating the potential “effects of the environment on the Project” (see Chapter 17), including the manner in which physical environmental conditions have and may eventually affect the planning, design and conduct of Project-related components and activities. As such, the primary focus of this chapter is on the Project Area as well as the associated vessel traffic route described in Chapter 2. In some cases, physical environmental conditions and processes may be relevant to the presence, distribution and other components of the biophysical and socioeconomic VCs and potential Project-related environmental changes upon them. These are also described and considered as part of the descriptions of the existing biological and socioeconomic environments (Chapters 6 and 7) as relevant, and in the VC-specific environmental effects assessments (Chapters 8 to 14).

5.1 Geology and Geomorphology

The geology of the eastern Newfoundland and Labrador (NL) offshore area is complex, and the bedrock and surficial characteristics of the region have been shaped by various factors and processes over time.

5.1.1 Bedrock Geology

The Project Area is located on the eastern continental shelf of the offshore region of the NL continental margin and is comprised primarily of Mesozoic to Cenozoic rock overlying pre-rift, Appalachian basement rock of Avalon terrane (Fader et al. 1989, Figure 5-1). The area was formed by a series of three rift episodes associated with the breakup of the supercontinent Pangea and the opening of the North Atlantic Ocean during the Late Triassic to mid-Cretaceous periods. Rifting and seafloor spreading heated the continental crust and lithosphere and then subsided. These rifting events, combined with salt tectonics in the area, created a complex series of Mesozoic rift basins that are generally oriented northeast-southwest and are separated by basement highs along the central to outer shelf. The resulting combination of stratigraphy, structure and timing have been conducive to hydrocarbon generation and entrapment (Bell and Campbell 1990).



Source: Fader et al. (1989); Enachescu and Fagan (2005)

Figure 5-1 Geological Overview (Bedrock)

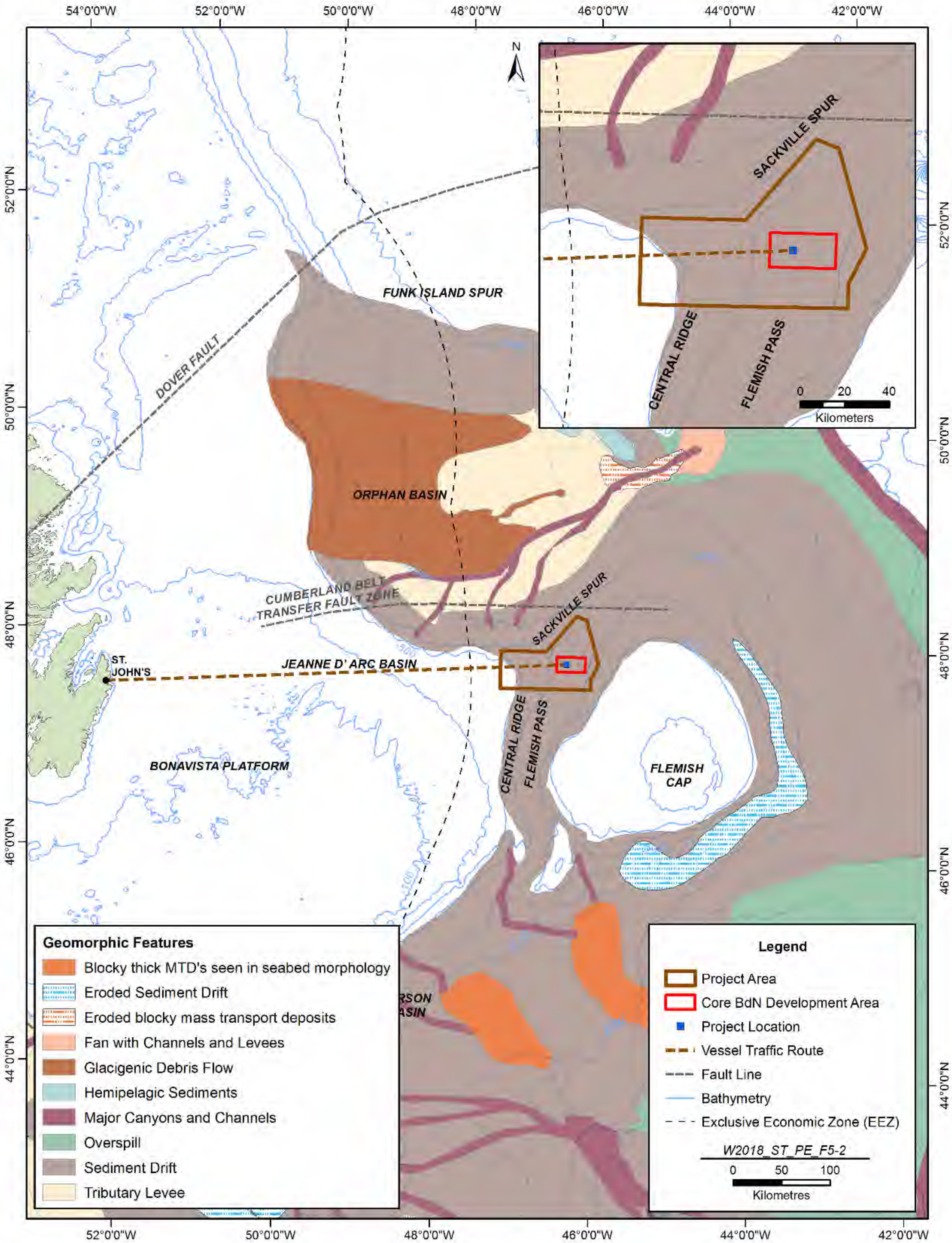
The main sedimentary basin is the Flemish Pass, as shown in Figure 5-1, which is a saddle shaped mid-slope basin covering an area of approximately 30,000 km^2, in which the Project Area is located. The Flemish Pass is bounded to the west by the Grand Banks, to the east by the Flemish Cap, to the north by Sackville Spur, and to the south by Newfoundland Basin. Geophysical evidence suggests that the Flemish Pass forms a terraced continuation of the adjacent, highly stretched and subsided East Orphan Basin, and both basins are interpreted to have had similar geologic histories during the Late Jurassic to Early Cretaceous periods (Lowe et al. 2011). The primary reservoirs are located in the shallow marine and fluvial shale and sandstone deposited during the Late Jurassic and Early Cretaceous periods of the Mesozoic Era. The Late Jurassic Egret member of the Rankin Formation is a world-class source rock that is recognized as the primary source of the oil and gas discovered in the Jeanne d'Arc Basin and has also been proven to be widespread in the Flemish Pass (G and G Exploration Consulting Ltd 2003).

5.1.2 Geomorphology and Surficial Geology

The geomorphology and surficial geology in and around the Project Area are a product of modern oceanographic processes and past glacial activity, a generalized overview of which is provided in Figures 5-2 and 5-3.

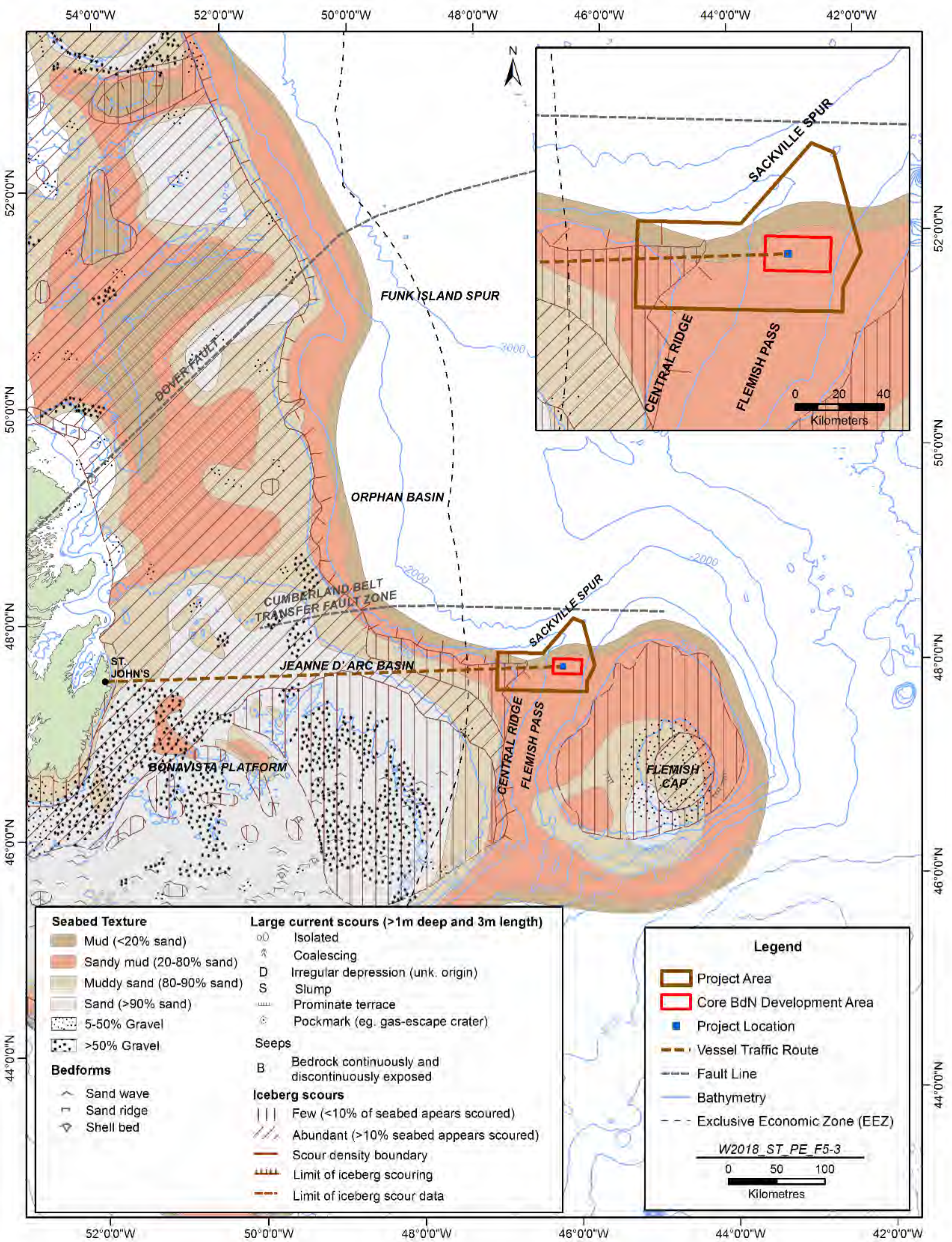
Notable geomorphic features in areas adjacent to the Project Area include the Sackville Spur, the Central Ridge and the Flemish Cap. The Sackville Spur is a prominent contourite drift which formed during the Neogene-Quaternary at the northern end of the Flemish Pass (Marshall et al. 2014) and has been incised by numerous canyons. On the Sackville Spur, eight metres of sandy gravelly mud has been locally observed overlying 4.5 m of grey mud and then a further 12 m of gravelly sandy mud. The Central Ridge is a faulted intrabasinal high separating the Jeanne d'Arc Basin and Flemish Pass (Enachescu 2012). The Flemish Cap is a large isolated continental basement high separated from the Grand Banks by the Flemish Pass and represents the most easterly extension of North American continental crust (King and Fader 1985). It is underlain by Avalon terrane bedrock and consists of a central core of Hadrynian rocks, including granodiorites, granites, dacites, and an onlapping sequence of Mesozoic to Cenozoic aged sediments (King et al. 1986). Locally, it is covered by a veneer of sand up to several metres thick.

Closer to shore, longshore drift processes include transport of pebbles and sand along coastlines. As indicated in Figure 5-3, the seabed near the Avalon Peninsula is generally made of two textures. Immediately nearshore the seabed is muddy sand (80 to 90 percent sand). Slightly farther offshore the seabed is sand (greater than 90 percent sand) with patchy outcrops of greater than 50 percent gravel. Together, these conditions indicate that some erosion and deposition are possible along the shoreline.



Source: Rudolph et al. (2017)

Figure 5-2 Geomorphic Features



Source: Cameron and Best (1985)

Figure 5-3 Seabed Features

Water depths in the Core Bay du Nord (BdN) Development Area range from approximately 1,000 m to 1,200 m, although water depths in the broader Project Area range from approximately 340 m to 1,200 m. Likewise, the surficial geology of the Project Area is highly variable. Generally, in water depths <600 m, such as in the westernmost part of the Project Area, the shallow geology consists of glacial till with a veneer of sand and gravel up to several metres thick. In deeper water, including the slopes of the Flemish Pass, the seabed generally consists of Holocene silty mud. On parts of the floor of the Flemish Pass, winnowed sands are present (Murillo et al. 2016). The coarser-grained sediments are found through the center and western side of the Flemish Pass while the finer-grained sediments are concentrated predominately on the eastern side of the Pass, including the terrace (Marshall et al. 2014); all of these may be encountered in the Project Area. There is also potential in the Project Area for gravel and ice-rafted cobbles and/or boulders on the seafloor and in the shallow subsurface (Fugro 2017). (Weitzman et al. 2014). Overall, seabed texture in the Project Area ranges from a mud to a sandy mud (Cameron and Best 1985).

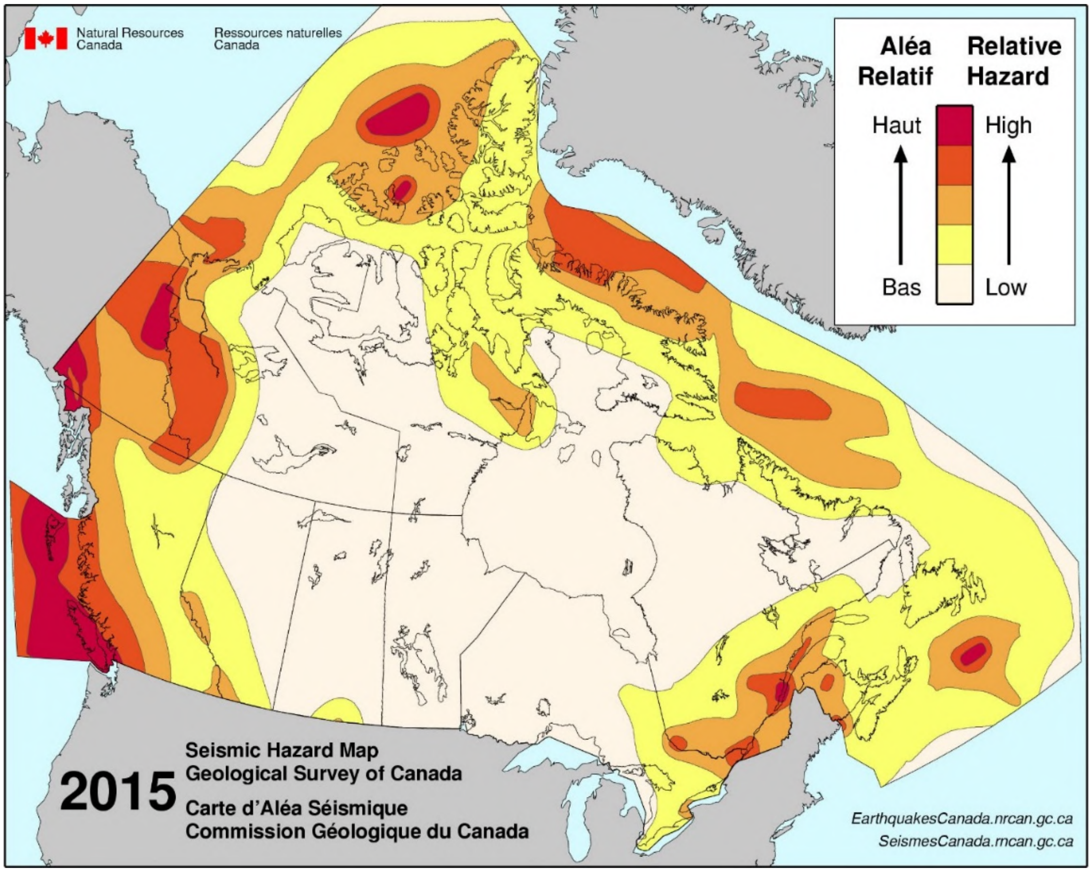
The Project Area is located over the northern portion of the Flemish Pass and the Nose of the Grand Banks. The late Quaternary sedimentary sequence in this part of the Flemish Pass is dominated by turbidite sand and mud derived from the Grand Banks of NL and hemipelagic mud and carbonate-rich sediment transported southward by the Labrador current and deposited as contourites (Rudolph et al. 2017). In the northern Flemish Pass within the Project Area, deposits up to 120 m thick have been recognized and are interpreted as debris-flow deposits that are thought to be derived from sediment failures that have left scarps both on the southeast side of Sackville Spur and on the northwest side of the Flemish Cap. Sediments recovered from this area are generally lean silt to lean clay and are considered to be normally consolidated. The western slopes of the Flemish Pass are comprised mainly of muds with some coarse-grained ice-rafted detritus. Interbedded sandy turbidites are most abundant between 2 and 3.5 metres below seafloor. On the floor of the Flemish Pass, successions of silty muds with ice-rafted detritus, thin sand, and mud turbidites overlie thick bedded sand turbidites. On the eastern slopes of the Flemish Pass, sediment consists primarily of mud with sparse ice-rafted detritus (Piper and Campbell 2005).

5.1.3 Geohazards

Common offshore geohazards include seismicity, slope instability, venting of shallow gas and gas hydrates. The discussion in this section is based on the existing information sources and are necessarily regional in scope. Known features and processes that are specific to parts of the Project Area are highlighted where relevant.

5.1.3.1 Seismicity

Canada's eastern continental margin is tectonically passive, and seismicity is relatively rare throughout much of the region. Natural Resources Canada (NRCan) estimates that approximately 450 earthquakes occur each year in eastern Canada (NRCan 2018a). Seismicity is generally concentrated south of the Grand Banks margin. The most recent edition of the Seismic Hazard Map prepared by NRCan (Figure 5-4), which illustrates the probability of earthquake occurrences across Canada, indicates that the Project Area has been classified as having a relatively low seismic hazard (Figure 5-4).



Source: NRCan (2018c)

Figure 5-4 Seismic Hazard Map

According to the National Earthquake Database (NRCan 2018b), no seismic events have been recorded within the boundaries of the Project Area during the 1985-2018 period (Figure 5-5). The closest event was over 53 km from the edge of the Project Area.

5.1.3.2 Slope Instability

Sediment failure is essentially a consequence of gradient, magnitude of seismic acceleration and sediment strength. Most continental margin sediments, except on slopes of more than a few degrees, are relatively stable and would require seismic accelerations associated with a large earthquake (magnitude of five or greater) to fail (Nadim et al. 2005).

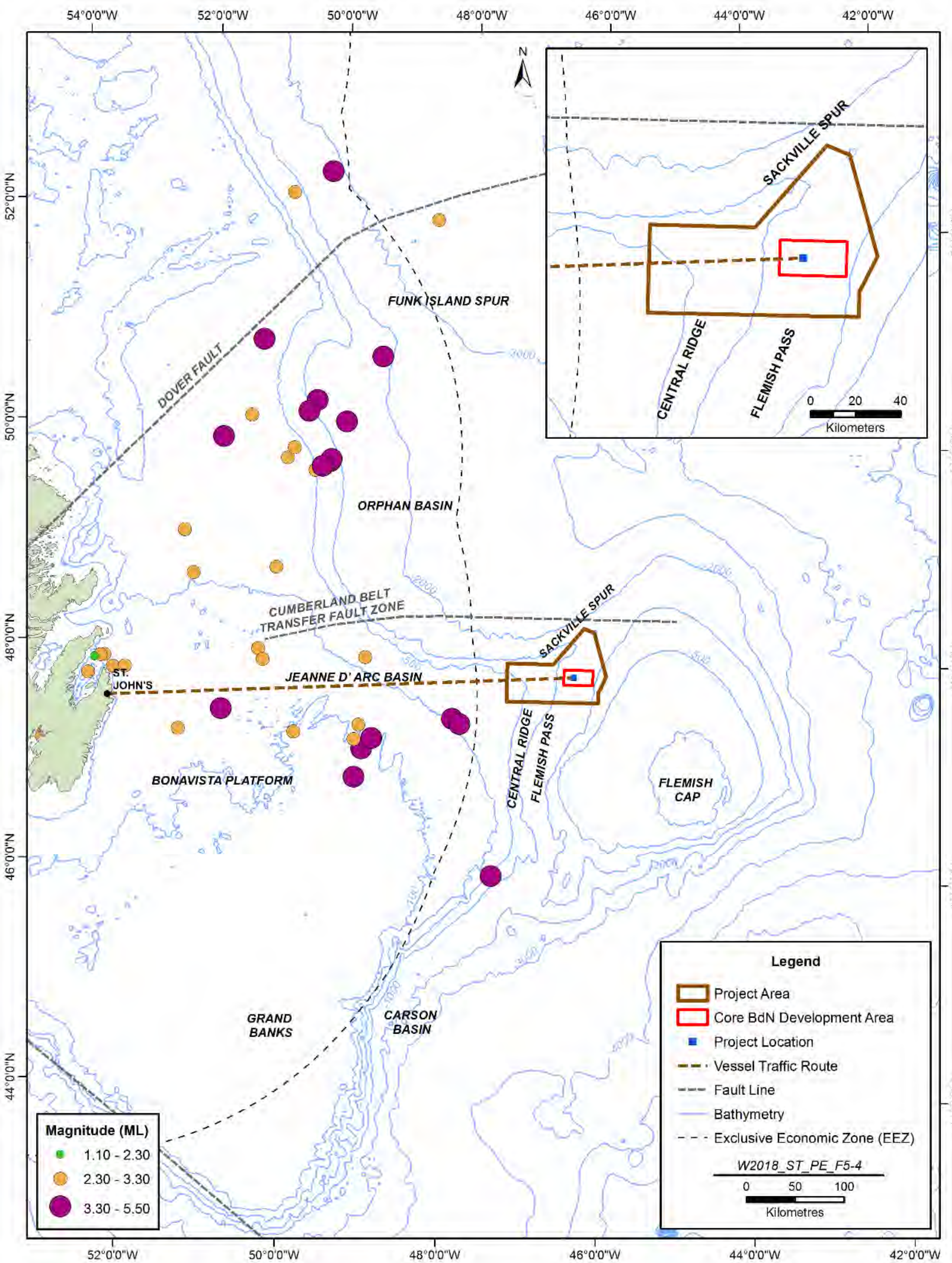


Figure 5-5 Earthquake Epicentres (1985 to 2017) and Seismotechtonic Setting

NRCan analysis indicates that the probability of a large landslide in the area offshore eastern Canada is one approximately every 20,000 years, and a minor one may occur every few thousand years. Most of the large failures on the seabed date back more than 10,000 years during periods of glaciation, when substantial amounts of sediment were deposited directly onto the slope of the continental shelf (NRCan 2010). Synchronous failures in multiple drainage systems suggest that most failures are earthquake triggered, with some seismicity induced by glacio-isostasy (Piper 2005). The mean recurrence interval of earthquakes with magnitudes of seven at any point on the eastern Canadian continental margin is estimated at 30,000 years from seismological models and 40,000 years from the sediment failure record (Piper et al. 2019).

In and near the Project Area, three prominent mass-transport deposit (MTD) complexes dominate the upper portion of the Flemish Pass stratigraphy. The youngest of these three is the Sackville Slide, which ranges in thickness from near-irresolvable at the headscarp pinchouts on both sides of Flemish Pass to a maximum of approximately 150 m beneath the central Flemish Pass (Fugro 2017). The Sackville Slide is believed to have occurred approximately 250,000 to 300,000 years ago and is interpreted as a single event triggered by an earthquake (Fugro 2017). Previous investigations also show a multiple failure complex nearby along a 65 km length of the northeast flank of the Flemish Pass and approximately 20 km downslope with four deep arcuate slide scars found at its centre. Failed sediments have run out as far as 20 km onto the floor of the Flemish Pass, forming mass transport deposits typically 50 m thick (Cameron et al. 2014). These major sediment failures occurred approximately 20,500 and 27,000 years ago, and are believed to have been the result of earthquake triggers (Cameron et al. 2014). Piper and Campbell (2005) presented a brief regional geohazard assessment of the Flemish Pass area, and suggest that most large debris flow deposits in the area are the result of earthquake triggered slumps on both flanks of the Flemish Pass. Geotechnical studies from piston cores show that these failed sediments are silty and have potential for liquefaction during cyclic loading (Piper 2014).

Piper and Campbell (2005) indicate that gas hydrates may also act as a trigger for failure in the Flemish Pass, as observed by a pattern of younger debris-flow deposits in the central region of the area. Bottom water temperature in the Flemish Pass is buffered by the supply of cold Arctic water through the Labrador Current, so that times of gas hydrate melting are likely restricted to periods of falling sea level between interglacial and glacial maximum conditions. Falling sea level results in less hydrostatic pressure in seabed sediments and consequently a melting of gas hydrate.

The risk of natural large slope failure appears low, with a recurrence interval of 100,000 years. It is likely preconditioned by high pore pressure and triggered by earthquakes. Generally, in the Flemish Pass, the steep slopes, abundant shallow gas, and possibly greater seismicity (D. Piper, pers comm) make large landslides somewhat more frequent, with a recurrence interval of 10,000 years. This translates to a 1 in 500 probability of a landslide occurring in a 20-year period (Cameron et al. 2014).

5.1.3.3 Shallow Gas

Evidence for shallow gas is widespread in the Flemish Pass (Cameron et al. 2014). Although no substantial shallow gas incidents have been noted in wells drilled in the Project Area or adjacent to the Project Area, the deep and cold waters of the Flemish Pass are considered to be conducive to hydrate formation (Fugro 2017). Shallow gas can lead to excess pore pressure in permeable strata such as silts and can be a preconditioning factor for submarine landsliding.

5.1.3.4 Gas Hydrates

Failures may be triggered by high pore pressures, which may be induced by seismic accelerations or by melting of gas hydrates as a result of reduction in pressure due to falling sea level or increase in temperature due to warming of bottom waters. Bottom water temperature in the Flemish Pass is buffered by the supply of cold Arctic water through the Labrador Current, so that times of gas hydrate melting are likely restricted to periods of falling sea level between interglacial and glacial maximum conditions (Piper and Campbell 2005).

According to Fugro (2017), shallow sediments within the Project Area are generally interpreted to be primarily fine-grained and likely lack sufficient porosity for the development of massive hydrate zones. If gas hydrates are present, they are likely localized and disseminated within the fine-grained sediment in the form of small crystals, small to large nodules, lenses and partings, or thin veins. No direct hydrate encounters or issues related to hydrates have been recorded in wells or cores in the region covered by the Project Area (Fugro 2017).

5.1.3.5 Faulting

Faults may allow migration of basinal fluids upwards, leading to excess pore pressure. Leakage of basinal fluids may precondition the seabed to be more likely to fail in earthquake-triggered landslides. Faulting can also lead to problems during drilling such as loss of circulation.

5.1.3.6 Tsunamis

Tsunami hazard along the Atlantic coast of Canada, including the Project Area, is relatively low. The only historical submarine landslide-triggered tsunami documented on the east coast of North America was the November 1929 event that resulted in 28 deaths in Newfoundland (Leonard et al. 2012, NRCan 2019). The epicentre of the quake occurred in the Laurentian Fan, approximately 250 km south of Newfoundland (Piper et al 1985). For the Project Areathere are no active plate boundaries nearby to generate tsunamis by displacement of the seafloor, but submarine landslides triggered by earthquakes can produce a tsunami. The earthquake (M=7.2) that triggered the 1929 submarine landslide was estimated to have a return period between a few hundred and one thousand years (Clague et al. 2003). However, it is acknowledged that not all earthquakes of this size will trigger a landslide that results in a tsunami (Leonard et al. 2010).

In a preliminary tsunami hazard assessment of the Canadian coastline, Leonard et al. (2012) use a tsunami runup threshold of 1.5 m for potentially damaging coastal waves and a tsunami runup threshold of 3.0 m for substantial damage potential. Their assessment of the outer Atlantic coastline indicates an expected recurrence of runup exceeding 1.5 m approximately every 300 to 1,700 years. For larger runup (greater than or equal to 3.0 m), the estimated recurrence interval is approximately 600 to 4,000 years.

Leonard et al. (2012) assume that a mean local runup greater than or equal to 1.5 m could result from failures with an along-slope extent of 50 km or more, and a mean local runup greater than or equal to 3.0 m may be produced from failures of 70 km or more in length. In the Flemish Pass the expected recurrence interval of landslides with an extent of 50 km or more is approximately 21,000 years.

5.2 Bathymetry

The bathymetry of the Project Area and surrounding regions is generally well known (Figure 5-6).

The Project Area is located over the nose of the Grand Banks to the west, Sackville Spur to the north and Flemish Pass to the east with water depths over this region ranging from approximately 300 m to 1,200 m.

The Grand Banks is a region with average depths of approximately 75 m and extends to approximately 350 km east of St. John's to the 200 m depth contour, and then a further 50 km east to the 1,000 m depth contour. The Sackville Spur extends the nose of the Grand Banks at depths of up to 1,000 m to the northeast. To the east of the Grand Banks lies the Flemish Pass, with depths of almost 1,300 m. On the eastern side of the Flemish Pass, water depths rise again to the Flemish Cap, a large bathymetric feature of approximately 50,000 km^2 with depths rising back up to approximately 130 m. The Flemish Pass extends to the northeast, remaining at depths of approximately 1,000 to 1,100 m, and separates the Orphan Basin to the northwest and the Flemish Cap to the east. The Project Area primarily includes the northern part of the Flemish Pass, and portions of the slope regions of the Grand Bank and Flemish Cap (Figure 5-6). Depths within the Project Area range from approximately 340 m to 1,200 m. The Core BdN Development Area has water depths ranging from 1,000 m in the east to approximately 1,200 m in west.

The vessel traffic route to the Project Area crosses the Grand Banks, a region with average depths of approximately 75 m, and extends to approximately 350 km east of St. John's to the 200 m depth contour and then a further 50 km east to the 1,000 m depth contour.

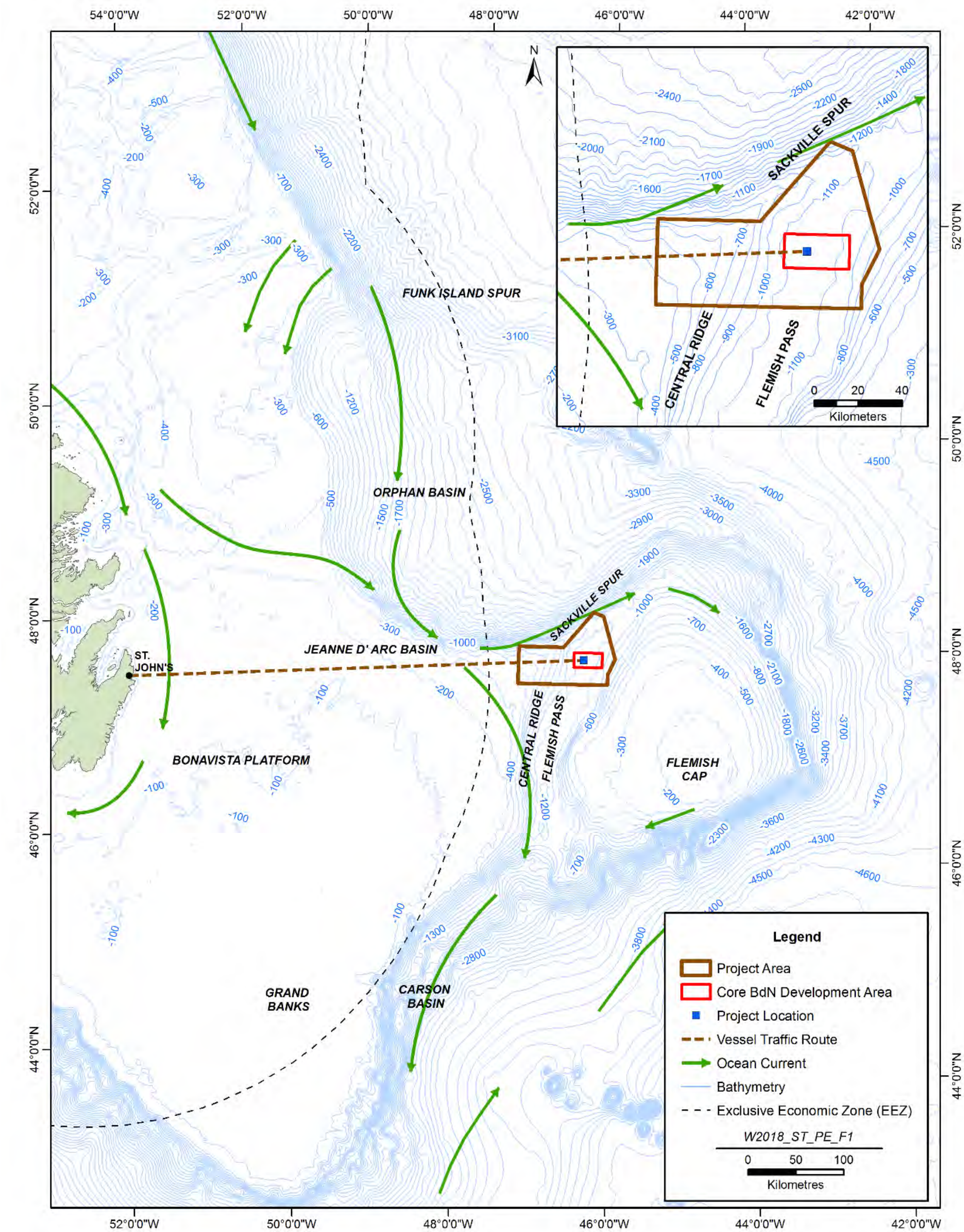


Figure 5-6 General Bathymetry and Ocean Current Circulation

5.3 Climatology

This section provides an overview of key climatological conditions including wind speed and direction, air temperature, precipitation and lightning, fog and visibility. Descriptions for each are presented for the Core BdN Development Area, Project Area, including the vessel traffic route.

Three additional resources provide further detail on these environmental characteristics, including:

- The Bay du Nord Field Metocean Design Basis (Statoil 2017a) presents wind, wave, current, temperature and salinity normal and extreme statistics for design activities; given the inherent conservative nature in these statistics, some of the physical environment values presented in this Chapter will be lower than those of the metocean design basis
- Chapter 5 of the Drilling EIS (Statoil 2017b) provides physical environment descriptions for regions near the Project Area and along the vessel traffic route
- Additional details for the vessel traffic route and the larger eastern NL Offshore Area are provided in the Eastern Newfoundland SEA, Section 4.1 (Amec 2014)

5.3.1 Wind Speed and Direction

A primary characterization of the wind climatology of the Project Area is provided with statistics derived from the most recent release of the MSC50 wind and wave hindcast. Additional information is presented from historical drilling campaigns in the area and the weather observations prepared, recorded, and distributed in the Manual of Marine Observations (MANMAR) format by offshore-based observers as a requirement of the Offshore Physical Environmental Guidelines (NEB et al. 2008). The reports are typically sent to shore-based forecasters every three hours on a 24/7 basis. The basis for marine weather observing in Canada is the MANMAR (ECCC 2017a).

The MSC50 dataset includes hourly wind and wave parameters of the North Atlantic Ocean (Swail et al. 2006, DFO 2018a). The hindcast data were produced through the kinematic reanalysis of substantial tropical and extra-tropical storms in the north Atlantic. The dataset covers hourly wind and wave parameters, from 1954 to 2015, for the North Atlantic Ocean and includes consideration of periods with sea ice coverage. Ice concentration data that were considered are mean monthly values through 1961 inclusive and then Canadian Ice Service (CIS) mean weekly ice concentrations for 1962 onwards. Given the poorer resolution of ice information from 1954-1961, this period of the MSC50 dataset was excluded from the present analysis. The 1962-2015 periods are considered for waves and, for consistency, winds.

The overall resolution of MSC50 hindcast data grid points (nodes) is quite high, with one point every 0.1° latitude by 0.1° longitude (approximately 7.4 km east-west and 11.2 km north-south near 47°N). To provide a characterization over the Project Area, two locations, one in the south and one in the north, near the previously-drilled exploration wells on SDL 1055 and SDL 1048, were selected. The nodes are shown in Figure 5-7 and described in Table 5.1.

Table 5.1 Location of the MSC50 Nodes Selected to Describe Wind and Wave Conditions

MSC50 Node	Latitude (°N)	Longitude (°W)	Water Depth (m)
M6013260 (Core BdN Development Area)	47.9	46.4	1,171
M6013912 (Project Area, North)	48.3	46.3	1,038
M6013252 (Project Area, West)	47.9	47.2	433
M6013072 (vessel traffic route, East)	47.8	49.1	183
M6012896 (vessel traffic route, West)	47.7	50.9	124

The MSC50 wind speeds are 1-hour average wind speeds for a height of 10 m above sea level. Wind speed measurements are frequently averaged over shorter durations (e.g., 10 minutes for marine reports and two minutes for aviation, and a one minute average is used for the categorization of tropical cyclones). Wind gusts are typically for one, two or five second durations. Several formulas (e.g., ISO 2005), can be used to scale winds to averaging times <1 hour and for different reference elevations (e.g., between 10 m and drilling installation anemometer height or vice versa), and are frequently applied in design criteria studies applying measured and hindcast data sets. Wind conditions are summarized with monthly and annual statistics presented in Table 5.2.

Mean hourly wind speeds for the Project Area range from approximately 6 m/s in July to 12 m/s in January, while the strongest winds of 35.3 m/s occur in January. The maximum wind speeds indicate that gale force winds, in the range from 17.5 to 24.2 m/s, occur in June and July, while storm force winds, in the range from 24.7 to 32.4 m/s, can occur during the rest of the year.

Inspection of both wind and wave statistics (discussed in Sections 5.3.1 and 5.4.1) and directional roses for the two MSC50 nodes considered for the Project Area indicates that there is little variation in wind and wave conditions between the two locations. Given conditions are comparable, one grid point node M6013260 (closest to Bay du Nord) is selected to illustrate regional conditions over the Project Area. Monthly and annual directional wind distributions are shown in Figures 5-8 and 5-9, respectively. The wind roses for the other four node locations are similar.

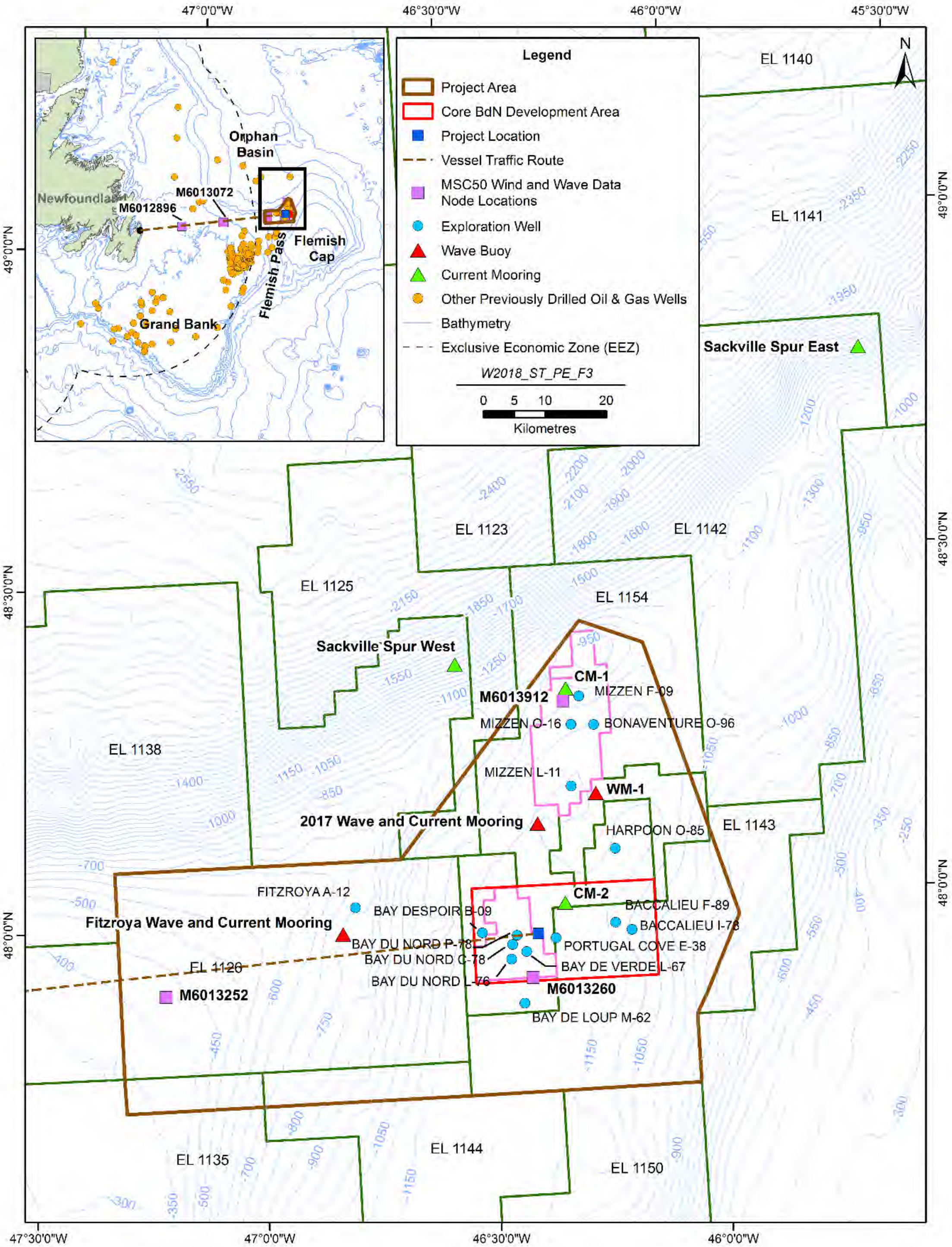


Figure 5-7 Equinor Canada Exploration Wells, 2013-2017, Met-Ocean Data Sources

Table 5.2 Monthly and Annual Wind Statistics

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Wind Speed (m/s)													
M6013260	11.9	11.6	10.4	8.6	7.4	6.8	6.3	6.7	7.9	9.4	10.1	11.2	9.0
M6013912	12.0	11.7	10.5	8.7	7.6	7.0	6.4	6.8	8.1	9.6	10.3	11.4	9.2
M6013252	11.7	11.4	10.2	8.5	7.3	6.7	6.3	6.6	7.8	9.2	10.0	11.1	8.9
M6013072	11.4	11.1	10.0	8.5	7.2	6.7	6.3	6.6	7.8	9.0	9.9	10.9	8.8
M6012896	11.1	10.7	9.7	8.3	6.9	6.3	6.0	6.5	7.6	8.9	9.7	10.7	8.5
Most Frequent Direction (from)													
M6013260	W	W	W	W	SW	SW	SW	SW	SW	W	W	W	W
M6013912	W	W	W	W	SW	SW	SW	SW	SW	W	W	W	W
M6013252	W	W	W	SW	SW	SW	SW	SW	SW	W	W	W	SW
M6013072	W	W	W	SW	SW	SW	SW	SW	SW	W	W	W	SW
M6012896	W	W	W	SW	SW	SW	SW	SW	SW	W	W	W	SW
Maximum Speed (m/s)													
M6013260	35.3	31.5	30.1	27.3	25.4	23.3	19.8	26.9	28.3	27.6	26.9	30.4	35.3
M6013912	29.6	31.1	30.7	25.7	25.4	23.1	19.9	28.4	28.7	27.8	27.0	31.0	31.1
M6013252	34.0	31.4	29.0	27.3	25.0	23.5	18.2	29.1	28.6	28.8	26.5	29.7	34.0
M6013072	30.0	30.5	29.0	24.8	23.6	23.8	20.0	22.2	29.7	31.3	27.3	28.5	31.3
M6012896	28.0	29.7	25.1	24.3	21.6	23.2	18.0	26.5	26.6	25.7	26.8	26.3	29.7
Direction of Maximum Wind Speed (from)													
M6013260	W	SW	W	N	NW	W	S	S	SE	NW	W	NW	W
M6013912	W	S	W	S	NW	NW	S	S	SE	NW	W	NW	S
M6013252	W	SW	W	N	NW	NW	S	S	SW	SW	NW	NW	W
M6013072	W	NW	NW	N	NW	NW	SW	SE	S	SW	W	NW	SW
M6012896	NW	NW	SW	W	S	NW	NW	S	SW	NW	W	W	NW

MSC50 data for the period 1962-2015.
Locations are noted as follows (see Figure 5-7):
M6013260 - Core BdN Development Area
M6013912 - Project Area (North)
M6013252 - Project Area (West)
M6013072-Vessel traffic route (East)
M6012896-Vessel traffic route (West)

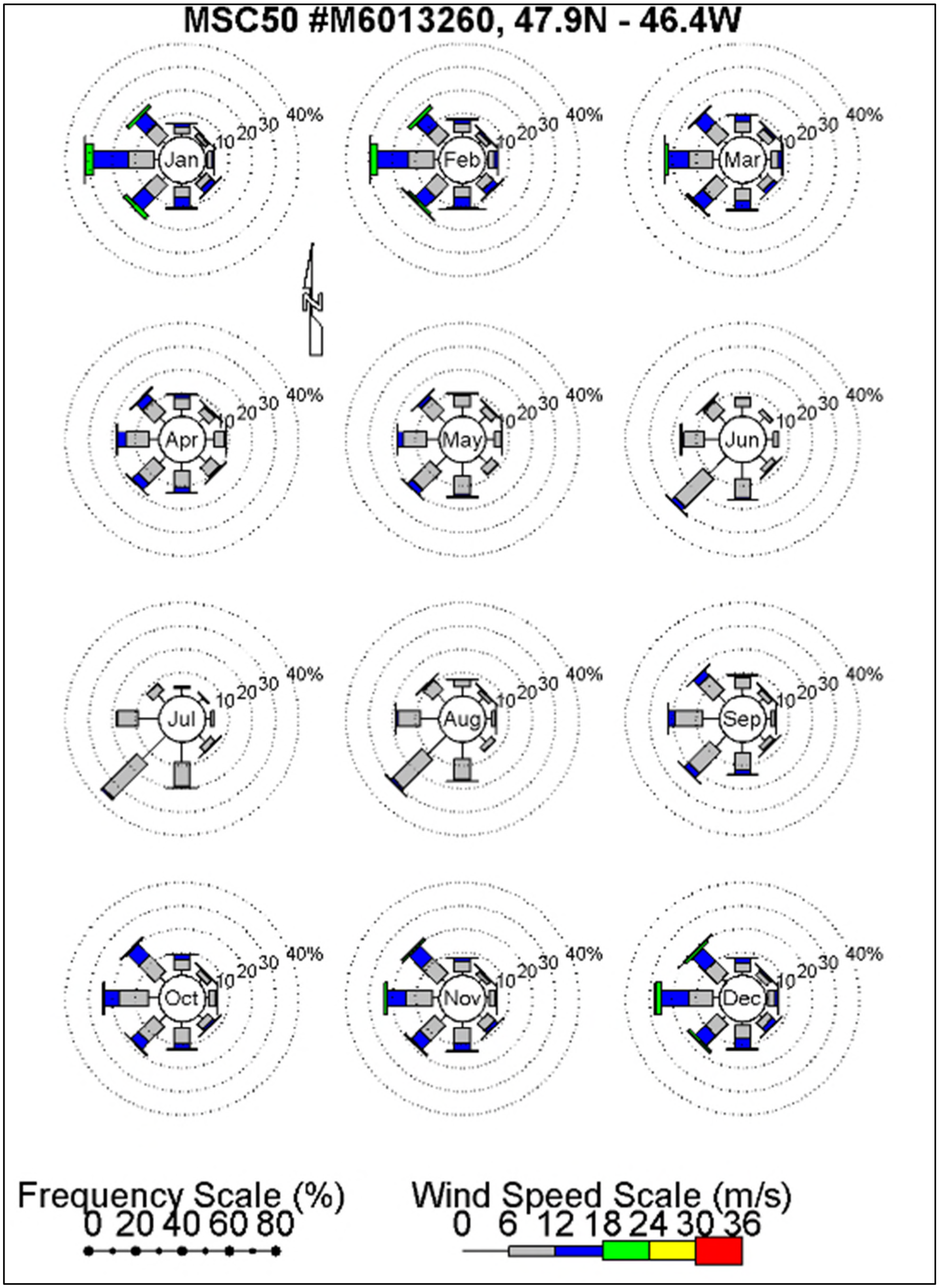


Figure 5-8 Monthly Wind Roses, MSC50 Node M6013260 - Core BdN Development Area (1962–2015)

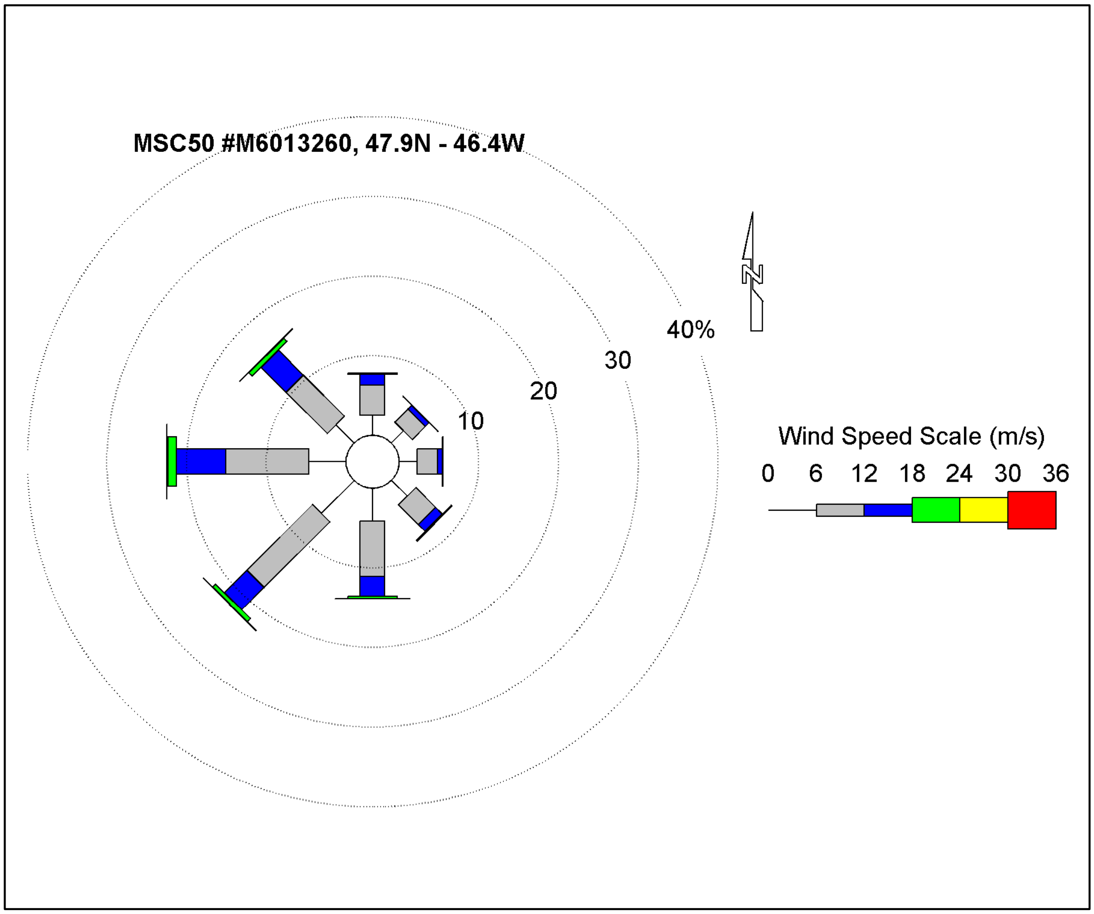


Figure 5-9 Annual Wind Rose, MSC50 Node M6013260 - Core BdN Development Area (1962–2015)

Environmental monitoring data collected as part of previous Equinor Canada exploration drilling campaigns in the Project Area, include data from nine wells drilled between from 2013 to 2017. These well locations are illustrated in Figure 5-7 and the associated timeline history is presented in Figure 5-10. It is noted that approximately 80 percent of these MANMAR observations were made during a portion of the day (i.e., at the synoptic hours of 0900, 1200, 1500, and 1800).

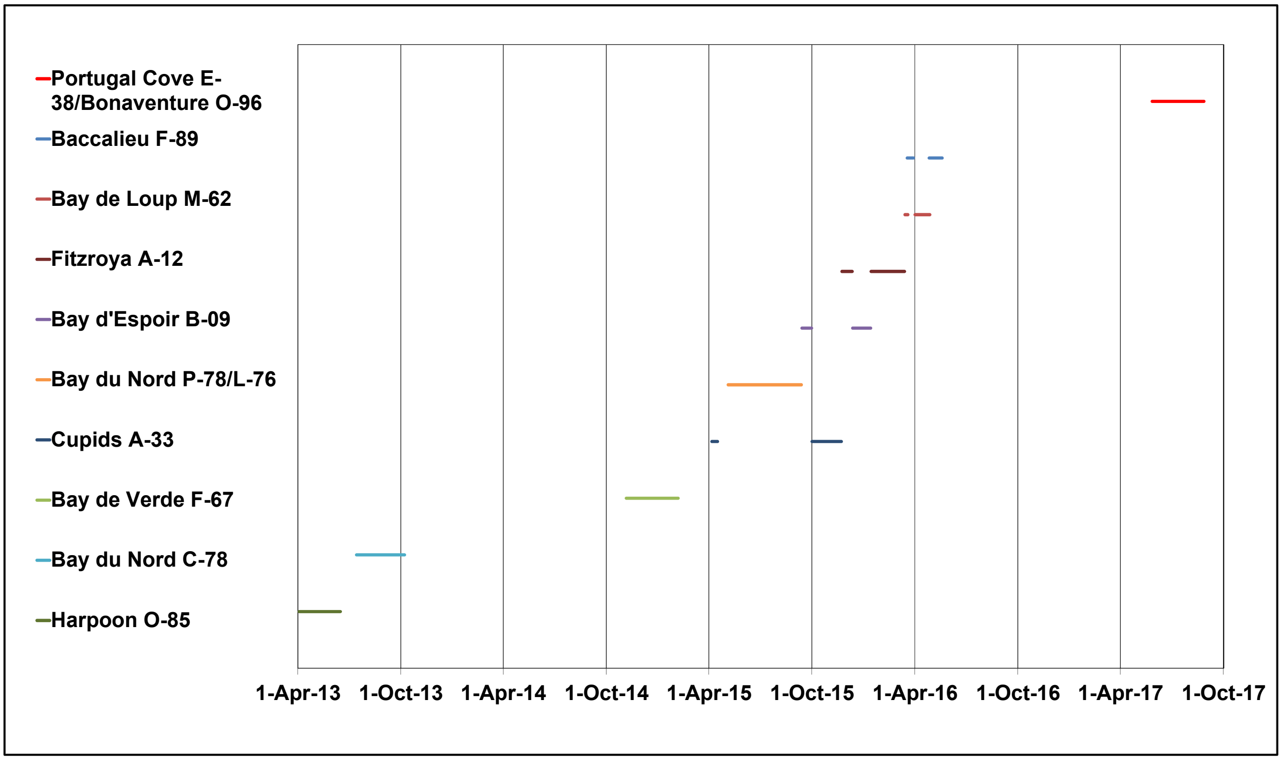


Figure 5-10 Equinor Canada Exploration Wells, Project Area, 2013-2017, Drilling Installation History

Wind statistics from the previously drilled exploration wells in the Project are presented in Table 5.3. Whereas the winds for MSC50 are representative of a 10 m elevation, these drilling installation winds are from an elevation of 107 m. Mean hourly wind speeds from these exploration drilling programs range from 9 to 10 m/s in the summer to 14 or 15 m/s in November, January, and February. Winds are most frequent from the west or southwest in all months. Maximum wind speeds range from 20.1 m/s in August to 31.4 m/s in January through March with the largest wind speed of 38.6 m/s measured on 17 April 2015 at Bay du Nord L-76.

Table 5.3 Monthly and Annual Wind Statistics, Equinor Canada Exploration Wells, 2013-2016

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Wind Speed (m/s)												
15.0	13.8	13.4	13.3	10.6	9.6	9.4	9.9	10.1	12.7	13.9	12.2	12.2
Most Frequent Direction (from)												
W	SW	W	W	SW	W	SW	SW	W	W	W	W	SW
Maximum Speed (m/s)												
31.4	31.4	31.4	38.6	30.3	26.2	22.6	20.1	23.7	26.7	34.5	25.7	38.6
Direction of Maximum Wind Speed (from)												
SW	S	SW	NW	NW	SW	SW	S	W	W	S	W	NW

The range of wind conditions experienced along the vessel traffic route to the Project Area are generally comparable to those experienced farther offshore as shown in Table 5.3 where two MSC50 nodes M13072 and M12896 along the route are included.

5.3.2 Air Temperature

Atmospheric properties over the ocean surface, including air temperature, precipitation and visibility have been characterized using the International Comprehensive Ocean-Atmosphere Data Set (ICOADS). ICOADS represents the most extensive available database of observations of atmospheric and sea conditions. The dataset consists of global marine observations recorded from 1662 to the present, compiled by the United States National Centre for Atmospheric Research (Freeman et al. 2017).

Air temperature conditions have been characterized by selecting all ICOADS observations for the period January 1980 to December 2017, inclusive (Research Data Archive et al. 2018) for the following areas of interest:

- Core BdN Development Area: 47-49° N, 45-48° W,
- Project Area: 47-49° N, 45-48° W, subset to exact Project Area coordinates
- Vessel traffic route – West: 47.44 - 47.98° N, 50.02 - 52.72° W
- Vessel traffic route – East: 47.65 - 48.08° N, 47.29 - 50.03° W

A secondary data source includes weather observations from historical drilling campaigns as described above for winds. These are presented for recent Equinor Canada drilling programs for the Project Area.

Monthly air temperature statistics for the Core BdN Development Area are presented in Table 5.4.and Figure 5-11 Air temperature exhibits strong seasonal variations, with mean temperatures ranging from 0.7°C in January to 13.4°C in August. The coldest observed air temperature on record (-11°C) was in February, while during the summer months the coldest observed temperatures range from 2.2°C in June to 7.5°C in August. The highest observed temperatures during winter months are approximately 10.5°C, while in summer the values reach as high as 18.5°C. Throughout the year the mean daily minimum and maximum temperatures generally stay within approximately 3°C of the mean temperature (Figure 5-11).

Table 5.4 Monthly Air Temperature (°C) Statistics (ICOADS) – Core BdN Development Area

Month	Mean	Max	Min	SD
Jan	0.7	9.0	-6.7	3.4
Feb	0.5	7.6	-11.0	3.8
Mar	0.7	4.8	-7.4	2.9
Apr	4.2	10.0	-0.4	2.3
May	4.9	11.0	-0.2	2.3
Jun	6.8	13.0	2.2	2.8
Jul	11.2	18.0	5.7	2.0

Table 5.4 Monthly Air Temperature (°C) Statistics (ICOADS) – Core BdN Development Area

Month	Mean	Max	Min	SD
Aug	13.4	18.5	7.5	1.9
Sep	12.5	20.4	8.0	2.7
Oct	9.2	14.0	1.1	2.1
Nov	5.7	12.7	-0.5	3.1
Dec	3.4	10.5	-2.0	3.2
Source: Based on Research Data Archive et al. (2018)				

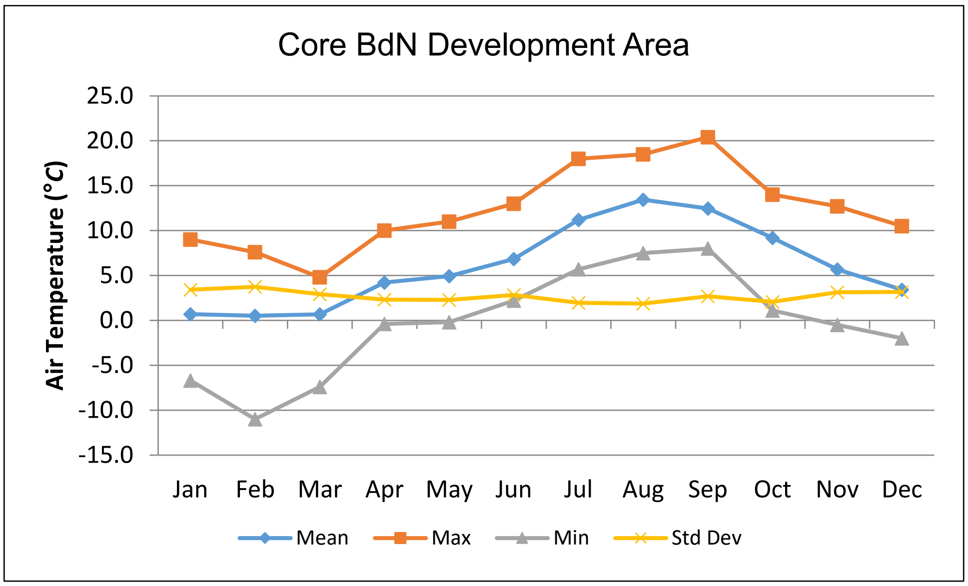


Figure 5-11 Monthly Air Temperature Statistics (ICOADS) – Core BdN Development Area

Monthly air temperature statistics for the Project Area differ from the Core BdN Development Area and are generally more extreme (colder minimums and hotter maximums) and are presented in Table 5.5 and Figure 5-12 Air temperature exhibits strong seasonal variations, with mean temperatures ranging from 0.2°C in January to 12.2°C in August. The coldest observed air temperature on record (-12°C) was in February, while during the summer months the coldest observed temperatures range from -0.1°C in June to 6.6°C in August. The highest observed temperatures during winter months are approximately 11°C, while in summer the values reach as high as 23.3°C.

Table 5.5 Monthly Air Temperature (°C) Statistics (ICOADS) – Project Area

Month	Mean	Max	Min	SD
Jan	0.2	9.0	-10.4	3.6
Feb	-0.2	11.0	-12.0	3.5
Mar	0.8	11.0	-8.5	3.1
Apr	2.3	13.6	-6.0	2.8
May	4.0	13.2	-3.0	2.3
Jun	6.1	16.6	-0.1	2.4
Jul	10.1	23.3	2.3	2.3
Aug	12.2	20.0	6.6	2.1
Sep	11.6	20.4	6.1	2.2
Oct	8.4	20.0	1.0	2.7
Nov	5.5	18.0	-3.2	2.9
Dec	2.8	11.0	-5.0	3.0
Source: Based on Research Data Archive et al. (2018)				

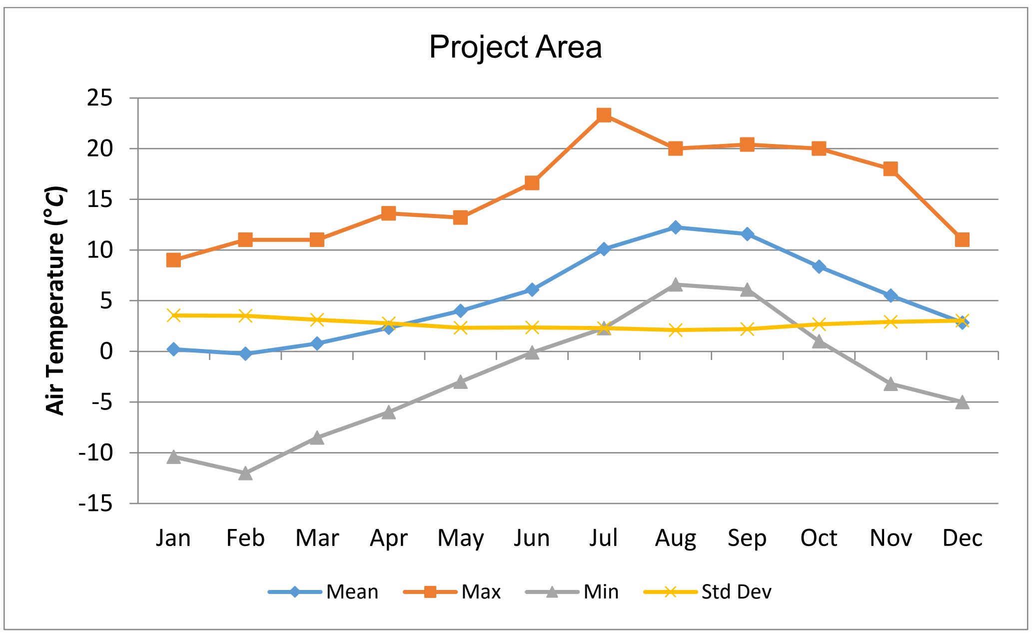


Figure 5-12 Monthly Air Temperature Statistics (ICOADS) – Project Area

Air temperature statistics from the Equinor Canada exploration drilling programs carried out in the Project Area are presented in Table 5.6. Mean air temperatures range from -1.0°C in March to 12.4°C in August. The coldest temperature reported is -9.5°C from 13 March 2015 at Bay du Nord P-78 (air temperatures on that date were in the range of -9.5°C to -8.4°C); the warmest temperature reported is 16.4°C from 2 September 2015 at Bay du Nord L-76.

Table 5.6 Monthly Air Temperature (°C) Statistics, Equinor Canada Exploration Wells, 2013-2016

Month	Mean	Max	Min	SD
Jan	0.6	8.4	-5.6	2.8
Feb	0.5	7.7	-6.2	2.9
Mar	-1.0	7.4	-9.5	3.4
Apr	2.0	9.0	-4.9	2.7
May	3.4	10.4	-1.3	2.4
Jun	5.5	10.9	0.7	2.0
Jul	8.9	14.2	5.7	2.0
Aug	12.4	15.7	8.9	1.3
Sep	11.2	16.4	5.4	2.1
Oct	8.6	13.6	0.9	2.5
Nov	5.0	12.4	-2.2	2.5
Dec	2.7	10.9	-5.7	3.5
Annual	3.9	16.4	-9.5	4.8

Air temperatures at sea will be strongly influenced by moderating effects of sea temperature, with daily and seasonal variations much smaller than on land. Once offshore, over the vessel traffic route temperatures range from a minimum of -15.0°C in February to a maximum of 24.3°C in July (Tables 5.7 and 5.8, and Figures 5-13 and 5-14). Over the eastern vessel traffic route, temperatures range from -13.5°C to a maximum of 21.0°C.

Table 5.7 Air Temperature Statistics (ICOADS) – Vessel Traffic Route - West

Month	Mean	Max	Min	SD
Jan	-1.5	13.4	-14.0	4.1
Feb	-2.8	8.7	-15.0	3.9
Mar	-1.6	11.1	-12.0	3.7
Apr	1.0	11.7	-8.0	2.7
May	3.3	15.0	-4.5	2.6
Jun	6.4	19.6	0.1	3.7
Jul	13.3	24.3	1.3	3.9
Aug	14.3	23.5	6.7	2.9
Sep	12.8	22.6	2.5	2.8
Oct	7.8	20.2	-2.0	3.9
Nov	3.9	16.3	-5.0	3.4
Dec	0.6	12.0	-10.5	3.7
Source: Based on Research Data Archive et al. (2018)				

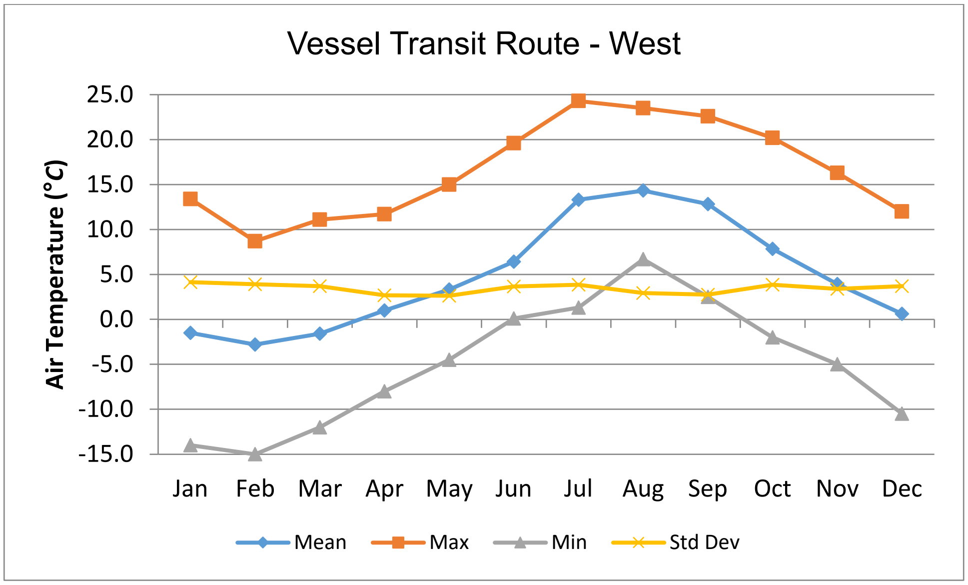


Figure 5-13 Air Temperature Statistics (ICOADS) – Vessel Traffic Route - West

Table 5.8 Air Temperature Statistics (ICOADS) – Vessel Traffic Route – East

Month	Mean	Max	Min	SD
Jan	-1.9	17.2	-12.0	4.0
Feb	-0.7	10.0	-13.5	3.7
Mar	0.1	12.0	-9.6	2.9
Apr	1.3	10.0	-6.0	2.3
May	3.3	14.0	-5.0	2.3
Jun	6.0	17.5	0.1	2.6
Jul	10.7	19.0	3.0	2.7
Aug	13.2	21.0	5.5	2.4
Sep	11.7	20.0	1.2	2.5
Oct	7.3	18.4	-1.0	2.7
Nov	3.3	16.0	-4.0	2.6
Dec	1.7	16.0	-8.8	3.1
Source: Based on Research Data Archive et al. (2018)				

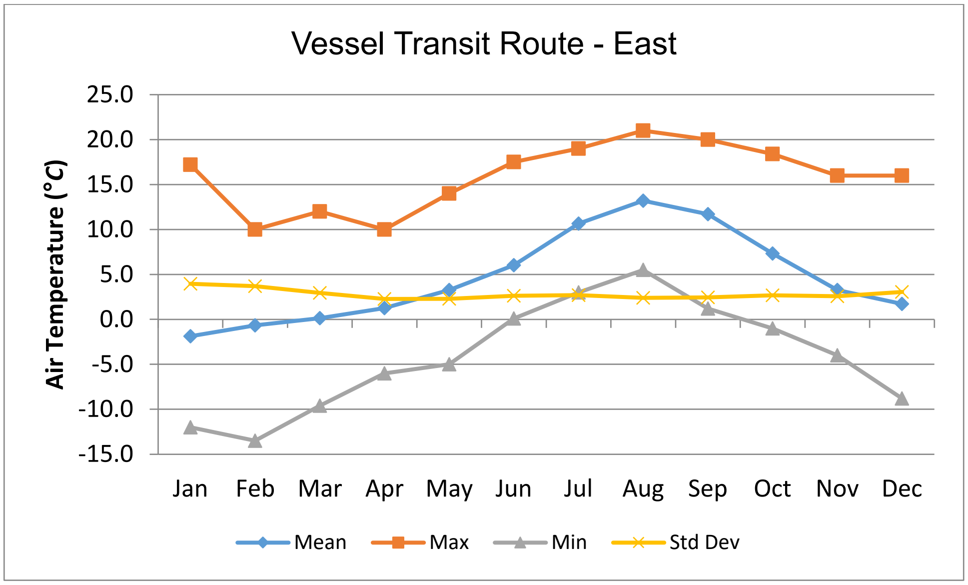


Figure 5-14 Air Temperature Statistics (ICOADS) – Vessel Traffic Route – East

5.3.3 Precipitation and Lightning

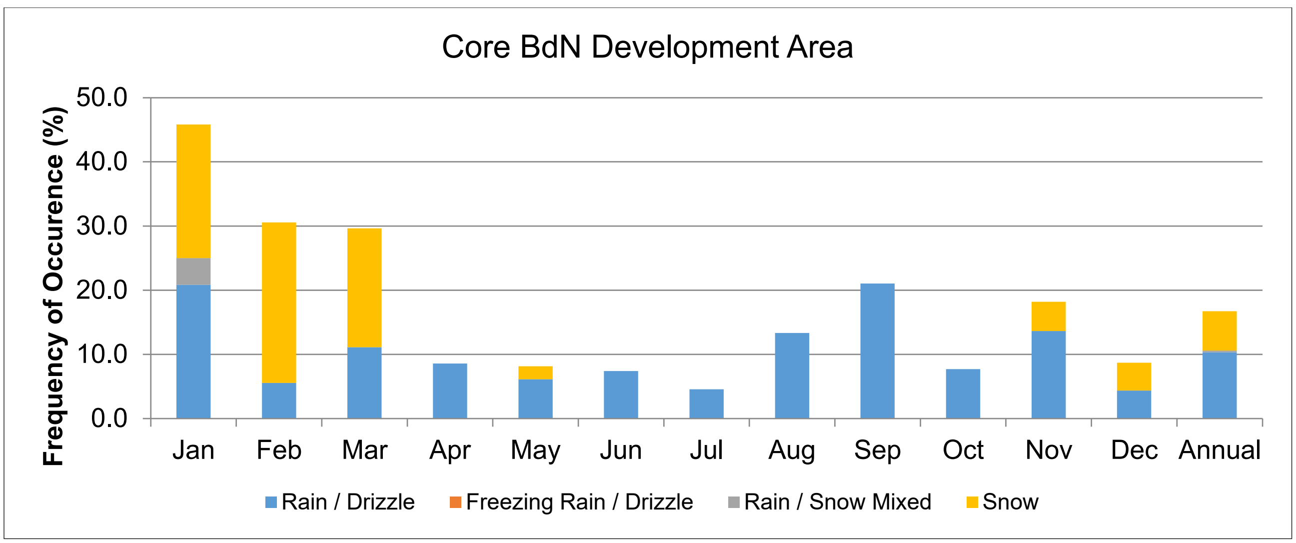
The ICOADS database contains observations of several precipitation types and thunderstorm occurrence. The weather state is recorded and categorized as an event based on the type (but not the amount) of precipitation during that event. The frequency of occurrence of the different precipitation types and thunderstorms have been calculated as a percentage of the total monthly and annual weather observations for the same data set described in Section 5.3.2 for air temperature, with observations spanning 1988 to December 2017.

A degree of variability of precipitation patterns within localized regions of the overall Project Area is expected. The statistics shown below in Table 5.9 are the percentage of a certain distinct weather states (e.g., rain, thunderstorms, hail) for weather reports available on record for that month. The weather states have been consolidated from 50 different ICOADS classifications, separating (without overlap) rain from freezing rain and snow (although some overlap may exist between these states and mixed rain/snow, hail, and thunderstorm, which represent a small percentage of the data). The frequency of occurrence – or, the percent of time the given condition(s) occurs in a given month (or annually) - can most closely be characterized as representing unspecified periods of time, for a percentage of all days.

For the Core BdN Development Area, the ICOADS data indicate that most of the observed precipitation events are in the form of rain, snow, and drizzle, while other precipitation types, such as mixed rain, freezing rain, and hail, occur far less frequently. Rain occurs approximately 4 to 21 percent of the time for all months of the year, while snow is most likely to occur in November through March (Table 5.9, Figure 5-15). Freezing rain is relatively infrequent in this area. Similarly, no thunderstorm observations are in the data set for the Core BdN Development Area searched (Figure 5-16), though they are still possible, and have been observed for the Project Area as reported below.

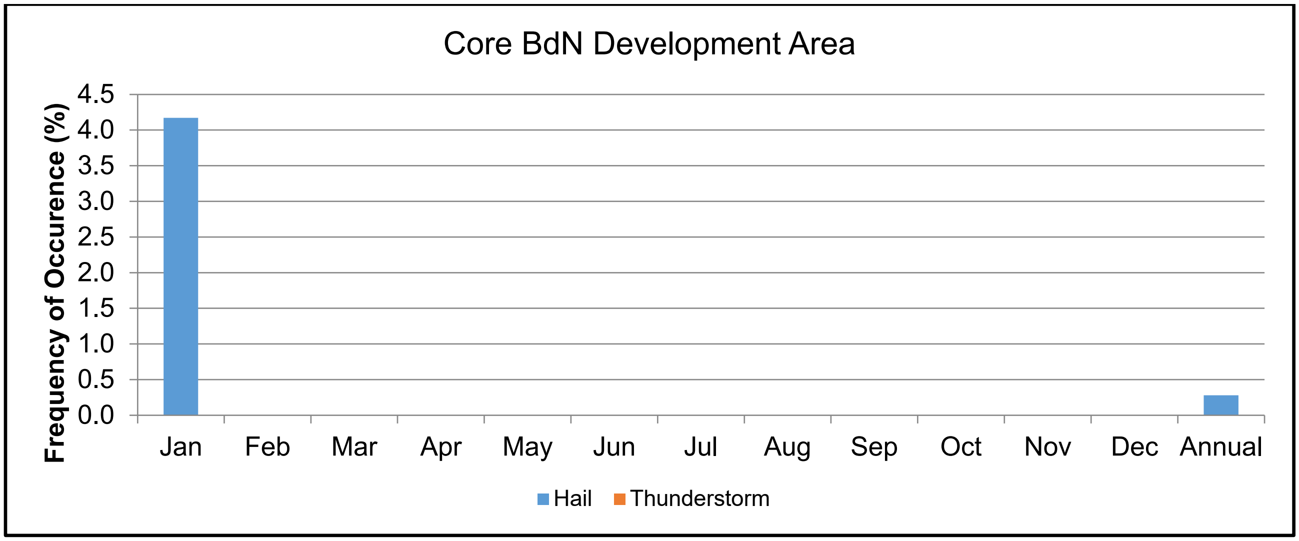
Table 5.9 Frequency of Occurrence (Percent) of Precipitation and Thunderstorms (ICOADS) – Core BdN Development Area

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Jan	20.8	0.0	4.2	20.8	4.2	0.0
Feb	5.6	0.0	0.0	25.0	0.0	0.0
Mar	11.1	0.0	0.0	18.5	0.0	0.0
Apr	8.6	0.0	0.0	0.0	0.0	0.0
May	6.1	0.0	0.0	2.0	0.0	0.0
Jun	7.4	0.0	0.0	0.0	0.0	0.0
Jul	4.6	0.0	0.0	0.0	0.0	0.0
Aug	13.3	0.0	0.0	0.0	0.0	0.0
Sep	21.1	0.0	0.0	0.0	0.0	0.0
Oct	7.7	0.0	0.0	0.0	0.0	0.0
Nov	13.6	0.0	0.0	4.6	0.0	0.0
Dec	4.4	0.0	0.0	4.4	0.0	0.0
Annual	10.3	0.0	0.3	6.1	0.3	0.0
Source: Based on Research Data Archive et al (2018)						



Source: Based on Research Data Archive et al. (2018)

Figure 5-15 Frequency of Occurrence (Percent) of Precipitation by Type (ICOADS) – Core BdN Development Area



Source: Based on Research Data Archive et al. (2018)

Figure 5-16 Frequency of Occurrence (Percent) of Thunderstorm and Hail (ICOADS) – Core BdN Development Area

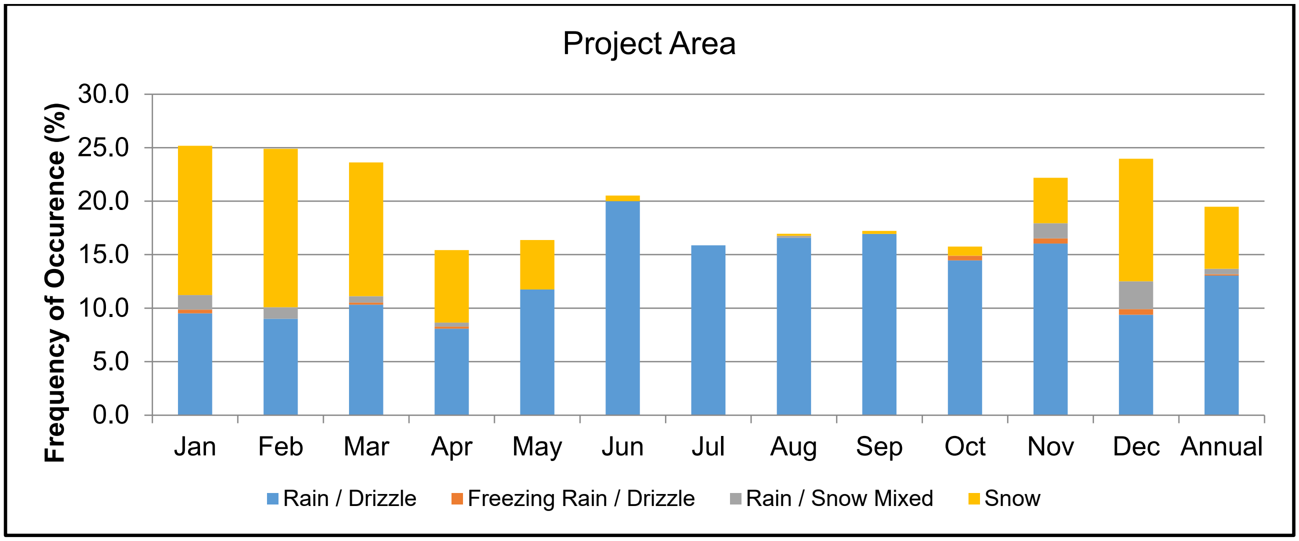
For the Project Area, the data indicate that most of the observed precipitation events are in the form of rain, snow, and drizzle, while other precipitation types, such as mixed rain, freezing rain, and hail, occur far less frequently. Rain occurs approximately 8 to 20 percent of the time for all months of the year, while snow is most likely to occur in December through March (Table 5.10, Figure 5-17). Freezing rain is relatively infrequent in this area, generally occurring one half of a percent (or less) of the time during a given month and does not occur between May and September. Thunderstorms are the main generating mechanism of hail, and therefore the observation of hail is expected during thunderstorms. Figure 5-18 illustrates that hail and thunderstorms occur with similarly low frequencies (less than one percent).

Table 5.10 Frequency of Occurrence (Percent) of Precipitation and Thunderstorms (ICOADS) – Project Area

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Jan	9.5	0.3	1.4	14.0	0.7	0.0
Feb	9.0	0.0	1.1	14.8	0.0	0.0
Mar	10.3	0.2	0.6	12.5	0.6	0.0
Apr	8.1	0.2	0.4	6.8	0.0	0.0
May	11.8	0.0	0.0	4.6	0.0	0.0
Jun	20.0	0.0	0.0	0.5	0.0	0.0
Jul	15.9	0.0	0.0	0.0	0.0	0.0
Aug	16.6	0.0	0.2	0.2	0.0	0.2
Sep	16.9	0.0	0.0	0.3	0.0	0.0

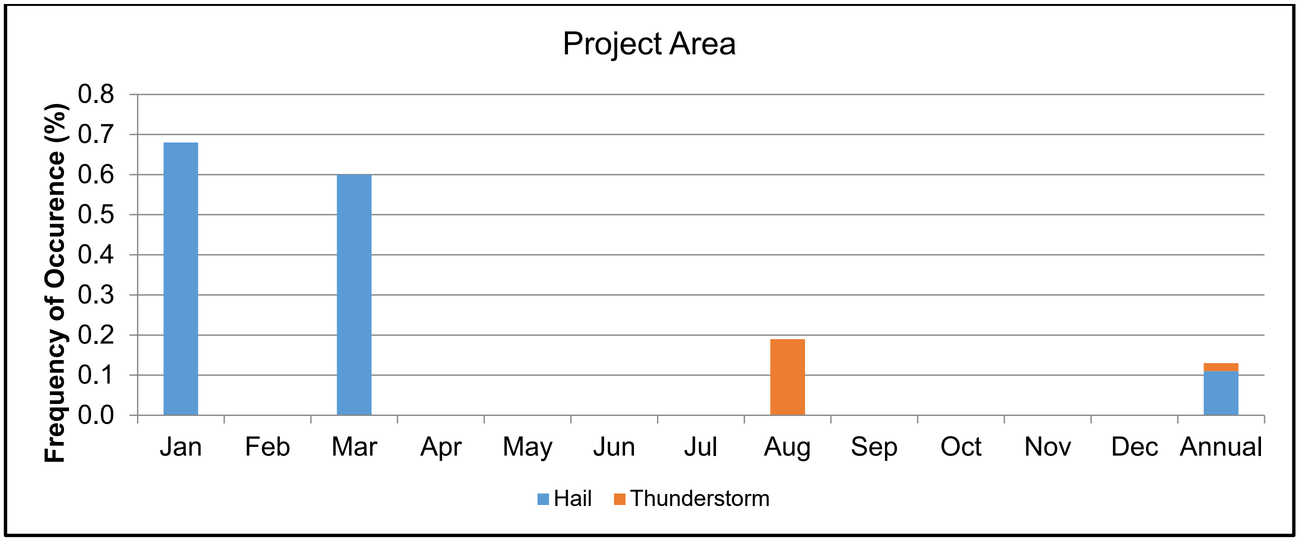
Table 5.10 Frequency of Occurrence (Percent) of Precipitation and Thunderstorms (ICOADS) – Project Area

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Oct	14.5	0.4	0.0	0.9	0.0	0.0
Nov	16.0	0.5	1.4	4.3	0.0	0.0
Dec	9.4	0.5	2.6	11.5	0.0	0.0
Annual	13.0	0.1	0.5	5.8	0.1	0.0
Source: Based on Research Data Archive et al. (2018)						



Source: Based on Research Data Archive et al. (2018)

Figure 5-17 Frequency of Occurrence (Percent) of Precipitation by Type (ICOADS) – Project Area



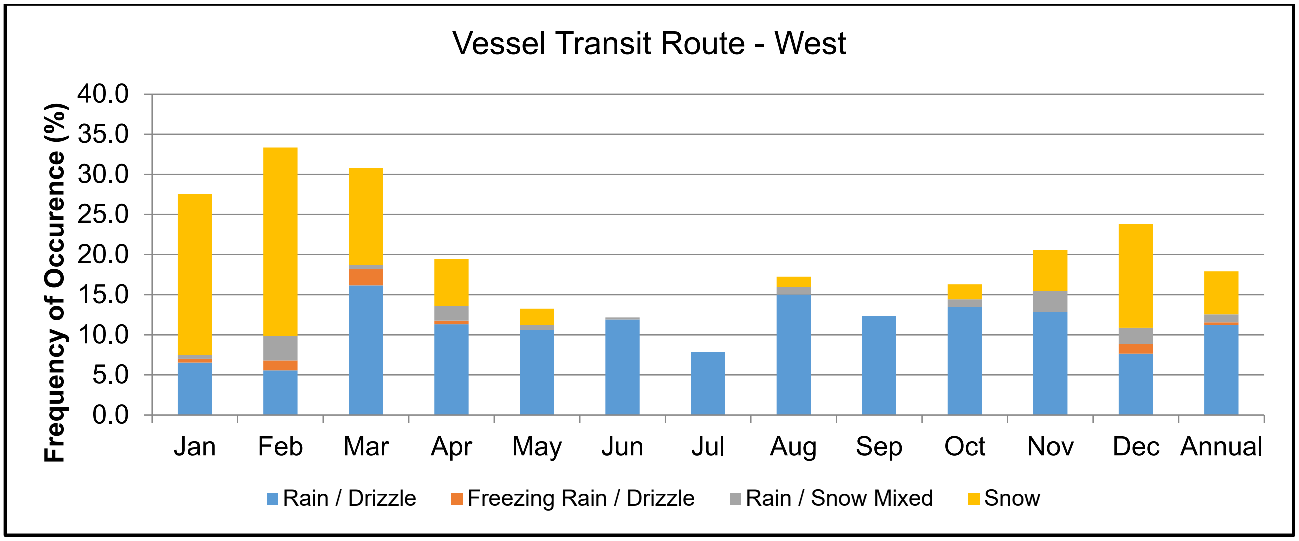
Source: Based on Research Data Archive et al. (2018)

Figure 5-18 Frequency of Occurrence (Percent) of Thunderstorm and Hail (ICOADS) – Project Area

Over the western portion of the vessel traffic route (Table 5.11 and Figures 5-19 and 5-20), precipitation are similar to the Project Area, with monthly frequencies of rainfall ranging from 5 to 16 percent of the time. Snow may potentially occur from October to May and little hail and thunderstorms, though they may occur in a given month. Likewise, the eastern vessel traffic route (Table 5.12 and Figures 5-21 and 5-22) has rain occurring from 6 to 14 percent of a given month, and snow possible between the months of October and June. Hail and thunderstorms are unlikely (less than one percent).

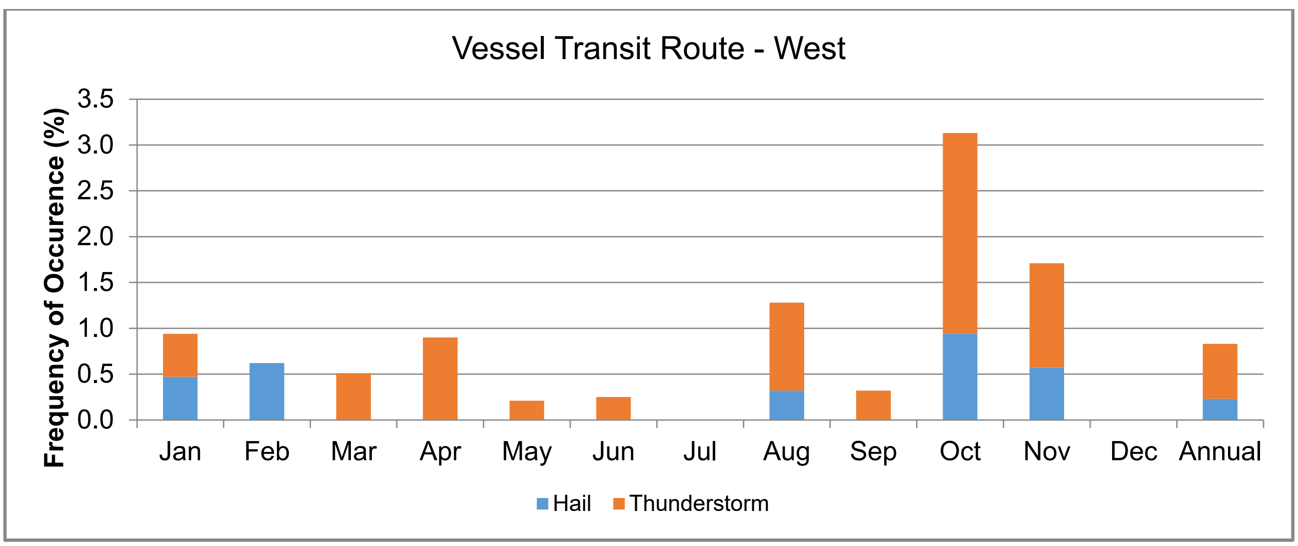
Table 5.11 Frequency of Occurrence (Percent) of Precipitation and Thunderstorms (ICOADS) – Vessel Traffic Route – West

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Jan	6.5	0.5	0.5	20.1	0.5	0.5
Feb	5.6	1.2	3.1	23.5	0.6	0.0
Mar	16.2	2.0	0.5	12.1	0.0	0.5
Apr	11.3	0.5	1.8	5.9	0.0	0.9
May	10.6	0.0	0.6	2.1	0.0	0.2
Jun	11.9	0.0	0.3	0.0	0.0	0.3
Jul	7.8	0.0	0.0	0.0	0.0	0.0
Aug	15.0	0.0	1.0	1.3	0.3	1.0
Sep	12.3	0.0	0.0	0.0	0.0	0.3
Oct	13.5	0.0	0.9	1.9	0.9	2.2
Nov	12.9	0.0	2.6	5.1	0.6	1.1
Dec	7.7	1.2	2.0	12.9	0.0	0.0
Annual	11.2	0.3	1.0	5.4	0.2	0.6
Source: Based on Research Data Archive et al. (2018)						



Source: Based on Research Data Archive et al. (2018)

Figure 5-19 Frequency of Occurrence (Percent) of Precipitation by Type (ICOADS) – Vessel Traffic Route –West

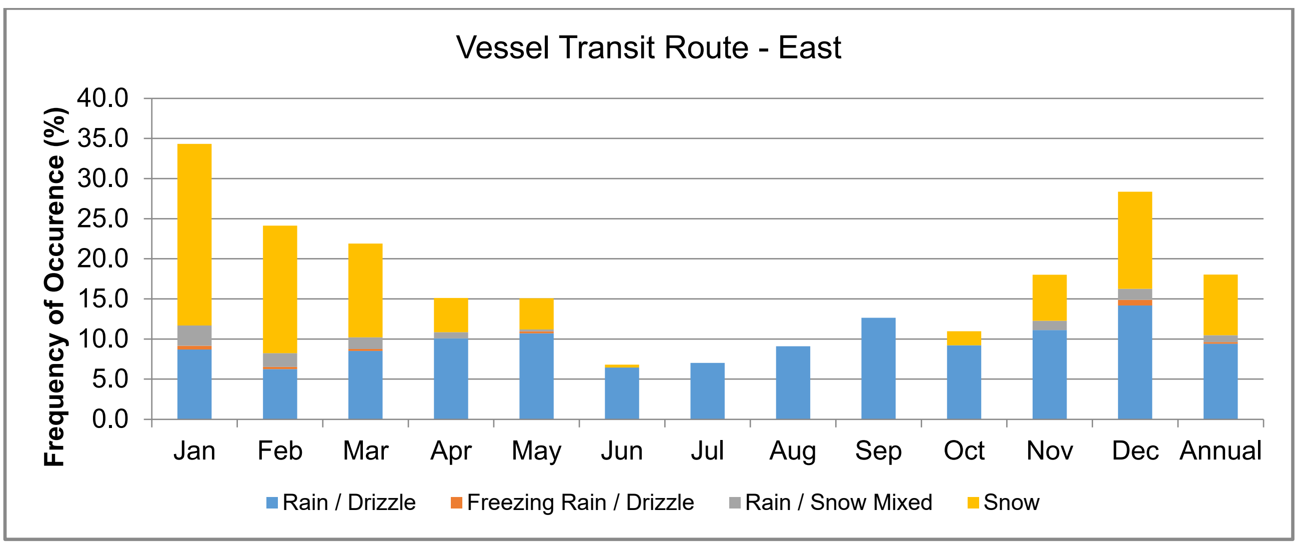


Source: Based on Research Data Archive et al. (2018)

Figure 5-20 Frequency of Occurrence (Percent) of Thunderstorm and Hail (ICOADS) – Vessel Traffic Route – West

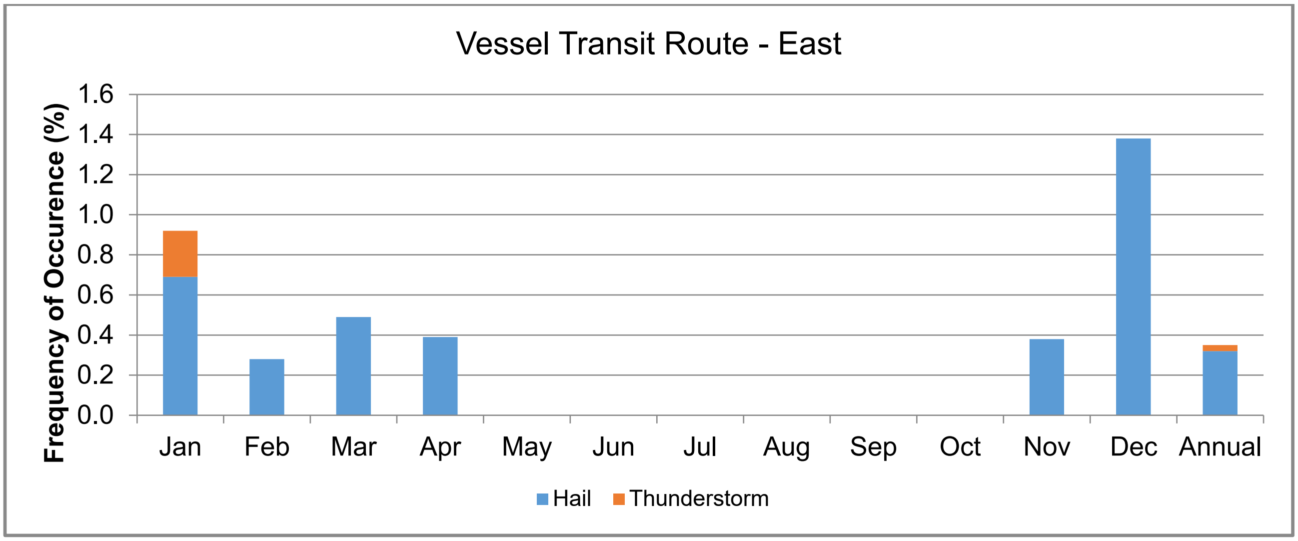
Table 5.12 Frequency of Occurrence (Percent) of Precipitation and Thunderstorms (ICOADS) – Vessel Traffic Route – East

Month	Rain / Drizzle	Freezing Rain / Drizzle	Rain / Snow Mixed	Snow	Hail	Thunderstorm
Jan	8.7	0.5	2.5	22.7	0.7	0.2
Feb	6.3	0.3	1.7	15.9	0.3	0.0
Mar	8.5	0.2	1.5	11.7	0.5	0.0
Apr	10.1	0.0	0.8	4.3	0.4	0.0
May	10.7	0.2	0.2	3.9	0.0	0.0
Jun	6.5	0.0	0.0	0.4	0.0	0.0
Jul	7.0	0.0	0.0	0.0	0.0	0.0
Aug	9.1	0.0	0.0	0.0	0.0	0.0
Sep	12.6	0.0	0.0	0.0	0.0	0.0
Oct	9.2	0.0	0.0	1.8	0.0	0.0
Nov	11.1	0.0	1.2	5.8	0.4	0.0
Dec	14.2	0.7	1.4	12.1	1.4	0.0
Annual	9.4	0.2	0.9	7.5	0.3	0.0
Source: Based on Research Data Archive et al. (2018)						



Source: Based on Research Data Archive et al. (2018)

Figure 5-21 Frequency of Occurrence (Percent) of Precipitation by Type (ICOADS) – Vessel Traffic Route – East

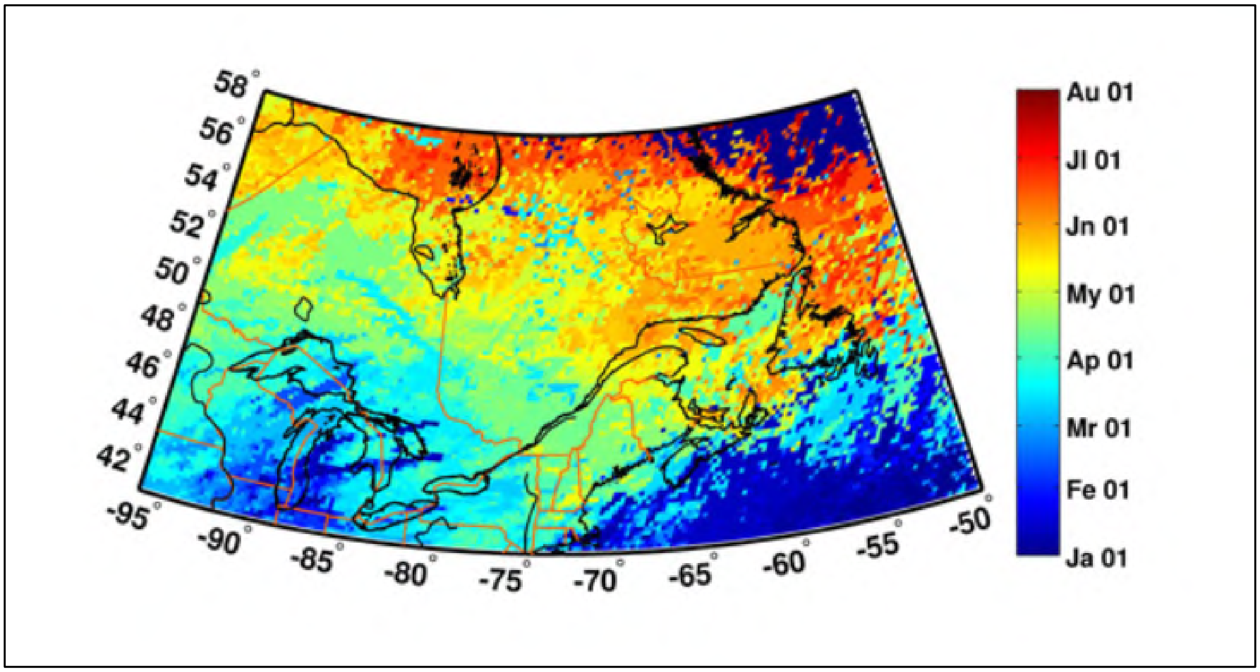


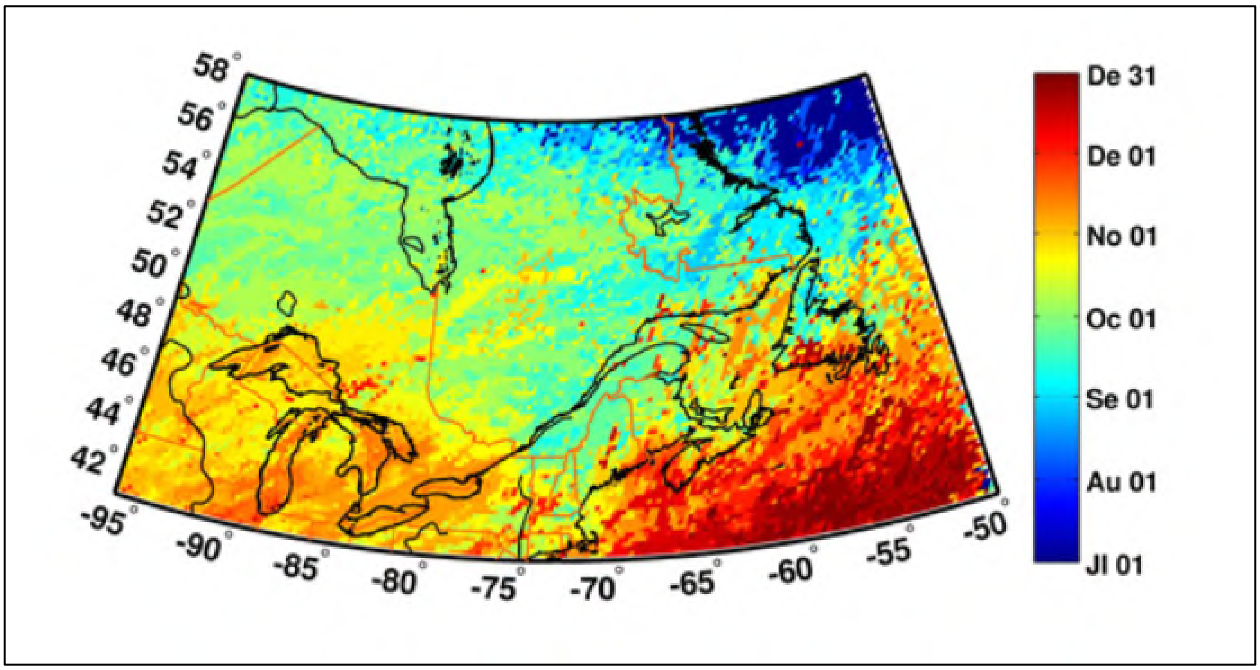
Source: Based on Research Data Archive et al. (2018)

Figure 5-22 Frequency of Occurrence (Percent) of Thunderstorm and Hail (ICOADS) – Vessel Traffic Route – East

Lightning is an electrical discharge most commonly produced in thunderstorms, usually accompanied by thunder. It occurs in clouds with vigorous convection where enough electrical charge is separated through the movement of cloud droplets and precipitation particles. By its nature, lightning is a localized phenomenon and, as a result, it is one which is difficult to accurately represent in numerical models. Measurements are available from the Canadian Lightning Detection Network; however, this is a land-based network, with coverage just to eastern NL (i.e., the Grand Banks are on the far eastern edge of the network).

Nevertheless, the available lightning statistics from Environment and Climate Change Canada (ECCC) for eastern Canada do provide some indication of conditions over the western portion of the vessel traffic route. This includes average dates for the beginning and ending of lightning season for eastern Canada as shown in Figure 5-23. Lightning occurs virtually year-round offshore NL. During winter, stronger strikes are possible.





Source: ECCC (2016)

Figure 5-23 Average Start (top) and End (bottom) Dates of the Lightning Season for Eastern Canada (1999-2013)

5.3.4 Fog and Visibility

The Project Area and surrounding areas have some of the highest occurrence rates of marine fog in North America, which in these regions is commonly of the advection type. Advection fog is formed when warm moist air flows over a cold surface, such as the cold northwest Atlantic Ocean, and persists for days or weeks. This type of fog is most prevalent in spring and summer. Visibility is affected by the presence of fog, the number of daylight hours, as well as frequency and type of precipitation.

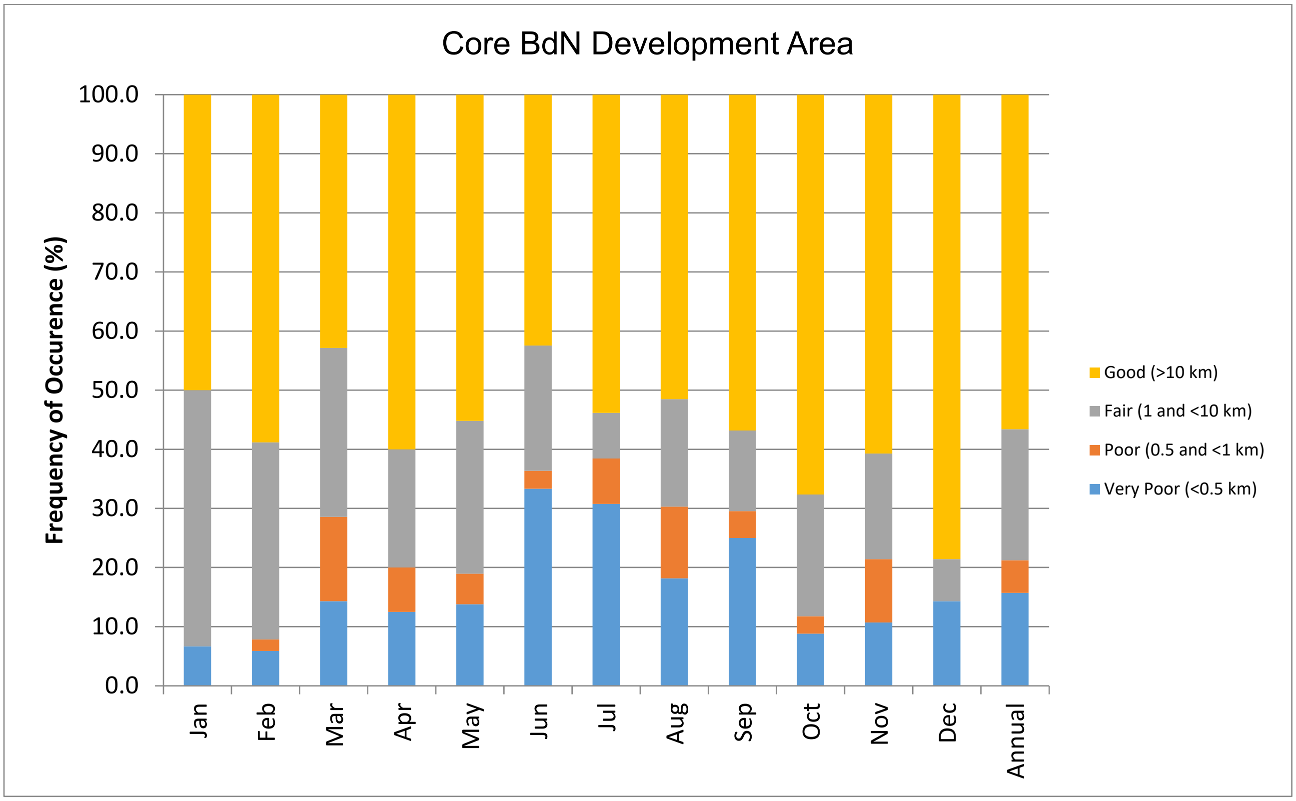
For this characterization, visibility from the ICOADS dataset (observations span 1980 to September 2018) has been classified for four regions: Core BdN Development Area, Project Area and western and eastern areas along the vessel traffic route. Classifications of very poor (<0.5 km), poor (0.5 to 1 km), fair (1 to 10 km) or good (greater than 10 km) are used. For offshore flying, helicopters need visual confirmation at 0.25 nautical miles (approximately 500 m) out and need a visibility of 1 km, or greater, to land.

The monthly and annual frequencies of occurrence of each state are shown in the following figures and tables. Fog and visibility conditions and seasonal variability are expected to vary across the Project Area and vessel traffic route.

As shown in Table 5.13 and Figure 5-24, visibility within the Core BdN Development Area varies considerably throughout the year. Annually, visibility is very poor 15.7 percent of time, poor 5.5 percent of the time, fair 22.2 percent of the time, and good 56.6 percent of the time. The best visibility occurs during fall and winter when fair or good visibility occurs approximately 70-90 percent of the time each month. Visibility is poorest in late spring and summer with very poor visibility (<500 m) occurring 33.3 percent of the time in June, 30.8 percent in July and 18.2 percent in August; September also is noted for poor visibility, occurring 25 percent of the month.

Table 5.13 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Core BdN Development Area

Month	Very Poor (<0.5 km)	Poor (0.5 – 1 km)	Fair (1 – 10 km)	Good (>10 km)
Jan	6.7	0.0	43.3	50.0
Feb	5.9	2.0	33.3	58.8
Mar	14.3	14.3	28.6	42.9
Apr	12.5	7.5	20.0	60.0
May	13.8	5.2	25.9	55.2
Jun	33.3	3.0	21.2	42.4
Jul	30.8	7.7	7.7	53.9
Aug	18.2	12.1	18.2	51.5
Sep	25.0	4.6	13.6	56.8
Oct	8.8	2.9	20.6	67.7
Nov	10.7	10.7	17.9	60.7
Dec	14.3	0.0	7.1	78.6
Annual	15.7	5.5	22.2	56.6
Source: Based on Research Data Archive et al. (2018)				



Source: Based on Research Data Archive et al. (2018)

Figure 5-24 Frequency of Occurrence of Visibility (ICOADS) - Core BdN Development Area

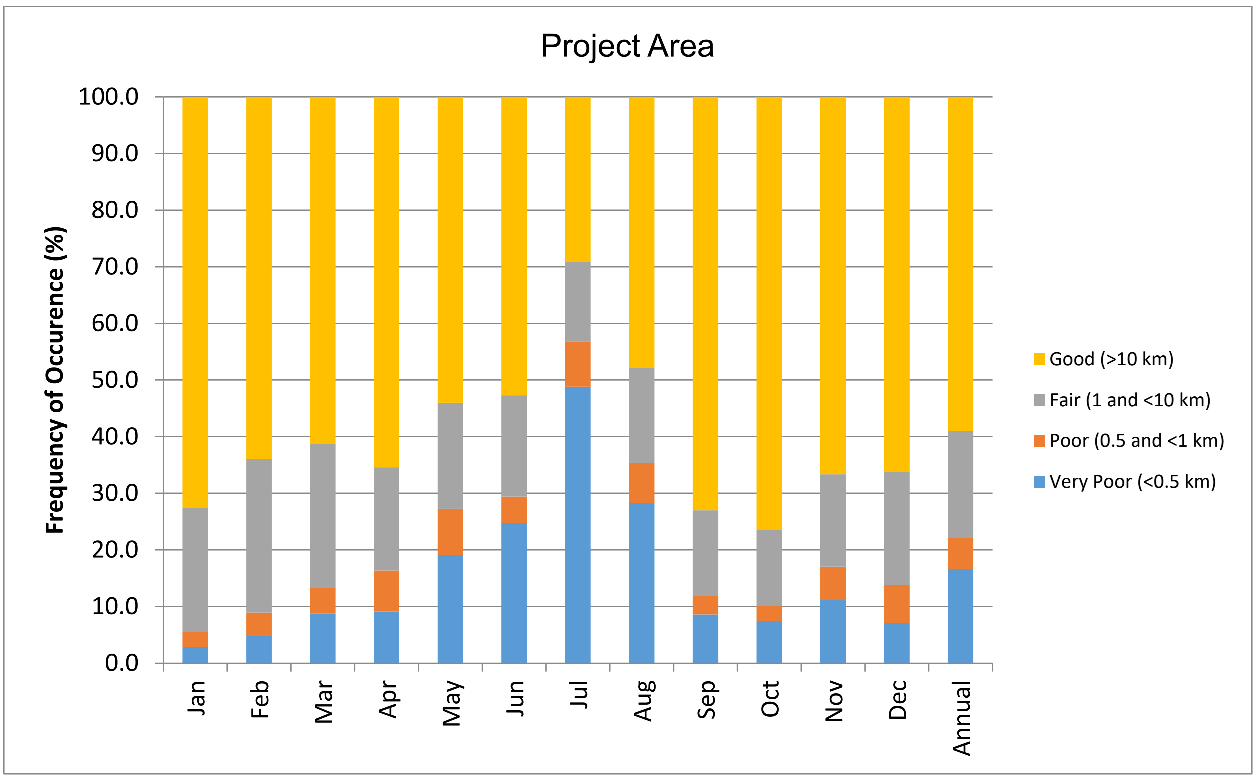
As shown in Table 5.14 and Figure 5-25, visibility within the Project Area varies considerably throughout the year. Annually, visibility is very poor 16.6 percent of time, poor 6 percent of the time, fair 18.9 percent of the time, and good 59.0 percent of the time. The best visibility occurs during fall and winter when fair or good visibility occurs approximately 85 to 90 percent of the time each month. Visibility is poorest in summer with very poor visibility (<500 m) occurring 48 percent in July and 28 percent in August.

Table 5.14 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Project Area

Month	Very Poor (<0.5 km)	Poor (0.5 – 1 km)	Fair (1 – 10 km)	Good (>10 km)
Jan	2.9	2.6	21.9	72.6
Feb	4.8	4.1	27.1	63.9
Mar	8.8	4.6	25.4	61.3
Apr	9.1	7.3	18.2	65.4
May	19.1	8.2	18.7	54.0
Jun	24.8	4.7	17.9	52.7

Table 5.14 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Project Area

Month	Very Poor (<0.5 km)	Poor (0.5 – 1 km)	Fair (1 – 10 km)	Good (>10 km)
Jul	48.8	8.0	14.0	29.2
Aug	28.3	7.1	16.8	47.9
Sep	8.6	3.2	15.2	73.0
Oct	7.4	2.7	13.4	76.5
Nov	11.1	5.9	16.3	66.7
Dec	7.1	6.7	20.0	66.2
Annual	16.6	5.6	18.9	59.0
Source: Based on Research Data Archive et al. (2018)				



Source: Based on Research Data Archive et al. (2018)

Figure 5-25 Frequency of Occurrence of Visibility (ICOADS) - Project Area

Visibility class statistics from the Equinor Canada exploration drilling programs noted above, are presented in Table 5.15 and shown in Figure 5-26. Conditions are generally comparable with those from the ICOADS analysis above for the Project Area (Table 5.14 and Figure 5-25). For example, visibility is very poor or poor 22.2 percent of the time annually for the region of the Project Area based on ICOADS compared with 15.4 percent of the time from the Equinor Canada exploration drilling programs data. Visibility is fair 18.9 percent of the time annually for the ICOADS Project Area region compared with 18.4 percent of the time for the drilling programs data (Table 5.15). Visibility is good 59 percent of the time annually for the ICOADS Project Area region compared with 66.3 percent of the time for the drilling programs data.

Table 5.15 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility, Equinor Canada Exploration Drilling Programs, 2013-2016

Month	Very Poor (<0.5 km)	Poor (0.5 – 1 km)	Fair (1 – 10 km)	Good (>10 km)
Jan	4.0	1.4	20.9	73.7
Feb`	9.5	1.6	24.9	64.0
Mar	5.5	1.2	18.4	74.9
Apr	15.5	1.1	20.8	62.6
May	22.5	3.6	17.5	56.5
Jun	16.3	3.3	20.6	59.8
Jul	26.9	2.4	19.7	51.0
Aug	24.6	2.0	16.6	56.8
Sep	17.7	2.0	10.3	70.0
Oct	9.2	0.0	14.9	75.9
Nov	4.5	0.0	14.5	80.9
Dec	9.8	0.4	13.8	76.0
Annual	13.7	1.7	18.4	66.3

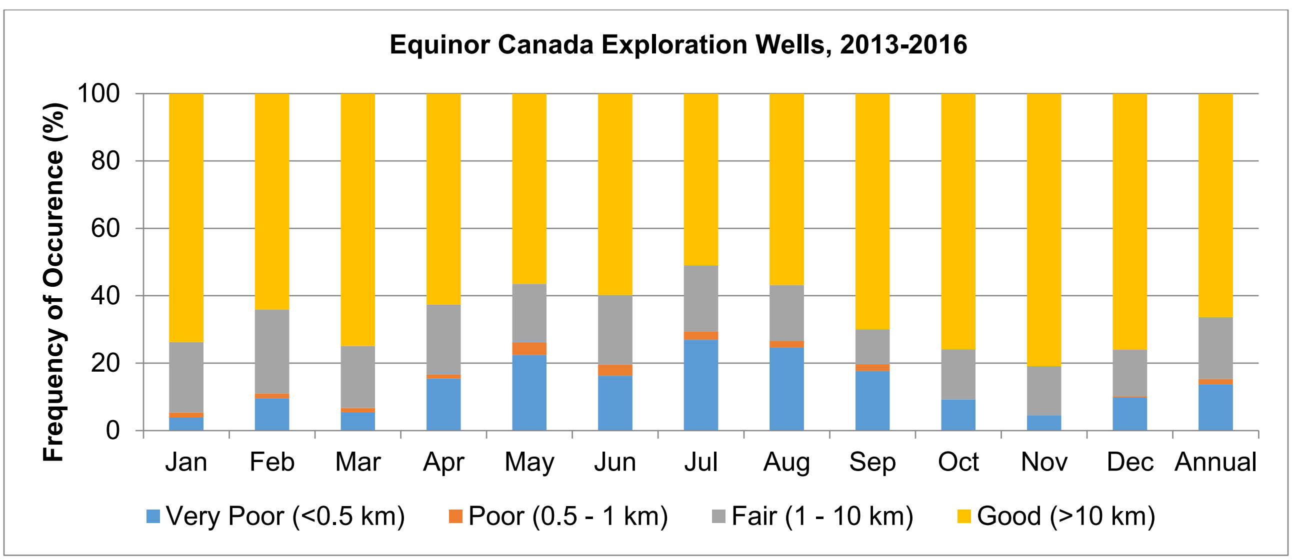


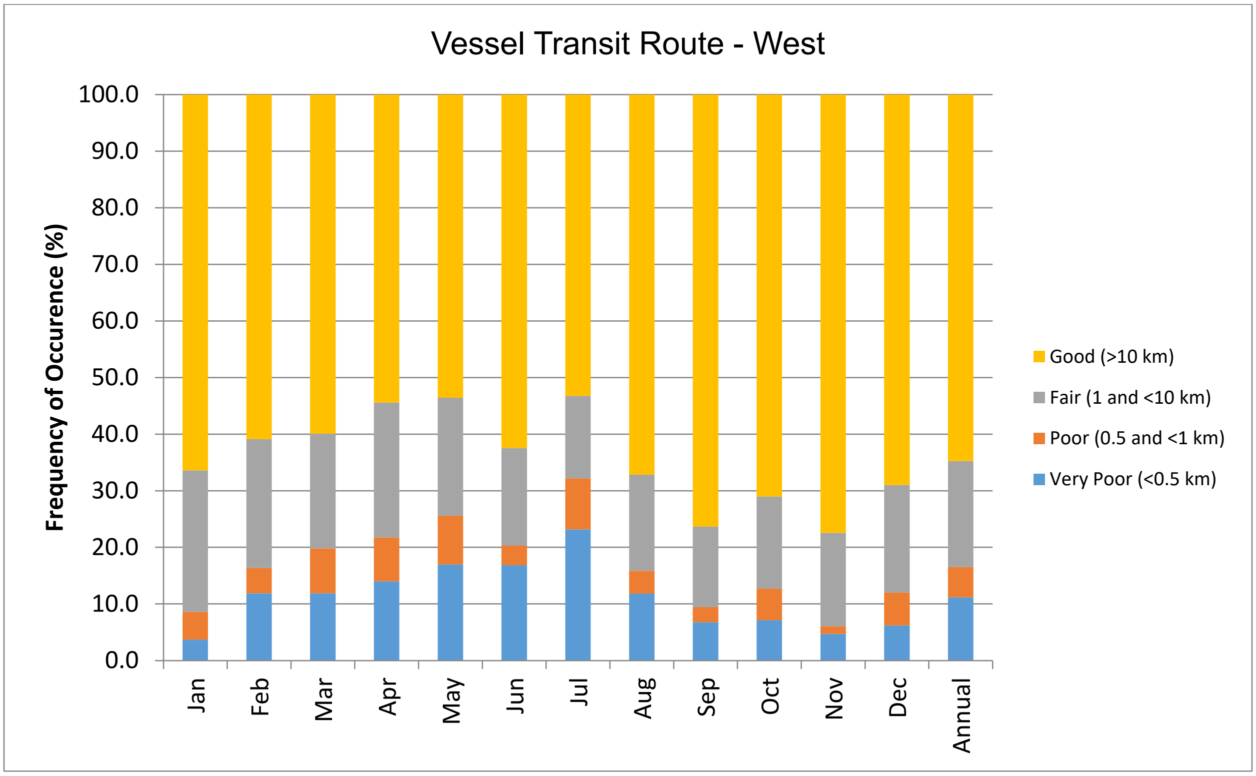
Figure 5-26 Frequency of Occurrence of Visibility, Equinor Canada Exploration Drilling Programs, 2013 to 2016

A simple comparison of these visibility statistics indicates noticeably less frequent conditions of very poor or poor visibility has been encountered by the drilling programs during June and July, compared with the ICOADS climatology. March and November also experienced better conditions than the ICOADS climatology. Conversely in May and September visibility conditions experienced were less favourable than the ICOADS climatology would suggest.

As shown in Table 5.16 and Figure 5-27, visibility along the western portion of the vessel traffic route varies considerably throughout the year. Annually, visibility is very poor 11.1 percent of time, poor 5.4 percent of the time, fair 18.7 percent of the time, and good 64.8 percent of the time. The best visibility occurs during fall and winter when fair or good visibility occurs approximately 80 percent of the time each month. Visibility is poorest in July with very poor visibility (<500 m) occurring 23.2 percent of the month.

Table 5.16 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Vessel Traffic Route – West

Month	Very Poor (<0.5 km)	Poor (0.5 – 1 km)	Fair (1 – 10 km)	Good (>10 km)
Jan	3.7	4.9	25.0	66.4
Feb	11.9	4.5	22.8	60.9
Mar	11.9	7.9	20.3	59.9
Apr	14.0	7.8	23.8	54.4
May	17.0	8.6	20.8	53.6
Jun	16.9	3.5	17.2	62.5
Jul	23.2	9.0	14.6	53.2
Aug	11.8	4.1	17.0	67.2
Sep	6.8	2.7	14.2	76.4
Oct	7.1	5.6	16.3	71.0
Nov	4.7	1.4	16.5	77.4
Dec	6.2	5.8	19.0	69.0
Annual	11.1	5.4	18.7	64.8
Source: Based on Research Data Archive et al. (2018)				



Source: Based on Research Data Archive et al. (2018)

Figure 5-27 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Vessel Traffic Route – West

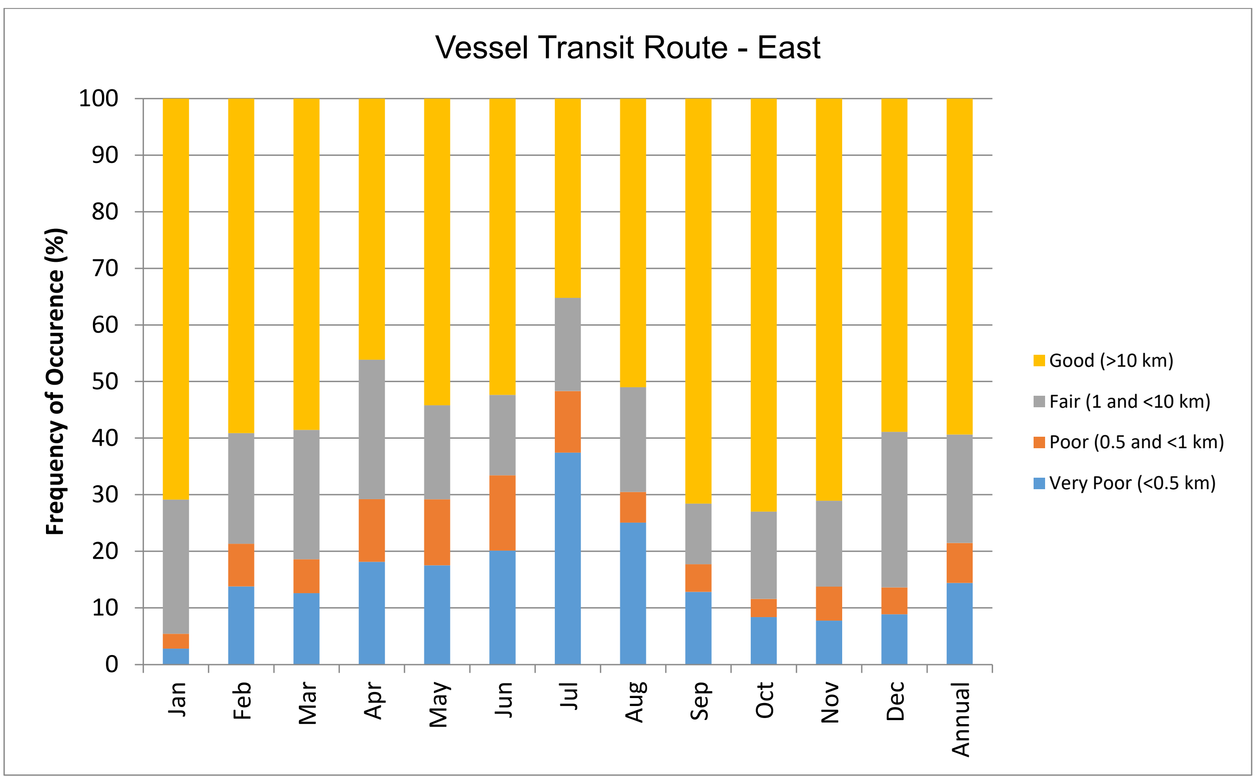
As shown in Table 5.17 and Figure 5-28, visibility along the eastern portion of the vessel traffic route varies considerably throughout the year. Annually, visibility is very poor 14.4 percent of time, poor 7.1 percent of the time, fair 19.2 percent of the time, and good 59.4 percent of the time. The best visibility occurs during fall and winter when fair or good visibility occurs approximately 80 percent of the time each month. Visibility is poorest in July with very poor visibility (<500 m) occurring 37.5 percent of the month.

Table 5.17 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Vessel Traffic Route – East

Month	Very Poor (<0.5 km)	Poor (0.5 – 1 km)	Fair (1 – 10 km)	Good (>10 km)
Jan	2.8	2.6	23.7	70.9
Feb	13.8	7.6	19.6	59.1
Mar	12.6	6.0	22.9	58.6
Apr	18.2	11.1	24.6	46.2
May	17.5	11.7	16.6	54.2
Jun	20.1	13.3	14.2	52.4

Table 5.17 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Vessel Traffic Route – East

Month	Very Poor (<0.5 km)	Poor (0.5 – 1 km)	Fair (1 – 10 km)	Good (>10 km)
Jul	37.5	10.9	16.5	35.2
Aug	25.1	5.4	18.5	51.0
Sep	12.8	4.9	10.7	71.6
Oct	8.4	3.2	15.4	73.0
Nov	7.7	6.0	15.2	71.1
Dec	8.9	4.7	27.5	58.9
Annual	14.4	7.1	19.2	59.4
Source: Based on Research Data Archive et al. (2018)				



Source: Based on Research Data Archive et al. (2018)

Figure 5-28 Monthly and Annual Frequencies (Percent) of Occurrence of Visibility (ICOADS) – Vessel Traffic Route – East

5.4 Oceanography

This section provides an overview of oceanographic conditions including waves, ocean currents, extreme winds and waves, seawater properties (temperature, salinity), tides and storm surge.

Three additional resources provide further detail on these environmental characteristics:

- The Bay du Nord Field Metocean Design Basis (Statoil 2017a) presents wind, wave, current, temperature and salinity normal and extreme statistics for design activities; given the inherent conservative nature in these statistics, some of the physical environment values presented in this Chapter will be lower than those of the metocean design basis
- Chapter 5 of the Drilling EIS (Statoil 2017b) provides physical environment descriptions for regions near the Project Area and along the vessel traffic route
- Additional details for the vessel traffic route and the larger eastern NL Offshore Area are provided in the Eastern Newfoundland SEA, Section 4.1 (Amec 2014)

5.4.1 Waves

For this EIS, the wave climate within the Project Area has been characterized by descriptive statistics derived from the MSC50 wind and wave hindcast dataset (DFO 2018a). The wave hindcast was conducted by using the wind field reanalysis to force a third-generation wave model (Swail et al. 2006) over the north Atlantic Ocean. The model used was Oceanweather's OWI-3G, adopted onto a 0.5 degree grid on a basin-wide scale. Inscribed in the 0.5 degree model was a further refined 0.1 degree shallow water implementation of the OWI-3G model, which allowed for shallow water effects to be accounted for in the maritime region. The MSC50 methodology and results have been extensively documented and validated (Swail and Cox 2000; Woolf et al. 2002; Caires et al. 2004).

As presented earlier for wind conditions, two MSC50 grid point locations were selected to provide a representative illustration of conditions over the Project Area, the preciously drilled exploration well locations on SDL 1055 and SDL 1047 (see Figure 5-7). This provides an overview for general illustration and EA purposes; detailed oceanographic information for design and operational purposes is presented in the Metocean Design Basis (Statoil 2017a).

The wave climate is described in terms of the significant wave height (Hs, defined as four times the square root of the total variance of the wave energy spectrum), and the peak wave spectral period (Tp, defined as the period of waves with the highest contribution to the energy spectrum). Ocean waves are due to the effects of wind on the air/water interface. Winds are due to the dominant local and regional weather systems encountered and exhibit a pronounced seasonal variability. Wind waves (or sea) will be generated in the immediate area of wind, developing quickly within an hour. Swells are what remains of the wind waves after they propagate away from where they were generated. Swells are long waves that contain a lot of wave energy, and can take days to subside. The range of wave periods for wind waves and swells overlap considerably with wind waves having periods up to 15 seconds (s) for large winds speeds, while swells of only a few seconds are possible.

Inspection of the MSC50 statistics and directional roses indicates wave conditions are comparable and vary little between the two locations. Table 5.18 presents monthly wave height and wave period statistics for both MSC50 nodes, listed from north to south. Given the similarity in conditions, the southern node, M6013260, is selected for monthly and annual wave rose illustration (Figure 5-29 and Figure 5-30).

Table 5.18 Wave Statistics

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean Hs (m)													
M6013260	4.5	4.1	3.4	2.9	2.3	2.0	1.8	1.9	2.5	3.2	3.6	4.3	3.0
M6013912	4.6	4.2	3.6	3.0	2.3	2.0	1.8	1.9	2.6	3.2	3.6	4.3	3.1
M6013252	4.4	3.8	3.1	2.8	2.3	2.0	1.8	1.9	2.5	3.1	3.5	4.2	2.9
M6013072	4.1	3.3	2.5	2.5	2.2	1.9	1.7	1.8	2.4	3.0	3.4	4.0	2.7
M6012896	3.7	2.8	2.0	2.3	2.0	1.8	1.6	1.7	2.3	2.8	3.2	3.7	2.5
Mean Tp (s)													
M6013260	10.7	10.2	9.6	9.4	8.6	8.1	7.8	7.9	9.0	9.5	9.9	10.6	9.3
M6013912	10.7	10.3	9.8	9.5	8.6	8.1	7.8	7.9	8.9	9.5	9.9	10.5	9.3
M6013252	10.6	9.5	8.8	9.1	8.6	8.1	7.8	7.9	8.9	9.5	9.9	10.5	9.1
M6013072	10.3	8.7	7.5	8.4	8.5	8.0	7.7	7.7	8.8	9.4	9.8	10.3	8.8
M6012896	9.9	7.9	6.3	8.0	8.3	7.9	7.5	7.6	8.6	9.2	9.5	10.0	8.4
Most Frequent Direction (from)													
M6013260	W	W	NW	SW	SW	SW	SW	SW	SW	NW	NW	NW	SW
M6013912	W	W	NW	SW	SW	SW	SW	SW	SW	NW	NW	NW	SW
M6013252	W	W	SW	SW	SW	SW	SW	SW	SW	NW	NW	NW	SW
M6013072	SW	SW	SW	SW	SW	SW	SW	SW	SW	SW	NW	NW	SW
M6012896	SW	SW	SW	S	S	S	SW	SW	SW	N	NW	NW	SW
Maximum Hs (m)													
M6013260	14.9	15.2	12.8	11.0	11.6	10.7	7.1	8.8	13.3	12.5	12.9	15.0	15.2
M6013912	14.2	15.3	13.1	11.0	11.7	10.5	7.1	8.2	13.3	12.5	13.2	15.3	15.3
M6013252	14.1	15.4	11.8	11.1	11.5	10.6	6.4	8.5	13.5	12.2	12.6	14.2	15.4
M6013072	12.6	13.9	10.6	10.5	10.7	10.2	6.5	7.8	13.3	11.2	11.2	13.6	13.9
M6012896	11.3	11.6	10.1	9.2	9.6	9.0	5.8	10.7	12.2	10.1	10.1	11.9	12.2
Tp of Maximum Hs (s)													
M6013260	15.9	15.2	14.7	14.3	13.3	12.2	11.0	11.6	14.4	14.8	14.4	15.7	15.7
M6013912	16.0	16.2	14.4	13.9	13.9	13.5	12.1	11.8	15.7	14.6	15.4	16.2	16.2
M6013252	14.8	16.9	13.3	13.8	14.0	13.8	11.9	11.7	15.5	14.7	14.6	15.9	16.9
M6013072	14.4	15.9	13.2	13.1	14.1	13.2	11.8	11.5	15.2	14.1	13.6	15.7	15.9
M6012896	14.3	15.2	13.9	12.7	13.0	12.6	10.7	14.2	14.9	13.1	14.1	15.3	14.9

Table 5.18 Wave Statistics

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Maximum Tp (s)													
M6013260	15.4	16.3	14.2	13.7	14.1	13.9	12.0	12.0	15.3	14.6	14.7	16.1	16.3
M6013912	17.3	17.0	17.4	16.9	17.3	21.0	17.3	17.4	17.5	17.4	16.0	17.3	21.0
M6013252	17.3	16.9	17.6	17.1	17.4	20.9	17.4	17.6	17.6	17.5	16.0	17.3	20.9
M6013072	16.8	16.7	17.4	17.4	17.4	15.3	17.2	17.4	17.3	17.5	15.9	17.0	17.5
M6012896	16.3	16.1	16.1	16.1	17.4	17.2	17.3	17.4	16.1	17.4	16.0	16.5	17.4
Direction of Maximum Hs (from)													
M6013260	W	SW	NW	NW	NW	NW	S	SW	SW	SW	W	NW	SW
M6013912	W	SW	NW	S	NW	NW	S	SW	SW	SW	W	NW	NW
M6013252	NW	SW	NW	NW	NW	NW	S	SW	SW	SW	W	N	SW
M6013072	NW	SW	N	NE	NW	NW	NW	N	SW	SW	W	N	SW
M6012896	S	S	NW	N	N	NW	SW	S	S	SW	NW	N	S

MSC50 data for the period 1962-2015.
Locations are noted as follows (see Figure 5-7):
M6013260 - Core BdN Development Area
M6013912- Project Area (North)
M6013252- Project Area (West)
M6013072- vessel traffic route (East)
M6012896- vessel traffic route (West)

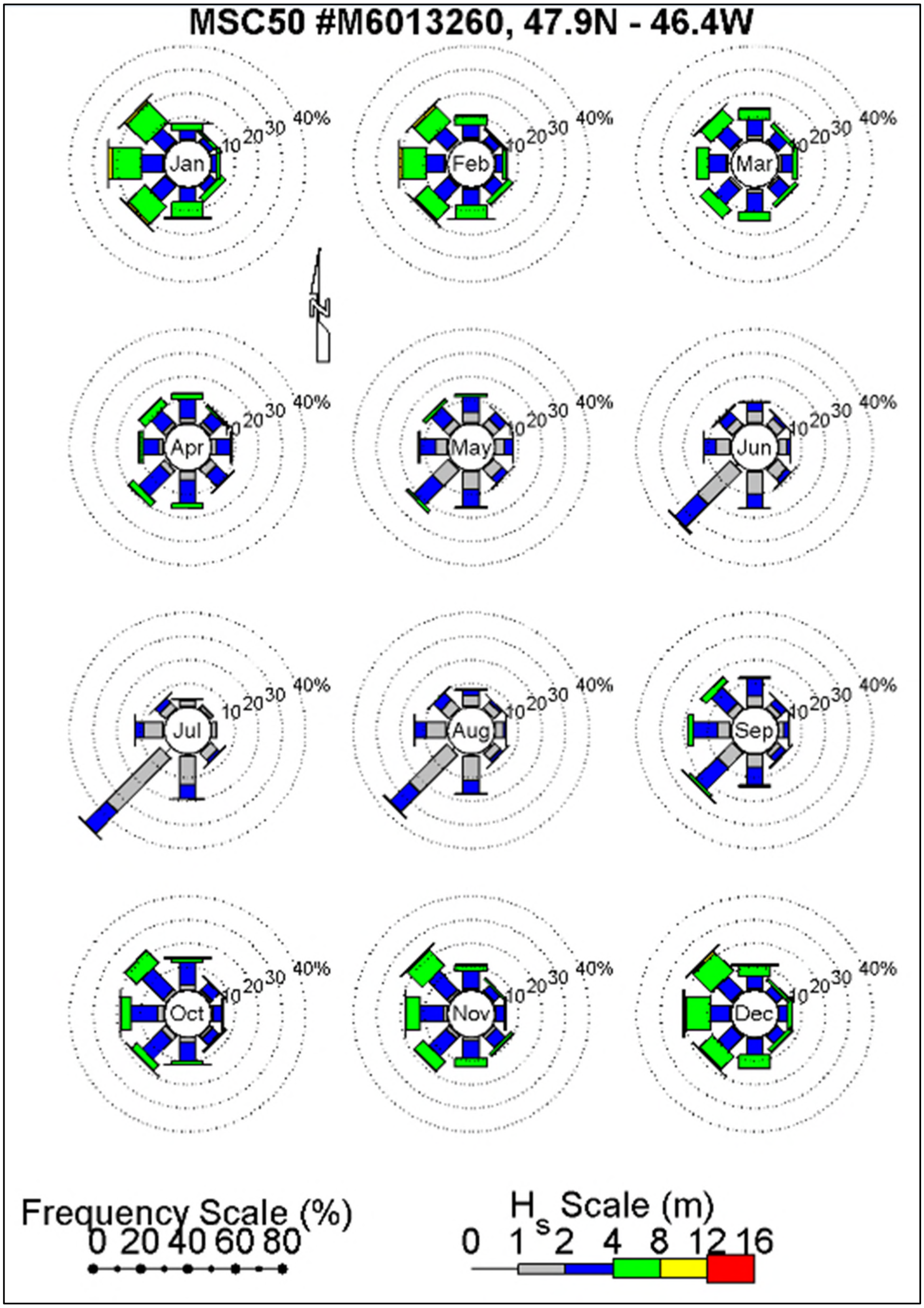


Figure 5-29 Monthly Wave Roses, MSC50 Node M6013260 - Core BdN Development Area (1962 – 2015)

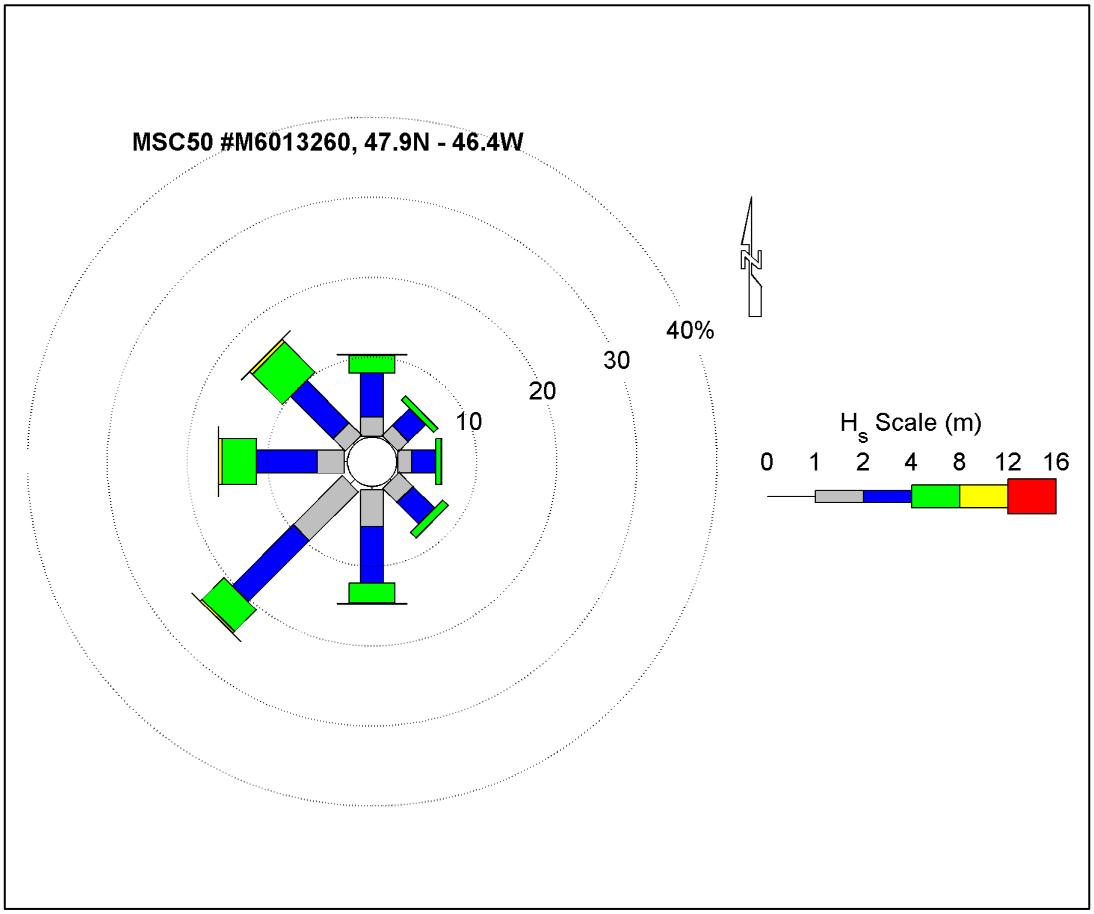


Figure 5-30 Annual Wave Rose, MSC50 Node M6013260 - Core BdN Development Area (1962 – 2015)

Mean wave heights range from approximately 1.8 m in July to 4.6 m in January (Table 5.18). The most severe sea states occur in December and January with maximum significant wave heights of up to 15.3 m in December and 14.9 m in January. These maximum wave heights are reported for directions from the northwest through southwest. Associated wave peak periods are 15 to 16 s. In contrast, maximum significant wave heights are less than half (7.1 m) in July, with associated peak periods of 11 to 12 s.

Wave information is also available from a directional waverider deployed at location WM-1 (see Figure 5-7) in the Project Area during an Equinor Canada met-ocean monitoring program from 2014 to 2016 (including two current moorings CM-1 and CM-2 (see Figure 5-7) in the northern Flemish Pass (Amec Foster Wheeler 2015a). Summary wave analysis from this program is presented in Figure 5-31, which includes a wave rose (indicating waves most frequently from the southwest), histogram of Hs, and statistics of Hs, Tp and wave direction for the overall program duration.

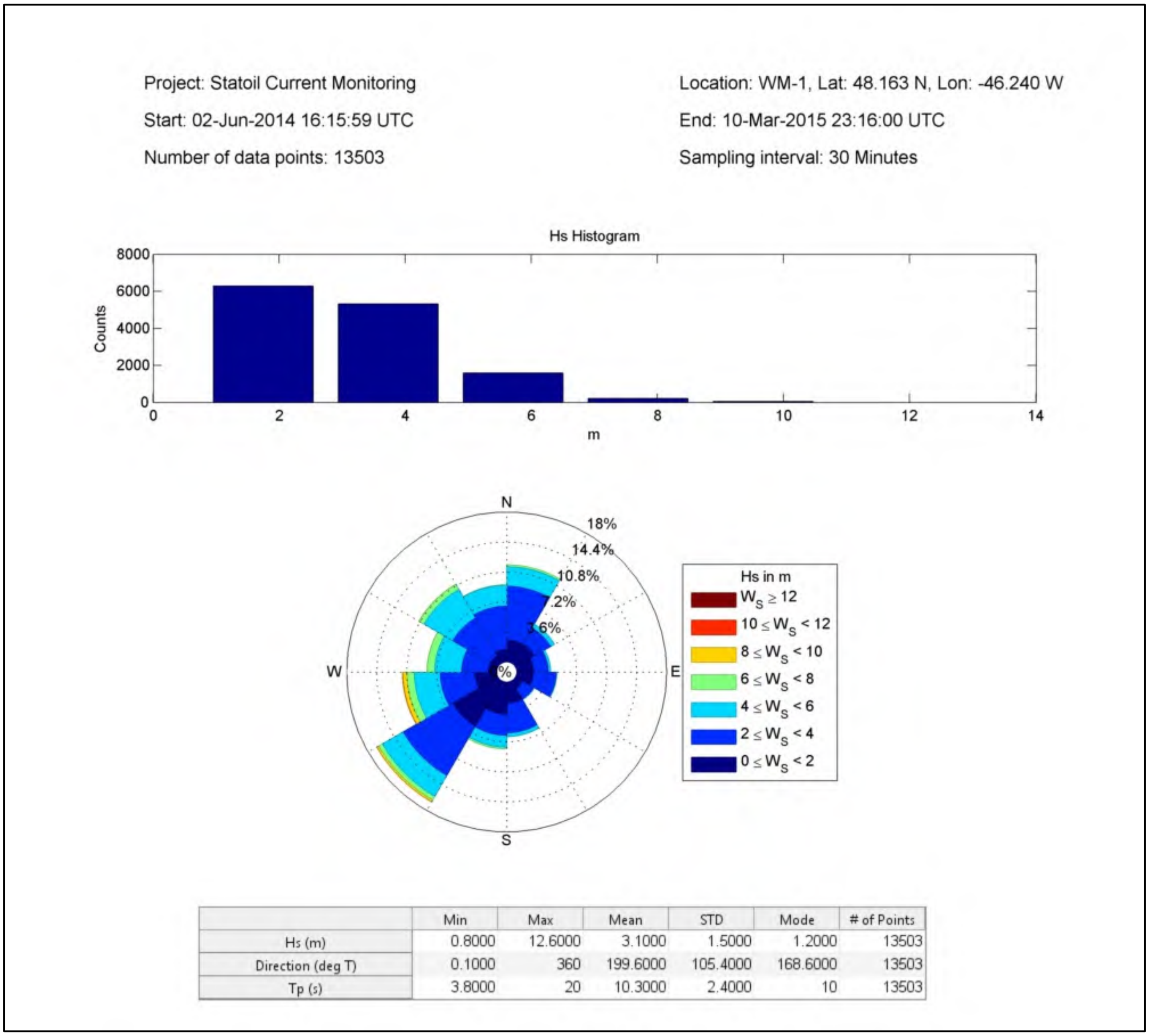


Figure 5-31 Wave Monitoring Summary Plot, Equinor Canada Flemish Pass MetOcean Program, June 2014 to March 2015

Monthly statistics from the WM-1 deployment are presented in Table 5.19. Annual and monthly wave roses are presented in Figure 5-32 and 5-33.

Table 5.19 WM-1 Monthly and Annual Wave Statistics, 2014-2016

	Min (m)	Mean (m)	STD (m)	Max (m)	Dir of Max (deg)	Tp of Max (s)	Most Frequent Direction	Num. of Points
Jan	1.5	4.4	1.4	12.3	266.7	13.3	WNW	2975
Feb	1.6	4.1	1.3	12.6	243.4	14.3	WSW	2736

Table 5.19 WM-1 Monthly and Annual Wave Statistics, 2014-2016

	Min (m)	Mean (m)	STD (m)	Max (m)	Dir of Max (deg)	Tp of Max (s)	Most Frequent Direction	Num. of Points
Mar	1.6	4.0	1.6	11.0	243.8	13.3	WSW	1967
Apr	1.1	3.2	1.5	11.5	243.5	13.3	E	1440
May	0.7	2.3	0.7	5.6	16.7	9.1	WSW	2122
Jun	0.8	1.9	0.8	5.7	233.6	10.0	N	2799
Jul	0.8	1.7	0.6	3.8	218.2	10.0	WSW	2976
Aug	0.9	1.9	0.8	7.4	30.8	11.8	NNE	2976
Sep	0.9	2.5	1.0	6.3	313.1	10.0	NNW	2880
Oct	0.7	3.2	1.4	8.8	228.9	11.1	N	2055
Nov	1.2	3.9	1.3	9.9	248.4	13.3	WNW	1986
Dec	1.7	4.0	1.4	8.9	295.0	13.3	NNW	2976
Annual	0.7	3.1	1.5	12.6	243.4	14.3	NNW	29888

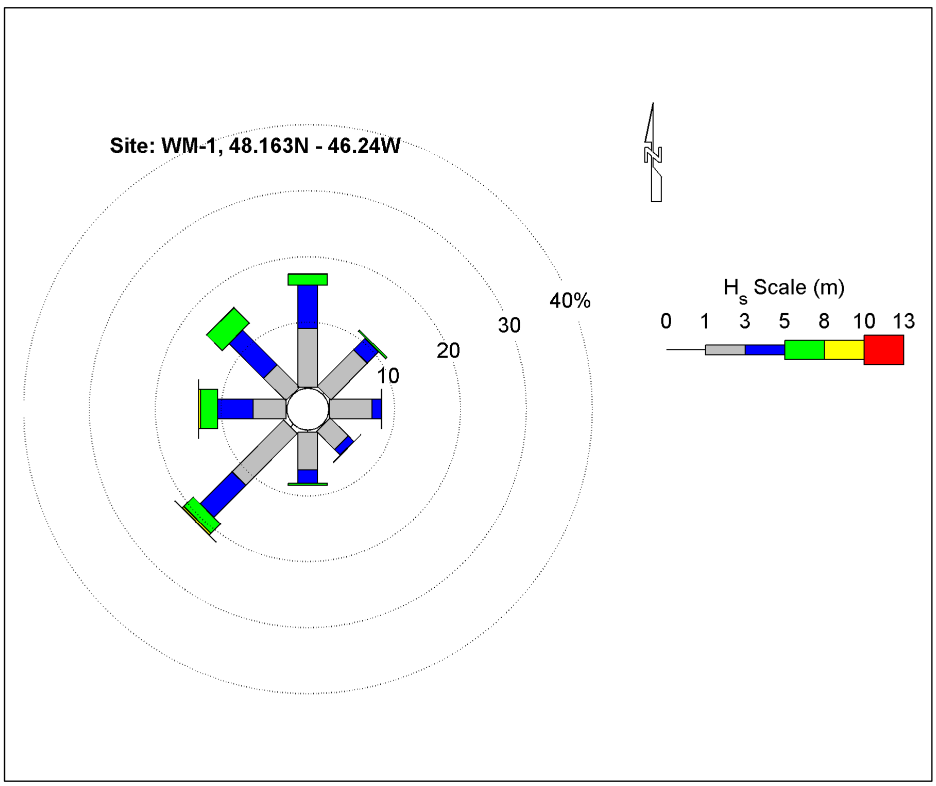


Figure 5-32 WM-1 Annual Wave Rose, 2014-2016

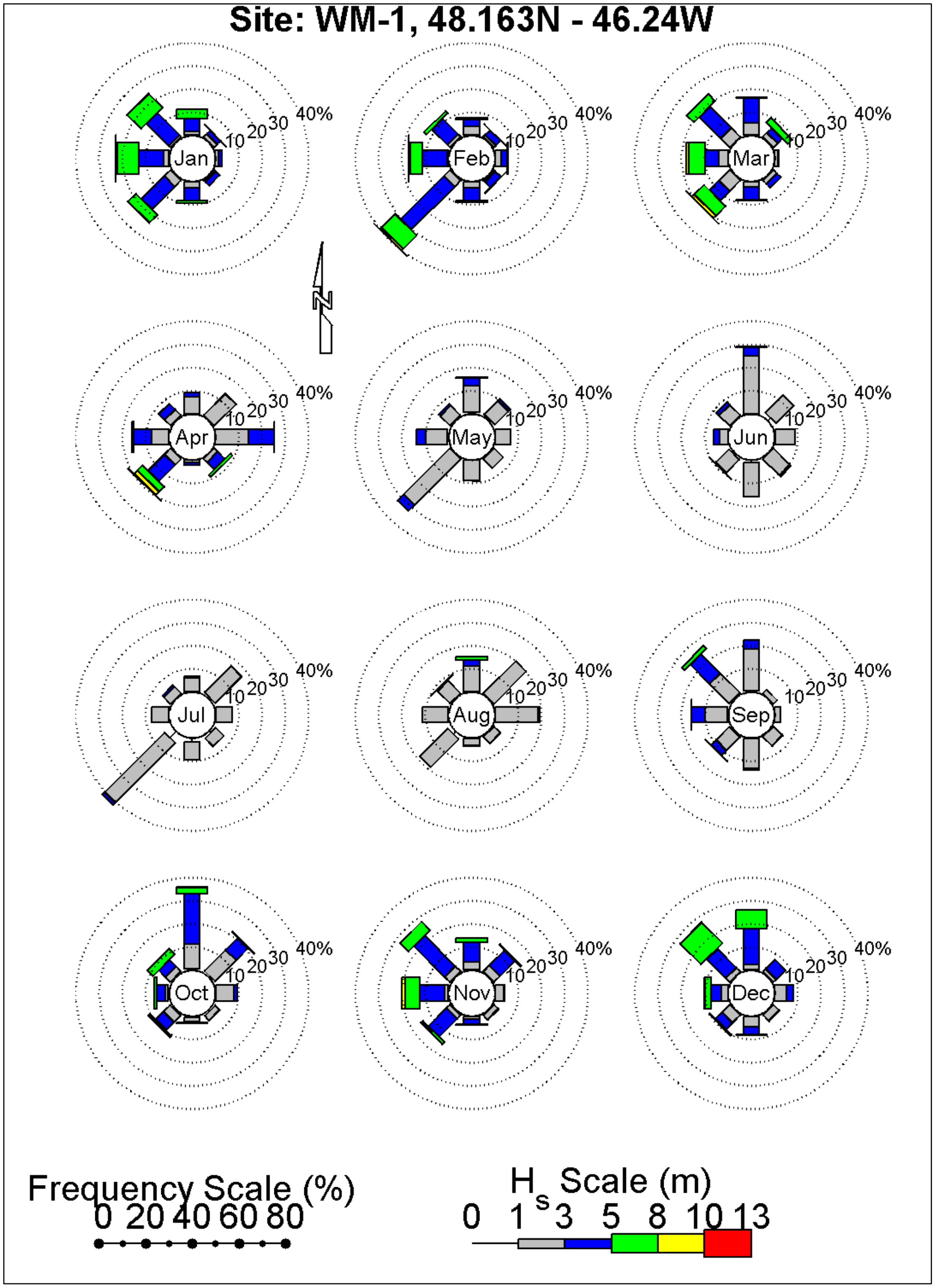


Figure 5-33 WM-1 Overall Monthly Wave Roses, 2014-2016

The wave conditions experienced along the vessel traffic route to the Project Area will be quite close to those experienced farther offshore, although with wave heights expected to be somewhat lower closer to shore. Annually, mean significant wave heights are approximately 2 m near St. John's compared with 3 to 3.5 m near the eastern portions of the Project Area. During fall and winter months, average significant wave heights can be expected to be 1.5 m higher than near St. John's; maximum wave heights can be expected to be at least 2 m higher.

Wave conditions experienced along the vessel traffic route to the Project Area are generally comparable to those experienced farther offshore as shown in Table 5.18 where two MSC50 nodes M13072 and M12896 along the route are included.

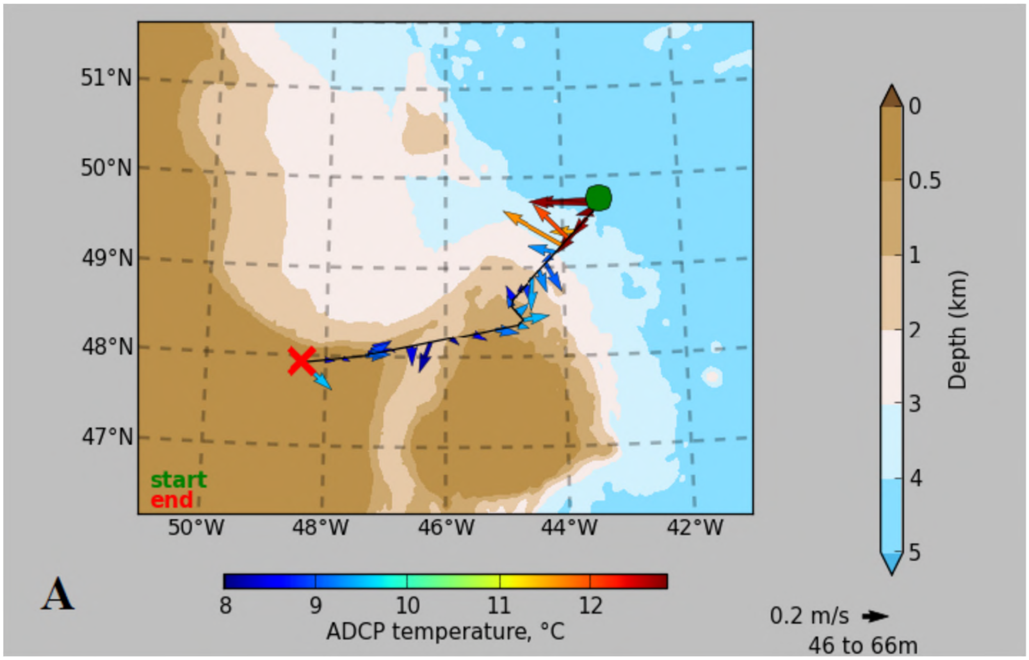
5.4.2 Ocean Currents

The cold Labrador Current dominates the general circulation over the eastern NL Offshore Area. The Labrador Current is divided into two streams: 1) an inshore branch that flows along the coast on the continental shelf; and 2) an offshore branch that flows along the outer edge of the Grand Banks (Figure 5-6). The Labrador Current's inshore branch tends to flow mainly in the Avalon Channel along the coast of the Avalon Peninsula but may sometimes also spread farther out on the Grand Banks. The offshore branch flows over the upper Continental Slope at depth, and through the 1,300 m deep Flemish Pass. The offshore Labrador Current (which remains bathymetrically trapped over the upper Continental Slope) has average speeds of approximately 40 cm/s carrying approximately 85 percent of the total transport, mainly between the 400 m and 1,200 m isobaths (Lazier and Wright 1993).

Near the Project Area, in the vicinity of the Flemish Pass, the Labrador Current divides into two branches with the main branch flowing southwards as Slope Water Current and the side branch flowing up to the east-northeast clockwise past the Sackville Spur and north-eastward around the Flemish Cap. The cores of the currents are located at an average depth of 100 m. This is illustrated in Figures 5-34 to 5-37 below, which show current transects (currents at depth approximately 45-65 m) from a recent Fisheries and Oceans Canada (DFO) oceanographic program in the Sackville Spur and Flemish Pass regions in 2013-2014. The arrows show the current magnitude and direction at the given depth. This field program, with funding from the Environmental Studies Research Fund (ESRF), had the objective of studying ocean current variability and dispersion in the vicinity of the Sackville Spur as well as to characterize some of the benthic habitat for assessment of vulnerable marine ecosystems (Greenan et al. 2016).

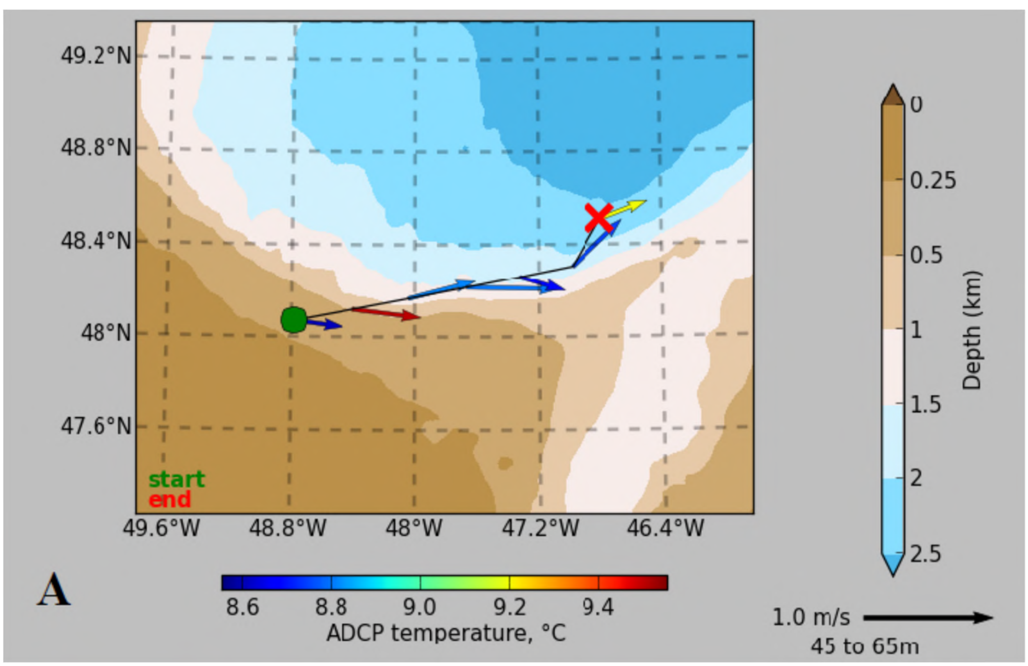
The oceanographic data from the DFO program includes shipboard conductivity, temperature and dissolved oxygen (CTD), lowered Acoustic Doppler Current Profiler (ADCP), vessel-mounted ADCP and water samples during two cruises in July 2013 and 2014 (Greenan et al. 2016). Moorings were deployed at three locations (as shown in Figure 5-7) with two moorings (Sackville Spur West, Sackville Spur East) located near the Project Area.

A query of the Bedford Institute of Oceanography Ocean Data Inventory (ODI) database (Gregory 2004) for the area 47°N to 49°N, 45°W to 48°W (DFO 2018b) returned current statistics just for these two (Sackville Spur) moorings (Figure 5-7) This includes measurements from 12 RCM11 single-point current meters (six RCM11s at each location).



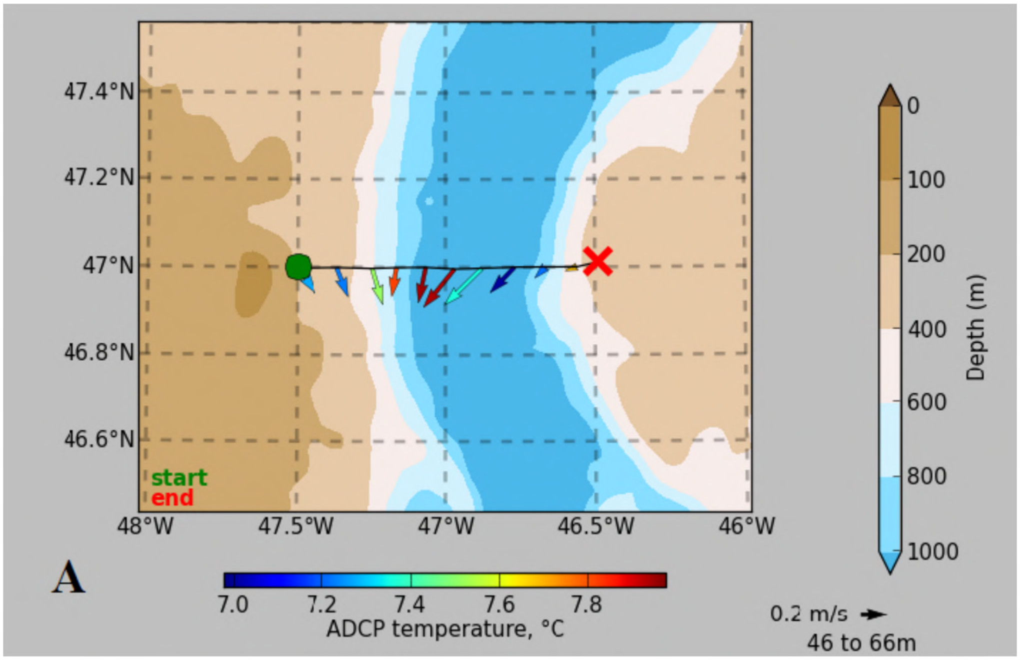
Source: Greenan et al. (2016)

Figure 5-34 Sackville Spur Region, VM ADCP Depth-Averaged Current Speed, July 2013



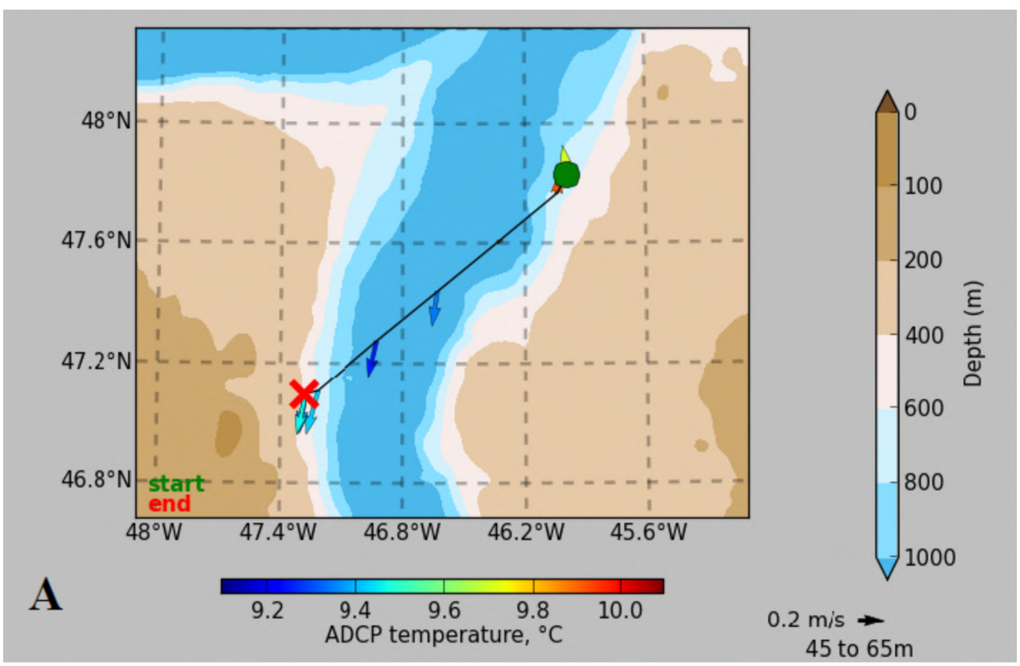
Source: Greenan et al. (2016)

Figure 5-35 Sackville Spur Region, VM ADCP Depth-Averaged Current Speed, July 2014



Source: Greenan et al. (2016)

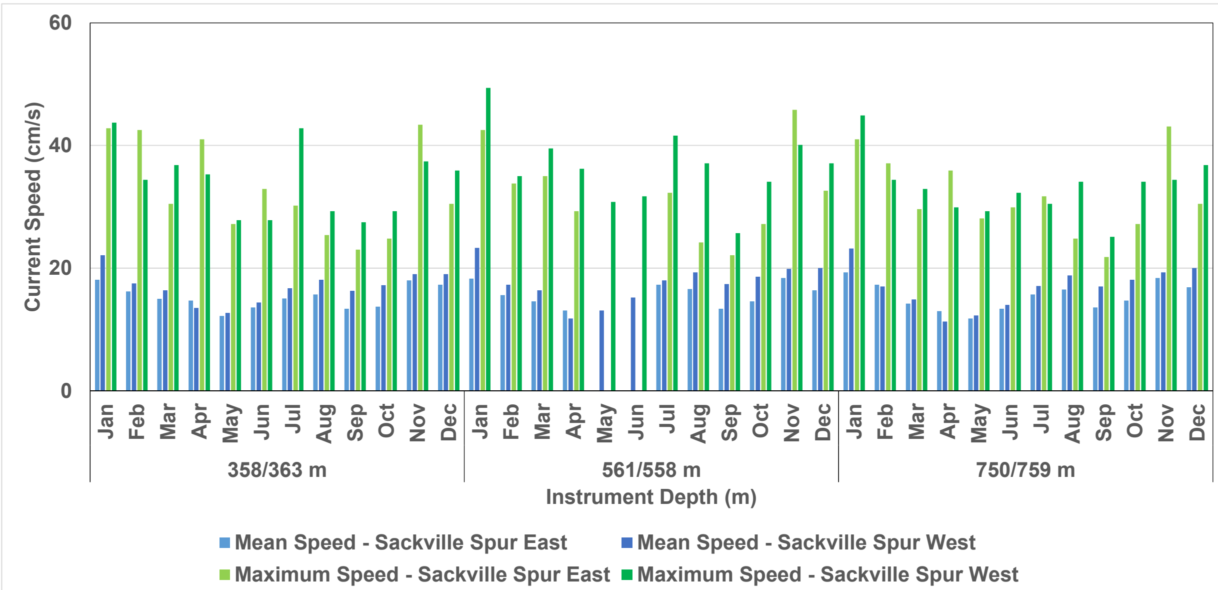
Figure 5-36 Flemish Pass Region, VM ADCP Depth-Averaged Current Speed, July 2013



Source: Greenan et al. (2016)

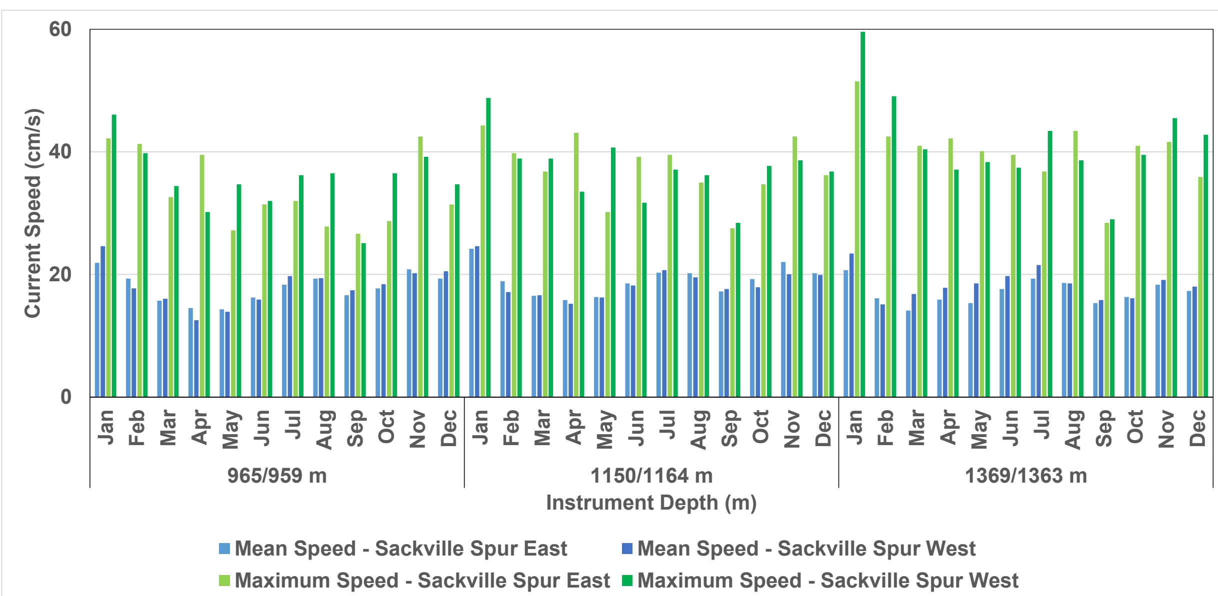
Figure 5-37 Flemish Pass Region, VM ADCP Depth-Averaged Current Speed, July 2014

The mean and maximum current speeds by instrument depth for these two current moorings are presented in Figure 5-38 and Figure 5-39, which report for the upper three and lower three instrument depths of the moorings respectively. The actual instrument depths between the two moorings differ by <10 m (14 m for the deepest instruments); for comparison purposes the average instrument depths are shown.



Source: based on DFO (2018b)

Figure 5-38 Mean and Maximum Current Speed, Upper Depths, Sackville Spur West and East



Source: based on DFO (2018b)

Figure 5-39 Mean and Maximum Current Speed, Lower Depths, Sackville Spur West and East

Mean and maximum currents are generally quite consistent between the two mooring locations. Monthly mean current speeds range between approximately 11 and 25 cm/s with larger values observed in the winter and a slight increase in mean speeds with increasing water depth. Monthly maximum current speeds range between approximately 22 and 60 cm/s with larger values again observed in the winter and largest values noticeably greater for the deepest instrument. As reported in Table 5.20, overall maximum current speeds of 59.6 and 51.5 cm/s are reported for the West and East moorings at the 1,366 m depth.

Overall maximum current speeds for the other instrument depths range between approximately 43 cm/s and 49 cm/s (Table 5.20). The overall mean current speeds are more consistent, ranging from approximately 15 cm/s to 19 cm/s for all six instrument depths, at the two locations.

Table 5.20 Mean and Maximum Current Speed, Sackville Spur West and East

Depth (m)	Sackville Spur West		Sackville Spur East		
	Mean (cm/s)	Maximum (cm/s)	Depth (m)	Mean (cm/s)	Maximum (cm/s)
358	16.9	43.7	363	15.2	43.4
561	17.6	49.4	558	15.8	45.8
750	16.9	44.9	759	15.4	43.1
965	18.1	46.1	959	17.9	42.5
1,150	18.8	48.8	1,164	19.2	44.3
1,369	18.6	59.6	1,363	17.2	51.5
Source: based on DFO (2018b)					

Within the Project Area, ocean current measurements are available from two current moorings equipped with Acoustic Doppler Current Profiler (ADCP) and Recording Current Meter (RCM) instruments. These were deployed at locations CM-1 and CM-2 (Figure 5-7) during an Equinor Canada met-ocean monitoring program in 2014-2015 in the northern Flemish Pass in water depths of 1,028 m and 1,120 m (Amec Foster Wheeler 2015b, 2015c). The CM-2 mooring continued to be operated through May 2016 with current data analysed as part of the Bay du Nord Field (located at 48.0°N, 46.4°W) Metocean Design Basis (Statoil 2017a).

Summary current statistics from these two deployments, through March 2015, are presented in Tables 5.21 and 5.22, which include selected depths near-surface, mid-depth, and near-bottom. Numerous other analyses were completed in compiling the monitoring program reports (Amec Foster Wheeler 2015b, 2015c). Progressive vector plots – which show the net displacement of a particle subjected to the current velocity - for a near-surface depth for the second CM-1 deployment and for the CM-2 deployment are shown in Figures 5-40 and 5-41, respectively. At CM-1 to the north the flow is directly to the east, whereas at CM-2 the flow is directly to the south and south-southwest.

Table 5.21 Flemish Pass Equinor Canada Current Monitoring, CM-1, Current Statistics

Depth (m)	Mean Current Speed (cm/s)	Mean Current Direction (°T) (to)	Maximum Current Speed (cm/s)	Direction of Maximum Current (°T) (to)
	1 Jun to 18 Jul 2014			
65	13.5	121	47.3	179
434	5.6	104	16.5	141
984	-	-	-	-
	2 Nov 2014 to 21 Mar 2015			
66	13.4	86	45.6	118
441	7.3	83	26.8	93
945	7.0	104	22.1	217
CM-1 located (both deployments) at approximately 48° 19.1'N, 46° 17.5'W, water depth=1,028 m. Three upward-looking ADCPs at 90 m (8 m current bins), 500 m and 1,000 m (both with 32 m current bins)				

Table 5.22 Flemish Pass Equinor Canada Current Monitoring, CM-2, Current Statistics

Depth (m)	Mean Current Speed (cm/s)	Mean Current Direction (°T) (to)	Maximum Current Speed (cm/s)	Direction of Maximum Current (°T) (to)
	2 Jun 2014 to 25 Jan 2015			
65	12.4	194	51.6	159
499	7.7	204	21.8	209
984	7.8	203	35.4	210
CM-2 located at 48° 0.364'N, 46° 19.241'W, water depth=1,171 m. Three upward-looking ADCPs at 80 m (8 m current bins), 570 m and 1,120 m (both with 32 m current bins)				

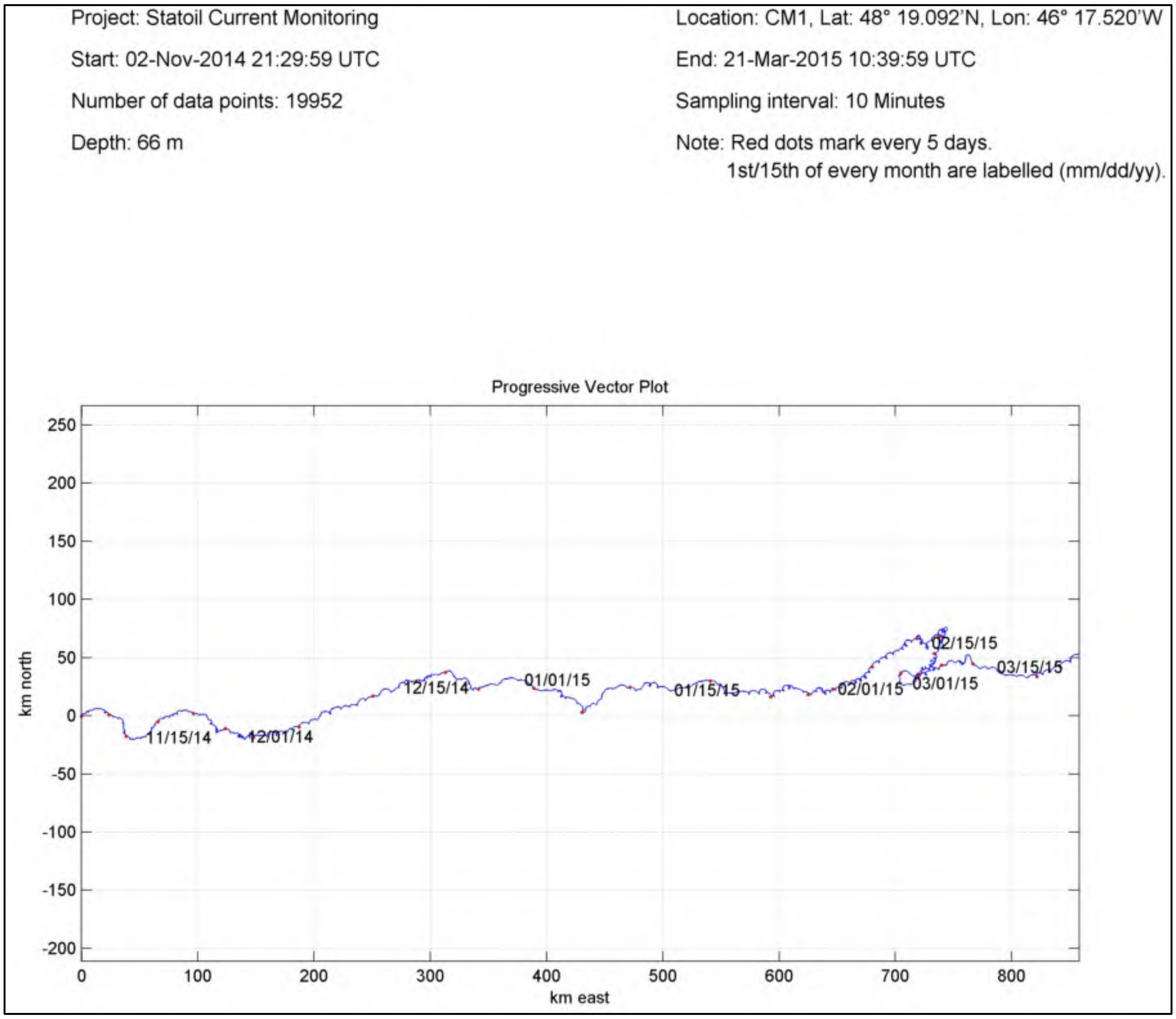


Figure 5-40 Flemish Pass Equinor Canada Current Monitoring, CM-1, Progressive Vector Plot, 66 m, November 2014 to March 2015

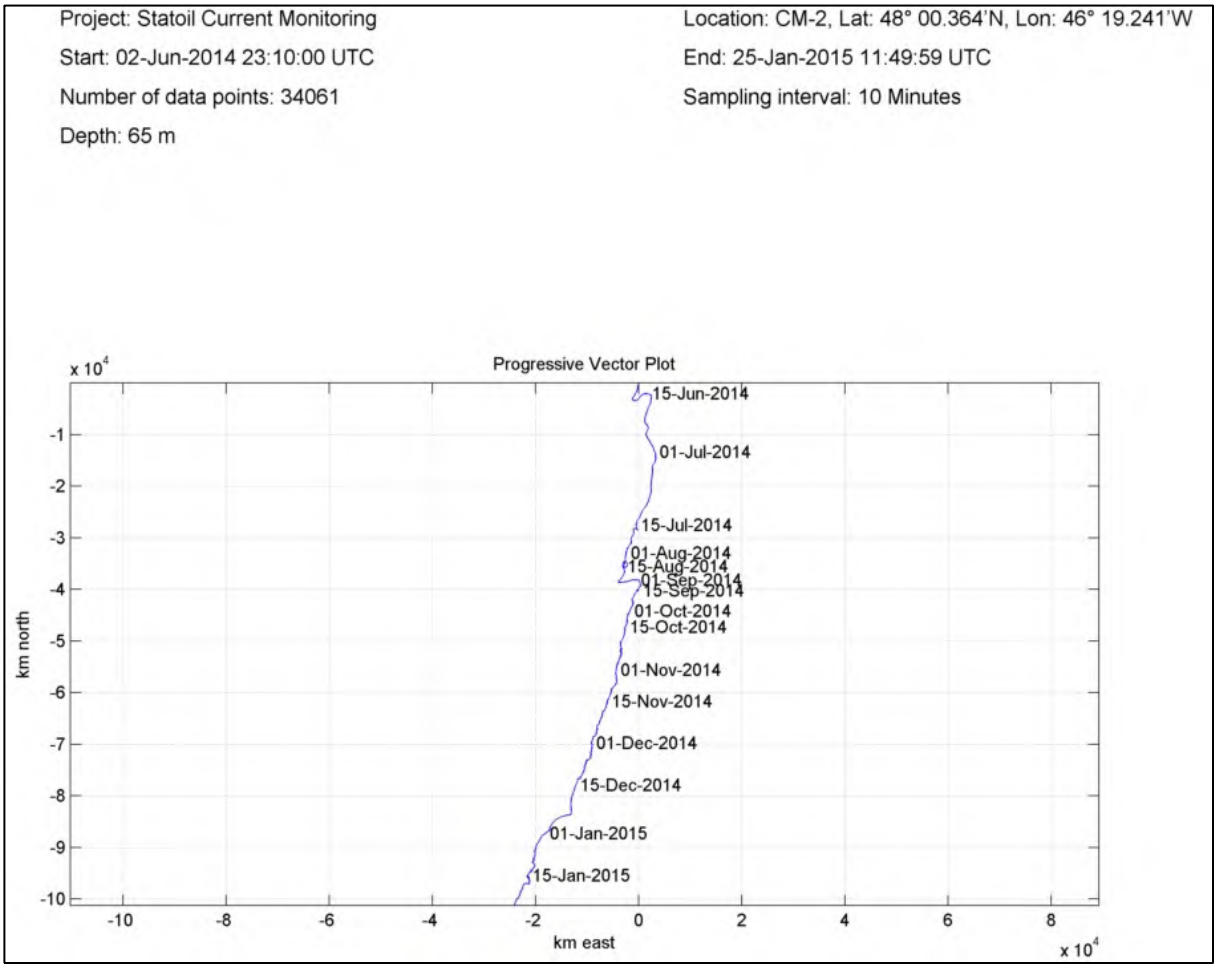
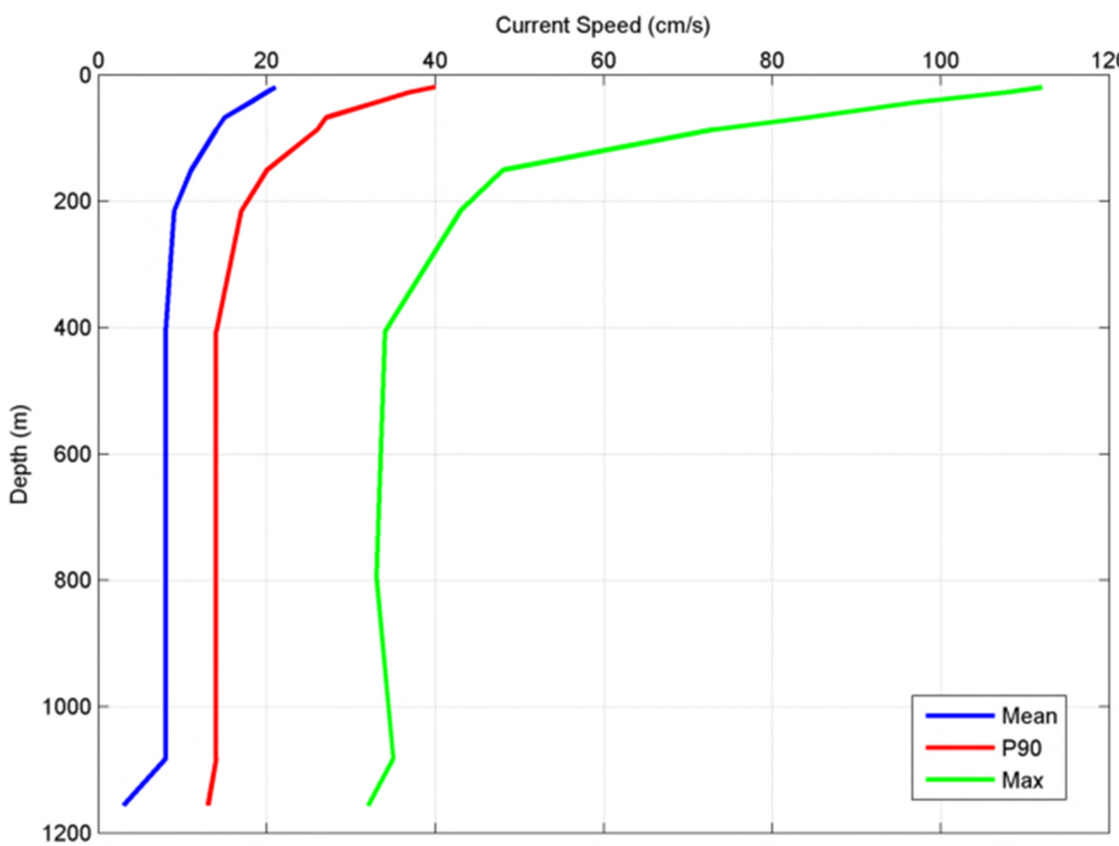


Figure 5-41 Flemish Pass Equinor Canada Current Monitoring, CM-2, Progressive Vector Plot, 65 m

A summary of current statistics derived in the Bay du Nord Field Metocean Design Basis (Statoil 2017a) from the full (2 June 2014 to 21 May 2016) CM-2 deployment is presented in Table 5.23. Currents are largest near-surface with mean and maximum speeds of 21 and 112 cm/s respectively at 19 m. Speeds decrease steadily to approximately 200 m after which speeds are fairly uniform with depth reaching mean and maximum near-bottom speeds of 3 and 32 cm/s respectively. The current profile is illustrated in Figure 5-42.

Table 5.23 Current Summary Statistics, Bay du Nord Field (CM-2)

Depth (m)	Mean Current Speed (cm/s)	P90 Current Speed (cm/s)	Maximum Current Speed (cm/s)	Direction of Maximum Current (°T) (to)
19	21	40	112	202
27	20	37	108	157
43	18	33	97	162
67	15	27	84	163
86	14	26	73	165
150	11	20	48	205
214	9	17	43	207
406	8	14	34	298
794	8	14	33	210
1,082	8	14	35	220
1,156	3	13	32	197
Source: Statoil (2017a)				



Source: Statoil (2017a)

Figure 5-42 Current Depth Profile, Bay du Nord Field (CM-2)

Annual current roses at selected depths are presented in Figure 5-43.

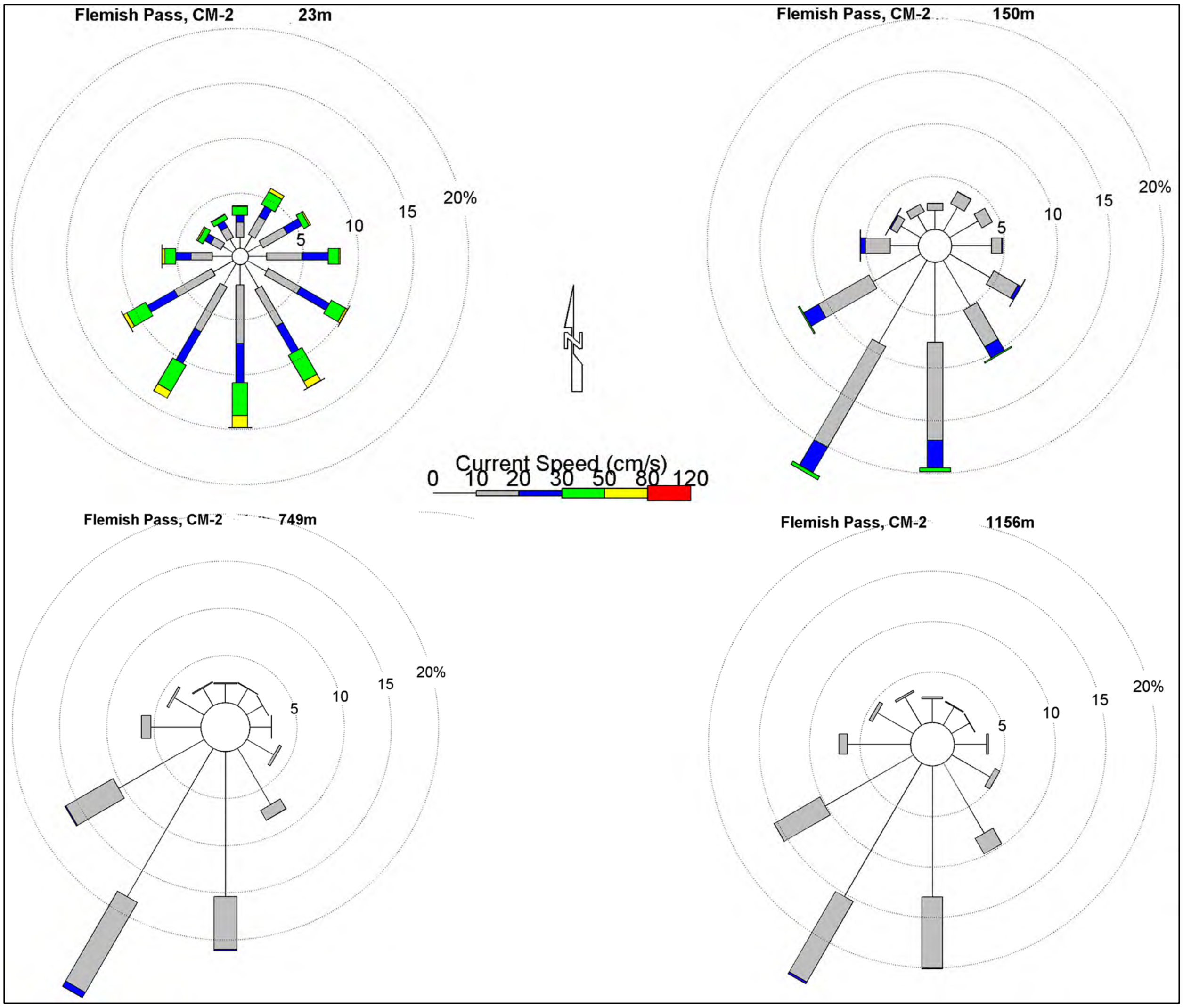


Figure 5-43 Flemish Pass Equinor Canada Current Monitoring, CM-2, Annual Current Roses, 23, 150, 794, 1,156 m

A combined wave and current mooring was also deployed between the Portugal Cove E-38 and Bonaventure O-96 Equinor Canada exploration wells in summer 2017 (Amec Foster Wheeler 2017a) (refer to Figure 5-7). A summary of monthly mean and maximum current speeds at four selected depths in the water column is presented in Table 5.24. Mean speeds generally range between 10 and 15 cm/s with higher mean speeds up to 33 cm/s in June for the 10 m near-surface depth bin. Maximum speeds generally range from 20 cm/s to as high as 114 cm/s in June. Currents from the two vector-averaging current meters (VACM) at 566 and 1,123 m are similar in magnitude, and with mean speeds generally half or less what they are near-surface; maximum speeds at these two depths are typically one third or less of the near-surface maximums.

Table 5.24 2017 Wave and Current Monitoring, Current Statistics - Equinor Canada Drilling Program

Depth (m)	Current Speed (cm/s)							
	May		June		July		August	
	Mean	Maximum	Mean	Maximum	Mean	Maximum	Mean	Maximum
10	19	79	33	114	18	74	27	71
30	16	60	26	94	10	34	12	44
566	10	16	7	18	7	18	5	13
1,123	10	19	8	20	8	24	7	16

1. Mooring located at 48° 07' 21.06" N 046° 22' 15.06" W, water depth=1,148 m, between Portugal Cove E-38 and Bonaventure O-96 wells, from 18 May to 27 August, 2017.
2. One upward-looking ADCP at 60 m (4 m current bins), and two, single-point, VACM at 566 m and 1,123 m. Two bins from the ADCP are reported here, 10 m and 30 m.

The ocean current conditions encountered along the vessel traffic route to the Project Area will vary depending on distance offshore. Close to the Avalon Peninsula circulation will be dominated by the inshore branch of the Labrador Current flowing south with average speeds of approximately 15 cm/s. This inshore branch sometimes also spreads out farther out onto the Grand Banks where currents are generally weak (less than 10 cm/s) and southwards and dominated by wind-induced and tidal current variability. Once the Grand Banks are traversed, the offshore branch of the Labrador Current that flows along the outer edge of the Grand Banks will be encountered. The flow here is stronger than inshore with average speeds of approximately 20 cm/s as reported above.

5.4.3 Extreme Events

To estimate extreme wind and wave conditions, extremal analysis was performed with the MSC50 node M6013260 near the Bay du Nord exploration wells to determine the highest expected values for wind speed, and significant wave height. The analysis was based on the Gumbel distribution to which the data were fitted using the maximum likelihood method. The analysis includes both tropical and extra-tropical storms over the entire period. The Gumbel fit is done using the maximum likelihood method. Lower and upper 95 percent confidence intervals are calculated. The confidence intervals on the extreme values are derived from the standard deviations on the maximum likelihood estimates under the assumption that they are normally distributed. These are derived from the covariance of the estimates of the maximum likelihood parameters of the Gumbel distribution (its mean and standard deviation). The covariance matrix of these two parameters is calculated from the data as the inverse of the observed Fisher information matrix (a measure of the curvature of the log-likelihood surface at the maximum likelihood estimate).

Extreme values were computed for four different return periods: 1, 10, 50 and 100 years (Table 5.25). In the Project Area, extreme winds range from 26.0 m/s to 36.0 m/s for the 1-year and 100-year return periods respectively, while extreme waves range from 11.8 m to 16.5 m.

Table 5.25 Extreme Wind and Wave Estimates, MSC50 Node M6013260 - Core BdN Development Area (1962–2015)

Return Period (years)	1	10	50	100
Significant Wave Height (m)	11.8 +/- 0.2	14.1 +/- 0.5	15.8 +/- 0.6	16.5 +/- 0.6
Wind Speed (m/s)	26.0 +/- 0.3	30.6 +/- 1.3	34.4 +/- 2.0	36.0 +/- 2.3

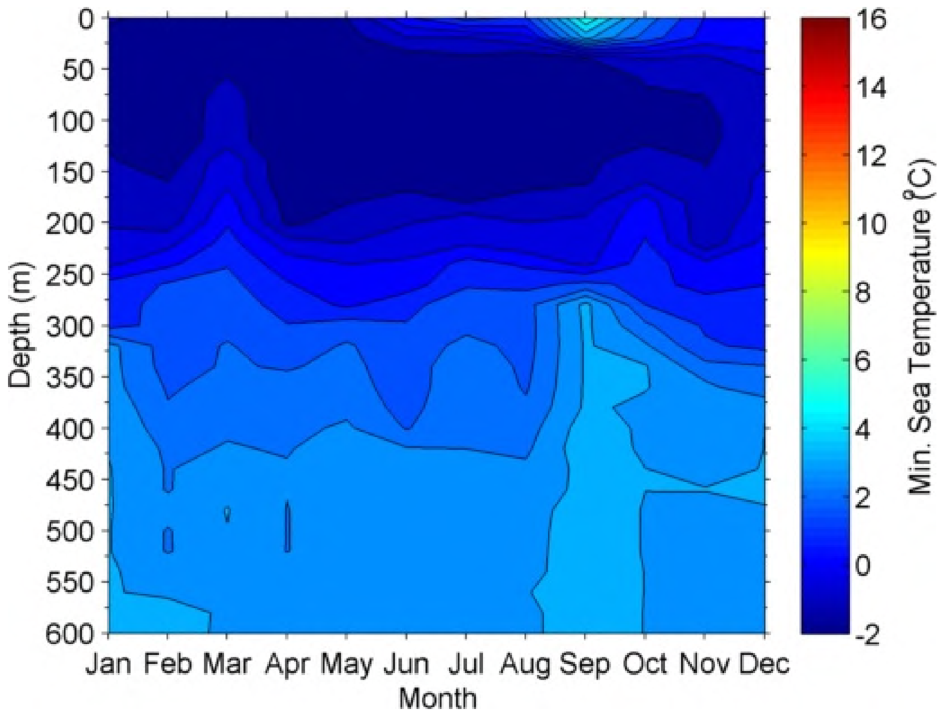
By way of comparison, the Bay du Nord Field Metocean Design Basis (Statoil 2017a) reports a 100-year return period (annual probability of exceedance of 10^{-2}) significant wave height of 15.5 m and a 100-year return period wind speed (1 h, 10 m as with the values reported in Table 5.25) of 39 m/s. It is noted the Metocean Design Basis employs MSC50 node M6013427 approximately 11 km north of the MSC50 node M6013260 selected here and uses the full 1954-2015 record. The 100-year return period extreme individual wave height and crest height (Forristall's formulation) are 29.7 m and 18.6 m respectively (Statoil 2017a).

5.4.4 Seawater Properties (Temperature, Salinity, pH, Turbidity)

Statistical summaries of sea temperature and salinity were derived from the Hydrographic Database of the ODI of the Bedford Institute of Oceanography (DFO 2018c) for a rectangular area (47.72 - 48.41N, 45.93 - 47.3 W) surrounding the Project Area, querying the period 1900 to 2018 for depths down to 2,000 m. Additional temperature and salinity measurements from CTD instruments deployed on Equinor Canada met-ocean monitoring programs in the Project Area are also reported. Figure 5- 44 through Figure 5-47 present monthly depth profiles and contours of minimum, mean, and maximum sea temperature for the Project Area.

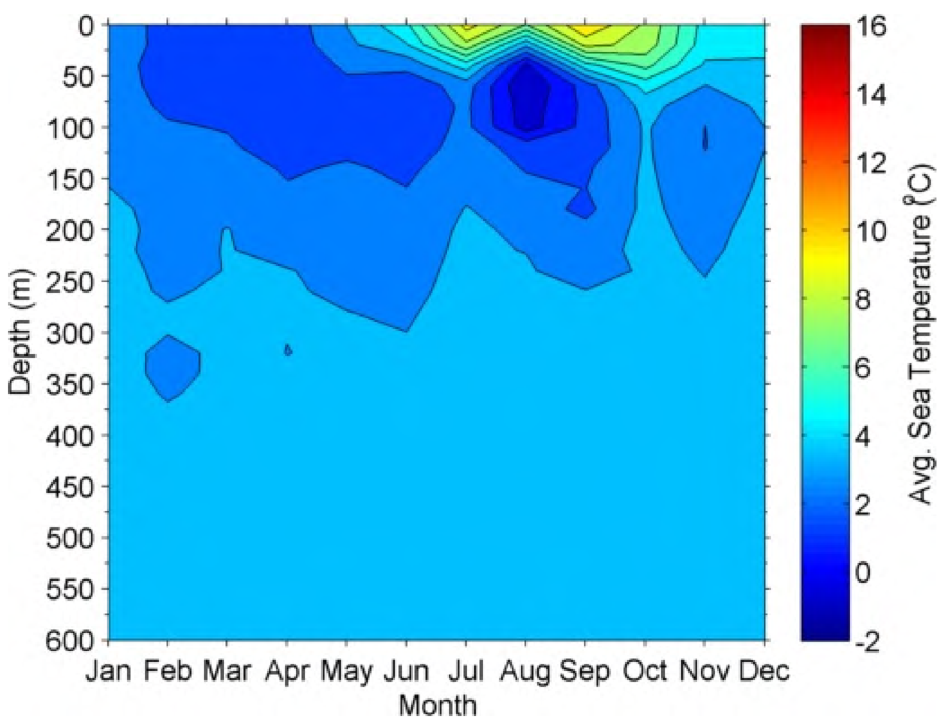
Mean sea surface temperatures range from 1.7°C in March to 10.3°C in September. Minimum temperatures at the surface range from -1.8°C in February to 5.3°C in September. A cold patch is evident in August over depths of approximately 30 to 150 m, although these statistics are based on few measurements, approximately one quarter to one tenth the number of measurements that exist at most other depths in other months. Maximum sea surface temperatures range from 4.6°C in March to 16.2°C in August. This seasonal temperature cycle is observed down to 250 m, where temperatures are higher in the summer than in winter. For depths greater than 250 m however, sea temperature is only slightly variable by depth with monthly mean temperatures ranging from 2.9°C to 4.0°C and averaging 3.4°C down to 2,000 m.

As a companion to the above sea temperature data, Figure 5-48 through Figure 5-51 present monthly depth profiles and contours minimum, mean, and maximum salinity for the Project Area. Sea surface salinities range from a minimum of 32.1 PSU in August to a maximum of 33.9 PSU in January and March. Considering depths down to 250 m, the variability in salinity ranges from 32.1 to 34.8 PSU and average 34.2 PSU. For depths below 250 m, the range in salinity is even less with measurements from 500 to 3,000 m variable being between 34.6 and 35.0 PSU.



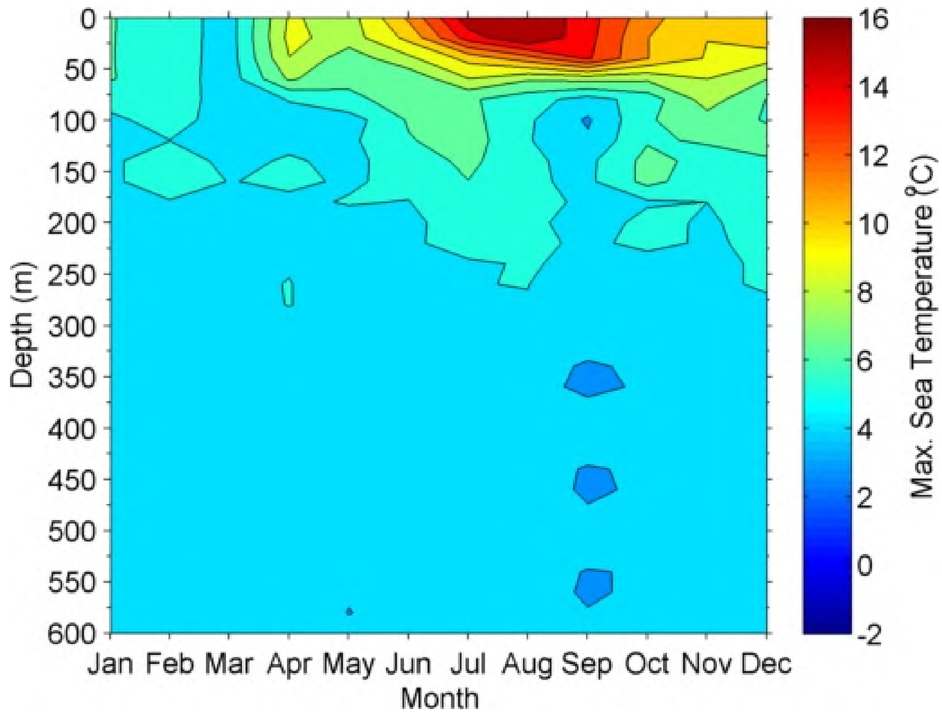
Source: based on DFO (2018c)

Figure 5-44 Monthly Minimum Sea Temperature



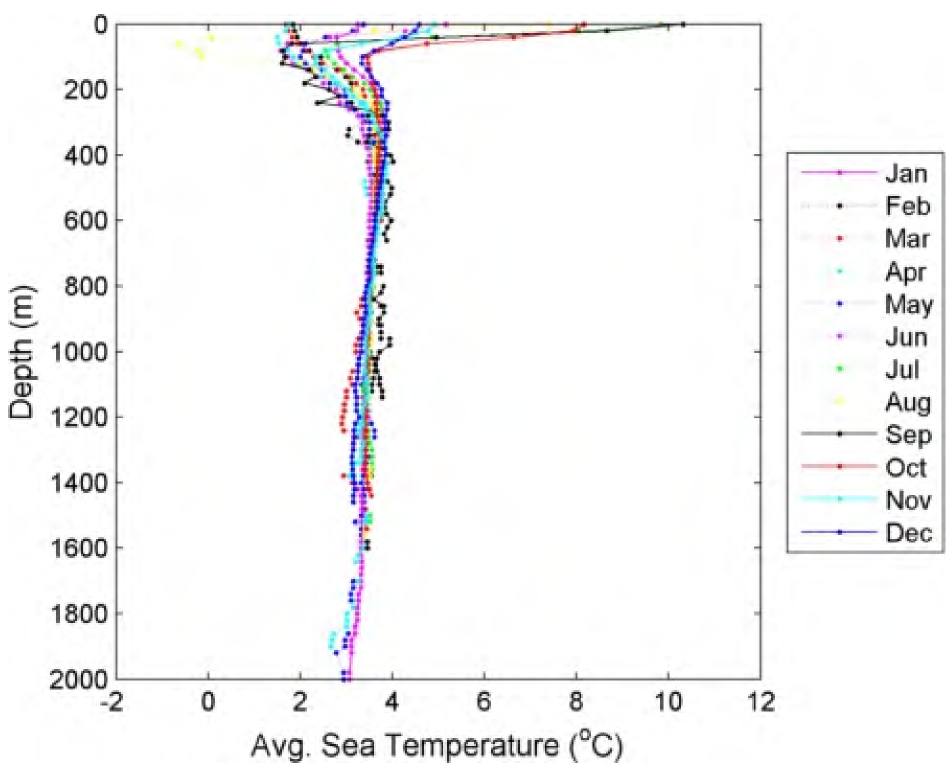
Source: based on DFO (2018c)

Figure 5-45 Monthly Average Sea Temperature



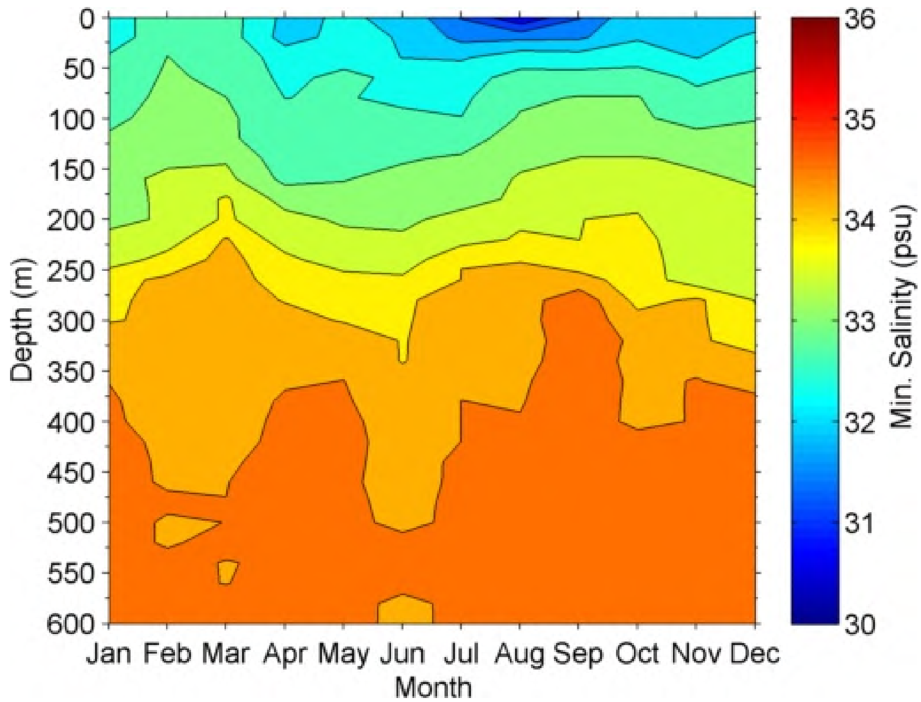
Source: based on DFO (2018c)

Figure 5-46 Monthly Maximum Sea Temperature



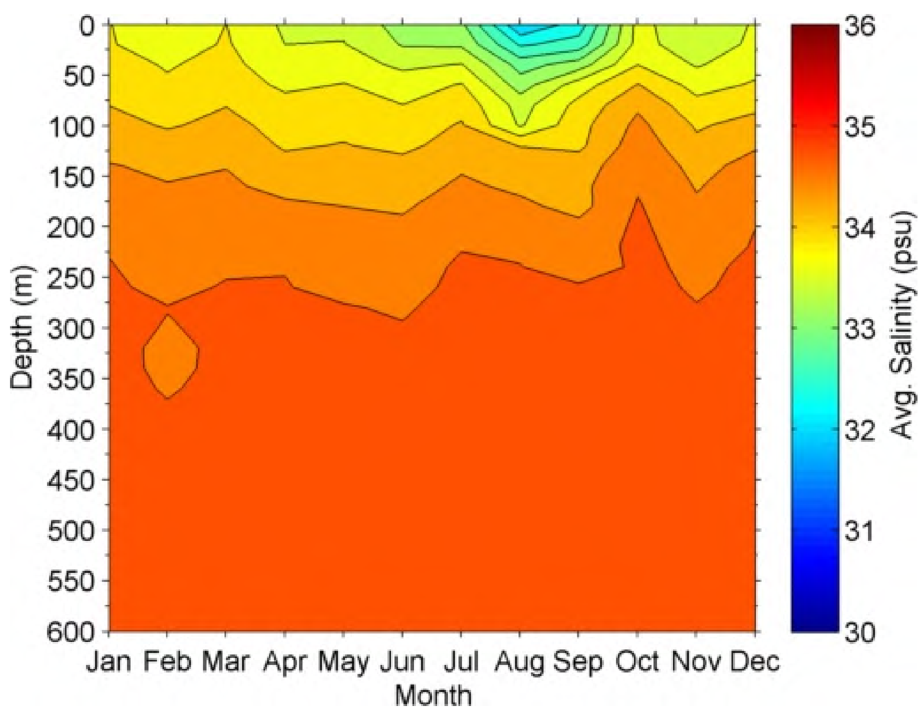
Source: based on DFO (2018c)

Figure 5-47 Depth Profile of Monthly Average Sea Temperature



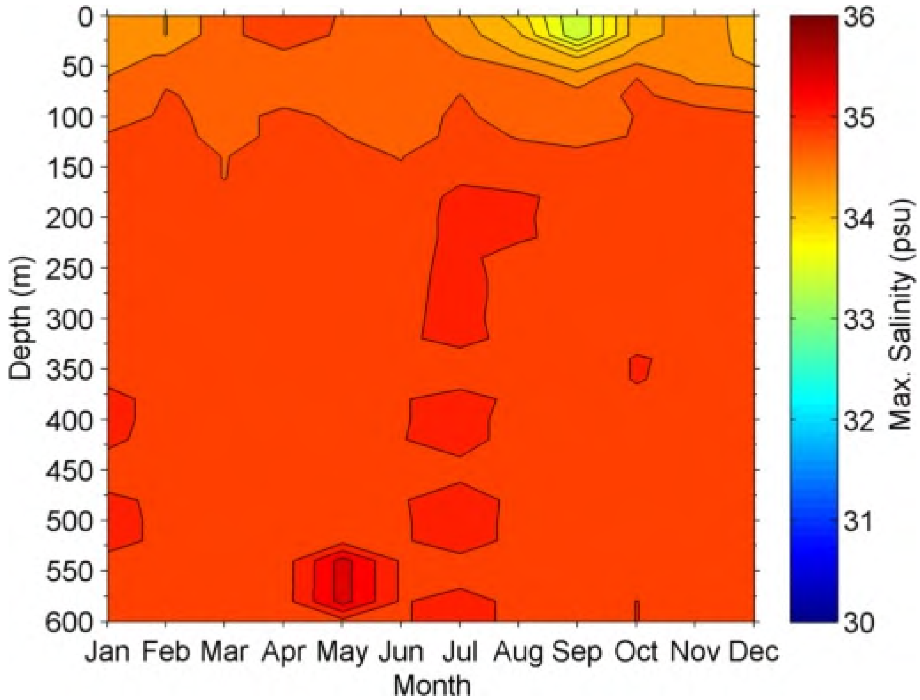
Source: based on DFO (2018c)

Figure 5-48 Monthly Minimum Salinity



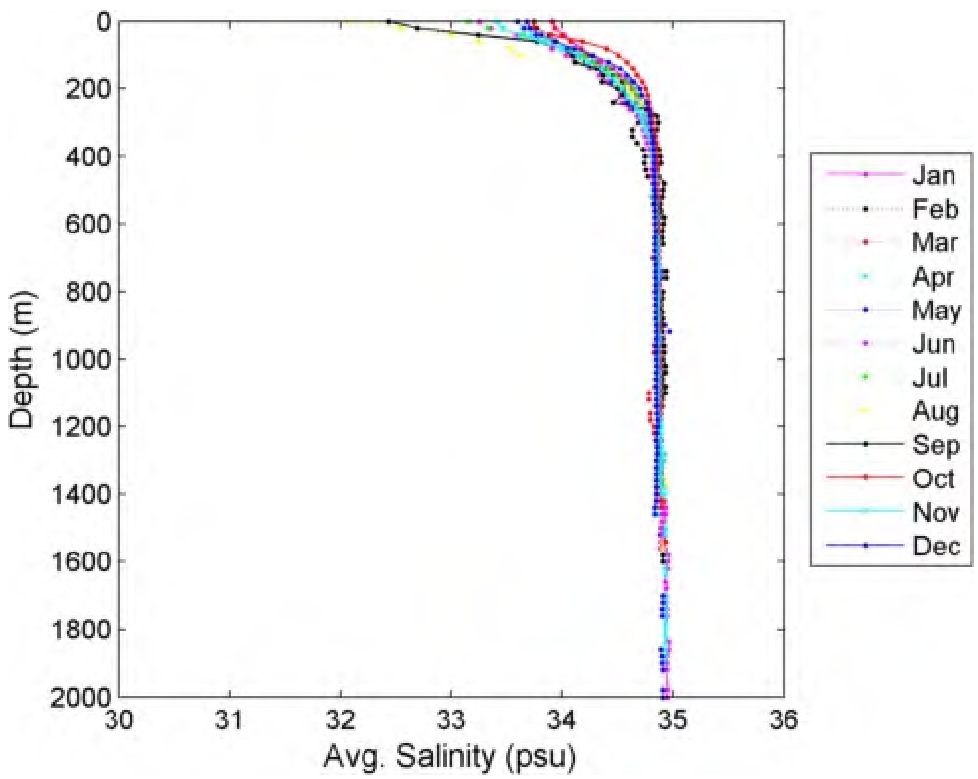
Source: based on DFO (2018c)

Figure 5-49 Monthly Average Salinity



Source: based on DFO (2018c)

Figure 5-50 Monthly Maximum Salinity



Source: based on DFO (2018c)

Figure 5-51 Depth Profile of Monthly Average Salinity

These temperature and salinity statistics represent the normal conditions across the Project Area. Local seawater properties may exhibit some spatial variability (both across the Project Area and by depth) and temporal variability. In addition, not all months or depths are well-sampled. For example, surface waters are typically better sampled than deeper waters, and similarly, summer months are better represented than winter months.

Table 5.26 reports monthly mean, minimum and maximum near-surface (approximately 90 m) temperature and salinity measured from CTDs deployed during the CM-2 (Amec Foster Wheeler 2015b) and Fitzroya (Amec Foster Wheeler 2016) current monitoring programs for Equinor Canada. Minimum sea temperatures range from -0.68°C in May to 3.12°C in November. Maximum sea temperatures range from 1.82°C in May to 8.2°C in October. Mean sea temperatures range from 0.53°C in May to 4.3°C in November.

Table 5.26 Monthly Sea Temperature and Salinity, Near-Surface, CM-2, Fitzroya Current Moorings

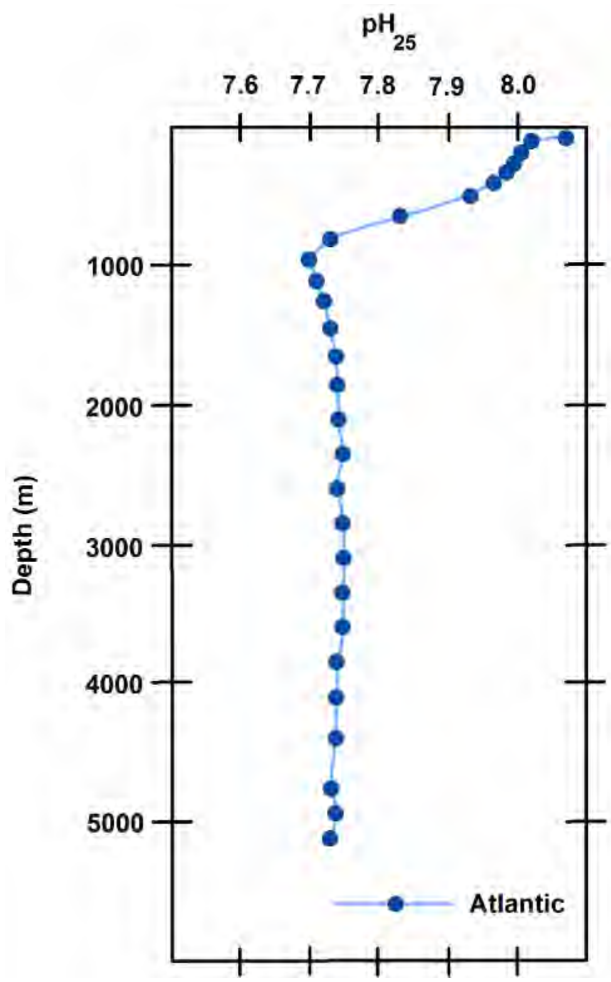
Month	Temperature (°C)			Salinity (psu)		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Jan 2015	1.63	3.13	2.33	34.12	34.54	34.32
Jan 2016	1.14	3.99	2.54	33.94	34.37	34.15
Feb	0.96	2.56	1.76	34.01	34.46	34.27
Mar	-0.52	2.05	0.71	33.65	34.31	33.97
Apr	-0.54	2.54	0.99	33.63	34.53	34.08
May	-0.68	1.82	0.53	33.60	34.23	33.94
Jun	0.47	4.09	1.90	33.83	34.57	34.18
Jul	0.62	4.15	2.16	33.92	34.50	34.21
Aug	-0.15	4.54	1.84	33.78	34.54	34.14
Sep	1.86	3.99	2.92	34.24	34.68	34.50
Oct	2.89	8.20	3.75	34.03	34.75	34.65
Nov	3.12	7.72	4.30	33.98	34.76	34.52
Dec 2014	2.25	3.58	2.84	34.04	34.65	34.25
Dec 2015	1.94	5.08	4.01	33.95	34.66	34.22

CM-2 statistics are reported for a depth of 85.2 m for June 2014 to January 2015 (Amec Foster Wheeler 2015b)
Fiztroya statistics are reported for a depth of 92.0 m for December 2015 to May 2016 (Amec Foster Wheeler 2016)

Two water samples collected near-surface in the Core BdN Development Area in September 2017 report pH values of 7.88 and 7.89. Measurements for pH data are otherwise scarce for the Project Area and limited in both temporal and spatial resolution, the description provided herein is based on data collected from the World Ocean Circulation Experiment (WOCE) database for the entirety of the Atlantic Ocean (data available at http://cdiac.ornl.gov/oceans/CDIACmap.html). Figure 5-52 shows that surface waters in the Atlantic Ocean have a pH (adjusted to 25°C temperature) range of 8.0 to

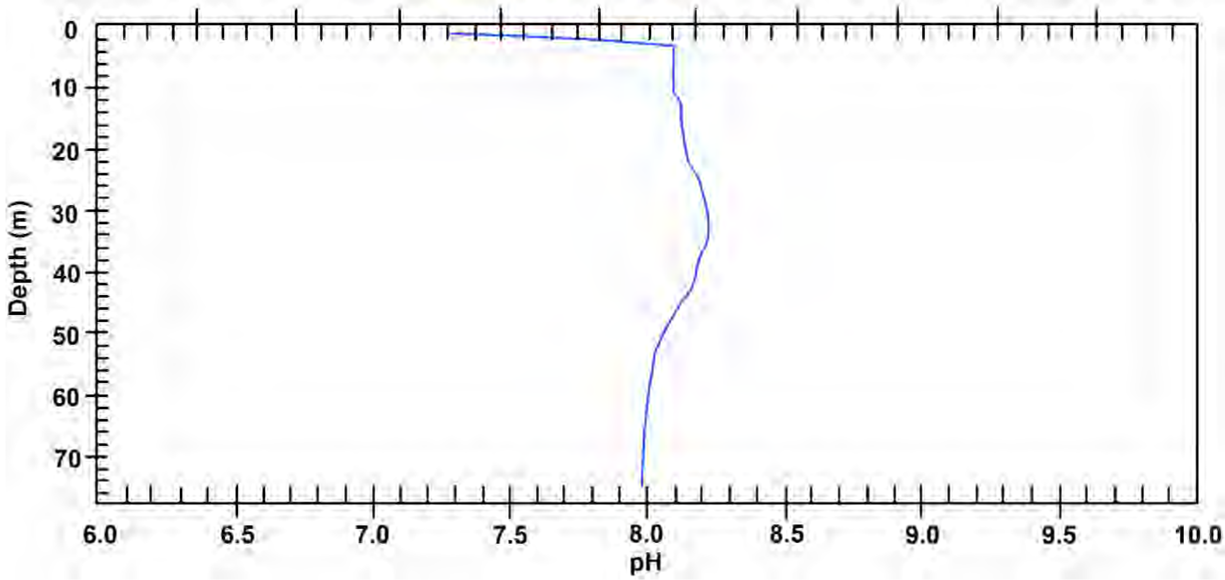
8.1, which decreases to approximately 7.7 at 1,000 m depth, then remaining stable to the ocean floor. An example CTD profile of surface waters (0-80 m) from the Hibernia Effects Monitoring (EEM) Program in 2014 is shown in Figure 5-53, which agrees with surface waters on the Grand Banks having a pH of approximately 8.1.

Turbidity data are similarly scarce for the Project Area. Data are available from National Oceanic and Atmospheric Administration (NOAA), from a cruise in March of 2011 in an area north of Flemish Pass (Ullman et al. 2013). From this cruise, it can be seen that turbidity is approximately 0.2 to 0.3 NTU in near-surface waters and steadily decreases to below 0.01 at 200 m and deeper. It should be noted that there is some potential for seasonal variability associated with biogenic fallout.



Source: Wallace (1997)

Figure 5-52 Overview of pH for the Atlantic Ocean from the WOCE



Source: Stantec Consulting (2014)

Figure 5-53 Surface pH data from Hibernia EEM Program, December 9, 2014

5.4.5 Tides

Water level variations due to tides in the Project Area are generally quite predictable. Several models are available for the prediction of water levels at specific locations where the tidal constituents are known or can be extrapolated from other locations.

Using the WebTide model (Dupont et al. 2002), based on tidal modeling studies conducted by DFO, tidal water levels are computed for the Core BdN Development Area at the same location of the referenced MSC50 node (used for wind and wave analysis). These results are presented in Table 5.27.

Table 5.27 Tidal Predictions

Project Area Location	Tidal Constituent	Constituent Amplitude (cm)	Phase (deg GMT)	Total Amplitude (cm)
47.9°N, 46.4°W	M_2	14.6	323.8	39.5
	K_1	8.3	159.7	
	N_2	3.0	309.8	
	S_2	7.7	359.9	
	O_1	5.9	130.6	

The contribution of each tidal constituent to the observed tidal range during a full tidal cycle is twice its amplitude. The largest contribution comes from M2, the principal lunar semidiurnal constituent, followed by S2, the solar semidiurnal constituent. The other components have a relatively smaller contribution toward the observed tides. Overall, the water levels exhibit two high tides and two low tides per day, with one set of tides having a higher tidal range than the other.

The highest and lowest astronomical tide (HAT, LAT) elevations at Bay du Nord, based on the NAO.99b tidal prediction system, as reported in Equinor Canada (2015) are 43 and -32 cm above and below mean sea level, respectively.

5.4.6 Storm Surge

Storm surge is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. Storm surge amplitudes can be high in coastal areas, but surges with comparatively smaller amplitudes can also occur offshore, away from the coastline. A hazard from storm surges is elevated mean water levels, specifically when they occur at high tide. Extreme storm surge calculations based on a study by Bernier et al. (2006), which used a hindcast of water levels over 40 years, calculated a potential 100-yr storm surge of 90 cm in the northwest Atlantic at the location of the MSC50 M6013260 data point, with a 10,000-yr storm surge of 1.23 m.

5.4.7 Total Water Level

A total extreme water level for the Bay du Nord field is estimated at 20 m for a 100-year return period and 24.9 m for a 1,000-year return period (Statoil 2017a). The 100-year estimate includes a tidal amplitude (HAT) of 0.4 m, a storm surge of 0.8 m and a wave crest height of 18.8 m. The 1,000-year estimate includes a storm surge of 1.0 m and a wave crest height of 23.9 m.

5.5 Ice Conditions

Portions of the Project Area are subject to seasonal incursions of sea ice and icebergs, as well as marine icing during certain wind, wave, and air temperature conditions. Sea ice and iceberg conditions vary each year and by location and are influenced by colder or milder winter conditions over NL and the surrounding waters, and seasonal wind patterns. Cold and dry winds from the west through north have the effect of moving sea ice farther offshore, while northeasterly winds tend to bring sea ice towards shore. These factors may influence the distribution of sea ice over the Project Area. This section provides an overview of sea ice, iceberg and marine icing conditions. Descriptions for each are presented for the Project Area as well as for the vessel traffic route.

Additional detail on sea ice conditions for regions near the Project Area are provided in Chapter 5 of the Drilling EIS (Statoil 2017b) as well as the two-volume Sea Ice and Iceberg Studies for Bay du Nord (C-CORE 2017a, C-CORE 2017b). Additional details for the vessel traffic route and the larger eastern NL Offshore Area are provided in the Eastern Newfoundland SEA, Section 4.1 (Amec 2014).

5.5.1 Sea Ice

This section provides an overview of the sea (drift or pack[2]) ice conditions most likely to be encountered in the Project Area.

Information is primarily drawn from the CIS regional (weekly) ice analysis. The most recent 30 years, 1989 to 2018, are selected to be representative of the normal ice climate. These data are used to characterize conditions over the Project Area and vessel traffic route, the sea ice is described at seven locations as illustrated in Figure 5-54.

Additional resources include the C-CORE Sea Ice Study which presents expected pack ice conditions at Bay du Nord to form the basis of sea ice risk and loads analyses for future exploration and production activities at the site (C-CORE 2017a). This study considers a two areas of interest (AOI), AOI1 focusing on Bay du Nord and a broader east coast AOI2 (Figure 5-54).

The CIS Sea Ice Climatic Atlas for the East Coast 1981-2010 (CIS 2011) covers the Project Area and vessel traffic route and includes weekly charts of frequency of presence of sea ice, median of ice concentration when sea ice is present, and median of predominant ice type when sea ice is present. The 1980-2010 atlas provides a recent comprehensive climatology of sea ice conditions in the region; though as discussed below, inclusion of sea ice charts through 2018 provides an update.

The CIS Regional Ice Charts are not always prepared on the same dates each year, so that a seven-day period centered on historical dates is general employed (as it is here consistent with the ice atlas). This results in an historical date for the weekly charts. Information for a given historical week is based on the weekly charts within three days on either side of the historical date. For example, the chart for historical date 15 January is representative for the period 12 to 18 January. As noted in the Ice Atlas, variations in the extent of sea ice over East Coast waters, and hence the Project Area, are great due to both winds and temperatures being effective in changing the location of the ice edge. A large variability in sea ice conditions can therefore be experienced from year to year, and also in a given year, on time scales of days to weeks and over comparatively small geographic scales of tens of kilometres.

Based on analysis of weekly charts, for the period 1986 to 2015, sea ice has been present within the AOI1 during January through May, although sea ice in January and May has not been observed since 1996. The most likely occurrence is during March and April, with the greatest occurrence in March.

During March from 1996 to 2005 sea ice was present in concentrations greater than 1/10 for two of these years for a mean duration of 0.2 days and for as long as 15 days. During March from 2006 to 2015 sea ice was present in concentrations greater than 1/10 for three of these years for a mean duration of 1.3 days and for as long as 28 days (C-CORE 2017a).

[2] Drift or pack ice is used in a wide sense to include any area of sea ice, other than fast ice (ice which forms and remains fast along the coast.), no matter what form it takes or how it is disposed. When concentrations are high (i.e., 7/10 or more, the term pack ice is normally used). When concentrations are 6/10 or less the term drift ice is normally used (CIS 2005).

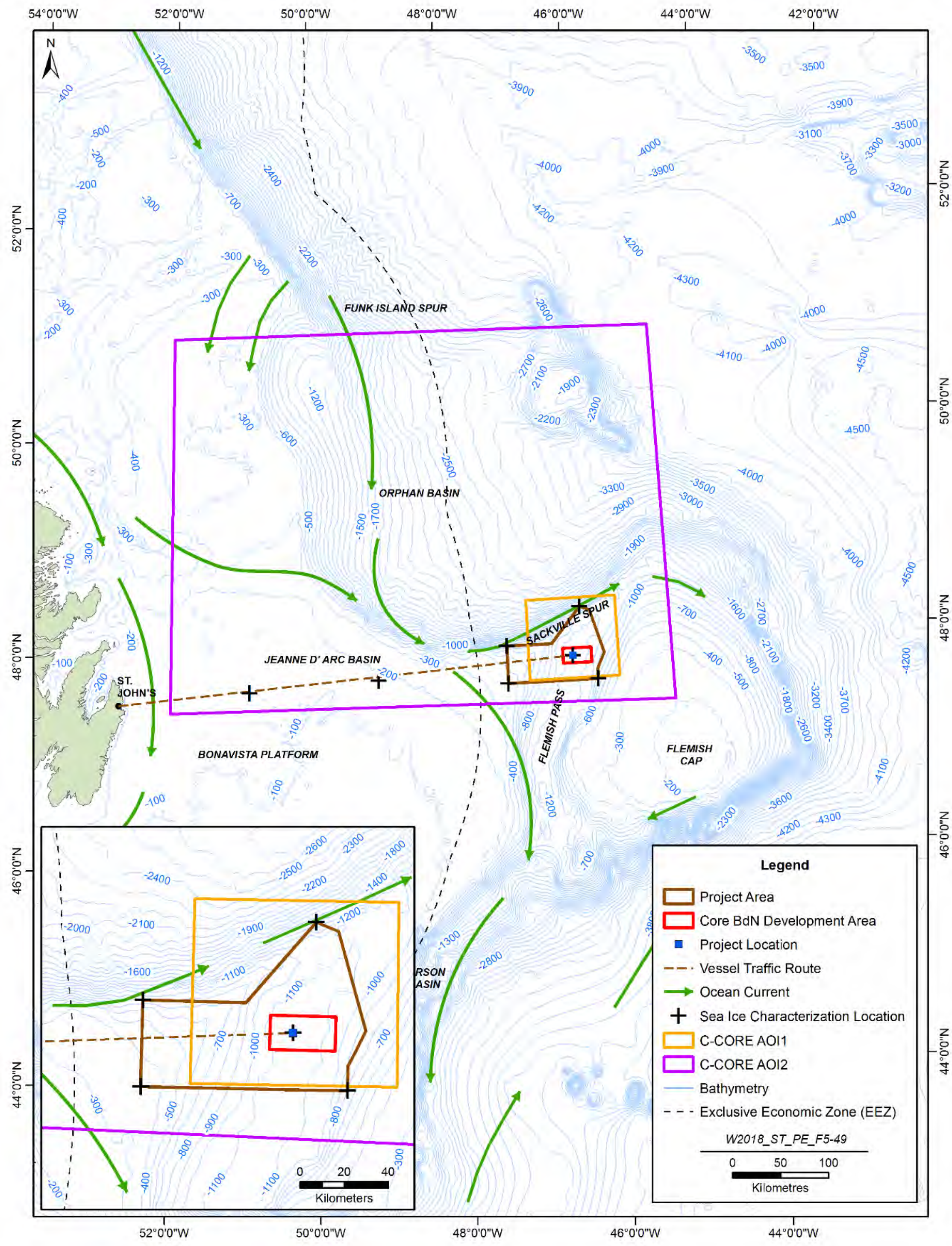
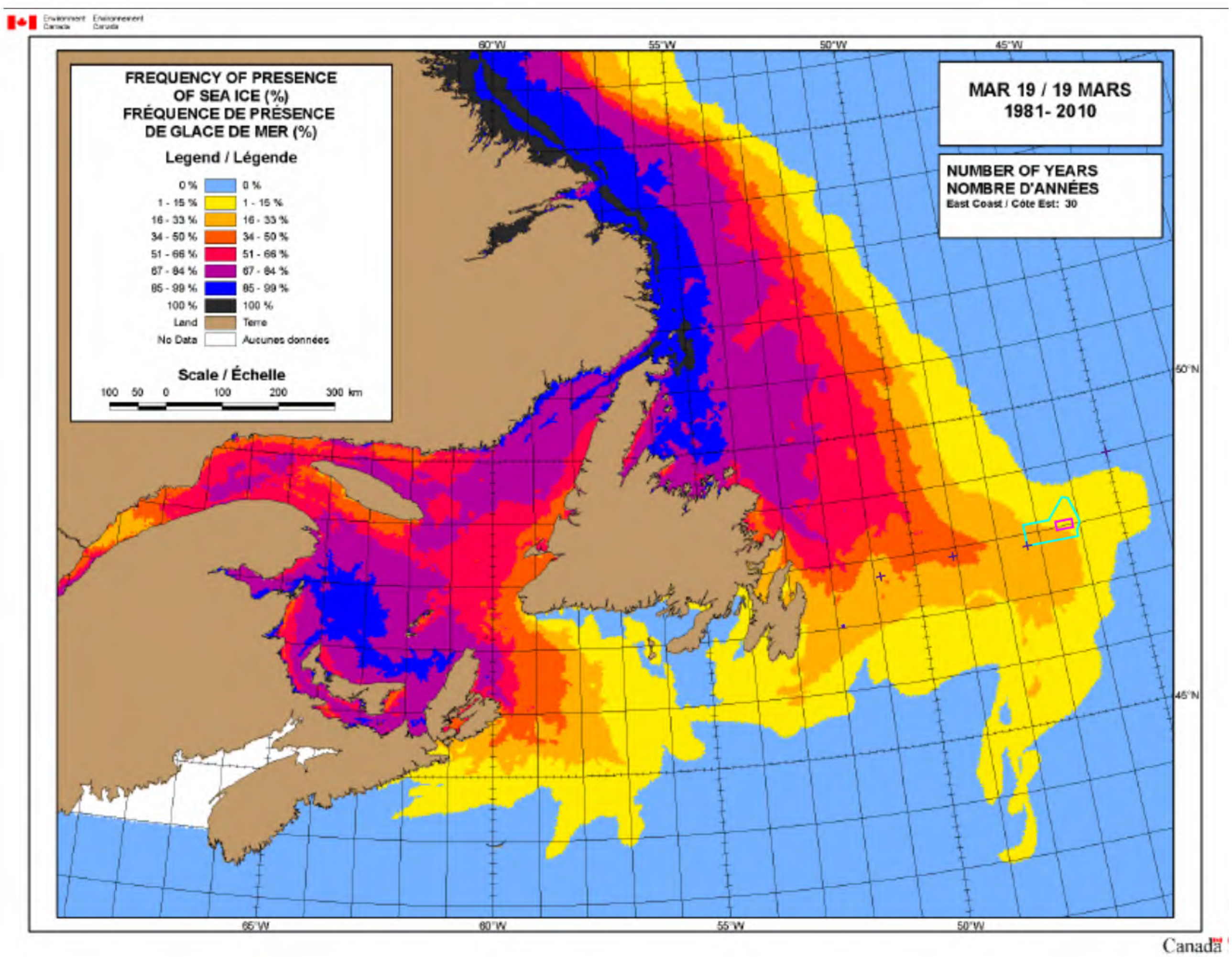


Figure 5-54 Project Area Locations Used for Sea Ice and Iceberg Characterization

An illustration of sea ice conditions on the east coast, and covering the Project Area, and vessel traffic route is shown in Figures 5-55 to 5-59. The week of 19 March is shown, which illustrates conditions when sea ice conditions are generally at their peak in terms of sea ice extent and sea ice presence of first year ice over the Project Area.

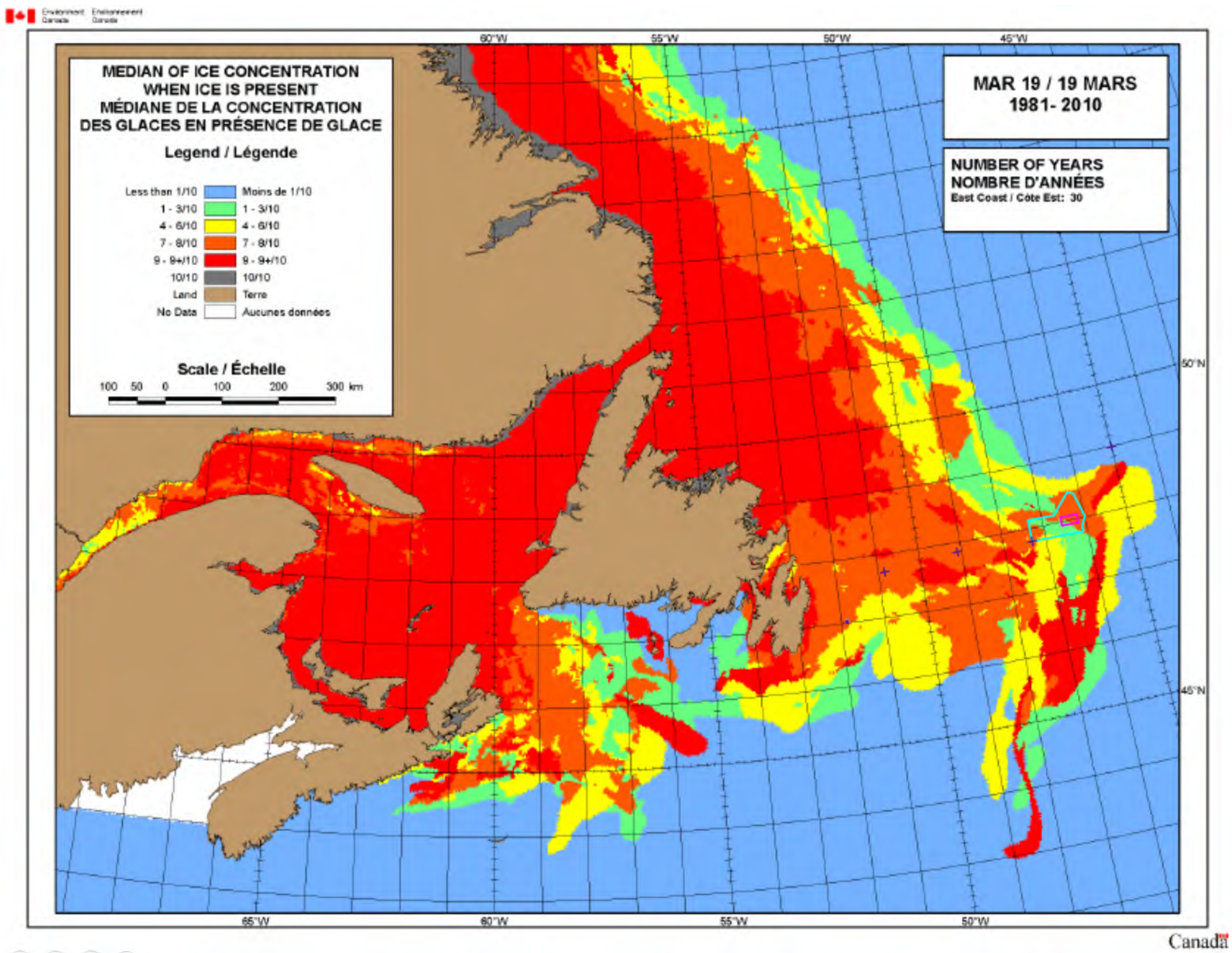
Figure 5-55 shows the frequency of presence of sea ice for the week of 19 March. The frequency of presence of sea ice is 1 to 15 percent, or about as frequent as every six or seven years, for most of the Core BdN Development Area and the northeastern half of the Project Area. The likelihood of sea ice doubles over the remainder (southwestern half) of the Project Area to 16 to 33 percent of the time. Along the vessel traffic route, during the week of 19 March, the likelihood of encountering sea ice is also 16 to 33 percent of the time though with the potential for a 34 to 50 percent frequency of occurrence at about one quarter and two thirds along the route from St. John's.



Source: CIS (2011)

Figure 5-55 Frequency of Presence of Sea Ice, Week of 19 March

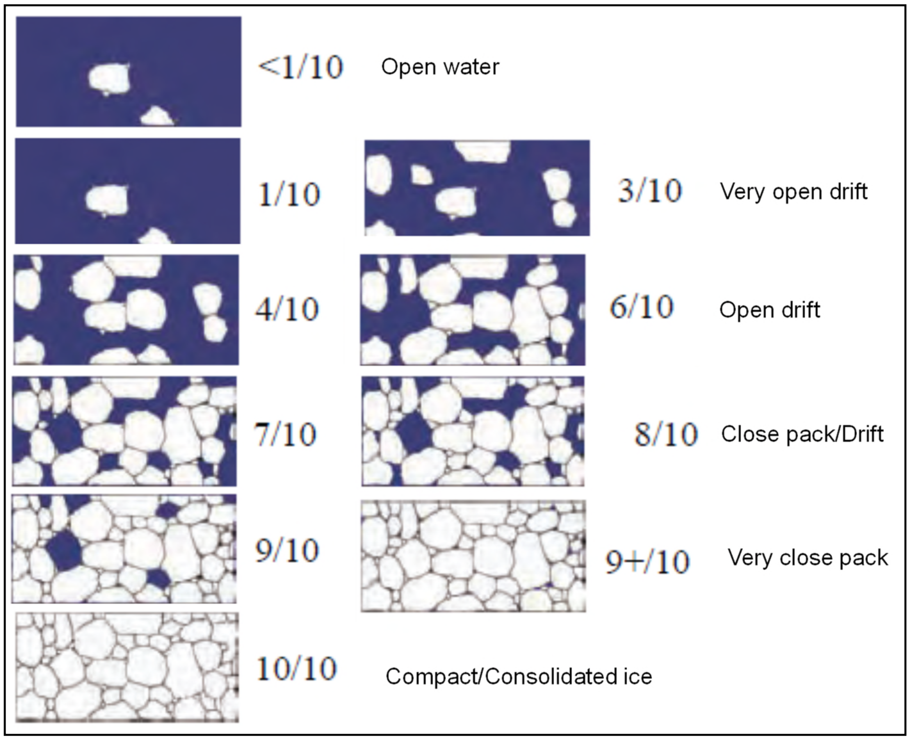
Figure 5-56 shows the median of sea ice concentration when sea ice is present for week of 19 March. During this period, the median sea ice concentration, when sea ice is present, over most of the Core BdN Development Area and northeastern half of the Project Area is 7 to 8/10, while over the remainder of the Project Area sea ice concentrations range from 1 to 3/10 to 7 to 8/10. Along the vessel traffic route, when sea ice is present, median concentrations are generally 7 to 8/10 with scattered patches of 9 to 9+/10 concentration.



Source: CIS (2011)

Figure 5-56 Median of Ice Concentration When Ice Is Present, Week of 19 March

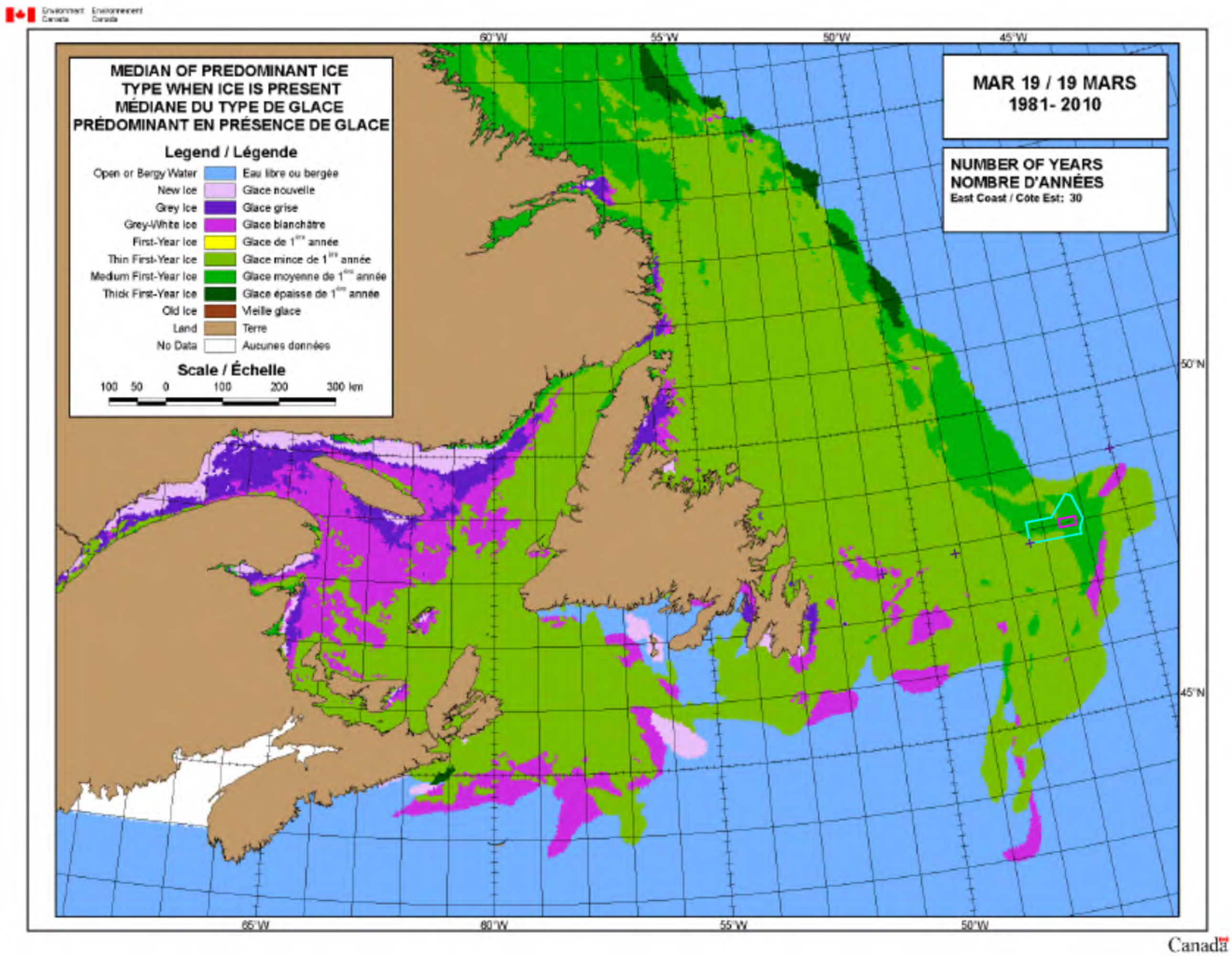
To accompany the discussions, Figure 5-57, which is derived from the MANICE publication (CIS 2005), illustrates the scale in which sea ice concentration is reported, from open water (sea ice concentration of less than 1/10) to compact/consolidated sea ice (10/10 concentration).



Source: CIS (2005)

Figure 5-57 Ice Concentrations from an Aerial Perspective

Figure 5-58 shows the predominant sea ice type when sea ice is present for week of 19 March. During this period, it is mostly medium first-year (FY) (sea ice of not more than one winter's growth) sea ice of thickness 70 to 120 cm over most of the Project Area including the Core BdN Development Area. Thin FY sea ice (30 to 70 cm) is also present in the Project Area and predominant to the west along the vessel traffic route. Areas of grey-white sea ice (15-30 cm) are also common along the vessel traffic route and east of the Project Area. Table 5.28 from MANICE (CIS 2005) lists the stages of sea ice development that occur together with their associated thickness.



Source: CIS (2011)

Figure 5-58 Median of Predominant Ice Type When Ice Is Present, Week of 19 March

Table 5.28 Stage of Development, Sea Ice

Description	Thickness
New	<10 cm
Nilas; Ice rind	<10 cm
Young	10-30 cm
Grey	10-15 cm
Grey-white	15.30 cm
First-year	≥30 cm
Thin first-year	30-70 cm
Medium first-year	70-120 cm
Thick first-year	>120 cm
Source: Table 5.1, CIS (2005)	

In general, for this part of the northwest Atlantic Ocean, for a given week during the period when sea ice is present, sea ice is more likely of greater concentration and thickness in the western portions and less severe farther offshore to the east. With passing weeks, as the sea ice advances, there is potential that thicker sea ice to the west and north will continue to drift farther offshore (south and east).

There is potential for land fast ice nearshore, which is ice that forms and remains fast along the coast and can extend from a few metres to several hundred kilometres offshore. Land fast ice has the potential to influence conditions within the vessel traffic route near shore; however, it is unlikely to be a factor in the Project Area itself. From analysis of the CIS sea ice charts reported below there were no occurrences of 10/10 (land fast) ice concentration for the four Project locations (Figure 5-59, Figure 5-54) considered. Inspection of the CIS Sea Ice Climatic Atlas for the East Coast 1981-2010 (CIS 2011) indicates one week only, the week of 23 April, with fast ice: a narrow (<20 km) strip of land fast ice along the east coast of the Avalon Peninsula south of St. John's.

Within the Project Area, sea ice is most prevalent over the southwest as this region sees the greatest influx of ice that drifts south from Labrador and the northeast coast of NL and out onto the Grand Banks and east over the Orphan Basin and Flemish Pass.

The CIS regional weekly ice charts, for the period January 1989 to August 2018, were analysed to facilitate the characterization of sea ice conditions over the Project Area and vessel traffic route[3].

[3] CIS charts in ArcINFO Workstation interchange file format (.e00) were downloaded (CIS 2018) and imported into ArcMap using the "Import from e00" conversion tool. An example ice chart is shown in Figure 5-59. The interchange file contains all associated egg code data and related information. Once the data were imported in ArcMap a spatial join was executed using the imported ArcINFO coverages and the set of seven representative locations shown in Figure 5-54 resulting in a final vector shapefile containing all associated egg code data. These steps were duplicated on 1,102 files (January 1989 to August 2018) and merged into a single vector file which was then exported to an Excel spreadsheet to be used for the ice characterizations presented below.

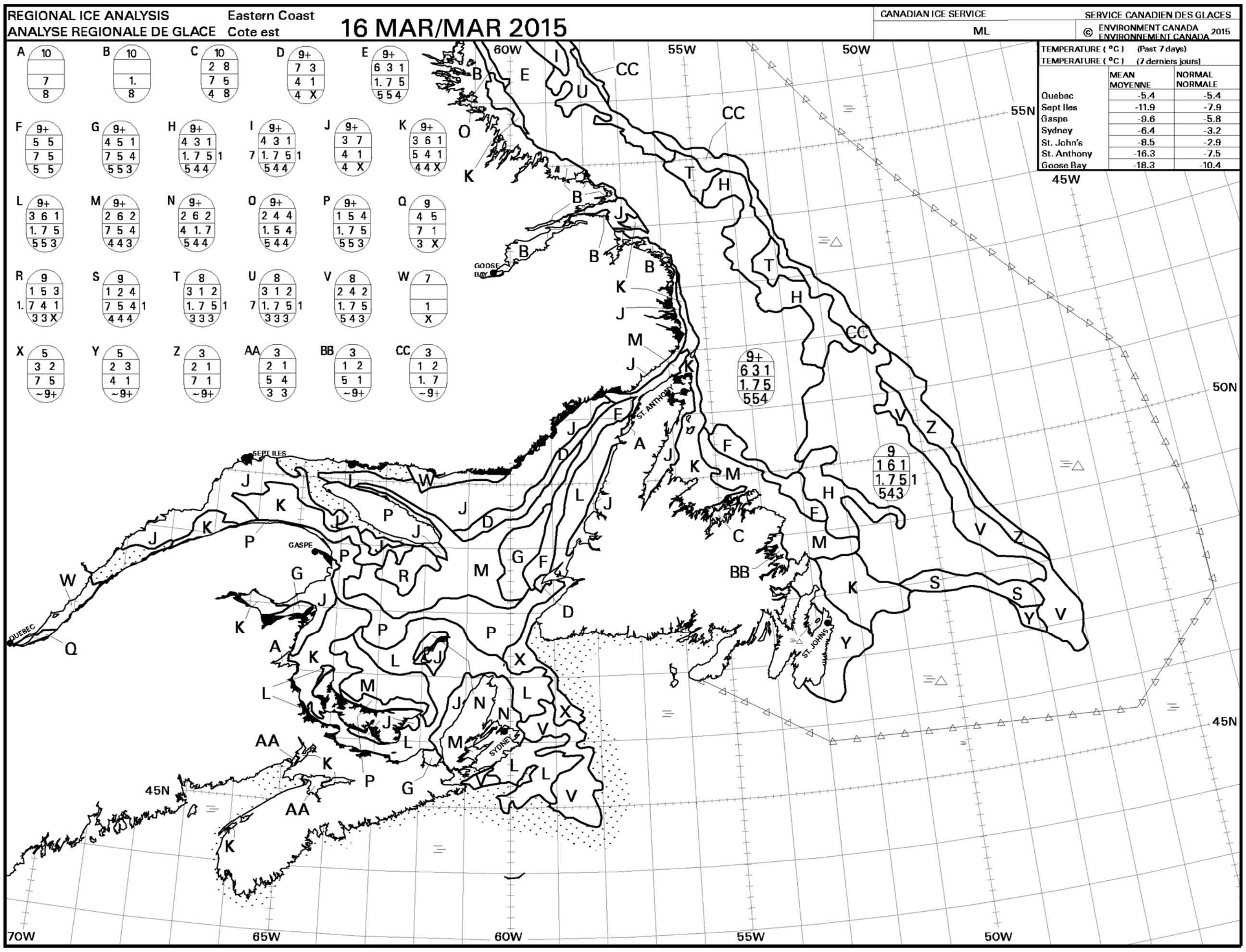


Figure 5-59 Regional Ice Analysis, Eastern Coast, 16 March 2015

It is emphasized, that for simplicity, each of these seven locations report just a single value at one location and are presented to give a representative sampling of conditions in a region: no attempt is made to integrate or average multiple sea ice conditions over the larger areas of the Project Area and the distances along the vessel traffic route between NL and the Project Area.

For each of the seven locations used to characterize the Project Area and vessel traffic route, two tables and one figure are presented:

- A table of weekly total ice concentration for 1989 to 2018 including weekly mean and maximum and annual maximum values
- A histogram of weekly mean and maximum total ice concentration for 1989 to 2018
- A table of weekly ice type which reports the stage of development of the thickest ice type seen for the given week

A summary of the range of ice conditions historically seen over the Project Area and vessel traffic route is first presented. Just those historical weeks for which ice is present in concentrations greater than 0.3 (to avoid the bergy water and open water classifications) are reported on.

Analysis of the weekly charts available from the weeks of 12 November to 8 January, and from 28 May to 27 August indicate that during these time periods bergy waters are present for the Project Area and vessel traffic route (as determined from the seven selected locations of interest) though no ice concentrations of 1/10 or greater are observed. While these weeks are during periods of the year when ice is present on the East Coast, and ice monitoring by CIS and IIP is underway, the corresponding weekly charts simply report bergy water (i.e., total concentration of ice is less than 1/10). These weeks are dropped from the analysis presented here.

Table 5.29 reports the number of weeks when sea ice is present at the seven locations of interest. For example, at Core BdN Development Area location there were 12 weeks over 1989 to 2018 for which sea ice in concentrations of 1/10 or greater were observed. Similarly low numbers of weeks had sea ice present for the Project Area – North and Project Area – Southeast locations. In contrast, the locations to the west (Project Area – Northwest, Project Area – Southwest, Route-West and Route-East) experienced from 45 to 87 weeks with sea ice.

Table 5.29 Weekly Count of Number of Weeks When Ice is Present, Bay du Nord Development Project

	Weekly Count of When Ice is Present, 1989-2018																			
	Historic Date (mmdd)																			
Location	0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Total
1 Core-BdN-DA				1		1	1	1	1	2	2	1	2							12
2 PA-Northwest	1		1	2	2	5	4	6	3	6	5	6	2	2						45
3 PA-North									1	2	2	1	1							7
4 PA-Southeast				1			1	1	2	3	2	1								11
5 PA-Southwest	1	1	1	2	3	5	4	6	9	9	8	5	3	1	2	1			1	62
6 Route-West	1	1	1	4	6	5	6	8	11	7	6	7	4	2	2					71
7 Route-East	1	1	3	4	5	6	6	8	11	12	11	5	7	5	2					87
Total	4	3	6	14	16	22	22	30	38	41	36	26	19	10	6	1	0	0	1	295

Tables 5.30 and 5.31 report weekly mean and maximum total sea ice concentration, respectively.

Table 5.30 Weekly Mean Ice Concentration, When Ice is Present, Bay du Nord Development Project

	Weekly Mean Ice Concentration (tenths), 1989-2018																			
	Historic Date (mmdd)																			
Location	0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Mean
1 Core-BdN-DA				1.0		5.0	3.0	8.0	5.0	5.0	3.5	9.7	5.5							5.0
2 PA-Northwest	3.0		7.0	7.9	5.9	5.0	5.0	5.8	6.7	6.0	6.4	5.7	5.5	6.5						5.8
3 PA-North									5.0	5.0	8.0	3.0	5.0							5.6
4 PA-Southeast				1.0			3.0	8.0	4.0	4.3	3.5	9.7								4.5
5 PA-Southwest	3.0	6.0	7.0	3.5	7.6	5.0	5.3	6.3	5.9	5.8	5.4	7.1	3.3	5.0	2.5	5.0			2.0	5.5
6 Route-West	2.0	5.0	4.0	6.7	7.1	8.2	7.5	8.4	6.2	7.5	5.2	4.3	6.7	7.0	7.4					6.6
7 Route-East	3.0	9.0	7.0	6.7	6.8	6.7	6.3	7.3	6.8	6.8	6.3	5.8	4.9	5.0	3.5					6.3
Mean	2.8	6.7	6.5	5.6	6.9	6.2	5.9	7.1	6.2	6.2	5.7	5.8	5.1	5.7	4.5	5.0			2.0	6.0

Table 5.31 Weekly Maximum Ice Concentration, When Ice is Present, Bay du Nord Development Project

Location	Weekly Maximum Ice Concentration (tenths), 1989-2018 Historic Date (mmdd) 0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Maximum
1 Core-BdN-DA				1		5	3	8	5	8	5	9.7	9							9.7
2 PA-Northwest	3		7	9.7	9.7	8	8	9.7	8	9	9	8	9	8						9.7
3 PA-North									5	8	9	3	5							9.0
4 PA-Southeast				1			3	8	5	8	5	9.7								9.7
5 PA-Southwest	3	6	7	6	9.7	8	8	9.7	9	8	9	9.7	5	5	3	5			2	9.7
6 Route-West	2	5	4	9.7	9.7	9	9.7	9.7	9.7	9.7	7	9	9.7	9	9.7					9.7
7 Route-East	3	9	9	9.7	9	9	9	9.7	9.7	9.7	9	8	7	9	5					9.7
Maximum	3	9	9	9.7	9.7	9	9.7	9.7	9.7	9.7	9	9.7	9.7	9	9.7	5			2	9.7

Weekly mean sea ice concentrations, when ice is present, average 6/10, over the weeks of 15 January to 21 May, and over Project Area and vessel traffic route locations considered (Table 5.30). The lowest overall (considering the weeks of 15 January to 21 May) mean ice concentration is 4.5/10 for the Project Area – Southeast location and the highest mean ice concentration is 6.6/10 for the Route-West which is not expected given that location's proximity to the coast.

Individual weekly mean ice concentrations in the Core BdN Development Area range from 1/10 the week of 5 February to 8/10 the week of 5 March and 9+/10 the week of 2 April. As noted above, the mean concentrations for these weeks are derived from a single year's observation. Weekly mean ice concentrations, when ice is present, over the Project Area are greatest to the northwest with mean values at the Project Area – Northwest ranging from 5/10 to almost 8/10 during the weeks of 29 January to 16 April.

Along the vessel traffic route weekly mean ice concentrations, when ice is present, are greatest during the week of 5 March at 8.4/10 for the Route-West location and as large as 9/10 during the week of 22 January for the Route-East location.

Weekly maximum ice concentrations (Table 5.31) of 9/10 or 9+/10 occur from the week of 22 January at the eastern location along the vessel traffic route to the week of 23 April at the eastern location along the vessel traffic route. Weekly maximum sea ice concentrations, when ice is present, are 9+/10 (quantified as 9/7 in Table 5.31) over the weeks of 15 January to 21 May, and in each of the Project Area and vessel traffic route locations considered, with the exception the Project Area – North location reports a maximum concentration of 9/10 (Table 5.31). Maximum ice concentration values of 9+/10 have been observed as early as the week of 5 February along the vessel traffic route and at the Project Area – Northwest location and as late as the week of 23 April for the Route – West location.

In general, sea ice concentrations are lowest for the northern and eastern portions of the Project Area and highest along the vessel traffic route.

5.5.1.1 Core BdN Development Area

Table 5.32 reports the weekly total sea ice concentration for 1989 to 2018 for the Core BdN Development Area location where sea ice concentrations are historically low. In the tabulations represented here, bergy water[4] is reported with a sea ice concentration of 0.2, and ice free=0, open water[5] is reported with an ice concentration of 0.3. The annual (based on weeks 1 January through 21 May) mean concentration is less than 1/10 with the predominant sea ice condition being bergy water. A weekly sea ice concentration reached a maximum of 9+/10 for the week of 2 April in 1994, though this was an unusual occurrence. The only other weeks with total sea ice concentrations of 8/10 or above are 8/10 the week of 5 March and 9/10 the week of 9 April both in 1994, and 8/10 for the week of 19 March 1992. Since 1994 there has been a weekly sea ice concentration greater than or equal to 1/10 once: 2/10 the week of 26 March 2015. Bergy waters are represented for the statistics with a concentration of 0.2/10.

Table 5.32 Weekly Sea Ice Concentration, Core BdN Development Area

Weekly Ice Concentration (tenths)
Historic Date (mmdd)

1 Core-BdN-DA	0101	0108	0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Annual Mean
1989	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1990	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
1991		0.2	0.2	0.2	0.2	1	0.2	5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.5
1992	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3	0.2	0.2	8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.7
1993	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4
1994	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	8	5	2	0.2	9.7	9	0.2	0.2	0.2	0.2	0.2	0.2	1.8
1995	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1996	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1997	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1998		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999							0.2							0.2								0.0
2000									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2001								0.2	0.2													0.0
2002											0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2003												0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2004															0.2			0.2	0.2	0.2		0.0
2005																						0.0
2006																						0.0
2007																					0.2	0.0
2008												0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2009											0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2010																						0.0
2011																		0.2				0.0
2012													0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2013																					0.2	0.0
2014							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2015										0.2	0.2	0.2	2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2016			0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2017								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2018											0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Mean	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.2	0.4	0.3	0.5	0.4	0.5	0.5	0.1	0.1	0.2	0.1	0.1	0.2	0.2
Maximum	0.2	0.2	0.2	0.2	0.2	1	0.2	5	3	8	5	8	5	9.7	9	0.2	0.2	0.2	0.2	0.2	0.2	1.8

[4] An area of freely navigable water in which ice of land origin is present. Other ice types may be present, although the total concentration of all other ice is less than 1/10 (CIS 2005)
[5] A large area of freely navigable water in which ice is present in concentrations less than 1/10. No ice of land origin is present (CIS 2005)

Table 5.33 reports predominant ice type: the number of years for the Core BdN Development Area location for which the thickest ice present has the noted ice type. The ice type charts report only for those historical weeks when total ice concentration was 1/10 or greater. For example, during the week of 19 March, there are two years with total ice concentration greater than 1/10; one with thin FY ice present (ice of not more than one winter's growth, 30-70 cm) and one with medium FY ice (thickness 70 to 120 cm) present. The occurrence of old ice (ice that has survived at least one summer's melt; second year ice will be generally thicker than FY ice) was during April 1994.

Table 5.33 Weekly Ice Type, Core BdN Development Area

	Historic Date (mmdd)	1 New <10cm	2 Grey 10-15cm	3 Grey-white 15-30cm	4 Thin FY 30-70cm	5 Medium FY 70-120cm	6 Thick FY >120cm	7 Brash	8 Old	Total
1 Core-BdN-DA	0205	1								1
	0219				1					1
	0226				1					1
	0305				1					1
	0312					1				1
	0319				1	1				2
	0326				1	1				2
	0402								1	1
	0409					1			1	2
	Total	1	0	0	5	4	0	0	2	

5.5.1.2 Project Area

The weekly mean and maximum total sea ice concentrations for 1989 to 2018 for the Project Area – here all five locations noted in Figure 5-59 - are shown in Figure 5-60. Weekly sea ice concentrations are lowest at the Project Area – North location with mean values of less than 1/10 and maximum values above 5/10 observed just during the last two weeks of March. Weekly sea ice concentrations are highest (of the five locations) at the Project Area – Southwest with mean concentrations between 1/10 and 2/10 from the first week of March to the first week of April: maximum concentrations of 6/10 or greater have been observed from the week of 22 January to the week of 2 April.

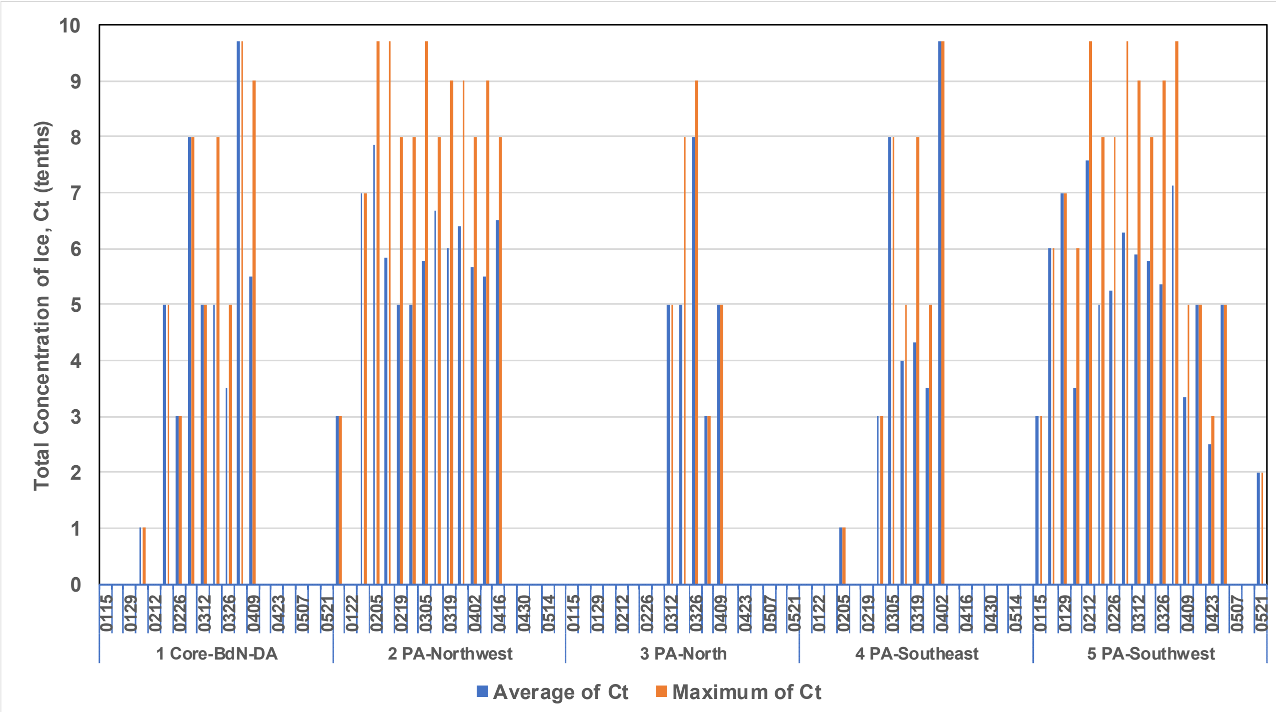


Figure 5-60 Weekly Sea Ice Concentration, When Ice is Present, Project Area

Table 5.34 and Table 5.35 report the weekly mean and maximum total sea ice concentration for 1989 to 2018 for the Project Area. The mean value for each week is calculated as the average of the weekly mean concentrations at each of the five Project Area locations noted in Figure 5-59. The maximum value is similarly taken as the maximum of any of the five maximum concentrations.

Mean weekly concentrations range from approximately 3/10 the last week of January to less than 2/10 by mid-April, peaking at approximately 8/10 the week of 19 March.

The greatest occurrence of sea ice in the Project Area was observed from 1990 to 1994 with concentrations as high as from 2/10 to 4/10 seen just in March 2009, 2014 and 2015. Maximum weekly concentrations historically range from 8/10 to 9+/10 between the weeks of 2 February and 16 April. Maximum values of 8/10 were most recently reached in 2014 and 2015 (these values observed at the Project Area – Northwest location).

Table 5.34 Weekly Mean Ice Concentration, Project Area

Weekly Mean Ice Concentration (tenths)
Historic Date

Project Area	0101	0108	0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Annual Mean
1989	0.1	0.1	0.1	0.1	0.1	0.1	0.2	1.3	0.2	1.8	1.2	0.8	0.8	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4
1990	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	4.0	0.6	1.7	2.7	2.9	1.3	0.2	0.2	0.2	0.2	0.2	0.2	0.7
1991		0.1	0.1	0.1	0.1	2.6	4.0	1.5	1.3	1.3	1.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.7
1992	0.1	0.1	0.1	0.1	0.1	0.1	0.2	2.9	3.6	1.9	3.5	8.2	2.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.2
1993	0.2	0.2	1.3	1.4	2.9	0.2	1.9	2.1	1.0	1.8	0.2	2.5	4.8	3.3	1.2	0.2	0.8	0.2	0.2	0.2	0.2	1.3
1994	0.1	0.1	0.1	0.1	0.1	2.5	1.4	3.3	3.3	6.4	5.6	4.0	2.0	6.5	3.7	0.2	0.2	0.2	0.2	0.2	0.2	1.9
1995	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.6	0.8	0.2	1.4	0.2	0.8	0.2	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.3
1996	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
1997	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	1.3	1.0	1.0	0.6	1.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4
1998		0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999							0.1							0.1								0.0
2000		0.4		0.4					0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2001								0.2	0.2		0.8	0.8		0.8	0.8	0.4		0.8	0.8			0.0
2002										0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2003												0.2	0.2	0.2	0.2	1.2	0.2	0.2	0.2	0.2	0.2	0.1
2004														0.8	0.1		0.8	0.2	0.2	0.2	0.8	0.0
2005																						0.0
2006																						0.0
2007												0.8				0.8				0.4	0.2	0.0
2008												0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2009										0.1	0.2	2.9	3.7	3.3	0.2	1.2	0.6	1.2	0.2	0.2	0.6	0.7
2010																						0.0
2011																	0.8	0.2				0.0
2012													0.2	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2013										0.4	0.4									0.8	0.2	0.0
2014							0.1	0.2	0.2	0.2	1.6	3.3	1.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4
2015										0.2	2.9	0.2	3.6	1.3	1.2	1.8	0.2	0.2	0.2	0.2	0.2	0.6
2016		0.8	0.2	0.2	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2017						0.8	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2018									0.8	0.8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
Mean	0.0	0.0	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.7	0.7	0.9	0.8	0.7	0.4	0.3	0.2	0.2	0.1	0.2	0.2	0.3
Maximum	0.2	0.8	1.3	1.4	2.9	2.6	4.0	3.3	3.6	6.4	5.6	8.2	4.8	6.5	3.7	1.8	0.8	1.2	0.8	0.8	0.8	

Table 5.35 Weekly Maximum Concentration, Project Area

Weekly Maximum Ice Concentration (tenths)
Historic Date

Project Area	0101	0108	0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Annual Maximum
1989	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3	0.2	8	5	3	3	3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	8.0
1990	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	9.7	2	6	7	7	2	0.2	0.2	0.2	0.2	0.2	0.2	9.7
1991		0.2	0.2	0.2	0.2	9.7	9.7	5	4	3	8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	9.7
1992	0.2	0.2	0.2	0.2	0.2	0.2	0.2	7	6	6	9	9	9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	9.0
1993	0.2	0.2	3	6	7	0.2	7	5	4	8	0.2	6	7	8	5	0.2	3	0.2	0.2	0.2	0.2	8.0
1994	0.2	0.2	0.2	0.2	0.2	6	6	8	8	8	8	7	9	9.7	9	0.2	0.2	0.2	0.2	0.2	0.2	9.7
1995	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2	3	0.2	6	0.2	3	0.2	3	0.2	0.2	0.2	0.2	0.2	0.2	6.0
1996	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1997	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3	4	4	2	5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	5.0
1998		0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
1999							0.2							0.2								0.2
2000		0.2		0.2					0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
2001								0.2	0.2		0.2	0.2		0.2	0.2	0.2		0.2	0.2			0.2
2002										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2003												0.2	0.2	0.2	0.2	5	0.2	0.2	0.2	0.2	0.2	5.0
2004														0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2
2005																						0.0
2006																						0.0
2007												0.2				0.2				0.2	0.2	0.2
2008												0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2009										0.3	0.2	7	9	8	0.2	5	2	5.0	0.2	0.2	2	9.0
2010																						0.0
2011																	0.2	0.2				0.2
2012													0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2013										0.2	0.2									0.2	0.2	0.2
2014							0.2	0.2	0.2	0.2	7	8	3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	8.0
2015										0.2	7	0.2	7	3	5	8	0.2	0.2	0.2	0.2	0.2	8.0
2016		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3.0
2017						0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2018									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Maximum	0.2	0.2	3	6	7	9.7	9.7	8	8	9.7	9	9	9	9.7	9	8	3	5.0	0.2	0.2	2	9.7

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Table 5.36 reports predominant sea ice type, with statistics again derived from the five locations within the Project Area (Figure 5-59). In the Project Area, thin and medium FY are most common and are can be present from the first or second week of February through the April. Thick FY has been experienced, albeit less frequently, over the same time period. Old sea ice has been observed from mid-March through early April, nine weeks in 1994 and one week in April 1995.

Table 5.36 Weekly Sea Ice Type, Project Area

	Historic Date (mmdd)	1 New <10cm	2 Grey 10-15cm	3 Grey-white 15-30cm	4 Thin FY 30-70cm	5 Medium FY 70-120cm	6 Thick FY >120cm	7 Brash	8 Old	Total
Project Area	0115			2						2
	0122			1						1
	0129			2						2
	0205	3		2	1					6
	0212				4		1			5
	0219			2	5	2	2			11
	0226				9	1				10
	0305				12	2				14
	0312				7	9				16
	0319			1	7	11	1		2	22
	0326				4	13			2	19
	0402				1	8	1		4	14
	0409					5	1		2	8
	0416					1	1			3
	0423					1	1			2
	0430									1
	0521				1					1
	Grand Tot	3	0	10	51	53	8		10	

5.5.1.3 Vessel Traffic Route

The weekly mean and maximum total sea ice concentrations for 1989 to 2018 for the two locations along the vessel traffic route are shown in Figure 5-61. Weekly sea ice concentrations are comparable at the two locations with mean values of 1/10 to 2/10 occurring from the first week of February to the first or second week of April. Mean concentrations peak at just over 2/10 at the western location during the first two weeks of March and peak at almost 3/10 the week of 19 March.

Weekly maximum values of 9+/10 have occurred most weeks at the vessel traffic route – West location between the weeks of 2 February and 23 April, while at the East location ice concentrations of 9/10 to 9+/10 have been observed about two weeks earlier the week of 22 January and as late as the week of 16 April.

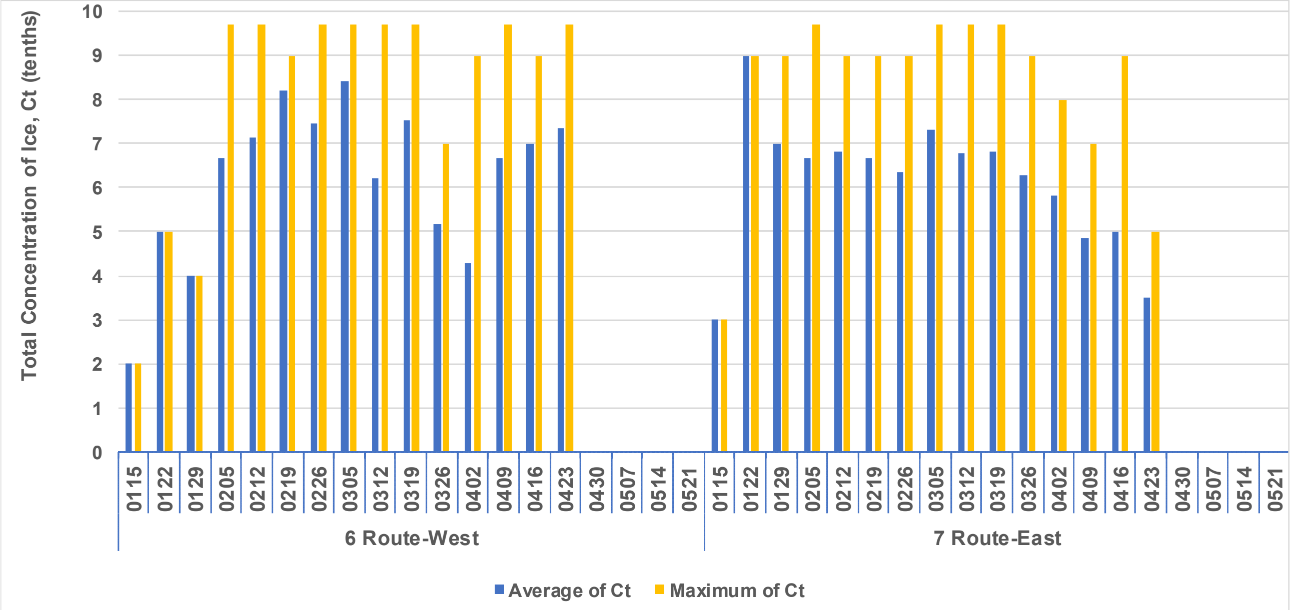


Figure 5-61 Weekly Sea Ice Concentration, When Sea Ice is Present, Vessel Traffic Route

Tables 5.37 and 5.38 report the weekly total sea ice concentration for 1989 to 2018 for the vessel traffic route – West and East locations respectively.

Table 5.37 Weekly Mean Sea Ice Concentration, Vessel Traffic Route-West

	Weekly Ice Concentration (tenths) Historic Date (mmdd)																					
6 Route-West	0101	0108	0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Annual Mean
1989						0.2	3	7	0.2	9	8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.4
1990						0.3	4	9	9.7	9.7	9.7	8	3	5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.7
1991					0.3	4	9	0.2	9	8	9	8	6	2	9.7	9	0.2	0.2	0.2	0.2	0.2	3.8
1992				0.2		4	9.7	7	9	7	9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.3
1993	0.2	0.2	2	5	4	9.7	9	9	4	0.2	2	3	3	8	6	5	0.2	0.2	0.2	0.2	0.2	3.4
1994						9	8	9	8	9.7	4	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.4
1995					0.2	0.2	0.2	0.2	0.2	7	6	8	0.2	1	5	0.2	0.2	0.2	0.2	0.2	0.2	1.4
1996														0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
1997				0.2				0.2	0.2	8	4	8	7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.4
1998					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999														0.2					0.2	0.2	0.2	0.0
2000									0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2001			0.2		0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2002							0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2003										0.2	3	8	7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.9
2004														0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.1
2005										0.2	0.2	0.2	0.2	0.2	0.2		0.2					0.1
2006																						0.0
2007										0.2	0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2008													0.2	2	0.2	0.2	9.7	0.2	0.2	0.2	0.2	0.6
2009									0.3	0.2	0.2	0.2	0.2	9	6	0.2	5	0.2	0.2	0.2	0.2	1.1
2010																						0.0
2011																0.2	0.2	0.2	0.2	0.2	0.2	0.1
2012												0.2	5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
2013										0.2	0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2014							0.2	0.2	0.2	9	9.7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.0
2015								0.2	0.2	0.2	4	9.7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.8
2016		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2017							0.2	0.2	0.2	0.2	0.2	0.2	0.2	3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
2018									5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4
Mean	0.0	0.0	0.1	0.2	0.2	0.9	1.5	1.4	1.6	2.3	2.4	1.9	1.1	1.1	1.0	0.6	0.7	0.2	0.2	0.2	0.2	0.8
Maximum	0.2	0.2	2	5	4	9.7	9.7	9	9.7	9.7	9.7	9.7	7	9	9.7	9	9.7	0.2	0.2	0.2	0.2	3.8

Table 5.38 Weekly Mean Ice Concentration, Vessel Traffic Route-East

Weekly Ice Concentration (tenths)
Historic Date (mmdd)

7 Route-East	0101	0108	0115	0122	0129	0205	0212	0219	0226	0305	0312	0319	0326	0402	0409	0416	0423	0430	0507	0514	0521	Annual Mean
1989						0.2	2	6	0.2	2	8	3	6	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.4
1990	0.1					6	0.2	7	3	9.7	9.7	9.7	9	7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.9
1991					9	3	9	0.2	9	9	6	0.2	6	0.2	3	8	0.2	0.2	0.2	0.2	0.2	3.2
1992					4	8	7	7	9	9.7	8	8	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	3.0
1993	0.2	0.2	3	9	8	9.7	9	5	0.2	8	2	9	9	8	7	5	0.2	0.2	0.2	0.2	0.2	4.4
1994						0.3	7	9	8	8	8	7	9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	2.8
1995					0.2	0.2	0.2	6	0.2	9	7	8	0.2	0.2	7	1	0.2	0.2	0.2	0.2	0.2	1.9
1996											0.2			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
1997		0.2		0.2			0.2	0.2	4	0.2	4	8	2	1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.0
1998					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
1999													0.2	0.2			0.2				0.2	0.0
2000									0.3	0.2	0.2	0.2	2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2001							0.2	0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2002							0.3	0.2	0.2	0.2	0.2	2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2003									0.3	3	4	7	7	5	2	0.2	0.2	0.2	0.2	0.2	0.2	1.4
2004														0.2	0.2		0.2	0.2	0.2	0.2	0.2	0.1
2005											0.2	0.2	0.2	0.2								0.0
2006																						0.0
2007									0.3	0.3	0.2	0.2				0.2		0.2	0.2	0.2	0.2	0.1
2008									0.3	0.3		0.2	0.2	8	6	2	2	0.2	0.2	0.2	0.2	0.9
2009								0.3		0.2	0.2	5	9	0.2	6	9	5	0.2	0.2	0.2	0.2	1.8
2010																						0.0
2011																	0.2	0.2				0.0
2012												0.2	3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
2013										0.2	0.2						0.2			0.2	0.2	0.0
2014							0.2	0.2	0.2	0.2	9.7	6	0.2	0.2	3	0.2	0.2	0.2	0.2	0.2	0.2	1.0
2015										0.2	8	9	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	1.0
2016		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	7	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.5
2017							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1
2018									5	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4
Mean	0.0	0.0	0.1	0.3	0.7	0.9	1.2	1.4	1.4	2.0	2.6	2.8	2.4	1.1	1.2	1.0	0.4	0.2	0.2	0.2	0.2	1.0
Maximum	0.2	0.2	3	9	9	9.7	9	9	9	9.7	9.7	9.7	9	8	7	9	5	0.2	0.2	0.2	0.2	4.4

As noted previously for the Project Area the greatest occurrence of sea ice on the east coast (from 1989 to 2018) has been observed from 1990 to 1994. 1989 and 1995 also experienced greater than normal ice concentrations at the two route locations. Since 1995 there have been six years recording ice concentrations of 8/10 or greater, the most recent in 2015 with a concentration of 9+/10 the week of 19 March. Three of the four weeks in March 1997 reported concentrations of 7/10 or 8/10.

The annual (based on weeks 1 January through 21 May) mean concentration is less than 1/10 with the predominant ice condition being bergy water. A weekly ice concentration reached a maximum of 9+/10 for the week of 2 April in 1994, though this was an unusual occurrence. The only other weeks with total ice concentrations of 8/10 or above are 8/10 the week of 5 March and 9/10 the week of 9 April both in 1994, and 8/10 for the week of 19 March 1992. Since 1994 there has been just weekly sea ice concentration greater than or equal to 1/10: 2/10 the week of 26 March 2015.

Generally similar conditions have been observed most weeks between east and west locations. The annual weekly mean and maximum concentrations of 1/10 and 4.4/10 at the east location are slightly larger than corresponding values of 0.8/10 and 3.8/10 at the west location. Since 1995 there have been seven years recording ice concentrations of 7/10 or greater, the most recent in 2016 with a concentration of 7/10 the week of 26 March. Historically, there have been years with as many as seven weeks with sea ice concentrations of 8/10 (close pack/drift – see Figure 5-57) or greater, which could impede supply logistics, although in most years the number of weeks is much less and has a maximum of two weeks (for one year, 2014) since 1997.

Table 5.39 reports predominant sea ice type, with statistics again derived from the two locations along the vessel traffic route (Figure 5-59). Along the route, thin and thick FY are most common and can be present from the end of January through mid-April. Thick FY has been experienced, albeit less frequently, over the same time period, as recently as April 2008, 2009 and 2014. Old sea ice was observed in March 1992 and 1994.

Table 5.39 Weekly Sea Ice Type, Vessel Traffic Route

	Historic Date (mmdd)	1 New <10cm	2 Grey 10-15cm	3 Grey-white 15-30cm	4 Thin FY 30-70cm	5 Medium FY 70-120cm	6 Thick FY >120cm	7 Brash	8 Old	Total
Established Supply Traffic Route	0115		1	1						2
	0122		1	1						2
	0129	1	1	1	1					4
	0205		2	3	3					8
	0212	1	1	2	7					11
	0219		1	1	8	1				11
	0226			4	7	1				12
	0305	1	1	3	10	1				16
	0312	1	1	2	8	9			1	22
	0319		1	3	5	7	2		1	19
	0326	2		1	3	8	2		1	17
	0402	1			1	5	5			12
	0409					2	7	2		11
	0416					2	5			7
	0423						2	2		4
	Grand Tot	7	10	22	53	36	23	3	4	158

5.5.2 Icebergs

The east coast of NL extending out to and including the Project Area frequently experiences icebergs in their journeys south from the fjords of Greenland. Icebergs are masses of fresh water ice which calve each year from the glaciers along west Greenland. A small number of icebergs originate from east Greenland. Icebergs are moved by both the wind and ocean currents, and typically spend one to three years travelling a distance up to approximately 2,900 km (1,800 miles) to the waters of NL. The West Greenland and Labrador Currents are major ocean currents, which move the icebergs around the Davis Strait, along the coast of Labrador, to the northern bays of NL, and to the Flemish Pass and the Grand Banks.

Icebergs will deteriorate in their drift southwards due to warmer sea temperatures and wave erosion. For example, the number of days required to melt a 100 m iceberg ranges from 179 days at a sea surface temperature of -1°C to 12 days at 6°C and five days at 15°C; this assumes a wave height of approximately 2 m, wave period of 10 s and relative drift velocity of 25 cm/s (U.S. Coast Guard Navigation Center 2009).Icebergs in sea ice may be less subject to wave erosion. Smaller icebergs are more difficult to detect in sea ice.

While each year is different, icebergs will typically appear offshore by February or March. Easterly and northeasterly winds will have the effect of moving icebergs towards the NL coast. Their usual path is southward with the ocean currents. The summary of iceberg sightings for the Project Area presented here is based on two data sets. The comprehensive National Research Council-Program of Energy Research and Development (NRC-PERD) Iceberg Sighting Database (Sudom et al. 2014; NRC 2017) contains iceberg sightings from various sources including industry, aircraft and ship, and include radar, visual and measured observations. The latest version of the database contains icebergs through 2016. This has been augmented, for the present analysis, by additional observations from the International Ice Patrol (IIP) Iceberg Sightings Database (IIP 1995, updated 2018) for both 2015 (absent in the NRC-PERD database) and 2017.

Characterizations of iceberg conditions were prepared for four regions: Core BdN Development Area, Project Area, and western and eastern portions of the vessel traffic route. For the vessel traffic route, the two areas were 47.6-47.8° N, 50.0-52.7° W for the west and 47.7-47.9° N, 47.73-50° W for the east; for the Project Area, a rectangle inscribing the Project Area was used – acknowledging this provides a slightly more conservative estimate as it will see observations to the immediate northwest.

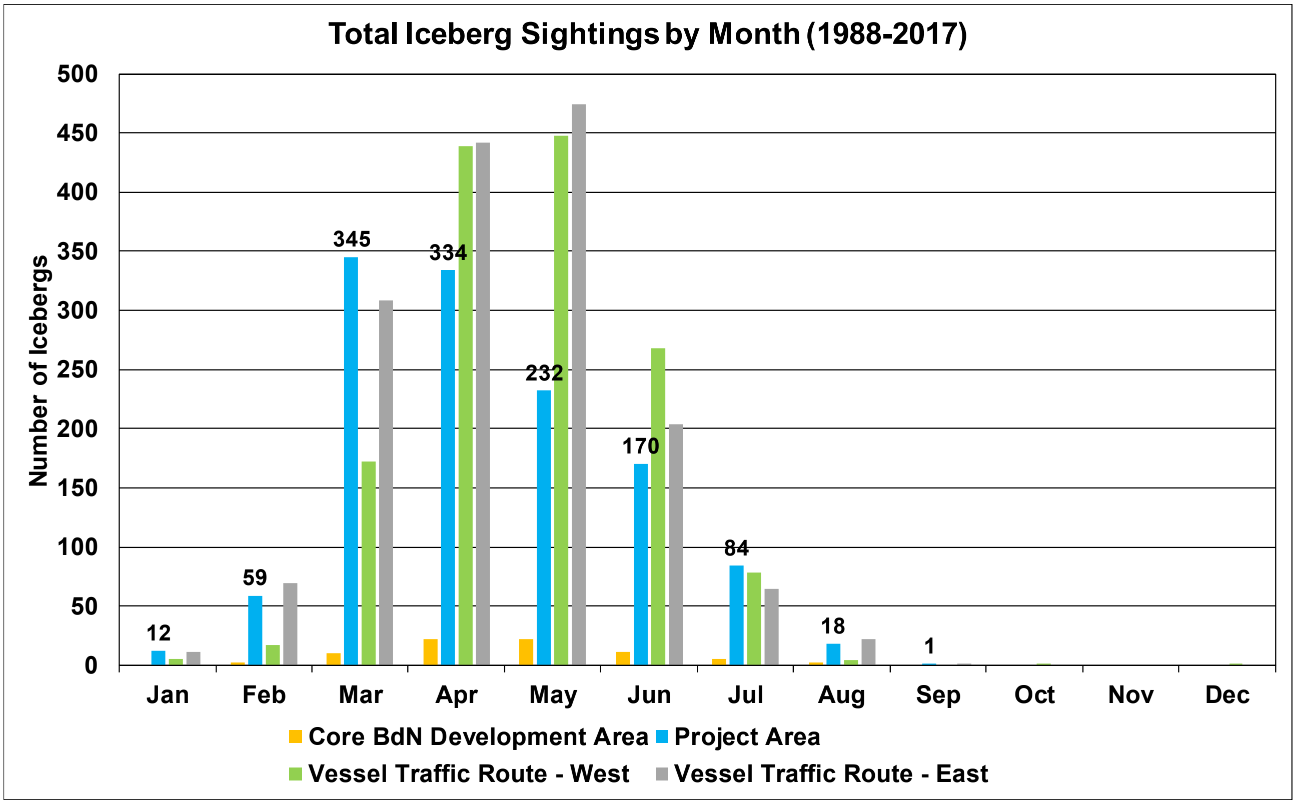
Observations for the past 30 years, 1988-2017, are reported. Statistics are reported here for each iceberg that is observed in the given region (Core BdN Development Area, Project Area, vessel traffic route – West and - East). Iceberg size classes range from growlers (less than one metre above water, less than five metres in length and mass approximately 0.001 Mt) to very large icebergs (greater than 75 m in height, greater than 200 m in length, and mass over 10 Mt) (Figure 2.3, CIS 2005). Icebergs of unknown size are also reported. Iceberg re-sightings in the database are not reported.

The query of the NRC-PERD plus IIP databases, for the years 1988 to 2017, yielded a total of 74 icebergs for the Core BdN Development Area, 1,255 icebergs for the Project Area and 1,433 and 1,597 for the western and eastern portions of the vessel traffic route, respectively.

Three sets of statistics for the number of icebergs by month and year are presented in Figures 5-62 to 5-64. Iceberg size statistics including indication of the usual iceberg height and length associated with each size are shown in Figure 5-65.

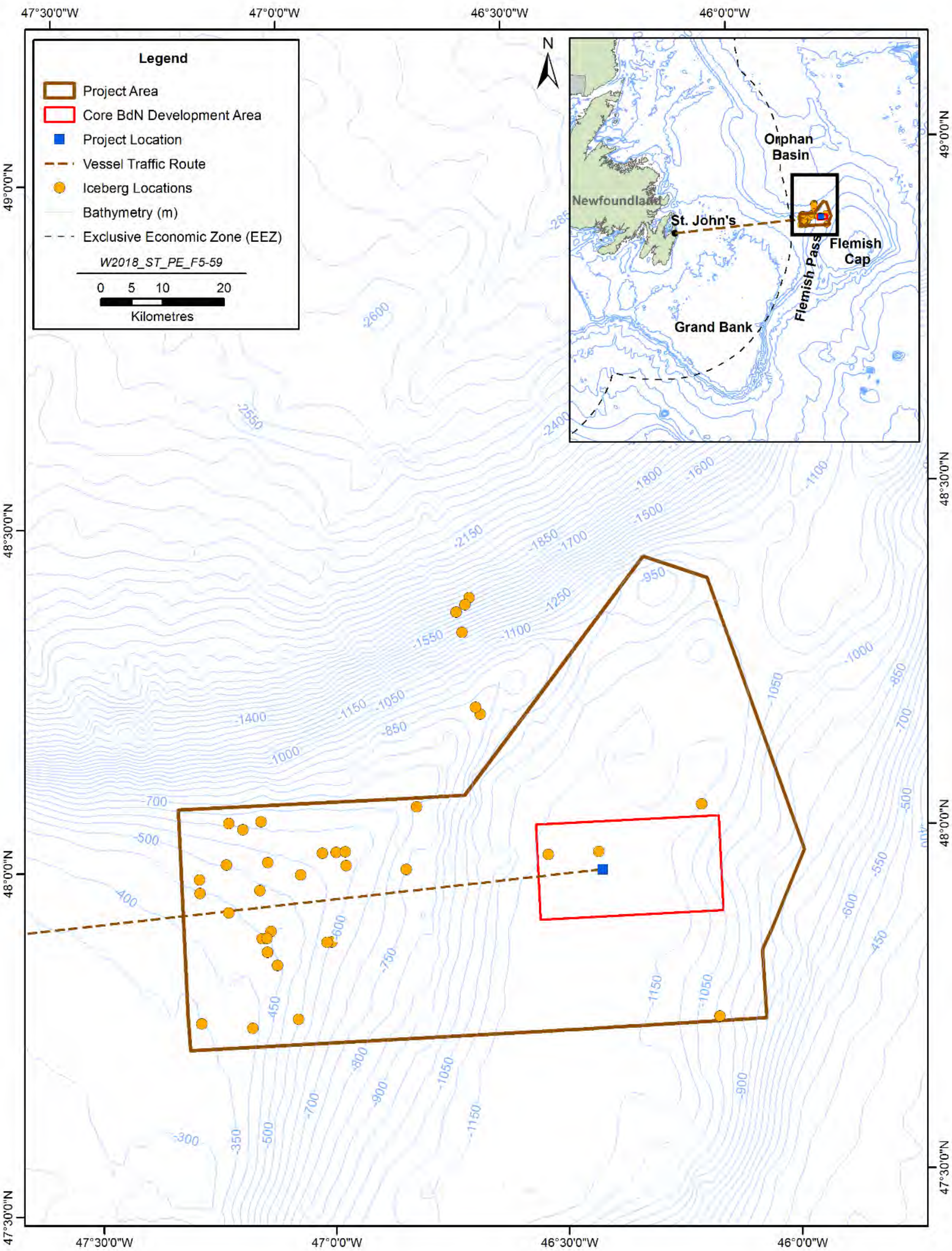
The 74 icebergs observed in the Core BdN Development Area were present from February through August, ranging from 2 each in February and August to 22 in April and May. One third of these observations were over the past four years, 2014 to 2017. The most observations in a single year were in 2016 with 4 in March and May and 9 icebergs in April.

For the Project Area icebergs have been observed from January (all in 1993) through September (one iceberg in 1992), with icebergs observed 27 percent of the time each in March and April (345 and 334 icebergs respectively) (Figure 5-64). When present over the Project Area, icebergs are more likely to be in the western portions, as illustrated in Figure 5-63 which shows the first sighting locations of 39 icebergs observed in March 2016.



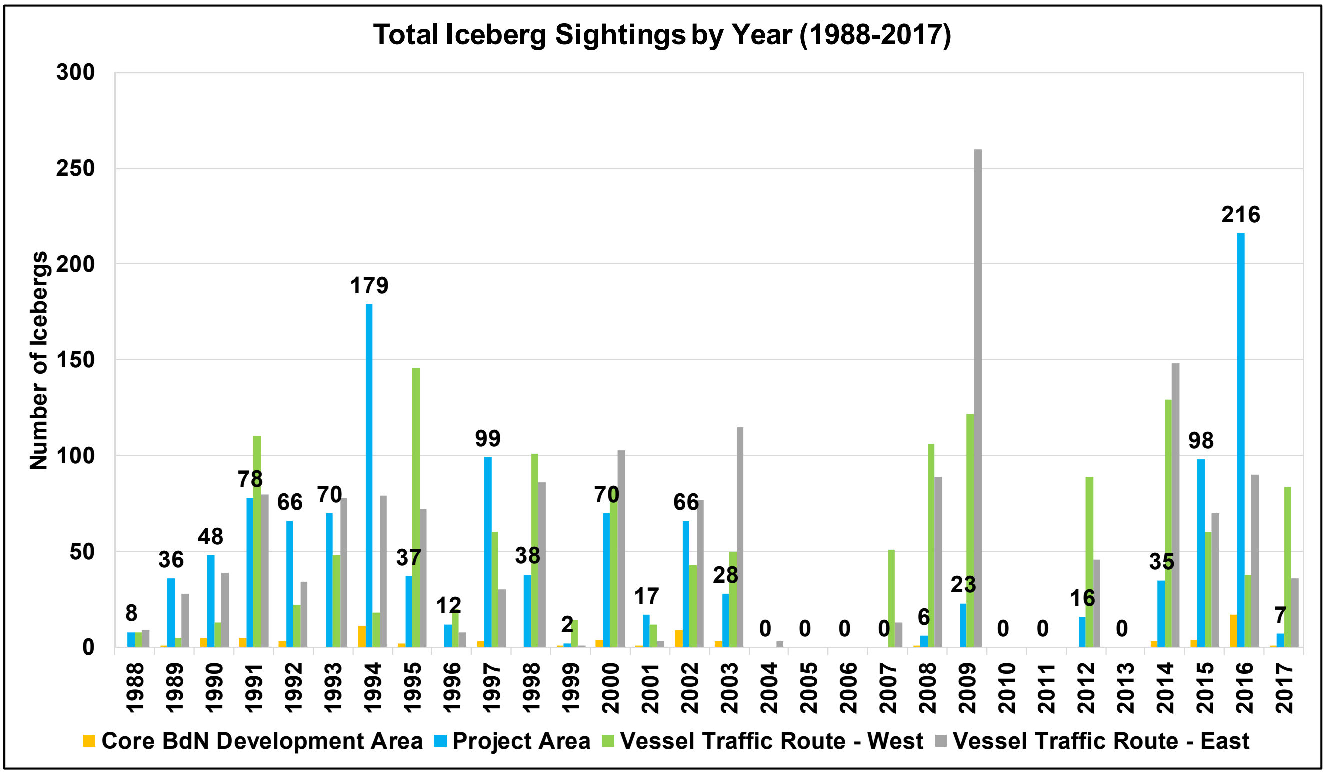
Source: NRC (2017), IIP (1995, updated 2018)

Figure 5-62 Iceberg Sightings by Month (1988-2017)



Source: NRC (2017), IIP (1995, updated 2018)

Figure 5-63 Icebergs Near the Project Area, March 2016



Source: NRC (2017), IIP (1995, updated 2018)

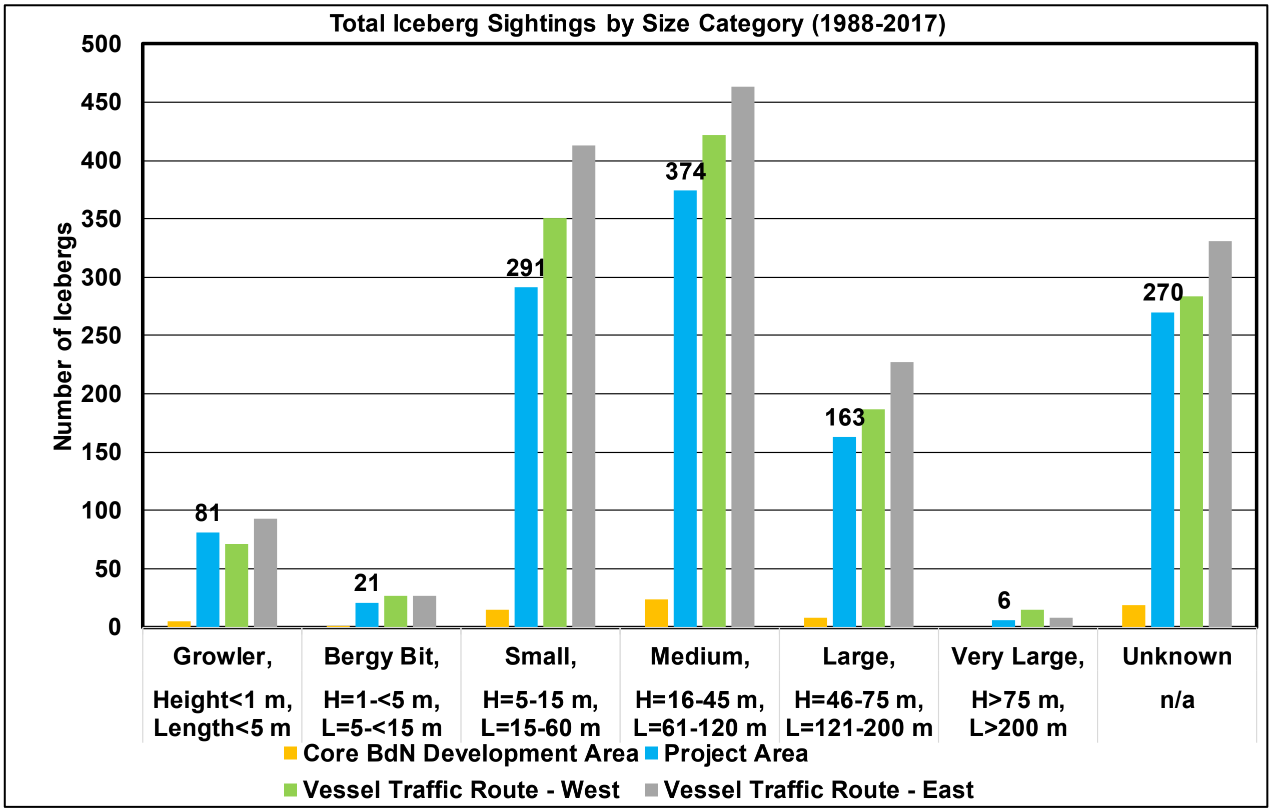
Figure 5-64 Iceberg Sightings by Year (1988-2017)

For the vessel traffic route – West location above, from January (as recently as 2016) through August, the historical (1988 to 2017) monthly total of icebergs ranges from 5 in January and 4 in August to 439 and 448 in April and May, in total representing approximately two thirds of the icebergs observed. One iceberg was observed each in October and December 1992.

For the vessel traffic route – East location, 89 percent of the 1,597 icebergs observed from 1988 to 2017 occurred between March and June, with the greatest numbers seen in April (442) and May (474). The large potential for icebergs along the vessel traffic route is well-illustrated in Figure 5-63 for 2015.

From 95 to 98 percent of the iceberg observations (in each of the four regions) have a size reported. In instances where there are multiple sightings of the same iceberg and different sizes are reported, the largest size is used (e.g., for an iceberg with size values of unknown, small and medium, the medium size class is selected). Icebergs of size 'general' have been grouped with those of unknown size. The iceberg size distribution is shown in Figure 5-65.

Of the 1,255 icebergs in the Project Area where size is known, 8 percent are growlers or bergy bits, 55 percent are small or medium, 13 percent are large, and 0.5 percent (six icebergs) are very large. The other three regions (Core BdN Development Area, and western and eastern portions of the vessel traffic route) exhibit similar iceberg size distributions.



Source: NRC (2017), IIP (1995, updated 2018)

Figure 5-65 Iceberg Sightings by Size Category (1988-2017)

The C-CORE Bay du Nord iceberg study (C-CORE 2017b) reports one could expect an iceberg size distribution for the BdN site similar to that used for the Grand Banks (i.e., with iceberg length mean of 59 m, maximum of 480 m and standard deviation of 54 m). Other relationships for mass and draft are likely similar to those of the Grand Banks as well (C-CORE 2017b).

There are 12 icebergs in the PERD database for the Project Area having size measurements, as listed in Table 5.40, all in 2003 and reported by Provincial Airlines. The average iceberg length is 155 m, and maximum iceberg length is 380 m. Iceberg masses range from 0.01 to 3.25 Mt and average 0.7 t.

Table 5.40 Iceberg Dimensions for the Project Area

Iceberg ID	Measured (M) or Estimated (E)	Length (m)	Width (m)	Height (m)	Draft (m)	Mass (Mt)
ER03-002	M	61	56	13	49	0.05
ER03-009	E	60	50	4	49	0.04
ER03-011	E	380	300	8	158	3.25
ER03-027	E	73	68	19	57	0.10
ER03-031	M	75	35	6	57	0.06
ER03-032	M	130	70	10	79	0.32
ER03-034	E	100	40	20	68	0.19
ER03-035	E	30	30	7	34	0.01
ER03-037	M	350	225	10	151	2.80
ER03-038	E	100	40	25	68	0.11
ER03-039	E	350	250	10	151	0.83
Average		155	106	12	84	0.70
Maximum		380	300	25	158	3.25

The C-CORE Bay du Nord iceberg study (C-CORE 2017b) reports, for AOI1, based on observations for approximately 100 icebergs, a mean drift speed of 0.43 m/s. Associated maximum and standard deviation drift speeds are 1.68 and 0.26 m/s respectively. Drift will generally follow the Labrador Current along both the Sackville Spur (to the northeast) and the Flemish Pass (to the south) routes, and will also be influenced by local wind conditions.

For the larger Bay du Nord Area of Interest 2 (AOI2), covering 47° 30 to 51°N and 45° to 52° W (Figure 5-54), the occurrence of icebergs in sea ice is reported to be approximately 67 percent when sea ice is present at Bay du Nord (C-CORE 2017b).

As evidenced by the monthly sightings (Figure 5-63) and distribution of icebergs on the east coast (Figure 5-66), there is potential for encountering icebergs while transiting the vessel traffic route. Depending on the iceberg conditions in a given year, and location offshore, icebergs may be encountered anytime between January and August although the period with likely highest frequency of occurrence is March through July.

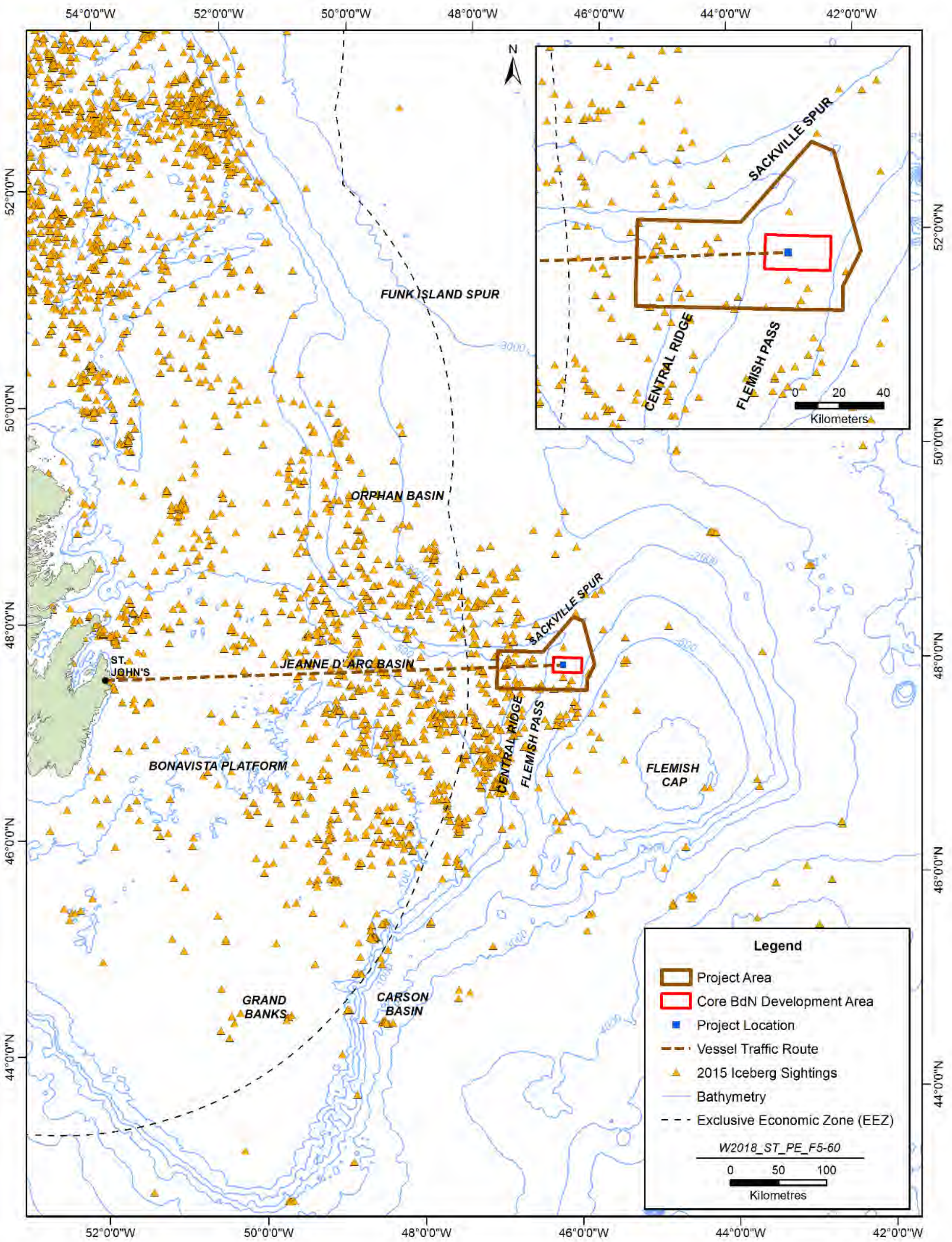


Figure 5-66 Recorded Icebergs Sightings in 2015, Newfoundland Offshore

5.5.3 Marine Icing

Marine icing, most frequently from freezing spray, is a marine condition that can hinder and limit shipboard or production installation activities, and increase a vessel's weight and alter its centre of gravity. Freezing spray is most likely to occur from November through April. Air temperatures must be lower than -2°C to produce freezing spray in salt water. Icing conditions worsen with colder temperatures, high winds, and large waves (Bowyer 1995).

A standardized way to determine the potential ice build-up rate has been developed by Overland (1990), which bases an algorithm on empirical observations and the heat balance equation of an icing surface. This algorithm has been used to derive estimates of icing potential by using concurrent air and sea temperature and wind speed data from ICOADS. The results have been sorted into four different categories based on the severity (light, moderate, heavy, and extreme), and are summarized below.

The icing potential for vessels in the Core BdN Development Area (Figure 5-67) is greatest from January through March with frequency of occurrence between 21.4 and 25.5 percent. The frequency of occurrence for moderate, heavy, or extreme icing is greatest in January at 3.5 percent. No frequency of occurrence of icing is reported for April through November. Annually, the frequency of occurrence of icing is 5.5 percent, with the majority being light icing.

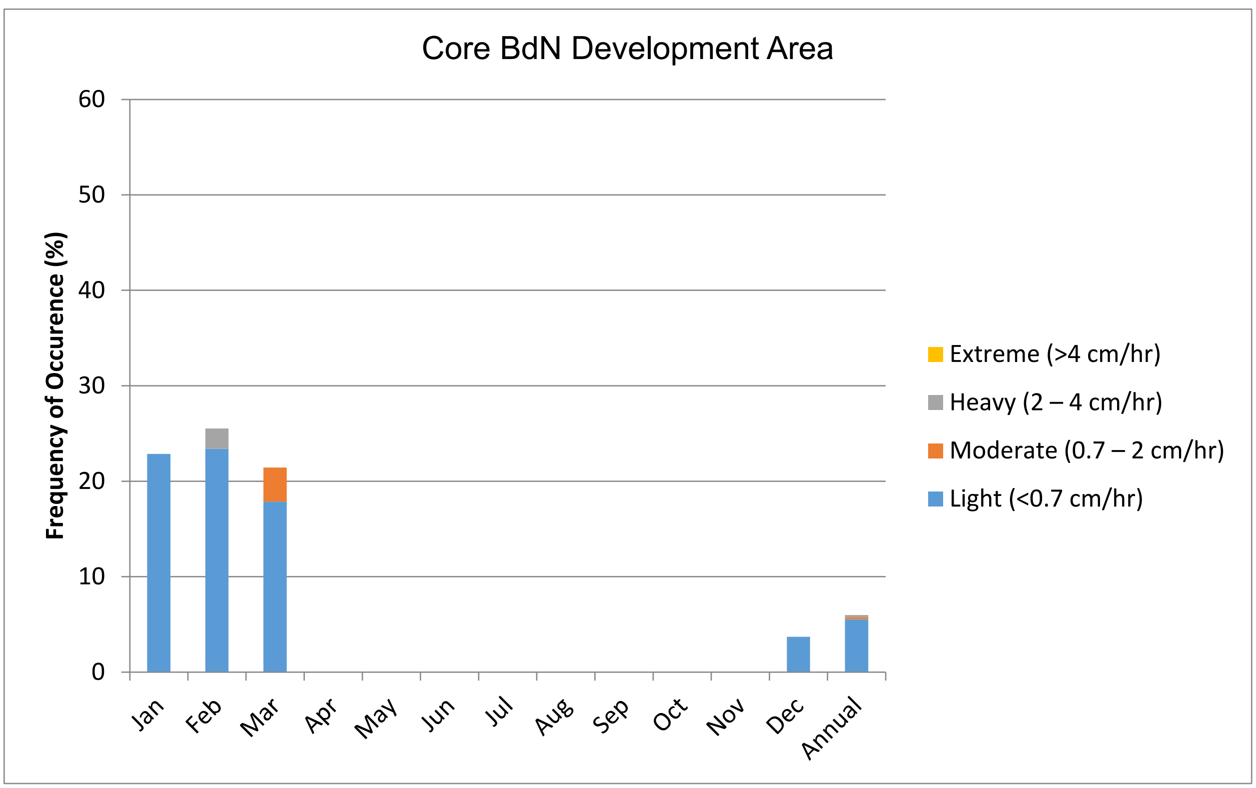


Figure 5-67 Icing Potential (ICOADS) – Core BdN Development Area

The icing potential for vessels in the Project Area (Figure 5-68) is greatest from January through March with frequency of occurrence between 21.2 and 28.8 percent. The frequency of occurrence for moderate, heavy, or extreme icing is greatest in January and February at 9.1 percent. No icing potential is reported for June through October. Annually, the frequency of occurrence of icing is 6.7 percent with the majority being light icing.

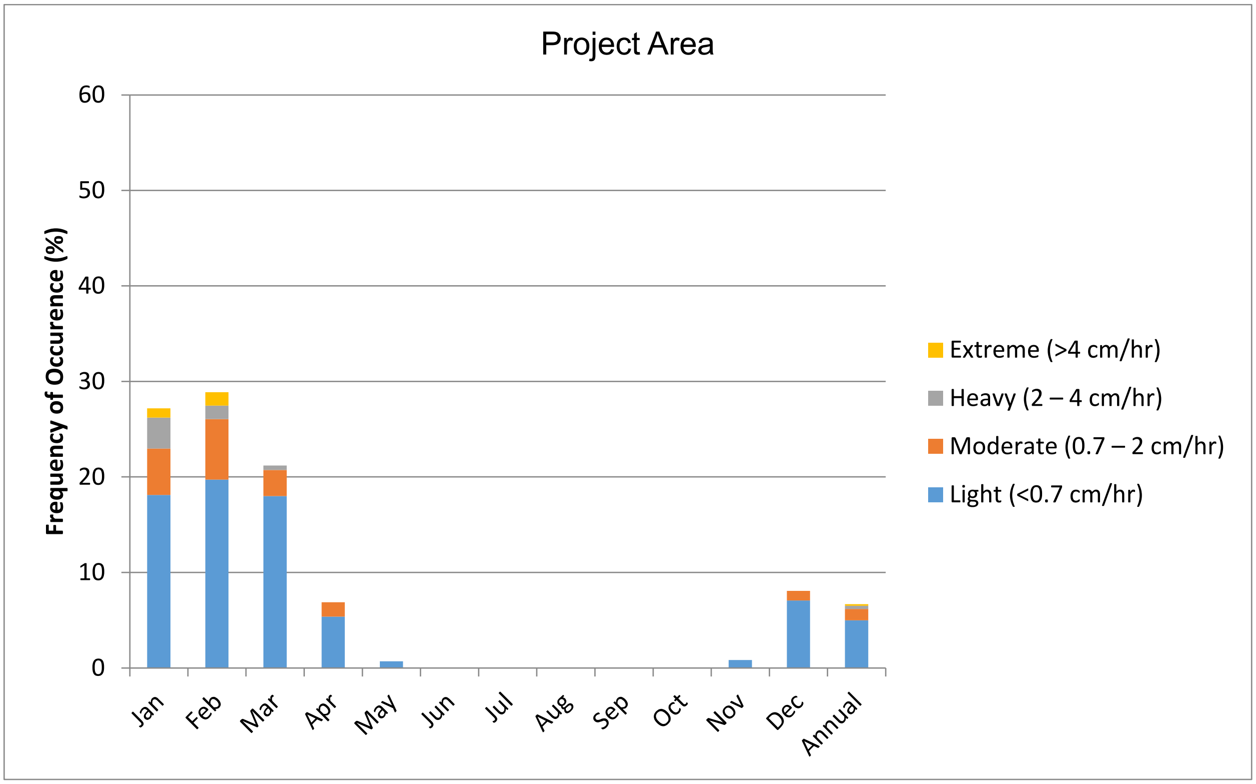


Figure 5-68 Icing Potential (ICOADS) – Project Area

Marine icing conditions along the western portion of the vessel traffic route will be similar to those experienced farther offshore as characterized above with some increased potential for heavier icing. Along the western portion of the vessel traffic route, there is moderate to severe icing potential between December and March with the greatest potential occurring in January and February (Figure 5-69).

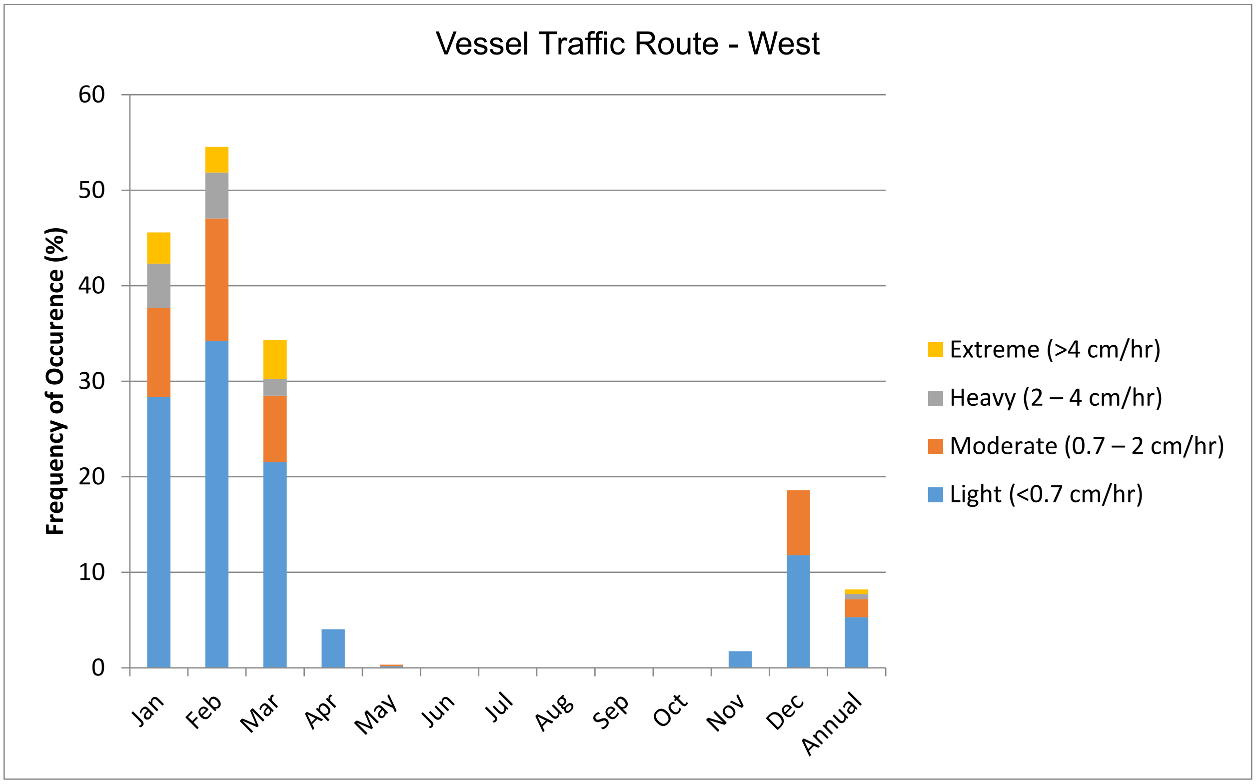


Figure 5-69 Icing Potential (ICOADS) – Vessel Traffic Route - West

Along the eastern portion of the vessel traffic route, there is moderate to severe icing potential between December and March with the greatest potential occurring in January and February (Figure 5-70).

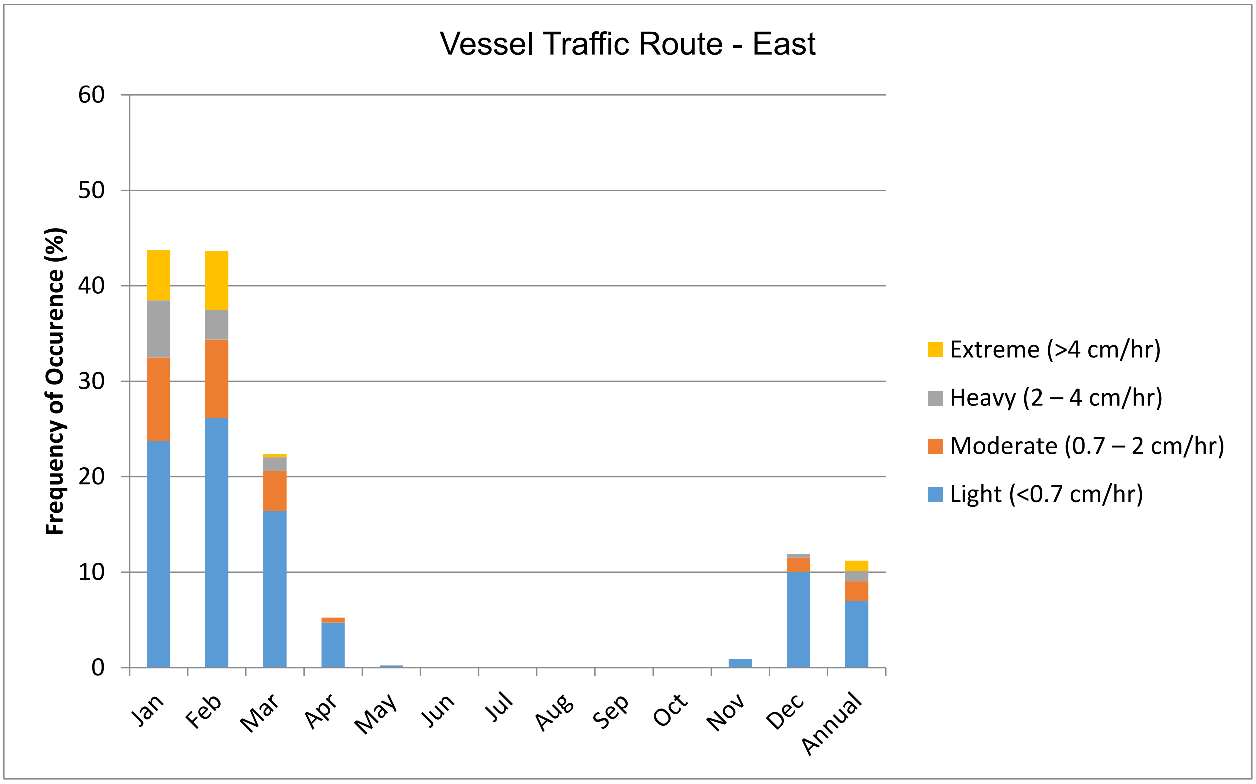


Figure 5-70 Icing Potential (ICOADS) – Vessel Traffic Route - East

5.6 Climate Change

Climate change is the long-term change in the magnitude, variability and timing of various elements of earth's climate system (e.g., as described in the previous sub-sections). Understanding of these changes in the climate system results from a combination of observations, studies of feedback processes, and model simulations (IPCC 2013). These changes are found to occur outside the expected ranges of natural variability and are typically determined over long timescales (typically on the order of 30 years).

Climate change will likely have some influence on the atmosphere, global water cycle, ocean heat content, Artic sea ice loss, and retreat of glaciers over time (IPCC 2013) (Figure 5-71). On a global scale, there are three changes in climate for which long-term trends are already being observed and future projections are in general agreement, though there remains substantial regional variability, including locations that exhibit trends counter to the global mean (Stocker et al. 2013). The first is that average global temperatures (air and ocean) are increasing, with an amplified warming trend occurring in the Arctic. The second is that the hydrologic cycle is intensifying as warmer air can hold more moisture, implying that precipitation events on average will tend to be more intense (though not necessarily more frequent) in the future. The third change is that the mean global sea level is rising.

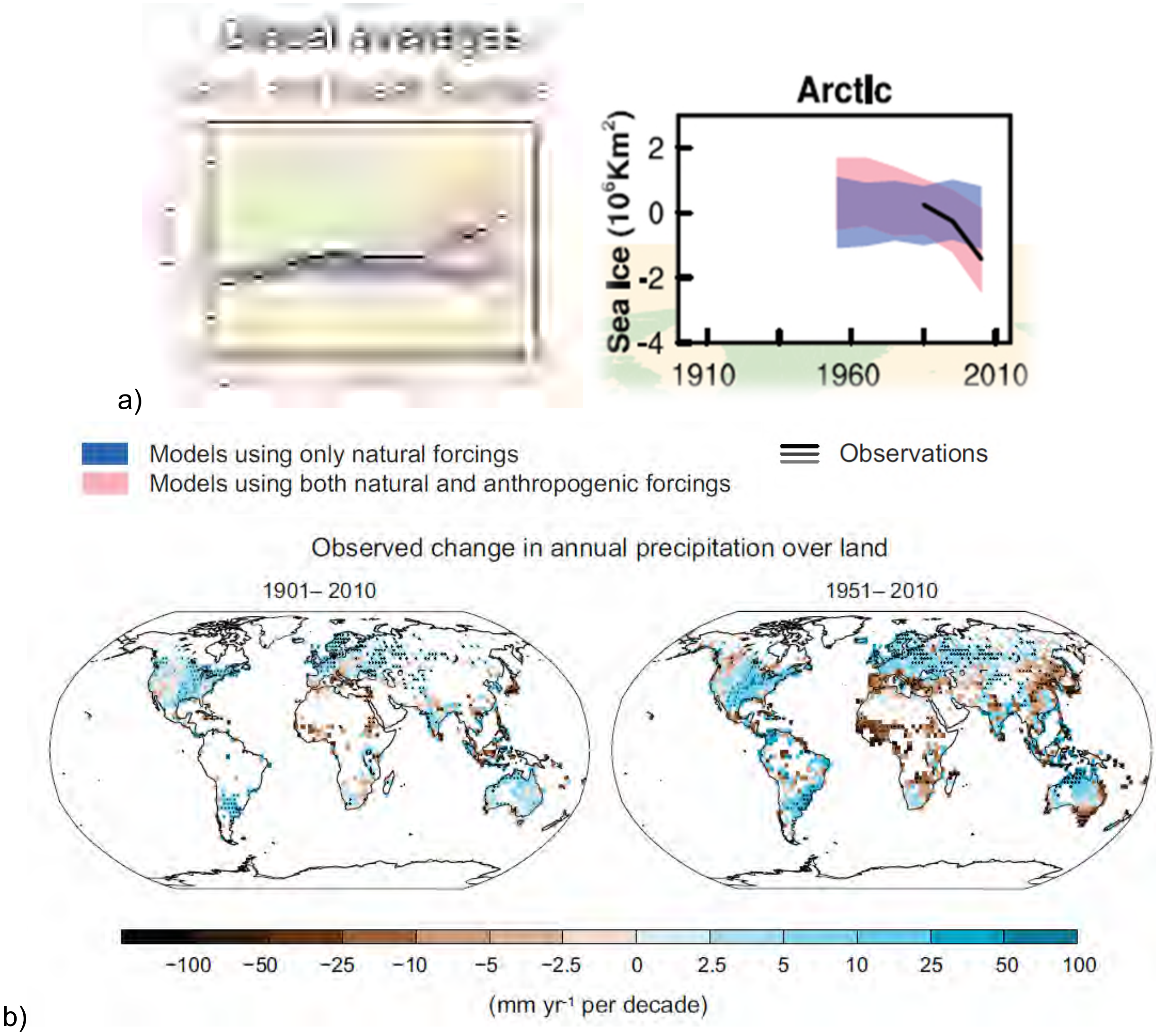


Figure 5-71 a) Global change in average temperatures and Arctic sea ice b) change in annual precipitation (IPCC 2013)

It is important to note that climate models aim to resolve a boundary value problem, which means it attempts to characterize what are the stable physical conditions that would exits under a particular emission scenario. Global climate models (GCMs) produce results at coarse resolution (usually ranging between 80 km to 400 km), which can be downscaled to produce greater resolution (10 to 50 km). However, it is best practice to take a regional perspective to account for uncertainty. This section provides an overview of climate change focussed on the Flemish Pass, the Grand Banks and offshore NL and is organized according to atmospheric variables (wind, temperature, precipitation, and extreme events), oceanographic variables (ocean-water temperatures, waves, currents, and sea level), and cryospheric variables (sea ice and icebergs). Assuming a projected life of field of several decades, recent trends and variability along with medium-term climate projections (to the middle of the 21st century) are presented.

Most studies that incorporate climate change rely on model-generated projections. These projections are most often generated by GCMs, which are dynamical system-based models that represent complex interactions between physical processes in the atmosphere, ocean, cryosphere and land surface. These are currently the most advanced tools to estimate how the climate system may respond to the natural and human driven stresses (e.g., increasing in greenhouse gas emissions, population, and other behaviours).

It is important to note that because each GCM provides a slightly different conceptualization of the earth-atmosphere system, the Intergovernmental Panel on Climate Change (IPCC) recommends using an ensemble approach. An ensemble is a grouping of climate projections. Together, the models in an ensemble provide a better characterization of the future and its uncertainty than any single model.

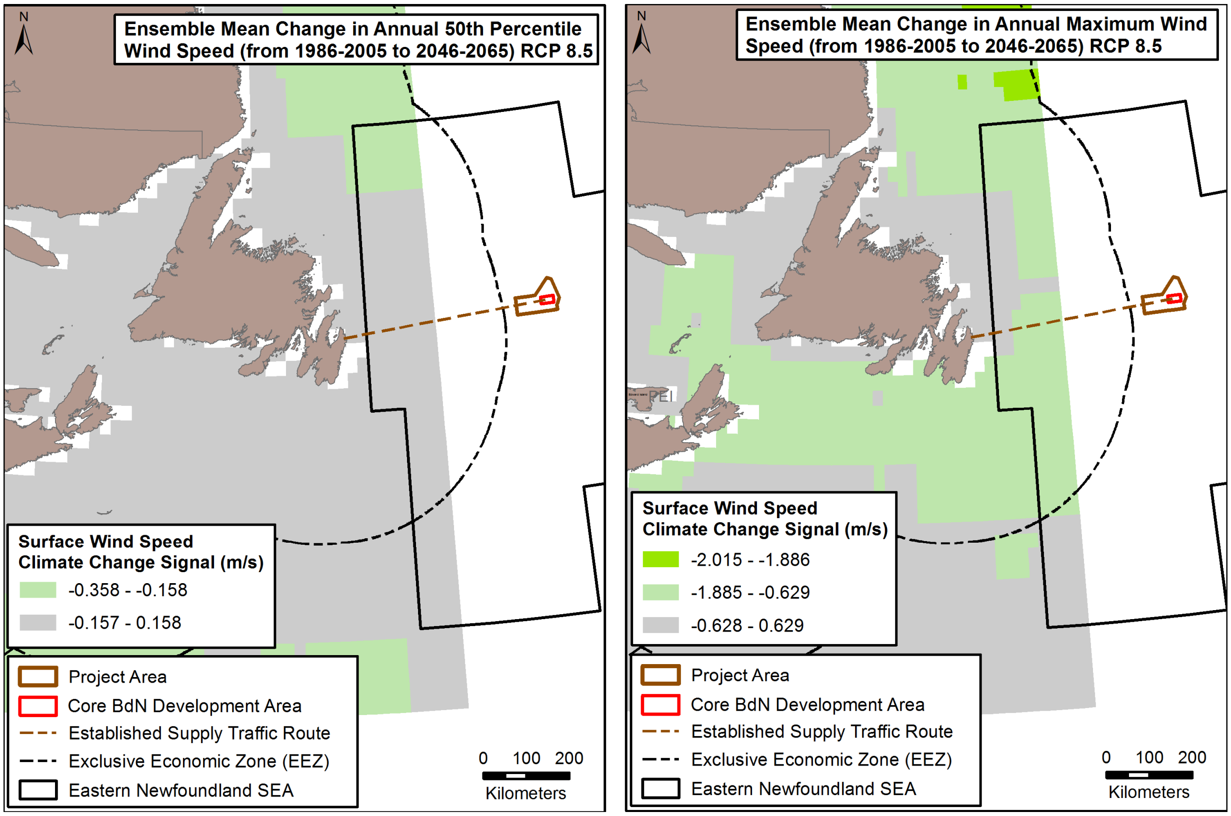
Similarly, it is unknown what future GHG emissions will be. In order to account for multiple possible future emissions scenarios, the IPCC developed four Representative Concentration Pathways (RCP) as part of a new initiative for the Fifth Assessment Reports (Taylor et al. 2012). The projections discussed here are primarily based on RCP 4.5 (a moderate emissions scenario that would require substantial reductions from current emission levels) and RCP 8.5 (a high, or business-as-usual, emissions scenario).

5.6.1 Atmospheric Climate Changes

5.6.1.1 Wind

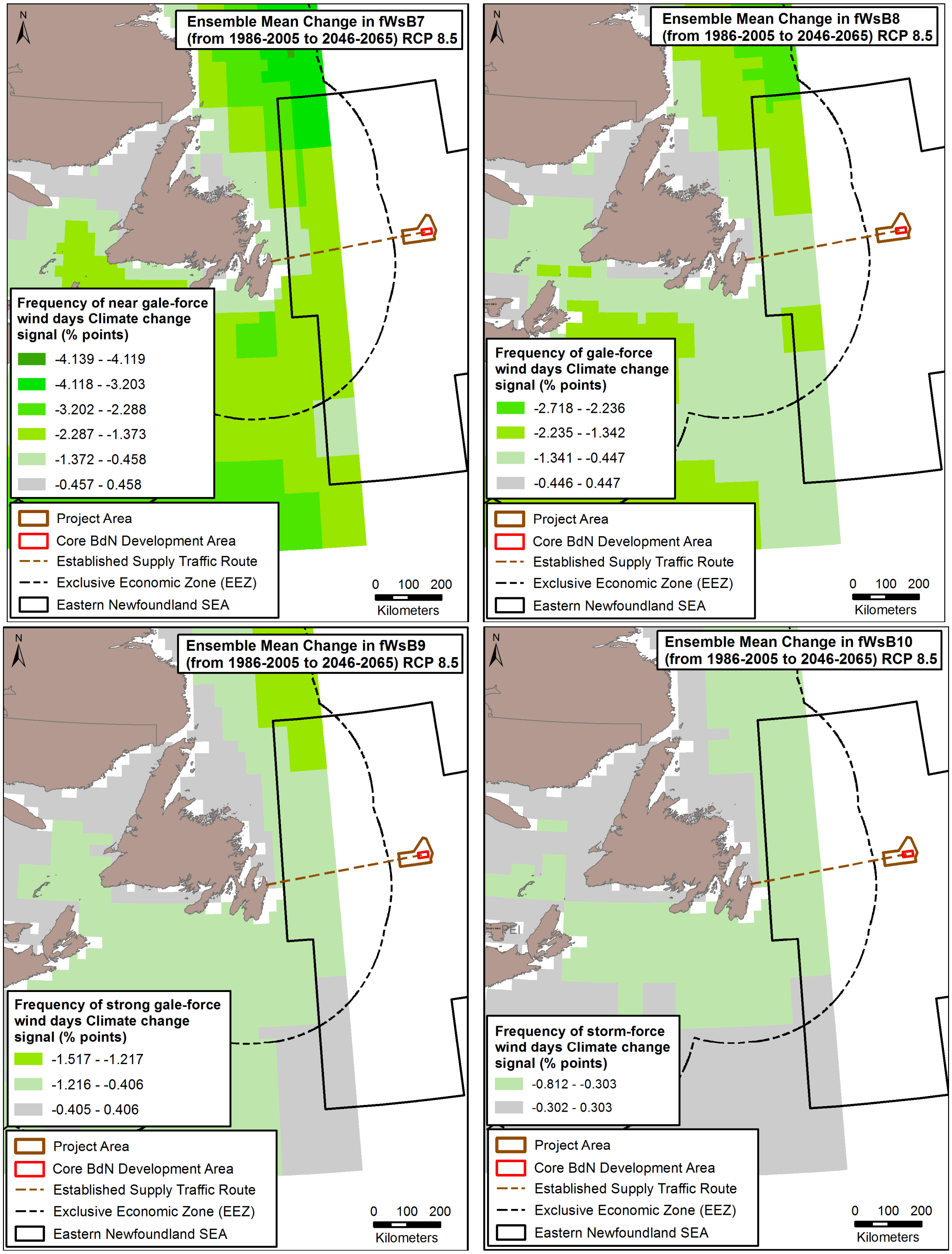
Confidence over the global estimates on changes to surface wind speeds is low in comparison to other variables (e.g., temperature and precipitation). This is in part due to shortcomings of the observations (Hartmann et al. 2013). However, regional studies have attempted to characterize possible trends to provide estimates of how other atmospheric changes (e.g., air temperature) may impact wind speeds and direction. Cheng et al. (2014) found that the frequency of high-speed hourly wind gusts in Atlantic Canada is expected to increase under both medium and high GHG emissions scenarios by the mid-21st century. Their study showed the frequency of gusts over 25.0 m/s could double, gusts over 19.4 m/s could increase by around 20 percent, and gusts over 11.1 m/s could increase by 15 percent.

However, in a more recent study (Amec Foster Wheeler 2017b), which used the latest generation of GCMs and GHG emissions scenarios, the median and maximum annual sustained (hourly average) wind speeds were projected to decrease slightly or remain unchanged over the coming decades along main transport routes adjacent to the Flemish Pass. This is illustrated in Figures 5-72 and 5-73, which originate from Amec Foster Wheeler (2017b). This report also found that mean monthly wind directions are not expected to deviate significantly from present day.



Source: Amec Foster Wheeler (2017b)

Figure 5-72 Projected Changes in Median (Left) and Maximum (Right) Annual Sustained Wind Speeds for the Mid-21st Century, Using Six-Member Climate Model Ensemble Forced by the RCP 8.5 Greenhouse Gas Emissions Scenario



Source: Amec Foster Wheeler (2017b)

Figure 5-73 Projected Changes in the Annual Percentage of Days When Daily Max Wind Speed Is >14.4 m/s (fWsB7, Top Left), >17.2 m/s (fWsB8, Top Right), >20.8 m/s (fWsB9, Bottom Left), and >24.7 m/s (fWsB10, Bottom Right)

5.6.1.2 Temperature

Air temperatures have increased in coastal meteorological stations in eastern Canada over the 110-year record by 0.75 ±0.34°C (Savard et al. 2016). Warming in the region has been found to be greater than or equal to global trends (IPCC 2013). This underlying trend is expected to continue and intensify over the coming decades.

IPCC (2014) projects that for 50-70 percent of the years in the mid-21st century the Grand Banks will experience a higher temperature greater than the maximum observed temperature between 1986 and 2005.

5.6.1.3 Precipitation

IPCC (2014) shows there is strong agreement among climate models that mean annual precipitation for the region will increase by up to 10 percent. The same report projected that the 20-year return value of annual precipitation extremes would increase by 5 to 10 percent by mid-century. This does not imply that there will be more precipitation events, but that the events that do occur are more likely to produce higher rates of precipitation. Savard et al. (2016) find that the precipitation is expected to increase in winter and spring but remain stable or decrease slightly in summer and fall.

5.6.1.4 Storms

While the overall frequency of tropical storms is not expected to increase, the hurricanes that do occur are expected to be stronger under climate change, with a higher percentage of Category 3, 4 and 5 storms than has been observed in the past, as shown in Bender et al. (2010). While Bender et al. (2010) say this trend has become more apparent since the 1940s, some of this may be caused by less comprehensive observations in earlier parts of the record and IPCC (2013) assigns low confidence in global trends in tropical cyclones.

With regard to winter storms, Loder et al. (2013) project that there may be a northward shift in storm tracks that will affect the Project Area, predominately caused by a warming arctic and a weakened polar-equatorial temperature gradient. Stemming from this is an expected change in the location and strength of the predominantly west-to-east jet stream. A well-defined west-to-east jet stream is correlated with more and stronger winter storms tracking through the region, while a relatively meandering jet stream associated with a weaker polar-equatorial temperature gradient will create blocking patterns and fewer winter storms. It has been suggested that the weaker polar-equatorial temperature gradient causes more persistent weather patterns in mid-latitudes, i.e., more extreme weather with prolonged droughts, floods, cold spells, heat waves, etc. (Francis and Vavrus 2012). This is currently an active area of science where debate has been had about the observation data coverage, the models, as well as their influence on estimates (Barnes 2013 and Cohen et al. 2014).

The probability of a spill related to hurricane damage is less than 0.0041 per year (less than one in 242 years).

5.6.2 Oceanographic Changes

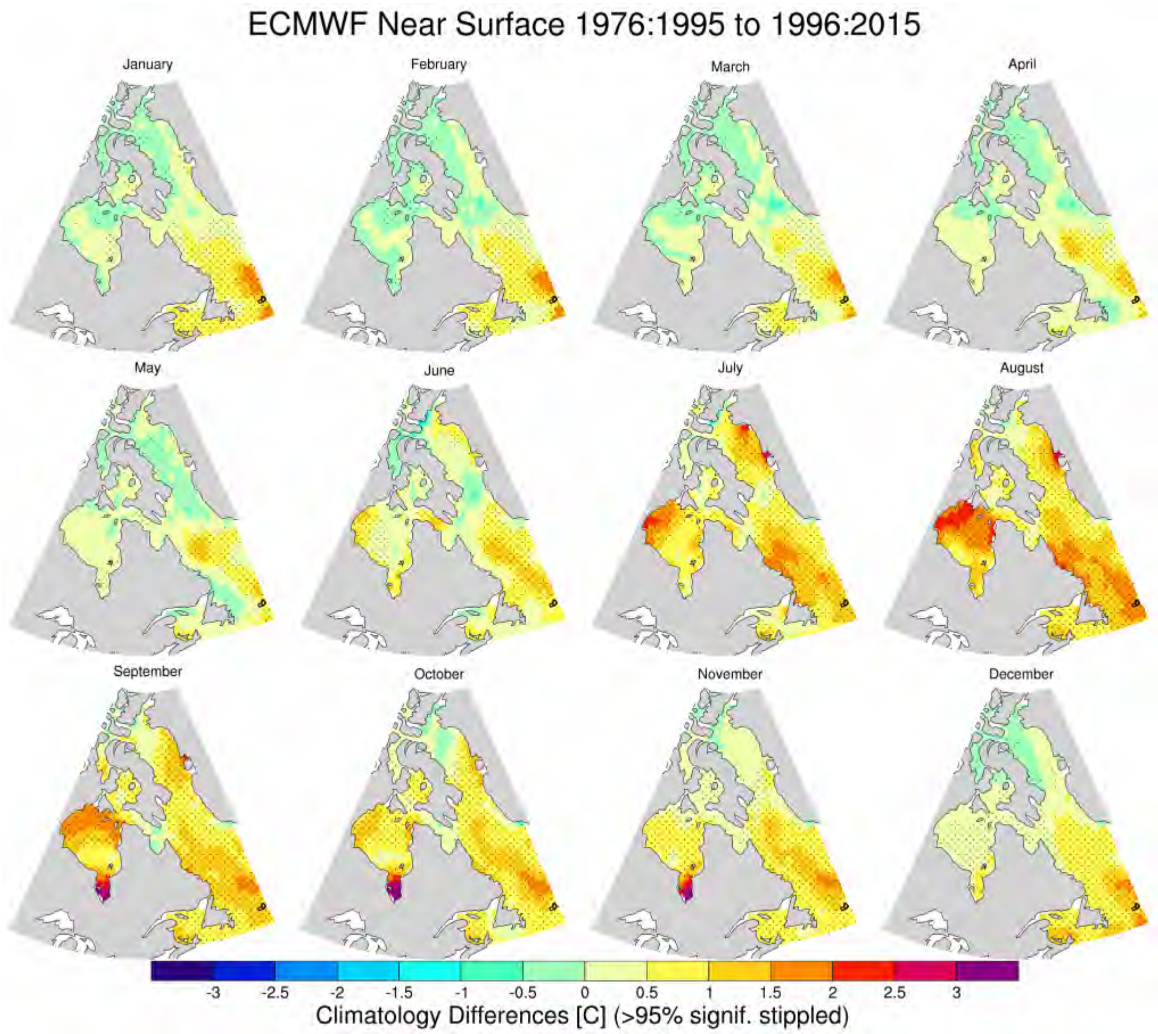
5.6.2.1 Ocean-Water Temperatures

Rising air temperatures in the region have also contributed to warming surface waters, which have increased 0.32°C from 1945-2010 (Han et al. 2013b). These warming trends are expected to continue and increase over the coming decades, although with significant seasonal, interannual, and spatial variability. Warming is expected to be of a smaller magnitude in waters just south of Greenland (including the northeast edge of the Project Area) due to an expected decrease in strength of the Atlantic Meridional Overturning Circulation and associated reduction in northward heat transport (Drijfhout et al. 2012, Caesar et al. 2018).

Figure 5-74 shows changes in mean monthly water temperature from 1976-1995 to 1996-2015 at depths of approximately five metres, based on European Center for Medium range Weather Forecasting (ECMWF) reanalysis data. The Project Area has experienced warming in each month, although statistically significant warming is most prevalent from late summer to early winter. Warming was also found to be widespread at depths of approximately 45 m (not shown) (Amec Foster Wheeler 2017c).

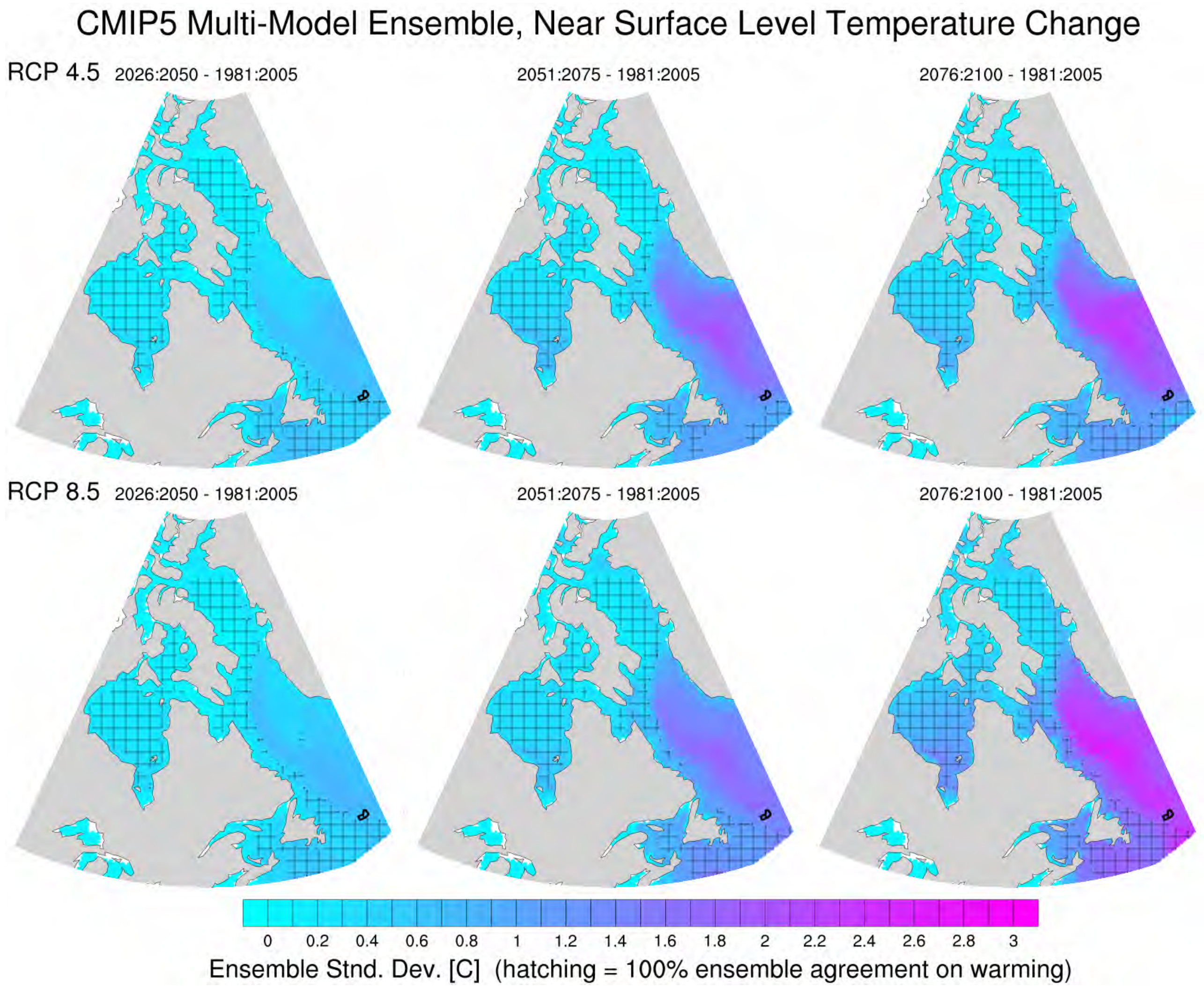
Figure 5-75 shows model agreement and the standard deviation of projected temperature changes of near-surface water (five to seven metre depths). Areas with cross hatching have 100 percent model agreement (based on an ensemble of seven CMIP5 global climate models) that there will be warming. The background colours represent the standard deviation of the magnitude of warming projected, which is a representation of uncertainty. The warming is enhanced for increased GHG emissions. During winter, the Antarctic normally produces cold, salty water that is dense and sinks to the deep ocean. This tends to produce a stirring effect and homogenize the water column. The injections of fresh meltwater projected and discussed in Section 5.6.3 would reduce the density of the upper ocean wind-stirred mixed layer. This may reduce the rate at which cold surface water sinks at high latitudes. It may be expected that the increase in stratification due to the change in density would allow the North Atlantic Ocean to retain heat at greater depths than presently. Furthermore, it has been suggested that many climate models often simulate excessive mixing, which would result in an underprediction of the impact of climate change on ice sheets and sea level (Hansen et al., 2016).

Figure 5-76 shows a representative GCM projection from the ensemble used to create Figure 5-75. This indicates that the next several decades will experience near surface water temperatures 1-1.5°C warmer than that recorded in 1981-2005.



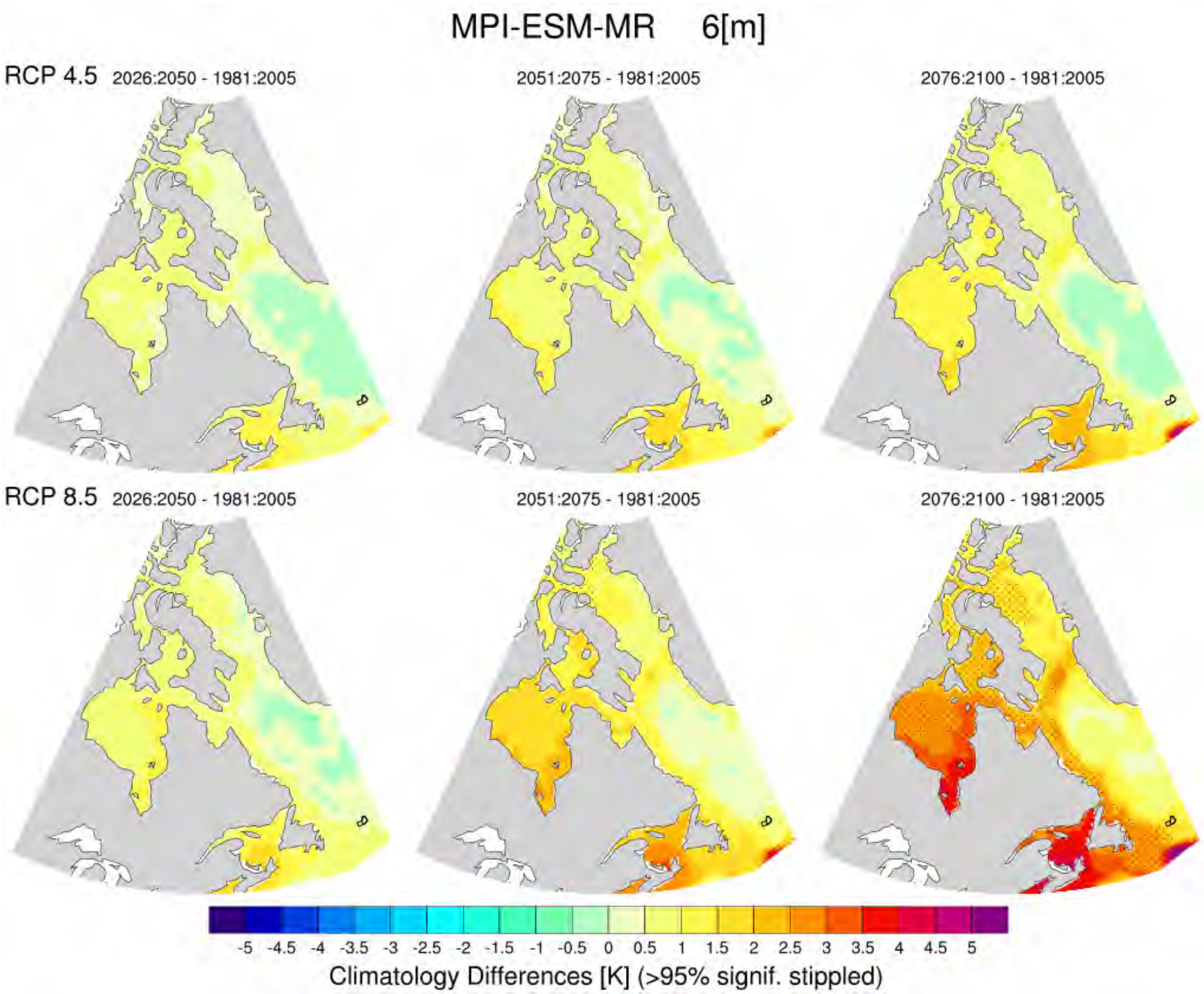
Source: Amec Foster Wheeler (2017c)

Figure 5-74 Changes in Mean Monthly Water Temperature From 1976-1995 to 1996-2015 at Approximately 5 m, Based on ECMWF Reanalysis Data



Source: Amec Foster Wheeler (2017c)

Figure 5-75 Ensemble Agreement of Projected Near-Surface Ocean-Water Temperature Projections

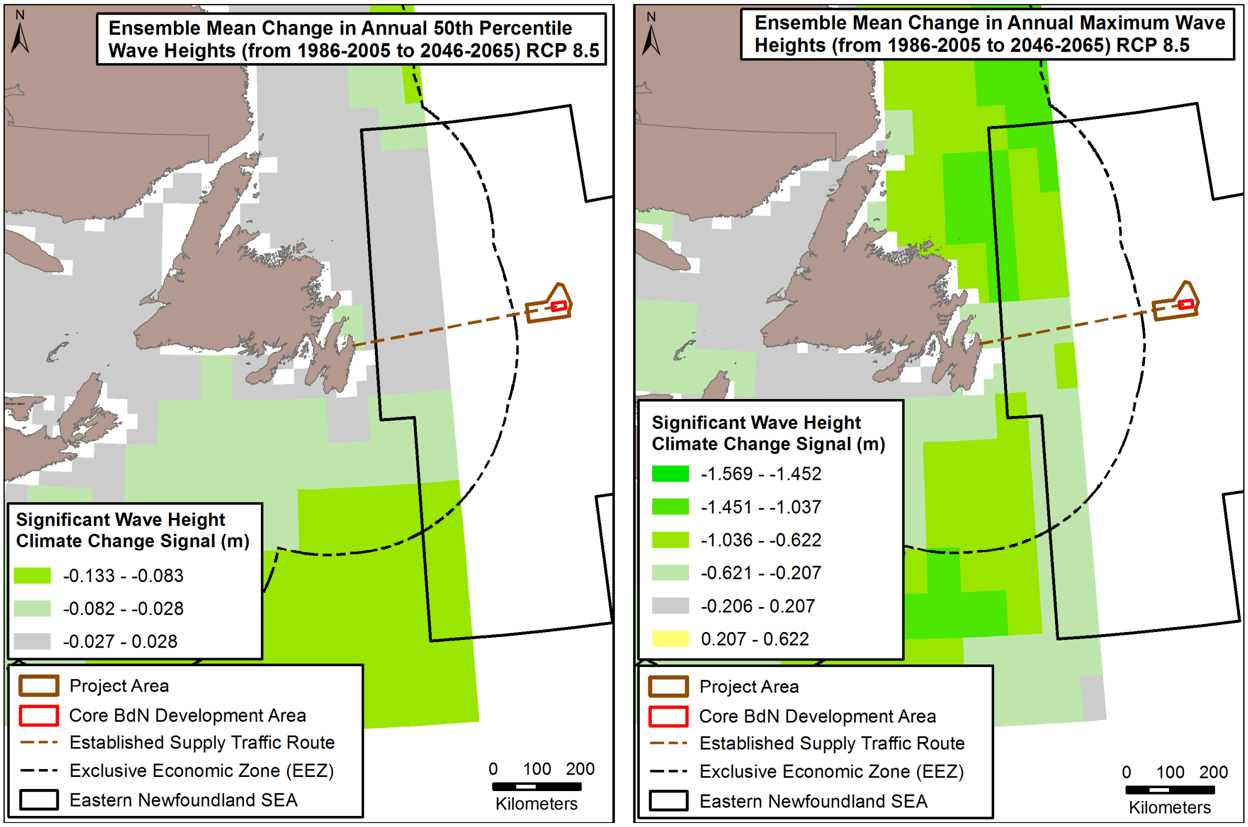


Source: Amec Foster Wheeler (2017c)

Figure 5-76 Representative GCM Projection of 6 m Depth Ocean Water Temperature Change

5.6.2.2 Waves

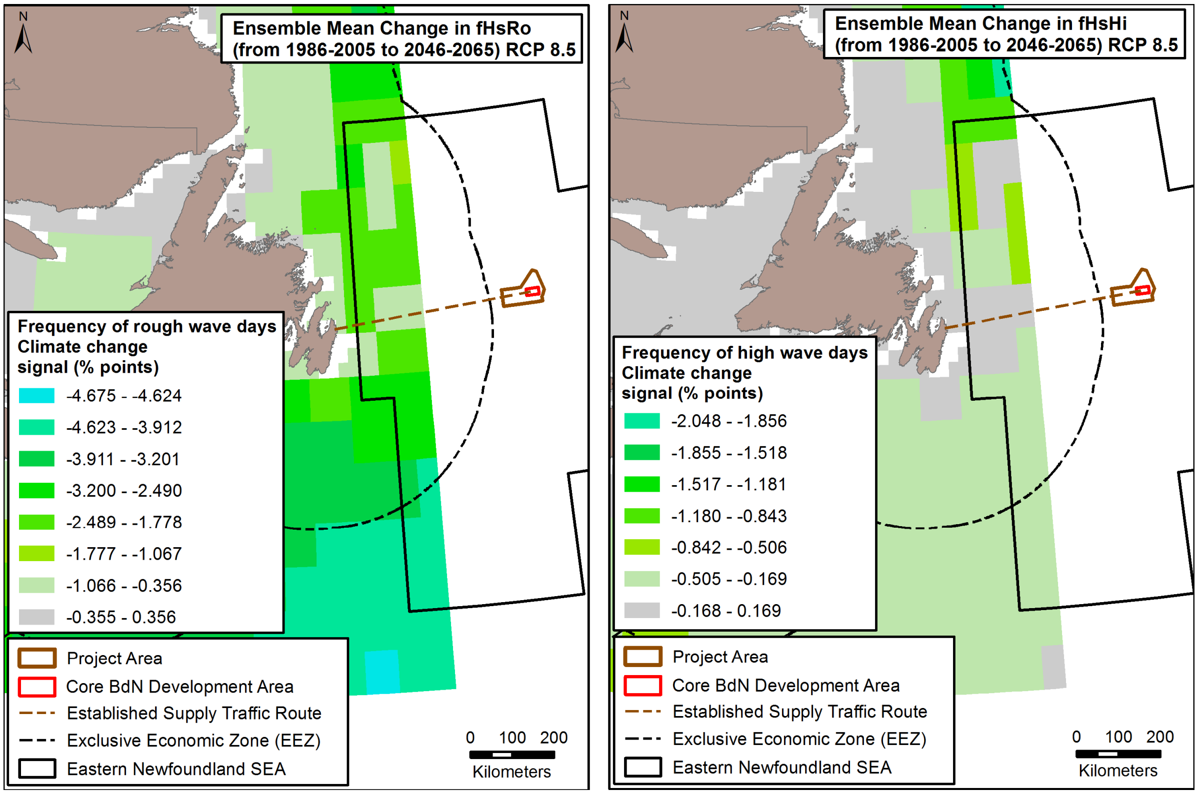
Waves are largely driven by winds, so it follows that as average sustained wind speeds are projected to decrease or remain unchanged over the coming decades so are average significant wave heights. It should be noted that there is a relatively low level of confidence on wind projections due to the limitations of historical observations. These issues are briefly discussed in terms of surface wind speeds in section 5.6.1.1. Figure 5-77, from Amec Foster Wheeler (2017b) shows that median and maximum annual wave heights are projected to decrease by mid-century, corresponding with the projected decreases in median and maximum sustained wind speeds discussed earlier.



Source: Amec Foster Wheeler (2017b)

Figure 5-77 Projected Changes in Median (Left) and Maximum (Right) Annual Wave Heights for the Mid-21st Century, Using a Six-Member Climate Model Ensemble Forced by the RCP 8.5 Greenhouse Gas Emissions Scenario

Figure 5-78 shows that the annual percentage of rough wave days and high wave days are also projected to decrease by mid-century; this is corroborated by Wang et al. (2014) who projected decreasing significant wave heights throughout the North Atlantic Ocean.



Source: Amec Foster Wheeler (2017b)

Figure 5-78 Projected Changes in the Annual Percentage of Days When Daily Max Significant Wave Height is >2.5 m (fHsRo, Left) And >6.0 m (fHsHi, Right)

5.6.2.3 Currents

Han et al. (2013a) found that the subpolar surface gyre transport, of which the Labrador Current is a component and in which the Project Area resides, has been declining in the past two decades, although this is believed to be part of multi-decadal variability as opposed to a long-term downward trend. Han et al. (2013a) also found that the Labrador Current transport is positively correlated with the winter North Atlantic Oscillation in regions north of Grand Banks slope, and negatively correlated in regions further south. What this implies is that over 1992-2011 when the North Atlantic Oscillation was generally weak, the Labrador Current extended southward beyond the Grand Banks but was weaker in strength. A potential mechanism for this is the southward shift of the Gulf Stream which correspondingly allowed this southward extension of the Labrador Current.

Rahmstorf (2006) discusses how the sinking of cold, salty water could be disrupted, thus potentially reducing the amount of North Atlantic Deep Water formed and weakening the thermohaline circulation. This disruption would be driven largely by projected increases in the melting of Greenland's ice sheet, decreases in the duration and extent of sea ice and increases in the rainfall over the North Atlantic. This could substantially alter a wide range of climatic and oceanographic variables and may or may not be irreversible (Liu W. 2017, Yin et al 2005). There is a great deal of uncertainty surrounding these projections due in part to the large number of contributing factors. As such it is unclear whether or not to expect significant changes to major currents in the Project Area over the next several decades. Observations across the Greenland-Scotland Ridge show for instance no weakening of the northernmost extension of the Atlantic Meridional Overturning Circulation since 1995 (Hansen et al., 2016).

5.6.2.4 Sea Level

Primary contributing factors to sea level rise include the thermal expansion of the ocean, increased water amounts from melting ice sheets and glaciers, glacial isostatic adjustments (rising or falling land), and the strength of the Gulf Stream (Yin 2012). Based on satellite altimetry and due to the interaction of the above factors, global sea level has risen at a rate of 3.2 ± 0.4 mm/year from 1993-2009 (Church and White 2011). As sea levels around eastern NL are projected to rise on the order of 0.5 to 1 m (or more) by the end of the 21st century (James et al. 2014), the rate of annual sea level rise may increase beyond present day trends. A recent study by Hansen et al. (2016) examined the feedback mechanisms potentially responsible for driving the acceleration of recent melt in Greenland and Antarctica ice sheets (mentioned in Section 5.6.3 below). By incorporating these feedback mechanisms into their climate models, they postulate that multi-meter sea level rise is possible by the end of the century.

5.6.3 Ice Conditions

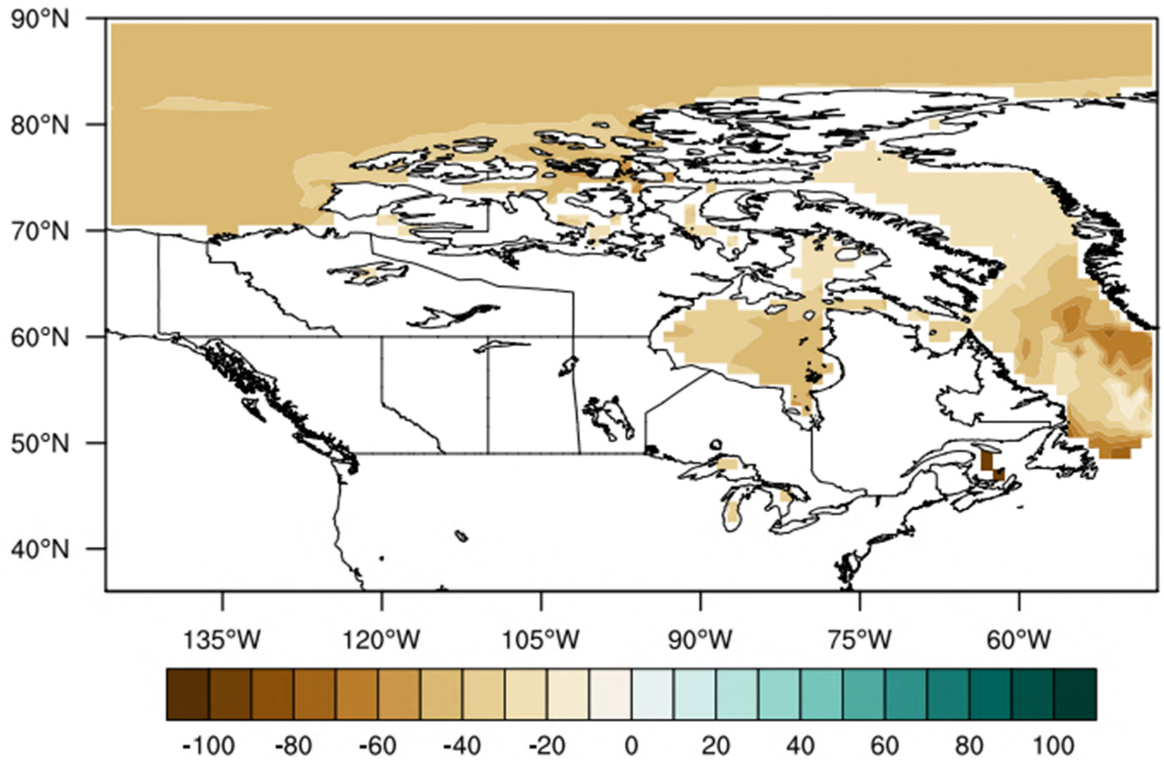
As described in the Eastern Newfoundland SEA (Amec 2014), the Arctic has undergone substantial warming since the mid-20th century. Greenland ice sheets have been losing mass and glaciers have continued to shrink almost worldwide over the past two decades. The average rate of ice loss from the Greenland ice sheet has likely increased from 34 Gt/yr over the period 1992 to 2001 to 215 Gt/yr over the period 2002 to 2011.

5.6.3.1 Sea Ice

Based on observations over the past three decades, the annual mean Arctic sea ice extent decreased over the period from 1979 to 2012 with a rate likely in the range of 3.5 to 4.1 percent per decade, and the summer sea ice minimum has similarly decreased in the range 9.4 to 13.6 percent per decade. Since 1979, the sea ice spatial extent has decreased for each respective season (IPCC 2013).

There is medium confidence that a nearly ice-free Arctic Ocean in September before mid-century is likely for RCP 8.5 (IPCC 2013). The reductions in ice range from 43 percent for RCP 2.6 to 94 percent for RCP 8.5 in September and from eight percent for RCP 2.6 to 34 percent for RCP 8.5 in February (IPCC 2013). Based on these historical trends and projections for shrinking Arctic sea ice cover, it is likely that sea ice extent and ice thicknesses will be reduced in the future for offshore NL in general, including the Project Area. This would be in keeping with increased northern warming as projected by Finnis (2013) for the province, with air temperatures increasing 4°C to 6°C in Northern Labrador.

CMIP5 RCP 4.5 and 8.5 projections of sea ice thickness change corroborate this, indicating that there will be up to a 70 percent reduction in spring (March – April) sea ice thickness by 2050 near the Project Area, as illustrated in Figure 5-79. The same projections also indicate a 10 percent decrease in sea ice extent for the corresponding dates and region.



Source: Government of Canada 2018

Figure 5-79 Projected Changes (percent) in Spring Sea Ice Thickness by 2050, according to RCP 8.5.

5.6.3.2 Icebergs

The regional iceberg climate is determined by the rate at which icebergs calve (from glacial regions to the north in Greenland, and to lesser extent ice caps on Ellesmere, Devon and Baffin Islands) and their size distribution (mass and draft, and geographic distribution and circulation). These are, in turn, affected by several factors, including local oceanic and atmospheric circulation patterns, water temperature, the frequency and duration of open water conditions (influenced by sea ice extent - iceberg drift is impeded through regions of sea ice) and by a variety of factors affecting the principal iceberg source regions (Marko et al. 2014).

The warmer air temperatures could lead to an increase in iceberg calving rates and could provide less obstructed routes from calving sites to the Project Area. While this would increase the number of icebergs in the waters off NL, the increased sea surface temperature (SST) and wave action (from reduced sea ice cover) may increase their melt and deterioration rates. The number of icebergs observed offshore NL varies widely from year to year, and so long-term trends may take multiple decades to become apparent.

5.7 Atmospheric Environment (Air Quality, Light, Sound)

5.7.1 Ambient Air Quality

The existing ambient air quality within the Project Area can be generally categorized as good, and is occasionally and locally influenced by exhaust emissions from transient marine vessel and helicopter traffic. Operations of the existing oil production platforms (Hibernia, White Rose, Terra Nova, and Hebron) are likely too far removed (approximately 180 km to 229 km away) to cause appreciable effects but are documented here for completeness.

The existing nearest emission sources to the Project Area are documented in the National Pollutant Release Inventory (NPRI) Reporting Program for criteria air contaminants (i.e., carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), total particulate matter (TPM), particulate matter less than 10 and 2.5 microns in diameter ($PM_{2.5}$, PM_{10}), and volatile organic compounds (VOCs)). The NPRI program is legislated under the *Canadian Environmental Protection Act, 1999* (CEPA 1999) and requires each facility within Canada meeting specified reporting triggers, to report their emissions to ECCC on an annual basis. An overview of the emissions reported from the operation of the Hibernia, White Rose, Terra Nova, and Hebron oil developments for the 2017 reporting year (the most recent such data available) are provided in Table 5.41.

Table 5.41 2017 Facility Reported CAC Emissions (NPRI Reporting) – NL Offshore Area Production Platforms

Facility	Distance to Project Location (km)	Air Emissions (tonnes/year)					
		CO	NO_2	TPM	PM_{10}	$PM_{2.5}$	VOC
Terra Nova	229	694	2,183	208	204	204	2,642
Hibernia	226	1,740	1,113	175	174	174	1,005
White Rose	180	505	2,782	130	130	130	422
Hebron	225	141	53	17	16	16	58
Source: ECCC (2018) * Emission estimates likely do not represent a full year of operation							

As the Jeanne d'Arc Basin is not known to contain sour gas, emissions of sulphur dioxide and hydrogen sulphide have not been reported.

Emissions of greenhouse gases (GHGs) from the operation of the existing offshore oil production platforms are also reported on an annual basis to ECCC, through the Greenhouse Gas Emissions Reporting Program (GHGRP). An overview of the 2016 reported emissions (the most recent such data available) for each of the existing production platforms are provided in Table 5.42.

Table 5.42 2016 Facility Reported GHG Emissions – NL Offshore Area Production Platforms

Facility	Distance to Project Location (km)	GHG Emissions (tonnesCO_{2eq}/year)			
		CO_2	CH_4	N_2O	Total
Terra Nova	229	527,836	22,556	10,208	560,600
Hibernia	226	517,524	40,320	4,619	562,463
White Rose	180	401,696	32,669	11,497	445,861

Source: ECCC (2017b)
* 2016 is the most recent year available for reported GHG Emissions. Hebron was not in production at that time.

Occasional influences from marine vessel traffic in the Project Area would also affect the air quality at the Project site, but the effects would be negligible as they are transitory and vessels are separated by safety margins. Emissions from marine vessels are regulated by the International Maritime Organization (IMO) through MARPOL.

It is reasonable to conclude that, apart from transient vessels or aircraft, no sources exist that compromise the air quality in the Project Area, which is considered to be virtually background and meeting relevant air quality objectives of Canada.

The existing acoustic environment in the Project Area would be influenced by naturally occurring sounds – marine mammals, birds, waves, and weather elements - and occasional vessel and aircraft passages. Other than transient sources, no anthropogenic sounds are known to be present in the Project Area.

5.7.2 Ambient Underwater Sound

The ambient, or background, sound levels that create the ocean soundscape consist of many natural and anthropogenic sources (see Figure 5-80). The main natural or environmental sources of sound are wind and waves, precipitation, sea ice (in polar regions), biological sounds (e.g., from marine mammal, certain fish and shrimp species), and in certain regions earthquakes and other geological events. Distant ship traffic sound is considered part of the ambient soundscape with shipping dominating ambient sound frequencies from 20 to 300 hertz (Hz) (Richardson et al. 1995).

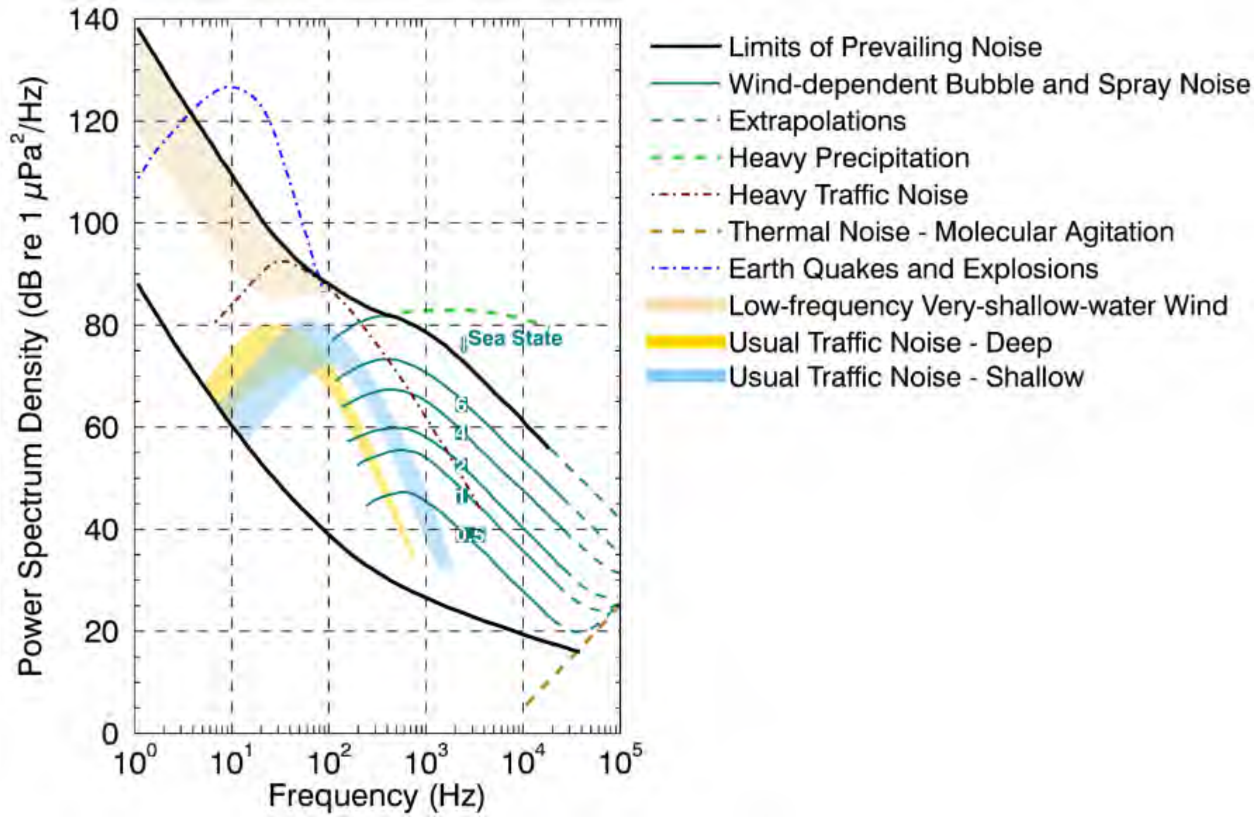


Figure 5-80 Wenz curves describing pressure spectral density levels of marine ambient sound from weather, wind, geologic activity, and commercial shipping (adapted from Wenz (1962), in Maxner et al. 2018).

5.7.2.1 Measured Soundscape

Acoustic data collected in and near the Project Area in recent years provide information on the local soundscape. There were two primary sources of acoustic data as summarized below.

1) An ESRF study conducted in 2015-2017 involved the collection of acoustic data by 20 acoustic recorders (JASCO Applied Sciences' AMAR) deployed at locations extending from northern Labrador to the southwestern Scotian Slope over a two-year period. The subsequent ESRF draft report "Acoustic Monitoring along Canada's East Coast: August 2015 to July 2017" included the analysis and interpretation of these acoustic data (Delarue et al. 2018). The closest ESRF acoustic recorder to the Project Area was located in the Sackville Spur area (i.e., Station 19, see Figure 5-81). From August 2015 to July 2016, Station 19 was located in the southern Orphan Basin in 1,282 m of water. In July 2016, Station 19 was relocated to the northern entrance of Flemish Pass in 1,547 m of water were the acoustic recorder collected data until July 2017. The acoustic data collected at Station 19 in 2016-2017 could not be analyzed for ambient sound levels as there was near-constant flow induced sound at lower frequencies. The flow-induced sound was caused by higher than anticipated currents speeds near the seabed.

2) An Equinor Canada study conducted in 2014-2015 involved the deployment of an acoustic recorder (i.e., an AMAR subsequently referred to as "CM2") in the Project Area in 1170 m of water (Maxner et al. 2017). CM2 was deployed from June to October 2014 and from May to September 2015. During the 2015 deployment, the acoustic recorder was 13.4 km from the *West Hercules* drilling installation, which was actively drilling at well site BdN4 L-76 (Figure 5-81). The purpose of the study was to collect baseline acoustic data in the area.

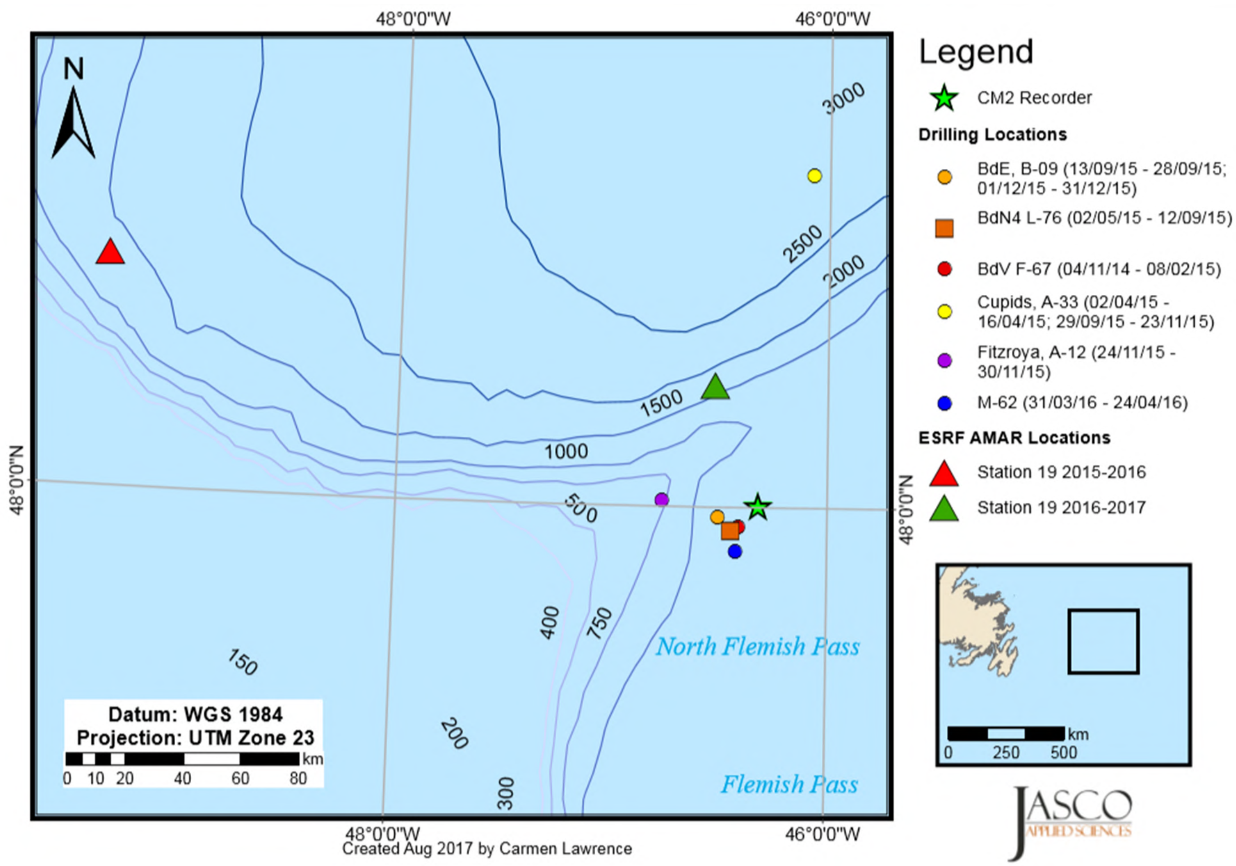


Figure 5-81 Locations of Equinor Canada's CM2 Recorder, ESRF Station 19 Recorder, and Equinor Canada 2015-2016 Drilling Locations in and near the Project Area

Acoustic data collected at the ESRF Station 19 and Equinor Canada CM2 were later combined to provide a more comprehensive analysis of the local soundscape (and marine mammal occurrence in and near the Project Area); these findings are presented in Maxner et al. (2018) (Appendix L).

5.7.2.2 Soundscape

As detailed in Maxner et al. (2018) (Appendix L), there was a substantial range in broadband sound levels recorded by the acoustic recorders depending on the location, time of year, and whether and what type of oil and gas activities were ongoing (Figures 5-82 and 5-83; Table 5.43). In 2014 (June to October), data collected at the CM2 recorder indicated that the minimum, median and maximum broadband sound pressure levels (SPL) were 104.9 dB, 130 dB and 165.8 re 1 μPa, respectively. At the same recorder location in 2015 (May to September), the overall broadband SPL recorded on CM2 were lower with minimum, median and maximum broadband SPLs reported as 102.4 dB, 117 dB and 148.3 re 1 μPa, respectively (Table 5.43). The substantial differences in median and maximum SPLs at CM2 in 2014 and 2015 were primarily attributable to seismic surveying activity, which in 2014 occurred closer to the CM2 acoustic recorder site. In all cases the 10–100 Hz frequency band (associated with seismic surveying and large shipping) contained the most acoustic energy (Figure 5-82). At Station 19 in southern Orphan Basin (August 2015 to July 2016), overall broadband source levels were lower than those recorded in the Project Area during both 2014 and 2015 with minimum, median and maximum broadband SPLs of 90.5 dB, 107.5 dB, and 139.5 dB re 1 μPa, respectively (Table 5.43). Maxner et al. (2018) (Appendix L) state that the median SPL at Station 19 (107.5 dB) is representative of the sound level measured in most northern deep-water ocean locations far from shipping lanes and industrial activity.

In 2015, average sound levels from the semi-submersible drill rig *West Hercules*, which was used to drill an exploration well (i.e., BdN4 L-76) in the Core BdN Development Area, were 110-115 dB re 1 μPa (rms) in the 100-1000 Hz band as recorded by CM2, which was 13.4 km away from the drill rig. This was considered approximately 13 dB above the baseline sound level (Maxner et al. 2018) (Appendix L).

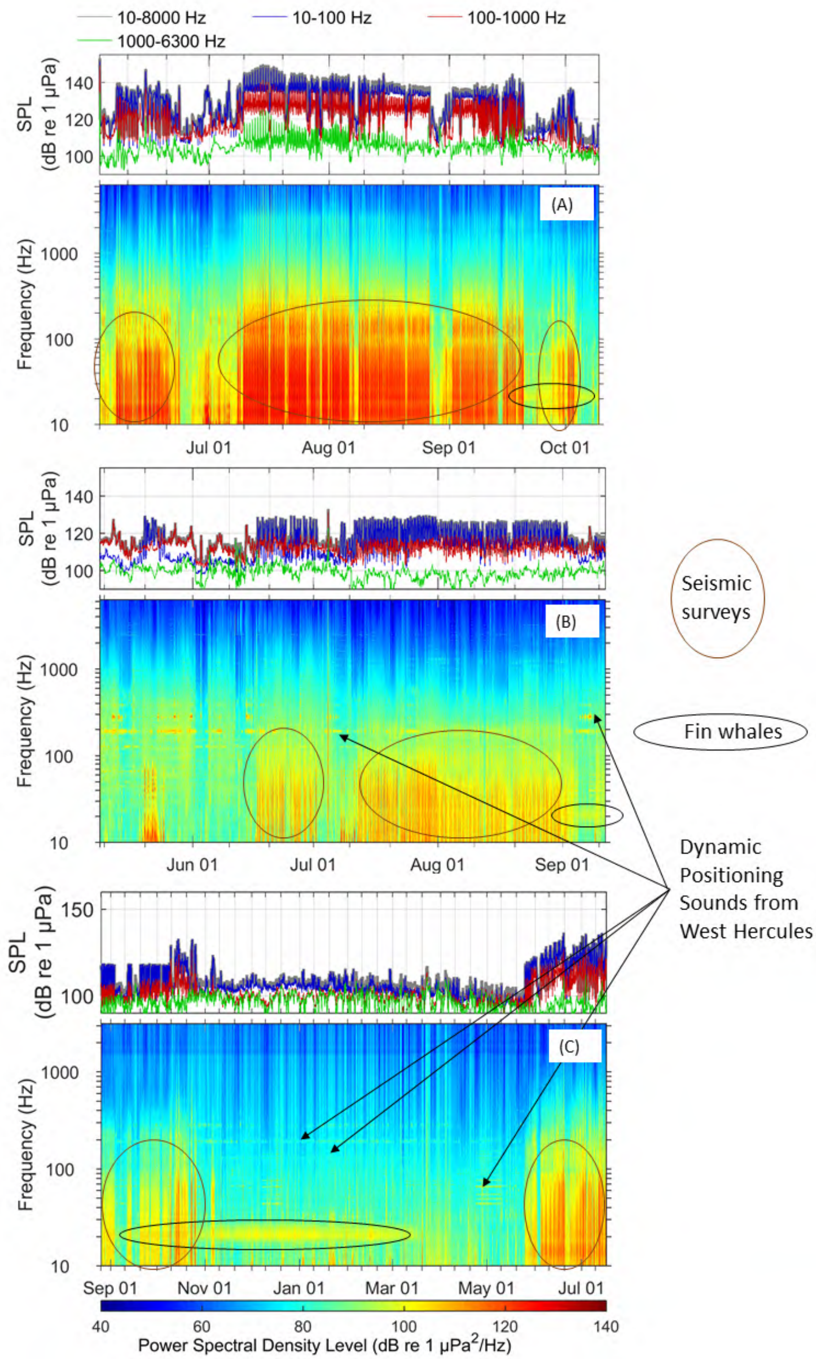


Figure 5-82 Baseline Sound Levels Recorded at (A) CM2 2014, (B) CM2 2015, and (C) Station 19, 2015-2016. For each recording station, the top figure is the median hourly in-band sound pressure level (SPL) and the bottom figure is the long-term spectral average of the measured sound. On the long-term spectral average figures, the sounds from seismic surveys, fin whales and the *West Hercules* are annotated.

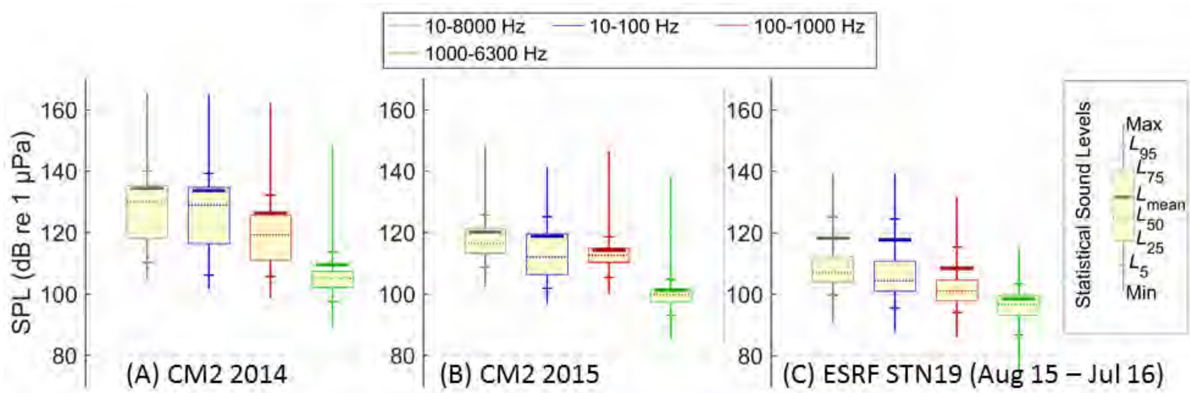


Figure 5-83 Comparison of the Broadband and Decade Band 1-minute Sound Pressure Levels for Acoustic Recorders (A) CM2 2014, (B) CM2 2015, and (C) Station 19, 2015–2016

Table 5.43 Summary of Broadband Sound Pressure Levels (1-min) at the Acoustic Recorder Locations CM2 and Station 19 (from Maxner et al. 2018)

Sound Pressure Level (SPL)	CM2 (2014)	CM2 (2015)	Station 19 (2015-2016)
Max [dB re μPa]	165.8	148.3	139.5
Median [dB re μPa]	130	117	107.5
Min [dB re μPa]	104.9	102.4	90.5

Figure 5-84 illustrates the daily SEL values for the CM2 recorder in 2014 and 2015 and the Station 19 recorder in 2015-2016. Once again, sound associated with a seismic survey was the main contributor to the daily SEL in 2014, which was up to 35 dB higher than daily SEL recorded at Station 19 in 2015–2016 in the absence of seismic surveys. At CM2 in 2015, seismic surveys and vessel sound were the main contributors to the daily SEL, which was 10–15 dB higher than the levels measured at Station 19 in the absence of seismic surveys. In winter, the daily SEL at Station 19 (2015–2016) increased due to both fin whale songs and increased wind and wave activity. Fin whale songs were at times a key contributor to overall sound levels at Station 19; more specifically, fin whale mating choruses were a dominant sound source in the band of 18–25 Hz from November to March (Maxner et al. 2018) (Appendix L). Fin whale songs can increase sound levels in this low-frequency band by 5–10 dB over extended time periods (Delarue et al. 2018).

In summary, the soundscape in and near the Project Area is variable and is influenced by both natural and anthropogenic sound sources. During summer and early fall, seismic surveys have been a dominant sound source, even at distances greater than 100 km from the acoustic recorders. Vessel sounds contribute to the soundscape and are generally transient sources that are detectable at any one location over a period of several hours. Closer to exploratory drilling areas (like the *West Hercules* in 2015) the sounds from vessels and dynamic positioning systems are continuously present. Fin whale calls increased ambient sound levels in and near the Project Area. Also, during winter ambient sound levels were generally elevated due to increased wind and waves.

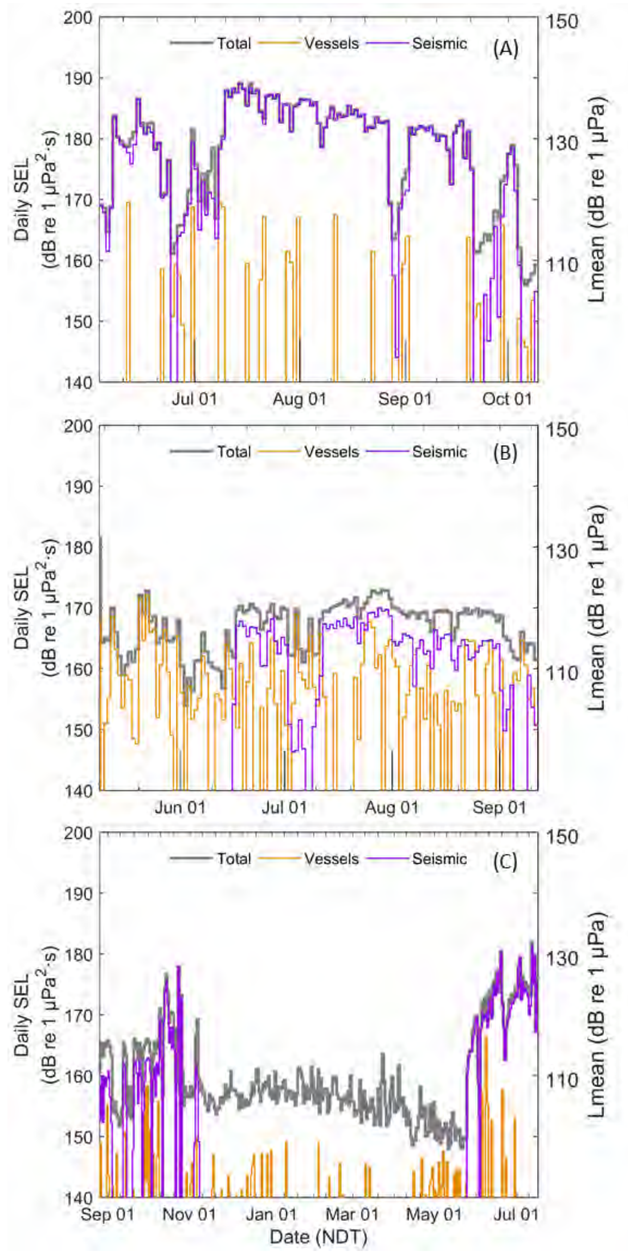


Figure 5-84 Daily Unweighted Sound Exposure Levels for (A) CM2 2014, (B) CM2 2015 (C) Station 19, 2015-2016.

5.7.3 Ambient Light

As is the case with air quality and underwater sound levels, light levels in the area are dominated by naturally occurring sources. Occasional transitory lighting would be observed due to passing vessels or aircraft, but would be localized and temporary.

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